

### 3.5 DEPLETION OF COASTAL RESOURCES

#### 3.5.1 Introduction

The term “coastal resources” refers to resources, both living and non-living, found in the coastal region. The term “coastal area” in the context of the Coast Conservation Act, is defined as the Coastal Zone, a 2 km wide band of ocean and an adjoining strip of land extending 300 m inland. In the event a water body connected to the sea occurs the zone extends two kilometres inland from the mouth of the water body (Coast Conservation Act of 1981 and amendments; Ministry of Fisheries and Aquatic Resources (MoFAR) 1999). This definition is applicable for administrative purposes. In resource management, the coastal region can be considered to represent an area of transition where terrestrial and marine environments interact to form unique environmental conditions. The coastal region therefore includes inshore waters, inter-tidal areas and extensive tracts of contiguous land (Brown, 1997).

Economically, the coastal region is considered a distinctive area where development is influenced to a

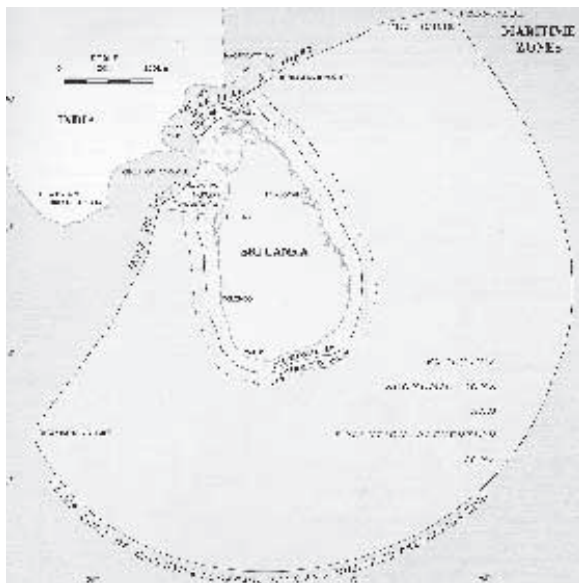
large extent by access to the sea (Savundranayagam et al, 1994).

For the purpose of this chapter, it would seem appropriate to use “coastal” in an environmentally and socially applicable context within a holistic and integrated perspective. It is well recognized that terrestrial and marine components of the coastal region are often closely connected through hydrologic linkages between upland catchments and coastal wetlands. A good example of these inter-linkages is seen where estuaries convert to lagoons with reduced water flow and/or increased silt load. The coastal region thus, could be considered to include an area of land or water where ecological processes of both land and marine environments are inter-linked, with a further linkage with human activities in the region.

The length of the Sri Lankan coastline is 1,585 km. from which the Exclusive Economic Zone (EEZ) extends 200 nautical miles. This is 6.7 times the country's land area occupying 437,400 sq. km. Coastal waters extend from the continental shelf to the other limits of the EEZ. The coastline and adjacent waters support highly productive marine ecosystems such as fringing coral reefs, shallow beds of coastal and estuarine seagrasses and an extensive system of 45 estuaries and 40 lagoons.

#### 3.5.2 Pressure

From time immemorial, man has used both living and nonliving coastal resources. These are closely related to a natural resource base and, given time and the requisite conditions, living resources will regenerate themselves while non-living resources will continue to be generated within bounds imposed by ecosystem processes. Resource depletion results when pressure of exploitation exceeds generation rates. Excessive exploitation causes pressure directly on the resource



The coastal habitat covers 24% of land area and constitute a significant natural resource base

#### Extents of some Coastal Habitats

Estuaries and Lagoons	158, 017 ha
Mangroves	12,500 ha
Salt marshes	23,819 ha
Sand dunes	7,606 ha
Beaches	11,788 ha
Marsh	9,754 ha
Other water bodies	18,839 ha

Source: Coast Conservation Department (CCD), 1992; Brown, 1997; Jinadasa, 1997; MoFE 1999

itself by its physical overuse and/or by indirectly exerting pressure on the resource-related ecosystem which disrupts resource generation rates. These can include a variety of causative factors such as pollution, destructive fishing gear and migration-related factors. Several factors contribute to coastal resource depletion through pressures brought about by increased consumer needs arising from residents in the coastal region or from geographically distant populations, either within the country or overseas. Diverse coastal resources are being subjected to extractive pressure (e.g. fish capture or sand mining) as well as non-extractive pressure (aesthetic enjoyment).

### 3.5.2.1 Population, Infrastructure and Industrial Expansion

Almost a third (32 %) of the country's population, two-thirds (65%) of the total urban population, two-thirds (67%) of the industrial facilities and over 80% of the tourist infrastructure accommodated within only one-, fourth (24% ) of the island's land area having a coastal boundary (CCD, 1992; MoFE, 1999; CCD, 2000).

The increase of the coastal sector's contribution to the GDP from 35 % in 1983 to 40% (Savundranayagam et al, 1994, Brown, 1997) is indicative of increasing economic activity in the coastal area.

Projections estimate that coastal migration will continue to increase coastal population densities to 446 and even over 1,000 persons per sq. km (CCD, 1992; de Silva, 1997). The provision of necessary infrastructure to expanding coastal communities and industries will inevitably bring with it enhanced pressures on the dwindling coastal resources.



