Abs. Nr. IT-106

Remote Sensing of Coastal Ecosystem

P.N. Sridhar[1]

Ecosystem is a unit of ecological community, comprised of biological, physical, and chemical components. The coastal ecosystem is the region of highly dynamic, diverse and productive region on the earth due to the combined action of physical features and bio-chemical processes from land and ocean. Coastal habitats perform a variety of important functions within the ecosystem and support the life history and ecology of many species. The shallow estuarine and nearshore habitats (e.g., submerged aquatic vegetation and large woody debris) are structurally complex and dynamic. They are the nursery areas for juveniles and provide food, refuge from predators, spawning habitats, and a transition zone to physiologically adapt to salt water existence. The sediment and morphodynamics of the nearshore region provide basis for foodweb based upon the nutrient supply and detritus produced by plants like marine algae, estuarine and saltmarsh vascular plants, and eelgrass that grow in highly productive shallow water habitats.

Nearshore ecosystem plays a critical role in support of a wide variety of biological resources, many of which are commercially, culturally, aesthetically, and recreationally important to the people of the region. Coastal wetlands act as a buffer to major storm impacts, particularly to damaging storm surges associated with cyclones. Coastal sand areas are an important source of fine aggregate material and beaches are recreational enjoyment, act as breeding, rest and feeding areas for fish, wildlife and waterfowl, and serve as buffer zones in shoreline protection. Recent studies estimate the global economic value of all the services costal wetlands provide to be in excess of $1.6 trillion per year. Coastal wetlands such as brackish water lakes, tidal marshes and mangrove forests, occur at the boundaries of land and ocean and because of their unique position in the landscape, they provide many important ecological services that maintain and improve the health of our earth's environment. Tidal marshes and mangroves store flood waters that run off from upland, thereby improving water quality by filtering out sediments and nutrients. They are critical habitat for juvenile and adult stages of many economically important marine fish and shellfish species that spend part of their life in the oceans. They also provide essential habitat for many species of waterfowl and wildlife.

Study of different biological resources and associated geological processes of the coastal zone enhance the understanding of linkage between biotic and non biotic components and their mutual dependence in sustaining the ecosystems integrities. Different Sensors onboard the remote sensing satellites in orbit have provided greater scope in mapping, monitoring and modeling global, regional and local phenomenon like El Nino, global warming, drought, sea level change, cyclone, fronts and gyres, and flood; processes like erosion and sedimentation,

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upwelling, productivity and pollution etc.; parameters like wave, wind, salinity, sea surface temperature, currents, suspended sediment concentration, chlorophyll etc. In this technical note, applications of remote sensing data in the study of coastal ecosystems are discussed.

Abs. Nr. IT-132

National River Links

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Abs. Nr. IT-107

Integrated Coastal Zone Management – Case Study (Chennai)

B.R. Subramanian[1]

Integrated coastal and Marine Area Management is a concept that facilitates, sustainable management of activities prevalent along the coastal and marine areas and rational utilization of resources available in the coastal land and adjoining sea. The conflicting use of coastal land area and non-mindful of adverse impact of activities on the resources and geomorphology of the coast cause loss of resources and damage to the coastline, thereby affecting socio-economic conditions of the dependent coastal communities. Evolvement of modern scientific tools and techniques like remote sensing, GIS and mathematical modelling has greatly helped in studying the problems caused by the manmade and natural activities in the coastal zone and their impact on the resources as well as on the physiography of the coast. They have helped in addressing the land use changes, changes in the bio-geochemistry of the marine area etc. The paper attempts to demonstrate the use of scientific tools and techniques for the integrated management of the coastal areas using Chennai coast as a case study.

The coastline of Chennai with a hinterland of 40km, from Pulicat lake to Mahabalipuram, harbours a variety of habitats/ecosystem, namely, Pulicat lake, Ennore and Muthukadu creeks, Adyar and Cooum rivers and beaches in the southern part of Chennai. The environment of these areas is widely exposed to several activities like port activities, waste disposal, fishing and recreation, leading to degradation of Pulicat lake, beach erosion at north of Fishing Harbour, accretion at tidal inlets of Pulicat, Ennore, Cooum, Adyar and Muthukadu backwaters, waste disposal in city waterways and the conflicting use of coastal land, especially in the southern part of the Chennai. Using scientific tools like remote sensing, GIS, mathematical modelling, integrated management solutions have been developed to solve the problems of accretion, erosion, pollution and conflicting use of coastal land.

