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LIVING COASTAL RESOURCES OF THE ASEAN REGION AND DATA REQUIREMENTS FOR THEIR MANAGEMENT

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ABSTRACT

Greater attention on the condition of the region's living coastal resources has become evident since the last decade. Investigations of coastal ecosystems have highlighted their significance and values, and drawn attention to their degradation as well as the need for proper management. Data requirements for the management of living coastal resources are dependent on the type of management programme intended. The most relevant data can be obtained only from survey techniques that are adequately designed to meet stated objectives.

Management of the coastal zone has developed into a prominent issue especially during the past decade and increasing attention is being focused on living coastal resources. Many countries are becoming increasingly aware that coastal resources warrant special consideration[1]. Some have taken positive steps to implement integrated coastal zone management programmes which include living resources conservation, either on a localized or nationwide scale.

While pressures on living coastal resources due to human influence were recognized as early as in the 1960s, it was not until recently that the important roles performed by these renewable resources were realized and better appreciated. This was made possible through important data collection and scientific study carried out in a more systematic and comprehensive manner. The obvious increase in publications dealing with various aspects of coastal ecosystems over the last decade not only demonstrated the growing concern generated over the degradation of these systems, but also contributed to a much better understanding of them.

SIGNIFICANCE OF LIVING COASTAL RESOURCES

Living coastal resources are found within major coastal ecosystems consisting of coral reefs, mangroves, seagrass beds, benthic systems, and estuaries or lagoons. Coastal ecosystems, particularly estuaries and inshore marine waters have the highest rate of primary production as compared to terrestrial and oceanic regions. Daily gross production rate in terms of grams of dry organic matter per square metre area for the narrow coastal band ranges from 10 to 25, with all other regions having substantially lower values[2]. The coastal band conveniently thought of as the transition area between land and sea, holds this great diversity of ecosystems, each characterized by its own unique ecological feature. Conditions here may be harsh with wide fluctuations in temperature and salinity, but because of the abundance of food supply, these areas can and do support a high diversity of species which have become efficiently adapted to the widely fluctuating environmental conditions. These ecosystems remain productive because of tidal action which circulates food and nutrients rapidly and efficiently and at the same time washes away waste materials. They also serve as efficient nutrient traps of the continuous nutrient input washed down from land.

Within these ecosystems, the autotrophic and heterotrophic layers are maintained in close contact so that energy transfer is more direct and better utilized. Primary production occurs all year round especially in the tropics, and the diversity of plant life (phytoplankton, benthic microflora, macroalgae and seagrasses) ensures a high primary production rate. A review of primary productivity rates of various ecosystems showed that the values for coastal ecosystems were far greater than for those of land, freshwater or the open ocean. The average gross primary productivity (gm $C/m^2/year$) was 2300 to 5074 for mangrove forests, 4650 for tropical seagrass beds, 4200 for coral reefs and 3836 for tropical algal communities[3]. Although the deeper open seas of the ASEAN region are not as productive as in temperate areas (except in areas of upwelling), the shallower inshore areas are extremely productive.

The coastlines of the six ASEAN countries combine to form a total estimated length of 85,523 km. This is made up of 54,716 km for Indonesia, 22,540 km for the Philippines, 4,675 km for Malaysia, 3,219 km for Thailand, 193 km for Singapore[4] and 180 km for Brunei Darussalam (estimated from maps). Such extensive coastlines provide a vast potential for the variety of coastal and nearshore marine ecosystems. This potential is recognized as being greatest in the East Asian Seas region (covering the six ASEAN countries) than in other parts of the Indian Ocean region[5].

EXTENT, UTILIZATION AND MANAGEMENT NEEDS

Coastal development in the ASEAN region is extensive with over 70% of the combined populations of the six countries concentrated in coastal villages or towns. Industrialization of coastal areas and offshore islands has been the trend, as the siting of industries in coastal areas makes them within easy reach of port facilities. With this development, coastal areas have become rapidly urbanized, placing a great strain on the coastal environment and its living resources as wastes are discharged in ever-increasing amounts. Some countries have implemented strict waste treatment measures in order to prevent excessive pollution of the coastal environment.

Many of the ASEAN nations depend on tourism as an important source of revenue and develop coastal environments to attract tourists. Beaches have therefore been developed for recreation and tourism, and new unexploited coastal areas are constantly being investigated for such development. As the values of coastal living resources become well understood, some countries have designated reserve areas along the coastal environment in order to prevent the total loss of such resources.

Mangroves

Mangrove stands and forests are extensive in the ASEAN region with a combined estimated area of more than five million hectares[6-10]. They form a valuable resource both directly as well as indirectly. Their direct value comes from the traditional use of mangrove wood for fuel and building materials. The bark is used for the production of tannin while some species have edible leaves or fruits[5]. Mangrove trees are also used for the production of chipboard and other purposes[11].