Source : SUK Ekaratne(2000)



Source : SUK Ekaratne, (2000)

### 3.5.2.2 Mangrove Ecosystems

An unmanaged industry can expand and create pressure on coastal resources eventually causing self-destruction as is well illustrated in the case of the tiger prawn export industry. Prawn farms were established in cleared ecologically sensitive mangrove areas in the northwest exerting tremendous pressure on mangroves and degrading associated lagoons and estuaries. It is estimated that 359.5 ha out of 1083 ha of shrimp ponds (Jayasinghe, 1995) and 400 to 500 ha of mangroves or mangrove associates (National Aquatic Resource and Development Agency (NARA), 1995) have been cleared. Pressure on water of lagoons and estuaries by the addition of chemicals and organic matter has resulted in changed water quality and depressed productivity of these waters. Waste from illicit liquor brewing has also exerted pressure on the productivity of these sensitive habitats

Pressure on mangroves and estuaries: causes of degradation /destruction;

- tiger prawn farming
- unsustainable fishing pollution
- timber felling and mangrove clearing
- land filling
- housing and infrastructure construction
- refuse dumping, including refuse from illicit breweries in mangrove hideouts

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### 3.5.2.3 Coral Reef Ecosystems



Source: *SUK Ekaratne (1997)*

Coral reefs are an important coastal resource that restrain coastal erosion and sustain coastal fisheries. Fringing reefs present around the island, also buffer shores from coastal erosion (CCD, 1997). Most of the known reefs, particularly readily accessible near-shore reefs, are damaged due to human pressure. Increases in organisms, such as tunicates and sponges, due to unknown causes, have also created pressure on reef ecosystem function (Bakus et al, 2000).

Unprecedented coral bleaching of a widespread and severe nature that occurred in April 1998 was due to increase in sea surface temperatures (Ekaratne and Jinendradasa, 1998) associated with global warming or “el nino” events. High sediment and particulate matter loads as well as pollution from land-based sources, with loads of up to 3.2 kg day<sup>-1</sup> m<sup>-2</sup> (Ekaratne, 1997c) are other pressures affecting changes in the reef habitat. Possible over-collecting, inappropriate techniques (moxy net) of aquarium fish collecting, holding and transport in the export aquarium trade, damage and destroy the reef habitat. Coral mining, dynamite blast fishing, ghost nets from bottom nets, unplanned expansion of domestic and overseas tourism in coastal areas contribute to further destruction of the reef structure and reef habitat.

The marine capture fishery for non-edible aquarium exported species, harvests mainly fish and invertebrates from reef associated habitats. Relatively fewer numbers are harvested from estuarine areas, such as young groupers, and exported for culture as foodfish. Although the freshwater fish export industry cultures most of its exported fish, no marine species are cultured in Sri Lanka, with individuals being caught from the sea by divers using snorkel or SCUBA gear. They are collected mostly from inshore areas where corals occur, often

#### Pressure on Reefs: Causes of Coral Reef Degradation / Destruction

- coral mining
- dynamite fishing
- sedimentation
- pollution
- anchoring
- removal of reef organisms (for curios, aquarium trade)
- harbour construction
- Crown-of-thorns starfish
- corallivorous gastropods
- tunicates
- sponges
- algae species (Halimeda, Ulva)
- Bleaching (due to global warming) and subsequent coral death

Source : *De Bruin, (1972); Rajasuriya and Rathnapriya, (1994); Ekaratne, (1990b, 1997c); De Silva and Rajasuriya, (1997); Abeysirigunawardana and Ekaratne, (2000b) Jinendradasa and Ekaratne, (2000)*

by “moxy net” that damages the reef structure. Collected organisms are exported to over 25 countries including USA, Japan, United Kingdom, Holland, Germany, Singapore and Hong Kong. Recent trends in the marine trade have witnessed its expansion in species as well as in numbers, species having increased from 139 in 1985 (Wood, 1985) to over 200 (Ekaratne, 2000) and numbers from about 200,000 to almost 1,000,000 individuals. The pressure exerted by expansion of the fisheries for sea cucumbers (beche-de-mer) and chanks have seriously reduced their populations.

### 3.5.2.4 Protein Needs - Fisheries Expansion

The coastal and marine fishery is a major activity , which provides 65 % of animal protein in human diet. Until the mid 1950's, when traditional, non-mechanized crafts such as canoes with or without sails, wooden rafts and traditional fishing gear such as beach seine, hook and line, gill nets and traps were used, the total marine fish production was about 39,600 mt. The introduction of mechanisation, nylon nets and other technological advances have subjected this resource to increasing pressure. Initially increased but was

followed by a gradual decline. Continuing advances in fishing technology will increase the exploitation efficiency of sea fisheries. At present, the emphasis has shifted from coastal to deep-sea fisheries.



Source: *SUK Ekaratne(1999)*

Infrastructure development for the fishing industry such as the construction of harbours creates pressure on coastal ecosystems and coastal resources. Additional pressure is created by pollution from boats, anchor damage, unsustainable fisheries such as catching small sized fish, use of dynamite and other destructive practices.