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Abs. Nr. IT-126

Sustainable Management of the Bay of Bengal Large Marine Ecosystem

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The Bay of Bengal has been identified as one of the world's sixty-four large marine ecosystems (LMEs). Located in the monsoon belt, the Bay is bounded by eight countries (Bangladesh, India, Indonesia, Malaysia, Maldives, Myanamar, Sri Lanka and Thailand). The southern part of the bay merges into the Indian Ocean. About one-quarter of the world's population resides in the littoral countries of the bay of Bengal, with approximately 400 million living in the Bay's catchment area, many subsisting at or below the poverty level. An average of 65% of the region's urban population lives in large coastal cities and migration towards the coastal regions is increasing. The Bay of Bengal receives large inflows of freshwater and sediment from rivers whose discharges heavily influence the dynamics of the ecosystem, particularly the coastal surface waters in the north of the bay. The coastal and offshore waters of the region support numerous fisheries of great socio-economic importance to the countries bordering the Bay and provide for direct employment of over 2million fishermen. Among the most important of these are inshore small pelagics, demersal and shrimp fisheries and offshore tuna. The assimilative capacity of the Bay of Bengal is unknown and current anthropogenic effects on the quality of coastal waters of the countries are thought to be still mainly local. However, increasing evidence suggests that certain activities are causing serious local and cumulative environmental degradation that threatens the sustainable management and health of the BOBLME as a whole. Continuation of such activities, together with on-going overexploitation of marine resources, could pose serious problems for the future health and food security of millions of people in coastal communities who depend on these resources for their livelihood.

Recognizing the need for integrated and co-ordinated management of their coastal and near-shore living marine resources, the Advisory Committee of the longstanding Bay of Bengal Programme requested FAO to assist in developing a project proposal, which would adopt a Large Marine Ecosystem (LME) approach, for submission to the Global Environment Facility (GEF) under the International Waters portfolio. The GEF approved a PDF Block B grant to develop the BOBMLE programme with the World Bank as Implementing Agency and FAO as Executive agency.

The PDF B development phase is now operational. In the first phase, the national and regional coordinating mechanisms will be put in place to ensure broad-based participation in the development of the Transboundary Diagnostic Analysis (TDA) and Strategic Action Plan (SAP). The BOBMLE programme will ultimately provide a comprehensive framework to determine and implement the specific actions required to address the priority transboundary problems. Potential

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national and regional investment, technical assistance and capacity-building interventions will be identified to improve the management of the living marine resources, with an initial focus on fisheries, as well as of the health of the BOBMLE as a whole for the continued sustainable use of the Bay by future generations.

Abs. Nr. IT-125

Some Perspectives of Regional Carbon Budget for the Large Tropical River Basin

M.M. Sarin[1]

River transport of N, P and Si is an important coupling between land and coastal ocean. Their dissolved concentrations in river waters are several orders of magnitude higher than those in the coastal and open ocean. Modeling of the geochemical data by Ver et. al. (Chem. Geol. 1999) demonstrates that increased mobility of N, P and Si resulting from present-day land-use activities would enhance the CO_2 fertilization effect; and that larger flux of river-born nutrients could also increase the carbon sink capacity of the coastal ocean. In this context, the humid tropics of Asia are potential among the highest contributors to this increased carbon storage. About half of the suspended sediments entering the ocean today come from Asian countries (Milliman & Meade, 1983); and this is likely to increase in the future in ways that will impact the global biogeochemical cycles of C-N-P-S (Meckenzie et. al. 1998).

