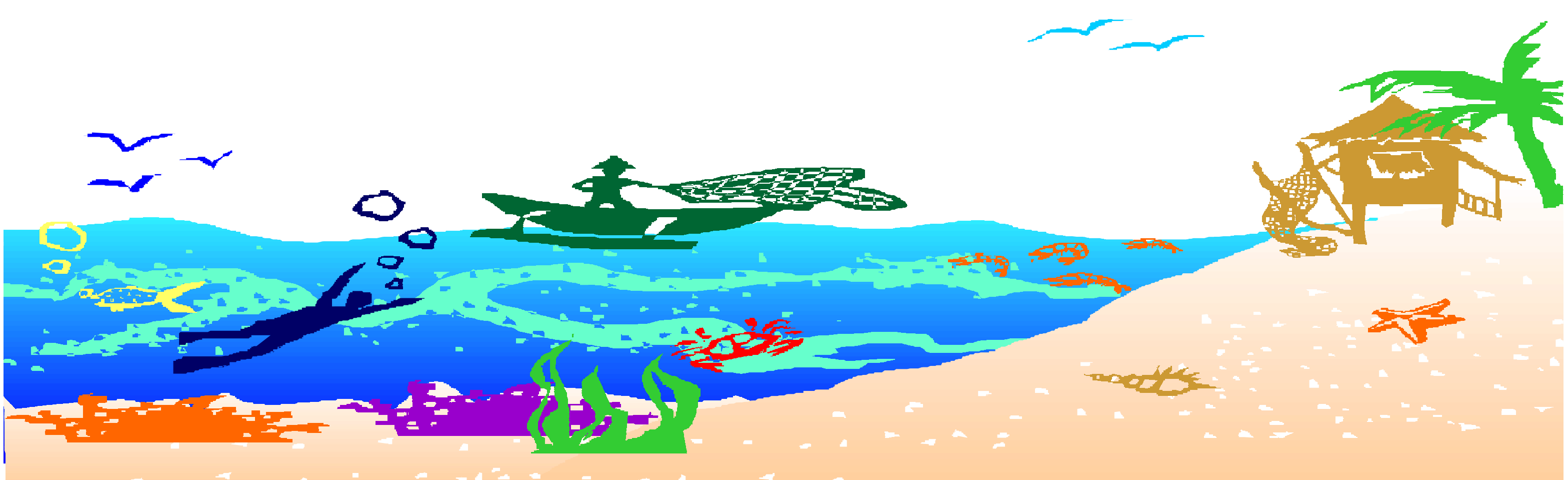
PRIMER
on
Coastal Resource Management



Primer on Coastal Resource Management

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ABOUT THIS PRIMER

This Primer on coastal resource management (CRM) was developed as a road map to the key steps in planning and implementing sustainable use of coastal resources. It describes the overall CRM process and provides snapshots of critical activities to be undertaken as part of this process.

In the Philippines, the responsibility for CRM has largely been devolved to the local government. This Primer was therefore designed for use by local government units as well as supporting and collaborating institutions such as national government agencies, non-government organizations, and academic institutions as an orientation tool for CRM.

This Primer provides a brief overview of the CRM process that can be used by coastal communities in developing sustainable fisheries, maintaining economic benefit from coastal resources, and preserving marine biodiversity. It describes the what, why, and how for each step of the CRM process. In addition, the national policy and legal framework supporting CRM is identified.

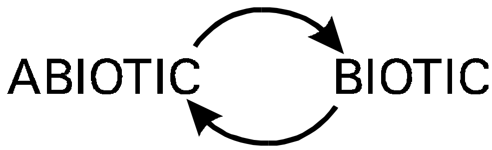
The Primer captures the essence of the CRM process, but additional reading is required for a more detailed study of the process.

This Primer is organized in sections and subsections as follows:

COASTAL AND MARINE ECOSYSTEM BASICS AND VALUES

Ecosystems and their Linkages

The ecosystem is the basic functional unit of ecology in which both the biotic communities (living organisms) and the abiotic (non-living) environment are inseparably connected and interact, maintaining the equilibrium necessary for life.



All living things are bound together in the web of life – complex food webs, symbioses, nutrient cycles and other ecological interactions. All ecosystems are thus inter-related and linked to each other. So when we talk about 'coastal resource management' (CRM), we cannot limit our view to the shoreline and water, because there are tight linkages between upland and coastal ecosystems and what occurs in one ecosystem inevitably affects the other ecosystems.

