COASTAL RESOURCE DEVELOPMENT, ENVIRONMENTAL PROBLEMS AND MANAGEMENT IN INDIA

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CERTIFICATE

The thesis entitled "**Coastal Resource Development, Environmental Problems and Management in India**" submitted by **Mr. Anil Kumar Jha** has not been submitted partially or wholly, for any other degree of this or any other university. This is his own work. We recommend that the thesis be placed before the examiners for their consideration for the award of the **Ph.D. degree**.

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Dedicated to my beloved
brother-in-law
SRI GOVIND JHA

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ANIL KUMAR JHA

New Delhi
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many coastal areas as a result of industrialisation and tourism. Today, about 60 per cent of humanity (or nearly three billion people) live in the coastal zone, and two-thirds of the world's cities with population of 2.5 million or more are near estuaries. Within the next 20-30 years, the population of this zone is expected to almost double.[2]

This population pressure is inevitably altering land use patterns in coastal zones thereby giving birth to multiple use conflicts. Other impacts come from pollution, flooding, land subsidence and compaction, and the effects of upland water diversion. Natural habitats are being lost through reclamation for urban and industrial development, agriculture and mariculture. Near-shore regions are being degraded by eutrophication and industrial waste; public health is threatend by sewage contamination of beaches and seafood; and the marine environment is being fouled by the progressive build-up of chlorinated hydrocarbons, plastic litter and the accumulation of tar on coastlines.

Some of the waste products of coastal development, augmented by discharges through coastal outfalls and rivers, spread outwards to the world oceans, carried out by the atmosphere, currents and ships. The visible fingerprint of humanity (oil slicks, plastic litter and other debris) can be found everywhere. Moreover, the oceans have also been affected by many 'invisible' changes in the current century. Most commercial stocks of fish are now over exploited and the balance of whole ecosystem is at risk.[3]

There was considerable concern over the state of coasts and oceans at the times of the Stockholm Conference on human environment. Since then, action has been taken to stop the dumping of polluting wastes at sea, to eliminate damaging pollution from ships to limit discharges from land-based sources, and last but not least to make world community aware of the issue.[4] Nevertheless, the pressures of coastal zone development are leading to continuing environmental degradation in many parts of the world and these conditions are likely to be exacerbated by climatic change and sea-level rise within the next 50 year or so.

Need for Integrated Coastal Zone Management :

Coastal zones are of great economic, social and environmental significance in most coastal nations. They are extremely attractive areas for human settlement and use due to their wealth of natural resources and amenities such as fisheries, productive wet-lands and beaches. Yet it is this very attraction that has led to intense pressures being placed on the diverse and valuable resources of the coastal zone, pressures which are likely to increase.

There is growing evidence that traditional sectoral approaches to the management of resources and activities in coastal areas are inadequate. Despite best efforts in many cases, natural coastal systems continue to degrade, resource use conflicts are mounting and the social and economic benefits which could be derived from the natural resources of the coastal zone are being lost.[5]

Integrated coastal zone management (ICZM) is a dynamic process in which a co-ordinated strategy is developed and implemented for the allocation of environmental, socio-cultural and institutional resources to achieve the conservation and sustainable multiple use of the coastal zones. The ICZM has five attributives :[6]

1. It is a process that continues over considerable time and requires continual updating and amendments. It is not a one time project.
2. It has a geographic boundry that defines a space which extends from the ocean environment across the transitional shore environments to a specified inland extent.
3. There is a management arrangement to establish the policies and process for making allocation decisions.
4. The management arrangement uses one or more strategies to rationalise and structure the allocation decisions.
5. The management strategies selected are based on a systems perspective which recognises the associations between coastal resources and processes. The systems perspective usually requires that a multisectoral approach be used in the design and implementation of the management strategy.

It is clear that integrated coastal zone management involves a non-sectoral approach to the management of coastal resources. It must consider the environmental, natural resources, socio-economic, political, cultural and geographic dimensions of the coastal zone in a multi-sectoral framework.

In the coastal zone the economic and environmental systems are highly interdependent. Any new development that changes the economic system effects the environmental system and these changes have a 'feed back effect' on the economic activities and can be seen below :[7]

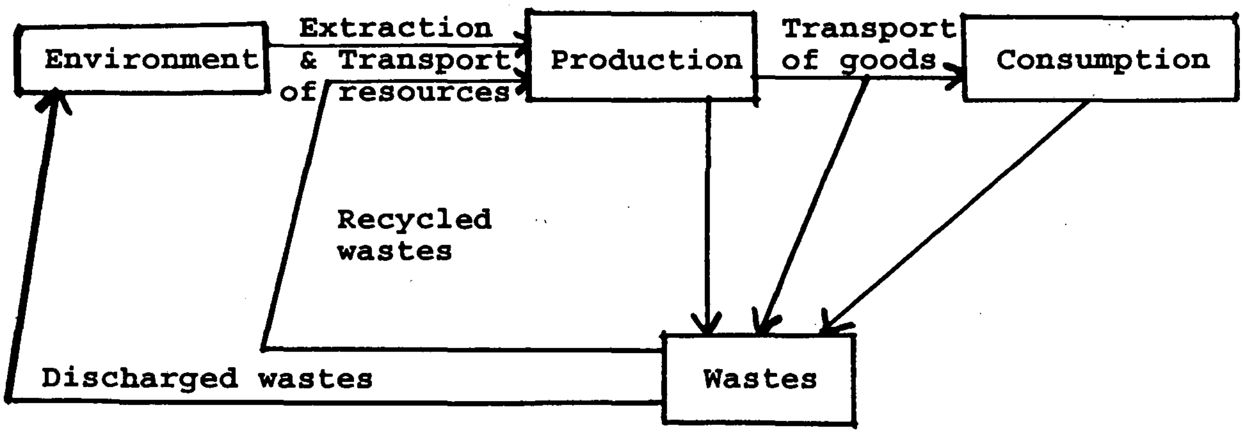

Fig. 1 : Relationship between Economic and Environmental System.

Where the change in environmental conditions is associated with one or more impacts then, directly or indirectly, the economic welfare and the pattern of economic-environmental circle is close. Fig.2 illustrates how an initial change within the economic system, which is triggered off by new development, leads to a set of responses within the environmental system which later reacts back upon other activities within the economic system. In turn, these may generate secondary responses in the environment which lead to further changes in the pattern of economic activities.[8]

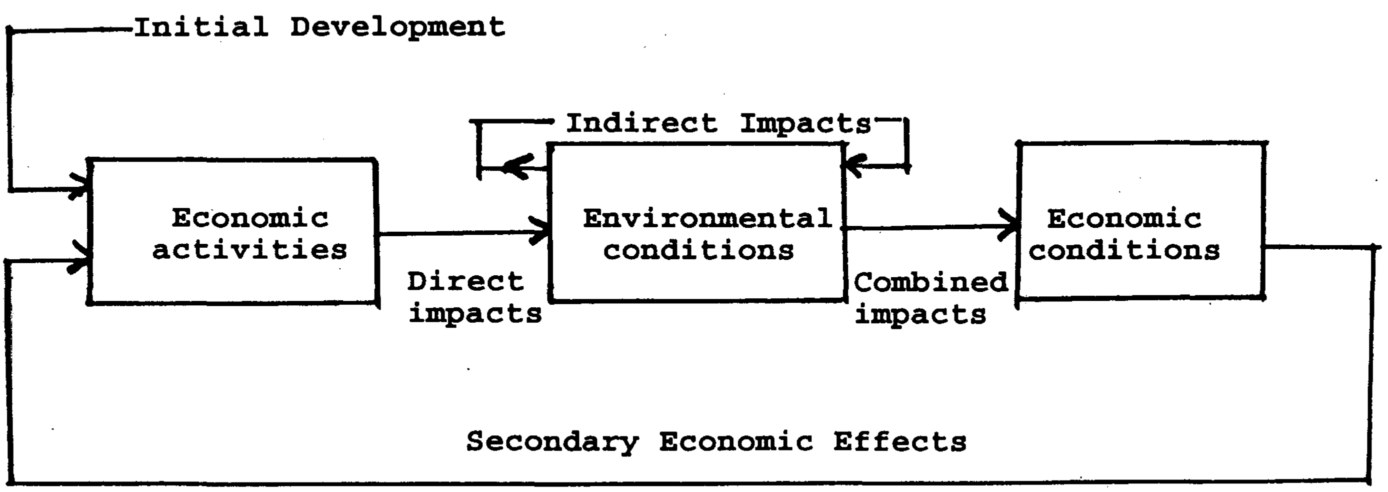

Fig. 2 : Change and Response in Economic and Environmental Conditions

At present these cycles of change and response which link the two systems tend to be regulated on a piece-meal, unco-ordinated basis with the result that the condition of coastal zones is too often unsatisfactory both from the environmental and the economic point of view. Hence, there is need to integrate the planning and management of economic development and of environmental protection in such areas.

Delineating Coastal Zone :

Located between the open ocean and the terrestrial domain lies a loosely defined area referred to as the coastal zone. Neither purely land or sea, it is an area of intense physical, ecological and social interaction. It has been generally defined as that part of the land affected by its proximity to the ocean. It is an area in which.processes depending on the interaction between land and sea are most intense.

The United States recognising that coastal areas are the focal point of a wide range of impacts from both territorial and marine activities enacted legislation in 1972 for the planning and management of coastal zones. The US coastal zone management Act 1972 is about the earliest legislation developed with respect to coastal zones management. Focusing on comprehensive resource management, it defines the coastal zone as the 'coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder) strongly influenced by each other'. The seaward limit is the outer boundary of the USA territorial sea. The landward limit is discretionary.[9]

In practices, the zone may include a narrowly defined area about the land-sea interface on the order of hundreds of meters to few kilometers, or extend from the inland beaches of coastal watersheds to the limits of national jurisdiction in the offshore. Its definition will depend on the particular set of issues and geographical factors which are most relevant to each stretch of coast. In India, the Ministry of Environment and Forests notification on coastal regulation zone (1991) has drawn an arbitrary boundary of 500 meters from the hightide line landward. However, for comprehensives planning and management purposes the zone may be much wider.[10]

Furthermore, the identification of space over which coastal policy applies requires a great deal of judgement and commonsense. The basic parameters for such a decision is set by the final intention of coastal management and the particular institutional context in each country.

LITERATURE SURVEY :

Although extensive research is progressing on environmental science, engineering and management aspect of oceans and coasts the study on integrated coastal zone management is limited to the study of environmental status only. Historically, the concentration of efforts has been on the scientific and technological aspect of coastal zone management. However, few literatures are available on the legal aspect of ocean and coasts management. Hence, the comprehensive planning and management studies on coastal environments is limited.

However, Brahtz, J.F.R (1972)[11] has brought out an edited volume on "Coastal Zone Management : Multiple Use with Conservation". This volumes has the specialised matters on conservation of biological and mineral resources, the needs of systems planning to control coastal zone development, marine waste disposal and marine transport system. These studies are framed for the policy derivation in general and status assessment in particular. Each physical character has been assumed as either extractive or non-extractive and appropriate primary resources for this activity has been identified for the multiple use of coastal environment. The Major conflicts involved in the use of marine and coastal resources and anticipated technology measures are discussed with reference to proper policy guidelines and decision making.

Ketchum, B.H. (1972)[12] in this volume has clearly outlined the why and how of the coastal zone management. He has identified the critical problem of the US coastal zone. Coastal zone management is a process designed to achieve set or stated objectives. The stated objectives would be to maintain and to improve coastal zone's usefulness for man by ensuring the quality and extent of the natural system upon which he depends. It puts forward some guidelines for policy and decision makers.

Clark, J.R.(1977)[13] has emphasized the increasing concern for ecology and conservation of resources in the coastal ecosystem. He has discussed in detail many techniques that have been developed to analyse and evaluate environmental impacts of different kind.

Barnes, R.S.K. (1977)[14] in his book discusses the ecological values of coastal ecosystems. The coastal ecosystems (salt marshes, dunes, beaches, wetlands, coastal waters etc.) plays extremely important role for human society. Coastal development has led to destruction of estuaries, beaches etc. He warns that areas of scientific and recreational value, with many important flora and fauna will be lost if proper coastal management is not practiced.

Honikawa, K. (1978)[15] has approached planning and management issue in the coastal zone from the standpoints of either controlling or avoiding unwanted impacts of physical coastal processes on assets and communities by engineering solutions and installations.

EKISTICS, (March/April 1982)[16] in this issue deals with various aspects of the problem of coastal areas, management perspectives and attempts to describe some positive national and international efforts to cope with the coastal area management. It advocates the role of ecological mapping and environmental impact assessment in coastal planning and management. The EIS is a valuable tool to encourage 'productive and enjoyable harmony between man and his environment'.

Sharma, R.C. (1985)[17] in this volume has edited papers which place pertinent focus on the various aspects of the marine environment surrounding India. It deals primarily with the scientific aspects of living and non living resources, the question and problems of their development, the issues confronting India in the context of the emerging international oceanic regime and perspectives on the maritime security aspects of India.

Nair, N.B. (1987)[18] has edited articles in this volume which focuses on all aspects of scientific management of Indian estuaries. They mainly deal engineering, physical geological processes, and human influences both as process and response. They are mainly status papers.

Tolley, M.J. and Ian Sherew (1987)[19] have analysed the implication of global warming and sea level rise on the coastal assets, communities and coastal ecological balances. For the next century, they caution the policy makers and planners about sea level rise and suggest integration of this phenomena in the planning and management process of the coastal zone.

Dwivedi, S.N. and et.al. (1989)[20] in this volume have edited articles on various aspects of coastal use and related problems in India. It is an outcome of a National seminar on 'Coastal Planning and Management : Sea Level Rise' in 1989.

It also recommends plan of actions to policy makers and planners to treat coastal zone as a sensitive area that needs special protection from over exploitation and destruction due to pollution.

Gable, F.J. and D.G. Aubrey (1990)[21] have analysed the threat of man - induced global change on the South Asian countries and seas. They have pointed out that it varies from place to place because of differences in exposure to monsoons and storms, differences in local tectonics and subsidence, and variations in air and sea climates.

R. Sengupta et. al. (1990)[22] in this report analysed the state of marine environment in the South Asia seas region. In all the countries of the region, the state of marine environment is far from satisfactory. Common problems of immediate concern for all the countries include petroleum hydrocarbons, microbial pollution, sewage and industrial wastes disposal with associated heavy metal, agricultural wastes including pesticides residues, siltation changes associated with changes in soil erosion and possibly hydrological cycles.

B.U. Nayak et.al. (1992)[23] in this article gives an over-view of Indian Coastal zone and seeks to establish one Central Coastal Zone Management authority for co-ordinating and implementing coastal zone management in India. Most recent advances in ocean science and technology are to be used to resolve any conflict that may arise in the interactive uses of the coastal zone and implementation of public goals. He also puts forward some engineering and management techniques to be applied in the coastal zone management.

Wells P.G. and J.M. Bewers (1992)[24] have in this special volume edited articles focussing on issues and directions of coastal and marine environment protection, advances in the field of integrated coastal zone management and challenges ahead. The application of remote sensing and geographic information system are notably emphasized in coastal management.

Singh, Chhatrapati (1992)[25] constitutes an exploration of 'water rights' and 'water laws' in India. Most assays in this volume direct attention to legal complexity which inevitably escalates asymmetry of power relations in society. The paper by Iqbal Siddiqui is a chronological survey of the history of legislative activity in the area of water law in India.

Sharma, O.P. (1993)[26] in his article discuses the legislation enacted, institutional arrangements devised, the scheme of enforcement envisaged and how various difficulties were resolved to protect the coastal waters and EEZ of India. Having had no cohesive oceans policy since attaining independence, India was like many other developing nations totally ill-equipped to enforce the new rights and assume obligations in its vast maritime zones because of this type of competence was being assumed for the first time in the maritime history of the country.

Satish Chandra et.al. (1993)[27] in this volume tackle four basic themes of Indian Oceans and its islands : strategic, legal, exploitation of resources and maritime traditions. While the contributors assess the scientific and developmental aspects of the islands in specific relation to India, these issues have a broad application to the problems facing all littoral countries. A unique feature of this volume is that it combines a discussion of strategic aspects with an exploration of India's growing dependence on oceans and coasts.

Swaminathan, M.S. and R. Ramesh (1993)[28] have edited papers presented in a seminar on 'sustainable management of coastal ecosystem' at Madras. Papers focus on all aspects of an integrated approach to ecological security of coastal zone and livelihood security of coastal communities. The impact of potential charges in sea levels as a result of global warming is also discussed. Coastal ecosystem management based on considerations of ecological sustainability and economic viability needs urgent attention in India. For this purpose, the authors have felt the need of coastal zone which would include 20 KM of sea surface and 20 KM of land surface from the hightide line.

Biliana Cicin - Sain and Robert W. Krecht (1993)[29] in this article provides an overview of implications of the

Earth Summit for ocean and coastal governance. comprehensive plan of actions for the protections of ocea and coastal areas was approved under Agenda 21. This plan action involves concurrent attention to the following :-

1. Integrated management and sustainable development coastal areas, including EEZ;
2. Marine environmental protection;
3. Sustainable use and conservation of marine livi resources of the high seas and under nation jurisdictions;
4. Addressing critical uncertainties for the management the marine environment and climate change;
5. Strengthening international including region cooperation and coordination; and
6. Sustainable development of small islands.

Coastal management (1973-93)[30] Journal : In its various volumes, consists of articles focussing on all aspects of coastal planning and management in different parts of the world. This is a landmark publication in this field of inquiry. Most of the articles focus on the status of coastal management in developed and developing countries. They also comprise articles on the methodological aspect of the coastal planning and management.

This quarterly journal named Indian Journal of Marine Sciences (1980-93)[31] comprises of articles focusing on scientific and technological aspects of Indian coasts and oceans. They deal mainly with geological, physical, chemical biological aspects of oceanography. They also have articles on marine instrumentation and technology. These articles give us an insight on the coastal processes, pollution, deep sea mining and exploration, availability of oceanic resources, coastal and marine water quality etc. both of micro and macro level.

This literature survey is brief but mentions the relevant. Rational inclusion of various other studies on related topics would have unnecessarily increased the bulk and hence has been deliberately avoided. The ones which have really contributed in the thought process while carrying out the study have been included.

Objectives of the Study

Recognising the importance of coastal ecosystem and urgent need for Integrated Coastal Zone Management (ICZM), the main objectives of the study have been taken as follows:

i) To prepare a complete inventory of uses and activities that take place in the Indian Coastal Zone.

ii) To identify ecologically harmful development in the coastal zone.

iii) To analyse and assess the possible impact of sea level rise at micro level - A case study of Paradip Coastal Stretch, Orissa.

iv) To examine and critically apprise the current statutory role and jurisdiction of central, state and local agencies in managing the coastal zone.

Methodology

Methodology adopted to pursue this study are : the first may be termed as descriptive/analytical. This involves the collection of facts and figures and the organisation of them as a description/analysis of the distribution of some phenomenon in an area.

The second type may be called problem solving. This involves keen observation of some phenomenon and requires adequate scientific explanation in terms of their occurrence through space and/or time.

Data Base

The data and information for this study have been derived from secondary sources - published and unpublished. However, to understand the ground realities with respect to the environmental factors, a reconnaissance survey was conducted. This survey gave a feel of the environmental realities of the Indian Coastal Zone.

The application of Bruun Theory in the estimation of the area of submergence and impact of possible sea level rise on population and land use of the Paradip coastal stretch has generated some valuable primary data at micro-level.

The major source of secondary data are listed below :

i) Census data and plan reports

ii) Data collected by Town and Country Planning Organisations of Maritime States/UTs.

iii) Statistical Abstracts published by Directorate of Economics and Statistics of Maritime States/UTs.

iv) Govt. of India/UNEP report and documents.

v) Data and information regarding environmental degradation and pollution from various sources such as books, journals, reports, scientists at NIO, Goa, etc.

Limitation of the Study

The body of knowledge related to this study has continued to expand rapidly, and for that reason this study can not give the last word on the subject. This study was finalised early in 1994 : thus, developments since that time are not covered. However, an attempt has been made to include technical, economic and legal developments that have taken place since only cursorily.

Chapterisation Scheme

The present study is divided into seven chapters. The first chapter deals with the conceptual framework of coastal planning and management. It also provides the design of the study.

The second chapter deals with national experiences and international cooperation for the protection and sustainable development of the marine and coastal area focussing on those developed and developing countries whose approaches are integrated in content and are precautionary and anticipatory in ambit.

The third chapter provides an overview of Indian coastal zone. It deals with the inventory and assessment of resources as well as man-environment interaction in the form of space utilisation and development.

The fourth chapter deals with the environmental problems of the Indian coastal zone - degradation of resources, pollution and challenges which may arise with global warming.

The fifth chapter deals with the dangerous implications of sea level rise on coastal communities. A micro area has been studied on a case basis.

The sixth chapter examines coastal management and planning practices in India and legal responses to emerging environmental menace in the coastal zone.

The last chapter deals with conclusions and suggestions as usual.

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CHAPTER - 2

NATIONAL EXPERIENCES AND INTERNATIONAL CO-OPERATION

The threat of diminishing or negative social returns from the uncontrolled use of coastal resources has been the main drive behind the efforts of several developed and developing nations around the world to cope with pressing issues of coastal areas. The practice of integrated coastal zone management is growing in prominence worldwide as coastal nations realize that purely sectoral approaches to the management of land and marine resources are clearly inadequate. Growing environmental degradation and resource use conflicts in the coastal zone, the persuit of unsustainable coastal development and narrowly focussed conservation and protection strategies dictate the need for a more integrated and well coordinated approach. While some success has been realised in the integrated coastal zone management in various coastal countries, the continued development of national and sub-national coastal management strategies, is required for the 1990 and beyond.

DEVELOPED COUNTRIES

The majority of developed countries with a long experience of the effects of industrialisation and urbanisation on coastal resources, have decided to prepare special plans and programmes for the development of their coastal areas.

In Great Britain, as early as 1966, the Department of Environment requested country councils to identify coastal protection areas. This led to the 'Heritage Coast' programme which aimed to protect and preserve the country's outstanding coasts. This programme constitutes about 40 per cent of the total undeveloped coast.[1]

In England and Wales, the coastal protection areas earlier extended to wherever the coast was visible, while the coastal preservation area vary from 300 meters to 8 kms from high tide line. The planning and management of coastal zone is primarily carried out within the well established British planning system based on a two tired local government. The Nature Conservancy Council and the Countryside Commission, as well as the National Trust, play significant part in the management of the unspoiled coastline.

The Netherlands have a long history of an integrated approach to coastal management, an issue of life and death for more than half of the total population of the country.[2] The basis for planning and management in the Netherlands dates back to the middle ages and is closely related to the protection of coast against the sea.

The Dutch coastal zone is used intensively for a number of human activities. Increasing activity at the North sea is also affecting the coastal zone. Present problems include lack of space for urban, industrial, recreation, transportation; pollution of coastal waters, and new innovative developments with potential severe impacts in the coastal region.

Planning and management in the coastal zone in the Netherlands has had and has many faces. In principle, planning and management in the coastal zone is not different from the national system for land use planning and management. For specific areas, however, specific regulations have been developed such as 'Zuyderzee' project, Delta plan in the southwest and for the 'Wadenzee' the emphasis in coastal planning and management has changed in recent years from a rather technocratic approach regarding coastal defence and land reclamation toward a more integrated approach in which conservation of natural resources is playing a major role.

In France 'La. Politique du littoral' was launched in 1972 with the 'Rapport Piccard' and was followed by a series of measures which included among others the creation of the 'Conservatoire du Littoral', the preparation of coastal regional plans and sea use plans, and the passing of a law in 1976 and a directive in 1979 on the safeguarding of coastal zone.[3] The 'Conservatoire du littoral' is responsible for coastal land policy and has proceeded to the acquisition of several sites throughout the country. In France, there is a 100 mtrs. zone from high tide line where construction and other development activities are generally prohibited. However, for planning and management purposes the zone considered is much wider.

Coastal zone management effectively started in Australia in 1879 when the state of Victoria put a blanket prohibition on further sales of coastal lands down to high water mark.[4] Other states followed this lead and in most parts of Australia or strip of coastal land, often only 100 meters wide, is in public ownership. This means that coastal zone management in Australia includes both the management of these public coastal reserves as well as the planning controls on private lands in the coastal zone. The coastal reserves have traditionally been managed either by local governments or by specifically elected committees in some states.

A recent inquiry by a Federal Parliamentary Committee found that state and local government authorities have recognised the sensitivity of the coast. Now the Australian coastal management council coordinates and supervises the coastal planning and management issues in the thickly populated, urbanised and industrialised coast in the country. The council with the consent of states has fixed 400 meters land ward from high tide line as the boundary of coastal regulation zone.[5]

Above the central door of the parliament buildings in Ottawa, Canadian capital, is inscribed the phrase "and at her gates the whole some sea". This connotes two important dimensions in managing Canada's coastline of about 250,000 km, perhaps the longest in the world. First the gateway function so necessary for commerce and economic development and secondly a dependence upon sound marine environmental quality to sustain renewable resources of the country.[6]

The Canadian coastal zone is administered and managed by a host of federal and provincial government agencies. Many of these agencies focus on particular sectoral issues such as fisheries, or transport, whereas others have wider mandates encompassing composite phenomena such as the 'environment'. Because Canada is a federal state; the number, nature and objectives of agencies involved in coastal zone development vary greatly from province to province. It does not have any federal coordinating and supervising institutions to look after the coastal planning and management.

The United States of America recognising that coastal areas are the focal point of a wide range of impacts from both terrestrial and marine activities enacted legislation in 1972 for the planning and management of coastal areas. This Act provides comprehensive guidelines for coastal resource management. It has been given a substantial boost by the reauthorisation of the National Coastal Zone Management Act, 1986.[7]

In the USA, the seaward limit of the coastal zone is the outer boundary of the US territorial sea, 3 miles from the mean high tide line, whereas in the other countries the seaward limit may extend to 6 or 12 miles. The landward limit is discretionary upto the individual states, although intertidal areas, marshes etc. are normally included. The variety of definitions used by the USA coastal states is an interesting indication of the picture of the situation.

The State of Oregon, for example, using the drainage basin concept, draws its inland boundary along the crest of the coastal mountain range. This is certainly a maximum width approach. California and Connecticut have used arbitrary boundaries of 8 kms and 150 meters respectively.[8]

Coastal area management is emerging as an increasingly important policy issue in modern Japan.[9] Not only are new uses being made of the coast and many of the traditional uses intensified, but there are demands for more citizen involvement in the coastal management decision process. The economic development ethic that dominated industrial policy in post war Japan provided great benefits for the country as a whole, yet imposed great costs on coastal environment.

Coastal planning and management in Japan has been a series of efforts attempting to keep pace with surging industrial growth and its attendant problems. Often the efforts have been insufficient, disjointed and timid because of lack of the political and economic support for coastal management. Technically Japan is capable of improving its coastal area management. It is given a high priority.

However, coastal area management in Japan is hamstrung by the lack of overall planning authority and policy guidelines because of the sectoral approach that currently exists and the lack of comprehensive national legislation and institution.

DEVELOPING COUNTRIES

There is increasing pressure in the developing countries for rapid development of coastal resources by both government agencies and private economic interests, which regard coastal areas as under - utilised. Typically, coastal development has evolved in response to the pressures of individual sectoral interests that plan development independently and do not adequately consider the effects of one form of exploitation upon another development activities. Consequently many coastal resources are succeptible to negative impacts, and the potential is great for severally reducing the long term productivity of the system.

The unmanaged growth of competing demands for coastal space produces over exploitation conflicts among uses and ultimately loss of the economic assets of coastal resource base itself. Conversely, planned and co-ordinated development of coastal resources can provide the basis for accelerated and sustainable economic growth that will have major employment generation, production and equality benefits.

Sri Lanka is one of the very few developing countries, which has enacted legislation specifically directed towards coastal zone management.[10] Increase in incidence of coastal problems, resource use conflicts and increase in the understanding of the intricate nature of the coastal environment led to realisation that piece-meal engineering solutions were not sufficient and that a more comprehensive approach of integrated coastal zone management was required. The Coast Conservation Act No. 57 of 1981, which because operative in October 1983 contains the comprehensive legislative and executive framework to safeguard the coastal zone of Sri Lanka. The landward limit of coastal zone is 500 meter's from the high tide line. The National Coast Conservation Department deals with planning and management of coastal zone.

China is a coastal state with 18,000 kms of the continental shore line and 14,000 kms of island shore line, with over 5000 islands. The coastal zone of china supports about 44 per cent of the population and constitutes about 15 per cent of the total area.[11] It is rich in natural resources. It is expected that the coastal zone will become increasingly important economically with the exploration and exploitation of offshore petroleum, development of marine transportation and sea shore place deposits, increase of marine fisheries, emergence of sea side tourism, and utilisation of land resources.

The Coastal zone is also an administrative region. In the provision of the tentative regulations on the coastal zone management in Jaingsu province, for example, the region is explained as a transition area of the interaction of continental and sea dynamics, it extends land ward for about 10 km and seaward to the vicinity of 15 meters isobath.[12] In large and middle coastal cities it does not extend landward over 1 km. The specific jurisdictional limit is decided by the authorities concerned, according to their administrative requirements.

The Chinese government has placed a priority on the development and management of the coastal zone. The first stage has been a national project for comprehensive investigation of the mainland coastal zone, begun in 1980 and stated for completion in 1988. It will help to further understanding of the natural environment and natural resources. On the basis of the investigation, a long term overall programme for the development and utilisation of the coastal zone will be formulated. During the second stage management experiments will be conducted at selected locations on the coast. The third stage is the legislation and management of the coastal zone, in particular, the drafting of a National Management Law on the coastal zone and local management rules and regulations for the coastal zone. Thus it seems that Chinese system of coastal management is recent and evolving one.

Before the discovery of the oil in the 1930s, Kuwait was historically a country dependent on the water of the gulf, both for fishing and pearl trading. New developments have continued along the edge of the coast. Economic development resulted in increased demands for housing, industry, trade and recreation thereby placing extensive pressures on coastal uses.

There is no known definition of coastal zone, but generally it is taken to be the area between the limit of the territorial waters and a few kilometers inland.[13] It includes estuaries, cliffs, sand dunes, salt-marshes and off-shore island. The inland zone may vary in width according to the natural features of the land adjacent to the water body.

Problems related to coastal natural resource utilisation and associated organisational process are the same, for all process are the same for all countries surrounding the same water body. Thus, the regional organisation for the protection of the marine environment (ROPME) was established in 1978 by the countries around the Arabian and Oman gulfs.[14] The main function of ROPME is to prepare national standards, laws, and regulations and recommend practice and procedures to prevent and combat pollution of the ROPME sea area from all pollution sources. However, the 1991 gulf war (Iraq vs. Kuwait) has created ruptures in ROPME.

With intensive utilisation and special demands made on the coastal zone, problems of coordination, cohesion, and different insights of different authorities are apparent in the ROPME countries, and Kuwait is no exception. Kuwait started a National Physical Plan in 1978, created an elaborate system of environmental agencies and committees to study environmental consequences of coastal development. However it appears that Kuwait does not have comprehensive national legislative and executive measures to manage the coastal changes but sectoral and piece meal approach.

There are 18 independent coastal countries and one semi-sovereign coastal state in the region known as Latin America. The region is rich in coastal resources as well as being richly afflicted with coastal hazards.[15] The region encompasses a great diversity of ecosystem and climatic zones, from polar cold to coastal deserts to tropical rainforests. Large portion of the region remain unaffected by human intervention. While many areas are severely degraded usually by natural resources exploitation or pollution from development and urbanisation.

Latin American countries with the exception of Peru have increased their fish harvests by 167 per cent between 1968 and 1980. In the last ten years, Equador has allowed the conversion of approximately 75000 hectares of its mangrove ecosystem (over 42 per cent of the nation's total ecosystem resource) to shrimp aqua-culture ponds.[16] The increasing rate of resource development is a reflection of both the need to improve socio-economic condition as well as the need to keep pace with a burgeoning population growth rate in coastal nations of latin America from 1971 to 1982 was 2.15 per cent, compared with USA (0.94 per cent) in 1980-85.[17]

All Latin American countries use sectoral planning to manage various coastal resources or activities. It is routinly used for managing fisheries, oil and gas extraction, ports and harbour development, tourism, naval defence and navigation, and coastal security. Sectoral planning fails to consider the coastal systems perspective. The designation of 'protected areas' is also used as a management strategy by all the countries in the region. They have created national parks/reserves for the specific purpose of preserving coastal/marine environments.[18]

Shore land restrictions is practiced by many Latin American countries. Costarica's coastal area management programme is essentially a shoreland restriction strategy. In 1977 the legislation was enacted that declared the first 200 meters inland from mean sea level to be part of the national heritage. However, it is only 20 meters in the Mexico. Latin American countries are trying to manage their coastal zone by special area plans and compilation of coastal atlas or data bank etc. The nation-wide coastal planning and management does not exist in this region.

The marine waters and coastal areas of the ASEAN are threatened by both the forces of nature as well as by human activities. Foremost among these threats are siltation, pollution from domestic and industrial wastes, agro-chemicals, oil spill pollution from tankers, on shore and offshore drilling for oil and minerals, and thermal pollution in areas near power plants. With a large part of the world's oil, chemicals and other dangerous goods being transported through ASEAN waters, the danger of pollution is ever present. In addition, the vast ecosystem of mangroves, coral reefs,intertidal flora and fauna of the region are threatened by the reclamation of land for multiple uses.[19]

A survey of the ASEAN countries reveals that many environmental control legislations have been developed and being implemented by different modes of organisation/ institutions such as ministry/department/Bureau/Division of Harbour and ports/coast guard etc. Legislations are there to control the source pollution e.g. landbased, vessel based, on shore and offshore activities. But there does not seem to be any national policy and institutions in any countries with a clear-cut focus on comprehensive resource management in coastal zone. Although several countries have implemented restrictions on haphazard coastal developments in specific areas through zoning or environmental impact regulations, an integrated coastal zone management is still in the evolutionary stages.