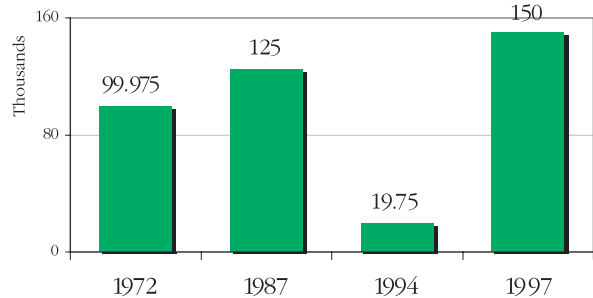
**Increasing Pressure on Fish Stocks - the advances:**

- Introduction of mechanized craft (late 1950's)
- use of nylon nets
- entry of private sector entrepreneurs (late 1970's)
- introduction of ice to freeze the catch at sea.

**3.5.2.5 Aesthetic Needs - Tourism Expansion**

The marketable “services” of coastal resources include the resource base for overseas and domestic tourism. Foreign tourist arrivals have risen at a rate of 33 % prior to the outbreak of ethnic strife in 1983. Although current rate has dropped to 15%, (Deheragoda and Tantrigama, 1997) increased visitation by domestic tourists, particularly to sites such as the Hikkaduwa Nature Reserve (the only marine Nature Reserve in Sri Lanka) has serious repercussions on the reef habitat. Increasing tourist arrivals will continue to be a source of pressure on coastal resources, particularly because coastal tourism is showing rapid growth worldwide (Brown, 1997). The changing

**Coastal Fishery (catch mt)**



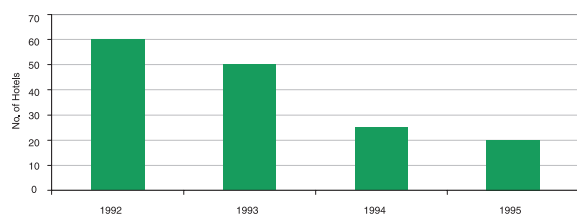
Source: *MoFARD*

pressure on coastal habitats through hotel construction, which was low over a 7-year period, is now seeing a gradual increase (data from CCD). While most coastal hotels discharge their used water and even sewage into the coastal waters causing pollution, social pressure is also created by communities through changed patterns of lifestyle. Reefs are damaged by careless snorkelling and diving by tourists. Increased sewage pits in the tourist areas of Beruwala, Bentota and Hikkaduwa have caused pollution of ground water and domestic wells.

**3.5.2.5 Material Needs: Expansion of Non-Living Resource Exploitation**

The collection of coastal non-living resources can gradually expand increasing pressure on the resource and instability of the habitat. For example, garnet sand mining creates instability of the shores at Hambantota, inland coral mining and seashell mining result in ground pits that alter the habitat profile. Sand mining carried out extensively affects beach nourishment and the integrity of the shoreline. Excessive sand mining from riverbeds would increase saline intrusion and riverbank collapse.

**Hotel Approvals**



Source: *Ceylon Tourist Board Data*

This issue is heavily addressed by plans for central waste treatment plans



Sand, a commonly used non-living resource, is exploited from the lower reaches of river basins and, to a lesser extent, from the shores. The volume of sand extracted has increased from 523,780 cubes in 1984 to 625,662 cubes in 1991 (CCD, 1997). Sand mining from the offshore seabed has attracted discussion in recent times for purposes of infrastructure development such as highways. Since the adverse pressure of sand mining on the coastal ecosystem has been reported even in other countries, such activities need to be carefully re-examined so as not to exert undue pressure on coastal resources.

### ***3.5.2.6 Infrastructure Expansion, Waste Disposal, Shipping and Transport, Energy Utilisation, Coal Power Plants, Pollution and Water Quality***

Considerable pressure is exerted on coastal water quality by ships operating on the major international shipping route off the southern and south western coast with an estimated annual traffic of over 5,000 tankers (NARESA, 1991). The routine dumping of engine oil into the water by fishing craft further pressurise water quality, food web functions and ecosystem integrity. Grounding of oil tankers, oil spills and leaks have occurred in the recent past, both from private and government-owned vessels/installations and create pressure on the coastal ecosystem processes. Mitigation measures need to be rapidly put in place in such an event to avoid degradation of coastal resources and ecosystem processes. Land filling occurs in several coastal wetlands for infrastructure facilities such as roads and housing. Even parts of the Mangrove Reserve of the National Aquatic Resources and Research Development Agency at Kadolkele in Negombo, which was a model mangrove system, has been encroached for housing.

The increasing trend in the country towards industrialisation cannot be supported by the available hydroelectric power generation capability. Unless power consumption is pruned down, which is unlikely in view of economic expansion, new power generation schemes such as coal power plants appear to be the only available option. The pressure on coastal resources exerted by such power plants has to be realistically assessed and mitigation measures adopted to prevent further degradation of coastal resources.

Industrialisation in the coastal zone also creates pressures on the natural ecosystem, e.g. the discharge of tannery industry waste. Pressure on coastal ecosystems from upland or upstream sources are

common, such as the seepage of chemicals, including agrochemicals, into the sediment load that eventually reaches the coastal habitats through river run-off. Pollution can therefore arise from point and non-point sources.

### ***3.5.2.8 Policy Disjunction and Operational Failure***

The most important factor that generates continued pressure on coastal resource is the common impression that it is a "Common Property Resource."

Although the resource serves common ecological functions and benefits the community at large, no individual takes responsibility, or is accountable, for its well being. A resource with such characteristics cannot be managed merely by enacting laws and regulations. Awareness and participation of key stakeholders in its management are central to their sustainability. Ongoing initiatives such as the master plans, management plans and policy statements are noteworthy.

