# Seagrass-Mangrove Ecosystems Management: A Key to Marine Coastal Conservation in the ASEAN Region

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**Seagrass beds and mangrove forests are intimately linked by functional interactive processes which are as yet little understood. These high-order interactions form a major basis which justifies an integrated management scheme for the two ecosystems. However, while dominating enclosed coastal areas in the ASEAN region, seagrass and mangrove habitats are being degraded and destroyed at an alarming rate, raising serious doubt on their capacity for biological sustainability and normal recovery within this generation.**

**An integrated approach towards seagrass and mangrove ecosystems management in the ASEAN region is discussed within a framework of known ecological principles. Recommendations are made for the conservation and sustainable use of the ecosystems and their resources.**

The ASEAN seas cover 8.94 million km$^2$ or 2.5% of the world's ocean surface (Soegiarto 1985). A common topographical feature found in these waters are the enclosed coastal seas dominated by two of the most productive tropical ecosystems knownseagrass beds and mangrove forests. The strategic coastal position of these ecosystems, however, makes them highly susceptible and vulnerable to stresses both natural and man-made (Fortes 1988). The region's coastal zone, inhabited by over 70% of the region's population, is recently being subjected to a high degree of resource exploitation as well as pollution. Fish harvested from its coastal waters is a major source of protein for human consumption and of foreign exchange through exports.

## Seagrasses and Mangroves: Habitats Under Stress

With a similar pattern of generic richness characterized by a maximum variety in the Indo-West Pacific (Heck and McCoy 1978), seagrasses and mangroves are known to have a wide spectrum of biological and physical functions. These functions, however, are being seriously threatened by pollution and severe prevailing pressure for the conversion of mangroves to other coastal uses, coupled with the increasing demand on seagrass beds mainly as avenues for transportation, for homesteads and as dumping sites for wastes. The intensified tin mining at Ranong, Phang-nga and Phuket provinces in Thailand (Aksornkoae 1986); nickel mining in Nonoc Island (Surigao del Norte) and coal mining in Semirara Island (Mindoro) in the Philippines (Fortes 1988); and mining for tin, bauxite, iron, sand, and shells in Indonesia (Soemodihardjo 1986) have added heavy deposits of spoil materials to nearby seagrass and mangrove habitats. These activities are known to affect mangrove species composition, productivity and natural regeneration (Havanond 1982: Aksornkoae 1986), while the high turbidity produced by the materials reduces the productivity of the seagrasses, and if severe enough, eventually kills them (Thayer et al. 1984).

Clear-felling of mangrove trees in the region far exceeds their annual regrowth (Rao 1986). Massive deforestation of mangroves started in the late 1960's, mainly for the production of wood chips for export to Japan. In 1968, the government of Sarawak (East Malaysia) set aside 62 km$^2$ of the forest for the production of cordwood for export to Taiwan. In Sabah in 1970, 1,227.5 km2 or 40% of the total mangrove area was alloted for wood chip export to Japan (Chan 1986). In Indonesia, more than 2,000 km$^2$ of mangroves are currently being exploited, producing 250,000 m$^3$ of wood chips annually (Darsidi 1984). The Five-Year (1984-1989) Development Plan of Indonesia marks the opening of thousands of square kilometers of mangrove lands for conversion to brackishwater fishponds ("tambaks") particularly for cultivating prawn (Soemodihardjo 1986). In Malaysia, the government plans to

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supplement marine food-production by promoting brackishwater aquaculture at the expense of vast tracts of coastal land and of coastal resources. The country is presently bent on undertaking a massive reclamation of a large portion of its western shores from Perlis to Johore mainly to accommodate its growing population and industrial needs.

In Singapore, large tracts of the mangroves have been transformed into ponds for prawn cultivation and fattening of the mud crab *Scylla serrata* (Corlett 1986). In recent years, however, this activity has declined in favor of reclamation for housing and industry. In the last 15 years, about 31 $km^2$ have been added to the land area of Singapore through reclamation, reducing its mangrove area from 12% of the total land area in 1922 to only three percent in 1987. In the Philippines, 878.2 $km^2$ of mangrove areas remain (PNMC 1986) 32.3% of which have been transformed into fishponds. Unfortunately, in all of these countries, the extensive peripheral impact of the cutting of trees and pollution, while largely unattended, are probably disproportionately high because of the failure of planners to realize the other economic and ecological potentials of the areas (Fortes 1988).

The high frequency of shipment of ores, fuels, and other raw materials from remote areas in the region, coupled with the increased tonnage of the transporting vessels, has also led to an increase in the construction of channels and harbors. The principal effect of these activities has been a change in hydrology with respect to mean water levels. This change brings about chronic salinity stresses, leading to changes in mangrove species composition (Saenger et al. 1988). In Sydney, Australia, harbor construction caused a change in the pattern of shore waves, leading to the erosion of mangrove areas and destruction of seagrass beds (Allaway 1982).

Along most of the major oil-tanker routes in the region are found luxuriant mangroves and seagrass beds. Thus, these communities face a high risk of being destroyed by oil spills and related degradative occurrences. Recently, there has been an increasing incidence of oil spills in these corridors where 3.23 million barrels (mainly crude) enter the region daily through the Straits of Malacca, and 3.81 million barrels (crude and refined products) leave the straits enroute through the South China Sea (Finn et al. 1979). For the period 1976-1979, five accidents due to heavy tanker traffic occurred in the straits, spilling at least 5,610 tons of crude and bunker oil (Bilal and Kuehnhold 1980). From 1975-1980, at least ten similar accidents occurred in Malaysian waters, 24 in Singapore, and at least 12 in Philippine waters (Gomez 1978). The grounding of the tanker Showa Maru in the Straits of Malacca in 1975, spilling 7,000 tons of crude oil, caused the dieback of hundreds of hectares of mangroves on the east coast of Sumatra (Finn et al. 1979).