The coral reef ecosystem, for example, provides a diverse habitat for a large number of organisms that forage and feed in the other coastal ecosystems, such as seagrass and mangrove, and also serves as a source of nourishment for non-reef species that forage there or prey upon their inhabitants. Reefs also play a role in maintaining the quality of local waters and thus have a positive and relevant influence on associated coastal habitats. Moreover, depending on their proximity to adjacent coastal areas, they serve to weaken incoming waves, thus minimizing erosion and coastal hazards behind the reefs.

Conversely, reefs are affected by biological and physical processes that occur in and above it. Coral reefs and coral reef organisms are extremely sensitive to freshwater inflows which reduce ambient salinity; water-borne sediments which interfere with the filtering action of the resident filter feeders; temperature extremes beyond the thermal limits of the coral organisms; pollutants (e.g. agricultural biocides) which may enter local waters; breakage, such as that caused by cyclonic storms and by boat anchors; and excessive nutrient loading which may stimulate the excessive growth of competing algae which cover and kill coral organisms.

The mangrove ecosystems also have a variety of linkages with the larger ecosystem in which they occur. Their most prominent role is the production of leaf litter and detrital matter which is exported, during the flushing process, to the nearshore marine environment, providing a nutritious food resource for a variety of marine animals. Shoreline mangroves are also recognized as a buffer against storm-tide surges that would otherwise have a damaging effect on low-lying land areas, or they help stabilize coastal shorelines that would otherwise be prone to erosion. Probably one of their more important roles is the preservation of water quality: they have the ability to extract nutrients from circulating waters, and thus help minimize the excess nutrient enrichment potential of nearshore waters.

Mangroves are relatively resistant to many kinds of environmental disturbances and stresses. But they are sensitive to excessive siltation or sedimentation, cessation of flushing, surface-water impoundment, and major oil spills, which reduce the uptake of oxygen for respiration and thus result in rapid mangrove mortality. In general, human activities are the biggest threat to mangroves. The conversion of mangroves to residential, commercial, industrial, and agricultural developments has resulted in the loss of the basic mangrove habitat and its functions, which in turn results in the loss of a valuable food resource for a variety of marine animals in the various coastal ecosystems.

The seagrass community, the third major coastal ecosystem, plays beneficial roles in tropical coastal waters. Seagrass beds hold the substrate, provide special sanctuary for the young of many fishes, provide food for grazers such as parrotfish and conch, and export particles of plant material to be eaten by many of the smaller organisms in the food chain. Seagrasses are extremely sensitive to excessive siltation, shading, water pollution, dredge and fill activities, and fishing practices that use bottom trawls which scrape the beds. They are also sensitive to hot water discharges and are usually eliminated from areas subjected to effluents from power plants. Typically, when a seagrass community is eliminated, its marine animal associates also disappear from the area. Seagrasses are an important item and habitat for endangered species such as sea turtles and dugong.

And then there's the human community. Humans, an ecosystem by themselves, are an integral part of the environment. Evolving from hunting-gathering to agriculture to industry to being an information- and knowledge-based society, they have shaped and re-shaped their environment, sometimes changing it, for better or worse, forever. Today, human interaction with the various ecosystems is perhaps the most influential factor affecting the coastal environment and the vital natural processes occurring there. CRM, therefore, is above all else managing people and human activities so that their negative impacts on the coastal environment are minimized to the extent that would promote the natural productivity and sustainability of coastal and marine resources.

(Some parts of this section were adapted from Coasts. Coastal Publication No. 2, Renewable Resources Information Series. S.C. Snedaker, C.G. Getter,Research Planning Institute Inc. in cooperation with National Park Service-United States Department of Interior and United States Agency for International Development)

COASTAL AND MARINE ECOSYSTEM BASICS AND VALUES
Oceanography

The sea is a dynamic environment where countless natural biological, chemical and physical processes occur. Some of these processes are described below:

Tides, tidal currents and tidal flushing

The scale of the marine environment is mediated by the dynamic nature of the ocean, expressed in tides and currents.

Tides are a regular rise and fall in sea level that affect the extent of exposed shoreline throughout the day. Tides ensure that plants and animals living along the shoreline are being alternately submerged in water and exposed to the drying effects of air. They vary from time to time and from place to place. At any one place, the tidal range changes gradually and in a regular way from day to day. In the Philippines, it is less than 3 meters.