These initiatives need to be enhanced to develop operational mechanisms to realise their objectives. It is necessary to evolve an integrated, holistic approach to planning and plan implementation in inter-related sectors and interest groups. Factors such as overuse of agrochemicals, upstream pollution and depletion of coastal water quality by industrial and solid waste disposal result in pressures on coastal resources and could be avoided

### ***3.5.3 State***

Living renewable coastal resources in the form of marketable "goods" include fish, shark fin, shrimp, prawn, lobster, crab, bivalve, squid, cuttlefish, brine shrimp (*Artemia*) sea weed (*Gracillaria*, *Sargassum*), chank (*Xancus pyrum*), sea cucumber (*beche-de-mer*) and other invertebrates for the export aquarium trade. Seashells for lime production, plant material for handicrafts and agricultural produce are also marketable. In addition, there are a range of other species that are not marketed or are prohibited for sale, such as estuarine crocodiles, turtles, wading birds, sea birds and about 16 marine mammal species that include dolphins, whales and dugongs. The non-living coastal marketable goods comprise salt, graphite, limestone, clay, sand, feldspar, metal stone lime, kabook, brick, gem and ilmenite and other mineral sands. (Savundranayagam, 1994) The "services" from coastal resources include a wide range, from flood protection, nutrient flows, nursery and breeding grounds of species harvested for commercial and

ornamental purposes, tourism, turtle, whale and dolphin watching. Such services embrace aesthetics, support cultural traditions and ways of life of coastal communities and increasingly attract the domestic urban dweller as well as the overseas tourist.

Fishery related activities in the coastal region can be categorized into edible capture fisheries, aquarium capture fisheries and culture fisheries, the latter being mostly the tiger prawn/shrimp culture fishery. Although the emphasis of this section is on the depletion aspects of coastal resource, many resources may still remain unknown since cataloguing and inventorisation of resources, particularly those in the sea, have not been carried out comprehensively.

### **3.5.3.1 Capture Fisheries**

The marine capture fishery of edible species is the major economic activity using biological resources of the coastal area. The coastal sea is the site of activity for the capture of finfish and shellfish (mostly for domestic consumption) as well as fish and invertebrates (for the marine ornamental export trade). Bays and other marine waters support the fishery of over 500 edible fish species (Jinadasa, 1997). Species ranging from small anchovies to coastal species of tuna, sharks, as well as semi-oceanic species such as spanish mackerel, skipjack and dolphin are caught. About 70% of coastal resources is composed of small pelagic fish like sardines, herrings, anchovies and mackerels and small demersal fish such as sciaenids and carrangids (Jinadasa, 1997). Brackish waters also contribute significantly to commercial fishery with a total production of about 4,000 mt per year. These fishery products include penaeid prawn (*Penaeus monodon*, *Psemisulcatus*, *Metapenaeus dobsoni*) mud crab (*Scylla serrata*) and brackish water species of fin fish (*Mugil cephalus*, *Chanos chanos*, *Leiognathus* sp and *Etroplus suratensis*) and bivalve molluscs (*Meretrix casta*, *Crassostrea* sp)

The capture fishery has risen to 206,300 mt in 1996 (NARA, 1998). The coastal catch that was 90,717 mt increased to 149,278 in 1987. During this period, offshore fishery contributed only 4,259 or 2.2 % of the total catch. Capture fishery increased to 174,500 mt in 1994 and fell back to 149,300 mt in 1996 but rose again to 152,750 mt in 1997 and to 171,950 mt in 1999 (MoFARD data through MoFE). Estimates of the maximum annual sustainable yield range from 250,000 mt (MoFARD) to about 300,000 mt of fish. (Jinadasa, 1997). Based on exploitation levels and with the gill net fishery reaching maximum economic profit levels, a "precautionary approach" of not encouraging further expansion has been advocated (NARA, 1998b). A

consensus has developed that the offshore fishery resource is under-exploited and that further expansion should target this resource. This is supported by the increasing contribution to total fishery landings made from offshore fishery. Offshore fishery which contributed 4,259 mt or 2.2 % to the total marine fishery in 1987, 7.1 % in 1990, expanded to around 25 % in 1995 and 1996 (NARA, 1998) and to 29 % in 1997. The estimate for the year 2000 is 84,400 mt. This compares with an estimated annual production from these sea areas that range from 90,000 mt (MoFARD, 1999) to about 100,000 mt (Jinadasa, 1997). Surveys have revealed that the deep-sea fish resource needs to be better exploited. A fleet of up to 160 tuna longliners can be sustainably maintained for this purpose (NARA, 1998), although scarcity of bait may pose problems for such a fleet size. These assessments are noteworthy and require regular updating. The estimated fish landings for 2000, as compared with MoFARD estimates (1999) for sustainable maximum yields per year would permit the harvesting of an additional 67,000 mt from coastal fisheries and about 6000 mt from off shore and deep sea fisheries. Further exploitation of these resources would be unsustainable.