Motivated by the perspective of understanding the carbon transport fluxes through the large tropical rivers in South Asia, a comprehensive study was conducted (under LOICZ programme) in the Godavari mainstream and its tributaries in order to understand the spatial and temporal distribution of POC, DOC and DIC. Godavari is the third- largest river in India. The abundance of total carbon in the mainstream and its tributaries ranges from 14 to 50 mg C l^{-1}. The most abundant form of carbon is DIC with an average concentration of 40 mg C l^{-1}. Relatively high concentration of POC is a characteristic feature occurring during high water discharge stages (period of SW-monsoon). A parallel increase in particulate C:N ratios (range: 8 to 12) suggest the contribution of allochthonous material contributed by surface run off. The impact of anthropogenic DOC signals is pronounced during lean flow stages in the upriver and feeder tributaries. The NO_3^- and SiO_2 concentrations in the mainstream vary as 0.1 to 6 and 15 to 35 mg l^{-1}, respectively, over the annual seasonal cycle. The annual budget of DIC, POC and DOC for Godavari basin is in the proportion of 75:21:4; DIC transport accounts for about 230×10^{10} g C yr^{-1}. The non-conservative trend of organic carbon (POC + DOC) transport, between upper and lower basins, indicates storage of sediments and organic carbon in river channels and dam sites. It is suggested that for highly disturbed watersheds in tropical regions, riverine transport of sediments and carbon requires a long-term sampling programme.

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Abs. Nr. IT-137

Coastal Pollution and Mangroves

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Abs. Nr. IT-131

Integrated Coastal Zone Management of Chilka Lake a Ramsar Site

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The Chilka lake lies between 19^0 28' - 19^0 54' N and 85^0 38'E in Orissa state. The lake is a hotspot of wide bio-diversity and rich resource development. Rich commercial production of prawn, crabs, shrimps and fish from the lake brings good foreign exchange by exporting these products. The salinity level of the lake water has decreased from 15ppt to 4ppt due to environmental degradation. Therefore, in order to protect the bio-diversity of the lake the salinity level should be maintained at 15 ppt.

Chilika is the biggest lagoon in the East coast of India. The lagoon supports many endangered and endemic species of flora and fauna. The Chilika lake is a wetland of International importance (A Ramsar site). The complex mix of resources in and around the lake, water, fish, land, forest and fauna, have an interrelated effect on community life. It is difficult to precisely arrive at a geographical area, and consequently, at the communities which should be included in the coastal zone management plan for the lake. Many communities, with very different socioeconomic backgrounds, are one way or another linked to resources in and around the lake. Three distinct communities can be identified as having crucial linkages to the lake and its coastal zone management:

(a) The fishermen (Traditional and non traditional)
(b) The farmers who live around the lake, and
(c) Those who depend on the forest resources in the lake catchment area for both their livelihood and to meet their fuel/timber requirements.

The issues and concerns can be grouped under six broad categories

(a) the lake as a whole and fish production in the lake
(b) the economic aspects and methods of fish catch by fishermen
(c) fishing right and prawn culture development
(d) the pricing and marketing of fish
(e) the socio-economic status of men, women youth and the potential opportunities and
(f) the present infrastructure in the villages and the future needs of the local communities.

An integrated approach to coastal zone management implies that all interrelated aspects of the environment are considered, that long-term conservation requirements are met, and that both technical and social dimensions are incorporated into management decision. The problem can be defined as a need to develop an effective inter-agency and community based operational frame work for coastal zone management. A comprehensive catchment treatment plan

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is prepared by using the latest satellite imagery using Orissa remote sensing application centre (ORSAC). It is proposed to dredge 2.4 million cu.m in the inlet as well as in the outer channel to ensure adequate supply of tidal water in to the lake.

A channel of length 2.7 km and 100 m width was dredged to increase the inflow of seawater into the lake to improve salinity. A creek connecting Chilika lake and Bay of Bengal was also opened to improve salinity of lake. After carrying out the above, the following improvements have taken place in Chilika lake

i) increase in fish production
ii) considerable increase in salinity level
iii) improved catchment area
iv) improved infrastructure and socio economic status of the farmers

The details of Coastal zone management of Chilika lake is discussed briefly in this lecture.

