Tropical Coasts

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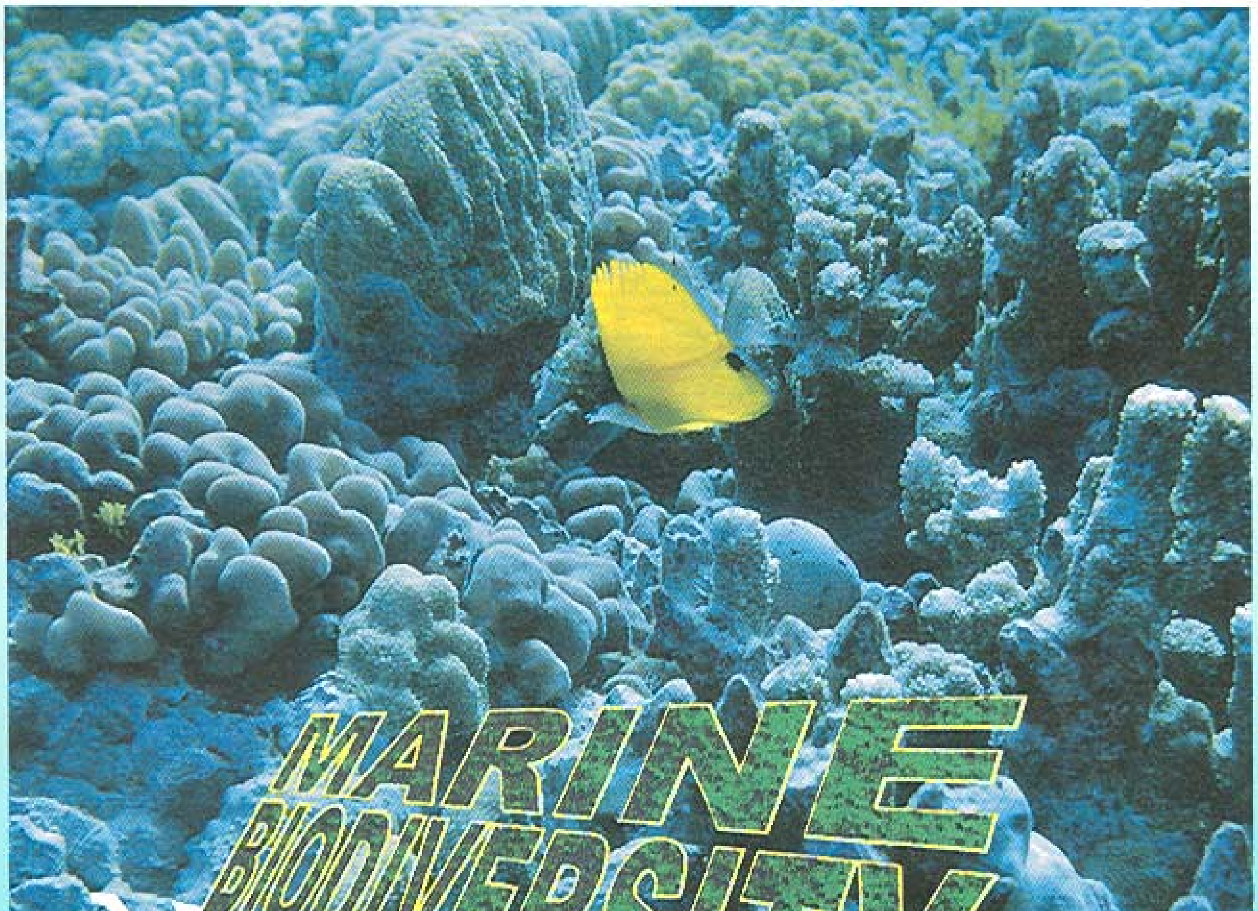

Marine Biodiversity

E D I T O R I A L

This issue of *Tropical Coasts* focuses on "biodiversity", a term that was introduced in the 1980s and has since become popularly used in documents relating to environment and development. In short, it refers to the variety of natural habitats, the variety of plants and animals, and the variety of genetic material among living organisms. Development has caused the loss of habitats while pollution has degraded what remains of it. To address the problem of biodiversity reduction, international agreements such as the 1992 Rio Declaration and the Convention on Biological Diversity have been introduced. These global protocols demonstrate the growing concern on habitat loss and degradation and call for action to protect biological diversity. In many instances, such loss could have been minimized or prevented if accompanied by careful planning and proper management.

The marine environment is known to contain a richer variety of species compared to the terrestrial environment. Countries with extensive coastlines particularly in the tropics have an immediate natural heritage of different coastal and marine habitats, and a treasure chest of plant and animal species containing important genetic material. The importance of this genetic material is fast gaining recognition and the article by T. Higa on "Coral reefs: mines of precious substances" highlights the strong economic potential of species diversity particularly in the pharmaceutical industry.

Southeast Asia is noted as the global center of marine biodiversity. There are far more species of many groups of marine plants and animals than elsewhere in the world. The article by L.M. Chou on "Southeast Asia - the global center of marine biodiversity" shows a richness that remains unmatched and one that the region should be proud of and accept as a natural treasure. In the article on "Strategic values of Indonesia's coastal and marine biodiversity", R. Dahuri discusses the importance of coastal and marine biodiversity in the world's largest archipelago.

Several measures have been introduced to attain the goal of sustainable development as well as protection of the marine environment. One of these is the establishment of Marine Protected Areas (MPAs). The phenomenal growth of MPAs in the region, however, is not matched by the required surveillance and enforcement in many cases. Over 90% of MPAs in Southeast Asia do not meet with management objectives. The article by D. Nickerson et al. presents a case study in Malaysia of the development of a special area management plan for a marine park. There are some interesting lessons that can be applied to other MPAs.

A different case study from Sri Lanka's Hikkaduwa Marine Sanctuary by M.W.R. De Silva shows how vulnerable reefs within a sanctuary are. There is a new threat of biological community takeover by an algal species in addition to other human-induced threats. Finally, the well-known problem of pollution and its impact on marine biodiversity is discussed in the article by B. Goh. Marine pollution has far-reaching effects than terrestrial pollution because of the openness and inter-connectedness of the marine environment. The sustainability of marine biodiversity requires greater care in the prevention of marine pollution by both land- and sea-based sources.

The region has this great natural marine treasure that has been providing goods and services to its people. When abused for short-term economic gains, the loss is tremendous and cannot be recovered. If effectively managed, the long-term gain will be of immense value particularly from the discovery of useful bioactive compounds. Preventing the loss of marine biodiversity certainly warrants serious consideration and action.

Chou Loke Ming, *Issue Editor*

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Cover photo: Coral reef in the Great Barrier Reef, Australia. Photo by Chou Loke Ming

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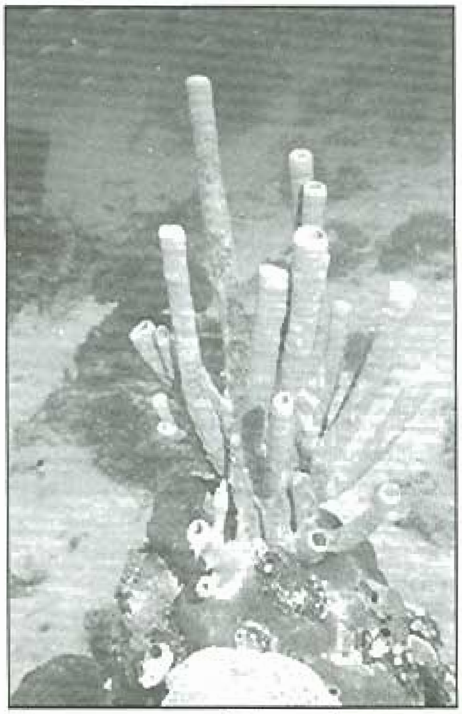
CORAL REEFS: MINES OF PRECIOUS SUBSTANCES

There are numerous species of organisms in tropical waters, particularly in coral reefs. The diversity of species in a coral reef is comparable to or even greater than that in a rainforest. Many bottom-dwelling invertebrates such as sponges, soft corals and tunicates have no value as food and, hence, have not been considered as economically important resources. However, chemical and pharmaceutical studies in the past three decades have revealed that these unpalatable organisms are important sources of biologically active (bioactive) substances which have potential to be developed into new drugs and other useful products.

Because of high diversity of species and hence of high competition for survival, coral reef organisms, particularly lower invertebrates which lack the physical means of defense, have evolved a variety of unique toxic compounds as their defense strategy. Many of these compounds have no terrestrial counterparts in the chemical structures as well as biological activities. These facts, together with a high incidence of bioactive compounds, have made coral reef organisms especially attractive targets of research.



Sponges are one of the most important sources of bioactive compounds. A variety of species inhabit coral reefs. (Photo by Dr. J. Tanaka)

Cytotoxicity (the degree of poisoning of cells) screening using animal or human cancer cell lines is often carried out as a first convenient step in the search of new anti-tumor drugs. When the author's research team screened the extracts prepared from several hundred species of invertebrates collected in the Okinawan waters, the incidence of cytotoxicity observed was more than 50%. Likewise, incidences of other activities such as anti-viral activity are also high with coral reef organisms, indicating that they are good sources of bioactive compounds. Indeed, we have discovered a variety of bioactive compounds from Okinawan marine organisms. Some of them are now under further evaluation as anti-tumor drugs.

Currently, several marine-derived compounds are under clinical trials as anti-cancer drugs in the world, especially in the United States. The most notable example is bryostatin-1, a minor constituent of the cosmopolitan bryozoan *Bugula neritina*, which was discovered by Professor Pettit of Arizona State University. In order to conduct clinical trials, several tens of grams of bryostatin-1 were obtained from more than 12 tons of the material collected in California. Since the compound has a complex chemical structure, chemical synthesis may not be a practical way to supply the drug when it is approved. A possible solution to meet the future demand is aquaculture of the bryozoan. Research is now under way at a venture company in San Diego.

In our collaboration with the Pharmaceutical Research Laboratory of Kirin Brewery, Co., Okinawa, Kirin scientists discovered a new compound (agelasphin) showing anti-tumor and immuno-stimulatory activity (activates immunity to disease) from a sponge collected at a coral reef in Okinawa. Chemical analysis revealed that agelasphin belongs to a class of compounds called cerebrosides which are constituents of the brain cells of humans and other animals. The relatively simple chemical structure of agelasphin allowed the Kirin scientists to synthesize a number of compounds having related structures for the evaluation of drug efficacy. One of them has now been selected for human clinical trials which are scheduled to begin in the United States within 1997. In tests with mice which were injected with colon cancer cells into their spleen, 100% of the mice died of liver cancer after 40 days, while all of those administered the drug were still alive after 100 days. It was proved to be highly effective in preventing translocation of colon cancer to the liver. When approved, annual sale of the drug is estimated to be more than 10 billion yen (US$88 million).

Other than human medicines, a number of marine compounds are now used as important research reagents

Table 1: Marine-Derived Biochemical Reagents Listed in the Sigma Catalogue, 1997

Reagent	Quantity	Price (Yen)	Source
Kainic acid	100 mg	4,900	Alga
Holothurin	10 mg	4,800	Sea cucumber
Domoic acid	1 mg	15,300	Alga
Tetrodotoxin	1 mg	20,000	Puffer fish
Brevetoxin	10 µg	13,500	Dinoflagellate
Saxitoxin	10 µg	9,800	Dinoflagellate
Palytoxin	10 µg	16,500	Soft coral
Okadaic acid	10 µg	10,800	Sponge
Manoalide	10 µg	12,000	Sponge
Calyculin A	10 µg	12,200	Sponge

in biochemistry and related areas of bioscience. For example, tetrodotoxin, which is a potent neurotoxin extracted from puffer fish, has been an important tool in the physiological study of nerve cells. Okadaic acid, a toxic compound discovered from a sponge in 1980, has become an extremely valuable reagent in the study of cell biology and is a highly expensive commercial product. To illustrate what are available and how expensive they are, some of the marine-derived reagents listed in the 1997 Sigma catalogue (a large chemical-supply company) are shown in Table 1. Most of these reagents are far more expensive than diamond itself. It should also be noted that most of them are products of coral reef organisms.