Some invertebrate species in the edible marine capture fishery have been overexploited resulting in dwindling numbers. For example, the sea cucumber (beche-de-mer) fishery (entire production is exported to Singapore and Hong Kong) has a recorded history from 1808. Although 13 of the 70 species recorded in Sri Lanka are consumed in various parts of the world, only the dominant species (*Holothuria scabra*) was selectively harvested mainly by skin divers at depths of 2 to 16m with some caught as by-catch of shrimp trawlers. The decline of the beche-de-mer fishery in the late eighties was attributed to indiscriminate over-harvesting. Unsubstantiated reports indicate that the several species that are now being over harvested. Export figures have recorded a decline from 272 mt in 1997 to 203 mt in 1998 (Joseph, 1993) Brown, 1997; data: MoFAR ). Lobster and crab are also exported with 1998 export quantities being 164 mt and 486 mt, respectively. The harvesting of lobster could have harmful effects on wild stocks, as gravid lobsters as well as small-sized lobsters are regularly collected in spite of bans on such collection.

### **3.5.3.2 Other Resources**

Seaweed is another living edible coastal resource with commercial potential. A trial project on seaweed culture, recently started in Kalpitiya lagoon is no longer in operation. Another edible coastal resource is coastal agricultural produce. Although not unique to coastal areas, maintenance of the integrity of agricultural land

will impact on social and ecological sustainability of coastal areas. Unsustainable land use practices for example, will lead to soil erosion and will in turn result in sedimentation of aquatic habitats. A loss of agricultural capacity will impact adversely as most coastal agricultural produce is marketed locally.

### ***3.5.3.3 Shrimp Culture Fishery***

The coastal culture fishery revolves around the farming of the tiger prawn/shrimp, *P.monodon*, begun in the late 1970's by the private sector. This industry grew at a rapid pace from the early 1980's. In 1996, there were 381 authorized and 600 unauthorized farms with a total area of about 2,500 ha. Shrimp production was 5,000 mt in 1995 (NARA, 1998).

The area under shrimp farming could be as much as 35 sq. km. or about 5 % of the 710 sq.km. of mangrove swamps, mud flats and salt marshes located along the coastline. Shrimp exports in 1998 were 5092 mt, almost doubling the 1997 figure of 2584 mt. All shrimp for culture are obtained from hatcheries and are grown in ponds in the farms concentrated along the north west coast. Most farms extract water from the Dutch Canal and also discharge effluents into the canal. (Corea et al, 1994, 1995, 1998) Although common property areas such as the mangrove-lagoon-estuarine areas are used for fishing of edible species, their conversion to prawn farms brings a greatly enhanced income, albeit to a few individuals outside the fishing community.

### ***3.5.3.4 Marine Aquarium Fishery***

In the marine capture aquarium fishery, 530 mt of organisms (both marine and freshwater) comprising approximately 200 species with a value of about Rs. 300 million was exported in 1996, which almost doubled to 1043 mt (with a value of Rs. 531 million) in 1998 (MoFARD; Ekaratne, 2000). All exported individuals are collected mostly from inshore areas where corals occur. The ecological status of the reef habitat (discussed below) would determine the sustainability of this industry. There are few pure limestone reefs in Sri Lanka, but corals grow on ancient sandstone largely along the west coast, or on gneiss or granite outcrops along the east coast (Salm, 1975, Wood, 1986).

Other non-edible living resources not exclusive to coastal areas such as raw material for handicraft products grow as a common property resource. However, to maintain the socio-cultural framework of coastal areas, sustainable use and common property issues of these resources need to be worked out.

### ***3.5.3.5 Non-Living Resources***

Non-living marketable coastal resources include mineral resources such as energy minerals, metallic minerals and non-metallic minerals. Among energy minerals, peat deposits that cannot as yet be economically used are estimated to be about 50 million tons. Radioactive minerals such as monazite, metallic ores such as iron ore (2.2 million tons), copper-magnetite deposits (4 million tons), mineral sands (4 million tons at Pulmoddai), ilmenite (3 million tons), rutile (6 million tons), zircon (4 million tons), high purity silica sands (6 million tons) as well as limestone, clays, deposits of inland coral and seashells, granite, granitic gneisses, marbles, quartzites and chamockites are also found in the coastal area. (Ranasinghe, 1997). Sand extraction is much - debated, since there are no firm estimates of sand generation and consequent availability. Government permits are required for sand mining but illegal extraction continues unabated.

### ***3.5.4 Impact***

Pressure generated by both human-induced activities and natural phenomena result in impacts on coastal resources, and brings about changes in the availability of coastal resources and their ecological functions (termed as goods and services or functions, respectively). Thus, impacts can have a direct effect on the related coastal resource and/or affect the resource generating process through effects on habitat and ecosystem quality.

Coastal resources may have a resilient capacity to withstand, or to rebound from, impacts by natural phenomena. This resilience may, however, be adversely affected by impacts arising from man-induced pressures. Any impact such as habitat loss (as in mangroves and coral reefs) would invariably impact negatively on biodiversity, at levels of genes, species and ecosystems. These impacts are more fully described below.