Mangrove Community Structure and Evolution at Coringa in the Godavari Delta, Andhra Pradesh

A.V. Raman[1], B. Satyanarayana[1] and Danny Lo Seen[2]

Coringa sanctuary, the second largest mangrove formation on the east coast of India next to Sundarbans has been under considerable human impingement over the last decade. Industrial development along with agriculture practices, oil and natural gas drilling, port expansion episodes and mangrove reclamation to build shrimp farms proved deterrent to the ecosystem. Such effects, not to mention the additional burden of pollution and changes in hydrological regimes caused by freshwater diversion projects, have had an adverse influence on subsistence dwellers in and around Coringa. Reports of mass fish kills in Coringa following release of industrial effluents upstream have become causes of great disquiet recently. As a result of all this, there has been a greater public concern for the protection of Coringa mangrove forest, and an increase in research and management effort. The qualitative degradation of mangroves at Coringa therefore needed comparison with available historical data and between sites differentially affected by man. Under the aegis of European Commission and Government of India Department of Ocean Development funded research, some 228 GPS fixed sites covering an area of 230 km^2 of mangroves were examined (based on PCQM) for a period of 6 years during 1996-'02 and a large amount of data on tree structural variables such as stem density, basal area, relative density, relative dominance, absolute frequency and species individual ranking was collected. Altogether 15 species of mangroves (11 major and 4 minor components) represented by 8 families and 10 genera and 6 species of salt marshes consisting of 2 families and 5 genera were encountered in Coringa. There were 10 mangrove associates. Based on multivariate analysis (Bray-Curtis similarity and MDS) implemented in PRIMER, the mangrove communities at Coringa could be distinguished into 6 combinations according to their stem density or basal area. These are (1) *Sonneratia apetala* group of trees, (2) *S. caseolaris* and *Avicennia alba*, (3) *Xylocarpus mekongensis*, *Rhizophora mucronata*, *R. apiculata* and *Bruguiera gymnorrhiza*, (4) *Avicennia marina*, *A. officinalis* and *Excoecaria agallocha*, (5) *Lumnitzera racemosa, Ceriops decandra* and *Aegiceras corniculatum* and, (6) *Bruguiera cylindrica*. A further division (based on basal area) of this vegetation into dense (>3.2 m^2/0.1ha), medium dense (3.2-1.7 m^2) and less dense (<1.7 m^2) stands could be made showing significant differences (R: 0.692, P: 0.1%) between sites with high (dense mangroves) and low basal area (less dense) of which the former were located within the (protected) Coringa RF. The findings have shown that mangrove distribution/zonation patterns in Coringa appeared largely determined by geographic location (sea or landward sites), freshwater runoff and the extent of

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neritic inundation. Superimposed effects could be due to human intervention particularly visible at sites with easy accessibility. Based on changes in mangrove area from 1977 to 1999, the two remarkable causes of mangrove loss in Coringa could be linked to natural events (e.g. coastal erosion, storm impact) and those related to human activities (shrimp culture).

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Water Related Issues in Mangroves of India

K. Kathiresan[1]

Mangroves are salt-tolerant species of tree and or shrub that grow at the interface between land and sea in tropical and subtropical latitudes. By virtue of complex root structure, the mangroves prevent the entry of seawater inland and protect the underground-water systems. They also protect the coastlines from heavy wind and flood and prevent the coastal erosion and sedimentation of seawater. The mangroves enrich the coastal waters with nutrients and support the coastal fisheries.

In India, total area of mangroves is 4,871 sq. km. Of which, about 57% are found on the east coast, 23% on the west coast and the remaining 20% on the Andaman & Nicobar Islands. The mangroves in India comprise of 69 species, under 42 genera and 27 families. Of which, twenty mangrove species are either endangered or rare or endemic.

The mangroves in India experience area-specific threats in different maritime states. The most significant threat is growing human pressure on mangroves and water related issues. Most of the rivers especially at mouth regions along the east coast are heavily silted up and this prevents the entry of tidal water into mangroves. This results in poor flushing of mangrove habitats. A number of irrigation canals and dams have been constructed in the upstream areas, interfering with free flow of freshwater into the mangroves. This results in poor supply of sediments to the mangrove habitats. Poor rainfall adds to the problems, resulting in high salinity and destruction of mangroves. This is a serious issue in Gujarat, Tamil Nadu and Andhra Pradesh. In Sundarbans, the freshwater loving species like *Nypa fruticans* and *Heritiera fomes* get reduced drastically. In Orissa, *Sonneratia apetala* shows tip drying disease due to high salinity during summer. Kerala has another extreme situation where seawater entry is prevented for the purpose of agriculture; this leads to heavy inflow of freshwater in to the mangrove habitats, affecting the mangroves due to overgrowth of freshwater species. Hence, conservation of mangroves relies largely to the management of water resources and this aspect deserves a top priority.

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