The overview of national experiences in coastal planning and management identifies three major axes of similarities/dissimilarities among countries. The first refers to the institutional and legal framework, particularly in what concerns the allocation of responsibilities among federal/central and regional/local authorities. The second axis is the identification of the Coastal zone or the spatial extent over which coastal policy is intended to apply. The third axis is the planning, management and implementation system employed which is a function of the other two axes : legal context and space. However, the thread linking them is the common aim and commitment to the integrated management of coastal resources.

INTERNATIONAL CO-OPERATION

The increasing awareness, during the 1970's and onwards, of the importance of coastal areas for all aspects of life has been expressed by the initiation of a variety of activities at the international level. Special programmes, resolutions, directives, protocols, conventions and conferences reflect the interest of many international organisations in coastal and ocean issues.

In the early 1970's the commission of the European Economic Community began to develop an environmental policy. Its initial focus has been the protection of the aquatic environment through a series of directives. Now the EEC necessitates and cooperates in the implementations of an integrated planning of coastal areas.[20] In the last decades the council of Europe has been instrumental in promoting special programmes directly or indirectly related to the coastal zone management.

Among the developing countries, involvement in coastal management and planning has been through the initiative of various UN agencies and particularly UNEP. The UNEP in response to the 1972 Stockholm Conference, calls for the protection of the marine environment, develops a regional approach to ocean management known as 'regional seas' in the mid - 1970's.[21]

Under the catalytic and coordinating role of UNEP the Mediterranean states agreed in 1975 on an action plan for the protection of the Mediterranean sea against pollution (MAP). In the following year, the Barcelona convention for the protection of the Mediterranean sea against pollution, and two protocols were signed. In the same year, a regional oil - combating center was established at Malta as part of the MAP. In 1979 a 'Blue Plan' for the long-term management of the Mediterranean sea was launched as part of the socio-economic component of the MAP. It was intended to integrate development plans with environmental protection measures in the Mediterranean basin.[22]

In 1980, the Mediterranean states moved a step forward by adopting the protocol for the protection of the Mediterranean sea against pollution from land based sources. This agreement identified measures to control coastal pollution from municipal sewage, industrial wastes and agro-chemicals. Two years later, the Mediterranean governments also approved a protocol providing special protection for endangered species of fauna and flora as well as critical habitats. In 1985, the Mediterranean countries established ten priority targets for the decade 1985-95.[23]

In addition to the MAP, action plans for the eight other region have also been adopted; these plans cover Kuwait (1978), the wider Caribbean (1981), West and Central Africa (1981), Eastern Africa (1985), the South-East Pacific (1981), the Red Sea and the Gulf of Aden (1982), the South Pacific (1982) and the East Asia Seas (1981). An action plan was recently drafted for the South Asia region, and is under consideration for approval by the governments concerned. Action plans for the Black sea and the North-west pacific regions are also being developed. All in all, the regional seas programme involves some 130 countries, 16 UN agencies and more than 40 other international and regional organisations, all working with UNEP to protect and improve the marine environment and make better use of its resources.[24]

Other international bodies worth mentioning are : the work of WHO/UNEP on environmental impact assessment for coastal areas, FAO/UNEP on the pollution of the marine waters in relations to fisheries and aquacultures, UNESCO's work on ocean and coasta marine systems as specified in its 1981-86 programmes, NATO/CCM's studies on the management of estuarine systems and IUCN's activities such as the promotion of specially protected marine and coastal areas; and UNCLOS (1982) also provides guidelines for international cooperation in relation to ocean resource management, jurisdictional problems, pollution etc. beyond Coastal waters.[25]

Oceans and coasts were important subjects of discussions at the UNCED at Rio in 1992. Under the aegis of the UNCED process, a broad international consensus was reached on the major problems in the oceans and coasts area and on principles to guide concerted action to address these problems. The UNCED process also gave political legitimacy to the concept of integrated ocean and coastal management, underscoring the importance of integration in the process, something that heretofore mainly been argued by academics.[26]

UNCED's ocean and coastal recommendation stress the interconnections between the land and the sea aspects of ocean and coastal management and emphasize the importance of dealing with land based sources of marine pollution within the ambit of integrated coastal management.

UNCED Agenda 21 also highlighted the positive opportunity for sustainable development of oceans and coasts and the special importance of these resources for small island developing states. It also underscored the desirability of strengthening regional arrangements for ocean and coastal management.[27] In a sense, Rio outlines the vision for further international cooperation in the ocean and coasts management.

Agenda 21, as and adopted at UNCED, urged the coastal nations to employ better integrated approaches to the management of coastal and ocean resources, and suggested the development of guidelines for integrated coastal management. In response, a number of organisations, including the FAO, the World Bank, and the UNEP have begun the formulation of such guidelines. Recently the Dutch Government organised an International Conference "World Coast Conference on 2-4 November, 1993" at Hague in the Netherlands.[28] Various approaches to the use of better integrated coastal management processes were presented and discussed.

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CHAPTER - 3

INDIAN COASTAL ZONE : AN OVERVIEW

PHYSICAL SETTING

Through ancient times the topography and geology of the land have govrerned the pattern and intensity of human activity. The physical regime of the Indian Coastline is characterised by different types of coastal and shore features like promotories, sandy spits, barrier beaches, embayments, estuaries and off shore islands. These characteristic features are the results of the geological and geomorphological history of the coastline.

PHYSIOGRAPY

Gujarat coastal zone is essentially a low rolling plain except for a few low irregular hills namely the Mandev, Thanga, and Girnar hills, in Kathiawar and a few low ridges of sand stone in Kutch. The coastal zone starting from Lakhpat, covering entire periphery of Sourashtra, extends upto Umergaon in Bulsar district. It is broken by several bays, inlets, estuaries and marsh lands.

The coastal tract of Gujrat show ample evidences of diasstrophism in the past. The kutch-Gulf of Cambay - Narmada valley region appears to have been faulted down along East to West or East-south-East to West-north-West faults in the upper poleozoic. Jurassic and lower cretaceous sediments have been noticed in many areas of Kutch and Kathiawar. Besides Jurassic rocks and Deccan traps, tertiary rocks are also found in the coastal zone of Gujrat. They are expossed all along the Coastal streteches of Surat Bharuch-Combay and also in southern kathiwar and Kutch.

The Maharashtra Coastal zone is characterised by undulaating lowlands. These are widest near Bombay, in the ampitheatre like basin of the Ulhas which has forced the Western ghat in this part to recede inwaarads away from the coast. Numerous hills and detached ridges dominate the lowlods in the area. Flat shores, with long sandy spits running into muddy shallows are found north of Vaitarni river. South of Bombay city, the rockey coast has a series of bays and creeks lying between jutting headlands and containing beaches of sands. North of Bombay, vast areas are covered by coastal swamps.

The steep west facing scarp of the Western ghat, according to some geologists, is the product of faulting which preceded the subsidence of the Arabian sea block between India and Africa at the close of the Eocene period. The Western Coastal lowlands of India and the sediments composing it, therefore, are of very recent origin, ranging in age from pliocene to some quarternary formations.

The Ratnagiri and Goa coastal zone are characterised by hills and elevated plateaus intersescted by numerous creks and navigational streems. The sea board from Fort victoria to Reddi fort is rocky. Rocky projections from the Wesstern ghat almost reach the coastline both north and south of Panjim. But the Goan coatal stretch north and south of Panjim is more deltaic than any where else in this part. It is characterised by wide Zurari and Mandovy estuaries and is of the ria type. The Goan coast is dotted by rocky and sandy beaches.

The Karnatka coastal zone is a narrow belt wedged between the sea and the ghats. Its physical feaatures include coastal plain to steep slopes of the ghats. A large number of rivers and rivulets flow across the region. The coastal zone is a relatively narrow belt of very recent deposits, forming sand dunes, estuarine mudflats, marshes and valley plains. It is generally flat or gently slopping with an average elevation of 30 metres.

The main rocks of the coastal area are the Pre-Cambrian comprising of the Archeans and the Proterozoic. In the north, rocks belonging to the Dharwar group are found, while rocks of the peninsular Gneissic complex are found in Dakhshin Kannada. Quarternesry formations in terms of lateisation and believed to be of pleistocene have given rise to bauxites and allluvium near Manglore to Karwar in narrow fringe.

The Kerala coastal zone is comparatively much wider and less hilly, extending from north of Cannnanore to Kanyakumari for about 500 km. They are 25 km wide and range

10 to 30 metres in elevation. Sand dunes of a peculier form, locally known as "Teris" are found almost all along the Kerala coast, except south of Kovalam, where the rocks project directly to the sea board. These sand dunes of pleistocene and recent times have helped to form a large number of shallow lagoons and backwaters which are locally known as " Kayals".

Laterites plateaus and foothils are found in the east of coastal lowlands. The laterites are associated with the Warkhali beds of pliocene period. Two erosion surfaces, probably represesnting former planes of marine erosion at 76m and 183m are found in the laterites The Gnessic hill lies farther inland.

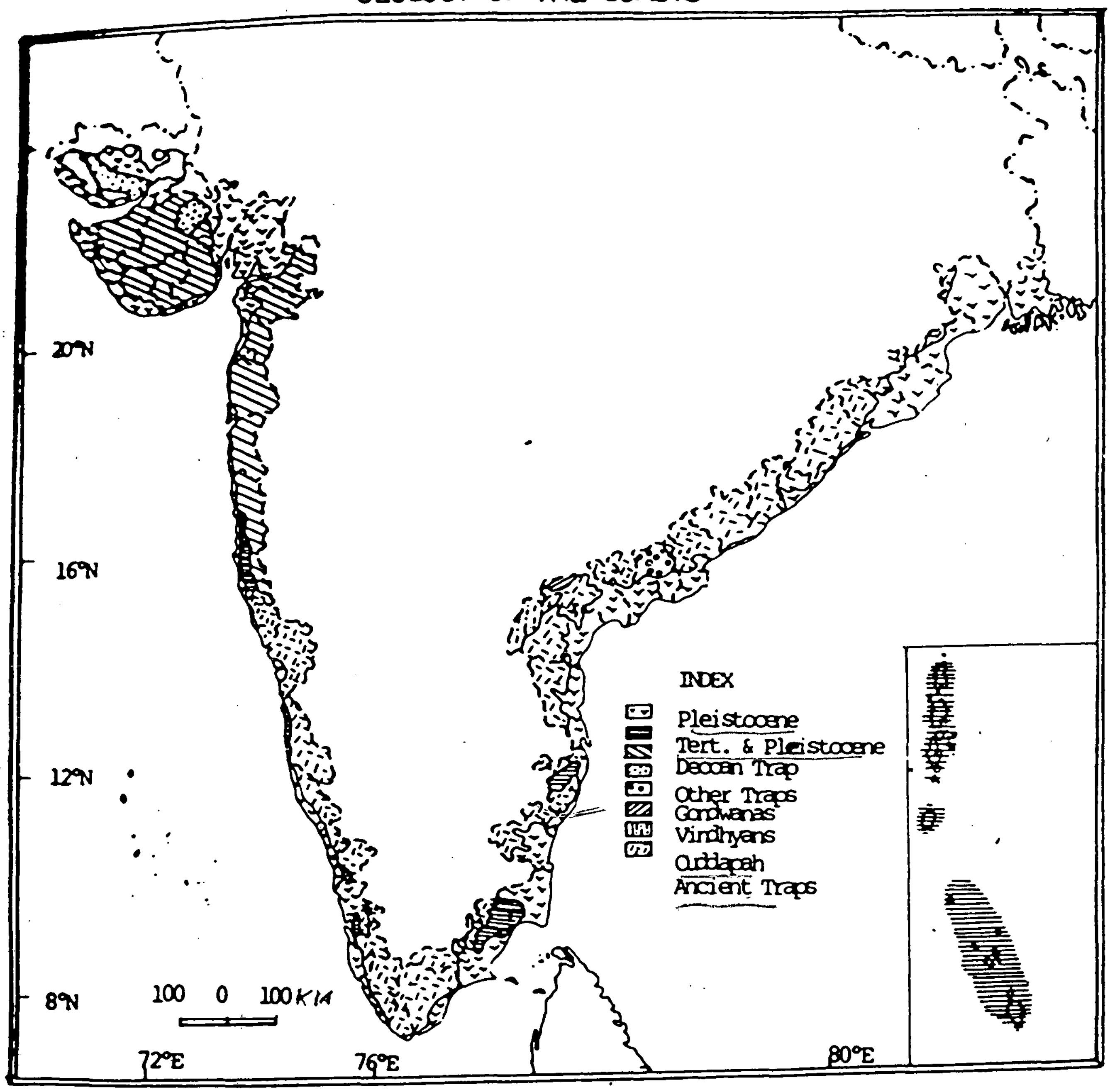
The West Bengal coastal zone comprises mostly of tertiary and recent formations except in Midnapur district. The Midnapur area of Bengal is continous with eastern Singhbhum (Chhotanagpur tanagpur plateau) and contains Gneisses, schists similar of those fornd in the latter. Underneath the alluvium of Twenty four pargana, borings of petroleum deposits have revealed thick series of Eocene strata over 1000 meters thick resting over a south east shelving platform of Rajmahal trap and some Cretaceous beds and underlying a thick succession of estuarine and marine oligocene to pliocene formations.

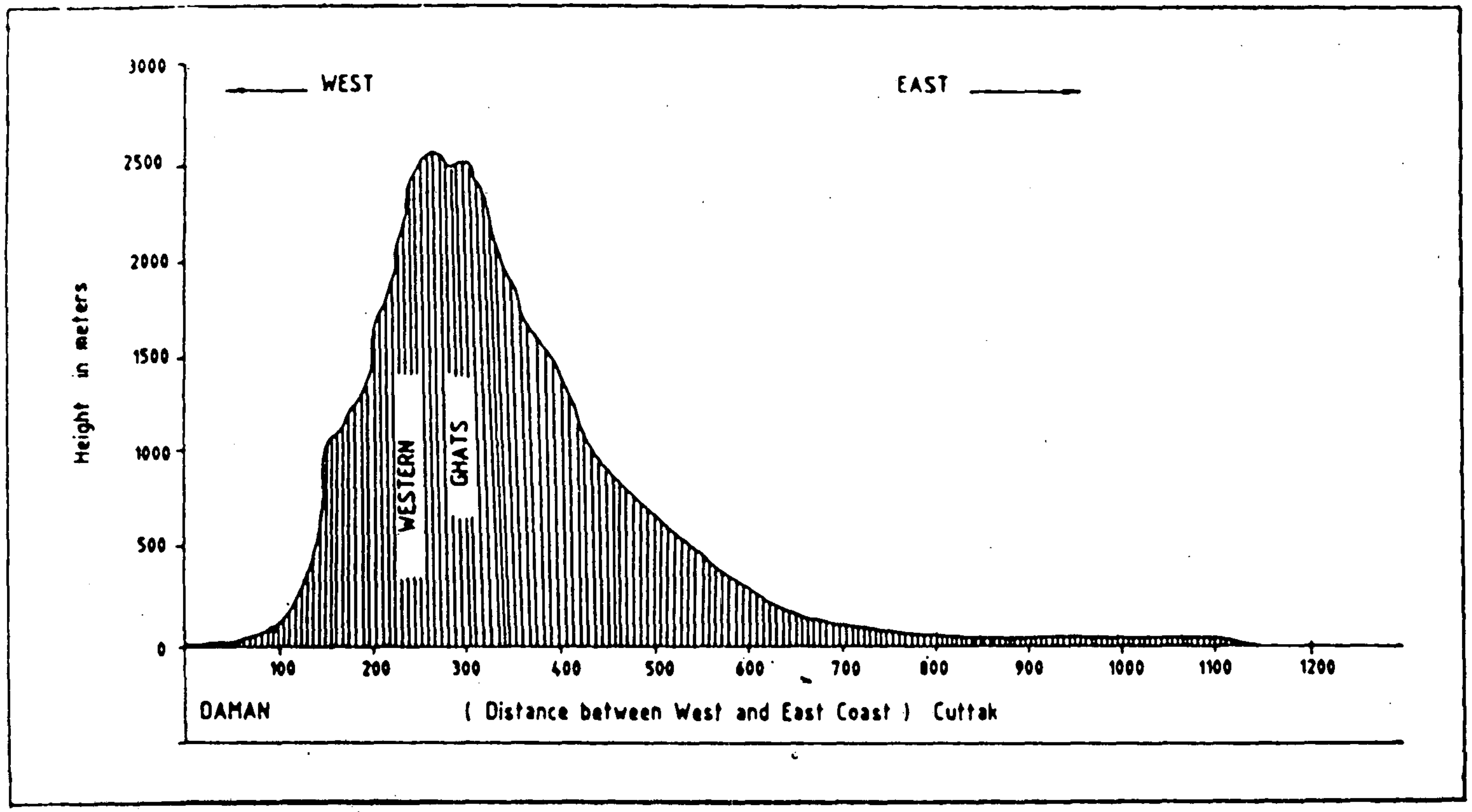
STATEWISE PARTICULARS OF COASTLINE AND SHELF AREA

State/UTs	Length of Coastline in Kms.	Continental upto 50 m depth (Sq Km)	Shelf Area upto 200 m depth (Sq Km)
West Bengal Orissa	600	27001	46421
Andhra Pradesh	970	16607	31044
Andaman & Nicobar	1500	-	16056
Tamil Nadu	960	13255	41412
Pondicherry	NA	NA	NA
Laccandires	-	-	4336
Kerala	560	12569	25941
Karnatka	270	7936	25473
Goa	105	2849	9984
Maharashtra	600	25512	104758
Gujrat	1500	64810	99373

Source : M.Phil. Dissertation of Miss Preminda Kundra, 1984 JNU, pp. 1-17.

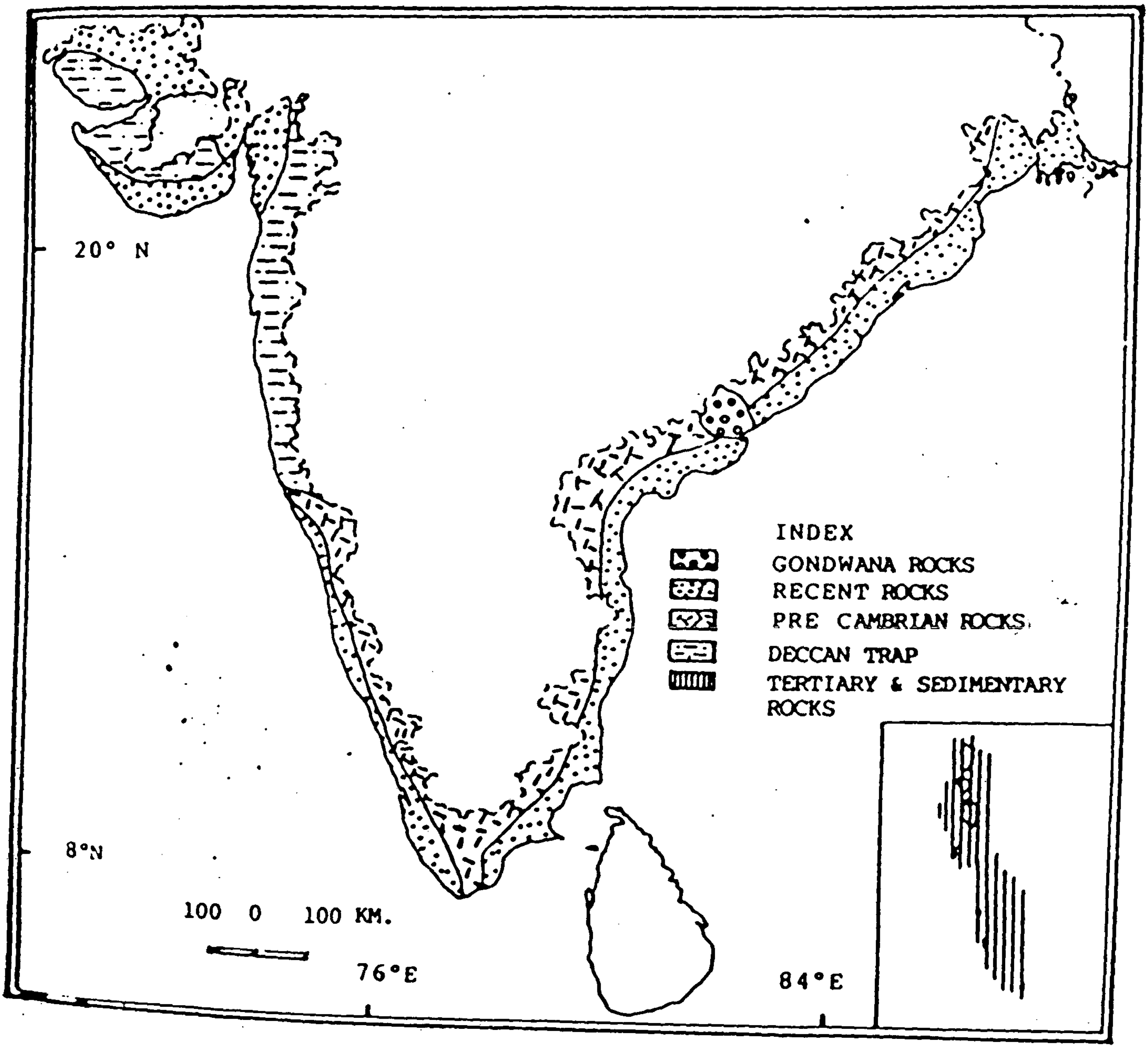
GEOLOGY OF THE COASTS





Graph showing gradients along the east and west coasts of India

COASTAL DISTRICTS
ROCK TYPES



River Hughly divides the West Bengal coast into two equal halves, having different morphological features. The western part of Hughly (Midnapur coastal plain) is characterised by three different rows of sand dunes of three differtent stages of marine regression. The last row of the sand dunes extends to about 10 km inland from the present day coast line.

The Eastern part of the river Hughly is characterised by the Sunderbans. Luckily the State of West Bengal includes a part of Sunderban which is used by man for many purposes. The Sunderban of West Bengal may be divided into two major regions: the Hughly-Matla river complex (reclaimed areas) and Matla Hariabhanga river complex (reserve forest). The East coastal zone from Orissa to Tamilnadu predominantly consists of recent and tertiary alluvium. Patches of Archeam, Gneisses and sandstones etc are also found along the Coastline. Pleistocene alluvium occurs at several places along the coastal tract of Orissa. Large deposits of laterites occur as capping over Khondalite hills. Such laterite is of in-situ origin, while the laterite occuring at lower levels is of detrital origin.

The coastal tracts of Balasore, Cuttack and Puri districts are covered with deltaic sediments of Mahanadi, Brahmni and other rivers formed in recent times. The narrow strip of coastal alluvium in Ganjam district also belongs to this age. The Coastal lowlands rises gradually from the Bay of Bengal to merge with the irregular alignment of the Eastesrn ghats where 75 metres contour seperate the region from the peninsular uplands.

The Coastal zone of Orissa has a remaarkably straight shoreline with well defined beaches of sand and shingles, the most famous being Puri - Konark beach. Sandbars on the mouth of rivers, paralllel sand dune ridges composed of decomposed granites, zircon etc. brought by ocean currents and winds from south west rise 16-27m high and are 1-4 km long. These are supposed to have originated due to coastal ulplift. In Puri the maximum height reached is 9m in some isolated patches near about Puri, but generally they are 4.5 to 6m high and extend inland. Each of this hills marks an old sea coast indicating the recession of the sea.

The Chilka lake is located in the south west edge of Mahanadi delta. It is 65 km long from NE to SW and is wider in NE and narrowed only to 8 km in the SW. It is the biggest lake in the country and its area varaies between 780 sq.km. and 1144 sq km from winter to monsoon months. The lake is shallow in the NE due to heavy silting by detrital matter brought by the Daya and the Bhargavi. It is deep in SW where the spurs of the Eastern ghats enter the lakes.

The Andhra coast has a long Coastline stretching from Sri-Kakulam in the north to Nellore in the south. The Archean group of rocks are the oldest formations of the Coastal zone. The upper Godwana are found between

Rajahmundry and Vijaywada in the Godavari districts. The head of the Godavari delta areas seem to be superimposed by estuarine sandstones and limestones of a total thickness of 15 M.

The Pulicut lake of Nellore is a lagoon which owes its origin to the deposition of bars or spits of sands drifted up along the coast by the action of obliqe sea current. The recent deposits occupy the entire coastal zone of Andhra Pradesh, except in portions between Srikakulam in the north and Vishakhapatnam in the south.

The Archean can be traced in some portion of the Pondichery and Tamilnadu coastal districts. The charniekites around Madras represesnt a plutonic igneous rock. Gondwanas are found near Madras (Sriperumdur) which contain marine animals and plants remains. The cretaceous rocks are found in areas separated by Pennar and Vellar rivers, besides a small patch to the south of Kaveri and Tanjore. The tertiary formation occuy most of the coastal stretch of Tamilnadu. They occupy coastal strip of south Arcot, Thanjavore, Ramanathpuram, districts attaining a maximum width of 75 km in the Kaveri Basin. A bore whole put down at Karaikal indicated the presence of fossilliferous Miopliocene strate which are called Karaikal beds.

The Tamilnadu coast is characterised by well defined beaches of sand and shigles (the most famous being Marina beach in Madras), sandbars (Rameshwaaram island is long preserved sandbar), sand dunes locally called "Tbens" rising 30 to 60 metres high along the Tirruvelli and Mahabalipuram. Between the mainland and the Gulf of Mannar and the Palkstrait, there are tiny coral islands which form flourshing fishing centres.

DRAINAGE

The Mahi, the Narmada and the Tapi form the main arteries of Gujarat coastal zones whereas the Banas, the Saraswati, the Dhadar. the Ambika, the Bhadar and a host of other feeders either merge in the Rann of Kutch or fall into gulf of Cambay and the Arabian sea. The radial drainage pattern of Kathiwar is guided by two hill masses of Rajkot (383 metres) and Gir range (728 metres).

The most important streams of Maharastra coastal zone are the Vaitarni, the Ulhas and the Amba. The Ulhas with a course of 113km is the largest in this part. It rises in the ravines of Bhor ghat and forms an ampitheatre like basin near Bombay before discharging into the sea north of salcette island (Basssiencreek).

The drainage of Goa coast is carried by nemerous short and swift flowing streams but the Mandovi and the Zuari along with Comberzua canal form the largest esstuarine complex. Mandovi and Zuari river basins cover about 69 percent of the total geographical area of Goa and are "life line" of the territory.

The Karnatka coastal zone is drained by streams that have carved out narrow valleys with steep gradient because the coastal lowland is the narrowest in this part, being confined to strips along the lower reaches of the rivers. The northern coast is drained by Kali Nadi, Gangavati, Tadri, Sharavati, etc. The Most Important stream in south Karnatka coast is the Netravati at whose mouth is located the port town of Manglore.

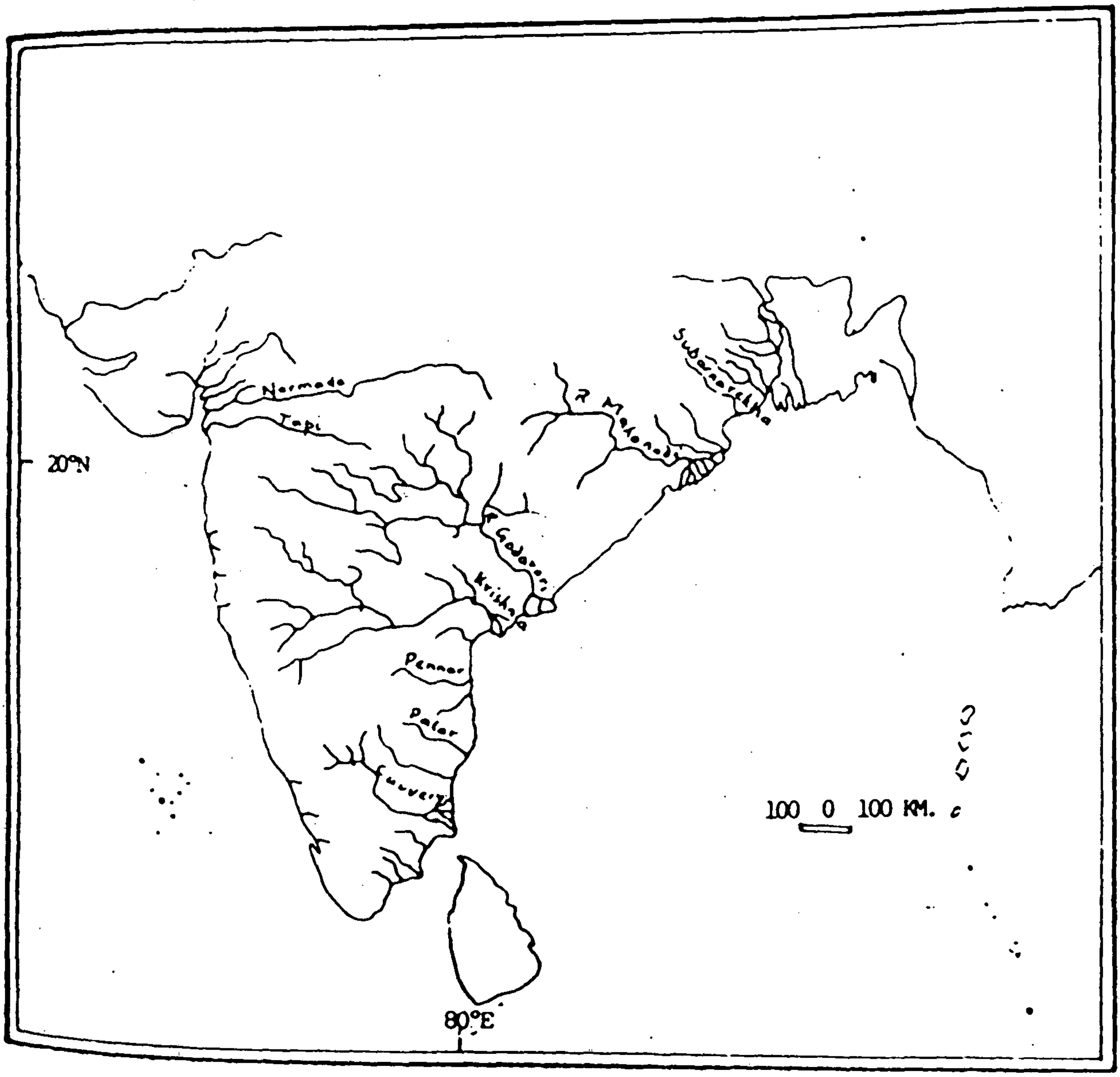
The Kerala coast has a large number of streams. Only four rivers the Beypore, the Bjaratpuzha, Periyar and Pamba are more than 150 kms long. The rivers of this coast have a total run-off of 2500 thousand million cubic feet - 5 percent of India's water potential. They serve as important arteries of inland transport and provide vast potential for hydro-electric generation and irrigation. Lakes and backwaters characterisee the greater part of Kerala coast. The Vemband lake, stretching from Allepcy to Cochin, and having an area of 205 sq kms is the largest water basin of the area.