#### ***3.5.4.1 Coastal Erosion***

Coastal erosion has been a problem over the years especially in the south, west and northwestern coasts. At certain locations, net erosion has been recorded up to 1 m per year. Accretion rates, on the other hand, have not exceeded 0.1 m per year, except in the northeast where the rate is 0.3 m per year. The average for the entire county is a net mean rate of erosion of 0.20 to 0.35 m per year (CCD, 1997). Apart from the impact on the shoreline, the financial impact brought about by the necessity for shoreline protection indicates, in economic terms, the gravity of the problem



and why factors that increase erosion need to be controlled. Protective measures to approximately 52 km of coastline by construction of revetments and groynes have cost Rs. 373 million since 1970; coast protection by stabilising 16 km of coast in Negombo and Moratuwa (1987 to 1989) have cost Rs. 322 million. The protection of threatened points along the main coastal road from Beruwala to Weligama (1990 to 1992) have cost Rs. 520 million (CCD, 1997). The expenditure incurred annually to mitigate shore erosion is at great cost to the national economy (Berg et al, 1998). Shoreward wave force in some areas in the southern coast has shown a statistically significant increase after post bleaching death of corals and the subsequent collapse of the reef structure. A 78% wave force increase has been recorded in January 1997 from 573.5 +- 43.50 to 1023.4 +- 36.70 in January 2001, as mg per hour of plaster dissolution (data from Jinendradasa, pers com). Coral destruction could thus lead to increased shore erosion and requires urgent remedial action and forward planning.

Causes of coastal erosion include damming of rivers, sand mining in beaches and rivers, destruction of protective reefs through coral mining, collection of coral rubble, removal of coastal vegetation, improperly sited shore protection structures and buildings and loss in river discharge due to upland water use (Ekaratne and Jinendradasa, 1997). Although evidence is not available for the causative factors, erosion remains a grim reality.

### **3.5.4.2 Mangroves and Associated Habitats**

The destruction of mangroves and interruption of natural drainage has reduced flood - buffering capacity, with the result that the northwestern shrimp growing areas experienced massive flooding in 1997.



Source: SUK Ekaratne (1998)

The pressures on mangroves and associated lagoons and estuaries attributed to tiger prawn farming have affected ground water quality and resulted in increased salinisation of lands upstream of estuarine areas. Increased salinity in paddy lands have rendered them unproductive (Jayasinghe, 1995) or reduced rice yields by over 50 % (Wilks, 1995). During the period of the shrimp farm boom from 1983 to 1992, water quality in the Dutch canal deteriorated dramatically (Jayasinghe, 1995).

### **3.5.4.3 Coral Reef Ecosystem**

Coral reefs are an important coastal resource that contain coastal erosion and sustain coastal fisheries. The mass coral bleaching that occurred in April 1998, resulted in extensive (around 80%) coral death followed by serious impacts on the reef ecosystem and in changes in fish populations, species composition, reef structure, biodiversity, succession and ecosystem functions. Even after two years of the bleaching, existing coral species have not recovered their reproductive capacities and there is little likelihood that reef ecosystems would regenerate and provide their normal services (Abeysirigunawardana and Ekaratne 2000a, 2000b; Jinendradasa and Ekaratne, 2000). Apart from bleaching, many other causes, outlined earlier, have resulted in most coral reefs being degraded or destroyed. Most of the known reefs, particularly readily accessible near-shore reefs, were degraded due to human-induced damage (Ekaratne, 1990b, 1997c). Possible over-collecting, improper and inappropriate techniques (moxy net) of collecting by the export aquarium trade damage or destroy the reef habitat. Coral mining and dynamite blast fishing, though banned, also goes on unabated in certain areas, impacting on reef quality and the integrity of reef structure.

### **3.5.4.3 Water Quality**

Water quality is central to many economic and ecological coastal processes and activities. Deposits of agro-chemicals, sediment, industrial chemicals, sewage, domestic waste and plastics have increased in recent times. Tar balls arising from oil pollution is commonly seen on sandy beaches of the south and southwest coasts and could reduce the tourist potential of these beaches. Water quality studies carried out at a site in the southern coast over the last 5 years reveal an increase in particulate suspended sediment loads in these coastal waters with values increasing from 7.4 +- 1.30 in 1997 to 38.6 +- 11.92 in 2000 indicating a five fold increase (data from Jinendradasa pers com).



### **3.5.4.4 Silting**

The construction of ill planned fishery harbours has produced almost continuous silting of harbours such as at Kirinda, whilst siltation has already commenced in the Hikkaduwa harbour, located adjacent to the Hikkaduwa Nature Reserve, which is now under construction. Fishery harbour construction will increase in terms of approved fisheries development plans. Lessons learnt from these experiences make it necessary to diligently carry out pre-construction impact assessment studies, to model, assess and plan for changed current patterns and silt loads that would be the inevitable results of construction.

### **3.5.4.5 Policy Framework**

The inadequacies in integration of policy frameworks have resulted in unplanned and disjointed coastal activities. These include expansion of industries, building of hotels, over-visitation, etc at sensitive coastal locations such as the Hikkaduwa Nature Reserve. Ignoring the time-tested "Precautionary Principle" (where activities with damage potential are undertaken only after careful verification) is a perceived weakness of the planning process. Inappropriate training activities also reflect the need to develop a long-term integrated and effective approach to implement coastal management initiatives.

### **3.5.5. Response**

Coastal resources are an integrated system and include a wide variety of habitats and ecosystems, each possessing important inherent features known as "functions". Such functions in coral reef ecosystems include high primary productivity giving rise to high rates of reef accretion as well as biophysical erosion resulting in the generation of calcareous sediment matter. In the case of mangroves and estuaries, functions include high primary and secondary production and enhancement of productivity by storage of organic sediments.

