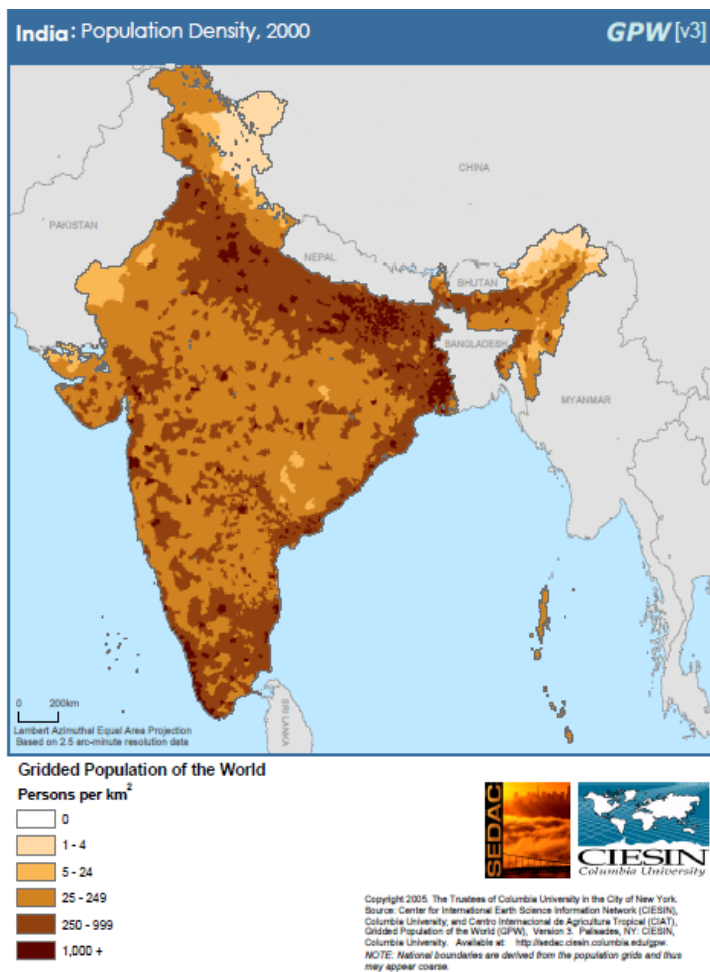


Sustainable Livelihoods

In common with most countries, the coastal zone of India has some of the highest population density levels (Figure 1). However, even with these high coastal population densities, only one quarter of Indians population lives at the coast so there remains an enormous inland rural population who could potentially migrate to the coast putting even greater pressure on coastal resources and systems.

Fig 1: Year 2000 Population density and distribution for India.



Therefore there is an existing and potentially growing population who rely heavily on coastal and marine ecosystems, habitats and resources for food, building materials, building sites, and agricultural and recreational areas and use coastal areas as a dumping ground for sewage, garbage, and toxic wastes. Along with growing urbanization, industrialization, and transportation, the pressures on the living and non-living resources of the coast can be expected to increase. Growth in the so-called mega-cities adds to

a tendency of people to concentrate in the coastal zone anyway. Clearly, this extends the range of impacts on the marine environment beyond traditional

sewage and waste, adding things like increased risk of disasters, excessive noise levels and thermal pollution.

As stated in the Swaminthan report¹ and we quote:

“the objective of coastal zone management is to protect with peoples participation....the livelihood security of coastal fishers and other communities....”

The key approach to supporting coastal dwellers over the last decade has been through building sustainable livelihoods. This approach to the development of sustainable livelihoods can focus in a more traditional way on maintaining or enhancing the natural resources of the area, for example through habitat enhancement, FAD's and MPA's to enhance fish stocks / catch. However, other approaches to development of sustainable livelihoods can be through developing alternative livelihoods (e.g. moving from fishing to batik making or guiding tourists) or through empowerment of society and increasing their “voice” in management decisions (e.g. through development of fisheries co-operatives, or mangrove management committees). It is likely that more than one of these approaches is required to build sustainable livelihoods for any particular coastal area, especially in modern times with resource pressure and predicted climate change. A generally perceived requirement for livelihoods development on coasts is for involvement and empowerment of the coastal society; this is reflected in the Swaminthan report (quoted above) in which the objective of coastal management includes explicitly **“...peoples participation...”**. Sustainable livelihoods thus become an issue not just associated with natural resource availability, but community involvement and empowerment.

¹ Swaminathan, M. S. (2005) Report of the committee: to review the coastal regulation zone notification 1991. Ministry of Environmental and Forests, New Delhi.