The indirect value of mangrove ecosystems lies in their role of sustaining other natural resources such as fish, crustacea and shellfish. They also serve as important nursery areas for other commercially important species of fish and shrimps and have been shown to support nearshore fish production[12,13]. In Indonesia alone, the value of mangrove forestry products, both for export and domestic use, amounted to an estimated US$ 26 million in 1978 while mangrove-linked fishery products amounted to US$ 194 million[14].

Mangrove forests are also important in protecting shorelines against erosion and modifying the effects of typhoons on coastal areas. They trap sediment washed down by rivers and restrict freshwater runoff from land so that the salinity of the coastal area remains stabilized. The Southeast Asian mangroves support a high diversity of over 300 plant species and more than 1000 marine invertebrate and vertebrate species, in addition to 177 bird and 36 mammal species associated with mangroves. Some of these, like the proboscis monkey, *Nasalis larvatus*, in Borneo are of scientific interest.

Coral Reefs

The estimated extent of coral reefs worldwide is 600,000 km^2 of which 25 to 30% are located in Southeast Asia[15]. The waters of the region are extensively shallow and abound with reefs. Reef life is rich and diverse and the ASEAN region is considered as the faunistic centre of the entire Indo-Pacific region. The most extensive reefs occur in Indonesia and the Philippines. The diversities of hard corals, reef fishes and reef-associated organisms are known to be high. Over 2000 species or 10% of the world's fishes are associated with coral reefs and many of them are valuable as a food source.

The high productivity rate of coral reefs is well known. It supports both resident as well as visiting species and is valuable for artisanal and commercial fisheries. It has been estimated[16] that reefs can sustain maximum fish harvests of 10 to 20 mt/km^2. Researchers are focusing more attention on reef organisms as these provide a source for natural substances of significant pharmaceutical importance. At the same time, other reef-related organisms serve as a source of food to man while limestone blocks make effective building materials. The visual splendour of coral reefs makes them important as tourist attractions and if properly managed and developed, can provide employment and an important source of revenue.

Coral reefs are also valuable in their natural role as breakwaters, buffering the impact of strong waves and thereby preventing erosion of the beaches. The breakdown of the limestone framework provides a source of sand for the beaches. Like the mangroves, coral reefs in the ASEAN region are being impacted by growing human influence. Excessive harvesting of edible fish, shellfish and other reef-related organisms for food leads to rapid depletion of stocks often with permanent effects. Coral mining weakens the framework of reefs and also destroys live corals and other organisms overlying the foundation. Mining of buried fossil giant clam shells is also detrimental. Destructive fishing methods such as muro-ami, blasting, cyanide poisoning are disastrous to the ecosystem. Man's activities on land such as deforestation, mine tailings and reclamation, increases the sediment level in the sea which affects coral growth by direct smothering or reducing light penetration.

Seagrass Beds

The major economic importance of seagrass beds stems from their provision of critical nursery grounds for many commercial species of fish and shrimps. The ecosystem with its high primary productivity supports large invertebrate and fish stocks in surrounding areas. Genera of commercial importance dependent on seagrass beds for some stage of their life history include *Penaeus, Lutjanus, Lethrinus* and *Siganus*. Seagrasses also form the major source of food for dugongs, green turtles and juvenile hawksbill turtles, all of which are of scientific or conservation interest.

The economic value of the fishery associated with a seagrass ecosystem in Tarut Bay, Saudi Arabia, has been estimated to be US$ 8 million. If the seagrasses were consumed directly by green turtles, the turtle yield would be US$ 46 million[17]. These values, although very theoretical, do give an indication of the importance of this living resource.

The indirect value of the ecosystem is usually ignored. These communities bind sediments, reduce turbidity, retard erosion and lower levels of pollution. Very little attention has been paid to the importance of the seagrass ecosystem and a high percentage has been affected by industrial, agricultural and sewage discharge, coastal reclamation and dredging, and overfishing. Destruction of this ecosystem has been known to cause the collapse of the shrimp industry in some parts of the world while overfishing leads to changes in the ecosystem, resulting in the population explosion of some species such as sea urchins which eventually destroy the natural balance.

Soft-bottom Benthic Habitats

Soft-bottom benthic habitats can be placed into two categories, open or enclosed. The open habitats include inshore seabed areas of sand and silt, as well as sandy and sand-mud beaches on exposed shores. In the ASEAN region, sand and clay predominate, influenced largely by river inputs. There is a higher diversity and greater biomass of flora and fauna on these shallow seabeds than on the deeper offshore seafloors. Molluscs and echinoderms are usually associated with these shallow soft-bottomed areas. Such habitats provide significant fishing grounds suitable for trawling. Stocks of a wide variety of fish species and shrimps are available. The sandy shores themselves with limited life are important as nesting grounds for turtles.