As shown by these examples, tropical marine organisms are rich sources of bioactive compounds. Although the majority of them have no commercial value today, some of them may contain compounds that are much more precious than diamond. In the light of the necessity of developing highly effective drugs to combat modern health crises such as cancer and AIDS, coral reef organisms are becoming increasingly important as the sources of such drugs.

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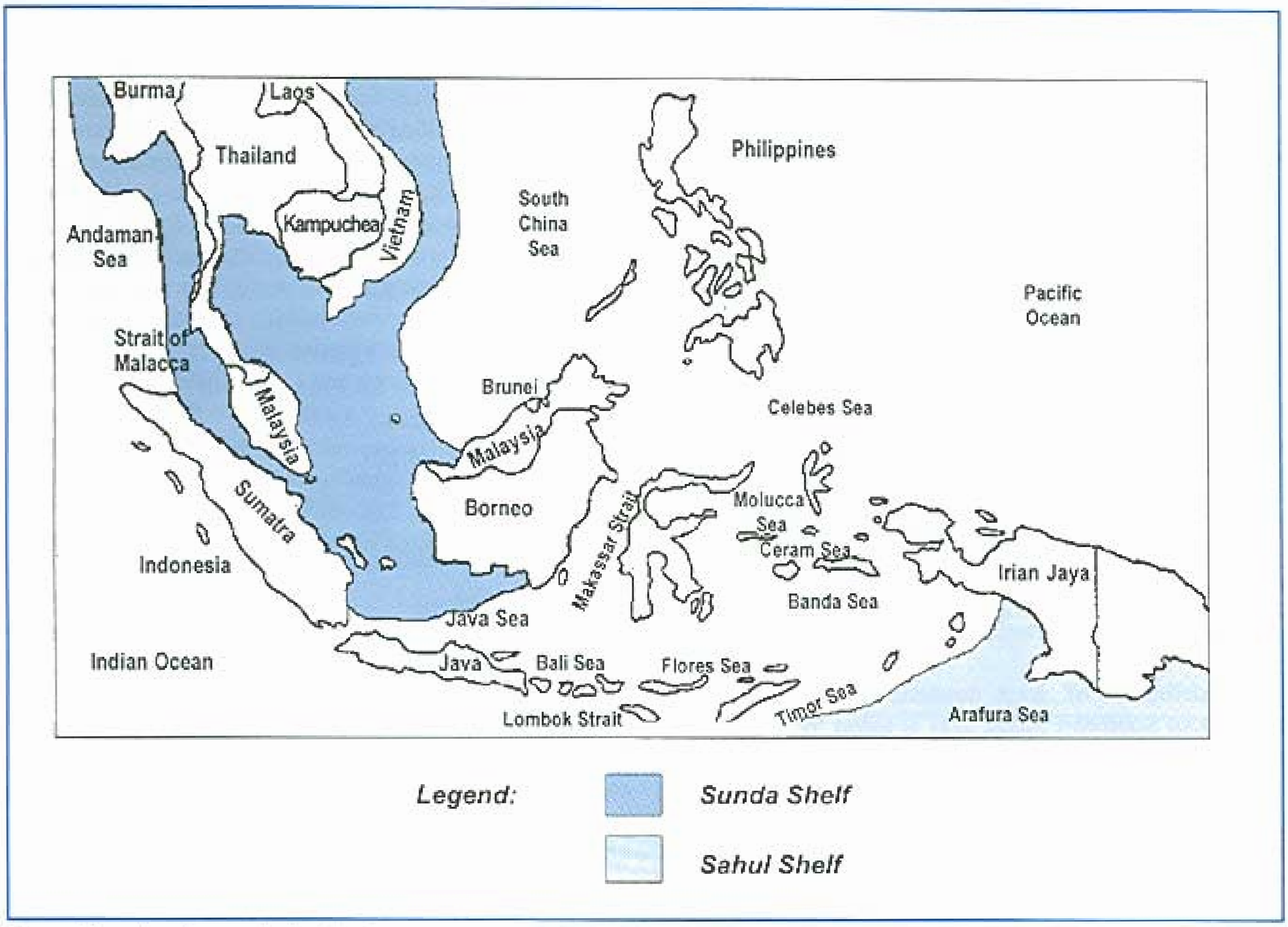
SOUTHEAST ASIA AS THE GLOBAL CENTER OF MARINE BIODIVERSITY

The seas of Southeast Asia cover 9 million km², equivalent to 2.5% of the earth's ocean surface. Yet they support a great variety and extent of coastal and marine ecosystems, known throughout the region for their distinct richness in species diversity. About 25 to 30% of the world's 600,000 km² of coral reefs are concentrated in Southeast Asian seas. Similarly, the region's mangroves represent about 30% of the world's total. These two ecosystems are more known than other ecosystems such as seagrass beds, soft-bottom seafloor, and different shore types. Few major expeditions have been made to explore the deep seas of the region. While research has resulted in a better understanding of processes governing these ecosystems and a greater appreciation of species richness, much more remains to be learnt, understood and applied to ensure sustainable development of these resources in the face of increasing population and development pressures.

Geographical Features

Southeast Asian countries have a combined coastline length of 92,451 km which is 15.8% of the world's total. The archipelagos of Indonesia and the Philippines (the two largest in the world with more than 20,000 islands



Map of the Southeast Asian Region.

combined) alone contribute 59% and 24%, respectively, to the region's coastlines. The numerous islands of varying sizes, most of which are coral or volcanic, compartmentalize but do not isolate the water body into different seas are also of varying sizes: Andaman Sea, Malacca Strait, Singapore Strait, Karimata Strait, Java Sea, South China Sea, Luzon Strait, Philippine Sea, Sulu Sea, Celebes Sea, Makassar Strait, Bali Sea, Flores Sea, Savu Sea, Molucca Sea, Ceram Sea, Banda Sea, Timor Sea and the Arafura Sea. These seas and islands form the link between the Pacific and Indian Oceans, and separate the continental landmasses of Asia and Australia.

The extensive coastline length modified by localized geomorphological forces throughout time provided a variety of coastal and marine ecosystems which are recognized as being the greatest throughout the Indo-Pacific. Almost all kinds of coastal features are present such as cliffs, coves, beaches (sandy, rocky, muddy), deltas, spits, dunes, lagoons. The seas are characterized by extensive shallow continental shelves (Sunda and Sahul) and deep sea basins, troughs, trenches and continental slopes. Surface current patterns indicate the Pacific Ocean as a source of water mass. Equatorial currents with warm water sweeping west across the Pacific deflect upwards at the Philippines towards Taiwan and Japan as the Kuroshio current, or downwards past Mindanao into the Celebes Sea as the Mindanao current. Another branch enters the Torres Strait, flowing through the Arafura Sea towards the South China Sea.

The region is heavily influenced by monsoons which give it definite wet and dry seasons. Heavy precipitation during the wet season transports silt and nutrients from land to sea, mainly through major river systems. The monsoons also reverse surface current patterns periodically resulting in dynamic circulation processes operating in these seas. The tropical waters experience little change in surface temperature and have moderate tidal variation influenced by the Pacific and Indian Oceans.

Coral reefs and beach rocks are common throughout the region while extensive mangroves occupy sheltered coasts. Large river deltas such as the Mekong and Chao Phraya form an important ecological component. The tropical conditions with high rainfall and constant warm temperature favor the high productivity of these ecosystems.

Productivity

Nutrient load in coastal waters is high because of river outflows, and while the average surface primary productivity based on limited data indicates low production rates of 1 µg C $m^{-3}h^{-1}$ in the open sea, higher rates are common in nearshore waters. Nutrient levels are increased during monsoons. Surface layers of offshore waters have low nutrient levels (phosphate content of 0.2 ppm), while the deeper layers have higher levels (3 ppm). The lack of an annual turnover in the tropics keeps nutrients trapped in the depths. These are brought to the surface only in areas where upwelling occurs.

Distribution of high nutrient content throughout Southeast Asian seas is aided by the scattering of numerous islands with each island contributing terrigenous inputs to the marine system Without these islands, larger sea areas would be beyond reach of this source of nutrients. The warm tropical temperature also contributes to high productivity enabling mangrove forests to reach their maximum development and greatest luxuriance in parts of the region.

Studies of mangrove ecosystem productivity based on different parameters such as phytoplankton production, primary production, benthic primary productivity and total litter production showed that the region's mangrove forests maintained the highest values than elsewhere in the world.

The wide variation of geomorphological features together with the physical, chemical, oceanographic and climatic conditions make the region's seas highly productive and supportive of rich and extensive marine habitats. The region is recognized as the marine faunistic center of the entire Indo-Pacific. It has a rich array of marine animals and plants and the abundance of coral reefs, mangroves and seagrass beds support probably the most diverse marine flora and fauna in the world.

Biodiversity

The term "biodiversity" shortened from "biological diversity" gained popular use as early as 1980, although biologists have been studying species diversity for a long time before. Biodiversity, however, is now considered at three levels: genetic, species and ecosystem.

The marine environment is dynamic with tides, currents and other physical forces moving water about. It is an open and interconnected system. However, geological, chemical and physical features provide some partitioning of the waters resulting in spatial and temporal variability throughout the region's seas. Geographical differences in chemical composition of surface sediments lead to spatial variability. Seasonal blooms of plankton for example, result in temporal variability. In addition, there are horizontal and vertical differences in distribution of materials. Availability of chemicals and variability in rates of material transfer or in geographic distribution of the reservoirs strongly influence the distribution and composition of biotic communities. Biogeochemical processes have a great impact on marine biodiversity and vice versa. While biogeochemical processes make available materials that support life, living organisms in turn exert an influence on these processes.

About 25 to 30% of the world's 600,000 km^2 of coral reefs are concentrated in Southeast Asian seas. Similarly, the region's mangroves represent about 30% of the world's total.

Since biogeochemical processes transport materials about, the distance between sources and sinks influence the rate of cycling. In deep seas, processes stretch over great vertical distances of the water column and localized processes can be seen operating within vertically stratified zones. In shallow areas, vertical separation is less pronounced and materials are exchanged over shorter distances. Corals have condensed this into an efficient process within their own tissues. The incorporation of unicellular algae "zooxanthellae" within their tissues has enabled direct exchange of materials between producer and consumer at the cellular level. This special arrangement has contributed to the high productivity of coral reefs. Other special marine ecosystems with high productivity ar- mangroves and seagrass beds. Biogeochemical processes, combined with physical, chemical and geological features have contributed to the rich marine habitat and species diversity.

Ecosystem diversity in the marine environment is high and probably greater than on land. The ecosystems support species richness at levels greater than elsewhere. The region has 16 species of seagrass, all of which are present in the Philippines making it the country with the second highest species of seagrass in the world after Australia. Apart from the high seagrass species number, the seagrass ecosystem also supports a high diversity of associated fauna and flora. Four species of turtles, *Chelonia mydas* (Green), *Lepidochelys olivacea* (Olive Ridley), *Caretta caretta* (Loggerhead) and *Chelonia depressa* (Flatback) are associated with seagrass systems while the dugong (*Dugong dugon*) remains fully dependent on the ecosystem. These turtles and the marine mammal are on the endangered list and demonstrate the importance of the seagrass ecosystem to their survival. Seagrass ecosystems are therefore critical habitats to these species.

A recent regional study (ASEAN-Australia Living Coastal Resources Project) of mangrove-associated animal communities presented a list of 545 species of fish, 2 species of amphibians, 24 species of reptiles and 60 species of mammals. It was concluded that the number of fish species was much more than previously known or expected. The study also provided a listing of endangered vertebrate species (excluding fish) present in the region's mangrove forests, consisting of 9 bird species, 1 amphibian, 1 reptile and 6 mammal species. Included are the crab-eating frog (*Rana cancrivora*) and the proboscis monkey (*Nasalis larvatus*). Over 50 exclusive and 171 non-exclusive mangrove plant species are present in the ASEAN countries.