There are no existing quantitative data on the effects of oil spills on seagrass communities in the ASEAN region, nor are there records to show the extent of the damage they caused. In 1987, however, an oil "mini-spill" occurred in Puerto Galera (Philippines) which, having completely decimated the mangrove stands along its coasts, did not exhibit observable damage to the benthic seagrasses. It is documented, however, that the Amoco Cadiz oil spill off the coast of Brittany (France) in 1978, discharging 216,000 tons of crude oil and 4,000 tons of bunker fuel, exhibited selective adverse effects on the animal groups associated with the seagrasses. The seagrass *Zostera* remained almost unaffected but the amphipods, isopods and polychaetes were seriously damaged and did not recover during the year following the spill (Jacobs et al. 1981). In Puerto Rico, an oil spill caused the wash-out of 3,000 $m^3$ of sand containing Thalassia due to the resulting greater buoyancy of the sediments when mixed with oil.

**Intersystem Coupling Between Seagrass Beds and Mangroves**

In tropical latitudes, seagrass systems are found between mangroves and coral reefs. This topographic position of the ecosystem invokes functional interrelationships which may have been developed through time with the other two habitats. Heck and McCoy (1978) considered seagrasses, mangroves and coral reefs concurrently because in the tropics, these taxa very often co-occur, being intimately connected in successional sequences.

The UNESCO Working Group has classified the interaction among the three ecosystems into: physical, nutrients, animal migration, and human impact. With the seagrass bed and mangrove forests, it is known (SPC/SPEC/ESCAP/UNEP 1985) that the former acts as a hydrodynamic barrier which creates a low-energy zone favorable to the latter. Seagrass beds also trap and stabilize sediments, thereby preventing abrasion or burial of the breathing organs of mangroves. On the other side, mangroves effectively bind sediments that would otherwise smother the seagrasses, and they regulate freshwater flow that buffers salinity changes unfavorable to the plants.

The ability of the two habitats to leak or export nutrients sustains their rich energy pool, ensuring that each system receives the level required for optimum development. This interhabitat export of materials leads to a rapid turnover of biomass and rapid carbon cycling to the benefit of the ecosystem components. Some members of the avifauna of mangroves feed on seagrass beds. By defecating in the mangroves upon their return, they may carry nutrients back to the ecosystem.

Seagrasses and mangroves are connected by animal movements, facilitating interhabitat energy exchange. In the Philippines, seagrass fish fauna showed a 28.4% species overlap with the mangrove fish fauna, suggesting a significant functional and structural similarity in habitat provisions for use by the organisms.

Environmental impacts resulting from man's activities clearly demonstrate the existence of vital connections between seagrasses and mangroves. Destruction of mangrove forests causes runoff of terrigenous materials, smothering and shading seagrasses, while also effecting eutrophication adverse to the latter. On the other hand, removal of seagrasses makes the substrate unstable, such that during storms, sediments are carried into the mangroves where they exert detrimental effects to the latter. In many parts of the ASEAN coasts where coral reefs, seagrass beds and mangroves co-occur, mangroves gradually die or at least their growth are stunted due to the increased impact from waves and storm surges. Such stress factor appears a result of the destruction (by dynamite and cyanide fishing) of nearby coral reefs and seagrass beds which, in their undisturbed condition, buffer the mangroves from the impacts of waves.

**Management Perspectives**

The interconnections between seagrass beds and mangroves extend their sphere of influence far beyond their physical boundaries. These processes in part play critical positive roles in improving and maintaining the quality of the marine environment. It thus becomes apparent that an integrated study of these ecosystems is the most pragmatic approach towards the sustainable development and conservation of these resources (Fortes 1988; 1989). In contrast to the sectoral scheme, such an approach treats the resource-base as a dynamic system where biophysical, socio-cultural, and economic factors continuously change and interact. The sectoral approach to marine resource management and conservation prevalent in the ASEAN region is based upon a single exclusive purpose, disregarding the fundamental concept of biological continuum which is the key to the integrity of the marine environment as an integrated whole.

Management and conservation of ASEAN seagrasses and mangroves as an integrated resource would tend to be difficult. This is in view of the current state of knowledge people have on the fundamental connections between them. In addition, the countries tend to place higher premium on economic gains at the expense of marine environmental imperatives and without regard to the costs of ecosystem rehabilitation. The need arises for management and conservation of these resources along major relevant goals. The agenda for action proposed by Fortes (1987) for the research and development of seagrass beds in the Philippines are for the most part applicable for those of mangroves, making management goals and needs closely similar for these two ecosystems. Indeed this striking similarity directly implies similarity in approach to understand their responses as an integrated system to environmental perturbation.

The proposed goals for seagrass and mangrove ecosystem management in the Philippines include:

1. To preserve the natural interconnections known of the ecosystems;

2. To protect their ecologically valuable and economically harvestable fisheries;

3. To protect the coastlines from erosion, siltation and pollution;

4. To establish seagrass and mangrove reserves for research and educational purposes; and

5. To preserve the aesthetic and recreational qualities of the natural shorelines.

Management of seagrass beds and mangroves in the ASEAN region should thus be on the basis of a philosophy of sustainable use and conservation. These concepts place economic benefits at par with the maintenance of the ecosystems as close to their original state as possible. It should begin by preventing further degradation and loss of existing ecosystems while accommodating traditional and contemporary needs, with adequate provision of reserves suitable for protection of the biodiversity within them. However, depending on established priorities, a compromise may be reached which allows sustainable yield and reasonable resemblance to an undisturbed system.

Since ASEAN countries depend largely upon their marine resources, the improvement of marine environmental quality should be a policy objective common to the countries in the region.

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