DETAILS OF MAJOR RIVERS OF INDIA

Sl. No.	Name of the River	Length in India (km)	Basin Area in India (sq.km.)	Average annual discharge (MCM)	Place of Origin	Destination
1.	Ganga	2525	861404	493400	Gangotri glacier, Uttar Kashi, U.P.	Bay of Bengal
2.	Indua	1270	321290	41955	Near Mansarover Lake, Tibet	Arabian Sea
3.	Godavari	1465	312812	105000	Nasik, Maharashtra	Bay of Bengal
4.	Krishna	1400	258948	67675	Mahabaleshwar, Maharashtra	Bay of Bengal
5.	Brahmaputra	720	187110	510450	Kailash Range,China	Bay of Bengal
6.	Mahanadi	857	141600	66640	Raipur, M.P.	Bay of Bengal
7.	Narmada	1312	09796	40705	Amarkantak, M.P.	Arabian Sea
8.	Cauvery	800	87900	20950	Coorg, Karnataka	Bay of Bengal
9.	Tapi	724	65145	17982	Batul, M.P.	Gulf of Khambat
10.	Pennar	597	55213	3238	Chennakesva Hills, Karnataka	Bay of Bengal
11.	Brahmani	800	39033	18310	Ranchi, Bihar	Bay of Bengal
12.	Mahi	533	34842	8500	Ratlam, M.P.	Gulf of Cambey
13.	Sabarmati	300	21674	3200	Aravali Hills, Gujarat	Gulf of Cambey

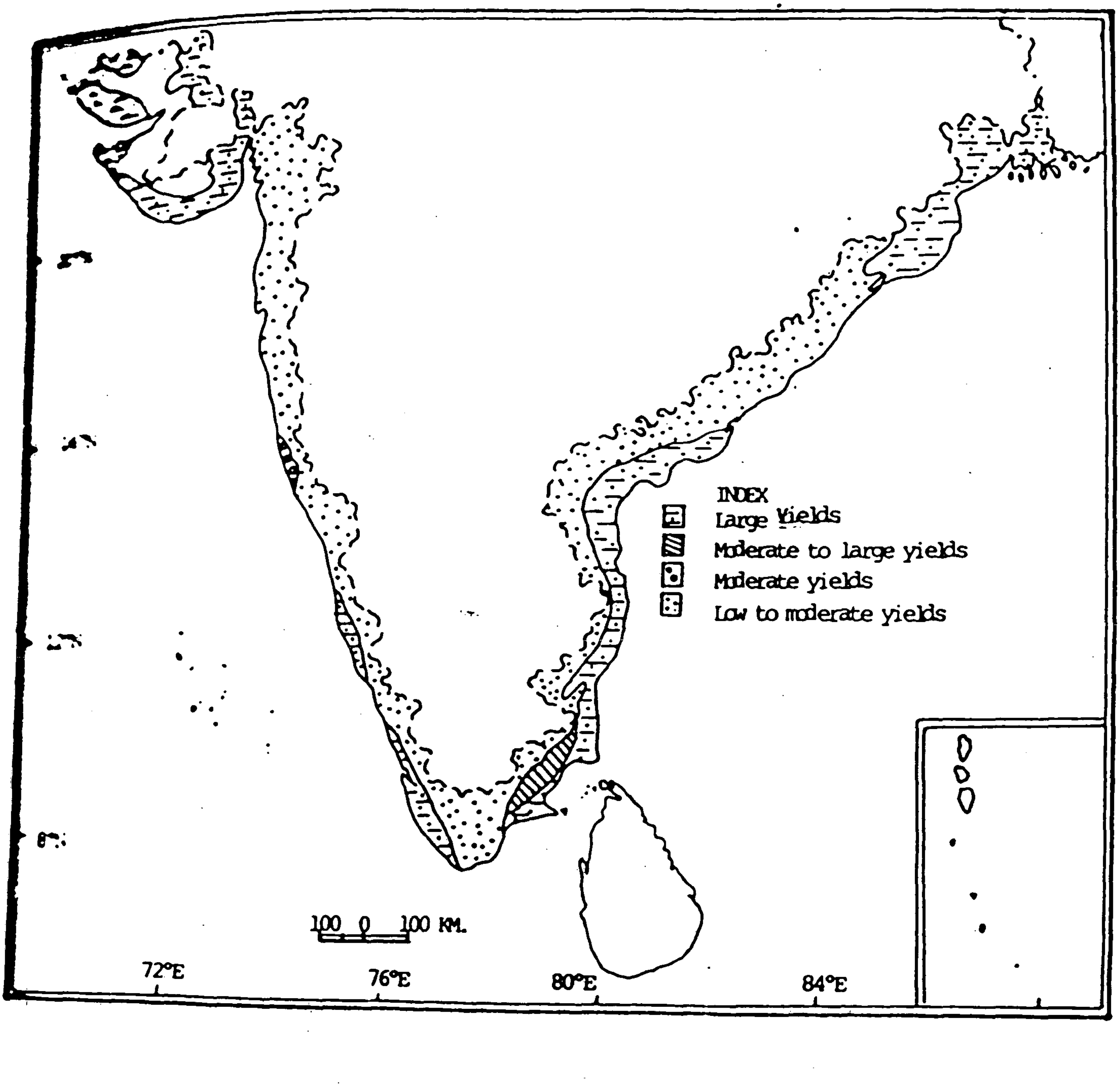
WATER RESOURCES

RIVERS



COASTAL DISTRICTS

GROUND WATER POSSIBILITIES



Drainage system of the W. Bengal coastal zone is constituted by the tributaries and distributaries of the Ganga (Hughly), along with some systems of the Kasai, the Subernrekha etc. discharging into bay of Bengal and draining the south west part of the region. The coast is very much dynamic due to the seasonal variability in silt load and discharge of the rivers, frequent occurence of tropical cyclones, tidal waves during equinoxes, macro tidal range, formation of newly inundated areas characterises the Sunderban delta.

The Mahanadi in combination with the Brahmni and Baitari forms extensive alluvial tract stretching from lake chilka in the south to Bhadrak in the north, 172 km long and over 80 km wide in the Orissa coastal zone. These rivers are subject to heavy flooding. The Rusikulaya is a notable stream in Ganjam with no delta formation though the coastal plain is extensive enough.

The main rivers of Andhra coast are Krishna and Godavari. These two rivers along with their tributaries and distributeries form coastal delta. These rivers carry silt enough to cover daily an area of 8 sq km to depth of one feet during high floods.

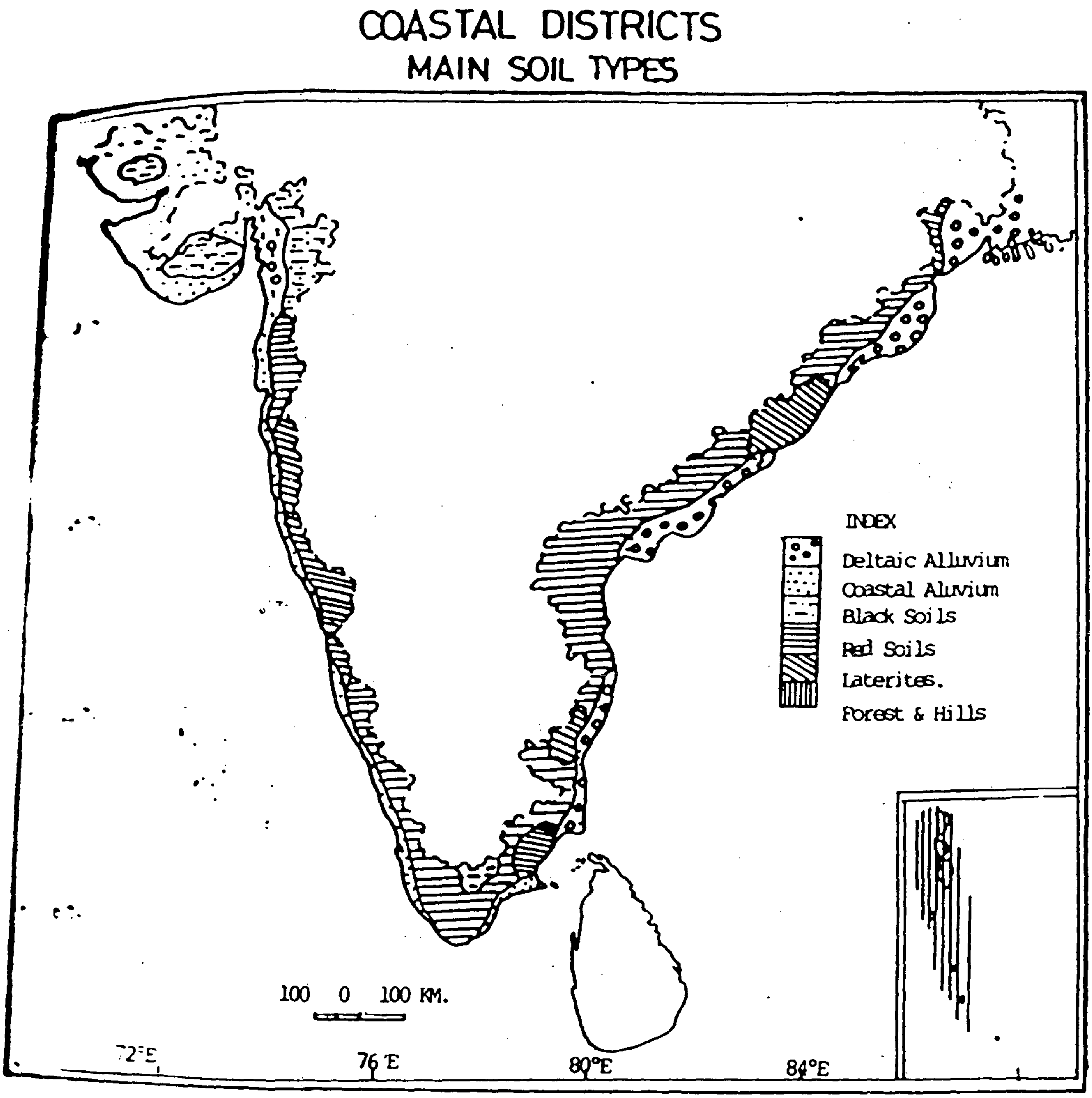
Kaveri is the largest and most important river of Tamilnadu coasts. Some of the branches of Kaveri find their way into the sea carrying surplus water. Other rivers draining the coastal plain are the Vaigai, the Tambraaparni emptying in the gulf of Mannar. The Arni enters Chingalpattu districts and joins thes sea ata Pulicat. The Coovam is formed by the surplus water from the Kuvam tank in Kanchipuram taluk. It flows eastward through Madras and joins the sea at fort ST George. The river Vaippar flows through Tirunvelli districts and empties itself into the gulf of Mannar.

SOILS

The main soil types of the Gujrat Coastal zone include deltaic, coastal alluvial, black soils, and a patch of red sandy soils. Black soils are found in the interior areas away from the coastal margin. In the Kutch Peninsula, deltaic alluvial soils are found along the coastal margin. Towards the southern Kutch a patch of red sandy soils and deep black soils occur around Bhuj.

The Coastal zone of Jamnagar, Bulsar districts comprises of coastal alluvium. Portion of the Rannof Kutch are marshy and inundated. Wind blown loess covers the greater part near the coast. The sandy soil is found close to the sea beach throughout the west coast of India.

Red loamy zonal soils cover most of the coastal tracts of Bombay, Thane and Raigarh districts of Maharastra coast. The Coastal tract of Ratnagiri district comprisess of laterite soils. The sandy soil is found close to the beach.


COASTAL DISTRICTS
MAIN SOIL TYPES
INDEX
Deltaic Alluvium
Coastal Aluvium
Black Soils
Red Soils
Laterites.
Forest & Hills
100 0 100 KM.
76°E
80°E
84°E

The Goan coastal zone has a mixture of lateritic and alluvial soils. Alluvial soils are found in fillings and low lying lands. Sandy soil is found in narrow strip all along the Coast. Laterites soil are found in the elevated pleteaus and valleys. Marsh soils are found along with the rivers and get affected by inundation of saline water.

Developed on the Dharwar rocks, Karnataka coastal zone comprises mostly of laterite soil. The coast is bordered by a thin strip of coastal alluviam followed by a broad belt of lateritic soils and the interior eastern part consists of red loamy soils.

Laterite and coastal alluviams are the dominant soil types of Kerala coast. Eastern part lying along the hills consists of laterites and coastal margin with allulvium in all the northern districts. The sandy soil is associated with the sand dunes along the sea beach and sandy island of backwater, sand being mostly of marine origin. The soil is generally saline and of poor fertility status. Pesaty soils are found in the pockets of Ernakulam, Kottayam and Allepey district in east of the backwaters.

The coastal soils of West Bengal are the outcome of the interaction of rivers and tides and have developed in the districts of Twenty four Pargana and Midnapur. The soils are saline and alkaline and contains deposits rich in Ca, Mg, and half decomposed organic matter.

The coastal zone from Orissa to Tamilnadu in the Eastern coast of India abounds in alluvium. Red soils, black soils and laterites are also found as transported soils. Alluvial soils are mostly found in river valley, deltaic tracts and along the coast from Balashore to Kanyakumari, occupying the litoral tracts varying in width from 10-20 km. These soils are exceptionally fertile and highly valuable for agriculture especially paddy. The soils are generally rich in lime, poor in nitrogen and phosphoric acids.

CLIMATE

The Gujrat coastal zone bounded by desert fringe in the north and Arabian sea with major part of Kutch and Combay in the south registers higher temperature in the northern segment and lower in the southern districts. The topic of cancer crossess the Rann of Kutch. In Dwarka the temperature ranges between 22.4^{O} C to 32^{O} C and in Bharuch it is 25^{O} C to 40^{O} C.

Summer months are very hot and dry. The summer months begin from late February when the average daily temperature of Bharuch remain 25^{O} C and daily maximum temperature exceeds 34.3 ^{O} C. From March the daily minimum temperature also exceeds 20 ^{O} C. The relative humidity is low and upto May there is absence of rainfall. In the case of Dwarka, which gets more exposure to sea then Bharuch, there is very low range of temperature. The summer months begin from

February - March, when the daily maximum temperature rises to 26.4^{O}C. and in March the minimum temperature becomes 21.5^{O} C. Due to its peninsular position, the relative humidity remains high around 70 percent. The summer months are almost dry. The air pressure in July varies between 999 mb to 1002 mb. This low pressure generates westerly winds.

During winter season the diurnal temperature varies between 16^{O}-29^{O} C in Dwarka and 12^{O} to 33^{O} C in Bharuch. The mean winter temperature varies between 20.7^{O} to 22^{O} C in Dwarka and 22^{O} to 23.5^{O} C in Bharuch. It clearly shows that winter is mild. The air pressure varies between 1016 - 1017 mb.

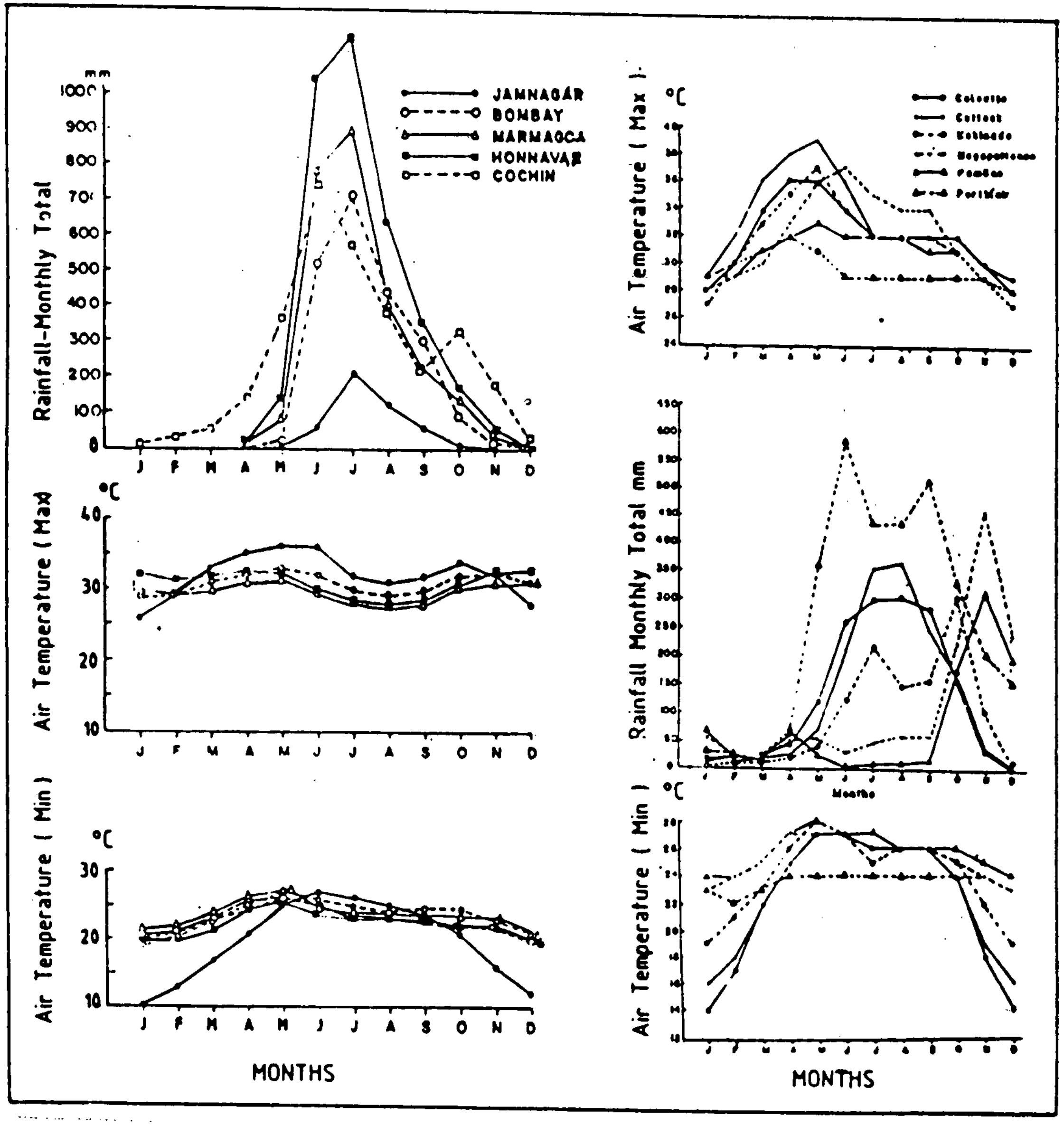
During Monsoon period the rainfall becomes scarce towards north and interior. The total annual rainfall in Dwarka is only 41.8 cm, while it is comparatively higher in Bharuch about 100 cm. Local topography and direction of winds govern the seasonal distribution of rainfall which is uneven and irregular in several segments of the coastal zone. The rainfall is heaavy in east of Khambat and very low in north and west. The central part except the hills receives 40 -80 cm of rainfall. The coastal maragin at Dwarka and Kutch are semi-arid. This is an area of stable air mass where no cyclones occur on the coastal zone.

The Coastal zones from Maharastra to Kerala on the Western sea board is a narrow strip compared to Gujrat coast. The Arabian sea washes it from west and the high western ghats bound it from east. This strip enjoys an equable climate with high temperature throughout the year. The temperature graphs show very small range of temperature. The maximum and minimum diurnal temperature varies betwen 24^{O}-30^{O} C in Bombay, 23^{O}-33^{O} C in Ratnagiri, 21^{O}-31^{O} C in Marmugao, 23.2^{O} C-32^{O} C in Manglore and 25^{O} to 30^{O} C in Thiruvananthpuran. So the summer temperatures are not as high as is found in the interior of India. It is clearly due to influence of sea on the temperature.

The marine influence is also evident on winter temperature. The diurnal temperature varies between 16.3 ^{O} C - 30.6 ^{O} C in Bombay. 19^{O} C - 31^{O} C in Ratnagiri, 21^{O} - 30^{O} C in Marmugao, 26.5^{O} - 29^{O} C in Manglore and 26.8^{O} to 28^{O} C in Thiruvananthpuram. It is evident that as we move from north to south towards equator, the annual range of temperature decreases. This is due to marine impact and nearness to equator.

Normally the souch - west monsoon bursts on Kerala coast during the first five days of June. This summer monsoon brings heavy rainfall which resulting into considerable run-off with excessive leaching and soil erosion. The 78 percent of thje total annual rainfall is received in the month of June, July, August aand September. After October the south-west monsoon begins to retreat.

The rainfall is orographic in nature. The high barrier of Western Ghat raises the south-west monsoon winds. The



Climatic changes in rainfall and temperature along some locations on the Indian west and east coasts average annual rainfall is 270 cm in Bombay, 302 cm in Ratnagiri, 261cm in Marmugao, 346 cm in Manglore, 164 cm in Tirvendrum and 100 cm in Kanyakumari. Though rainfall is comparatively low in Kerala due to effective lack of eastern barrieer, but is well distributed throughout the year.

Thus, the whole of west coast of India is hot, wet and humid. The cool season is very small between December and February. It is a period of low humidities, little precipitation and bright sunshine. The fall in temperature is more in north than south. This is the time when the domestic and foreign tourists flock to these coastal resorts for sunbathing.

Situated in the tropics, the West Bengal coast experience a hot and humid climate. The temperature varies from the highest of 39.9^{o} C in May to 9.8 degree C of extreme lowest in the months of November and December. The maximum temperature gradually increases in the month of February and rises upto the month of June and decreases slowly. The minimum temperature is less in the month of January and gradually increases upto 27.4^{o}C at May and after that decreases gradually. So the winter season sets in the end of Nov., whereas the peak summer is between April and July. The humidity vareis from 39 per cent to 98 per cent in a year. The highest humidity is observed between May and October whereas the lowest is observed between Nov. & April. The annual rainfall varies from 740.5 mm to 2066 mm. The rainfall fluctuates from month to month. The highest rainfall is received in the period between July to September. It is observed that the period June to September is the rainy season and August and September being cyclonic periods. The records show that the cyclonic rainfall is more than the monsoon and conventional rainfall received in different seasons.

The wind velocity is high in the months of April and May and very low in January. The direction of wind is north to south in the beginning of January/February. The wind flows from south west to north east for the period from March to October. Depending upon the sunshine and rainfall, the rate of evaporation changes. The highest evaporation is recorded in the month of April-May.

The coastal zone from Orissa to Tamilnadu exhibits a hot tropical climate characterised by oppressive summer, low daily range of temperature, high humidity and moderate rainfall. The Coastal tract from Orissa to the Krishna delta experiences a tropical Savana climate (AW); from the Krishna delta in Andhra Pradesh to the Vaipar in the extreme south of Tamilandu it is a tropical wet and dry climate with distinct dry summer (AS). Parts of the southern districts of Tamilnadu experience a tropical monsoon climate with a short dry winter season (AMW).

Temperature continuously increases from the end of February to May, the hottest month with $31^{o}C$ at Puri, $35^{o}C$

at Masullipattanam and Madras. The January records a temperature of 22^{O}C in the coastal zone and 19^{O}C in the interior. There is a little variation in annual normal temperature mainly because of low relief and moderate influence of the sea.

The diurnal range of temperature is lower. It is of the order of 2^{O} to 3^{O}C during June to December and 4^{O} to 6^{O}C from January to May. Rainfall decreases from the shore (140-170 cm) to the interior (70-80 cm). Balshore on the Orissa coast gets 168.6 cm, Puri 148.2 cm, Kakinada on Andhra coast 117.9 cm, Madras 121.6 cm Nagapattanam 136.7 cm and Tuticoran 60.2 cm only on Tamilnadu coast. This variation in rainfall distribution is largely due to the fact that Orissa and nothern Andhra get rainfall from the South West monsoon about 78 per cent southward upto the Krinshna delta, the decrease in rainfall is mainly because the region lies off the main track of the monsoon and the associated depressions.

But further south most of the rainfall is caused by the retreating monsoon (44.6 per cent) which is mainly associated with the storms and depressions originating in the Bay of Bengal giving copious rainfall while striking the coast. The decrease in rainfall further south at Tuticoran (62.2) cm is due to the barrier like effect that Sri Lanka exert by preventing the rain bearing winds from reaching this region. In general, high humidities prevails throughout the years in coastal areas. In Tamilnadu it varies from 60 per cent in June to 80 per cent (November/December). In Orissa it remains 60 per cent from December to April and over 80 per cent in July/August.

Winds are of moderate strength throughout the year becoming stronger in the monsoon season (15 km/h). From October to January winds blow from North east and from South west during the summer monsoon. In the Tamilnadu coast gusty east-south easterly to south-south easterly winds often average speed of 16 km/h in April/October set in.

During the post-monsoon and early part of the NE monsoon storms and depressions originating in the Bay of Bengal affect the weather of the region. Some of these depressions intensify into severe storms with strong winds (80-100 km/h) and squalls giving heavy rainfall in the coastal zone and causing considerable dislocation to communication and loss of property.

NATURAL VEGETATION

The natural vegetation in Gujrat coast is thorny stunted type due to limited amount of precipitation. Acasias are dominant in Kutch amidst Zerophytic vegetation. In dry areas small trees or open scrubs are terminating into poor grass and bush in the northern coasts of kutch and Kathiawar. In wet parts of Gujrat moist deciduous thorny and littoral types of vegetation are common e.g. Bobool, Neam, Mango, Mahua and teak. Along coastal margin and beaches there are lines of casurina. The Gir hill is forested and is the only home of lions in Asia.

The high temperature, heavy rainfall and high humidities causes luxuriant growth of vegetation from Maharastra to Kerala. Though at many places the virgin forests are in the process of deforestation due to various projects and constructions activities. At many places where they are untouched they are containing many of unique species of endemic flora and fauna.

The coconuts, casurina and palms are main species of vegetation dominating sandy saline beaches throughout the western coast of India. Mangroves and various types of swamp vegetation are main features in marshes, creeks and estuaries. Scrubs, bamboos, thorny bushes are found on the low laterite platform or hills.

COASTAL PROCESSES

The western coastal water of India is an area of negative water balance where evoporation exceeds precipitation and run off (especially Gujrat coast). The excess of evoporation over precipitation is highest (100-150 cm) off the coast and decreases steadily towards the southeast. A slight excess of precipitation over evoporation (20 cm) occurs anually of Karnatka-kerala coast of India.

The high rate of evoporation results in the formation of several high salinity water masses. The high salinity water masses formed in the north western Arabian sea (Gujrat coast), flows south ward and can be traced as a tongue of high solinity within the surface layer. Increaes in solinity from March (34.6 per thousand) to May (36 per thousand) and an abrupt fall in August (28 per thousand) is typical of south west coast of India.

The water temperature in general increases from October (23.7^{0}C) to May (31^{o}C). During August-October the difference in temperature between the surface and the bottom layer was 1.3^{o}-5^{o}C which may be due to the intrusion of upwelled cold water into nearshore areas.

Surface circulation in the Western Coastal water undergoes biannual reversal associated with the south west monsoon and north east monsoon. The NE Monsoon is weak in this region but the SW monsoon is very intense. Strong winds blowing with the coasts cause intense upwelling off these coasts during SW monsoon. Moderate upwelling monsoon occurs off the south west coast of India partly due to the cyclonic motion in the neighbourhood of the Maldives and the Laccadives.

The wave heights vary between 1.5 and 3 M and the wave periods vary between 5 and 8 seconds during June to September and 0.5 to 1.5 m and 5 to 6 seconds during October to January along the Maharastra coast.

Tides on the west coast are predominantly semi-diurnal. the average spring tidal range is about 2 and 3 m and the average neap tidal range is about 0.2 to 0.6 M.

In contrast to the west coast, the East coastal water is a positive water balance. The average annual excess of precipition is of the order of 70 cm. The total annual river run off to the Bay of Bengal has been estimated to be about 2000 Cubic Kilometre.

The high excess of precipiation over evoporation and the massive river run off results in low surface salinities along the Bengal-Orissa coastline. The salinity of the sea water is about (34.62 per thousand in July and it decreases to 28.3 per thousand) in October all along the East coast. The high salinity of the sea water during summer may be due to incursion of oceanic water in the Bay of Bengal from Central Indian Ocean, upwelling of high saline water from the bottom and increased evoporation. In chilka and Pulicat lake the salinity varies from (36.5 per thousand to 0.10 per thousand, but the average is about 14 per thousand).

The water temperature is (31.4^{O}C) at Gopalpur in June in Orissa coast. However, in October the maximum surface water temperature is (28.3^{O}C). This level of temperature is due to the SW monsoon and increased solar radiation.

The surface circulation in the Eastern Coastal waters of India changes with the monsoonal cycle. The NE monsoon is much more intense here as compared to the Western coast of India. Induced by favourable currents and winds, moderate upwelling occurs along the coast, during the south west monsoon, even though the runoff from the rivers may partially compensate for the offshore movement of surface water.

The wave height varies from 0.97 to 4 m and more than 60 per cent of the wave height are between 1 M to 2 m in the Bay of Bengal during the south west monsoon. The period of Swells is about 6 to 8 seconds before the onset of monsoon.

TIDAL LEVELS ALONG THE EAST AND WEST COASTS OF INDIA

Localities	**Tidal Levels Refferred to Chart Datum**				
	MHHW	**MLHW**	**MHLW**	**MLLW**	**MSL**
EAST COAST					
Calcutta (West Bengal)	5.94	0.94	4.42	2.14	3.30
Cuttack (Orissa)	2.58	0.71	2.02	1.32	1.66
Kakinada (Andhra Pradesh)	1.54	0.20	1.13	0.60	0.87
Nagapattanam (Tamilnadu)	0.65	0.03	0.47	0.20	0.34
Pamban (Tamilnadu)	0.70	0.10	0.40	0.32	0.41
Andaman-Nicobar Islands (Union Territory)	2.18	0.28	1.53	0.90	1.21
WEST COAST					
Kori Creek (Gujarat)	3.0	2.8	1.3	0.5	1.9
Okha (Gujarat)	3.5	3.0	1.2	0.4	2.0
Bhavnagar (Gujarat)	10.2	8.3	3.5	1.4	6.1
Bombay (Maharashtra)	4.42	3.30	1.86	0.76	2.51
Marmagoa (Goa)	1.9	1.8	1.0	0.5	1.3
Coondapur (Karnataka)	1.5	1.3	0.3	0.9	-
Cochin (Kerala)	0.9	0.8	0.6	0.3	0.6

The storm data show that the cyclonic storms with a wind speed of 34 knots or more are formed over the Bay of Bengal practically all the months of the year and create strong wind, heavy rain and tidal waves. The coastal tract of Eastern sea board is exposed to the effect of the abnormal hightide inthe range of 3 to 5 M especially across the Bengal and Orissa coast.

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NATURAL RESOURCE SETTING

The natural resources potentialities of a region have a profound influence on man and his activities. The preservation of natural resources and ecosystem is one of the crucial aspects of coastal planning and management. Therefore, it is imperative to have a brief persual of natural resources setting of the Indian Coastal Zone.

Capture Fishery : The oceans occupy 78.8 per cent of the earth's surface with an average depth of 3730 m. The zone of maximum importance to mankind today for the exploitation of natural living resources is the uppermost layer of 100m.[1] This is the zone where most of the photosynthetic production of organic matters occurs. It forms about 1.8 per cent of the world oceans. From this zone, more than 50 per cent of the world's fish catch is obtained at present. The regions occupying this zone are either fairly close to the coast or in very fertile areas of the coastal or offshore upwelling regions.[2]

In India, marine fish production consists largely of capture fisheries and for these the intensively exploited areas are found in the narrow coastal belt. The estimates of potential fish yield from the Indian ocean vary from about 7 million to 17 million tonnes. Of this potential, India's contribution is expected to be of the order of 5-9 million tonnes.[3]

ANTICIPATED STATE-WISE YIELDS IN INDIA'S MARINE AND INLAND FISH CATCHES IN 1994-1995

('000 tonnes)

State	Marine	Inland	Total
	1994-1995		
Andhra Pradesh	197	192	389
Gujarat	392	43	435
Karnataka	195	66	261
Kerala	417	48	465
Maharashtra	434	62	496
Orissa	84	109	193
Tamil Nadu	328	232	560
West Bengal	78	744	822
Andaman	14	-	14
Goa	56	3.2	59.2
Lakshadweep	9	-	9
Pondicherry	28	3.2	3.2
Dadra & Nagar Haveli	-	-	-
Total	**2,232**	**2,218.4**	**4,450.4** say 4.5 mmt.

Among the maritime states of India, Gujrat has the longest coastline (1640 km) and the largest continental shelf (164,000 km), there being 11 coastal districts with 173 landing centres. The state has excellent estuarine potential. The annual landings ranged between 0.75 lakh tonnes in 1966 to 3.14 lakh tonnes in 1989.[4] Bombay duck is the most important species caught mostly from the south and southeastern coasts. Kutch region has very rich resources of clams, cockles, oysters, chank etc. They are underexploited.

Maharastra with 5 coastal districts, 720 km of coastline, 153 landing centres, the state's share in the country's total marine production formed about 18-22 per cent in recent years. The total continental shelf area of the state is estimated at 89,096 km. Estimated marine catch in the state was 3.47 lakh tonnes in 1989. The share of pelagic species dominated by Bombay duck and ribbon fishes (48.75 per cent) and rest of that of demersal. Raigad and Ratnagiri districts hold promise of increased yield.[5]

The tiny state of Goa with a coastline of 105 km and a continental shelf area of 10,000 sq.km. contributes on an average 2.3 per cent of the total marine fish landings of the country.[6] The total landing of the state in 1989 was 45000 tonnes with 46 landing centres. Pelagic groups constituted 43 per cent and demersal 57 per cent of the total landings. Oil sardine, other sardines, catfishes, croakers, white baits, mackeral and penaied prawns dominated the fishery and together contributed about 56 per cent of the total. It has also large estuarine potential.

Karnatka has a coastline of 270 km and a shelf area of 25000 sq. km. It contributes on an average 9 per cent of the total catches of the country. With 105 landing centres, it produced 1.56 lakh tonnes in 1989; dominated by oil sardine and mackerel. Pelagic groups of fishes formed 69 per cent and the demersal groups 31 per cent of the catches. The minimum expected yield of marine fish in Karnatka is estimated as 2.3 lakh tonnes.[7]

With a continental shelf area of 39,700 sq.km., Kerala's potential yield of marine fish is estimated at 8 lakh tonnes. But the annual landing of the state in 1989 was 3.34 lakh tonnes. It is seen that pelagic groups formed two thirds of the total and demersal the rest. Oil sardines, mackerel, penaied prawn etc. dominate the pelagic catches. In the 25-30 m depth zone there is good potential for resources like anchories, carangids, ribbon fishes, cat fishes and perches.[8]

The West Bengal has the shortest coastline (65 km.) among all the maritime states, a wide continental shelf of 150 km. and an area of 20,000 sq.km. upto 200 m depth. The shelf area has a muddy bottom and its configuration is affected by large river systems and tidal currents. The marine ladings of the state varied between 5366 tonnes in 1977 to 62 thousand tonnes in 1989. Catfishes, non-panied prawn, pomfrest, Bombay duck, Hilsa Shad etc. are major species of West Bengal.[9]

Orissa has a coastline of 480 km and forming 8 per cent and 4.5 per cent respectively of the country's total. There are four coastal districts enjoying a heavy south west monsoon contributing to 90 per cent of the total rainfall. The coast is, however, cyclone prone. South Orissa, comprising Ganjam, Puri and southern parts of Cuttack has a narrow continental shelf (about 40 km) and open sandy beaches whereas northern Orissa is characterised by an extended continental shelf (about 120 km), intertidal flats and extensive river deltas. The total marine catch from the state varied between 15,072 tonnes in 1977 to 55000 tonnes. The contribution of demersal fishes was 67 per cent and the rest pelagic. Crookers, catfishes, pomfrets, other sardines, hilsa shad and prawns, formed the important fishereis of Orissa. Maximum harvestable yield of the state is estimated at 1 lakh tonnes.[10]

With a coastline of 980 km. continental shelf of 31,000 sq.km., discharge of two large rivers - Gidavari and Krishna and enjoying the copious rainfall of both monsoons, Andhra Pradesh has an average annual marine fish production of 1.41 lakh tonnes in 1989. There are nine coastal districts with 280 landing centres. Exploitable stock upto 50 m depth in the state is estimated in a range of 1.5 - 2.63 lakh tonnes, a safe level being 2 lakh tonnes.[11] Good pelagic landings portend higher marine production in the state.