Hard corals have their global center of diversity in the region, particularly around eastern Indonesia, the Philippines and the Spratly Islands, where over 70 hard coral genera are present. Throughout the rest of Southeast Asia, over 50 hard coral genera can be found. The central Indo-Pacific region, of which Southeast Asia is a part, is also considered to be the center of evolution of hermatypic corals. The reef ecosystem supports a high diversity of associated species of plants and animals, contributing further to the region's status as the global center of diversity for marine invertebrates such as molluscs and crustaceans.

Over 2,000 nearshore fish species have been recorded in the Philippines. The wider East Asian region is considered as the center of the world's radiation of true sea snakes (Family Hydrophiidae). Of the 14 genera and 47 species worldwide, all 14 genera and 30 species are represented in East Asia. Of the cetaceans, 28 species have been confirmed to be present in the region.

Relatively less known are the soft-bottom macrobenthic communities. These are also diverse with 368 families (excluding unidentified specimens) identified under the ASEAN-Australia Living Coastal Resources Project from 1985 to 1994. These communities contribute to the ecological processes of the marine environment and perform a significant role in maintaining productivity.

Species Distribution

Some species remain endemic to the region in spite of the connectivity of the marine environment. For example, the gastropods, *Tectarius rugosus, Littoraria vespacea* and *Littoraria conica* are known only from the Southeast Asian region. The highest number of *Strombus* species occurs in the Philippines, Okinawa and Indonesia, with a decline in diversity east and west of the region. The pattern of declining species diversity away from the region is repeated for many groups of invertebrates (Table 1), fish and seasnakes. Pomacentrid fish species diminished as distance increased into the Pacific from the Southeast Asian region. The decline in species of inshore fishes from Southeast Asian seas eastwards into the Pacific Ocean suggests that the region provides the source of larval recruits to the seas west and east of the region. Species of seasnakes show a similar decline west of Southeast Asia and east past the Australasian region.

Table 1: Geographic Variation in Species/Generic Diversity of Some Marine Fauna

Location	Penaeid (species)	Damsel/ angelfishes (species)	Butterflyfishes (species)	Hard corals (genera)
Indo-West Pacific	125	268	98	83
East Pacific	16	22	4	10
West Atlantic	21	19	7	29
East Atlantic	16	11	4	5

Management Considerations

Information on species and ecosystem diversity and distribution has important implications on their management. While these ecosystems maintain high biodiversity and provide larval recruits to surrounding regions, development and economic growth have caused great losses in the extent of marine ecosystems and increasing degradation. It is important to manage the marine environment so that it can continue to provide goods and services to mankind and to maintain the rich biodiversity for which they are known.

The marine environment and its resources are heavily depended on by the region's population. For example, reef-related fisheries contribute the highest level of total marine fisheries in Southeast Asia. Human impacts have caused changes in ecological processes such that ecosystem integrity cannot be maintained, leading to reduced opportunities in exploitation. The cockle beds of Jakarta Bay have already been destroyed and many of the region's rivers are biologically dead, spreading the pollution load to coastal seas. Destructive fishing methods continue to devastate entire coral reefs while mangrove habitats have diminished extensively. Pressure on coastal and marine resources continues to mount from expanding economies, rapid population growth and coastal tourism. All these point to the need for stronger and more effective management measures.

There is obviously a weak link that makes management considerations for the protection of coastal and marine resources unattractive against the tangible and strong economic returns seen from resource exploitation and destruction. This lies in the lack of a convincing and yet acceptable economic valuation of natural resources. Resource economists and scientists are now addressing this problem, but even with a realistic financial valuation of coastal and marine resources, another great challenge is to persuade people to accept that long-term gain is best for everyone over short-term gain for a few.

As an important center for marine biodiversity, more studies are required to document the numerous species that remain undiscovered. Even in recent times, new species are still being found, e.g., *Acropora suharsonoi* in Lombok, Indonesia. The region has featured prominently in the discovery of species new to science. There is little doubt that it presents a rich genetic bank with a great potential for the discovery of novel bioactive compounds.

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STRATEGIC VALUES OF INDONESIA'S COASTAL AND MARINE BIODIVERSITY

Indonesia is the largest archipelagic state in the world, consisting of more than 17,000 islands and a combined coastline of 81,000 km, and has been frequently described as a "megabiodiversity" country. This is particularly true with respect to coastal and marine biodiversity. The highest biodiversity of shallow benthic species in the world occurs in the tropical waters of the Indo-Pacific, followed by the tropical Pacific coast of America. Within Indo-Pacific waters, the highest biodiversity is centered on the Indo-Malayan regions, of which Indonesia is part. Indonesia's coastal and marine habitats support a large proportion of its biodiversity resources, such as mangroves, coral reefs, seagrass and seaweed beds, as well as deep-sea ecosystems.

Indonesia is the largest archipelagic state in the world... 17,000 islands ... combined coastline of 81,000 km... a "megabiodiversity" country.

Based on the association of taxa and groups of taxa with particular geographical locations, Indonesia spans two major biogeographical realms, Indo-Malaya and Australasia, as well as several distinct biogeographical provinces. The western islands of Sumatra, Borneo, Java and Bali, lying on the Sunda Shelf, were joined to mainland Asia at times of lowest sea level during the Pleistocene. Similarly, the eastern province of Irian Jaya and the Kai and Aru Islands on the Sahul Shelf were once connected to Australia. The biota changes in species composition west to east but the flora remains dominantly Malesian throughout the archipelago. Fauna distributions more closely reflect ancient land connections with placental mammals in the west and marsupials in the east. The islands of Sulawesi, Maluku and Nusa Tenggara lie in a major transition zone, Wallacea, between the Indo-Malayan and Australasian realms. Many of the Indonesian islands have been isolated for millennia and consequently show high levels of species endemism. Due to its unique biogeography, Indonesia is one of the most biologically diverse countries in the world.

There are seven major biogeographic regions in Indonesia, centered on the major islands and groups and their surrounding seas: 1) Sumatra and offshore islands; 2) Java and Bali; 3) Kalimantan, including the Natuna and Anambas islands; 4) Sulawesi, and offshore islands including Sula; 5) Nusa Tenggara; 6) Maluku; and 7) Irian Jaya, including the Kai and Aru islands. These biogeographic divisions do not always correspond to provincial boundaries. Thus, Wetar and Tanimbar (Maluku) lie within the Nusa Tenggara biogeographic region and Aru and Kai (Maluku) are included with Irian Jaya.

The Indonesian coastal zone is rich in estuarine beaches, mangroves, coral reefs, seagrass and algal beds and many small island ecosystems. Each of these marine ecosystems, with its associated habitats, supports a wealth of marine resources.

The mangroves of Southeast Asia are extremely diverse and the Indo-Malayan region is regarded as the center of mangrove distribution. Indonesia has the greatest area of mangrove where it forms the dominant coastal community in Sumatra, Borneo and Irian Jaya. Mangroves in Java have suffered heavily from human impacts that include illegal cutting, conversion of uses and other forms of coastal development and possible land-based industrial pollution while in Sumatra, Kalimantan, Sulawesi and Irian Jaya signs of degradation have been recorded.

Indonesia is the global center for coral species diversity. Approximately 70 genera of hard coral comprising of more than 350 species occur in the vicinity of the Eastern Indonesian Seas. Throughout the Indonesian coastal waters, fringing reefs are most common and are present around most small- to medium-sized islands especially in the eastern part, while on the eastern coast of mainland Sumatra, West and South Kalimantan and the southern part of Irian Jaya, coral reefs are not remarkably present.

Marine biota, animals as well as plants, have been exploited for human consumption or other needs since before recorded history. Fishes, crustaceans, molluscs and also marine mammals are easily a source of animal protein. Coral reef fishes and other coral inhabitants displayed in the public aquariums attract millions of people all over the world, decorate houses of the rich and have good prospects as export commodities.

Indonesia's extensive coastal and marine biodiversity resources provide highly significant values to the socioeconomic development of both Indonesia and the world.

Marine biota play an important role in industries. Corals, shells and seaweeds are exploited as raw materials for industries. More recently, people are looking for active substances from the sea for medical and pharmaceutical purposes.

Scientists know very little about the loss of genetic and species resources from the marine environment. Marine species or even populations have disappeared in historical times and in some areas, marine ecosystems have been disturbed or destroyed and could result in the loss of genetic diversity.

The diversity of Indonesian marine life can only be estimated. The results of some expeditions are sometimes reported as parts of other works or published several decades after the expedition. Keen taxonomists require much patience and careful study of existing literature to record accurately the diversity of the Indonesian marine life.

A study by Soegiarto and Polunin in 1981 provided an inventory of Indonesian marine organisms which gives an idea of the richness of marine life as well as an impression of how poor is the knowledge on some species groups. Information on sponges, soft corals, worms, tunicates, bryozoans and gorgonids is not available. Table 1, which is amended from the data of Soegiarto and Polunin, includes additional taxa with their estimated species in Indonesian seas.

Indonesia's extensive coastal and marine biodiversity resources provide highly significant values to the socioeconomic development of both Indonesia and the world. Through proper management, the benefits that can be derived from these resources can be utilized to develop and maintain conservation practices, and also, to enhance the development of sustainable industries and livelihood systems. As the development of biotechnology increases, the role of coastal and marine biodiversity in sustainable economic development will be even more prominent, especially in the field of food, cosmetics and pharmaceutical industries.

Table 1: Species Richness of Selected Groups of Marine Organisms in Indonesia

Major group	Group forms	Range recorded	Number of species
Plant	Green algae	1	196
	Brown algae	1	134
	Red algae	1	452
	Seagrass	1	13
	Mangroves	1	38
Corals	Scleractinians	2	350
	Soft coral	1	210
	Gorgonians	1	350
Sponges	Desmospongia	1	850
Mollusca	Gastropoda	1	1,500
	Bivalvia	2	1,000
Crustacea	Stomatopoda	1	102
	Brachyura	1	1,400
Echinoderms	Crinoidea	2	91
	Asteroidea	2	87
	Ophiuroidea	2	142
	Echinoidea	2	248
	Holothuroidea	2	141
Fishes	Shore fishes	1	>2,000
Reptiles	Sea turtles	1	6
	Crocodiles	1	--
Birds	Marine birds	2	148
Mammals	Whales and dolphins	1	29
	Dugong	2	1

Notes: 1 = Specifically Indonesia
2 = Indonesia and adjacent waters

Threats to Coastal and Marine Biodiversity

As it is elsewhere around the world, coastal and marine biodiversity in Indonesia is under siege from loss of habitats, overexploitation of living resources, pollution, introduction of exotic or alien species and also potentially due to climate changes and ozone depletion.

Habitat loss and destruction

More than 60% of the Indonesian population reside within 50 km of the coastline, and also, most of the large cities are located in the coastal zone. Consequently, the pressures from development in the coastal zone kept increasing with time. Such development pressures resulted in conversion of important coastal habitats (for example, mangroves, sandy beaches, estuaries as well as coral reefs) into other uses such as industrial estates, residential areas, coastal aquaculture farms, and ports and harbors. It is the main threat to coastal and marine biodiversity.

Overexploitation of living resources

Although Indonesia has a huge potential in sustainable marine fisheries, estimated at 6.7 million tons per year, the current level of exploitation is about 48%. However, some coastal and marine waters have already been overfished. These areas include the Straits of Malacca, the north coast of Java, Bali Straits and the south coast of Sulawesi. Meanwhile, there have been reports of some marine species having been pushed to extinction.

Pollution

Some coastal waters, especially those near high population density and intense industrialization areas (e.g., Jakarta Bay, Semarang, Medan, Ujung Pandang and Bontang Bay), have been severely polluted by nutrients, organic materials, heavy metals, sediment and oil. The sources of pollution originate from land- or marine-based human activities. Incidences of massive fish mortality and red tides have increased in the last seven years and are attributed mainly to marine pollution.

New and exotic species introduction

There are a few cases that can be classified as true marine introductions. However, there are many cases of estuarine species introduction, including the well-known *Tilapia* sp.

Those four aspects of threats that endanger Indonesia's coastal and marine biodiversity have resulted from ignorance of the strategic values of biodiversity resources for sustainable economic development. It is compounded by consumerism and greed, while part of it is the result of the desperate plight of the poor who do not have any decent alternative livelihood.