Tidal currents are horizontal water movements produced by the rise and fall of the sea, for example, water that falls into harbors as the tide rises (the flood tide and flood currents) and flows out of harbors as tide falls (ebb tide and ebb currents). Each time the current changes direction, a period of no current occurs (slack water). The shape of the coastal sea floor, coastline, waves, wind and other currents (e.g. river currents) can affect tidal currents, so in some areas there might be tides but no net tidal current.

The strength of a tidal current depends on the volume of water flowing through the entrance to a harbor, bay or reef as well as the size of the entrance. In general, the strongest currents in coastal areas tend to be tidal currents.

Tidal flushing refers to the concentration of waste removed from the water body in one tidal cycle.

Tides affect human activities along the shoreline, including fishing. During low tide, many coastal residents glean the shallows. At high tide in some areas, they may gather fry for pond culture, and boats come ashore to unload their cargo. Also, the effectivity of some fishing gears, such tidal waves (*pabhas*), is based on tidal patterns, and fishponds depend on the tide for water circulation and flushing.

Currents

Currents are large-scale water movements driven primarily by winds and by the unequal heating of ocean waters. Their transporting property is perhaps the most important factor linking different marine habitats. A basic understanding of the nature and causes of currents in the marine environment is therefore required in CRM, for example, for planning and managing marine sanctuaries.

There are two general types of currents:

a. drift currents, which are caused by the wind
b. geostrophic currents, which result from the meeting of bodies of water of different density, which is, in turn, controlled by water temperature and salinity

In general, currents along shorelines flow with the depth gradient, that is, along the shoreline. The drag of wind blowing across the surface of the sea sets up currents in the top 2-3 meters of water column. Much of the drifting food and larvae occur in this layer, thus wind-driven currents have a major effect on coastal habitats. Current speeds decrease below this surface layer.

Monsoonal winds also have significant effects on currents in the Philippines. Due to seasonal variations in strength and direction of prevailing winds and currents, planktonic larvae, silt and pollutants are likely to be distributed differently if they enter coastal waters during a southwest or northeast monsoon.

Waves

The wind blowing across the surface of the sea produces waves, the maximum height of which depends on wind speed, the length of time wind persists and the distance that the wind blows across the surface. Waves can greatly influence the distribution of plants and animals on reefs and in other coastal habitats. Waves break down corals and carry fragments of corals across the top of reefs. Also, the turbulence generated by waves, along with prevailing currents and long-shore currents (caused by waves and tides), transport sediment parallel to shore. Large-scale oceanic currents can greatly affect coral reefs and other habitats, depending on whether such currents bring nutrient-rich or nutrient-poor waters, whether those waters are warm or cold, and whether they bring planktonic food and larvae from far away.

Waves and currents also change the profile of beaches and have a significant effect on the shape and extent of sandy shorelines. During seasons of low swell and low-energy waves, sand is deposited onto beaches. During seasons of high energy waves, beaches are cut back by erosion. Sand bars develop offshore because of massive amounts of sand. Construction of wharves, jetties, sea walls and the removal of coastal-stabilization vegetation (e.g. mangroves) to develop mariculture ponds or for other uses will likely alter these processes and have major effects on the organisms living in these coastal habitats.

Currents can run in a linear fashion from upstream to downstream, as in estuaries or channels with strong and persistent uni-directional flow. Most systems are much more complex. Water currents change direction or even reverse under the influence of the tide, wind or variation in major oceanic patterns. In some offshore situations, the edge of a broad, strong current can wander or meander away from the mainstream and pinch off, forming a ring or eddy. Small, shallow eddies can also form when strong currents pass through coral reefs. These occur in depths as shallow as 15-60 meters. Eddies transport heat, nutrients and weak-swimming or planktonic organisms (e.g., larvae). Larvae tend to concentrate in island-effect eddies, which makes for good marine sanctuary sites.