Coastal industries and constructions

Industrial development has altered, disturbed, and destroyed coastal ecosystems, including sensitive habitats. Many important industrial centres are situated on estuaries and in the vicinity of urban areas and ports. Main industrial activities affecting coastal areas include metal smelting and processing, chemical, petrochemical (oil and gas storage and refining), paper mills, vehicle factories, ship building, power plants (coal, oil gas, nuclear energy), and food processing (including fish). Data and energy cables are numerous with similar effects to pipelines which are submerged in the seabed. This creates problems for other users (bottom trawl fisheries, marine aggregate extraction). Construction engineering activities very often cause permanent destruction of habitats or decreases in habitat size and their fragmentation, due to land reclamation, coastal protection, and extraction of bottom material, dumping and disposal.



Habitat infilling, in particular of salt marshes and mangroves, has taken place for centuries almost everywhere in estuaries, intertidal bays and inlets throughout the world. The main impacts on marine ecosystems are disturbance and removal of benthic organisms, damage to sites as spawning areas for fish, alteration of seabed profiles, increase in instability of shallow banks and an increase in erosion. Severe beach erosion is a problem shared by many countries. The threat from industry and tourism infrastructure is still acute even if local and regional management plans help by slowing down the rate of construction.

Changes to the shoreline have been extensive in recent decades and threats from rising sea levels and sinking landmasses have required new strategies to be developed.

Dredging and dumping at sea

Dredging mainly causes physical disturbance and may result in the redistribution of contamination through release from the sediment. Contaminants might be re-



suspended and remobilised from sediments and create new entries in food webs. It is well known that changes in substrate quality are synonymous to changes in the structure of benthic communities. The bulk of material eligible for dumping at sea comes

from dredging operations from navigation channels, material removed in coastal engineering projects, beach nourishment, and reclamation and coastal marsh preservation. Sewage sludge dumping increases the fallout of organic material and associated contaminants to the seafloor. It can contribute to eutrophication in naturally nutrient rich coastal waters.

Marine litter is derived from land-based and marine sources. It is found in large quantities on coastal seabed, floating in the water column and on the shore. It originates from many diverse activities such as shipping, fishing and mariculture or recreation and tourism. About 80% of the material is plastic which is non-degradable and provokes smothering. Entangling and drowning of biota (birds, mammals) may happen and inflict physical injury to animals (turtles) or even an obstruction of digestive system after ingestion of plastic objects. Once in the food-web, plastics release toxic substances.

Freshwater inputs

Flow of fresh water and contained materials to the coastal zone has been grossly altered by human activities. In some arid regions where freshwater on land is a major resource limiting human activities, discharge has diminished to 10% or less of natural flow. In other regions the issue is management of water, with the seasonal pattern of discharge having been greatly modified. Either water loss or alteration of the seasonality of discharge can have major impact on coastal ecosystems. Human activities have also altered the patterns of sediment discharge. Although increased erosion has occurred associated with human land use



(especially agriculture) and has led to increases in sediment delivery, a confounding effect has been increased trapping of sediments in water reservoirs. Thus, some regions experience artificially elevated sediment discharge; others experience severe diminution of discharge. To an ecosystem acclimated to receive a particular level of sediment load, either change can be detrimental. For example, severe erosion without sediment replacement may occur in systems poised to receive high sediment loads. By contrast, ecosystems such as coral reefs are generally acclimated to low sediment discharge, and large amounts of sediments can bury or otherwise damage reefs. Human activities have generally led to an increase discharges of pollutants which affect water quality.

Although not as obvious as river discharge, continental ground waters also discharge directly into the sea. Like surface water, groundwater flow down-gradient. Therefore, groundwater flows directly into the ocean wherever a coastal aquifer is connected to the sea. Furthermore, artesian aquifers can extend for

considerable distances from shore, underneath the continental shelf. In some cases, these deeper aquifers may have fractures or other breaches in the overlying confining layers, allowing groundwater to flow into the sea. Conversely, where there is excessive groundwater extraction depleting aquifer reserves, saltwater can intrude into the aquifer leading to salination of soils and loss of sweet water supplies.

Recreation and Tourism

Coastal areas provide recreation opportunities for local people and for tourists who travel the whole world. Tourism cause pressures on coastal ecosystems by excessive influx of visitors. People movements rely on transportation systems which range from pathways for walkers to landing strips for airports. Such movements at the planetary level mean the wandering of pests, construction and building with associated pollution and eutrophication and disposal of litter and other waste in tourist areas. The paradox is that, most often, tourism will disturb and threaten local populations and wildlife and their habitats, which attracted them to the area in the first instance.

a) Beaches, swimming, recreational boating

Beaches are important areas for tourism. However, the increasing population and standard of living push many areas to their sustainable limits, both from a tourism and environmental point of view. In beach tourism there are clear feedback



mechanisms, nice beaches attract people, and too many tourists on the beach decrease the attractiveness.