The main threats to these habitats is beach sand mining for construction purposes and overfishing of stocks. Development of beaches for recreational use also occurs throughout the ASEAN region and in some areas, extensive development has placed a high level of stress on the habitat.

Enclosed soft-bottom habitats include lagoons, mudflats, bays and estuaries. These are widespread in the ASEAN region, and are extremely productive when they support mangrove and seagrass communities. Mudflats have a covering film of microalgae and are highly productive. The estuarine areas of the region support major fisheries. Mudflats are usually associated with river mouths and the nutrient-rich organic sediments support growth of benthic organisms. Mudflats are used for the culture of blood cockle, *Anadara granosa,* which forms a significant industry in some countries in the region. Coastal lagoons are converted for the aquaculture of milkfish *(Chanos chanos),* tilapia and catfish *(Puntius javanicus).*

These habitats are often subjected to heavy pollution as human populations naturally converge to the vicinity of major rivers for logistic reasons. The process of coastal geomorphological change is dynamic and influenced by natural causes such as tides and storms as well as by human influence such as reclamation and deforestation. While these ecosystems can withstand the effects of natural causes, they may not be able to tolerate the impact of man's influence which is widespread in the region. The management of these ecosystems with their living resources is therefore of increasing importance.

DATA REQUIREMENTS

The question that is usually asked when these coastal living resources need to be managed is what specifically is to be managed and why. Answers can be obtained through proper studies designed to generate the appropriate data. Environmental impact assessment guidelines have been improved and refined to enable assessments of various types of impacts on an area to be quantified and such information is of immense value to decision-makers[18]. In the formulation of any management programme, baseline information, which provides a record of what biological communities are present in the area, has to be obtained. This entails surveys as well as a review of all existing documents relevant to the area under consideration. In some cases, detailed documentation of the communities of that area may already exist and the actual field surveys can be carried out on a reduced scale. The extent and depth of such field surveys depend largely on the level of refinement expected of the results, taking into consideration manpower, time and funding limitations. The methodologies employed in the first phase of the ASEAN-Australia Living Coastal Resources Project were modifications of tested field methods designed to meet with certain agreed objectives.

For the coral reef ecosystem, the surveys were meant to :

1. determine the patterns of distribution of macrobenthos in reefal areas;
2. monitor changes in reef community structure and

3. study and assess fish stocks in reefal areas.

The techniques agreed on were the manta board tow, line transect, visual census, permanent quadrat and fish catch statistics, all of which have been fully described[19].

The mangrove ecosystem survey methods have been selected to generate baseline data sets which can be used to monitor changes and will allow comparisons between mangroves in different localities. The survey techniques used are designed to :

1. describe plant community structure;
2. determine various soil parameters;
3. estimate potential forest primary production and
4. quantify the fish associated with mangroves.

For soft-bottom benthic communities, interest lies in the study of them in terms of their economic contributions to fisheries, and other nearshore activities. Various techniques were recommended such as :

1. sledge sampling which is important for characterization and assessment of the epibenthic fauna since it gives semi-quantitative but consistent results;
2. trawl surveys which give community structure data, particularly on species important to fisheries and
3. grab sampling which provides in-depth quantitative data of in-fauna that form an integral component of nearshore communities.

It can be seen from these techniques employed that results are aimed at being both qualitative and quantitative. They therefore not only tell what organisms are present, but also the condition of the biological community.

Apart from biological surveys which indicate the nature and condition of living coastal resources, socio-economic as well as cultural considerations connected with them need to be examined. It is important to know who is using the area at present, what the impacts are, and how the livelihood of these people will be affected by the implementation of a management plan. Will a management plan be effective in minimizing the present and future levels of impact? Information will also have to be gathered on the current traditional uses of the area and whether these practices provide for sustained use or are totally destructive[20].

Yet, more knowledge is required of living resources. Inter-relationships and energy flows between these coastal ecosystems remain largely unknown. Data on this aspect will enable management needs to be viewed in a wider perspective, for example, how will development in a particular coastal ecosystem affect adjacent ecosystems?

Living resource survey methodologies have been improved upon to enable reliable data to be obtained within a relatively short period of time. However, it is common in such sampling to obtain variance much greater than the mean because of clustering of the living organisms. This non-normal, non-poisson distribution is not due to insufficient sampling but is a result of a real biological phenomenon[21]. In biological surveys, what species are present forms the important parameter. Wrong identification of species especially in pollution monitoring will confuse the statistics[22,23]. Species identification and its reliability play an important role especially when spatial and temporal comparisons have to be made. In any biological community, temporal changes have to be monitored to identify what are caused by human influence and what can be attributed to natural inherent dynamic processes of the community. Attention will have to be made to the need for continuous taxonomic updating.

The need for information concerning living resources can never be completely fulfilled, for what we are dealing with are living dynamic systems. However, the most relevant and appropriate types of data can be obtained through survey techniques designed adequately to meet with stated objectives.

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