The total landings in Pondichery was 22000 tonnes in 1989. Pelagic varieties formed 60 er cent of the catches and the demersal 40 per cent. Other sandines (17 per cent), Carangids (10 per cent) etc. were the main contributors to the catch.[12]

Tamilnadu has the unique distinction of facing three major seas - the Arabia Sea, the Indan Ocean and the Bay of Bengal, and has the benefit of both SW and NE monsoons, With a total coastline of 1000 km, a continental shelf of 35000 sq.km. and an estimated offshore area of 2.2 lakh hectares, the state produces 2.06 lakh tonnes (1977) and 2.62 lakh tonnes in 1989 and during the decade with an average of 2.32 lakh tonnes. The present level of exploitation is supposed to be only one-fourth of the potential yeild. Demerasal varities of fish dominated (54.6 percent) over the pelagic ones (45.4 per cent) in the total landings in eight coastal districts with 352 landing centres. Major fishes included silver bellies, other sandines, anchories etc. Potential harvestable yield is estimated at 3.25 lakh tonnes.[13]

Mariculture : Another important and productive sector, namely mariculture, is not properly organised in India. It is being practiced on a small scale in the enclosed backwater and estuaries areas of Kerala, Karnatka and West Bengal. The culture is largely based on traditional methods of trapping the juveniles of prawns and fishes brought in by the tidal currents into the enclosed areas provided with sluice gates, where they are allowed to grow from three to nine months before harvesting. The total production of fish and prowns from aquaculture practicas is about 10,000 tonnes. The potential of mariculture appears to be most promising and by the year 2000, the annual production of 2.5 million tonnes appear to be within reach.[14]

Seaweeds : Seaweeds are one of the important living resources exploited by man for food, animal feed, fertilisers, and for chemicals and pharmaceautical products. The total marine algal yield of the world has been estimated as 18 million tonnes wet weight per year. Of ths India contributes only 1.09 per cent of the total.[15]

SEAWEED RESOURCES OF THE INDIAN COAST *

Sr. No.		Annual Yield in tons (fresh wt.)	Authors
I.	**GUJARAT**		
	(a) Gulf of Kutch	100,000	Desai (1967)
	" " "	19,000	Chauhan & Krishnamurthy
	(b) Hanumandandi to Vumani (Okha)	650	Bhanderi & Trivedi (1975)
	(c) Adatra Reef	60	Sreenivasai Rao et.al.(1964)
	(d) Saurashtra Coast	282 to 608	Chauhan & Mairh (1978)
II.	**MAHARASHTRA**		
	(a) Entire Coast	315	Chauhan (1977)
	(b) " "	20,000	Untawale et.al. (1979)
III.	**GOA**	2,000	Dhargalkar (1981)
IV.	**KARNATAKA**		
	(a) Entire Coast	Negligible	Untawale & Agadi (1981)
V.	**KERALA**	?	--
VI.	**TAMIL NADU**		
	(a) Cape Comorin-to-Colachel	5	Koshy & John (1948)
	(b) Calimare-to-Comorin	66,000	Chacko & Malu Pillai (1958)
	(c) Pamban	1,000	Varma & Rao (1964)
	(d) Palk Bay	900	Umamaheswara Rao (1968)
	(e) South East Coast	20,535	Subbaramaiah et.al. (1977)
	(f) Entire Coast	22,044	Subbaramaiah et.al. (1979)
VII.	**ANDHRA PRADESH**	?	--
VIII.	**ORISSA**		
	(a) Chilka Lake	5	Mitra (1946)
IX.	**WEST BENGAL**	?	--
X.	**ANDAMAN & NICOBAR ISLAND**	?	--
XI.	**LAKSHADWEEP ISLANDS**	3,645 to 7,598	Subbaramaiah et.al. (1979)

Source : Untawale et.al. 1981

The demand for agrophytes and alginophytes by industry in India and abroad is increasing very rapidly. Unfortunately, India has not yet fully utilised its seaweed resources. The potential resource of the Indian coast is 260,000 tonnes of which industrial consumption is at the level of 4 to 5 thousand tonnes per annum.[16] Individual farmers may be using a thousand or two tonnes per year. There are about 624 marine algal species belonging to different families and genera along the 7000 km Indian coastline. As a resource, 1 lakh tronnes (wet weight) per year of seaweed biomass may potentially be harvested and used for various purposes, provided good management practices are used.

Estimated Quantity of Industrially Used Seaweeds on Indian Coast (Quantity - Tonnes - Wet Weight)

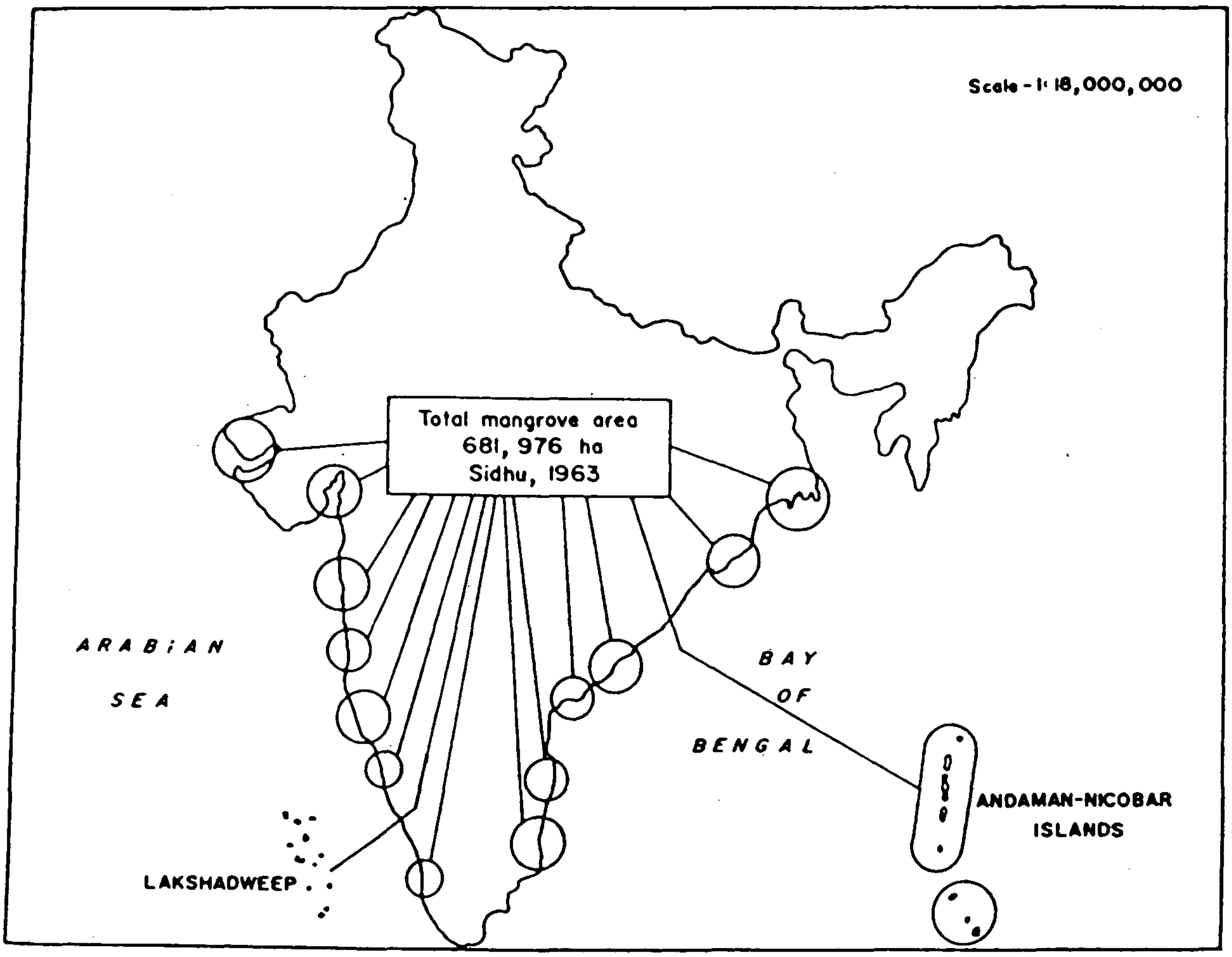
Species	Gujarat	Maha-rashtra	Goa	Laksha-dweep	Andhra Pradesh	Tamil Nadu	Total
Sargassum	12400	8000	1200	0.30	220	9381	31200
Turbinaria	-	-	-	11	-	714	700
Gelidiella	4	-	-	945	-	74	1000
Cracilaria	19	800	400	420	422	974	3000
Hypnea*	-	500	200	33	53	798	1600
Total (round figurs)	12400	9300	1800	1400	700	11900	375000

*Not yet used. However it has got high potential for industrial use.

Mangroves : The role of the mangroves forests in stabilising the shoreline or coastal board is well known. They prevent soil erosion and encroachments by the sea to the interior. Thus, the waterlogging and creation of saline blanks are prevented. It is worth noting that the coastal vegetation like the lagae including seaweeds and the mangroves play a significant part in enriching the coastal sea. They transport through their ecosystems dissolved organic matter, nutrients (besides serving as nursery areas for the larvae and juveniles of marine denizens) and thus, support the benthic populations of the sea.[17] Their importance in the recycling of organic matter and enrichment of the coastal sea has to be appreciated and understood.

VARIOUS SURVEY ESTIMATES FOR MANGROVE FROESTS IN INDIA

Major Zones	**Mathauda (1957) (Acres)**	**Waheed Khan (1957) (Sq.Mil.)**	**Sidhu (1963) (Hec.)**	**Balsco (1977) (Hec.)**
West Coast				
1. Gujarat	-	147.0	52,616	20,000
2. Maharashtra	-	96.0	62,208	20,000
3. Goa	-	-		
4. Karnataka	-	-		
5. Kerala	-	-		
6. Lakshadweep Islands	-	-		
East Coast				
7. Tamil Nadu	1,660	-	2,640	1,500
8. Andhra Pradesh	46,060)		18,424	10,000
	)	74.5		
9. Orissa	30,000)		12,000	5,000
10. West Bengal	1,047,220	1,637.0	418,888	200,000
11. Andaman-Nicobar Islands	288,000	465.0	115,200	100,000
Total	**1,412,940**	**2,419.5**	**681,976**	**356,500**
	572,240.7 ha	**(549,950 ha)**		



Distribution of mangroves along the Indian coast

No accurate data are available on the total mangrove area in India. According to Sidhu (1963) it is around 680,000 ha, wherease Blasco (1975) has estimated it tobe about 356,500 ha. Recent remote sensing studies of the coastal mangroves of Andhra Pradesh, however, support Sidhu's estimates.[18] Untawale (1987) estimates that the total mangrove area in the recent past must have been approximately 1.4 million ha, of which 50 per cent has been lost because of indiscriminate deforestation, large scale land development and natural calamities like geotectonic movement, sea level rise, and extreme climatological change. Therefore, there is a need for proper management practices and rehabilitation of mangroves.

Coral Reefs : Coral reefs are among the most bilogically productive,taxonomically diverse and aesthetically important living communities. While their massive occurence provides much needed protection for the coastline from waves, their biological productivity yields a multitude of fauna and flora dependent on the coaral reef ecosystem. These communities also form the main attraction for skin diving, underwater photography, sport fishing and shell collecting. They thus provide a vital stimulus to the tourist industry.

Due to population pressure, most of the coral reefs have become extremely vulnerable to pollution and industrial development along the coastline. Hence, unless protection is offered to coral reefs in the future, most of them will shrink in size and ultimately die. The fore cast is that most of the fringing reefs of India along the main coastline will not survive by the year 2000, unless extensive protection is offered to them in the form of coastal marine parks. The only reefs that would probably survive would be on the attols of Laccadives and on some of the islands of Andaman and Nicobar.

Fresh Water From Sea-Water : In terms of population growth, the world supply of fresh water is dwindling very rapidly every year. There are many areas in the Indian coastal zone where potable water is in short supply and thus people even resort to drinking saline water.

Solar stills, flash distillation, electrodylysis, reverse osmosis etc. desalination technologies are being employed to generate fresh water from the sea water inthe coastal zone. A solar still of 5,000 litres per day capacity has been installed in Avnia village in Gujrat where 500 families obtain their drinking water from this source.

Reverse osmosis is the most widely used desalination technique. In this process, suitable osmotic membranes are used which reject salts and allow the water to pass through. Several plants with capacities of 10,000 to 15,000 littres have been set up in Indian coastal villages (especially Gujrat, Tamilnadu) to supply potable water to the villagers.[19] It has been estimated that towards the year 2000 A.D. about 90,000 million tonnes of fresh water will have to be produced annually world wide. A significant portion of this will come from the sea by desalination.[20]

Energy from Oceans : Energy is one of the most essential human needs. With an increasing standard of living, there has been a sharp increase in the requirements of energy in India. Self sufficiency in enegy is essential for a developkng country like India.

There are at least eight sources of energy to be obtained from the sea. The various ingenious methods of extracting energy are from : Ocean Waves, Ocean Tides, Ocean Thermal Energy Conversion (OTEC), Ocean Currents, Ocean Winds, Salinity Gradient, Ocean Geothermal and Bioconversion of Seaweeds.

India,using the OWC method has designed a wave energy plant which is being built in Kerala. The ocean engineering centre of the IIT, Madras, after several years of painstaking effort, has been able to develop an ingenious design. After the wave energy plant is commissioned, it would be first of its kind in the world. A tidal power plant based ocean tides has been designed in the bays of Cambay and Kutch (Gujrat) in the Indian Coastal Zone, where tides have been found to be of the right range. One OTEC plant has been planned to be installed at a small Indian port Kulasekharapatnam in the Tirunevelli district of Tamilnadu.[21]

Our estimate says that the world production of oil is likely to reach its maximum by 1995 and by 2025, 80 per cent or more of the oil reserves would be exhausted.[22] Nuclear power plants are expected to supplement the power demand, but the environmental impact of the nuclear reactors has become a controversial global issue. Therefore, our seas are a source of endless pollution free energy to be tapped.

Placer Deposits : Chemically stable minerals are not decomposed by weathering processes, and as the rocks surrounding such minerals become dissolved and disintegrate, the heavy particles settle to the bottom in layers and become continuously enriched as heavy, chemically stable minerals. All such concentrates are called placers.

Mineral placers along the seashores, usually known as black sand, occur in many localities along the Indian coast. Deposits on west coast are largely concentrated as high-grade beach and low grade dune deposits, extending from Kanyakumari to the Maharastra coast with interruptions between. These depostis mainly contain lmenite, rutile, zircon and monazite with varying proportions of mangnetite and garnet.

Marine Chemical Resources : One cubic mile of sea water contains about 165 million tonnes of salts, chlorine and sodium constitute about 89.15 and 49.5 million tonnes in it and so a lot of common salt can be manufactured from sea water.[23] Now a days from the sea water common salt is produced by drying sea water in the ponds all along the Gujrat coastline. This is an important and totally sea based economic activity.

One cubic mile of sea water contains 64 lakh tonnes of magnesium, 3 lakh tonnes of bromine, 14 tonnes of uranium, 1 ton of silver and 20 kg of gold.[24] Also from the sea bed petroleum, natural gases sulfur, tin, diamond, coal, iron ores etc. are produced. When the withdrawl of these sea based minerals become economical, it is hoped that environmental protection will not be ignored in the search for profitability.

Mineral Resources : The important bauxite deposits occur in laterite cappings in basalt plateau, lying between the deccan traps and the Gaj beds for about 48 km., with width of 3.2 to 4.8 km. between Gulf of Kutch and the Arabian Sea, through Bhavnagar and Junagarh districts. High grade ores of about 12 million tonnes are said to occur in Jamnagar district and others in Kutch and Kheda districts.[25]

Other non-metalic minerals include calcite (Bharuch and Kutch), sea sands all along the Gujrat coast, silica sad and glass sand (Bharuch, Surat), and minerals of minor imprtance are also found.

The Gujrat basin constitutes an important oil producing belt of India. At present, the two important areas include the Cambay-Kalol area north of the Gulf of Cambay and the Ankleshwar-Olpad area south-west of Vadodra. The total production of the Gujrat oil-fields is about 40 lakh tonnes per year. The average depth of wells in Combay basin is just under 1700 meters. The Cambay basin has large reserves of natural gas.

Minerals of commercial significance in Maharastra coastal zone are found only in Ratnagiri district. Iron ore occurs in Sawantwadi, Vengurla Reddi and the resources are of the order of 31.20 million tonnes with iron content of 55 to 58 per cent. Chronites with 31 to 38 per cent content, bauxite and silican seeds are also found.[26]

Oil represents the most important mineral resources of coastal Maharastra. The Bombay high as well as Bassein structure are important oil and natural gas basins. It lovers an area of 2500 sq.km. The estimated resources of this strructure is 200 million tonnes.[27]

The Karnatka coastal zone produces iron ore, copper, maganese, dolomite, limestone and other building materials. The iron ore resreves estimated is about 79.96 million tonnes with 55 to 60 per cent iron content. Titaniferous magnitite reserves is 3.2 million tonnes. The total reserve of magnese is 0.25 million tonnes.[28]

The availability of mineral resources in the Eastern Coastal Zone is very poor.Chronite, nickel, gold, fire clay etc. are found in the Sukinda area of coastal Cuttack. In Ganjam district occurs the dune and beach sands comprising rare earth materials. Salt is produced along the Chilka lake.

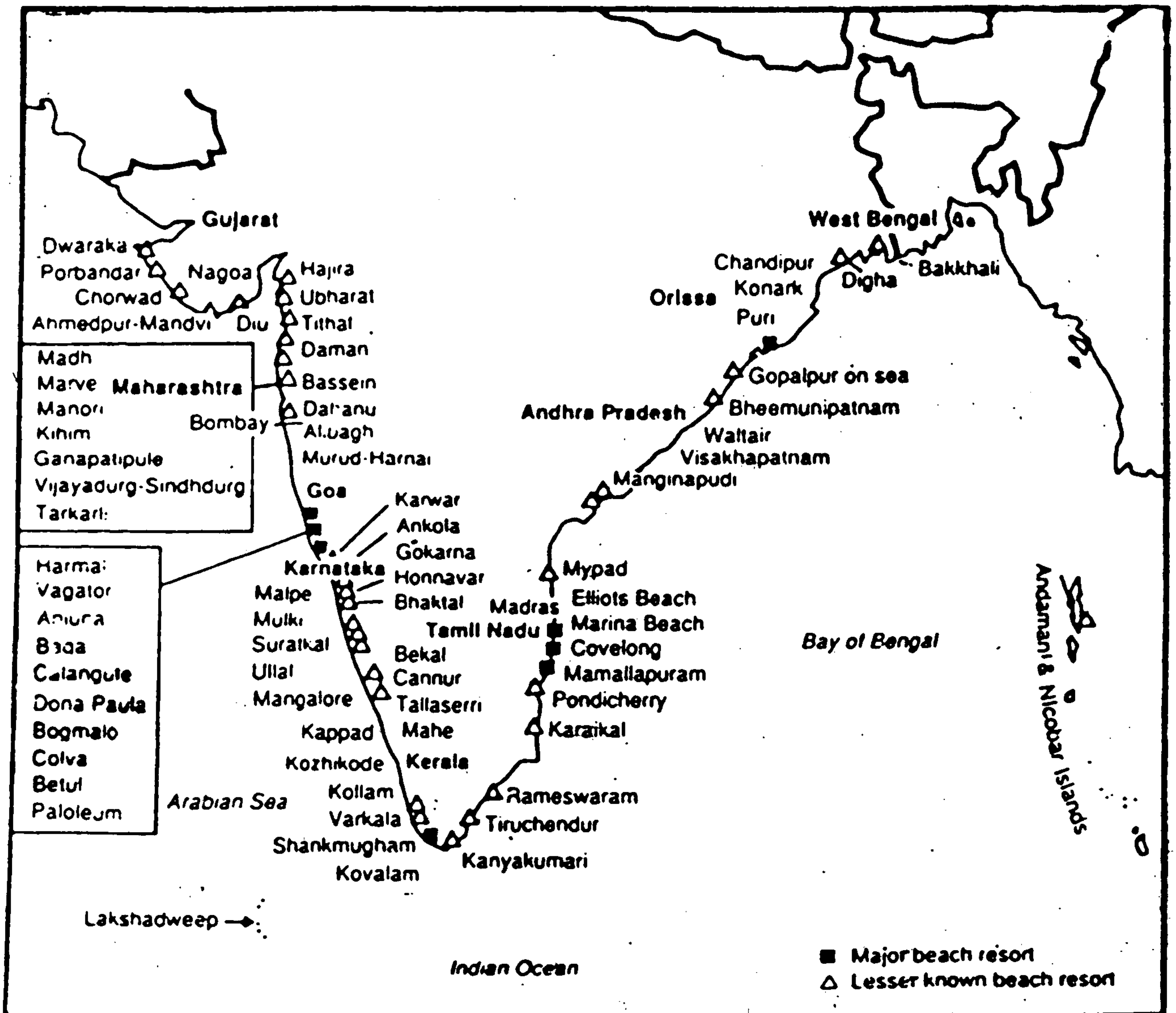
Magnaese deposits in Srikakulam and Vishakahapatnam in Andhra Pradesh contain 25 to 30 per cent mineral contents and reserves estimated to be 0.5 million tonnnes.[29] Coastal Andhra is also rich in mica producing one tenth of Indian production in Nellore district.

The Tamilnadu coastal zone has limestone, dolomite, graphite, pyrites, kaolin, silica sand, salt, garnet etc. Some oil reserves have also been located in the coastal zone of Kaveri basin in the state.

Beaches : India has a long coastline of about 7500 km of which 5560 km is in the mainland. Beaches extend from Dwarka of Gujrat in the West, Kanyakumari of Tamilnadu in the South and Digha of West Bengal in the East amidst Arabian Sea, Indian ocean and Bay of Bengal. Apart from those two emerald Archipelgous of Lakhadeep and Andaman provide coastal beauties of nature. Among the 70 odd beaches some like Goa, Kanyakumari, Kovalam, Marina etc. are famous, a few like Waltair Pondichery, Puri, Chandipur, Digha etc. are popular and many are not so well known.

The never ending and everchanging seanic beauties of beach resorts are the most important natural resources available in the coastal zone of India, Many of these beaches are quite developed and many others need attention and planning for future developments with environmental protection in mind.

Beach Resorts in India



Source : Department of Tourism, Government of India by Visual Communication.

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POPULATION AND SETTLEMENT

The pattern of human settlements in a region is very much the result of a combination of compulsive factors such as geomorphological features, ecological setting and man's endeavours to shape his envriornment in accordance with the changing socio-economic needs. In a coastal zone, this relationship between the environmental factors, the human endeavours and the settlement pattern is demonstrated in a dramatic manner.

The coastal districts of India account for an area of 420.746 million sq.km. and houses a population of 165.097 millions which means nearly one sixth (15.2 per cent) of total area of the country and more than one-fifth (21.4 per cent) of the total population. The density of the population is of the order of 392 persons per hactare and embraced 64 districts having 69,233 villages, 654 urban centres and a population of 98.60 million and 43.41 million respectively.[1]

Coastal areas have already started coming under lot of pressure from developmental activities. As per 1991 Census 6 out of 23 metropolitan cities, i.e. Greater Bombay, Calcutta, Madras, Surat, Coimbatore, Vishakhapatnam lie in the coastal zone. In fact, the first metro city i.e. Calcutta was a coastal city. Further, 3 out of 4 super-metro city are located along the coastal zone showing that urbanisation process is firmly rooted in this terrestrial and marine interface.

POPULATION CHARACTERISTICS OF INDIAN COAST
1991 CENSUS

Coastal State/ District	Population Growth Rate in % 1981-1991	Density Pop./Sq.Km. 1981	Density Pop./Sq.Km. 1991	Sex Ratio in /000	Literacy Rate in %
Gujrat	**20.80**	**174**	**210**	**936**	**51.65**
Jamnagar	10.92	99	109	955	50.46
Bhavnagar	21.73	168	205	950	48.46
Junagarh	13.88	198	226	960	51.93
Amrali	15.97	160	185	982	50.57
Bhuj (Kutch)	18.65	23	27	973	43.79
Ahmedabad	23.56	445	550	899	63.09
Khada	14.01	419	478	919	56.71
Bharuch	18.99	143	171	933	52.41
Surat	36.11	445	606	920	74.67
Maharastra	**25.36**	**204**	**256**	**936**	**54.38**
Thane	55.89	351	547	880	58.80
G. Bombay	20.20	13670	16432	820	71.55
Raigarh	22.31	209	254	1011	53.84
Ratnagiri	11.58	168	188	1211	53.27
Sindhudurg	6.38	150	160	1140	67.25
Goa	**15.96**	**272**	**316**	**969**	**66.92**
North Goa	16.86	327	382	964	69.10
South Goa	14.81	224	257	975	64.04
Karnatka	**20.69**	**194**	**234**	**960**	**47.02**
Dakhin Kannad	13.27	282	319	1063	65.50
Uttar Kannad	13.49	104	118	967	56.44
Kerala	**13.78**	**655**	**747**	**1040**	**78.10**
Kassargod	22.67	438	537	1027	70.15
Kannur	16.27	651	757	1055	79.40
Khozikode	16.37	958	1115	1031	79.40
Mallapuram	28.74	677	871	1054	71.84
Thrisur	12.08	805	902	1088	79.30
Ernakulam	10.36	1053	1162	1002	82.12
Kottayam	07.20	771	826	1005	85.49
Allapey	06.71	1319	1408	1061	83.61
Kollam	10.25	873	963	1043	79.88
Trivendrum	13.19	1184	1341	1041	78.11

P.T.O.

Coastal State/ District	Population Growth Rate in % 1981-1991	Density Pop./Sq.Km. 1981	Density Pop./Sq.Km. 1991	Sex Ratio in /000	Literacy Rate in %
Tamilnadu	**14.94**	**372**	**428**	**972**	**54.61**
Madras	15.82	19274	21811	930	72.54
Changai-Anna	27.77	460	588	957	57.45
South Arcot	15.92	386	447	968	45.76
Thanjavur	11.40	491	547	996	57.64
Puddukottai	14.32	248	284	1006	50.03
Ramanathpuram	11.11	242	268	1020	52.46
Chidambarnar	7.79	292	315	1047	63.20
Tirunveli	12.15	326	366	1036	56.53
Kanyakumari	11.79	845	945	994	72.14
Andhra Pradesh	**23.82**	**195**	**241**	**972**	**37.46**
Srikakulam	18.12	336	397	1014	31.13
Vizinagarm	16.47	276	321	1000	29.37
Vishakhapatnam	27.00	231	293	976	39.40
East Godavari	22.70	342	420	998	41.37
West Godavari	22.27	371	454	995	45.66
Krishna	21.15	349	423	967	45.81
Guntur	18.96	302	359	972	40.70
Prakasham	18.06	132	156	973	35.10
Nellore	18.64	154	183	980	41.29
Orissa	**19.50**	**169**	**202**	**972**	**40.97**
Balashwar	24.13	357	443	968	48.70
Cuttack	18.89	415	494	964	53.36
Ganjam	17.72	213	251	1012	36.62
Puri	22.22	287	351	940	54.35
West Bengal	**24.55**	**615**	**766**	**917**	**48.13**
Medinapur	23.83	479	593	944	57.64
S. 24 Pargana	30.08	441	573	929	44.77
Dadar Nagar H.	**33.63**	**211**	**282**	**953**	**32.53**
Daman	**27.58**	**674**	**860**	**917**	**65.10**
Diu	**29.81**	**761**	**987**	**1064**	**53.61**
Pondichary	**30.60**	**1229**	**1605**	**982**	**64.57**
Pondichary	32.76	1517	2014	967	63.61
Karaikal	21.42	750	911	1008	64.20
Mahe	17.57	3157	3712	1156	82.77
Yannam	74.51	388	677	969	65.23

P.T.O.

Sl. No.	Particulars	States/Union Territories Maritime	Inland	India
1.	Number	13	19	32
2.	Population (millions)	417.657	426.667	844.324
3.	Population (per cent)	49.5	50.5	100.0
4.	Area in km^2 (millions)	1.396	1.770	3.166
5.	Area (per cent)	44.1	55.9	100.0
6.	Density (persons/km^2)	299	241	267
7.	Urban Population (millions)	127.030 (58.49)	90.148 (41.51)	217.178 (100.00)
8.	Urbanisation Level (Per cent)	30.4	21.1	25.7
9.	Total Workers (millions)	167.995 (53.35)	146.908 (46.65)	314.904 (100.00)
10.	Total Workers - % of Total Population	40.2	34.4	37.6
11.	Main Workers (millions)	153.415	132.008	285.423
12.	Main Workers - % of Total Population	91.3	89.8	90.6
13.	Household Workers (millions)	5.962 (57.48)	4.411 (42.52)	10.373 (100.00)
14.	Household Workers % of Total Population	3.89	3.34	3.60
15.	Other Workers (millions)	55.389 (61.67)	34.423 (38.33)	89.812 (100.00)
16.	Other Workers % of Total Population	36.1	26.1	31.5

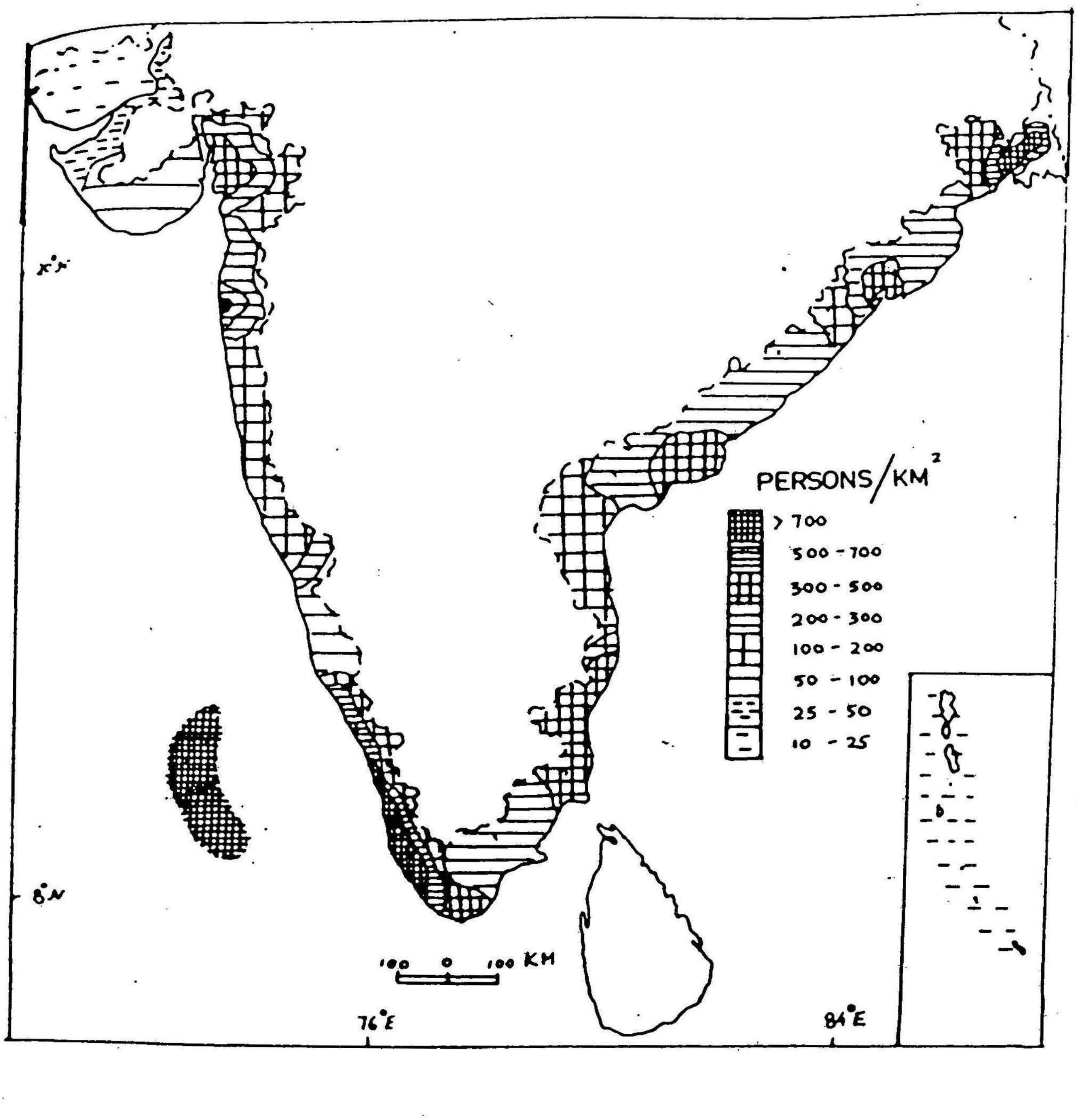
Source: Census of India, 1991. Series 1, papers 2 and 3.

Note : Figures in brackets show percentages of totals.