Recommendations for the Conservation of Coastal and Marine Biodiversity

In order to conserve or utilize coastal and marine biodiversity resources sustainably, Indonesia should follow the general guidelines developed by UNEP for conserving biodiversity, namely the saving, studying and using of biodiversity.

Saving Coastal and Marine Biodiversity

1. Improvement of the management of existing coastal and marine conservation areas.
2. Establishment of new coastal and marine conservation areas.
3. Mitigation and prevention of development's negative impact on coastal and marine biodiversity.
4. Integrated coastal and marine management.
5. Protection of endangered (protected) coastal and marine biota.
6. Training and education on conservation and sustainable use of coastal and marine biodiversity.
7. Community awareness and participation.
8. Institutional strengthening.

Study of Coastal and Marine Biodiversity

1. Production of inventories on coastal and marine biodiversity from genetic, species to ecosystem levels.
2. Creation of Coastal and Marine Biodiversity Database.
3. Taxonomic reference collections.
4. Studies to develop technologies for sustainable utilization of coastal and marine biodiversity.
5. Economic valuation of coastal and marine biodiversity.

Sustainable Use of Coastal and Marine Biodiversity

1. Extraction of bioactive substances (natural products) from coastal and marine biota.
2. Development of mariculture.
3. The use of microbes for bio-remediation of polluted waters.

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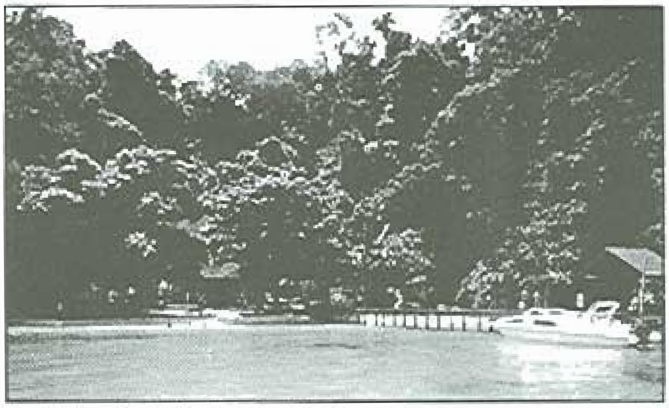
Indonesia

SPECIAL AREA MANAGEMENT FOR CONSERVATION AND SUSTAINED PRODUCTION OF MARINE BIODIVERSITY IN MALAYSIA

On the northwest coast of Malaysia within the Langkawi Islands lies a well-known and well-visited marine park. It is the Pulau Payar Marine Park, the first marine park in Malaysia, established in 1987. It is the only clear-water reef on the west coast of Peninsular Malaysia, famous for its beautiful arrangement of soft corals, and healthy and diverse fish and coral population. It has become so popular that the increase in visitors is now a major management issue, adding stress to the marine park's environment. This, and other stresses, including the general degradation of resources, particularly mangrove areas, corals and seagrass beds; overfishing; conflicts between artisanal and commercial fisherfolk; organic and inorganic pollution from industrial development; multi-use conflicts; and loss of fishing grounds were identified in a situation analysis on Malaysian fisheries, conducted by the Department of Fisheries, Malaysia (DOFM) and the Food and Agriculture Organization (FAO)/Bay of Bengal Programme (BOBP) in 1994. The FAO/BOBP is working together with the DOFM in addressing these issues under Malaysia's BOBP third phase project, 'Special Area Management Plan for Pulau Payar Marine Park and Surrounding Areas'. The analysis recommended a sustainable resource management approach to emphasize the importance of marine parks as productive ecosystems contributing to fisheries and biodiversity.



The Pulau Payar Marine Park in Malaysia.

Much effort and resources had been put in the establishment of marine parks by DOFM since 1983. The idea of a Special Area Management Plan (SAMP) was new to Malaysia at the beginning of the project, but it made sense and is now a well-established management approach. The SAMP approach allows decision-makers to focus on the unique features of the area's ecosystem, and the people living in the area, who depend on the health of the ecosystem in one way or another. It also allows for a different type of decision-making than is traditional in resource management. It balances the decision-making between those most affected by the decision—the local community—and those that have traditionally and 'legally' been given responsibility—the government agencies.

The SAMP decision-making Committee is currently composed of the DOFM, the Fisheries Research Institute (FRI), Ecology Branch, Marine Parks Branch, Sector Planning Branch, the State DOF and Resource Management Branch. This Committee was initiated in mid-1995 and worked closely with the area stakeholders and State agencies to further assist in the project design, guide the scientific studies, public outreach activities, institutional review and complete a draft SAMP. The draft SAMP will be used as a platform for discussion at an upcoming integrated coastal zone management (ICZM) Workshop, discussed later in this article, which will introduce a broader representation on the SAMP Committee. The future Committee will also include the DOFM State agencies in Kuala Kedah and Perlis, the State Planning Unit, Universities (Universiti Pertanian Malaysia—UPM and Universiti Sains Malaysia—USM), fishermen organizations, tourist organizations, major investors of marine tourism projects, other area stakeholders, Ministries of Environment, Agriculture and Forestry, and NGOs including the World Wildlife Fund. The results of the project will be used as an example for management of other marine park islands in Peninsular Malaysia, and to use the lessons learned to develop a national ICZM framework.

Although the project is still in the early stages, there have been some interesting applications of science to coastal resources management decision-making. These are improving the quality of and public confidence in the difficult choices made under the project.

Science Helps Ensure a Comprehensive Understanding of the Management Issues

A first step of the project was to identify the geographic area for management. How much more than the marine park waters could the project attempt to manage? Science helped to answer this question. The area would have to include the locations of the sources of the problems affecting the marine park. The management area under the SAMP includes the coastal areas north and south of Kuala Kedah, Langkawi, and the southernmost portion of Perlis, out to the marine waters and islands of the Pulau Payar Marine Park. There is potential that extensive land-based development in Langkawi and Kuala Kedah may bring about deterioration of water quality by increased sedimentation. The well-promoted tourism industry in Langkawi is a major contributor to rapid development on land. In addition, industrial growth in Kuala Kedah brings fear of increased inorganic pollution, as fisherfolk in all the three coastal areas utilize the reefs within the SAMP area.

The second major application of science in the SAMP process was to characterize the marine resources of the area. This helps to better understand the problems initially identified by the project and help the SAMP Committee come up with priority problems for management. This process often leads to unexpected findings, and can add or subtract problems from the early list and change preconceived notions of causes of the problems.

Managers and scientists together developed the methodology for conducting the scientific characterization studies. The interactive approach to develop the study was a useful SAMP planning tool. It achieved consensus among the scientists in FRI, the DOFM, the managers in the SAMP Committee and FAO/BOBP on the objectives and application of the scientific work under the SAMP. For example, the studies are very much applied to management decisions and each study is interlinked to give a comprehensive picture of the issues. They include: (1) the status and trends of reef-related key target species of the area's fisheries; (2) additional ecological indicators; and (3) trends and probable effects of tourism on the Park's fishery habitats. These are complemented with a socioeconomic study and demographic and land-use information.

Special Area Management ... balances the decision-making between those most affected by the decision—the local community and those that have been traditionally and 'legally' given responsibility—the government agencies.

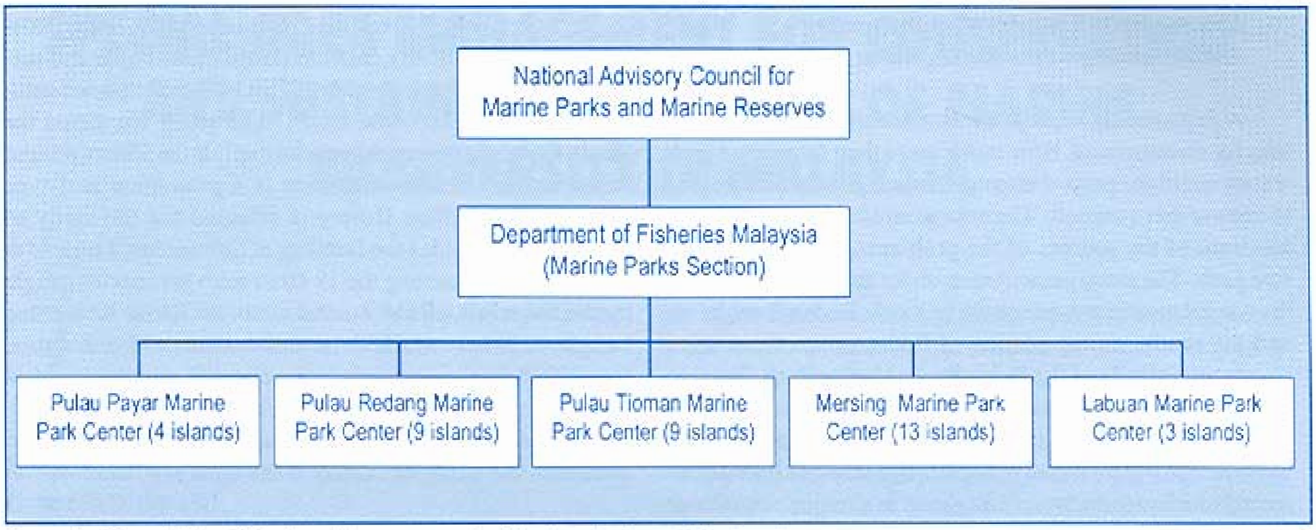
Fisheries status and trends

Changes in the catch before and after the establishment of the marine park of the more important fisheries that are dependent on the coral reefs of Pulau Payar and surrounding areas are being determined. Because of the lack of historical data specifically collected from Pulau Payar and surrounding areas, the researchers of FRI used the species landing statistics of the State DOF. The study identified the Kuala Kedah fishers as those who exploit the waters around Pulau Payar. Because handline is a prominent reef-type fishery, the handline fishery is selected for the study of trends. This includes the families of Serranidae, Lutjanidae and Scombridae among the 19 other relevant species caught by the fisherfolk of five coastal areas off Kuala Kedah and Langkawi. Where available, data from Kuala Kedah station from 1970 to the present were collected and analyzed to show change over time and areas in the key target species. The preliminary assessment by the SAMP Committee recommends the study to extend to the anchovy fisheries.

In addition, these findings will be plotted against demographic trends and socioeconomic changes in the fisheries including fisherfolk population, introduction of more sophisticated fishing equipment and fisheries management measures. A socioeconomic baseline study for the SAMP area complements the scientific study by providing measurements of change in area communities with SAMP implementation. The study began in late 1996 and early findings will be presented at an ICZM Workshop in 1997. Trawl data have been collected and analyzed to indicate changes in catch biodiversity. The fisheries catch data are being complemented with interviews of fisherfolk to gauge their perceptions on changes within the fishery resource. The questionnaires were developed by FRI as part of the study with assistance from FAO/BOBP.

Additional ecological indicators

The monitoring of ecological indicators is required to measure the effectiveness of the SAMP actions over the long term. Monitoring was designed to indicate changes in fisheries coral reef habitat conditions within the area over time. Monitoring began in October 1996 and will provide a baseline for measuring change under the SAMP. Parameters currently being monitored include: (1) water quality indicators like dissolved oxygen, salinity, nitrate and phosphate levels, the last two of significance where human activities are associated with visitors that go to the island as tourists; (2) differences in assemblages of reef fishes at different sites using abundance categories, population



Organizational Chart for the Management of Marine Parks in Malaysia.

structure of specific species in the marine waters of the SAMP area, including but not limited to Serranidae and Lutjanidae; (3) biological condition, growth, mortality and recruitment of corals; (4) water quality; (5) occurrences of sea urchins and sea cucumbers; and (6) algae coverage on the coral reefs. Trends in these indicators from 1979, where available, have been plotted up to the present status.

Trends and probable effects of tourism

The Pulau Payar Marine Park visitors have increased from 1,373 in 1988 to over 90,000 in 1996. This rapid increase poses a potential risk to the health of the marine environment, to reef and reef fisheries productivity, in addition to the sociological impact on the host communities and fisherfolk in the SAMP area.