Tourism, a major source of income for many coastal communities, can have major effects on coastal environments unless the scale and type of activities

are controlled. Biodiversity reduction, resource depletion, and human health problems may result from the accumulated environmental effects. Setting maxima to tourist numbers is a proper managerial measure, however, once these maxima are reached, pressure to relax the restrictions increase. Clear definitions of maxima, and scientifically adopted calculation methods are necessary. With the increasing standard of living, the recreational boating increases, and in some countries harbours and marinas built primarily for recreational use by small boats may disturb more of the coastal zone than commercial and industrial use. The environmental impacts of marinas and small harbours depend on site location, design, construction methods, and 'house-keeping'. Careful site planning can help avoid or minimize many of the impacts.

Natural disasters

The coastlines of many countries face high risks of damage from certain types of natural disasters. With the exception of long term sea level rise, climate change is not likely to introduce new types of coastal hazards. However, climate change is likely to increase the frequency, intensity and extent of existing coastal hazards. This means that for some parts of the Indian coast, climate change impacts are likely to exacerbate coastal erosion processes and inundation, potentially further increasing the impacts of these coastal hazards on existing and future coastal communities and development. While some climate change impacts such as sea level rise are gradual and occur over a long timeframe, extreme weather events can occur at any time and can significantly reshape the coastline. Land use planning



decisions have long-term implications due to the relatively long life span and permanency of use and development proposals such as residential growth areas, buildings, roads and utilities.

The major concern is death and property loss by winds and waters of hurricanes or cyclones. Along many densely populated coastlines, the risks of natural disasters are being increased by population growth and unmanaged development projects, including residential urban development. Coastal natural disasters cut across all economic sectors. Wind or water damage from a cyclone (hurricane), inundation by tsunami, wreckage from an earthquake, or coastal erosion from storms can affect tourism, fishing, port operations, public works, transportation, housing and industry. Tropical cyclones (hurricanes) form over the warm oceans (at least 26° C) mainly over the western parts where no cold currents exist. Apart from the wind and rain, a major impact is from the associated storm surge and storm waves. These have been responsible for major loss of life particularly in low lying densely populated coastal areas. Tsunamis are quite a different phenomenon and are associated with subsea earth movements. However, their speed and height can cause extensive coastal destruction with little warning and some distance from their origin.

Threats to Biodiversity

The composition and structure of the fauna, flora and habitats of coastal seas has been changing at an unusual rate in the last few decades, due to changes in the global climate, invasive species and an increase in human activities. The unusual rapid rate of change, rather than the nature of the change itself, is the reason for the deterioration of many environments; over the last 50 years the rate and extent of this deterioration has been unprecedented, as were the consequences on biological diversity. The term biodiversity is used by the Convention on Biological Diversity (1992) to refer to all aspects of variability

evident within the living world, including diversity within and between individuals, populations, species, communities, and ecosystems. The term is commonly used loosely to refer to all species and habitats in some given area, or even on the Earth overall. In fact, it relates to environmental attributes, often species or species groups, which can be sampled and whose modification is supposed to reflect a change of biological diversity.

What is important is the capacity of ecosystems to fulfil their role within the biosphere. The notion of functional diversity is useful in that it provides insight into the resilience of ecosystems and how changes affect them. There are many causes to losses of marine biodiversity, especially in the coastal waters of industrialized countries. Direct habitat destruction through the erection of engineering and drainage works which disturb the physical integrity of coastal and marine systems is the most drastic, as the habitat itself is changed to a point where the ecosystem loses its identity and fulfils a completely different function as before. Poor fisheries management, including the uncontrolled exploitation of corals and molluscs and the by-catch of large numbers of non-target species in fisheries is another important aspect of the detrimental exploitation of marine living resources due to the lack of an integrated approach to coastal zone management, leading to impoverished functioning. As a consequence, the productivity of fisheries and such important ecosystems such as mangroves and coral reefs has been depressed, and local human communities are suffering. In general, estuaries and salt marshes, mangrove forests, and sea grass beds near cities and towns are severely degraded worldwide with many species being threaten. The increasingly observed worldwide bleaching of corals could lead to massive ecological changes for coral reefs and other marine ecosystems.