The earliest coastal settlements had a basic character of being centres of trade and commerce and they still continue to do so. Further, they are port towns thus handling large volume of goods traffic including that of export and import. There are in all 10 major port cities in the country i.e. Bombay, Calcutta, Madras, Marmugao, Manglore, Cochin, Vishakhapatnam, Kandla, Paradip and Tuticoran and all of them have shown tremendous growth rate during 1981-91 census period. Manglore and Cochin are likely to join the select list of metrocities by 2001 A.D.[2]

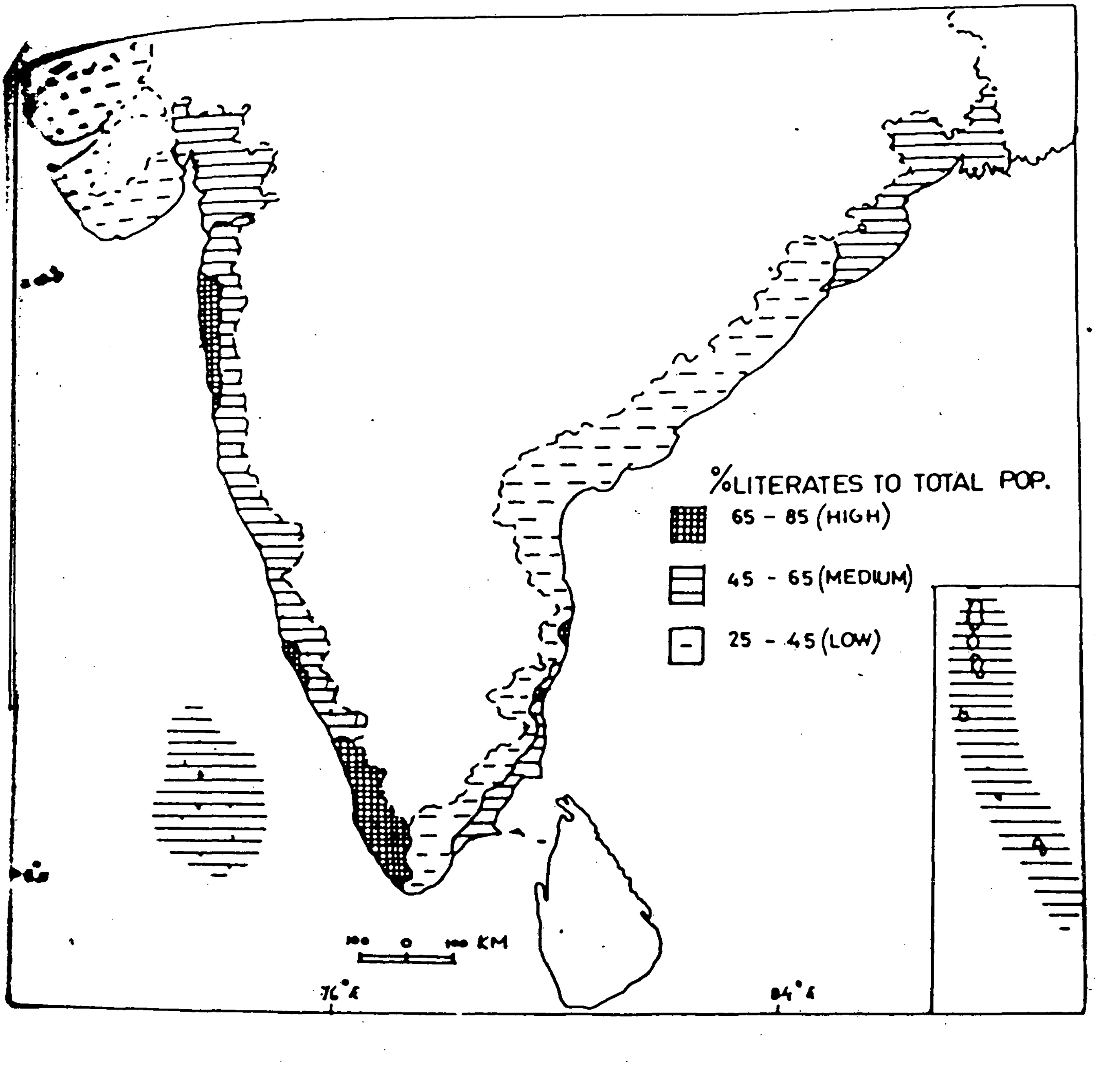
However, coastal zone in the state of Gujrat i.e. Rann of Kutch is still by and large low density area (27 persons per sq.km.) because of marshy land, hostile climate. The islands which form part of coastal belt are also showing different trends in population distribution. Lakhadweep has a high population density of 1615 persons per sq.km. against an all India average of 267 (1991) whereas Andaman and Nicobar islands have density of 34 persons only. As against this the coastal states in general have exhibited high density in 1991. Pondicherry (1605), Daman and Diu (906), West Bengal (766), Kerala (747), Tamilnadu (428), Goa (316), Dadara and Nagar havali (282) have density higher than that of all India average.[3] However, the other coastal areas which have lower density have also shown considerable increase in their concentration of population.

COASTAL INDIA
POPULATION DENSITY (1991)



COASTAL DISTRISTS

LITERACY



The maritime states are more urbanised with 30.4 per cent of their population living in urban areas as compared to only 21.1 per cent in inland states. Similarly, though the maritime states constitute only about 44 per cent of the total area of the country, they account for as much as 53.35 per cent of total workers, 57.48 per cent of the workers in the household industries and 61.67 per cent of the "other workers". The last two figures significantly reveal relative concentration of industries, trade, commerce and services in these states as compared to other inland states.[4]

Analysis of maritime states in respect of coastal and inland districts similarly reveal a trend of concentration of population and activities in the former. Whereas the coastal districts cover only about 30 per cent of the total area of the maritime states, they contain 47.1 percent of the urban population, 39.16 per cent of all urban areas, 36.98 per cent of the total workers, 36.96 per cent of the main workers, 37.62 per cent of the household industrial workers and 46.66 per cent of the other workers.[5]

Though only 6 of the 23 metropolitan cities are located in coastal zone of India, these 6 cities contain as much as 42.3 per cent ofthe total metropolitan population.[6] These data clearly show the nature of concentration of population, urban areas and economic enterprises in the maritime states and within them in the districts located on the coastline. There is a distinct indication of successive

Comparative Analysis of Coastal and Inland Districts in Maritime States/Union Territories based on Specific Physical, Demographic and Economic Particulars, 1991

Sl. No.	Particulars	Districts Coastal	Districts Inland	Total Districts Maritime States/UTs
1.	Number	64	104	168
2.	Population, 1991 (millions)	165.097	252.561	417.657
3.	Population, 1991 (percent)	39.5	60.5	100.0
4.	Area in km^2 (millions)	420.746	975.794	1,396.540
5.	Area in km^2 (percent)	30.1	69.9	100.0
6.	Density in Persons per hectare	392	259	299
7.	Urban Population (millions)	59.835 (47.1)	67.195 (52.9)	127.029 (100.00)
8.	Level of Urbanisation (per cent)	36.2	26.6	30.4
9.	Total Number of Urban Areas	654 (39.16) (100.00)	1016 (52.90) (100.00)	1670 (100.00)
i	Class I UA	61 (35.67) (9.33)	110 (64.33) (10.83)	171 (100.00)
ii	Class II UA	67 (35.26) (10.24)	123 (64.74) (12.10)	190 (100.00)
iii	Class III UA	180 (34.68) (27.52)	338 (65.32) (33.26)	519 (100.00)
iv	Class IV UA	215 (45.35) (32.87)	259 (54.65) (25.49)	474 (100.00)
v	Class V UA	105 (41.83) (16.06)	146 (58.17) (14.37)	251 (100.00)

Continued.,

Sl. No.	Particulars	Districts		Total	Districts
		Coastal	Inland	Maritime	States/UTs
vi	Class VI UA	26 (38.46) (3.98)	40 (61.54)	(3.94)	65 (100.00)
10.	Total Workers (millions)	62.127 (36.98)	105.868 (63.02)		167.995 (100.00)
11.	% Of Workers to Total Population	37.6	41.9		40.2
12.	Total Main Workers (millions)	56.705 (36.96)	96.710 (63.02)		153.415 (100.00)
13.	% of Main Workers to Total Workers	91.3	91.3		91.3
14.	Household Workers	2.243 (37.62)	3.719 (62.36)		5.962 (100.00)
15.	% of HH Workers to to Main Workers	3.95	3.84		3.89
16.	Other Workers (millions)	25.847 (46.66)	29.541 (53.33)		55.389 100.0)
17.	% of Other Workers to Main Workers	45.6	30.5		36.1

Source: Census of India, 1991
Note : Figures in brackets show percentages of totals.

Table 3 Distribution of Population between Coastal and Inland Metropolitan Urban Areas/Agglomerations, 1991

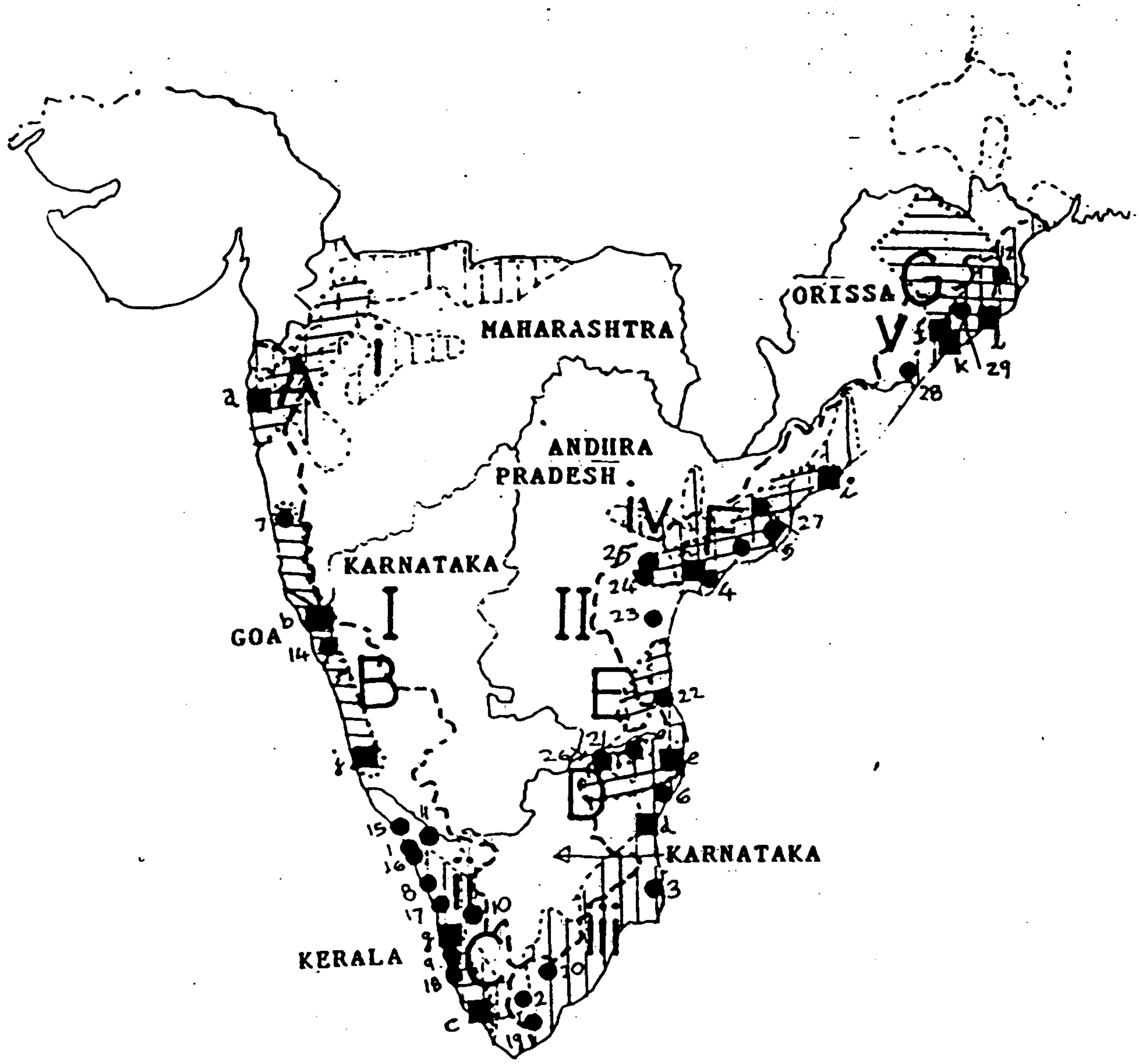
Sl. No.	Particulars	Metropolitan Urban Areas/Agglomerations		
		Coastal	Inland	Total
1.	Number	4	19	23
2.	Population, 1991 (millions)	29.901	40.760	70.661
3.	Population, 1991 (per cent)	42.3	57.7	100.0

Census of India, 1991

layering of increasing concentration of economic activities and population towards the coasts. However, near the coast the settlement pattern tends to become marginally more balanced, as the percentages of lower size urban areas (classes IV, V and VI) in coastal districts are a shade higher as compared to inland districts. As per the available trends, the rate of urbanisation in coastal states in general and coastal districts in particular are likely to record quantum jump in not only in their population but also in the levels of urbanisation and associated economic activities in future.

The settlements in the coastal districts depict varies characterisation depending on the area and part of the country they are located. The range varies from a small town to a supermetro pattern. Concentration of settlements also show a differential pattern from state to state with considerable number of settlements located along the West Coast area of Kerala, Tamilnadu in the East coast and only few in the states of Maharastra, Gujrat and West Bengal. However, Andhra Pradesh show large number of settlements in the Massulipattnam area. In Kerala, the settlements along the coastline show a well spread pattern.

In case of Maharastra state, Konkan region which forms part of coastal zone (comprising districts of Bombay, Thane, Raigarh, Ratnagiri, Sindhudurg) have displayed most erratic trends in population growth and has the lowest density among



LEGEND

BOUNDARIES
———STATES
----AGRO-CLIMATIC REGIONS (ACR)
.........SPATIAL PRIORITY URBAN REGIONS (SPURS)
------URBAN CORRIDORS (UC)
■ NATIONAL PRIORITY CITIES (NPCs)
● STATE PRIORITY CITIES (SPCs)

COASTS OF INDIA : VARIOUS REGIONS, NPCs AND SPCs

Source : Ministry of Urban Development, National Commission on Urbanisation Report, Maps 1,3,4,5,6.

THE NATIONAL PRIORITY CITIES IN WEST AND EAST COAST REGIONS

Criteria	Name of the NPCs located in	
	West Coast Region	East Coast Region
State Capitals	a) Greater Bombay b) Panaji c)Trivandrum	d) Pondicherry e)Madras f) Bhubaneswar
Existing & Potential million Plus Cities	g) Cochin	h) Vijayawada i) Vishakhapatnam
Other Potential Growth Centres	j) Mangalore	k) Puri l) Paradeep

a, b, c...... code for NPC names in Fig.1

THE STATE PRIORITY CITIES IN THE WEST AND EAST COAST REGIONS

Criteria	Name of SPCs Located in	
	West Coast Region	East Coast Region
District HQ Urban(Other than NPCs	1) Mahe	2) Tirunelveli 3) Karaikal 4) Machlipatnam 5) Yanam 6) Tiruppur
District HQ (Rural)	7)Ratnagiri 8)Malapuram 9)Kottayam 10)Idukki 11)Kalpetta	12)Baleshwar 13) Dhenkanal
Other Potential-Growth Centres	14)Karwar 15)Cannanore 16)Calicut 17)Trichur 18)Alleppey	19)Tuticorin 20)Sivakasi 21)Tirupati 22)Nellore 23)Ongole 24)Guntur 25)Narsaraopet 26)Madanapalla 27)Rajmundri 28)Berhampur 29)Cuttack

all the divisions of Maharastra state. The districts of Greater Bombay and Thane are highly developed and have large concentration of population whereas Ratnagiri, Raigarh, and Sindhudurg have settlements which are far and few in number. This is due to the fact that the last districts do not have enough rail and road communication network. Absence of adequate rail linkage have been one of the major cause of backwardness of the area. The Government of India has already initiated the proposal of Konkan Railway, which when materialises would act as a catalyst for ushering in the developmental forces in the area.

In the state of Gujrat, coastal districts of Ahmedabad, Kheda, Surat, Junagarh show higher density against the state average at 210 (1991) whereas other coastal districts of Bhavnagar, Valsad, Jamnagar, Amreli and Katchh show lower density. In fact Katchh district has a density which is as low as 27 persons per sq.km. and is the lowest in the state. The coastal zone of Gujrat also shows settlement structure which is highly varied from high concentration to a very few urban areas.[7]

In the state of Karnatka the coastal belt comprises of Karwar (Uttar Kannada) and Manglore (Dakhin Kannada). Out of the two districts, Manglore district is highly populated one with density of 319 persons as against the state average of 234 persons per sq.km., whereas the karwar district has a density of 118 persons only which is lowest in the state.

Manglore being the port city seems to be the reason behind this differential. However, both the districts have shown slower growth rate during 1981-91 census period when compared to the state average.[8]

In the state of Goa, North goa district has higher density of population (387) when compared to the South Goa district which is of the order of 257 persons as against the state average of 316 persons per sq.km. North Goa which has a larger share of state population (56.8 per cent) as against that of South Goa (43.2 per cent) out of a total population of 11,68,622 (1991).[9] However, Goa is very small state with population which is merely 9.3 per cent of total population of Bombay city.

Further, North Goa has shown a higher growth rate (16.86 per cent) as compared to South Goa (14.81 per cent), which is much lower than all India average of 23.56 per cent. On the urbanisation front the state has shown remarkable progress and level of urbanisation has jumped from 14.80 per cent (1961) to 40.02 per cent in 1991.[10] Number of towns have also increased much more rapidly in North Goa where their number increased from 6 to 18 whereas in South goa the increase was only from 7 to 13. With Panaji fast emerging as a city of future, North Goa is likely to record high pressure of population in years to come.

The state of Kerala due to its limited area and width form part of the coastal zone.It has the highest literacy rate in the country. It has lot of population pressure with density of 766 persons as against national average of 267 persons. The level of urbanisation (26.44 per cent) is marginally higher than Indian avearage of 25.72 per cent.[11] The distribution of population is not uniform all over the state. Mallapuram, is the most populated district whereas Wayanad is the least populated. only 9 districts have higher density when compared to state average of 747 persons whereas five districts have lower density.

Kerala has recorded a slower growth rate of only 13.98 per cent as against all India growth of 23.56 per cent. Mallapuram district has recorded a high growth rate of 28.74 as against 5.45 per cent recorded by Pathanamthita district. In general, southern districts have shown distinct decline in growth rate when compared with northern districts. Out of 109 urban centres in 1991, class I cities numbers 14 which house a total population of 66.34 per cent, i.e. two-third urban population of the state whereas rest of 95 towns cator to merely 33.66 per cent of population. Class-I cities have shown much higher growth rate during 1981-91. Incidently, there is not class VI town in the state[12]

As though the settlements are unevenly distributed over the Eastern coastal zone of India, the population concentration is more in the coastal districts. In case of West Bengal, the density of population in coastal districts of Midnapur (593) and Twenty four Parganna district (573) persons per sq.km. are less than the state average of 766 persons per sq.km. The 24 parganna district has recorded a growth rate of 30.08 per cent as against the state average of 24.55 per cent in 1981-91. The level of urbanisation in the coastal districts of south 24 pargana (12.49 per cent) and Midnapur (10.10 per cent) are much less against the state avearage of 27.39 per cent in 1991. However, the decadal growth rate of urbanisation was substantial in the coasal districts, i.e. 35.44 per cent and 45.82 per cent respectively in 1981-91.[13] This differential seems to be due to the absence of significant industrialisation. The coastal zone has only 30 towns out of total 150 towns/urban agglomeration in the state, most of them being administrative units.

The concentration of population and settlements in the coastal zone of Orissa show a remarkable differential pattern. The coastal districts of Balaeshwar (443), cuttack (494), Puri (351) have high density of population against the state avearge of 202 persons per sq.km. Baleshwar (24.13 per cent) and Puri (22.22 per cent) districts have experienced higher population growth rate as compared to the state average of 19.50 per cent in 1981-91.[14] However, Ganjam district has the density of 251 persons per sq.km. only and lowest growth rate of 17.72 per cent among coastal districts of Orissa.

The level of urbanisation is extremely low in the coastal districts as against even state (13.43 per cent) and the country (25.76 per cent). Baleshwar is the least urbanised (9.46 per cent) among coastal districts. Only Puri district is having 19.76 per cent urban population and has experienced highest urban growth rate of 63.30 per cent as against the state average of 36.08 per cent in 1981-91.[15]

In the state of Andhra Pradesh, coastal districts are more densely populated than the inland districts. The high density is found in West Godavari (455), East Godavari (420), Krishna (423), Srikakulam (397) and the lowest in Prakasham (156) and Nellore (183) persons per sq.km. as against the state average of 241.[16]

In the Andhra coastal zone urban concentration is high around Vishakhapatnam city, and in fact, a zone of urban concentration is formed from Rajahmudry and Kakinada to Vishakhapatnam with 21 to 39 per cent urban to total population in the entire area. This zone spreads out in the rich Godavari delta with several towns along the GNT road. Vishakhapatnam has 39.76 per cent of urban to total population and this district had the urban growth rate of 61.70 per cent compared to state avearage of 42.64 per cent in 1981-91.[17]

The growth of population in the coastal districts varies beween 17 to 22.73 per cent except Vishakhapatnam

27.22 per cent as against the state average of 23.91 per cent in 1981-91. The coastal districts have exhibited only reasonable growth rate in total population. The Prakasham and Nellore districts are basically plateau area along the coastline thereby not attracting much population cncentration.

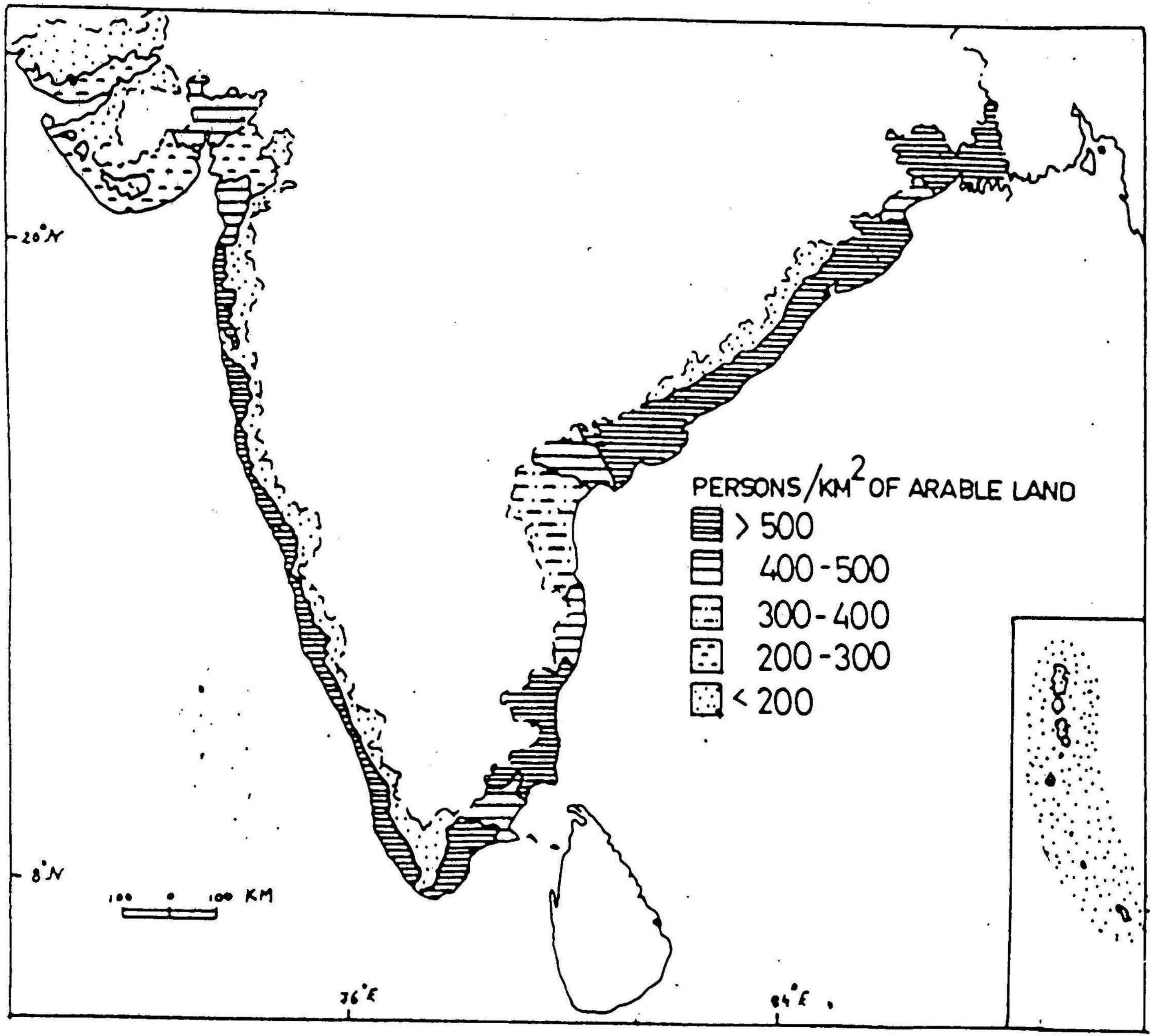
In Tamilnadu coastal belt, high density is found in the lower Palar Valley including the region around Madras covering Chengai Anna district (588 persons per sq.km.), the lower Ponnaiyar and Vellar basins comprising the coastal tracts of South Arcto (447) and Pondicherry (1640), the lower Kaveri basin in the district of Thanjavur (547), and Tambrapani (366). The Kanyakumari district has the highest density of 945 persons per sq.km. in the coastal districts as against the state average of 428 in 1991.[18] The dry tract of Puddukottai, Ramanathspuram has only 284 and 268 persons per sq.km. respectively. The high rural density is found in the delta area manly because of fertile alluvial soils and irrigational facilities.

The coastal tract of Tamilnadu i the most urbanised region. A network of roads and railway lines and rapid economic development in recent years have favoured the growth of urban centres. Madras district forms the metropolitan area. The Chengai Anna, (44.83 per cent), Chidambarrar (41.39 per cent) and Tirunvelli (31.72 per cent) of urban population are higher than the state average of 34.20 per cent in 1991. Thanjavur district with 22.94 per cent of urban population comprises 27 towns, the largest number among the coastal districts. However, the Changai Anna is the only district which has the urban growth rate of 47.15 per cent as compared to the state average of 19.28 per cent in 1981-1991; rest quite below the state average.[19] The growth of total population in the coastal districts is quite low compared to the state average of 14.94 per cent in 1981-91 except the Chengai Anna (27.97 per cent).

The East Coast Settlement is dominantly rural in outlook as 80 per cent of the people live in the villages. In West Bengal, Orissa, Andhra Pradesh, Tamilnadu coastal plains the settlement pattern is generally linear changing to the roads and river levels, avoiding flood prone areas. In the shore areas settlements have developed in between the coastal sand ridges which run almost parrellel to the coastline. They are located in the trough zones for shelter against the high velocity of the cyclones. The settlements in Tamilnadu are generally nucleated and compact located near sources of water supply. In Krishna-Godavari delta, there is a tendency to form small nucleations along canals too.

From above it can be observed that there are large population density and settlement distribution variations not only among the different maritime states but also within the states. The above analysis highlights the necessity of

COASTAL DISTRICTS
PRESSURE ON LAND



carefully planned interventions to guide the development of settlement pattern in coastal areas so as to realise the inherent potential for a better quality of life for the people without letting the existing problems exacerbate.

The planning of coastal settlements would have to be considered in the context of their locations, problems such settlements face, inherent potential they have and level of infrastructures and services required to optimise their growth. The coastal zone of each state have by and large peculiar problems and accordingly they would require different planning and management strategies. The coastal belt of each state or combination of states where they reporesent similar problems could be considered as one unit first for regional planning.

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MAN-ENVIRONMENT INTERACTION

After a close perusal of the natural setting and human settlement scenario of the Indian coastal zone, it becomes now imperative to trace out the ways in which man has made use of these resources and conversely how the utilisation of these resources have affected man.

The limitation of the earth surface for living space appears to constitute a limiting factor as regards the size of population. This is not, however, equivalent to the Malthusian doctrine of scarcity as it was conceived a century and half ago. Man may eventually undertake to limit his numbers, not by the operation of positive Malthusian checks, but voluntarily. The space limitation is likely to reach a critical level in over crowded urban areas, despite the abundance of unoccupied land, and the technological possibilities of utilising space.

From the resource utilisation point also stems up a host of other problmes; either resulting through the under-utilisation of resources or through the over and unwise resource utilisation resulting in the spill over effects of wastes usually produced in the urban areas, resulting in air, water and land pollution. Thus, the man-environment interaction is basically faced with two sets of environmental problems :

GENERAL INFORMATION REGARDING COASTAL ZONE OF INDIA

1.	Area covered by Oceans	:	$361x16^6Km^2$, 71% of the Earth Surface.
2.	Area of India Ocean	:	73,556,000 Sq. Km. (Including Red Sea and Persian Gulf).
3.	Width of Indian Ocean	:	10,000 Kms.
4.	Volume of Indian Ocean	:	292,131,000 Km^3.
5.	Indian Coastline Length	:	7,000 Kms.
6.	EEZ area of India	:	2,020,000 Sq.Km.
7.	Coasal Population (25% of the total)	:	188 million
8.	Average Surface temperature	:	25^oC
9.	Average Surface water salinity	:	$35^o/oo$
10.	Estimated Reserves of Shell deposits in Indian Ocean		
	a) in Vembanand	:	1.7 - $2.6x10^6$ tons
	b) in Kdarundi	:	4.5 x 10^6 tons
	c) in Pulle & Thatpalli Rivers	:	1 x 10^6 tons
11.	Area covered by pollymetalic Nodules in Indian Ocean	:	10-15 x 10^6 Km^2
12.	Estimated polymetalic Noduesl resource	:	1.5 x 10^{11} tons
13.	Area covered by Ilmenite bearing sand off the Indian shore	:	90 Km^2
14.	Projected Fish sequenced by 2000 AD for Indian Populaiton.	:	11.14 million tons
15.	Total Annual fish catch at present in India	:	3.1 millions tons
16.	Total Marine Fish catch at present in India	:	1.75 million tons
17.	Total Marine Algal yield in India.	:	1720 tons/year.
18.	India's food harvest	:	1.6 million tons/year
19.	Area of Sedimentary basins of Continental shalf	:	0.4 million sq.km.
20.	Area of sedimantery basins of Continental slope	:	0.4 million sq.km.
21.	Hydrocarbon potential	:	3306 million tons.

22.	Recoverable amount of hydrocarbons	:	800 million tons
23.	Production of offshore crude oil	:	20.6 million tons (9.9 m tones onshore)
24.	Estimated Mineral deposits	:	163 million tons
25.	Production of Mineral deposits	:	0.189 million tons
26.	Total Biogeneous deposits	:	7.8 meters
27.	Amount of Calcareous sands in Lagoons	:	711×10^{6} tonnes
28.	River Runn off (annual mean)	:	1645 Km^{3}
29.	Rainfall per year (entering the Bay of Bengal)	:	$6.5 \times 10^{12} m^{3}$
30.	Rainfall per year (entering the Arabian Sea)	:	$6.1 \times 10^{12}\ m^{3}$
31.	Domestic Sewage added to the sea by Coastal industries Yr^{-1}	:	$4.1 \times 10^{9}\ m^{3}$
32.	Industrial wastes added to the sea by Coastal industries Yr^{-1}	:	$0.41 \times 10^{9}\ m^{3}$
33.	Sewage and effluents added by the rivers to the sea Yr^{-1}	:	$50 \times 10^{6}\ m^{3}$
34.	Solid waste and garbage generated by coastal populaiton Yr^{-1} (at 0.5 kg per head day^{-1})	:	$34 \times 10^{9}\ m^{3}$
35.	Fertilisers used per year (at 30.5 kg ha^{-1} Yr^{-1})	:	5×10^{6} tones
36.	Pesticides used per year (at 336 g $ha^{-1} Yr^{-1}$)	:	55000 tones
37.	Synthetic detergents use Yr^{-1}	:	125,000 tones
38.	Oil transported from Gulf countries Across the Arabian Sea and Bay of Bengal (1985)	:	447 million tons
39.	Tar deposition on beaches along the west coast of India Yr^{-1}	:	750-1000 tones
40.	Oil transported to west	:	215 million tons

42.	Dissolved/dispersed petroleum hydrocarbons in the upper 20 m of the Northern Indian Ocean	0.7 - 31.0
	Concentration range (Mg/Kg.) in Bay of Bengal	5.2 - 29.5
43.	Reserves of Natural gas in	351.91 billion m^3
	India off Shore (Bombay high)	5.2 - 29.5
44.	Production of Natural gas in	11.47 billion M
	India Off Shore	4.12 billion M
45.	*Heavy Mineral Placesr on India's (Onshore) Reserves	
	Ilemenite	1380,00000 tones
	Rguntile	70,00000 tones
	Zircon	220,0000 tones
	Monazite	40,8000 tones
	Garnet	9000 tones
	Heavy Mineral Placesr onshore Production	
	Ilemenite	165000 tones
	Rguntile	12000 tones
	Zircon	10000 tones
	Monazite	2800 tones
	Garnet	6000 tones
46.	Mangroves along the Indian Coast (Total)	681976 hectares
	East Coast	565152 hectares
	West Coast	116824 hectares
47.	Potential Brakish water area for Mariculture in India	1528,000 hectares.
	Area under prawn culture presently	43,370 hectares.
48.	Exports of Frozen prawns from Major Indian Ports	Rs. 3799789,000
49.	No. of fishing villages in Indian coastal zone (1980 census)	2408
50.	Fishermen population (1980)	20,96,314
51.	No.of Fishermen Households(1980)	367398
52.	No. of landing Centres (1980)	1414.
53.	No. of fishermen engaged in Actual fishing (1980)	474731

54.	No. of Mechanised fishing crafts (1980)	:	18,790
55.	No. of non-mechanised fishing crafts (1980)	:	140,833
56.	Annual fuel (Diesel) consumptions in Marine fishing operations in India (1986)	:	200,236,000 liters

*Champ, M.A. et.al. (1984-85), "Non-living EEZ Resources : Minerals, Oil and Gas", Oceanus, 27(4), p.30.

a) the problem of a fast growing population which creates a greater pressure on land and secondly b) the problem of a growing science and technology and its application on the natural resources-exploitation.