The study over the past year observed the impact on the fisheries habitat, primarily coral reefs and social impacts on the visitors themselves. To observe habitat impact, the percentage of coral cover and species composition, general morphology and extent of damage were observed at the most frequented visitor sites in the Park. The less frequented sites in the Park were covered by the study on additional ecological indicators. Data on past survey work at Pulau Payar on reef conditions before the park was established and at different levels of visitation, where available, were compared to current conditions at present high visitation levels.

Surveys via interviews using standard questionnaires with regular and new visitors, tour and dive operators at differing levels of visitation helped to determine the tourist social carrying capacity, or the level beyond which visitor satisfaction drops unacceptably from overcrowding. The data were collated and analyzed vis-à-vis visitor user groups including divers, snorkelers and non-reef users. Findings discussed indications of visitor satisfaction at different levels of visitation.

The results of the impact on the fisheries habitats and the social impact on the visitors themselves have been combined into management recommendations for the issue of visitation within the Marine Park. These results will also be integrated with the other studies.

Applying Science to the SAMP

The use of the marine park and surrounding waters by visitors is one of the major activities which will be managed under the SAMP. Results of this study will be used to help determine possible visitor fees to fund other SAMP actions, including, among others, alternative employment of fisherfolk especially those whose fishing area was in the now prohibited area declared off limits to fishing by the gazettement of the Marine Park and other integrated fisheries management measures. Two training programs to prepare fisherfolk for alternative employment as ecotourist and natural history guides and diving supervisors have been conducted under the project. The outcome of this study on tourism effects will determine limits on the numbers of tourists and therefore how many fisherfolk can enter into alternative employment in the tourism sector. Benefits include reducing illegal fishing and fishing pressure within the marine park.

Simple plots or other forms of graphical analysis of the above studies are being compiled for presentation at an ICZM Workshop, tentatively scheduled for October 1997. The Workshop is part of the SAMP activities where the findings of the scientific and socioeconomic characterization studies will be presented to a wide audience. Participants will include DOFM State agencies in Kuala Kedah and Perlis, Universities (UPM and USM), fisherfolk, other key stakeholders in the area, Ministries of Environment, Agriculture and Forestry, NGOs including WWF. Key stakeholders include fisherfolk (primary targets), industry and hotel owners, fish vendors and middlemen, landowners, and Langkawi Area Development Authority and developers.

The Workshop will enable interactions with the managers, scientists and public who will be members of the Tier II Committee and involved in SAMP finalization and implementation. A first draft of the SAMP will be further developed at the Workshop and by the Committee throughout 1997. The Workshop is also expected to build consensus among the Committee representatives and wider public on the objectives and issues for management. The early scientific findings will help direct the Workshop discussions towards clear and quantifiable objectives for management.

Early findings of the studies will also lead to recommendations for changes in future fisheries data collection techniques and activities by DOFM in the SAMP area. DOFM is identifying areas for improvement in data collection, based on the results of the study and vis-à-vis the objectives of the SAMP. This includes identifying additional sampling areas within the SAMP area which should be monitored to improve the ability of the SAMP Committee to measure the changes in the fish populations and recruitment vis-à-vis future SAMP actions. For example, possibilities discussed include training of Marine Park rangers to participate in the long-term fisheries monitoring program under the SAMP.

The scientific findings will also help to indicate whether the Pulau Payar Marine Park boundary should be expanded to give greater protection for reefs outside the Marine Park and increase the area's biological productivity.

All the studies will help measure the conditions of the resources before and after the establishment of the Marine Park, vis-à-vis other management initiatives in the area. They will also help to direct the SAMP Committee on potential management actions to include in the SAMP and lastly, to provide a baseline for measuring future changes after the SAMP implementation. Thus, social and ecosystem changes resulting from management actions of the SAMP can be determined and this will be used to improve the actions during implementation when needed.

Conclusions

The scientific characterization findings are being used throughout the SAMP process for several purposes: (a) the information base used by the SAMP decision-making committees for development and implementation of management actions under the SAMP; (b) to illustrate potential benefits of the Marine Park, when managed as habitat enhancement for the fisheries resources of the surrounding areas; and (c) to form the basis of the awareness materials that will be widely disseminated in area communities.

The goal of the SAMP for the Pulau Payar Marine Park and surrounding areas is to promote the conservation and sustained production and use of the area's reef fisheries resources and habitats. Science applied to the SAMP process is helping to create an understanding and acceptance among the key stakeholders of the need for and benefits of ICZM and helping to obtain their collaboration as stewards of the local resources in pursuit of this goal.

Science applied to special area management is helping to create an understanding and acceptance among stakeholders of the need for and benefits of ICZM and helping to obtain their collaboration as stewards of the local resources in pursuit of this goal.

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A NEW THREAT TO THE CORAL REEFS OF THE HIKKADUWA MARINE SANCTUARY IN SRI LANKA

A coral reef like any other natural ecosystem is resilient within limits and adapts as best as possible to prevailing conditions including any natural or human-induced changes to its environment. What changes would take place, how a reef and its organisms would react, and whether it would be able to regain its original integrity will depend on several factors. Among them would be the type of stress, duration and intensity of the stress as well as the health and environmental conditions to which the reef had been subjected at the time of and prior to the stress. Healthy reefs can recover from damage caused by natural disasters such as typhoons and storms, and even population explosions of coral predators such as the "Crown of Thorns" starfish (*Acanthaster planci*). Good reefs subjected to short-term damage such as the use of explosives to catch fish (illegal in many countries) have at times recovered almost to its original state with time. The time taken for recovery varies depending on the situation, from a few years to a few decades. On the other hand, there are many instances where reefs have been completely destroyed or have changed into unproductive systems due to human-related activities. An example of this would be the destruction of the Polhena Reef in Sri Lanka which was once proposed as a Marine Sanctuary, by an overgrowth of the green alga *Ulva* spp. (Plate 1). Overgrowth of the alga was attributed to eutrophication due to the retting of coconut husks (a process to separate fibers by bacterial action when soaked in water) that was carried out on the foreshore of Polhena Beach to service the coir industry (Plate 2).

Plate 1: A live coral under threat from overgrowth of the alga Halimeda *sp.*

Threats to coral reefs from overgrowth or population explosions of reef organisms are nothing new. While scientists theorize on what have caused these, resource managers face the dilemma of what should be done. This would be particularly critical when such overgrowths threaten limited good and valuable coral reef areas on which the economic stability of a community rests.

The Hikkaduwa Marine Sanctuary

Hikkaduwa is a picturesque seaside fishing village located in Galle District approximately 100 km south of Colombo, the capital of Sri Lanka. Its main natural assets are the golden sand beaches, high diversity coral reefs, clear waters and the shallow reef lagoon. To sustainably manage these natural assets, and in particular to provide some protection to the high diversity coral reefs, the 44.5 ha (110 acre) Hikkaduwa Marine Sanctuary was created on 18 May 1979. Today, Hikkaduwa is one of the more popular coastal resort areas in Sri Lanka.

The Hikkaduwa Marine Sanctuary (HMS) could be taken as an afterthought as critical irreversible changes had already taken place before it was declared a sanctuary. The status of the once unstressed coral reefs had already changed dramatically with the introduction of mechanized fishing boats to the reef lagoon, the tourist boom, and the collection of ornamental marine fish for export. The entire beach front is now almost completely occupied by hotels, guest houses or restaurants. The reef lagoon serves as an anchorage to over 30 mechanized fishing craft that used massive concrete anchors and heavy chains to anchor. Glass bottom boats numbering over 70 compete not only for passengers, but also for anchoring space on the beach. The level of pollution had also begun to steadily increase even prior to the area being declared a Marine Sanctuary.

Table 1: Main Threats to the Coral Reefs of the Hikkaduwa Marine Sanctuary

a) Uncontrolled glass bottom and mechanized fishing boat activities:
   - Spillage and discharge of diesel, kerosene and petrol
   - Discharge of bilge and waste oil
   - Disposal of wastes
   - Damage caused by anchors and chains
   - Glass bottom boats coming in direct contact with the coral
   - Glass bottom boat operators stepping on coral to hold the boats steady for the passengers to get a better view of corals or to release boats caught on the reef

b) Sedimentation

c) Collection of corals and shells as souvenirs

d) Tourists/visitors stepping and walking on live coral areas

e) Collection of ornamental fish/lobsters/ organisms

f) Discharge of untreated/semi-treated effluents/sewage from hotels and restaurants

g) Polluted freshwater runoff from canals

h) Changes to current patterns due to illegal constructions on the beach

i) Discharge of wastes by visitors

j) Use of explosives to catch fish just outside the Sanctuary

A New Threat to the Coral Reefs and Biodiversity

The previously recognized major threats to coral reefs of HMS are given in Table 1.

Although several reef surveys had been conducted since 1965, there had been no reports of unusual population densities of any marine algae that could pose a threat to HMS.

Halimeda is commonly associated with coral reefs but not as a dominant component of the reef's algal community. In 1965, the dominant microalgae genera recorded on the reef crest were the brown algae *Sargassum, Turbinaria* and *Dictyota*, the red algae *Carpopeltis, Acanthophora, Hypnea, Gelidium* and *Gracilaria*, and the green algae *Caulerpa, Chaetomorpha* and *Ulva*. Although several calcareous red algae such as the coral binding *Lithophyllum, Jania* and *Amphiroa* were recorded, they were subdominant. Other surveys carried out since then had not recorded *Halimeda* as a major component of the reef community.

A recent survey undertaken by the Coastal Management Center (CMC) with assistance from the National Aquatic Resources Agency (NARA) and sponsored by the University of Rhode Island (URI) and the Coastal Resources Management Project of Sri Lanka (CRMP Sri Lanka) brought to light the threat posed by an overgrowth of the calcareous green alga *Halimeda*. The survey indicated that *Halimeda* was the dominant alga on the reef crest that acts as a protective barrier to the reef lagoon, and which gets exposed at low tide. In this area the *Halimeda* cover varied from approximately 30 to 70% or more. Heaviest growth was on the consolidated part of the reef crest. Cushion-like formations of bright green *Halimeda* were a common sight as the tide recedes to expose the reef crest. Depth of the cushion-like clumps was as much as 10 to 12 cm with diameters of 30 to 40 cm or more. Some traditional fishermen who normally fished from the reef crest prior to a ban since early 1996 (and permitted to fish again in April 1997) were surprised by the abundance and dominance of *Halimeda* on the reef crest.

In the shallow sublittoral areas of the reef lagoon, the alga had colonized many coral areas. Coral heads that had been completely overgrown by *Halimeda* were frequently observed here. The colonization of massive corals such as *Porites* and favids in a relatively healthy condition were from the base up. Top down colonization was observed in some massive corals where the flattened heads had accumulated sand to provide a stable base for the *Halimeda*.

Most disturbing was *Halimeda* invasion of good live coral areas. Live corals were being gradually overrun by the spread of algal colonies from the reef crest down to the sublittoral zone. In several sublittoral areas of good coral cover and growth, the algae had established and overrun the coral or were beginning to establish themselves amidst the branches of live corals.

Two obvious methods of colonization of new areas could be observed. One was fragmentation of a colony due to heavy wave action or currents and the fragments being carried over to new areas. The second was by the growth and creeping of an already established colony to neighboring areas. Live coral areas being colonized by both strategies were frequently encountered.

Possible Causes of Halimeda *Growth*

From available evidence, the overgrowth of *Halimeda* is a recent occurrence on the coral reefs of HMS. There is circumstantial evidence that pollution levels, particularly of hydrocarbons (diesel, kerosene and waste oil) have increased appreciably due to increased numbers of mechanized fishing and glass bottom boats within the reef lagoon.