Economic development and planning

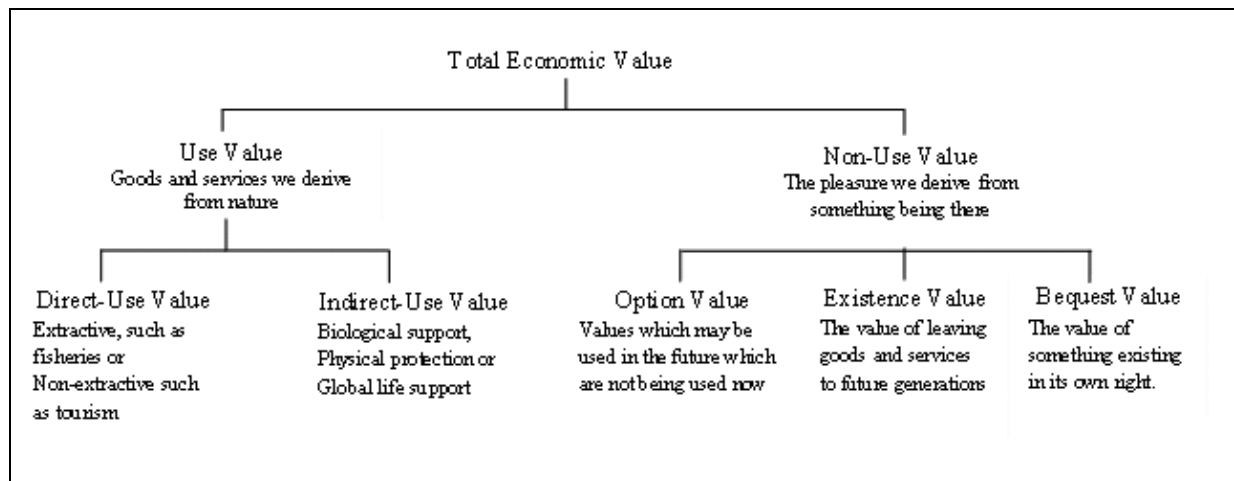
The previous sections have identified a range of issues on the coast which reflects the rich natural resource base and high population densities which coastal areas tend to have. Although resources may have been degraded on the coast, there is still a desire by many governments for sustainable and economic development of coastal areas. This means that the coastal areas generally have a wide range of plans, for example, regional development plan, spatial (zoning) plan, and tourist plan, in addition to local government plans and master-plans of large developments. Generally plans are devised on a sectoral basis, which involves an emphasis on development of that sector, and possibly to the detriment of other sectors. Thus, coastal planning tends to be fragmentary and can lead to conflicts between competing sectors; this means that the full economic potential of the coastal area is not optimised.

More recently, attempts have been made to integrate planning on the coast; these approaches come under the general heading of Integrated Coastal Zone Management (ICZM), although a variety of terminology is used by different workers (e.g. ICM, ICAM etc). The purpose of integrated planning is to allow multi-sectoral development to progress with the least unintended setbacks. Thus, fulfilling the potential of economic development is about moving from unplanned or fragmented planning towards integrated multi-sectoral planning. This is challenging due to the necessities for an interdisciplinary approach, for communication and collaboration between government agencies and for “breaking the mould” of traditional attitudes, behaviours and practises. However, in a dynamic and degrading world, integrated planning is the approach required to optimise economic development.

A classical economist view, and in many places government view, on economic development is about increasing income streams from the coast. For example,

economic development in a coastal area can lead to an increase in tourist revenue by \$XX and fisheries catch by \$YY. However, with the increase in sophistication in environmental economics and economic valuation methodologies, the complexity of the economy of the coast is becoming more apparent. Classical approaches view the economy of the coast as direct use values (e.g. fisheries or tourist revenue), however, there are many more elements of the economy of the coast, all these elements make up the Total Economic Value (TEV) of the coast (see Fig. 2)

Fig. 2: The elements which make up Total Economic Value of a coastal area



Coastal planning and economic development, thus becomes an issue of maximising the TEV of the area, not just concentrating on direct-use values. Certainly management of coasts lead to changes in the value of each of the elements of TEV. For example, Hicks et al. (2008)² show that different types of management (government led, community led and co-management) in areas of coast in Kenya lead to changes in the different elements of TEV and state that

² Hicks, C.C., McClanahan, T.R., Cinner, J.E. & Hills, J.M. (2008) A comparison of the ecological goods and services within the coral reef fisheries of southern Kenya under varying management structures. *Ecology and Society*, 14. <http://www.ecologyandsociety.org/vol14/iss1/art10/>

“the results reflect the effects management choices can have on economic and social resilience, and indicates that important trade-offs may be needed for effective management”. Thus, coastal planning for economic development is not just about income streams from direct-uses, but a more subtle approach to maximise, with acceptable trade-offs, the various elements of TEV, and thus maximising TEV of the area.