The coastal regions of India (apart from the urban centres and ports), have essentially an agrarian base. Hence, man-environment interaction is, therefore, seen in the form of mainly how man has utilised the existing natural resources and how he has created his own resources and cultural landscape to supplement his development process. In fact, the coastal zone of India, portray those areas where although the natural and economic resources have not yet been fully exploited they are gradually marching towards the goal of development, with the increasing help of science and technology.

The main heads of discussion (of how man has utilised the existing resources to modify the environment) here are land utilisation, economic activities of man (expressed in the form of agriculture, irrigation, forestry, fishing, mining, power and industries, tourism) settlement types and infrastructural facilities created by man for a better use of exiting resources.

THE GUJRAT COASAL ZONE

The Gujrat coast covering a large part of the west coast and comprising eleven districts is a region where the environment has made a clear impact on man and his activities. The land utilisation pattern expresses how the environmental factor has resulted in varied use of land in the different coastal district of the coastal zone.

Landuse : The landuse table reflects considerable inter-district variations. About 1043700 hectares of the total area of the coastal districts are forested tracts comprising 8.72 per cent of the total coastal area. Among the districts, Valsad has the largest forested tract (24.27 per cent) of the total area of the district, followed by Junagarh (18.75 per cent), Bharuch (18.63 per cent) and Surat (18.25 per cent) respectively. The lowest proportion of the forested tracts exists in Ahmedabad (1.34 per cent) and Kheda (1.45 per cent). A large portion of the coast is barren and uncultivable (22,295,00 ha), forming 18.63 per cent of the total coastal area. The highest proportion of this is found in Kutchh district where 38.36 per cent is barren and uncultivable forming the Great Rann of Kutch. By contrast only 2.23 per cent of Valsad is barren.

GUJRAT

LAND USE PATTERN 1983-84 IN '00' HECTARES

	Reported area for land	Forest	Bareau & un-cultiv-able	Land put to non-agricul-ture use	Cultur-able waste	Permanent pasture & Grazing	Land under tree crop	Current fallows	Other fallows	Net area soun	Gro cra are
Gujrat	188250	18923	26285	10811	19782	8472	41	7203	752	96165	11097
Jamnagar	10167	350	1301	636	505	774	-	591	50	5960	726
Bhavnagar	9789	310	1016	718	372	704	-	429	45	6195	777
Amreli	6720	402	173	390	96	449	-	311	19	4880	566
Junagarh	10560	1980	314	507	128	1132	-	485	-	6014	749
Katchha	45652	3060	17512	700	16005	70	-	435	113	7127	749
Gandhinagar	653	-	3	97	11	34	-	28	-	480	57
Ahmedabad	8523	115	723	627	238	334	-	523	66	5897	616
Kheda	6891	100	311	854	24	274	-	70	4	5254	636
Bharuch	7803	1454	217	987	450	244	-	231	-	4220	423
Surat	7762	1417	610	828	228	242	-	375	-	4021	427
Valsad	5145	1249	115	366	241	78	41	145	-	2951	325
Total	**119665**	**10437**	**22295**	**6710**	**19298**	**4335**				**52999**	**6056**

About 67,10,00 ha is under non-agricultural uses, comprising 5.61 per cent of the total coastal area. The highest proportion under this category exists in Bharuch (12.64 per cent), followed by Kheda (12.39 per cent) and Surat (10.67 per cent). The lowest share is found in Kutch (1.53 per cent) in 1983-84 assessment year.

Again a large proportion of land of the coastal districts are cultureable or cultivable wastes (1829800 ha) comprising 15.29 per cent of the coastal area. The largest share exists in the Katchh (35.06 per cent) exhibiting the low level of development in this region. By contrast Kheda has only 0.38 per cent of her land classed as cultivable wastes.

About 433500 ha of land comprising 3.62 per cent of the total coastal area are under permanent pastures and grazing, the Junagarh district has the highest share (10.72 per cent). About 5399900 ha of the total coastal area are net sown area comprising 44.29 per cent of the total coastal area. The coastal zone is about 63.56 per cent of the total reported area for land in Gujrat. The 76.24 per cent of the Kheda district has net sown area to total area, followed by Bhawnagar (63.28 per cent) Ahmedabad (69.19 per cent), Bharuch (54.08 per cent) and Amreli (72.62 per cent). Kutchh has the lowest proportion (15.61 per cent) under net sown area in the coastal zone. The gross cropped area is again highest in Kheda (92.29 per cent).

Agriculture : In spite of large areas of barren land, cultivable wastes, agricultural activities are quite prominent in coastal Gujrat. Unlike other coastal tracts, rice is not as prominent a crop hence as are millets (Jowar and Bajri) and wheat among the foodgrains. Some amount of pulses, potatoes and chillies are also grown. Ground nut cultivation is quite important. Sugarcane is grown nearly in every coastal districts. Cotton cultivation is quite important and cotton occupies 8.66 per cent of the net sown area of the coastal districts. Ahmedabad district has the largest share (29.89 per cent) in cotton acrage of total cotton acrage in the coastal zone. The coastal zone occupies 33.20 per cent of area of the total acreage in the state.

Kheda district has 131900 ha under rice cultivation and produces about 260800 tonnes, followed by Valsad 90100 hactare and 181000 tonnes in 1984-85. Bhavnagar has 142700 hactare under Bajri cultivation and produced 199600 tonnes in 1984-85. Junagarh district has the highest area (441500 ha) under Ground nut cultivation and produced 521700 tonnes in 1984-85 among all the coastal districts.

Irrigation : The main sources of irrigation are government canals, tanks and potable ground water. There exists schemes for artisan wells in many places. The Mahi right bank canal distributes water in Kheda district and is responsible for the general fertility of the area. The highest share of canal irrigation exists in Kheda and Surat districts. The net irrigated area of the whole coastal zone is 1202900 ha of which kheda has the largest share of 19.06 per cent.

The coastal area from Khambhat to Valsad in south Gujrat is in alluvial tract of the hydrological region. The ground water occurs both under confined and unconfined conditions. These formations yield large quantities of ground water from wells and tube wells. The discharge from tube wells varies between 36 and 80 cubic meters per hour. The water level in alluvial deposits varies between 5 and 35 metres below ground level. The thickness of alluvial deposits goes upto 300 metres. The quality of ground water varies between TDs 500 and 2000 PPM.

Wild Life : Gujrat holds a unique bioclimatic position in the country. It possess several bio-climatic gradation, from dry thorny ecosystem to humid sub-evergreen and dry hill scrub lands to coastal swampy forests. The coastal region is the main domains of aquatic fauna and marine wild life which is a natural resource of profound economic and socio-cultural value. Wild animals and birds play an important role in preserving the balance of the nature.

The wild life resources of the Gujrat coast is fully harvested. The coastal region consists of Marine. National Park along the coast from Okha to Jamnagar, having 110 sq. km. area. The marine sanctuary and national park in Gulf of Kutchh having area of 217 sq.km. is also very important. These sanctiuaries and parks are centres of attractions for tourists and nature lovers.

GUJRAT

AREA UNDER FORESTS BY DIVISIONS/CIRCLE (AS ON 31 MARCH 1986) in Sq. Km.

Divisions/ Circles	Reserved	Protected	Unclassed	Total
JUNAGARH CIRCLE				
Jamnagar	423	1	280	704
Bhavnagar	200	-	182	382
Junagarh	451	-	25	476
Surat Circle				
Vijara	674	2	309	985
Rajpipla	1709	-	217	1926
GANDHINAGAR CIRCLE				
Gandhinagar	45	-	35	80
Katchha Circle	1667	-	1218	2885
Valsad	1163	19	7	1189
Marine National Park Jamnagar	11	-	530	541
Gujrat	13493	1021	4804	19318

Source : Statistical Abstract of Gujrat State 1985 and 1986 Directorate Economic and Statistics, Gandhinagar, Gujrat, 1988.

Dairy and Poultry : Animal husbandry and poultry farming comprise an important activity of the Gujrat coast. It is especially important in the semi-arid Kutch and Kuthiawar. Apart from cattle and buffallows, sheeps, goats camels etc. are also reared to make for the precarious agriculture. A large number of cattle (3958024) and buffalows (2419685) are reared for milk. The yield of milk is quite high, particularly where there is less summer heat. Modern dairy industries are located in many of the coastal villages. Valsad has the highest proportion of poultry population.

Fisheries : The areas available for fishing extends from Lakhpat in Kutchh district to Umargaon in south. The important commercial varieties of fish namely pomfrets, hilsa, shark, catfish, mullets etc. are found in large quantity. It has 216 marine landing and 71 estuarine landing centres. Out of the total 3.07 lakh fishermen, 1.5 lakh are active fishermen engaged in fishing, marketing of fish, repairing of boats/nets etc. As on 30th September, 1991 there were 17300 fishing boats registered and out of these 8523 boats were mechanised boats.

Against the target of 5.55 lakh tonnes of fish production in Gujrat for the year 1991-92, the production of 1.59 lakh tonnes has been achieved till September 1991. The marine fish production is of the order of 92 per cent of total. During the year 1990-91, foreign export of fish was reported to be about 22155 tonnes worth Rs. 7525.17 lakhs.

Large ship breaking yards have been developed at alang near Bhavnagar and at Sachna near Jamnagar. These yards ar first of its kind in west coast. The ship breaking activities has generated large scale employment in various fields including metal scrap, timber plywood, rare metals, electrical goods, turbines etc. A boat building yard has been set up at Mangrol by Gujrat Fisheries Development Corporation in order to provide quantity boats to fishermen at reasonable prices.

GUJRAT

MARINE FISHERIES IN GUJRAT COAST

No. of fishing boats	12876
Mechanised boats	4858
No. of active fishermen	80,000
Fish production	331000 tonnes
No. of fishing villages	590
Landing Places	599

Source : Statistical Abstract of Gujrat State 1985 and 1986 Gujarat, 1988.

Mining : The Gujrat coast is an important limestone producing area and had produced a total of 4412295 tonnes in 1985. Most of the quarries are located in Jamnagar, Junagarh, Amreli, Kheda, Bhavnagar and few in Kutch and Bharuch. High grade bauxites (446866 tones in 1985) are available in Jamnagar, Junagarh,Kutch and Kheda districts.

Fossil fuels also occur in the form of petroleum and natural gas and the Gujrat coast is famous producing area. Production occurs in Cambay, Ankleshwar and in some places in Vadodra. The production capacity of Ankleshwar is 8340 tonnes per annum. In the Cambay basin oil is produced at Kalol, Nawgaon and Sanand. The total oil production of the Gujrat coast is 40 lakh tonnes per year (1985).

GUJRAT

MAJOR MINERALS PRODUCTION (1985) in tonnes

Minerals	Jamnagar	Bhavnagar	Amreli	Junagarh	Gandhinagar	Ahmedabad	Kheda	Bharuch	Surat	Valsad	Kat
Agate Stone	-	-	-	-	-	-	-	-	-	-	
Bauxite	391342	-	-	13855	-	-	10580	-	-	-	310
Calcite	21	200	-	86	-	-	-	115	-	-	
Calcareous & Sea Sand	708641	-	-	-	-	-	-	-	-	-	
China Clay	-	-	160	-	-	-	-	-	-	-	102
Dolomite	-	890	-	-	-	-	-	760	-	-	
Gypsum	-	-	-	-	-	-	-	-	-	-	11
Limestone	818473	35233	982106	2302671	-	-	268860	1830	-	-	31
Plastic clay	-	-	-	-	-	-	-	-	1708	11820	
Silica & Glass Sand	-	-	-	-	-	-	-	28154	500	-	541
Chalk	-	800	-	119567	-	-	-	-	-	-	
Clay	-	86	29532	-	-	-	-	21775	-	-	196
Lignite	-	-	-	-	-	-	-	1410991	-	-	7260
Sand (common)	85929	21584	41914	17215	504262	311038	102994	1049771	343164	241584	472

Source: Statistical Abstract of Gujrat State 1985 and 1986 Directorate Economic and Statistics, Gandhinagar, Gujrat,

Industries : The industrial development along coastal region contains important industries as well as major GIDC estates. The list of industries incorporates cement industries, sea food industries, chemical industries, textile, fertilisers, diamond cutting and other export oriented industries. Power is obtained from natural gas, electricity being generated at Dhuvran (near Cambay) and Utaran (near Surat).

Saurashtra Chemical Ltd. at Porbandar and Tata Chemicals at Mithapur manufacture refined soda (650 MT/day) and compressed soda ash (150 MT/day) each. Indian rayon industry is located at Verabal. It manufactures rayon fibre and generates about 3200 m^3/day of wastewater.

The South Gujrat coastal stretch from Khambat to Maharastra border is a region of intensive industriali-sation and has some of the largest petrochemical complexes, refineries, fertiliser plants, thermal power plants and chemical works. This stretch also includes some of the biggest industrial estates in Asia such as GIDC estates at Ankleshwar and Vapi. With the discovery of gas and oil on the continental shelf and in the Gulf of Khambat, added impetus has been provided to locate several large scale industrial undertakings on the coast.

Cement manufacturing is located at Dwarka, Porbandar, Salaya, Sikka based on locally available limestones. This is a cement cirplus region producting 12.8 per cent of the total output of the country. Jafrabad cement plant is close to sea shore.

GUJRAT

DISTRICT WISE DISTRIBUTION OF WORKING FACTORIES (1985) AND TRANSPORT DEVELOPMENT IN 1985-86

Districts	No. of Working fact.	No. of SSI reg.	Broad gauge (km)	Meter gauge (km)	Narrow gauge (km)	Mettled road (km)	Non-Mettled (km)
Gujrat	13067	5830	1429	3174	1097		
Yamnagar	447	136	46	341	-	2323	375
Bhavnagar	469	188	-	279	108	2948	631
Amreli	40	82	-	318	-	2208	553
Junagarh	294	127	-	348	-	3103	248
Katchha	170	107	67	191	-	3570	707
Gandhinagar	86	60	28	52	-	403	45
Ahmedabad	4212	1906	153	259	-	3174	349
Bharuch	427	322	49	-	208	2866	397
Surat	1395	700	148	-	69	3308	425
Valsad	1186	456	110	-	53	3149	301
Kheda	662	250	213	-	104	3842	181

Source : Statistical Abstract of Gujrat State 1985 and 1986 Directorate Economic and Statistics, Gandhinagar, Gujrat, 1988.

All along the coastline, there are thousands of salt pans, where salt is produced by drying sea water in the ponds. Salt pan activities are located at Jakhu, Mundra, Tuna port, Gogha, Bhavnagar etc. developed by large and small sectors. The entire area in between Gandhidham and Navlakhi port, called as little Rann of Kutchh is intensively involved in salt pan activity.

Ports : Kandla port is a major commercial port with frieighter and tanker traffic through the Gulf of Kutchh. The port is used for export of iron ore, zinck ore, bones, cotton, salt and general merchandise and import of food grains, steel, fertilisers, petroleum and oil. The length of the Kandla port channel is elevan kilometres. Close to Kandla port, there is free trade zone in which several industrial units meant for export of their products are located.

The Porbandar harbour handles salt, cement, bauxite, stone chips etc. and occasionally grain and sugar. Verabal harbour at Saurashtra coast is a small commercial port mainly involved in the export of ground-nut cakes, cotton, limestone etc., and imports of dates, tea etc. The area also has a large commercial fishery activity. Along is engaged in intensive ship breaking activity with 61 ship breaking yards. There are commercial ports at Bhavnagar involved in mainly handling of salt, urea and scrap paper.

Dahez port in south Gujrat coast handles fertilisers and oil. The area also has salt pan and ONGC drilling activity. It is an old active port but the use has got minimised due to high silting. The port of Magdella (Surat) has ship building activities.

These ports handle a traffic of about 7 million tonnes per annum. During 1990-91, they handled a traffic of 75.54 lakh tonnes.

Infrastructure : So far as communication is concerned, a coastal highway starting from Lakhpat via Verabal-Somnath to Khambat act as a lateral spine for the coastal region. In south Gujrat, there is no coastal highway but National Highway leading to Bombay is very near to coast line below

Ankleshwar upto Umargaon. A road network of major/minor districts roads can subserve the coastal region. Thus even though only 42 per cent of these settlements are connected by roads, apparently there does not seem any problem of road communication. However, in future road network might be inadequate at certain points like Jaffrabad Hazira where new activities are likely to be started.

Major urban centres of coastal region are well connected by railway line. Kandla is having both meter gauge and broad gauge railway line, providing important links with entire North Western India. An important fact to be mentioned here would be the new hover craft service between Surat and Bhavnagar which is first of its kind in India. With this service, the need for strengthening roads and rail linkages inland is imperative.

Settlements : There are about 10515 inhabited villages and there were 58 most important urban centres. The common feature of the rural settlement is that the whole population reside in large settlements in a compact form. The urban centres are Jamnagar, Bhawnagar, Porbandar, Okha, Bharuch, Surat, Kandla etc. Many cultural and pilgrimage centres such as Somnath, Dwarka etc. are located in the coastal zone.

As par 1991 census, total number of employed persons were 30.24 lakhs, out of which 11.50 lakhs were engaged in primary sector whereas 18.74 lakhs were engaged in secondary and tertiary sector. Thus 62 per cent population is engaged in secondary and tertiary sector. Thus dependency on the agricultural is very less and hence emphasizes the role of secondary and tertiary sector in the region.

Tourism : The coastal zone has five beautiful beach resorts at Mandvi in Kutchh, Chorwad near Verabal, Ahmadpur Mandvi near Diu, Ubharat and Tithal in south Gujrat. All these beach resorts are well developed by Tourism Corporation of Gujrat. The coastal region also has well known pilgrimage centres like Narayan Sarovar in Kutchh, Krishna temple at Dwarka, Jyotirling temple at Somnath and Kirti mandir at Porbandar. The well-known Lion sanctuary at Sasangir, though not falling in the coastal zone, is very near by to provide good tourist support to the coastal region. The marine park and sancturary in Gulf of Kutchh and Gir forest are other tourist attraction. Thus tourist oriented activity is becoming important and development potential is very high.

Hazira has immense potential for development. Hazira is now centre of petro-chemical complexas, natural gas supply pipelines and gas based fertiliser industries. So Hazira beach resorts is getting prominence and preference by planners. The risk of pollution is very high. Ubharat is quite and charming beach in south Gujrat near Surat.

GUJRAT

DISTRICT-WISE TOURIST CENTRES AND MEMBER OF TOURISTS (1985-86)

Districts	Tourist centres	No. of tourists
Gujrat	19	129508
Jamnagar	Dwarka	6368
Bhavnagar	Politana	5089
Amreli	-	-
Junagarh	Chorwad	5256
	Tulsichyan	252
	Porbandar	9123
	Sasan	-
	Ahmedpur Mandavi	105
Katchha	-	-
Gandhinagar	-	-
Ahmedabad	Ahmeda city	-
	Lothal	183
	Ashram Attuthi Grih	3708
	Nal Sarovai	-
Khada	-	-
Bharuch	Shukal Trith	543
Surat	Hazira	5133
	Ubharat	25225
Valsad	Tithal	6554

Source : Statistical Abstract of Gujrat State 1985 and 1986 Directorate Economic and Statistics, Gandhinagar, Gujrat, 1988.

MAHARASTRA COASTAL ZONE

The Maharastra coastal zone, though offer good scope for development, is somehow still virgin except Bombay and its surroundings. Recently Bombay area has faced abuse of resource development in the wake of increasing population pressure and industrialisation. Therefore, the resource development has to be thoughtfully done and the sight on posterity should not be lost.

Land Use : Land use is influenced by physical and biological factors; besides socio-economic conditions, the ownership of land and the level of technology. In the Maharastra coast, as the fortile soil is largely limited to the river valleys, only a small area is under cultivation. Only 26.78 per cent of the total coastal districts is net sown area with crops, 19.18 per cent under forest, 19.20 per cent barren and uncultivable, 13.45 per cent cultivable waste, and land put to non-agriculture use is 5.40 per cent of the total area of the coastal districts (29790,00 hec). Of the five districts, the area under forests is largest in Thane (39.43 per cent), whereas the net sown area is largest in Ratnagiri (28.78), followed by Thane (28.66 per cent), Raigarh (26.74 per cent), Sindhudurg (20.94 per cent) and G. Bombay (16.31 per cent) only. In all, the land is limited for agriculture activities.

Agriculture : Agriculture in Maharastra coastal zone is one which is more traditional and dependent on rainfall. Predominant crop being paddy, monsoon is the only season when occupancy of land appears to be maximum. While in all other seasons, the land use is limited to fruit crops and/or fallows. Of the net cropped are, 55.47 per cent is under rice, 11.66 per cent Ragi, 5.27 per cent pulses, 4.76 per cent fruits and vegetable and fodder crops 26.35 per cent.

MAHARASTRA

LAND UTILISATION (1986-87) IN HUNDRED HECTARES

Districts	Geog. Area	Area under forest	Land put to non-	Barren and unculti-vated	Permanent pasture & other grazing lands	Land under misc. tree crops and groves	Cultur-able waste	Current fall cros	Other fallows	Net area soun	Area soun more than once	Gross Cropped area
Maharastra	307583	53697	10827	17254	15421	1825	10319	9012	10000	179232	19968	199200
G. Bombay	380	15	211	73	6	-	7	-	6	62	-	62
Thane	9337	3682	607	816	870	50	408	110	109	2676	109	2785
Raigad	6869	1617	455	1281	399	243	379	249	409	1837	259	2090
Ratnagiri	8165	58	132	2366	130	69	1528	3102	1222	2350	253	2609
Sindhudurg	5039	343	204	996	1	119	1684	11	626	1055	NAS	1055
Total	29790	5715	1609	5532	1406		4006			7890		

Source : Statistical Abstract of Maharastra State 1986-87.
Directorate of Economics and Statistics, Bombay, Maharastra, 1991.

Rice is most important in Thane and Raigarh districts whereas Ratnagiri tops in Ragi in terms of area under production, outturn and yield respectively. There is a great demand for fodder by dairies supplying milk to Bombay. Ratnagiri with 38.63 per cent and Thane with 30.97 per cent area under fodder crops meet the demand of dairy industry.

The coast is fringed with coconut palms. Orchards of betal leaf, betal-nut and bananas are found in the valley plains and along the coast as well. Sugarcane is raised where irrigation is available. Ratnagiri also produces a variety of Mango called "Alphonso".

Irrigation : Irrigation in Maharastra coastal zone (Konkan) is not very developed. Many minor, medium and major projects have been initiated as well as planned during past two decades. But unless profound extension work is undertaken simultaneously, the potential created will remain underused. Raigarh (32.62 per cent) has the largest areas irrigated, followed by Thane (15.66 per cent) and Ratnagiri (14.35 per cent) and Sindhudurg is negligible. Raigad has 3.56 thousand hactares irrigated by major and medium projects, 3.97 thousand hactares by minor projects and 0.19 thousand hactares by lift irrigation in 1986-87.

Irrigation potential created at the end of June 1986 was highest in Raigad district (23.67 thousand hactares), followed by Thane 16.03 thousand and Ratnagiri 6.69 thousand hactares respectively. Raigad has the largest area

MAHARASTRA

IRRIGATION POTTENTIAL CREATED AND ACTUAL IRRIGATED AREA 1986-87

(in thousand hactaes)

Districts	Irrigation pottential created at the end of June 1986				Actual irrigation area in 1986-87				
	Major and Med. Projects	Minor Projects	Lift irrigation	Total	Major and Med. Projects	Minor Projects	Lift irrigation	Total	Percentage of irrigated area
Maharastra	1730.86	479.24	112.28	2332.40	669.10	124.83	10.76	804.69	34.50
G. Bombay	-	-	-	-	-	-	-	-	-
Thane	11.11	4.61	0.31	16.03	1.34	1.17	-	2.51	15.66
Raigad	14.39	7.03	2.25	23.67	3.56	3.97	0.19	7.72	32.62
Ratnagiri	1.53	5.16	NA	6.69	0.12	0.29	-	0.55	-
Sindhudurg	-	-	-	-	-	0.55	-	0.55	-

Source: Statistical Abstract of Maharastra State 1986-87.
Directorate of Economics and Statistics, Bombay, Maharastra, 1991.

under surface irrigation and area irrigated by wells followed by Thane and Ratnagiri.

Chemical Fertilisers Consumption : The new high yielding varieties of crops and fruits, with reasonably assumed irrigation, have now become popular amongst the farmers : hence, the need for fertilisers, pesticides, insecticides are common now, but quantity used is still low.

MAHARASTRA

CONSUMPTION OF CHEMICAL FERTILISERS 1986-87

(in '000' mt.)

Districts	**Nitrogenous**	**Phosphate**	**Pottasic**	**Total**
Maharastra	3979	1594	993	6566
G. Bombay	-	-	-	-
Thane	54	22	8	85
Raigad	69	8	5	82
Ratnagiri	21	9	6	35
Sindhudurg	22	8	7	37

Source : Statistical Abstract of Maharastra State 1986-87. Directorate of Economics and Statistics, Bombay, Maharastra, 1991.

Raigad districts tops (6900 million tonnes) in nitrogenous fertiliser consumption in 1986-87, followed by Thane (5400 million tonnes) Sindhudurg (2200 million tonnes) and Ratnagiri 92100 million tonnes) respectively. Phosphate and potash consumption are relatively low. Only about 50 per cent of the farmers, mostly well to do have adopted the high yielding varieties.

Forestry : There are several tracts of forest in the Konkan coast thus giving rise to forestry as an important occupation. The forest products include timber, fuel, bamboos, bidi leaves etc. Thane has the greatest proportion of forested area. She produced 37000 Cu.M. of timber, 18600 m^3 of fuel wood in 1981-82.

Animal Husbandry and Poultry Farming : Ratnagiri district has the greatest number of cattle and poultry. Thane has also a good number of cattle and animal husbandry is very marked in these two coastal districts of Maharastra coast.

Fishery : Fishing as an activity is a most marked feature of the Maharastra coast. Thane has 375 marine fishing villages and hamlets in this area with 15841 boats engaged in fishing activities. The total productin from marine fisheries is 332407 tonnes. Several ice factories and cold storage plants have been set up at Malvan on the Ratnagiri coast and elsewhere. At Bombay, a quick freezing plant has been installed at the Karmani market. Ice making plants have been erected all along the coast. Fish curing yards are located at Borvia, Jaigad, Mirkarwadan, Ratnagiri, Vijaydurg, Malvan, Kochhara, Tara Mumbai etc.

The importance of fishing in Konkan steps up from the fact that there are extensive harbours along the coastline which can provide excellent shelter to fishing boats. Coastal areas yield a variety of fish in large quantities. Bombay duck, Pomphret, Mullet, Mackerel, Indian Salmon etc.

are largely caught. Bombay is the largest producer of fish followed by Thane, Raigad, Ratnagiri and Sindhudurg districts.

MAHARASTRA

FISH CATCH AND LANDINGS IN TONNES 1986-87

Districts	Fresh Water Fish	Marine Fish	Total Catch
Maharastra	43295	332407	375802
G. Bombay	1000	128865	129865
Thane	1870	99738	101608
Raigad	1156	40238	41394
Ratnagiri	-	39397	39397
Sindhudurg	7	24169	24176

Source : Statistical Abstract of Maharastra State 1986-87. Directorate of Economics and Statistics, Bombay, Maharastra, 1991.

Mining : The mining activities of Maharastra coast is concentrated in Sindhudurg and Ratnagiri districts where iron ore (Raddimines) and silica sands are important minerals. Raigad district produces bauxite. Along the coast, however, salt is produced in many areas. At hightides, sea water is allowed to flow into the salt pans. Bhayander, Goregaon, Kharoli, and Wadala are some of the places near Bombay where a large quantity of salt is obtained from sea water.

Sindhudurg produced (144914 tonnes) of silica sand in 1986-87, followed by Ratnagiri 25906 tonnes. Raigad produced 13589 tonnes of bauxite in 1986-87.

Hydro-carbons : India's premier offshore oil field, Bombay High, contributes nearly 66 per cent and 73.5 per cent of domestic production of crude oil and natural gas. In Bombay high, There were 67 platform at the end of 1986 and these increased to 83 in 1988-89. Besides, there is network of offshore pipelines for transport of crude oil and gas. The production of crude oil and natural gas from Bombay high in 1988-89 were 21,112 million tonnes and 9731 million cubic meteres respectively. In the near future, there is likely to be more exploitation of gas resources and consequently the wider network of pipelines. This is due to ever increasing ratio of natural gas to crude oil resources and emphasis to bring down the level of floring of gas from Bombay high to zero.

Industrialisation : The coast of Northern Maharastra presents only one major industrial development at Tarapur, which, besides the existing atomic power plant, is fast becoming a major Maharastra Industrial Development corporation (MIDC) industrial complex. Chemical industries are encouraged to be located here and the waste water generated is proposed to be discharged directly into the Arabian sea through an eight kilometer long outfall. There are already about 400 industries in Tarapur industrial complex out of which twenty are major industries. The total effluent quantity discharged from this complex is about 10000-15000 m^3/day.

The Thane-Belapur industrial belt is an area of intense industrial activity with several small medium and large scale industries (mostly chemical and pharmaceutical). The MIDC industrial complex at Panvel and other ones such as Hindustan Insecticide Ltd., Maharastra Agro-industries Development Corporation, Bombay Dyeing, Reliance textiles, Hindustan Organic Chemicals Ltd. located at Panvel, Pan and Resayani areas also discharge their wastes into Patalganga river and estuary, leading the waste to sea.

This stretch is also housing Nhava Sheva port, ONGC operations at Nhava and Uran, Rashtriya Chemicals Fertilisers Plant at Thal and also a heavy water plant.

The southern Maharastra coast from Revadanda to Goa border is the least industrialised and perhaps the most scenic of the entire coastal belt of Maharastra.

Ports : Among the major ports in India, Bombay is the biggest. It is located on a low hilly island running southwards, called the Bombay island. It is a natural harbour of 112 sq.km. protected by the mainland on its east and island of Bombay on its west. The deep waters in the harbour provide ample shelter for shipping. Internationally, it is the nearest port to the Suez canal and that has helped in making it a premier port.

Being the oldest port in the country, it has built up a large number of facilities for the approaching ships, pilotage, ship-to-shore and shore-to-ship loading/unloading, berthing, storage and transport. The port has nearly 60 berths - 14 at prince's dock. The Jetty at Trombay can receive tankers of 15,000 dwt. Of the three modern oil terminal berths at Butcher Island two can receive tankers of 53000 dwt. The fourth berth receives tankers of 80000 dwt and would eventually of 125,000 dwt.

Bombay port handles, over one fifth of total traffic of the major ports located on the West coast, bulk of which consists dry cargo. In 1986-87, it handled 20.2 per cent of total traffic handled by all the major ports. In 1987-88, 21.4 per cent of 266.6 lakh tonnes of total traffic handled by all the major ports was handled by this port.

To relieve congestion at the Bombay port and handle increasing shipping traffic, Nhava Sheva port has been established. The two sleapy, small islands of Nhava and Sheva lie 11 km across Bombay's mountain rimmed harbour, facing the Elephanta caves. This satellite port has a 680 meter Wharf to handle containers and another 500 - metre wharf to serve bulk materials. The port has the capacity to accomodate ships upto 200,000 dwt. The port handled cargo of 7.23 million tonnes in 1987-88.

The other important ports are Ratnagiri, Vengurela, Bhagwati etc. in Ratnagiri, Raigad and Sindhudurg districts respectively. They are all minor ports. The old port of Ratnagiri is not in operatioin and only fishing is noticed in the area. The Bhagwati port, however, is an active port. the activities include mainly unloading of cement clinker.

Settlements : The rural settlements are different from the ordinary villages on the East coast and other parts of India, in the sense that they are not a tightly packed group of houses. Nearly every residence is surrounded by a bird of yard. The richer people have home surrounded by gardens of varying sizes, thickly planted with coconut palms, areca-nut and banana trees etc. In the coastal strip, the linear alignment of settlements along the creek or close to coast is prominent. Often the settlements are located on safe sites as those require protection from the sea and river floods.

The urbanisation in Maharastra coastal zone is still not well set for many reasons. Bombay metropolis is an outstanding industrial, commercial and port city of India. Bomaby has attracted migration from rural Konkan and thus has hampered the growth of other urban settlements. However, the measures taken by Maharastra Industrial Development Corporation (MIDC) and the induced transport, trade and commerce in the region have recently given some boost to few urban centres, such as Roha, Alibag, Mahad, Chiplun, Ratnagiri, Kudal, Sawantwadi etc.

Infrastructure : The only highway cutting across Konkan into two east-west halves, runs through the central strip of the rgion crossing all rivers, and thus, joins Bombay in the north and Goa in the south. The districts roads are more like link-roads. Rural road links are also being developed.

MAHARASTRA

ROAD LENGTH CLASSIFIED BY CATEGORY BY DISTRICT 1986-87

(in kms.)

Districts	Black top	Water Bound Macadam	Total	Road Length per 100 sq.km.	Road Length per lakh pop.
	PWD Pucca Roads				
Maharastra	31626	71936	103562	50	245
G. Bombat	49	-	49	8	1
Thane	1664	2999	4663	48	136
Raigad	1584	1319	2903	62	311
Ratnagiri	1321	1826	3147	53	320
Sindhudurg	925	1046	1971	44	294

Source : Statistical Abstract of Maharastra State 1986-87. Directorate of Economics and Statistics, Bombay, Maharastra, 1991.

MAHARASTRA

NUMBER OF MOTOR VEHICLES REGISTERED BY DISTRICTS (1986-87)

Districts	Buses	Cars Station Wagens	Jeep	Taxies	Three Wheelor	Two Wheelor	Total Passenger Vehicles	Four Wheelor	Three Wheeler	Total good Vehicles	Tractors	Tralers	Others	Gran Tota
Maharastra	22851	291343	52363	40592	87576	1093170	1587895	127505	33806	161311	44185	43792	4205	184138
G. Bombay	6714	210898	11471	34338	24577	186952	474950	34616	11072	45688	905	871	1911	52432
Thane	2189	10730	1894	438	9632	39024	63917	15324	2949	18273	5300	572	216	8350
Raigad	543	2928	517	114	1562	7977	13641	2896	1072	3968	215	159	86	1806
Ratnagiri	466	1952	345	44	1431	8139	12377	1703	632	2335	81	97	61	1495
Sindhudurg	301	653	115	11	393	2629	4102	610	227	837	22	18	28	500

Source: Statistical Abstract of Maharastra State 1986-87.
Directorate of Economics and Statistics, Bombay, Maharastra,1991.