> *Live corals were being gradually overrun by the spread of algal colonies from the reef crest down to the sublittoral zone.*

One can speculate on what has caused the population explosion of *Halimeda*. One possible cause would be eutrophication or increased nutrients coming from the many sources associated with the sanctuary—effluents from hotels and restaurants, polluted water from the nearby canals, waste from fishing and other boats, diesel oil and kerosene etc.; but, there could be other hidden triggering mechanisms. What is unusual about *Halimeda* is that it involves a calcification process which sets it apart from other algae that have caused problems to reefs elsewhere. Whatever stimulates the growth of the alga has to have a direct link with the enhancement of the calcification process as well. This suggests that whatever the process, it might not be a simple and straightforward eutrophication process.

Management Options

While one ponders on the cause of *Halimeda* overgrowth, what course of action is available? Some of the options are to:

a) consider the highly stressed and abused limited coral reefs of the Hikkaduwa Marine Sanctuary as a natural ecosystem and let nature take care of itself. In short, do nothing but wait and see.

b) find the manpower and financial resources to initiate a study to determine the cause of *Halimeda* growth and wait for the results of the study to initiate any action.

c) use the already accepted management technique of culling (removing the excess) to:

   i) bring back some equilibrium to the coral reef system and

   ii) remove the immediate threat to the live coral areas.

Studies should be initiated concurrently with available resources to monitor the situation. Manpower and financial resources should also be sought at the same time to determine the cause of the population explosion and to find a better solution, if any.

Before a final decision is taken, the following should be considered:

- it is known that coral reefs can be subjected to natural fluctuations of destructive organisms and still recover with time. How much time and whether a stressed reef could recover to its original state still remains unanswered

- it is also known that reefs could be completely destroyed within a short period of time by heavy infestations of algae and other organisms such as "Crown-of-Thorns Starfish".

- several reef areas in highly stressed tourist areas under threat from marine organisms have been saved by timely human interventions such as the removal of such organisms, regular monitoring, and controllling pollution and other stresses.

Because of the highly stressed nature of the coral reefs of the Hikkaduwa Marine Sanctuary, the economic importance of good quality coral reefs to the stakeholders, and

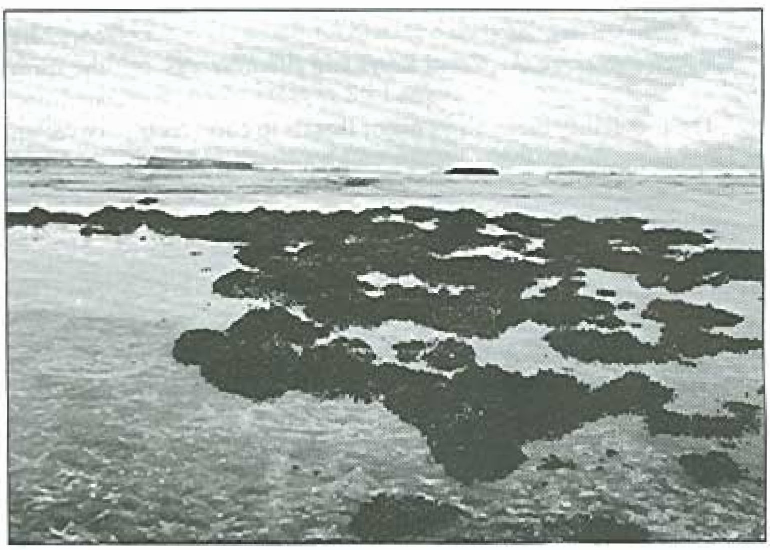

Plate 2: Halimeda *infestation on the coral reefs of Hikkaduwa.*

the very limited area of good coral cover, special care in the form of timely interventions might be necessary to keep the very fragile balance of the coral reef ecosystem.

During the recent CMC/URI/CRMP Sri Lanka/NARA Project to Implement the Hikkaduwa Marine Sanctuary Management Proposals of the Hikkaduwa Special Area Management and Marine Sanctuary Coordinating Committee, some first aid measures were taken where some *Halimeda* posing a threat to live coral areas were removed. Subsequently, a 2-day *Halimeda* cleanup effort was carried out on 23 and 24 April 1997 with the support of the World Conservation Union (IUCN) and which involved the local community and stakeholders (Plate 3) such as the traditional fishermen, glass bottom boat owners, hotel employees, diving station employees and local youth. Although only 20 local participants were requested for the cleanup, 31 turned up on the first day. Due to logistic problems the number had to be restricted to 22 local community participants with preference given to those who could not join the first group. The local participants operated under the supervision of the project members from NARA, CMC, IUCN and the Department of Wildlife Conservation. This cleanup effort was a temporary measure to prevent the invasion of *Halimeda* into the best live coral areas of the newly demarcated Protected and Snorkeling Zones and the Research Zone of the HMS. It was a hurriedly organized effort to clean up as much of the *Halimeda* as possible from the most threatened live coral areas, before the onset of the southwest monsoon period from May to July/August. The cleanup efforts resulted in the removal of approximately 12 cubic meters of *Halimeda* from the live coral areas under threat. What was accomplished was only a fraction of what would be required to keep the *Halimeda* in check, if we consider the other areas of the HMS where no attempt was made to clear it. A reassessment and perhaps a long-term monitoring and cleanup program would be necessary to keep the *Halimeda* from invading and colonizing at least the live coral areas until a better option is available. This should be carried out as soon as the present monsoon season is over.

Plate 3: Traditional fishermen assisting in the Halimeda *cleanup.*

The *Halimeda* cleanup effort was also designed to build awareness among the local community and stakeholders so that they could be useful components of any future HMS management efforts.

...it would be better to tend the limited reef areas of the Hikkaduwa Marine Sanctuary as one would tend one's beautifully kept home garden...

Otherwise, the choice could well be between a coral garden or a *Halimeda* bed.

Conclusion

The Hikkaduwa Marine Sanctuary, situated in a highly accessible and developed tourist resort area, is vulnerable to many stresses. Absence of a common sewerage system to serve the town and the hydrocarbon pollution from fishing and glass bottom boats are major concerns which could have direct as well as indirect impacts on the reefs and the biodiversity of the HMS. The overgrowth of *Halimeda* could well be one. The cause of the overgrowth of *Halimeda* is academic. The real ground level problem is containing and preventing it from overrunning the good coral areas.

A first aid measure has already been taken which would give some time so as to enable a better assessment of the situation. Stressed coral reefs such as those of the HMS have to be treated as such and due care in the form of human interventions should be considered to keep the integrity of the ecosystem so that it can continue to serve the useful purposes it provides to the stakeholders. Given sufficient time, unstressed coral reefs can recover from natural disasters and even limited human abuses. Given the historical background, the very limited reef areas, the present stresses, and the importance of good quality reefs to sustain the livelihood of stakeholders dependent on them, it would be better to tend the limited reef areas of the HMS as one would tend one's beautifully kept home garden. Otherwise, the choice could well be between a coral garden and a *Halimeda* bed.

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IMPACT OF POLLUTION ON MARINE BIODIVERSITY

The rapidly expanding economies in the East Asian Seas region have been achieved largely through economic development, particularly industrialization taking place in coastal areas. Unfortunately, unregulated development has often led to environmental degradation as countries overlook the management implications of increasing demands placed on natural resources. Ironically, environmental protection is often afforded a lower priority as economic success becomes the prime moving force in the development of the region, and this has led to an increased threat of pollution on the marine environment.

Marine pollution, defined by GESAMP (International Joint Group of Experts on the Scientific Aspects of Marine Pollution) in 1969 as the "anthropogenic input of substances into the marine environment resulting in harm to marine life, human health, marine activities and a reduction in the quality and usefulness of seawater", is a problem increasingly faced by nations bordering the South China Sea region. Contrary to popular perception, the main sources of pollution in the marine environment does not originate from oil spills from ships and tankers, but rather from land-based sources. The United Nations Environment Programme (UNEP) has identified land-based sources as contributing some 80% of pollution in the marine environment, encompassing runoff and land-based discharges, as well as atmospheric inputs, which are mainly derived from land-based sources (Table 1).

Land-based sources of pollution in the marine environment may be divided into three broad categories, based on the different degrees of impact they have on marine life and the ease of measurement (see Figure 1). Broadly separated, the three categories of pollutants are distinguished by those that are organic in nature, e.g. nutrients and oils; inorganic substances including metals and radionuclides; and the persistent organic pollutants (POPs) made up of pesticides/herbicides, polyaromatic hydrocarbons, polychlorinated biphenyls and other synthetic organics. Of these, POPs rank highest both in terms of environmental impact and difficulty of measurement, while the organics are easily detected even though they are known to have a high impact.

Table 1: Sources of Pollution in the Marine Environment

Source	% of All Potential Pollutants
Run-off and land-based discharges	44
Atmosphere (largely from land-based sources)	33
Maritime transportation	12
Dumping	10
Offshore production	1

Source: GESAMP. 1990. The State of the Marine Environment. UNEP Regional Seas Reports and Studies No. 115.

In the East Asian Seas region, pollution arising from both point and diffuse land-based discharges of domestic and industrial wastes are the main threats to coastal and marine ecosystem integrity, ultimately affecting ecological biodiversity. In Southeast Asia alone, domestic and industrial sewage, sedimentation and oil have been singled out as the main pollutants threatening the diversity of marine life (Wilkinson, 1995). The coastal zones are most vulnerable as these are areas where more than 60% of the population in the region live, and where most economic development takes place. Significant economic and social benefits may be obtained from coastal development and associated coastal ecosystems, with fisheries and tourism being two obvious examples. Coastal ecosystems at risk from pollution, particularly those that are long-term and chronic in nature, are the estuaries, mangrove swamps, coral reefs, seagrass beds, soft-bottom benthic communities, as well as adjacent waters that support important fisheries.

Pollutants impact ecosystems in many ways. Human waste, often untreated, from large coastal populations enters rivers, estuaries and eventually the sea. The effect is an increased organic nutrient load resulting in eutrophication, especially in areas with poor tidal flushing. Although small sewage loads may benefit mangrove ecosystems, it causes degradation in other ecosystems like coral reefs and seagrass beds. In particular, eutrophication in waters supporting coral reefs are known to cause the rapid growth of highly competitive organisms, e.g. macro-algae, sponges, sea squirts, worms and molluscs which overgrow and smother corals, or burrow into coral skeletons, causing them to collapse. This eventually leads

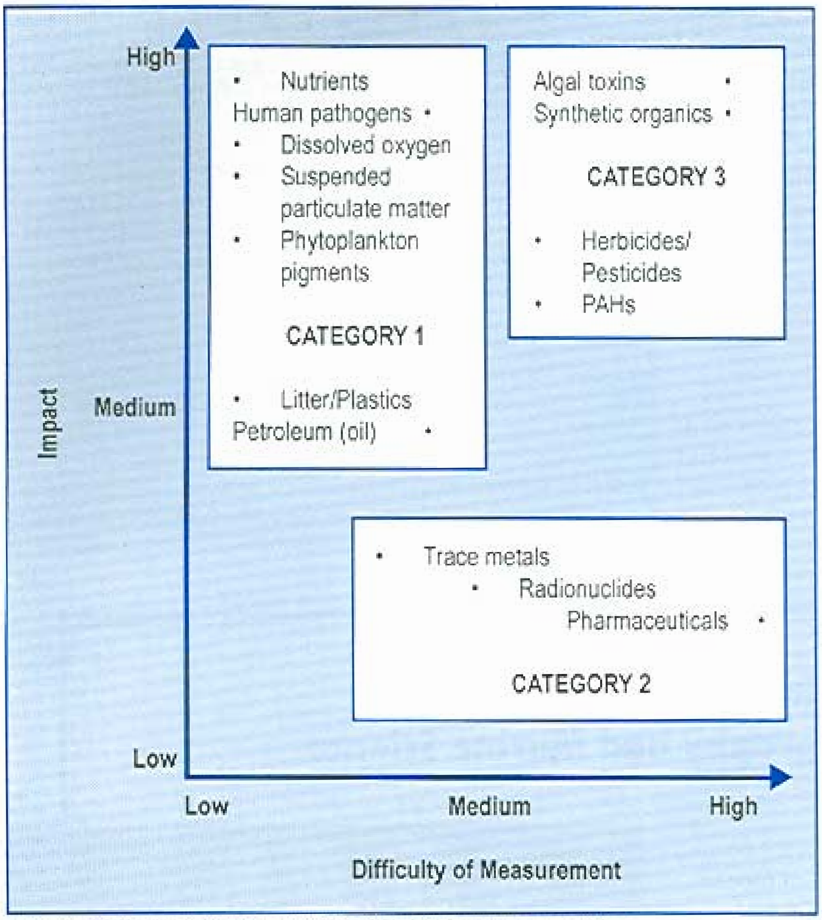

Figure 1: Impact Versus Difficulty of Measurement for Contaminants/Analytes (adapted from the Programme for Global Investigation of Pollution in the Marine Environment).

to a deterioration in the integrity of the ecosystem structure, and an alteration in biodiversity, resulting in a community dominated mainly by opportunistic species to the exclusion of natural species (Wilkinson, 1995).