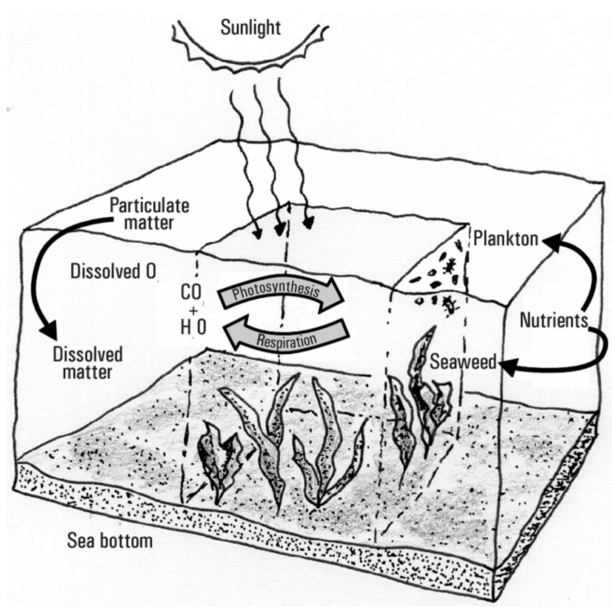
Some bio/physico-chemical characteristics of, and processes in, the marine environment

In order to appreciate why criteria for planning and management of the coastal and marine environment differ from those for terrestrial environments, it is important to look not only at the degree of interconnectedness among marine areas, but also at how the nature of the marine environment itself differs from the environment on land. Overall, the marine environment provides its inhabitants with more protective and more nurturing conditions than the terrestrial environment.

1. The marine environment is wet. This means that marine organisms generally do not need to expend much energy to maintain the concentrations of water they require to function normally.
2. One of the most biologically important properties of seawater is that it is relatively transparent, so sunlight can penetrate fairly deep into the ocean. This is vital because all plants need light to grow. The transparency of the ocean depends to a large extent on how much and what kind of material is suspended and dissolved in the water. Water near coasts often contains a lot of material brought in by rivers, which gives coastal waters a greenish tint and makes them less transparent than the blue waters of the open ocean.
3. Seawater is a "soup" of nutrients and food. It carries nutrients in the form of particulate

matter and dissolved materials, biologically important gases, living and dead organisms – indeed, in the sea, adults, juveniles and larvae of plankton (organisms that drift in the water), nekton (organisms that swim), and benthic organisms (those that live on the bottom) are surrounded by food.

4. Seawater is about 85% sodium and chloride, which is why it tastes like table salt. There are only a few types of dissolved materials (ions) present in seawater, and their relative amounts (percentage) are always the same. The relative concentrations of these ions are thought to have existed for 1.5 billion years. This makes it easier for marine organisms to control their internal salt and balance. Salinity is kept fairly constant by mixing and opposing the processes of evaporation by the addition of freshwater by rivers and rain. Acidity, on the other hand, is maintained by the strong continuous entry of carbon dioxide from the air into solution in seawater, making for a good buffer against changes in acidity caused by the by-products of photosynthesis and decomposition.
5. Salinity influences the density of seawater: the saltier the water, the denser it is. The density of seawater therefore depends on both the temperature and salinity of the water.
6. Being about 800 times denser than air, seawater can support plankton and nekton partially or totally against the downward pull of gravity. It can also support sessile organisms without their own means of support (e.g. soft corals, sea squirts, anemones and plants). Many invertebrates without internal or external skeleton take seawater into their bodies and/or are composed of 90-95% seawater to serve as their internal, "hydrostatic" skeleton.
7. There are gases as well as solid materials dissolved in seawater. These include oxygen, carbon dioxide and nitrogen, which are found in the earth's atmosphere and dissolve in seawater at the boundary between the atmosphere and the sea surface, or released from the sea surface to the atmosphere. Gases dissolve better in cold water. This is important to marine organisms as this brings oxygen to the deep sea. In addition, the photosynthetic processes that occur in seawater produce oxygen, which is released as a by-product. Marine organisms also affect the amount of dissolved gases in the water, for example, by using up oxygen in their respiration.
8. Seawater is physically buffered against large temperature changes. It can absorb and release large amounts of heat without much change in temperature and thus has a much narrower range of temperatures than air. In a given area in the sea, daily temperatures typically fluctuate less than 5° near the surface and less than this in deeper waters.



(Adapted from Staff Training Materials for the Management of Protected Areas, R. Kenchington and K.L. Ch'ng (editors). RCU/EAS Technical Report Series No. 4, UNEP, 1994
Marine Biology, M. Kemp (editor). Wm C. Brown Publishers, 1997)