Absence of adequate rail linkage have been one of the major cause of backwardness of the area. The on-going Konkan railway project would help usher in developmental forces in this region. Motor traffic is very high in Bombay and Thane.

Beach Tourism : The Maharastra coast has many small beaches. Morve is a lovely little fishings village, facilitated with tourist bunglows. It is located at only 40 km from Bombay. Gorai and Manori are also famous beaches near Morve and popular for parties. Marnd-Zanjira are popular for its alluring beach, an ancient forts and zanjira caves. Panvel is the nearest rail head and Bombay is only 165 km by road.

Vengurla-Malvan is a long stretch of white sands and hills covered with cashewnut, coconut and mango groves. Other famous beaches are Velneshwar and Ganapati Pule in southern Maharastra coast.

However, the coastal beaches could not be developed in Maharastra coast for tourist purpose on large scale. Bombay and Nhava Sheva ports as crowded bussiness centres and major ports can be the reason. Tourists need peaceful isolated and natural coasts. In Bombay, the famous beaches are Juhu, Versova, and Choupati.

Maharastra is very rich in ancient historical art, architecture and other monuments like Ajanta, Ellora and Elephanta etc. So beach tourism might not be top priority. But now the Government is targetting sea lovers also. Around 30 locations along the coast are being developed and as many as 18 hotels are slated to come up. So it is hoped that in near future many sea beaches will emerge on Maharastra coast as tourist centres.

The Goan Coastal Zone

This tiny state of India possesses very important place in the maritime activities and history of India. Goan culture is essentially maritime in nature and its economy is also greatly influenced by marine endowments. The bedrock of the Goan economy is fishery, mining, tourism and agriculture.

Land Use : Land use pattern in the coastal zone is entirely different from that of inland talukas. Out of 11 taluks in the state 7 are coastal. Orchard including pasture is the dominant user of land in the region, whereas natural cover and forest is dominant in the inland talukas. Around 19 per cent of the reporting area is under cultivation in the coastal talukas while it is only 8.67 per cent inland talukas. Proporion of cultivable wasteland is also comparatively higher in the region than the inland talukas and the state's average. A considerable proportion (9.07 per cent) of land surface is also utilised for settlement in the coastal talukas while it is only 2.09 per cent in the Inland talukas.

Cultivation occupies 32.05 per cent of total land area in Salcete taluka, followed by wasteland 21.02 per cent settlement 19.33 per cent. Bandez taluka has 23.16 per cent area under cultivation, orchard/pasture 27.25 per cent, wastland 20.64 per cent, settlement 14.80 per cent, Marshy land/water body/sandy area 9.65 per cent of the total area of the taluka. On the other hand, Tiswadi taluka has marshy land/water body/sandy area 27.38 per cent, orchard/pasture 27.10 per cent, cultivation area 25.88 per cent, settlement 14.10 per cent, wasteland 2.93 per cent and the industrial area only 0.83 per cent of the taluka.

It appears that by 2001 A.D. cultivated area would be 25.37 per cent, orchard/pasture 21.33 per cent, natural cover/Government forest 23.40 per cent, settlement 16.35 per cent, marshy land/water body/sady area would be 8.68 per cent of the coastal area.

Agriculture : Agriculture is one important activity in the Goan coastal zone. Paddy is the main cultivation in the coastal zone. It has the share of 40.51 per cent in the total net area cropped of the state. The 70.40 per cent of the total paddy cultivation of Goa is done in coastal talukas (1986-87). Salcete taluka alone has the share of more than 20 per cent. Paddy is followed by coconut and cashewnut cultivation in coastal zone. Other crops such as oil seeds, pulses, sugarcane etc. are also grown. In 1989-90, the yield of rice was (Kharif) 2135 kg per hectare and rice (Rabbi) was 2500 kg per hectare in the coastal talukas.

In 1987-88, the production of paddy in the state registered 1.665 lakh tonnes and in 1990-91 it was 2.01 lakh tonnes. The increase has been possible on account of increase in the area under high yielding varieties of paddy.

About 95 per cent of the coastal zone paddy cultivation and others are covered by heavy dose of chemical fertilisers. However, use of pesticides and insecticides are limited. Goa has an irrigated area of 13383 hectares of which 41.62 per cent is found in the coastal zone. Agriculture is mainly dependent on the monsoon and partly on irrigation. Minor irrigation and sources such as tanks, wells, bundhs etc. constitute 85 per cent of the irrigation and only 15 per cent of irrigated area is under major and medium projects (2500 hectares) in 1986-87.

Forestry : The heavy precipitation and hilly terrain have developed luxurious growth of vegetation but forest cover decreases towards the coastal low lands. In coastal talukas of Tiswadi, Bardez, Salcete and Marmugao, forests are almost non-existent. The ever green forests occur mostly in pockets along the coastline in the streams and on the high rocky slopes. Economically valuable species are Eculyptus, Bamboo, Cashew, Coconut, Teak etc. The deltas of Mandovi and Zuari estuaries have mangroves forest.

Minerals : Coastal talukas do not have iron ore mines except some deposits in Quepem and Canacona talukas. Bauxite is exclusively found in the coastal talukas of Quepem and

Canacona. These bauxites have the fineness of 45 to 60 per cent. The other minerals like limestone, clay, silica sands etc. are found both in inland and coastal zone of Goa. The entire production of iron-ore from the inland talukas is exported to Japan mostly.

Most of the mineral ores are transported by barges through Mandovi and Zuari rivers to Marunugao port. There were 161 barges in 1964 and now has increased to 222 as per Goa Mineral Ores Exporters Association.

Sand mining has also been reported time and again legally and illegally. Sands are extracted for construction, for foundaries and glass industries. The quantity of sand extracted in 1988 from Goan beach of Arrosim, Benaulium, Cavelossim, Utorda and Verca was 48176 million tonnes.

Industry : A study of industrial development in Goa reveals two very distinct pattern, one as the industrial Goa comprising the coastal talukas where about 90 per cent of the large, medium and small scale industries are located, and other comprising the inland talukas (western ghat foothills) which almost devoid of industrial development except the midland taluka of Ponda.

At present (as on 31-3-92), there are 196 factories registered in operation under the factories act in the coastal talukas. There are 47 large and medium industries in the state. Out of these, 23 are located in the coastal talukas employig 6065 persons. Number of small scale industries registered in coastal zone is 3775 out of 4987 in the state.

The existing large and medium industries unlike the small units are mainly engaged in the production of modern sophisticated items such as chemicals, fertilisers, pharmaceuticals, brewarries and distilleries, barge repairs and ferrous metal works, rubber, sugar and textile, pelletization and ore benefication plants etc. The Zuari Agro-chemical Fertiliser Plant at Sancoale, the Hindustan Ciba Geigy Plant at Santa Monica, HPCL's LPG Plant at Kundaim, the Shiroda Pelletization Plant, Usha Ispat Ltd.,and Sanjivani Sugar Factory etc. are notable large and medium industries.

Though the large and medium scale industrial units account for only 2 per cent of the total number of industrial units in Goa, they are one of the most largest sector in the region in terms of investment, employment, power and water consumption etc. The contribution of the industrial sector, including the mining (iron ores), transport and tourism is to the extent of almost 46 per cent of the state domestic product as against the 16 per cent of the agriculture. Therefore, it appears that the Goan coastal zone has experienced high level of man-environment interaction as is reflected in the urbanisation and industrialisation process.

Fishery : Fish forms an integral part of Goan life. With a coastline 105 km long and 40000 to 50,000 people being dependent on fish harvesting for a living. It would be difficult to overstate the importance of this commodity in either the Goan economy or diet. There are 61 marine fishing villages, 900 mechanised boats, 850 trawlers, and 2000 non-mechanised boats in the Goan Coastal Zone (1992).

At first glance, it might seem there has been a substantial increase in fish yields, up from 17,186 tonnes in 1965 to 64,929 tonnes in 1991-92 - an increase of 278 per cent in 26 years. The general trend, however, stands out in bleak contrast. Over a 20 year period from 1967 (when there were 10 trawlers) to 1987 (when there were around 200), the peak annual catches were strikingly similar : 39,980 tonnes in 1971, 39,477 in 1984 and 41,469 tonnes in 1985. The number of trawlers increased by almost 700 per cent between 1977 and 1989 (91 to 726), but the total yield increased by a measurable 24 per cent (34,414 tonnes to 42,729 tonnes).

A majr part of the yield comprises of pelagic fishes like sardines and mackerels, which contribute about 70 per cent, rest being demersal represented by shrimps, butterfish, pomfrets, silver bellies etc. Besides the open sea fishing,. on an average about 1800 tonnes of fish, shrimp, clams, mussels, and oyasters are harvested from creeks, estuaries and backwaters of Goa, spreading ever an estimated area of about 200 sq.km.

It is estimated that the maximum sustainable yield (MSY) of the marine fisheries off the Goa coast is 70,295 tonnes per annum - 41,760 tonnes pelagic and 28,535 tonnes demersal subject to natural variation. It refers to all fishery resources off the Goa coast, including the deep sea. Three sectors of fishing are : a) the area between 0-10 m. depth reserved for the traditional fishermen, b) the 10-15 m. depth zone which can be exploited by the existing trawlers, and c) the area marked for deep sea fishing. But the major problem is that it is essentially sector one which is being viciously over-exploited, to the detriment of the local ecology.

Aquaculture : The three different kinds of aquaculture practiced in Goa are : a) the permanent fish farm, b) the use of ponds for salt and fish production, and c) prown culture in "Khazan lands" - paddy cum fish farming. The first one involves round the year operation and is mosltyfound in Salcete taluka; but other two types essentially include seasonal activities. The annual yield varies from 350 kg per hectare in a salt-cum-fish farming to 1060 kg. or even upto 2000 kg per hectare in a parmenent fish farm.

The estimated harvest from different fish farms and sluice gate systems in Goa is about 50 tonnes. this is just about 0.1 per cent of the total marine fish landing in Goa.

Khazans are being devasted by an array of activities :

Willful and illegal inundation, uncontrolled and unplanned urbanisation, pollution and siltation, and the building of Konkan railway etc.

Tourism : Goa, with its natural and scenic beauty, having a coastline of 105 km. of which 65 km. consist of extensive sandy beaches and navigable rivers network, churches famous for architectural uniqueness, temples, and above all, hospitable people with a rich cultural history has an ideal tourist profile. It started attracting tourists immediately after its liberation in 1961. From a mere two lakhs in 1975, the flow of tourist traffic has shown a steady growth and in 1991, stood at 8.35 lakhs. The projected inflow of tourists to Goa by the year 2000 A.D. would be of the order of 16.12 lakhs. The world tourism organisation which conducted a study of the tourism carrying capacity of Goa under its sectorial support programme in September 1989 has, however, forecast, that Goa is capable of receiving as many as 25 lakhs of tourists, if adequate infrastructural facilities are made.

Keeping, therefore, the above objective in mind, the state government is laying greater emphasis on the creation of infrastructureal facilities and provision for accomodation for low and middle income group tourists who constitute the bulk of domestic traffic, leaving the private sector to cater to tourists in high income group, and those chartered from abroad. As of present, the total bed capacity stands at 14500, of which the public sector accounts for 10 per cent, while the rest is in the private sector. About 77 per cent of the hotels in Goa have come up in the coastal belt with 73 per cent of the total bed strength.

Statistics reveal that 77 per cent of domestic tourists and 95 per cent of foreigners prefer to stay in the coastal areas. The existing bed capacity is found short of the requirements during the peak months - November to January. The seasonality factor has been countered by launching a special compaign for promotion of tourism during the monsoon seasons - June to September. Since 1986 and has resulted in 10 per cent increase in the tourist inflow. About 20 per cent of Goans are earning their livelihood by tourism.

With the likely establishment of Holiday village in Arabol with Japanese assistance, Golf course with 18-Hole capacity at Verna in south-central Goa, and water sports institute at Carazalem, close to Miramar beach of Panji, Goa would be tourist resort with international standard.

But the excess of exploitation of tourist resources - beaches, navigable river network etc. has started abusing and spoiling the total get-up of the beautiful seafronts. It seems that Goa has reached its carrying capacity for tourism if environmental degradation and pollution is not further increased and abetted.

Ports : Marmugao port has two hills with extended headlands like two bastions as defence, and the coasts are bathed by the waters of the Arabian sea and Zuari river. Unlike Bombay and Cochin, which are some way inside land, Marmugao is a open harbour protected by a 522 - metre long breakwater from its seaward end. having been constructed on the leaward side of the headland, the harbour is also protected from the south-west monsoon. To the north and west of the harbour is a large roadstead where about 50 ships can be laid at anchor during fair season. During monsoon sheltered anchorages are available for about 15 ships.

The navigational channel from the channel to the open sea is about five km. in length, 250 - metre in width and 13.7 metre in depth with a turning basin of 480 - m diametre. A number of tags and launches are available and pilotages service is provided by the port round the clock.

The port has now 10 berths including six conventional quay berths with a total of 841 metres and 100 metre long lighter berth. The new multipurpose deep drafted berth will be able to handle bigger ships and all types of dry general cargo including containerised shipments. The port has the distinction of being the first in the country to have a mechanical ore handling plant.

Marmugao occupied fifth position in terms of total quantum of traffic in 1987-88, its share being 10 per cent among the major ports of India. It handled 133.3 lakh tonne cargo in 1987-88. The major commodities handled were fertilisers, petroleum products, iron ore, edible oils and all types of other general cargo.

TRENDS IN TOTAL TRAFFIC IN PRINCIPAL COMMODITIES AT THE MAJOR PORTS ON WESTERN COAST

PORT	1980-81	1985-86	1986-87	1987-88
KANDLA	**88**	**165**	**162**	**181**
	(10.95)	**(13.80)**	**(13.02)**	**(13.44)**
Mineral Oils	64	123	119	134
Fertilisers and Raw Materials	7	13	4	4
Food Grains	4	3	5	8
Others	13	26	34	35
BOMBAY	**170**	**243**	**251**	**296**
	(21.17)	**(20.33)**	**(20.18)**	**(22.00)**
Mineral Oils	82	45	163	194
Fertilisers and Raw Materials	13	8	14	12
Food Grains	-	6	5	6
Others	75	184	69	84
MARMUGAO	**138**	**161**	**149**	**133**
	(17.18)	**(13.50)**	**(11.98)**	**(9.88)**
Mineral Oils	6	7	8	6
Fertilisers and Raw Materials	126	142	135	117
Food Grains	2	4	2	1
Others	4	8	4	9
NEW MANGALORE	**10**	**37**	**55**	**61**
	(1.24)	**(3.10)**	**(4.43)**	**(4.43)**
Mineral Oils	3	4	5	4
Fertilisers and Raw Materials	-	23	39	44
Food Grains	2	2	2	1
Others	5	8	8	12
COCHIN	**52**	**53**	**69**	**68**
	(6.45)	**(4.43)**	**(5.54)**	**(5.05)**
Mineral Oils	40	39	54	54
Fertilisers and Raw Materials	7	6	7	7
Food Grains	-	-	-	-
Others	5	8	8	7
ALL MAJOR PORTS	803	1195	1244	1346

All figures in lakh tonnes
Figures in brackets denotes percentage

The port has a floating workshop at the Goa shipyard to take care of minor reparis. Chipping, painting and cleaning of tanks is being undertaken by the authorised private parties. All storage plots, sheds and warehouses have rail sidings or roads to facilitate speedy movements of merchandise.

Settlement and Infrastructure : The 1991 census reports 188 inhabitated villages and 26 urban settlements in the coastal zone of Goa. The latest (1991) census figures reveal that the urban populaiton increased by a massive 48.63 per cent during the previous decade, upto 41.01 per cent of the state's total population from 32.03 per cent in 1981. The census also showed tht the increase in north and south Goa was 44.46 per cent and 52.54 per cent respectively. Thus the demand for urban accomodation has sparked construction boom thereby threatening the ecological security of the coastal zone in Goa.

The transportation network of Goa is quite developed. The total road length is 7202 km. and density of road is 1945 km. per 1000 sq. kms. (1992). Motor vehicles in operation as on 31st March 1991 was 1,25,965. For large country craft and mine ore barges, the navigable river network is 239 kms. passengers ferried during 1990-91 in Mandori, Zuari, Chapora, Tiracol Sal etc. were 5.21 crores, Mandovi has the largest share between Patto (Panjim) to Malim (3.80 crores).

Further, the ongoing Konkan railway project would give impetus to transport development. The Miraz-Vasco-da-Gama railways is already contributing to the developmental processes in Goa.

THE KARNATKA COASTAL ZONE

The Karnatka coastal zone is one of the prosperous and high growth areas in the state of Karnatka. The occupational structure showe that secondary and tertiary sectors are more prominent in the coastal zone.

A large number of major developmental projects have been envisaged in the coastal zone and some of them have already been initiated. The notable projects are New Manglore Port, Manglore Oil Refinery, Manglore thermal Power Plant, the Kaiga Nuclear Power Plant and the Naval base at Karwar in the Uttar Kannada. These projects are estimated to involve an investment of about Rs. 10,000 crores and would have major impact on the development (man-environment interaction) in the region.

Land Use : Though fisheries, forests and mineral wealth are undoubtedly of great economic significance in the Karnatka coast, it is cultivable land that really sustains the economy of the region. According to the land use statistics for 1988-89, out of the total geographical area, forests account for 80.93 per cent, lands put to non-agriculture use, barren and uncultivable lands besides lands under miscelleneous trees and groves together form 5.79 per cent cultivable wastes form 1.4 per cent while current and other fallows constitute 1.46 per cent for Uttar Kannad, followed by Dakshin Kannada, 27.60 per cent forests, barren and uncultivable land 8.70 per cent, non-agricultural use 9.90 per cent permanent pastures, miscelleneous trees and cultivable waste together 25.20 per cent, fallow lands constitute 5.70 per cent respectively. The net area sown is only 10.68 per cent in Uttar kannada and 22.90 per cent in Dakhin Kannada.

The low net sown area in Uttar Kannada is mainly attributable to mountaneous tract, and therefore the density of population is less. However, there is tremendous pressure on land in the Dakshin Kannada. The density of population is high.

In the coastal strips, there are patches of what are known as "Khar lands". since 1960s consistent efforts are being made to put up bunds and reclaim such lands for effective cultivations in Uttar Kannada.

Agriculture : Paddy is the principal agricultural crop in all the coastal talukas. Sugarcane and ground nut are also important agricultural crops. Sunflower is also grown. As regards the horticulture crops, it may be mentioned that Karnatka coastal zone is well known for production of areca nuts, coconut, pepper, cardamum, cashew, pineapples besides plaintains. The other crops raised are chillies, ragi, sweet potato, ginger and vegetables. In view of the heavy to very heavy rainfall experienced in most parts, the yields are genrally good.

About 70 per cent of the net sown area is unde paddy, cashew nut 14 per cent of the net sown area and the rest being devoted to others.

Irrigation : There are no major irrigation works. The irrigated area in the coastal Karnatka is only 94761 hectares and is very low compared to other coast. At several places barrages have been put up across streams to divert water for irrigating small stretches of lands. Wells and tanks are the main sources of irrigation. Dakhin Kannada has the largest share (78.75 per cent) of total irrigated area.

Forestry : Forestry enjoys an unique place in the economy of the coastal Karnatka. The slopes of the western ghats are clothed with dense forests containing valuable timber. The rainfall and soil conditions stimulate spontaneous growth of vegetation all over the coastal zone from the areas lying beyond a few kilometres east of the coastline. Even in the coastal strip, though there are no forests classified as such, there is plenty of tree growth. The major items of forest produce are the softwood, package timber, boat timber, construction timber, sandal wood and firewood. It contains forests of different types such as evergreen, moist-deciduous, dry-deciduous and scrub forest. Minor forest produce are bamboo, pepper, tamarind, lac, soaprut, resins etc. Cashew, rubber and cocoa plantatious are found in the Dakhin Kannada coastal strip.

There has been some amount of denudation in recent yeras as a result of the unauthorised and indiscriminate clearence of forests for purposes of cultivation and plantatin by encroachers, setting up of rehablitation centres for displaced persons and allotment of lands to the landless poor and submersion of forests under reservoir projects as well as formation of new roads and widening of existing ones.

Availability of forest-based raw materials has promoted the growth of several industries, the most important is the West coast paper mills at Dandelli. The Forest industries corporation has also set up a green grass dehydration and pelletization plant.

Minerals : The mineral wealth of Karnatka coastal zone includes iron ore, maganese, bauxite, lime, clay, garnet, silica and sand. Iron ore deposits (estimated at 169 million tonnes) are exploited since long time in Uttar Kannada in talukas of Ankola, Honavar and Yellapur. The deposits of high and low grade iron ore in Dakhin Kannada is estimated at 5 and 80 million tonnes respectively in Puttur, Bantval, Daltangadi taluka. The magnese deposits in Uttar kannada is estimated at about 25 million tonnes. Bauxite is estimated to be 21 million tonnes. limestone and Dolounite, glass sand and clay are of considerable economic value. The availability of these minerals has promoted the growth of mining industry and has also resulted in mineral based industries such as the ferro-maganese plant, silicon-maganese plant and the caustic soda plant. The coastal strip is dotted with numerous units engaged in the manufacture of tiles and bricks. An estimated reserve of 12 thousand tonnes of silica sand is available along the coast in Dakhin Kannada.

Fishery : With a coastline of 255 km., the Karnatka coast has a rich continental shelf of about 25000 sq.km. which abounds with pelagic fisheries in addition to a rich prawn fishery. The estuaries of rivers are noted for the richness of their fish fauna and in fact these are natural hatcheries which serve as breeding grounds during the monsoon period. In view of the abundance of mackerels, this part of the west coast is popularly known as the Mackerel coast. However, recently sandines have been dominating the catch.

There are 147 fishing villages with 105 landing centres. The fishermen population is 1.13 lakhs in 15600 households. Fish production showed wide fluctuations during the decade 1975-84, the trend being governed by oil sardine and mackerel. Catches varied from 87000 tonnes in 1975 to 155000 tonnes in 1984. Pelagic groups of fishes formed 69.1 per cent and the demersal groups 30.9 per cent of the catches. The contribution of the mechanised sector to the total catch was 85.9 per cent.

During the last decade several technological innovations have taken place in the fishing industry with mechanised crafts and gears slowly and steadily replacing the traditional non-mechanised ones. There are 2000 mechanised boats in the state consisting of trawlers (1500), purse seiners (300), gil netters (900) and others. A total of 6900 non-mechanised fishing crafts exist dominated by dugout canoes (64 per cent). Mechanisation has occured more in Dakhin-Kannada than in Uttar Kannada.

By way of infrastructural facilities, the Karnatka coastal zone has 27 freezing plants, 9 canning factories, 15 ice plants, 5 fish meal plants and 31 cold storages. Shrimp trawling is carried out near the shore in 10 to 14 fathoms of water. However, despite mechanisation catch per unit of effort of purse seins and trawlers showed a decreasing trend now.

Industrialisation : There are large number of small scale industries along the coast connected with fish curing, manufacture of fish oil, manufacture of building tiles cashew and rubber processing etc. The major industries along the coast are :

Manglore chemicals and fertilisers, situated at the outskirt of Manglore, is an enterprise with an investment of Rs. 68 crores and went into production in 1976 and provides employment to 1500 persons today. At present the industry disposes 13000 cu m/day of wastewater after treatment into the Arabian sea through a pipeline extending 105 metres into the sea from the low tide level.

Ballarpur Industries Ltd. is situated in Binaga village, 3 km from Karwar town and is manufacturing caustic soda, chlorine phosphoric acid and sodium tri-poly phosphide. It was established in 1975. The company has acquired about 12 sq.km. of marshy lands containing salts in Gujrat state for salty earth as raw material. It involved an investment of Rs. 23 crores and went to production in 1979. The factory employs about 1800 persons at present.

The wastewater of 5000 cu m/day after treatment is discharged at a point 3.5 km. away from the factory through a submarine pipe line and outfall diffuser.

Kudremukh Iron Ore Co. Ltd. is a plant producing iron-ore concentrate and dispose slury through a 4 km. pipeline into sea at 50 metres distance from high tide.

An oil refinery with a capacity of 6 million tonnes/annum has been set up at about 2 km. north of New Manglore Harbour which is generating waste water of about 1000 mm per hour. A large number of downstream industries are coming up in the region.

The Manglore Thermal Power plant would be the main consumer of coal to be imported through new Manglore port. The major impact is in terms of disposal and dumping of ash which would have an impact both on transport and environment.

The Karwar Naval base is estimated to have a strength of 20,000 naval personnel by 2005 A.D. It would therefore, generate certain industrial development which in turn has an impact on movement of men and material on the transport system and thereby on total environment of the region.

Ports : There are nine recognised ports along the coast namely Manglore, Mangarkatta, Coondapur, Malpe, Baindaru, Mulki, karwar, Honavar and Bhatkal.

The New Manglore port is being developed as a major port in the country. This all weather port provides for three alongside berths to cater to general cargo, iron and maganese ore, raw materials (imports for fertiliser factory etc.) and export of finished goods and an oil jetty for handling naptha and petroleum products. This has been developed in two stages and the second stage included facilities such as those for the export of iron ore concentrates from kundremukh region and an exclusive iron ore berth for bringing in bulk ore carriers of 60,000 DWT with a draft of 12.5 meter, deepening of the lagoon and approach to the port. It is the deepest inner harbour in the country.

The traffic handled by New Manglore Port (NMP) is slowly and steadily increasing from about 0.91 lakh tonnes in 1974-75 to 22.72 lakh tonnes in 1982-83 and 61.08 lakh tonnes in 1987-88. Of this, imports accounted for 8.51 lakh tonnes and exports 14.2 lakh tonnes. Amongst the imports, petroleum products accounted for high share of 3.5 lakh tonnes, cement 2.78 lakh tonnes and fertilisers 1.52 lakh tonnes. Amongst export, iron ore was the most important commodity accounting for 11.21 lakh tonnes. A total quantity of 208 lakh tonnes by 2000 A.D. is estimated to be handled at NMP. Of this, import is estimated at about 80 lakh tonnes and export at 128 lakh tonnes respectively.

The state government has recently developed Karwar as small but all weather port. items being exported from the ports include minerals, fish and fish products.

Beach Tourism : The Karwar beach possesses a fine grove of casurines and a stretch of white sand from the mouth of Kalinadi to the sheltered inlet of Baithol cave, a distance of about 20 km. There is Binaga beach which is famous tourist spot. But due to Naval base, the tourist activities would be closed now.

Ullal and Penambur beaches are popular and situated near Manglore. Ullal is only 6 km from the city. This is thickly populated by fishermen. Other beaches are Suratkal, Goondapur, Honvar, and Gokarna. Since the Goan beaches are too crowdy, foreign tourists are seen exploring the north Kannada beaches of Gokarn and others which are peaceful, cheap and unspoiled. However, it is observed that beach tourism in Karnatka is small affair companed to Goa and Kerala on the west seaboard of India.

Settlements : There are 1283 inhabited villages and 13 towns in North Kannada and only 635 villages but 27 towns in Dakhin Kannada. The Northern coastal zone is sparsely populated compared to southern which is thickly populated. The settlements in villages are not nucleated. In fact, in most cases, there is more open ground between the villages and also between the houses themselves. The coastal areas and low lands contain relatively large settlements as compared to the hilly and forested Malnad tracts. Small villages dominated the rural scene and constitute 65.24 per cent of the total number of villages. It is only in the inland side that nucleated settlements are found. But Dakhin Kannada has large villages in contrast to Uttar Kannada.

There are 27 towns in South Kannada, followed by 13 in North kannada. But there are only 12 towns and cities located along the coastline. The average population per town in North Kannada is 21000. Only Manglore and Karwar towns have sewerage system and only Manglore town has primary treatment facility. The Manglore urban agglomeration covers 10 small towns in addition to city itself. The class I towns accounts for 52.63 per cent of the total urban population in the Karnatka coastal zone.

Transport : It is observed that Dakshin Kannada with 75 per cent of its village under well developed network of road and river navigation network is quite developed as compared to Uttar Kannada having only 33.66 per cent of the villages.

The regional roadnetwork constitutes two natinal highways (NH), and many state highways (SH) and other roads providing the accessibility to different parts of the region as well as the state. The total road length of all types was about 9484 km., the NH share being only 400 km., comprising of NH 17 and 48. The NH and SHs constitute about 16 per cent of the total road length in the coastal zone.

The rate of increase of traffic (vehicular) on NH had been substantial over the years (11.78 per cent). The rate of increase of traffic on village roads is increasing thereby indicating the increase in accessibility and mobility levels of rural areas. The average annual growth of traffic in respect of all roads was observed to be more than 7 per cent. It is expected that within 15 years, traffic will be doubled. Therefore, the necessesity of improvement of existing roads and development of new roads should be taken upto meet the future traffic demands.

The Karnatka coastal zone is poorly served by the rail transport system. The two railway lines that traverse the region are Manglore-Coimbtore line which is broad guage and Manglore-Hassan-Banglore line which is meter gauge. The Konkan railway, presently under construction would greatly improve the accessibility and connectivity of the region by rail system.

THE KERALA COASTAL ZONE

The Kerala coastal zone, with a coastline of about 580 km. is a "sand wiched piece of land" nourished by the waves of the Arabian sea on the west and supported by a series of backwaters, lakes and lagoons on the eastern side. It is blessed with estuaries of 41 rivers mostly monsoon-fed and active. There are about 30 backwaters (lakes) which form a specially attractive and economically viable feature of Kerala. The man-environment interaction is expressed in totality in the Kerala coast. It is one of the coastal zone with highest population pressure, intense agricultural and fishing activities.

Land Utilisation : The land use statistics reveal that about 56.79 per cent of the coastal area (3885497 hectares) is net sown area, forest 27.84 per cent, land put to non-agricultural use 6.77 per cent, cultivable waste 3.33 per cent, barren and uncultivable land 2.12 per cent, permanent pastures, miss. tree crops 1.30 per cent, current fallow and other fallows 1.85 per cent and total cropped area of 73.87 per cent in 1986-87.

The greater share of forests are seen in Quilon (49.77 per cent) Trichur (34.61 per cent) and Mallapuram (28.47 per cent). Alleppy has the highest proportion of land put to non-agriculture uses (16.88 per cent). Cultiable waste is highest in Cannanore district (5.18 per cent). Apart from Quilon, all the remaining coastal districts have more than

LAND UTILISATION PATTERN IN KERALA (PERCENTAGE)

Head of Classification	1975-76	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87
1	2	3	4	5	6	7	8	9
1. Total geographical area	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2. Forests	27.84	27.84	27.84	27.84	27.84	27.84	27.84	27.84
3. Land put to non-agricultural uses	6.67	6.94	6.86	7.10	7.15	7.20	7.17	7.77
4. Barren & unculticable land	2.02	2.21	2.20	2.22	2.23	2.21	2.14	2.12
5. Permanent pastures and other	0.51	0.14	0.14	0.14	0.13	0.11	0.11	0.10
6. Land under misc. tree crops not included in net area sown	2.17	1.64	1.42	1.41	1.41	1.31	1.29	1.20
7. Cultivable waste	2.92	3.32	3.35	3.35	3.32	3.34	3.23	3.33
8. Fallow land other than current fallow	0.59	0.69	0.69	0.71	0.71	0.70	0.72	0.71
9. Current fallow	0.94	1.12	1.14	1.14	1.10	1.07	1.11	1.14
10. Net area sown	56.34	56.10	56.30	56.10	56.11	56.22	56.81	56.79
11. Area sown more than once	20.38	18.15	18.41	17.56	17.54	17.76	17.39	17.08
12. Total cropped area	76.72	74.25	74.77	73.66	73.65	73.98	73.77	73.87

50 per cent of their area under net sown category as in Kottayam (83.16 per cent), Allepy (79.58 per cent), Ernakulam (75.90 per cent) and Mallapuram (69.55 per cent).

Of the gross cropped area, 34.79 per cent is under paddy, 36.91 per cent under coconuts, 13.20 per cent under tapioca and 10.96 per cent under rubber thus indicating prominance of the plantation crops.

Agriculture : The Kerala (Malabar) coast is a region of agricultural diversity. In the low lying areas rice, tapioca, sugarcane, coconut, arecanut, peoper etc. dominate. However, in upland areas plantation crops of rubber, tea, cocoa, coffee, cashewnut, cardmom etc. dominate. This coast is also famous for spices and condiments production. A wide variety of fruits and vegetables are also grown in the region.

Kozhikhode has the largest area under cocconuts (59.96 per cent), Cannanore has the highest proportion of pepper growing area whereas Trivendrum has the highest tapoica growing area (42.06 per cent). About 34.63 per cent of net sown area is under rubber in Kottayam. Thrisur with 73.81 per cent, Alleppy 61.09 per cent and Ernakulam with 56.78 per cent are most important paddy producer. Trichur was the top producer with 1.43 lakh tonnes of rice, followed by 1.31 lakh tonnes Ernakulam and 1.17 lakh tonnes in Alleppy. Trivendrum produced 7.65 lakh tonnes of Topioca, followed by Quilon 5.39 lakh tonnes, Kottayam 4.16 lakh tonnes in 1986-

87. Again Trivendrum topped the coconut production with 343 million nuts, Quilon 340 million nuts, Khozikode with 527 million tonnes, trichur 312 million tonnes respectively in 1986-87.