More intensive and efficient agricultural practices have led to increased effluents made up of fertilizers, animal wastes and sediment finding their way into waterways, coastal estuaries and the sea. Industrial pollution is also a threat in this region as countries move towards developing economies based on heavy industries. Unlike domestic sewage which is biodegradable, industrial effluents are persistent and remain in the environment for long periods of time, and may poison food chains for decades. Inputs of pollution from the shipping and oil industry, although small in comparison to other sources of pollution, also affect the environment dramatically. Oil spills have been known not only to cause the death of wild fowl and marine mammals, but more importantly, to result in the loss of mangrove, seagrass and coral reef habitats.

Throughout the East Asian Seas region, estuarine communities are also being affected by pollution. Domestic and industrial sewage contamination in Jakarta Bay, Indonesia; Bangkok, Thailand; and Manila, Philippines has resulted in severe damage and loss of coral reefs and associated fisheries (Wilkinson, 1995). Pollution by domestic and industrial wastes in Manila Bay, Philippines has resulted in its waters becoming unsafe for bathing and other recreational activities, and also a drastic reduction in the biological diversity of the bay's soft-bottom benthic biota (Guerrero et al., 1987). The frequency of red tide incidences in Manila Bay has increased in recent years possibly due to organic pollution. A major outbreak of red tide caused by a toxic dinoflagellate in Maqueda Bay, Philippines during 1983 resulted in major commercial losses due to an 8-month ban on the harvesting of the green mussel and commercial fisheries cultured in the area.

The effects of certain pollutants in coastal ecosystems may, however, be reversed if the source of pollution is removed and mitigation measures taken. In fact, most dramatic recoveries in ecosystems may be observed after cessation of domestic polluting activities. The results from a 10-year program from 1977 to 1987 to clean up the Singapore and Kallang River catchments in Singapore demonstrates how the biodiversity of an ecosystem may be restored with proper management. The Singapore River was a center of trade since the early 1800s, and landing and trading activities have taken place along its banks for many generations. These activities resulted in the river becoming polluted with organic debris from untreated sewage discharge, decomposing matter from animal and food, and litter. Subsequently, a program to clean up the river was introduced in 1977, consisting of the removal of polluting activities (e.g., the installation of proper sewerage treatment, relocation of street hawkers, markets, lighter activities and squatters to properly managed areas), physical engineering improvements to the river, and restocking of marine life (e.g., fish and crustaceans). Studies carried out after the restoration indicated that the physical and biological conditions of the river had improved with time, and the river was subsequently reported to support over 20 species of soft-bottom invertebrates (Yip et al., 1987).

Clearly, with rapid economic development, pollution from domestic and industrial sources remains a major threat to the coastal ecosystems that border the coastlines of the East Asian Seas region. The value of these natural biological resources to the region in terms of economic yield cannot be over-emphasized. It is, therefore, important that a balance is struck between achieving economic excellence and environmental protection through good pollution management strategies. Without such a balance, we risk losing the very resources that would ensure that we achieve a sustainable future.

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REFERENCES

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Wilkinson, C. 1995. Living coastal resources of Southeast Asia: status and management. Report of the Consultative Forum. Third ASEAN-Australia Symposium on Living Coastal Resources, Bangkok, Thailand, May 1994. 133 p.

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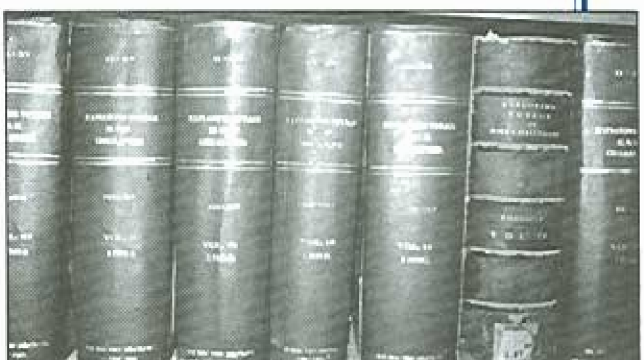
Saving Rare Documents on Oceanography and Marine Science



Old but highly important library documents in the Nha Trang Institute of Oceanography in Vietnam were saved from damp and dusty conditions. Such documents as "Voyage de la Perouse autour du monde, 1785-1788, vol. 1-4", "Exploring voyage of HMS Challenger Narrative, 1874-1875, vol. 1-32", "Siboga Expeditie, 1899-1900", "Resultats de Campagnes scientifiques du Prince de Monaco, 1889-1938, Facs, 1-110" are housed in its library. There are also about 4,000 rare books on oceanography and thousands of unpublished oceanographic documents, original field survey data, maps and charts housed in the library. Presently it holds 60,000 books, scientific reports and magazines. The library is the biggest and most precious oceanographic library in Vietnam and possibly even in Southeast Asia.

The Coastal Management Center (CMC) with financial support from Sida/SAREC (Swedish Agency for Research Cooperation with Developing Countries) provided US$20,000 to repair the library facilities and purchase equipment such as book shelves, air conditioner and computer. The roof was repaired of leaks; a new electrical system was installed to replace the 70-year old system which caused several fires; and doors and windows were renovated to allow air circulation. It was a wise and worthy investment to save books, serials and documents on oceanography and marine science. Now important oceanographic documents at Nha Trang are being scanned and filed in computers.

The response of CMC and Sida/SAREC to save the library documents at the Nha Trang Institute of Oceanographic brought additional support for the library from the British Council and the Vietnamese government. **Rogelio O. Juliano**

Newsbriefs

The Global Environment Facility (GEF) /United Nations Development Programme (UNDP)/ International Maritime Organization (IMO) Regional Programme for Marine Pollution Prevention and Management in the East Asian Seas (MPP-EAS) is now on its fourth year of implementation. The Programme is participated in by Brunei Darussalam, Cambodia, China, DPR Korea, Indonesia, Malaysia, Philippines, Republic of Korea, Singapore, Thailand and Vietnam. This section highlights recent activities of the Programme from January to July 1997.

REGIONAL WORKSHOP ON THE PREVENTION AND MANAGEMENT OF MARINE POLLUTION IN THE EAST ASIAN SEAS

The workshop was held on 4-6 July 1997 in Subic Bay, Philippines organized by the GEF/UNDP/IMO MPP-EAS and the Coastal Management Center participated in by 30 senior experts from nine countries in the East Asian region. The gathering aimed to identify, express and formulate suggestions on issues concerning the environmental state of the East Asian Seas.

Discussions evolved on the successes and failures of regional efforts toward the protection and management of the East Asian Seas, building partnerships and prioritization of regional environmental management efforts.

The workshop concluded that natural resources in the East Asian Seas are heavily exploited. Coastal and marine environmental problems are handled in a piecemeal manner, thereby, there is a need for a systematic, comprehensive and effective framework in addressing the problems.

INTEGRATED COASTAL MANAGEMENT (ICM) IN XIAMEN, CHINA

Xiamen Demonstration Project Evaluation Workshop. A panel of experts and scientists evaluated on 26-28 June 1997 the project's outputs and progress. The panel concluded that the project is very successful as a whole and that the experience gained is a cutting edge in ICM development at the international level. It recommended to the government of Xiamen that: (1) interagency marine management mechanisms be strengthened; (2) the adoption of the proposed cross sectoral marine environment monitoring program and sea water quality standards be facilitated; and (3) an "environment foundation", as part of sustainable financing mechanism, be established.

The coastal environmental profile of Xiamen published. This 110-page document depicts the management issues of Xiamen, coastal resources and environment, their causes, priorities and consequences, in order to provide a scientific basis for developing a strategic management plan and other demonstration activities.

Participants to the Regional Workshop on the Prevention and Management of Marine Pollution in the East Asian Seas at the Subic Bay, Philippines.

Newsbriefs

ICM DEMONSTRATION PROJECT IN BATANGAS BAY, PHILIPPINES

Batangas Bay Demonstration Project Evaluation Workshop. A workshop was held on 24-25 July 1997 in Batangas City to assess the results and impact of the project. This was attended by delegates from national government offices, local government units, academic institutions, the private sector and non-government organizations. The project is able to apply the integrated coastal management (ICM) framework for marine polution prevention and mitigation successfully in the Batangas Bay Region. Significant progress has been made in ICM institutional arrangements, developing integrated waste management frameworks and programs, fostering public and private sector partnership, strengthening capability in marine pollution monitoring and assessment, capacity building in local institutions and personnel, and enhancing public awareness and participation. A summary report of the workshop is available.

Hazardous waste risk assessment study. Professor Davide Calamari of the University of Milan, Italy, conducted a pesticide risk assessment study for the Batangas Bay Region and Xiamen. It was a joint project between the Food and Agriculture Organization and the Programme. Professor Calamari also gave a series of lectures on ecotoxicological and chemical hazards and introduced the fugacity models to be used in assessing risks from pesticides in the Region for the local stakeholders in the public and private sectors.

MALACCA STRAITS DEMONSTRATION PROJECT

Regional database system and environmental management atlas. Meetings were held with National Focal Points, universities and scientific and technical institutions/agencies in Indonesia, Malaysia and Singapore to review proposals for developing a regional database system and an environmental atlas for the Malacca Straits, and to establish agreements on coordinating activities within and among the three countries.

Economic assessment of benefits from the Malacca Straits. A draft report entitled "Marine Pollution Prevention and Management in East Asian Subregional Seas Areas: A Benefit-Cost Framework,: by Thomas A. Grigalunas of the University of Rhode Island, has been completed. The model will be used to assess the benefits, costs and efficiency of existing environmental management projects and translate them into monetary values. The report is under review by the Programme Office, as a starting point for development of related initiatives in the Straits.

MARINE POLLUTION MONITORING AND INFORMATION MANAGEMENT NETWORK

Directory of institutions involved in marine pollution studies. An abridged electronic version of the directory is planned to be uploaded into the Programme's Web site. Links with another directory in the Philippines of more than 200 institutions involved in coastal and reef work are being developed.

Programme's Web page. The Programme's current Web page is <http://www.skyinet.net/users/imo>. The page includes Programme objectives and strategies; technical services offered; institutional linkages; Legal Information Database; publications; and future activities.

Network mailing list launched. The Marine Pollution Monitoring and Information Management Network mailing list has been launched. Its primary aim is to provide subscribers and Network members, who have e-mail access, fast and current information on on-going activities of the Network. The list also aims to provide a medium for interaction among members, especially in the exchange of marine pollution monitoring data and information.

Publications. The following documents were published during the first half of 1997: 1) The Coastal Environmental Profile of Xiamen; 2) Tropical Coasts, December 1996 issue; 3) Marine Pollution Updates, March 1997 and June 1997 issues; 4) Malacca Straits Consultative Meeting; 5) Malacca Straits Initial Risk Assessment; 6) Sustainable Financing Mechanisms: Public Sector-Private Sector Partnership; 6) French, Portuguese and Swahili translations of ICM Good

Practices; 7) Proceedings of the National Workshop on IMO Conventions for the Prevention and Management of Marine Pollution (Vietnam); 8) Proceedings of the National Workshop on the Ratification and Implementation of MARPOL 73/78 in the Philippines; and 9) Summary Report of the Batangas Bay Demonstration Project Evaluation Workshop.

INTERNATIONAL CONVENTIONS

Legal Information Database. Conversion of the database software to Microsoft Access was completed. The database is now called the Legal Information Database Reference Catalog. Two reference manuals were completed at the end of February 1997: the User's Manual and the Technical Manual. This can be accessed through the Programme's Web page.

