The Environment and Sustainable Local Development in Coastal Areas

N. Lourenço and M. Jorge

Between 1998 and 2002 a multi-national research project – *Measuring, monitoring and managing sustainability: the coastal dimension* – was funded by the International Cooperation with Developing Countries programme of the European Commission. The project analysed interactions between social and environmental issues to better understand the impact of socio-economic drivers on ecosystems, focussing on issues of importance to sustainable coastal development planning and management. This included a consideration of stakeholder-sensitive instruments to support coastal policy-making.

The collaboration involved the Energy and Resources Institute (India), the National Institute of Oceanography (India), Goa University (India), the Universidade Nova de Lisboa (Portugal), the Laboratório Nacional de Engenharia Civil (Portugal), the Instituto Cartografic de Catalunya (Spain), and the Universita Degli Studi di Trieste (Italy).

The study analysed land-use change and sustainability in the coastal regions of India in terms of both societal pressures and the nature of coastal ecosystems. Regions were identified where socio-economic and biophysical problems led to coastal vulnerability, and indicators of both the pressure and state of vulnerability were defined for all coastal regions. The indicators were used to classify 66 coastal districts of the west and east coasts, and to identify the most vulnerable districts. The three most vulnerable regions were also found to be representative of the major forces responsible for change in coastal areas: tourism in north Goa, industry and urbanization in Thane (near Mumbai), and intensive agriculture and aquaculture in east Godavari.

Detailed socio-economic and ecosystem health investigations in north Goa, Thane and east Godavari identified the key variables affecting coastal resources in the context of the above drivers, and assessed the nature and extent of the demands that societal drivers place on coastal resources under present and alternative growth strategies. In north Goa, beach and coastal vegetation degradation, land form changes, and surface water quality degradation have stemmed from land-use and land cover change and groundwater use. In east Godavari, deterioration of the quality of groundwaters, coastal and fresh surface waters has accompanied mangrove swamp conversion and rising groundwater levels, while in Thane, polluted coastal and groundwaters are associated with changes in land-use and land cover.

Comparative analysis across locations and drivers [1] suggested that while well managed tourism could improve vegetation cover and biodiversity (in spite of the disappearance of some beach vegetation near Goa), industrial expansion degrades vegetation. In Thane, where plant biomass is declining and vegetation cover is becoming fragmented, Normalized Difference Vegetation Index (NDVI) analyses showed that although agricultural expansion has had significant negative impacts, it has increased plant diversity. Plant diversity has declined however near villages

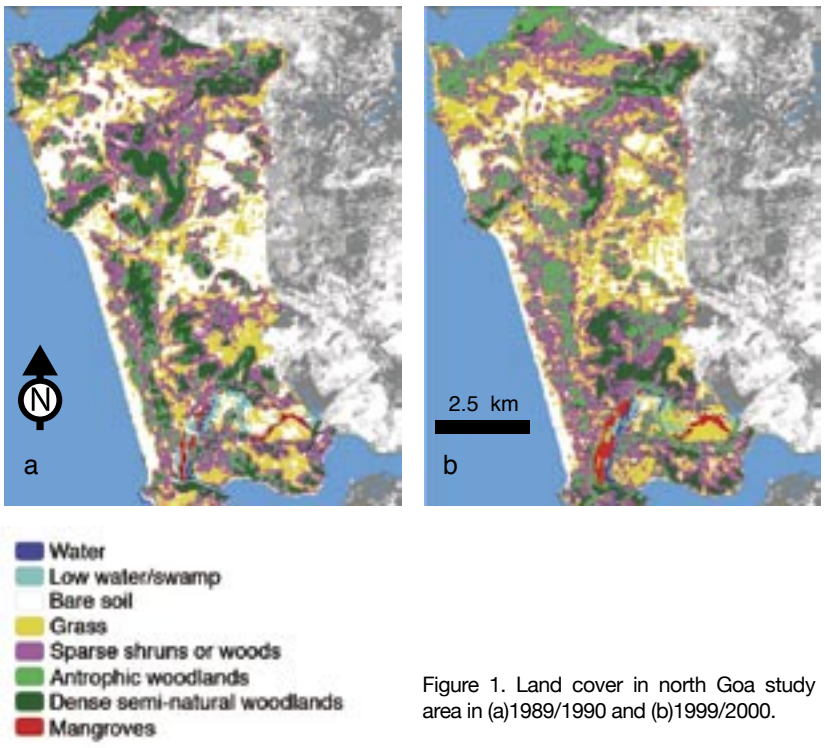

Figure 1. Land cover in north Goa study area in (a)1989/1990 and (b)1999/2000.

Figure 2. A five star hotel next to the shoreline in Fort Aguada beach in the north Goa study area.