The functions of all coastal ecosystems include maintaining linkages between ecosystems for sustaining high production, food chain integrity, and migration routes for life history stages, etc. These generate the economically recognisable "goods" e.g. fish, shellfish, minerals, "services" such as recreation, flood control, storm and tidal wave defences, nursery grounds, nutrient flows, transportation and coastal tourism, to immediate or secondary communities. Therefore, an integrated holistic approach has to be adopted to achieve effective responses.

Sri Lanka has an impressive and comprehensive range of legal measures. The Coastal Zone Management Plan (CCD, 1997) is a well-thought out document that could be further expanded as new requirements surface. Some legal measures and plans require operational mechanisms for effective enforcement, and the removal of implementation gaps in the planning framework. Political will and change of anti-social attitudes, the provision increased resources to implementing authorities are matters requiring serious attention. Studies to elucidate changing ecosystem functions, resource inventorisation with regular updates and a planned and sustained long-term training strategy will facilitate the formulation of policy for sustainable utilisation and management of rapidly depleting coastal resources.

### **3.5.5.1 Range of Responses**

A range of responses to meet the pressures and impacts on coastal resources include:

- Promulgation of laws (such as the Coast Conservation Act, Environment Acts, and regulations promulgated under the provisions of the Fisheries and Aquatic Resources Act)
- Preparation and implementation of National Coastal Zone Management Plans of 1990 and 1997
- Requirement for Environmental Impact Assessments and issue of permits by the Coast Conservation Department for major developmental activities in the coastal zone
- Banning of coral mining and the use of lime plaster on Government buildings
- Preparation and implementation of beach access plans, beach parks in narrow coastal stretches
- Outlawing unsustainable methods of fishing, such as "light course" and dynamite fishing, as well as the capture of gravid lobsters and undersized lobsters
- Increasing inputs into deep water oceanic fisheries so as not to increase pressure on coastal near-shore fishery resources
- Policy reviews to mobilize community participation
- Initiatives to mobilise local stakeholder ownership and stewardship (such as the community based shrimp fisheries management at Rekawa: (Davenport et al, 1999 and SAM project)
- Training and awareness programmes e.g. for customs officers
- Declaring protected areas for in-situ habitat conservation such as the Hikkaduwa Nature Reserve and the Bar Reef Sanctuary
- Inclusion of the concept of sustainable utilisation of coastal and marine resources in the 1999 six-

year development plan of the Ministry of Fisheries and Aquatic Resources Development

Programmes, studies and reviews encouraging a holistic and integrated approach such as the

- Coastal 2000 review

### **SAM : Special Area Management in Sri Lanka**

Special Area Management can be defined as a collaborative, adaptive and flexible approach to planning resource management within a defined geographic area. It assumes that residents of a local community and the local government have both the incentives and the knowledge of the resources and resource-use problems to act collectively in ways that ensure that resources are used sustainably. A key aspect of the SAM approach is that even during planning, implementation of small projects can proceed.

Two areas have since 1991 been pilot testing sites for SAM planning: Rekawa and Hikkaduwa. The Coastal Resources Management Project (CRMP) has been acting as facilitator in the processes, through emphasis on data collection and analysis and education and organization of the local communities. The pilot areas are characterized by a varied set of management issues.

- Special Area Management Programme and the Wetlands Conservation Project
- Coral rehabilitation and research / training initiatives and programmes (such as projects done by Global Coral Reef Monitoring Network, Darwin Initiative, University of Colombo, NARA, University of Ruhuna, CCD)
- Development of oil contingency plan and the coastal sensitivity mapping project
- Improvement of the preparation and implementation of Special Area Management Plans for identified areas
- Preparation of zoning plans for identified coastal districts undertaken by the Marine Pollution Prevention Authority
- Community participatory, economically profitable lagoon fishery programmes (Davenport et al, 1999)
- Updating of ornamental fish export regulations

- Establishment of new agencies such as the National Aquaculture Development Authority (NAQDA), which would hopefully divert pressure from coastal non-sustainable activities to sustainable aquaculture activities
- The setting up of a Fauna and Flora Task Force by the Customs to apprehend illegal export/import of organisms, which have so far included many coastal animals and animal parts
- Incorporating eco-tourism concerns in management plans

### ***3.5.5.2 International Conventions***

International Conventions to which Sri Lanka is a signatory include the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973), the Convention on Biological Diversity (1992),

UN Convention on the Law of the Sea (UNCLOS), Conventions within the UNEP Regional Seas Programme, RAMSAR Convention, MARPOL Convention,

Convention for the Prevention of Marine Pollution from Land-based Sources (Paris Convention).