MARPOL Projects. The National Workshop on the Ratification and Implementation of MARPOL was held on 9-10 June in the Philippines. A Workshop Resolution and Action Plan were adopted. The goal of the Government is to submit an instrument of accession to the President and to the Senate within the year. A Workshop report is available from the Regional Programme Office. Another workshop, on IMO Conventions for the Prevention and Management of Marine Pollution was held in Hanoi and Ho Chi Minh City, respectively, in Vietnam on 21-22 April and 24-25 April. Five IMO Conventions were reviewed and an Action Plan was prepared outlining steps necessary for Vietnam to assess its needs and proceed with the ratification of the five conventions. Copies of the proceedings are available from the Regional Programme Office.

CAPACITY BUILDING

Internship. A six-month contract for Mr. Fan Zhijie from Dalian, China, began on 17 February and will end on 15 August 1997. Mr. Fan is tasked to assist in the review of technical outputs from the Programme demonstration projects in Xiamen, PR China, and Batangas, Philippines and the activities of the Regional Network for Marine Pollution Monitoring and Information Management.

Fishery Assessment Project Workshop. The workshop, conducted on 13 June, assessed the project; evaluated data from secondary and survey activities; and identified means of filling data gaps. It was attended by twelve participants from the Department of Agriculture, University of the Philippines Marine Science Institute, Management Training Development Center of De La Salle University-Lipa, and the Regional Programme Office.

Workshop on Environmental Risk Assessment for Pesticides. This workshop was conducted under the Batangas Bay Demonstration Project on 26-27 June. The workshop explained risk assessment for pesticides in reference to the Bay area and was attended by sixteen participants from the Regional Programme Office, PG-ENRO, and the Office of the Provincial Agriculture.

Training courses on OPRC. Two training courses on Oil Pollution Preparedness, Response and Cooperation for the Gulf of Thailand (Bangkok) and the Southern South China Sea (Brunei Darussalam) were conducted on 15-20 June and 22-27 June, respectively. The training courses aimed to provide basic response strategies and tactics, and organizational planning skills required of operational supervisory staff to deal with major oil spills. Forty-four participants representing national government units and the private sector from six countries, i.e., Thailand, Cambodia, Malaysia, Vietnam, Brunei Darussalam and the Philippines, attended.

SUSTAINABLE FINANCING MECHANISMS

CV survey. A contingent valuation (CV) survey for the Batangas Bay region to assess support for priorities and willingness-to-pay of the general public for marine and coastal resource and environmental management programs was conducted on 16-25 May 1997 in the coastal municipalities of Batangas Province. Results will be utilized to assist/reinforce marine coastal resource and environmental planning, implementation and evaluation in the Bay. Two outputs, a Manual of Practice and a Technical Report, from the survey will be published.

announcements

International Symposium on Integrated Coastal and Marine Resource Management

This symposium will be held in Malang, East Java, Indonesia on 25-27 November 1997. Interested parties may contact:

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National Institute of Technology
Jl. Bend. Sigura-gura No. 2, Malang
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Tel.: (62) 341 551431
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Seventh International Training Workshop on Integrated Coastal Zone Management (ICZM)

This annual international training workshop will be held on 20 March-10 April, 1998 at the Prince of Songkhla University, Hat Yai, Songkhla, Thailand. For more information, please contact:

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E-Mail: corin@ratree.psu.ac.th
WWW: http:\\ratree.psu.ac.th/~corin

Fifth International Conference on Cohesive Sediment Transport (INTERCOH '98)

This four-day conference will take place in the Korean Ocean Research and Development Institute (KORDI), Ansan, Republic of Korea on 26-30 May 1998. For details, please contact:

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Secretary, Local Organizing Committee
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Coastal Engineering Division
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Fax: (82) 345 408 5823
E-Mail: intercoh@sari.kordi.re.kr
WWW: http:\\sari.kordi.re.kr/~intercoh

Photo Competition and Symposium on Women in Asian Fisheries

The Asian Fisheries Society (AFS) and the Partnership for Development in Kampuchea (PADEK) have organized the second photographic competition on "Women in Asian Fisheries" to highlight the crucial role of women in the socioeconomic fabric of Asian fisheries. Entries will be displayed during the Fifth Asian Fisheries Forum in Chiang Mai, Thailand on 11-14 November 1998. Deadline for entries is on 30 September 1998.

AFS is also inviting poster and oral contributions on issues relating to women in any of the divisions within fisheries (capture, culture, processing, marketing, research, development, etc.) during a one-day special Symposium on Women in Asian Fisheries during the Fifth Asian Fisheries Forum in Chiang Mai. The Symposium will be chaired by Dr. Meryl Williams, Director General of the International Center for Living Aquatic Resources Management and Dr. M.C. Nandeesha of PADEK will be the Convenor. Deadline for papers is on 30 June 1998. Please address inquiries on the photo competition and the Symposium to:

Secretariat
Asian Fisheries Society
MC P.O. Box 2631
0718 Makati City
PHILIPPINES

PUBLICATIONS

NOW AVAILABLE

On Batangas Bay

- **Strategic Environmental Management Plan for the Batangas Bay Region.** 1996. 71 p.
- **The Coastal Environmental Profile of the Batangas Bay Region.** 1996. 133 p.
- **Integrated Waste Action Management Plan for the Batangas Bay Region.** 1997. 66 p.

On Xiamen

- **Strategic Management Plan for Marine Pollution Prevention and Management in Xiamen.** 1997. 46 p.
- **Coastal Environmental Profile of Xiamen.** 1997. 110 p.

On Integrated Coastal Management

- **Enhancing the Success of Integrated Coastal Management: Good Practices in the Formulation, Design and Implementation of Integrated Coastal Management Initiatives** *(Available in English, Vietnamese, Bahasa Indonesia, French, Portuguese, Swahili, Korean, Chinese and Thai).* 1996. 21 p.

- **Integrated Coastal Management in Tropical Developing Countries: Lessons Learned from Successes and Failures.** 1996. 66 p.

On Sustainable Financing Mechanisms

- **Sustainable Financing Mechanisms: Public Sector - Private Sector Partnership.** 1997. 352 p.

Annual Report

- **Marine Pollution Prevention and Management in the East Asian Seas: From Planning to Action (1996 Annual Report).** 1996. 40 p.

Newsletters

- **Tropical Coasts Newsletter.** Vol. 3, No. 2, December 1996.
- **Marine Pollution Updates.** Vol. 3, No. 1, March 1996 and Vol. 3, No. 2, June 1996.

FORTHCOMING

- **Malacca Straits Environmental Profile.** 1997. 259 p.

- **Oil Spill Modelling in the East Asian Region: with Special Reference to the Malacca Straits.** 1997. 304 p.

- **Manual of Practice: Contingent Valuation Survey for Integrated Coastal Management (ICM) Applications.** 1997. 28 p.

For copies, interested parties may contact:

PUBLICATIONS UNIT
GEF/UNDP/IMO
Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas
P.O. Box 2502, Quezon City 1165
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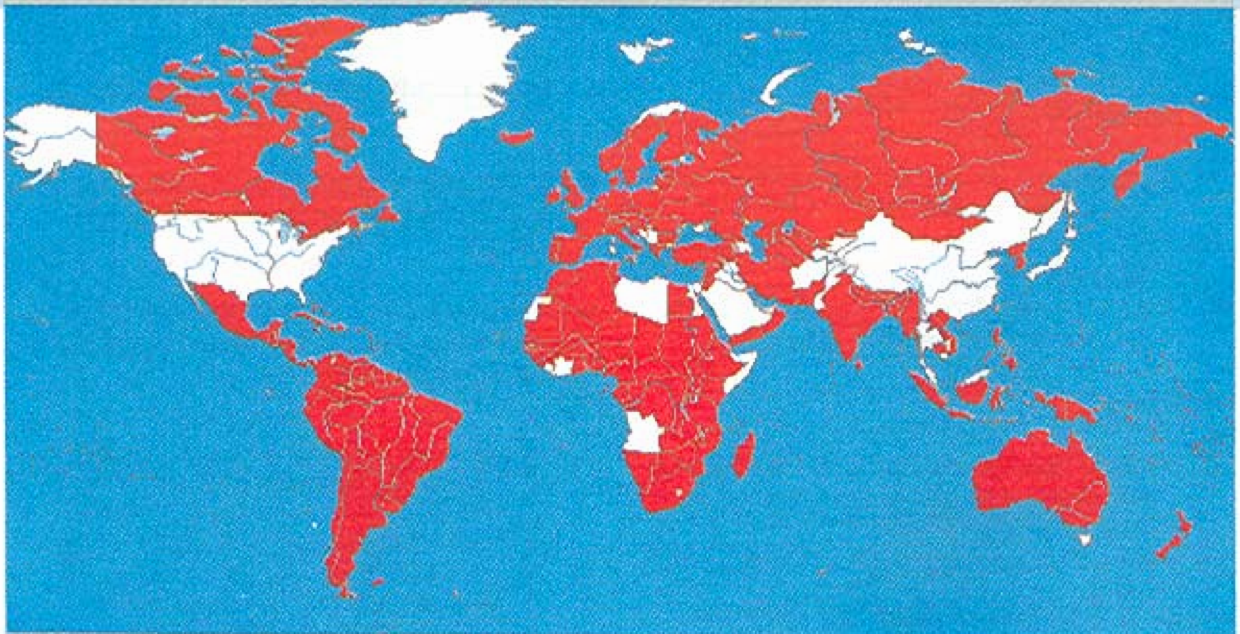
READERS' CORNER

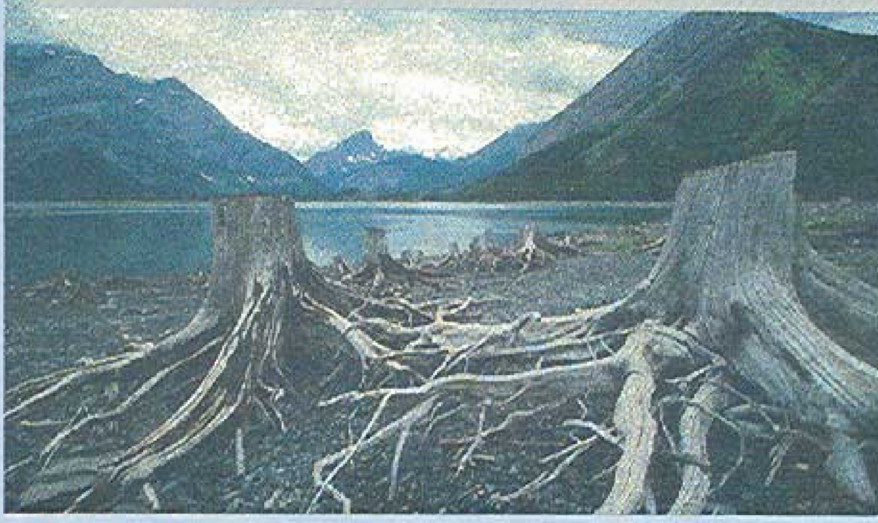
Tropical Coasts invites readers to send comments or submit short write-ups (250-300 words) about the various topics covered by the newsletter. Items should be concise and to the point. The editors reserve the right to shorten or condense the write-up as they see fit and to ensure that it is appropriate to the themes of *Tropical Coasts*.

READERS' CORNER

Convention on Biological Diversity: Ratification Status



The Convention was ratified by 169 countries as of 1 June 1997 (as shown in red on the map).
Source: http://www.biodiv.org/conv/ratify.html



"We abuse the earth because we consider it as a commodity which we own. When we see the earth as a community to which we belong, then we will be able to use it with love and respect."

Aldo Leopold
A Sand County Almanac, 1949

Tropical Coasts is being published to stimulate exchange of information and sharing of experiences and ideas with respect to environmental protection and the management of coastal and marine areas. This newsletter is published twice a year and distributed free of charge to individuals and relevant organizations in the developing countries. Readers are strongly encouraged to send their contributed articles to:

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