Figure 3. A view of Calangute with the seasonal shacks build on the beach in the north Goa study area.

in east Godavari, and mangrove forest area has been reduced due to expansion of shrimp breeding ponds and paddy fields. Sustained development soon leads to water demands, sewage loads and levels of fertiliser and pesticide use that exceed the impact resistance or assimilative capacity of the environment. These thresholds depend on the nature and health of the ecosystem, and hence ecosystem health must be understood before the environmental impacts of future development can be adequately assessed. The relationships between development pressures and environmental responses are often non-linear and mediated by intermediate pressure-driver relationships.

From the case studies a framework for integrated analyses of the social and ecological aspects of coastal development emerged, and tools and approaches to improve sustainable ecosystem management were developed. Examples include a new method for delineating groundwater well-head protection areas, optimisation models to help manage growing water demand, and a coastal groundwater management policy based on optimisation and protection zoning. Three types of tools were developed for decision-makers: visualisation tools, spatial analysis tools and advanced modelling tools. The visualisation tools help consider the study area from different perspectives, define the main biophysical characteristics, highlight direct cause-effect relationships and establish the basis for condition assessments. The spatial analysis tools enable exploration of the spatial and attribute relationships between datasets, while the advanced modelling tools use mathematical and raster modelling to undertake multi-criteria analyses.

An important output of the project is the book *Coastal Tourism, Environment, and Sustainable Local Development* [2], which deals with the results related to tourism impacts. The book details the research analyses and results, and describes the decision tools developed in the project to measure, monitor, and manage coastal tourism development along sustainable paths. Sustainability – a concept that was central to project approach – is highlighted in the book. Sustainability requires an understanding of the complex relationships between society and nature, and so demands an integrated, interdisciplinary approach. While there are different ways to achieve sustainable development, all must consider the interactions between social and ecological systems, and this is reflected in the integration of natural and social sciences in the book.

The book is organised in three parts: (i) *Tourism Drivers and Coastal Ecosystems*, (ii) *Linking*

Social and Ecological Systems, and (iii) *Designing New Approaches to Managing Coastal Tourism*. Part I focuses on the tourism dynamic of the Goa study area. The analysis highlights the spatial dimension of tourism and its importance as the driving force of social, economic and environmental change. Increasing tourist numbers and tourism infrastructure appear to drive local population movement and behaviour, land-use and land cover change, and the patterns of natural resource consumption.

A typology of tourism destinations was used to differentiate the patterns of natural resource consumption that stem from differences in tourist accommodation infrastructure. Analysis of 1989/1990 and 1999/2000 land cover (Figure 1) showed that while the NDVI increased in the study area, the diversity of species has decreased due to loss of the original vegetation. Coastal vegetation has increased in tourism locations due to the desire for an attractive environment (Figure 2), and tourism-related activities have had a strong impact on forest-related activities, and on traditional activities including salt extraction, agriculture and aquaculture. Land reclamation is increasingly common, broadening the coastal tourism belt eastward towards the hinterland. The natural flow of tidal waters and estuaries has been adversely affected, and shore widths have diminished where sand dunes have been razed for tourism development (Figure 3). Water quality data show that sewage effluent is causing high levels of bacterial contamination in rivers and creeks. However, coastal waters are not polluted suggesting efficient biotransformation by heterotrophic bacterial communities.

Part II of the book develops the links between social and ecological systems, and the assessed ecosystem changes. The tourism-related environmental changes are used to identify models and build projections to 2021. Alternative development scenarios are presented with discussion of the potential ecosystem implications. Scenario land cover projections were simulated in a geographic information system. Part III of the book discusses different approaches to sustainable coastal tourism management. New methods are presented and discussed, and a variety of indicators and instruments to support decision-making are compared.

The final discussion considers the political framework required to support sustainable tourism. The EU experience and the outputs from the collaborative research described above suggest that coastal management policy (formulation and implementation) should include a range of creative approaches, with development and its impacts continuously monitored and managed. Participatory development is recommended, wherein local communities are active in guiding development and sharing in the benefits. This points towards decentralised coastal management in India, within broad enabling frameworks, and with regular consultative workshops. To adopt this approach would require the creation of institutions to promote the approach, the building of trust amongst stakeholders, the establishment of equity in information flows, new ways to address tourism needs and impacts, the building of social capital to enable a participatory approach and a strengthening of local governance. Specific measures to enable a participatory approach to development include establishment of state tourism boards with strong representation from key stakeholders, regional and local councils to expedite decision-making and improve transparency, and multi-stakeholder advisory committees to address tourism-related environmental, governance and social issues.

The book *Coastal Tourism, Environment, and Sustainable Local Development* is likely to be of interest to coastal planners, tourism professionals, researchers and all those with an interest in sustainability science. The book can be ordered from The Energy and Resources Institute (www.teriin.org). This research comes under the umbrella of International Cooperation Programme of the European Union, and contributes to the LUCC project of IGBP.

Nelson Lourenço
Universidade Nova de Lisboa
Lisboa, Portugal
E-mail: nelson@netcabo.pt

Maria do Rosário Jorge
Universidade Atlântica
Barcarena, Portugal
E-mail: rosarioj@uatla.pt

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