### ***3.5.5.3 Legislation***

The laws of particular relevance to coastal resources include

### ***3.5.5.4 Recommendations***

Recommendations for more meaningful management of coastal Resources;

- Develop capacity, strategies and procedures, including oil combating emergency procedures, for rapid pollution assessment, monitoring and containment for existing and potential pollutants
- Develop personnel, strategies and procedures for rapid coastal resource assessment and monitoring
- Develop procedures for regularly identifying permissible exploitation rates based on regular resource surveys and inventories, such as for edible and aquarium fisheries
- Develop management plans for sensitive and threatened coastal ecosystems and habitats as well as for presently-exploited and potentially-exploited living and non-living coastal resources, including the development of no-take areas. Also develop practice of periodic review of such plans.
- Develop indicators for assessing adequacy-inadequacy of effectiveness with regard to coastal resource management strategies

- Develop an interlinked coastal and marine Protected Area Network to include sensitive and threatened coastal ecosystems and habitats, specially in the seas which is not sufficiently developed at present
- Develop ex-situ and in-situ conservation and management procedures for threatened coastal resources
- Strengthen capacity for coastal impact assessment studies, coastal ecological studies and for identifying coastal biological resources through purpose-built bespoke courses
- Develop increased political will to allow implementation of laws
- Establish a nationally networked coastal/marine units in environment and marine-related agencies manned with personnel trained specifically for working in aquatic environments, which is lacking at present for coastal monitoring, surveillance and awareness creation
- Establish dynamic and flexible monitoring programmes
- Establish a programme to regularly identify sensitive and threatened coastal ecosystems and habitats
- Establish regular periodical reviews of policies, action plans, management strategies underpinned by resource survey and monitoring data
- Establish of a nationally-integrated politically-feasible holistic policy framework with regard to resources from near-shore to continental shelf areas
- Strengthen the Coast Guard services and train its personnel in coastal resource identification and management
- Strengthen monitoring, implementation and advisory capacities at local government level
- Mobilise greater stakeholder participation in resource management activities as well as in resource management planning and review
- Increase awareness in the multiple social layers with regard to resource sustainability and management concepts
- Place stronger emphasis in training younger persons and in quality recruitment procedures
- Integrate practices of different stakeholder agencies with responsibility for coastal resources and minimise/remove duplicated responsibilities to make specific agencies accountable for specific resources and management strategies
- Adopt precautionary practices where resource status is unknown

Legislation	Provisions
The Seashore Protection Ordinance, Gazette No.7710 (1929)	Bans the removal of coral, sand , etc
The Fauna and Flora Protection Ordinance, Gazette No.8675 (1940) and subsequent Amendments such as the Amendment Act, No 49 (1993)	Protects threatened and endangered wildlife including sea turtles and their nesting habitats. The Hikkaduwa Nature Reserve was declared on 14.8.1998 under this Act
The Fisheries Ordinance, Gazette No.12304 (1961)	Bans the use of destructive fishing gear and supports sustainable fishing activities; related regulations under Section 33 bans the possession of lobsters with eggs.
The Fisheries and Aquatic Resources Act, No 2 (1996)	
Adoption of the Coastal Zone Management Plan by Parliament in 1991	Transforms common-property open access fisheries into a managed industry, with a licensing system of all fishing operations and provisions for establishing "committees" of stakeholders, recognising a participatory approach.
The Tourist Development Act No.14 (1968)	Regulates services and prevents indiscriminate and unplanned development in resort areas.
The Natural Heritage and Wilderness Act (1980) amended in 1988	Requires Environmental Impact Assessments and licenses for industries, which may produce air, water and/or land pollution.

<p>The National Aquatic Resources Research and Development Agency (NARA) Act No. 54 (1981)</p>	<p>Established NARA to bring about the conservation of aquatic resources in aquatic habitats including coastal and offshore areas, as well as to undertake research, disseminate information and provide advisory and consultancy services</p>
<p>The Coast Conservation (CCD) Act No.57 (1981)</p>	<p>Mandated CCD to develop a Coastal Zone Management Plan, regulate and control activities within the Coastal Zone, and formulate and execute coast conservation projects. It defined Coastal Zones to include portions of lagoons, estuaries and rivers. It also established uniform procedures for permit applications without distinction between development activities undertaken by private and state sectors. Among other provisos, this legislation encouraged collaboration among various government agencies involved in research and development activities within the Coastal Zone, specified penalties for violation of the law, and authorized the Director of CCD to demolish unauthorized structures. It also made possible the establishment of horizontal links between the relevant legislation.</p>
<p>Coast Conservation Amendment Act No. 64 of 1988</p>	<p>Empowers the Director of CCD to delegate powers, duties and functions to Government Agents or public officers of any administrative district, which contains a portion of the Coastal Zone. It bans the mining, collection, possession, storage, burning and transportation of coral, and the possession of limestone kilns. It authorises the demolition of kilns and the seizure of boats engaged in illegal activities within the Coastal Zone. Importantly, it grants the public the right to use any beach.</p>
<p>The Forest Ordinance No.3 (1945) Amendment No.13 (1966) and Act No.13 (1988)</p>	<p>Provides for the issue of permits for the harvesting, possession, sale and transportation of timber and provides for the prosecution of offenders. This law is of relevance to mangroves and their harvesting.</p>
<p>The Marine Pollution Prevention Act No.59 (1981)</p>	<p>Authorises the Marine Pollution Prevention Authority to prevent, reduce, and control pollution in Sri Lankan waters.</p>
<p>The Specified Tourist Services Code (1984)</p>	<p>Provides for the registration and licensing of all tourism-related establishments as well as enabling their classification</p>
<p>The National Environmental Act No.47 (1980) and Amendment No.56 (1988)</p>	<p>Establishes the Central Environment Authority (CEA) and provides for the protection of the environment against environmental degradation and the prevention and control of pollution. The Amendment provides greater environmental quality control including the EIA and EPL</p>



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