Irrigation : About 306261 hectares of land are irrigated in the Kerala coastal districts. It is paddy (191913 hectares) which share 62.66 per cent of the total irrigated area in the region, followed by Coconuts, arecanuts etc. in 1986-87.

KERALA

DISTRICT - WISE GROSS AREA UNDER IRRIGATION (CROP-WISE) 1986-87

District	Paddy	Tubers	Vegetables	Coconut	Arecanut	Cloves & nutmeg	Other spices & condiments	Banana	Betal leaves	Sugar-Cane	Others	Total
Trivandrum	8787	27	437	828	1	17	2	282	80	2	1006	11569
Quilon	3970	6	228	184	9	4	-	50	77	2	278	4808
Alleppey	9968	223	569	15948	49	52	97	130	23	74	830	27963
Kottayam	10659	15	285	11	-	106	19	113	18	2	1046	12274
Ernakulam	62142	9	60	11593	688	379	20	956	12	1	1671	77531
Trichur	55840	64	353	28914	2670	67	260	625	28	-	977	89798
Malappuram	22297	192	1017	1907	1972	3	60	1471	424	-	826	31169
Kozhikode	3355	19	141	211	119	2	2	925	9	-	1840	6623
Cannanore	6872	33	143	3468	318	23	128	1711	9	6	1082	13793
Kasargod	8023	1	517	12342	8986	-	152	568	41	-	103	30733
State	**298440**	**604**	**4781**	**80671**	**16669**	**679**	**1066**	**8025**	**733**	**2001**	**1191**	**425588**

Source: DES

Trichur has the largest canal irrigated area, Ernakulam by government tanks and wells, Alleppy by private tanks and wells, whereas Ernakulam also has the hgihest proportion of land under minor and lift irrigation system. Some of the important irrigation schemes of the area are Chalakudi, Malampusha, Periyar valley, Walyar etc. This coast is deficient in food grains therefore, much attention has been paid to increase irrigation facilities and some reclaimation of low level water-logged areas because of intense population pressure in the coastal zone.

Fertilisers Consumption : About 95 per cent of the coastal zone paddy cultivation and others are covered under heavy dose of chemical fertilisers : N (Nitrogen) P_2O_5 (Phosphorus) and K_2o (Potash). The total consumption of NP_2O_5 K_2o together was 109333 tonnes in 1986-87. Kottayam topped with 17855 tonnes (7239 N, 4729 P_2O_5 and 5887 K_2O respectively), followed by Ernakulam (15353 tonnes), Trichur 13435 tonnes, Alleppy 12241 toness respectively. The average consumption of plant nutrients in Kerala coastal zone is substantially high (52.8 kg/hectare of cropped area) compared to Indian avearge of 48.7 kg./hectare in 1986-87.

KERALA

SEASON-WISE CONSUMPTION OF N, P_2O_5 AND K_2O 1986-87

DISTRICT	TOTAL			
	N	**P2S5**	**K2O**	**TOTAL**
Trivandrum	3164	2131	2742	8037
Quilon	3143	1979	2845	7967
Alleppey	4800	2421	5020	12241
Kottayam	7239	4729	5887	17855
Ernakulam	5416	3642	6295	15353
Trichur	5105	2627	5703	13435
Malappuram	4418	2512	3756	10686
Kozhikode	2801	2183	4009	8993
Cannanore	2896	2104	4069	9069
Kasaragod	2142	1414	2141	5697

Forestry : Forestry is another important activity in the Kerala coastal stretch. The total land under forestry is of the order of 9400 sq.km. Kerala is famous for coconut cultivation with production to the tune of 4000 million tonnes, most of which is harvested from the shores of the backwaters.

The plentiful availability of coconut husk and the vast stretch of shallow brackish water are two major factors that contributed to the growth of the coir industry. The coir industry, almost exclusively located along the coastal belt of Kerala, produced 90 per cent of total coir products of the country making India the largest exporter of coir goods in the world.

Important forest products of Kerala coast includes Reed (137.534 million tonnes), Timber round logs (51.115 thousand cu meter), fuelwood (25.438 million tonnes) in 1987-88. The area under Eucapyptus plantation was 33.987 thousand hectares, soft wood 10.695 thousand hectares, fuel wood 1.448 thousand hectares, cashew 4.157 thousand hectares in 1987-88.

Fishery : With a continental shelf area of 39700 sq.km., Kerala's potential yeild of marine fish is estimated at 8 lakh tonnes. There are 304 fishing villages spread along the ten coastal districts; 222 landing centres, two major harbours Cochin and Sakthikulangara and 4 minor ones - Munambam, Azhikal Ponnani and Beypore. The total fishermen populatin of the state is 6.4 lakhs, comprising one lakh households.

CONTINENTAL SHELF AREA AND ESTIMATED POTENTIAL DEMERSAL FISHERY RESOURCES OF KERALA

Division of continental shelf based on depth range	**Area (Sq.km.)**	**Estimated total demersal fishiry resources based on ave. each rates (tonnes)**	**Estimated potential substanciable yield at 68% (in tonnes)**
In shore area (0-10 Fathems)	5057	37935	22761
Off shore area (10-40 Fathems)	24442	90432	54259
Deep sea area (40-100 Fathems)	10224	17040	10224
Total Area (0-100 Fathems)	**39723**	**145407**	**87244**

Source : Facts & Figures 1980 - Fisheries - Kerala

There are 3038 mechanised vessels consisting of 2630 trawlers, 362 gill netters, 37 purse seiners and 9 others. Non-mechanised crafts are composed of catamarans (44 per cent), dugouts (40 per cent) and plank built boats (16 per cent). Motorisation of crafts picked up very fast in the eightees and by 1984-88 there were 6000 such crafts in the state. Out of a total of 4000 trawlnets, 1500 are owned by fishermen. The most common gear is the gill/drift net followd by boat scienes in all the districts except Trivendrum where hook and line, traps and scoop nets dominate.

The state has 25 ice and cold storage plants in the public sector and 267 units in the private sector distributed in eight districts. There are two boat building yards in the public and 36 in the private sectors.

Annual fish landings in the state were 3.07 lakh million tonnes in 1986-87 worth value of Rs. 13203.84 lakhs, The pelagic groups formed two-third of the total and demersal the rest. Kerala accounts for 78 per cent of the total oil sardines landing of the country. In 1986-87 oil sandines (1.29 lakh tonnes), sardines (14160 tonnes), Non-penacid prawns (28118 tonnes), seer fish (16032 tonnes) were the notable catches. The cannanore with 25.8 per cent of total length of Kerala coastline tops the production and fishing activities, followed by Alleppey (13.9 per cent), Trivandrum (13.2 per cent), Khozikode (12 per cent) and mallapuram (11.8 per cent) respectively.

In 1987-88, India exported 97179 tonnes of marine products in which Kerala had the share of 35576 tonnes (36.61 per cent) and constituted mainly frozen shrims 26892 tonnes tonnes (75.59 per cent), frozen squids 3132 tonnes (8.80 per cent), frozen cuttle fish 2806 tonnes (7.89 per cent), fresh and frozen fish 1818 tonnes (5.11 per cent) frozen hobstertails 260 tonnes (0.73 per cent) etc. It was worth Rs. 18394 lakh in 1987-88.

Indiscriminate expansion of motorisation may not be advisable as the catch rate is declining and earning per boat dwngling over the year. In view of this spree of motorisation of country creafts, consideration is needed of allocating the coastal frinze zone for artisanal fishing using traditional non-mechanised crafts.

Aquaculture : Increasing population, shortage of food grains, acute unemployment are some of the major problems facing this coastal state. The surest and quickest way for solving this, lies in a vigorous and sustained drive for the development of natural resources. It is in this context that the development of backwater fisheries in Kerala emerges as the foremost necessity of the time. It can ensure ample quantity of cheap and quality food and generate employment oppurtunities.

Thirty backwaters occur along the 590 km. long coastline of Kerala covering an estimated area of 242000 hectares. There is an estimated 121600 hectares of brackish marshy wetlands lying adjacent to estuaries and exposed to tidal effects. Brakishwater fishery resources is composed of several species of fishes, crustaceans and molluscs. The milk fish, the mullets and the pearl spot represent an ideal combination of species. The prawns and the crabs have the great potential for culture in brackish water ponds.

The total brakish water fish landings in 1986 was 28959 tonnes. Infact, the first brackishwater fish farm in India was established at Narakkal (Ernakulam distt.) in Kerala. There are seven farms with total area of 163400 hactares, with Ernakulam alone having 75400 hactares. They are located adjacent to tidal rivers an estuarine tracts. Tidal water is periodically taken in through a sluice gates and an exchange of water between the estuary and fish farms occur. The major groups cultivated in these farms are prawns and fishes.

Industrialisation : The Kerala coastal zone has varied complex of industries mostly agro-based and of cottage type. Cashew processing, employing 1.10 lakh workers is most important among food industries. It is mainly concentrated in Quilon district with 216 factories out of a total of 243 in Kerala in 1985. Fish product industries are located in Khozikode, Ernakulam and Quilon districts. Shrimps, lobrters and frog's legs are exported through Cochin. Tea processing, coffee curing and bidi making are important around Kottayam and Idduki. coir making is largely concentrated in Alleppey with 195 units, followed by Khozikode 36 units in 1985.

KERALA
DISTRICT-WISE REGISTERED WORKING FACTORIES 1988

Districts	No. of factories	No. of small scale Industries
Trivendrum	452	4514
Quillon	920	4828
Allepey	762	4287
Kottayam	1012	4266
Ernakulam	1855	6298
Trichur	1368	5171
Mamallapuram	487	2743
Khozikode	1317	3978
Cannanore	1380	5196

Among the forest based industries, saw-milling, plywood splint and venneers are most important with 177 and 100 units respectively in Khozikode only. Other districts are Cannanore, Quilon, Ernakulam, Trivendrum, etc. dominate. Boat and ship building industry is located in Ernakulam and Quilon districts where there are 16 units engarged in construction and repair of boats, tugs, banges. The best ship building yard is at Cochin.

The most important among mineral based industries are Indian Rare Earths Ltd. at Chavara, almunium factory at Alwaye, Cement factories in Kottayam, titanium factory at Trivendrum, fertiliser factory at Alwaye. Tiles and brick industries are located in Thrisur and Quilon districts. Cannanore has the largest concentration of cotton textiles with 450 units employing 10,000 persons in 1985. Ernakulam Khozikade, Alleppiy etc. dominate the chemical industries.

There are ten major industries in the coastal zone of kerala employing about 15000 people. They are Cochin Refinereis Ltd. Cochin, Cochin Shipyard Ltd., Cochin, Travancore Fertilisers and Chemicals Ltd., Alwaye, hindustan Latex Ltd., Trivendrum, Hindustan Newsprint Ltd., Kottayam, Hindustan Insecticides Ltd at Alwaye, Modern Food Industries Ltd., Cochin etc.

The number of registered and small scale industrial units as on 31 March 1988 was highest in Ernakulam (6298), followed by Cannanore (5196), Trichur (51710, Quilon (4828), followed by Cannanore (5196), Trichur (51710, Quilon (4828), Trivendrum (4514), Alleppey (4287) and Kottayam (4266).

Ports : The coastal stretch of Kerala is characterised by major intermediate and minor ports; namely Cochin, Neendakawra port, Khozikode, Alleppey port etc. Cochin harbour is one of the best natural harbour along the western coast of India. It handled about 6.8 million tonnes of cargo out of which 5.4 million tonnes is mineral oils and 0.7 million tones of fertilisers and raw materials etc. in 1987-88. Silting poses a major maintenance problem to the Cochin harbour, the accumulated silt having to be dradged out periodically to keep the harbour navigable.

Foreign exports from the ports of Neondakara, Khozikode and Alleppey included metals, minerals and ores, fish and prawns of about 53600 million tonnes worth Rs. 1184.23 lakhs in 1986-87. Foreign import throgh these ports are negligible.

KERALA

IMPORT AND EXPORTS FROM INTERMEDIATE AND MINOR PORTS DURING 1985-86

(Rs. in lakhs)

Name of Ports	Exports	Imports
Neemdakara Port	402.16	-
Khozikode Port	137.55	80.16
Allepey Port	-	-

Settlements : There are 1000 inhabitated villages and 100 towns in the Kerala coast. Trichur has the largest number of villages (213) and the Cannanore the largest number of towns (26) in 1991. The rural settlements comprise of homesteads surrounded by a kind of yard. In case of poor people, the humble yard is merely a swept place around the naval. The richer houses are surrounded by gardens of varying sizes.

The important urban centres are Trivendrum, Cochin, Calicut, Alleppey, Cannanore, Trichur. Partial sewerage system exists only in the cities of Trivendrum and Cochin and it is estimated that only about 2 per cent of the population of state are provided with underground sewarage system.

Transport : The Kerala coastal zone has a good network of roads, navigable rivers and backwaters and railway line. Though almost all parts of Kerala are accessible within a distance of 4 km, from a mettled road, the mobility is handicapped by innumerable channels and waterways. The frequency and speed of the water transport fall far short of the total requirements of the entire region.

The total road length in the coastal Kerala was 19750 km. in 1987, comprising state highways (2020 km.) major district roads (5937 km.) other district roads 98650 km.), village roads (3143 km.) respectively. Most ofthe roads are perpendicular to coastline. The parallelness to coastline has led to ribbon type development along these roads. This should be avoided to prevent further agglomeration of development all along the coastline.

KERALA

TRANSPORT DEVELOPMENT IN COASTAL DISTRICTS (1987-88)

National highways	839 km.
State highways	2020 km.
Other PWD roads	14587 km.
Village roads	3143 km.
Panchayat roads	84409 km.
No. of Vehicals on road	473789

The transport network of the Kerala coast has improved recently by the opening of the Kochi-Alappurzha-Karyamkullan coastal railway line. The proposed Thakazhy-Thiruvalla link railway will reinforce the transport network.

The transport network, though extensive has several qualitative drawbacks such as unsatisfactory geometrics road network, metre gauge nature of railway and somewhat silted character of the navigable rivers and backwaters.

Beach Tourism : The Kerala coastal zone has well developed bars and lagoons with discontinuous stretches of sands or sand hills. In extreme south, the cardamum hills submerge directly into sea where the sandy beaches are 200 m to 1000 m. wide. This stretch is 25 km. long at Trivendrum. The famous Kovalam beach is located here.Further north, the beaches are replaced by very narrow barriers (100-200 m) or spits or rocky cliff coasts. There is no sandy beach from Trivendrum to Cochin through Quilon.

Kappad beach near Calicut is the place which started modern history of India. From Cochin to Calicut, the shore is broken stretch of sand, partly thrown by waves and partly by alluvial deposits.

Nature has endowed Kerala with a lavish decoration of all beautiful things; blue lagoon, backwaters, golden beaches, blue-green mountain ranges, wildlife sanctuaries, temple, churches and many cultural varities and presentations attracting both foreign and domestic tourists. A total of 948991 domestic tourists arrived in kerala in 1991, while another 69309 were foreign tourists. Kovalam tourist resort alone attracted 40189 foreign tourists and 83814 domestic in 1991.

THE WEST BENGAL COASTAL ZONE

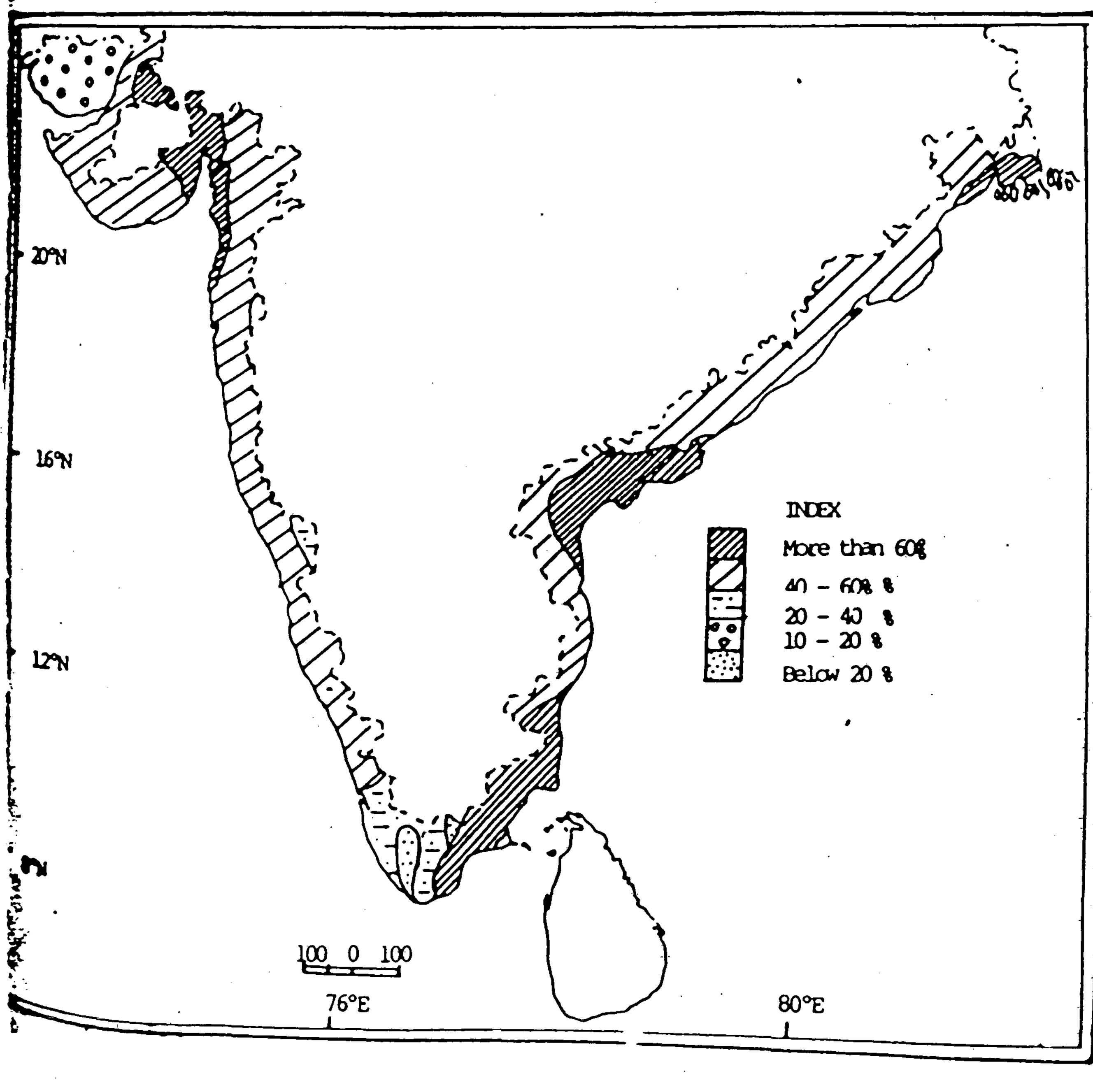
The West Bengal coastal zone embodies highly productive systems which support a braod range of economic activites. These resource offer immense scope and potential to contribute significantly to economic development in the state of West Bengal. However, being the victim of excessive anthropogenic agression and conflicts in resource use due to lack of coordination between sectors that are presently under regression. It portrays great diversity in abiotic and biotic features of 0.82 million hectares coastal area and a coastline of 210 km.

Land Utilisation : The land utilisation pattern shows that Medinipur district has a greater proportion of net soun area (64.14 percent) to total cultivated area and less amount (12.65 per cent) of forested land. By contrast the 24 Parganas has a much greater proportion (24.19 per cent) of forested land. This is because the coastal margin of this district is entirely forested comprising of 112 km wide belt popularly known as Sunderbans. The net sown area of the 24 pargana is also less being 48 per cent only. The proportion of land put to non-agricultural use is 21 per cent. The other categories exhibit insignificant proportions in both districts in 1988-89.

Agriculture : Of the 2.45 million population of the coastal West Bengal, about 80 per cent are engaged in agriculture and the rest in fisheries, collection of firewoods etc. Aboout 60 per cent of the land in Medinipur is under cultivation. The bulk of the cultivable land in both districts is under food grains. Rice is the dominant crop. High temperature, adequate rainfall and the fertile deltaic soil ensures rich harvests of rice 'Aman' crops account for about 85 per cent of the total rice production in both the coastal districts.

Production-wise medinipur has the greatest proportion in terms of all three 'auns;, 'aman' and 'boro' paddy. Other notable crops of the region include pulses potateas, oilseeds and jute. The 24 Parganas has the greatest

COASTAL DISTRICTS
PERCENTAGE OF CULTIVATED AREA



proportion (7.72 per cent) of pulses cultivation. In jute also the 24 Parganas is the leading producer.

Irrigation : The principal source of irrigation of the two districts are canals, tanks, wells etc. Medinipur shows the greater proportion among the two districts regarding each source, with 286200 hectares irrigated. The 24 Parganas has 58000 hectares of irrigated area. The Kansabati projects alone irrigates 33155 hectares in Medinipur district.

Forestry : Nearly 85 per cent of the Indian 'mangals' are confined to West Bengal and the islands of Bay of Bengal. Mangroves are examples of open ecosystems with respect to both energy and matter. The mangals have always been useful to the coastal people. The fishermen have been extracting from them firewood, planks and posts, wood for boat building thatch material, wood for making toys.

The forest area of Sunderbans with an expanse of 4264 sq. km. provide base for the indigeneous as well as large scale forest based industries including paper mills. The Sundari trees is quite famous. It also provides medicinal plants and honey collection. They provide ground for wild life preservation in the region.

Fishery : The proponderance of water bodies, natural and artificial and to some extent other factors like climate, acute shortage of agricultural lands, more than 1200 persons per sq.km. and lack of other sources of animal protein, have led to the adaptation of fisheries in the region.

The 65 km. long coastline of West Bengal has a wide continental shelf of 150 km. and an area of 20,000 sq.km. upto 200 m. depth. The shelf area has a muddy bottom and its configuration is affected by large river systems and tidal currents. There are 303 fishing villages with a fishermen population of 0.84 lakhs, 24 per cent of it being actively engaged in fishing. Of 1054 mechanised boats, 73 per cent are gill netters and the remaining are carried boats. There are 12911 gears comprising drift/gill netts, hooks and lines, shore scienes, traps and scoop nets.

The marine landing of the state varied between 5266 tonnes in 1977 and 39,910 tonnes in 1984 with an average of 19580 tonnes between 1975-1985. On an avearage 53 per cent of total catch are landing by mechanised boats. The average share of pelagic and demerasal varieties in the catch was 44 per cent 56 per cent respectively. Catfishes, non-penacid pranns, Bombay ducks, hilsa shad, etc are major catches of West Bengal coast.

Industry : The industrialisation in the coastal zone along the coastline is negligible but the Hooghly estuary is richly endowed with industrial activities of all types. The Hooghly estuaries's impact on the coastal zone is immense.

The Calcutta Industrial belt is responsible for employing about 80 per cent of the total workers in the manufacture of jute textiles. Among all groups of chemical industries, the spatial break-up being 41 per cent Calcutta, 55 per cent in the 24 Parganas and 63 per cent in Howrah. Other industries such as wood basd, leather, food-processing, fish curing, transport equipments, fertilisers, oil refinery etc. are concentrated in the coastal zone of West Bengal, especially along the Hooghly estuary.

Ports : Calcutta is the riverine port of historical significance, situated 232 km. away from the sea. It lies on the left bank of river Hooghly. The port commands a vast hinterland of about 80,000 sq.km. comprising states of West Bengal, Bihar, Assam, Orissa, as also Nepal and Bhutan. The main exports are tea, jute, ores, hides, mica, sugar, enginering goods etc. and imports are fertilisers, petroleum, cement, phosphates, edible oil, machinery etc.

On account of the perennial navigational problems faced by Calcutta, the Haldia harbour, 104 km. downstream of Calcutta, has been established. The total traffic of both the ports combined rose from 6.68 million tonnes in 1972-73 to 10.70 mt. in 1983-84.

Settlements : Medinipur district has a large number of villages and the 24 Parganas a large number of towns. The rural settleemnts comprise of compact villages with straw thatched roofs. The average rural population per village is about 1200 though there exists some micro-level variation. Linear patterns of settlements are most common along the coastal dunes. The tendency towards agglomeration is most marked in the low-lying paddy areas and along the coast where fishing is the most important occupation.

The towns are mostly over-grown villages and polarised along the Hooghly river. The Contai and Digha are the main towns along the coastline proper. The present urban centres were originally market centres, when the river Hooghly formed the main line of transport and communication for the trade and commerce.

Beach Tourism : On the West Bengal coast, Digha, Bakhali, Sagar, Frazengunj, Janbudwip, Junpur etc. are worthy centres of coastal tourism. Among these, Digha is the most attractive beach resort. It is situated on the south-western corner of West bengal in the Midnapur district adjacent to Orissa border. It is only 133 km. from Calcutta. This beach resort is developing fast and the growth rate of Digha town was 230 per cent in 1981-91.

THE ORISSA COASTAL ZONE

The Orissa coastal zone is predominantly agricultural where 82.48 per cent of the main workers are engaged in primary sector and 1.18 per cent engaged in secondary sector and 16.34 per cent of main workers in tertiary sector. The main occupation of the population includes agriculture, fishing and other activities such as forestry and animal husbandry. Paddy is the major crop besides oil seeds, pulses, and vegetables. The Mahanadi delta is highly productive.

PATTERN OF LAND UTILISATION IN ORISSA 1989-89

District	Geog. Area	Forest area	Mist. tree crops	Permanet pasture & other grazing lands	Cul-tivable waste	Land put to non-agri. uses	Barren and un-culturable land	Current fallows	Other fallows	Net area sown	Total cropped area (Excluding fruits	Area under fruits	Gross cropped area
Orissa	15540	5583	716	726	444	723	450	262	356	6280	8918	251	9169
Balasore	647	26	24	26	20	50	24	15	10	452	621	17	637
Cuttack	1089	161	30	38	42	100	10	22	13	673	1141	45	1187
Ganjam	1220	589	38	38	5	60	3	2	5	480	826	21	847
Puri	1046	312	27	66	29	67	43	19	18	465	703	43	746

Source : Statistical Abstracts 1991, Directorate of Economics & Statistics, Orissa, Bhubneswar, 1991.

Land Utilisation : The land utilisation picture of the Orissa coast is marked by 27.19 per cent of forest, net sown area 51.72 per cent, land put to non-agricultural use 6.92 per cent, permanent pasture 4.20 per cent, 1.82 per cent cultivable waste, 2.62 per cent fall under current and other fallows and the rest is devoted to tree crops, pastures and fruits etc. in 1988-89.

Of the four coastal districts of Balasore, Cuttack, Ganjam and Puri, forested tracts are greatest in Ganjam (48.28 per cent), followed by Puri (33.08 per cent) in 1988-89. Land under settlement is greatest in Balasore (10.97 per cent). Permanent pastures are also greatest in Balasore (4.79 per cent) and the proportion of cultivable wastes is highest in Puri district (3.35 per cent). Highest proportion of net sown area is seen in Balasore (65.53 per cent), followed by Cuttack (64.74 per cent) and the lowest is observed in Ganjan district (41 per cent) in 1988-89.

Agriculture : Rice cultivation is the dominant feature so far it occupies about 82 per cent of the total net sown area of the Orissa coast. Other crops include wheat, pulses, Maize, Ragi, Ground nuts, condiments and spices etc. Of the commercial crops jute is significant in Cuttack.

The proportion of area under different crops to the net sown area reveals a contrasting picture among the four coastal districts. About 93.53 per cent of net sown area in Balasore is devoted to rice followed by Puri (83.78 per cent) and Cuttack (83.67 per cent). Area under Ragi is significant in Ganajam (12.45 per cent). Area under pulses is greatest in Puri (50.66 per cent), area under oilseeds being greatest in Gnjam (12.57 per cent), and 5.07 per cent of the area is under Jute in Cuttack.

CONSUMPTION OF FERTILISERS IN ORISSA 1988-89

Districts	Nitrogenous	Phosphate	Pottasic	Total
Orissa	123.49	47.54	30.91	201.94
Balasore	11.00	3.14	2.44	16.58
Cuttack	19.86	7.98	6.55	34.39
Ganjam	21.92	5.69	2.95	30.56
Puri	14.43	2.55	2.83	19.81

Source : Statistical Abstracts 1991, Directorate of Economics & Statistics, Orissa, Bhubneswar, 1991.

The average yield of different crops in coasal Orissa is quite good. Ganjam tops with 18.84 quintal per hectare, followed by Cuttack (14.15 qtl./hectare), Puri (13.42) and balasore (12.84 qtl/hectare) in 1988-89. Balasore tops in Ground nut yield with 19.12 qtl/hectare.

The consumption of fertilisers-nitrogenous, phosphate and potassic is quite substantial in the coastal zone of Orissa. About 50 per cent of the total fertilisers used in the state (201.94 thousand million tonnes in 1988-89) is consumed by coastal districts alone. Among coastal districts, it is Cuttack which tops with 34.39 thousand million tonnes of fertilisers. The intensity of cropping is very high in Cuttack and Puri districts of the coatal zone.

Irrigation : Of the irrigation facilities existing in coastal zone, mention can be made of the famous Mahanadi delta project that irrigates about 68,000 hectares in Cuttack and Puri districts. The Taldanda canal is also an irrigation canal in the Mahanadi catchment area. The largest proportion of the area under the major and medium irrigation projects in coastal Orissa lies in Cuttack, the largest area under minor flow irrigation and irrigation by traditional methods is in Ganjam district. Area under minor lift irrigation system is also highest in Cuttack. About 485.90 thousand hectares of Cuttack is irrigated, followed by Ganjam 281 thousand hectares in 1988-89.

Forestry : About 27.19 per cent of the coastal districts area is forested. Forested area is quite high in Ganjam (48.28 per cent) and Puri (33.08 per cent) and so forestry constitutes an important occupation of the people. Ganjam has 1886 sq.km. under reserved forest and 3126 sq.km. as protected in 1989-90. The major products are timber, firewood, bamboos, tendu leaves etc. and minor products are gums and resins, lacs, honey, fodder etc. Balasore is the least in reserved forests (208 sq. km.) and only 46 sq.km. of protected forests.

Fishery : Orissa has a coastline of 480 km. and a continental shelf area of 25,000 sq.km. forming 8 per cent and 4.5 per cent respectively of the country's total. The state enjoys a heavy south-west monsoon contributing 90 per cent of the total rainfall, the average being 148 cm. The coast is, however, cyclone prone. Total fishermen population is 1.17 lakhs spread among 20329 households. The 26 per cent of this population is active fishermen. There are 236 fishing villages and 68 landing centres. The main infrastructural facility is the Paradeep fishing harbour with freezing, ice producing and other facilities.

DISTRICT-WISE FISH PRODUCTION IN ORISSA IN MILLION TONNES (IN 1989-90)

Districts	Fresh Water	Marine Water	Brackish Water	Total
Orissa	50500	77895	25370	153765
Balasore	4471	40499	567	45837
Cuttack	5873	23635	14313	43821
Ganjan	7787	5456	2128	15371
Puri	4553	8005	8362	20920

Source : Statistical Abstracts 1991, Directorate of Economics & Statistics, Orissa, Bhubneswar, 1991.

South Orissa, comprising Ganjam, Puri and southern parts of Cuttack has a narrow continental shelf (about 40 km) and open sandy beaches whereas northern Orissa is characterised by an extended continental shelf (about 120 km), intertidal flats, and extensive river deltas. The distribution of marine crafts and gears in the state is closely related to the diversity of marine ecology. There are 745 mechanised vessels in the state, of which 470 are trawlers and the rest gill netters. Non-mechanised crafts numbered 10450 with a total of 33936 fishing gears consisting of mainly trawl nets, drift gillnets hooks and lines, shore seines, fixed bag nets, small purse seiners and boat seines.

During the decades 1975-1990, the total marine catch from the state varied between 15072 tonnes (1977), 46773 tonnes (1984) and 77895 tonnes in 1990, with an average of 35000 tonnes. About 53 per cent of the total catch are landed by mechanised vessels. The contribution of pelagic fishes was 61 per cent in 1977 and 33 per cent in 1984 showing a declising trend, whereas an increasing trend was observed in the case of demersal fishes reaching a maximum of 67 per cent in 1984. Croakers, catfishes, pomfrets, other sardines, hilsa shad and prawns formed the important fisheries of Orissa. A new development in the fishery of Orissa is the landing of oil sardines and mackerels.

The brackish water areas of the state suitable for fish culture are about 60,000 hectares. Prauns and mullets, milk fish, pearl spot etc, are produced. The culture of crabs, musseles, oyesters, seaweeds etc. are also available. The

NUMBER OF FISHING CRAFTS AND GEARS IN ORISSA 1982

Districts	FISHING CRAFTS			FISHING GEARS							
	Mechanised	Non Mech-anised	Total	Draught	Gillnet	Trawlaet	Castnet	Share Scienes	Spaun Collecting nets	Others	Total
Orissa	2763	16324	19087	59958	38506	40872	108406	4237	3371	222495	477845
Balasore	1801	1053	2854	15161	14416	14778	29286	1329	534	1993	77467
Cuttack	596	5392	5988	15621	10130	10490	51545	1092	1979	70630	161487
Ganjam	318	1758	2076	2654	1303	751	733	138	40	982	6601
Puri	7	5401	5408	11442	6506	4253	10042	1426	419	88717	122805

Source : Statistical Abstracts 1991, Directorate of Economics & Statistics, Orissa, Bhubneswar, 1991.

total production of brackish water fish was 25370 tonnes in 1989-90.

Industrialisation : Despite considerable industrial development since independence, coastal Orissa lags behind compared to other maritime states of the country. The Jajpur-Cuttack-Khurda Raod zone and Paradeep port zone are the most important industrial complex in the coastal Orissa. Cuttack and its industrial suburbs, Chandwar, are the primary ones comprising large and medium scale industries. They are galvanised tube factory, composite textile mill, paper mill, steel re-rolling factory, rice mills etc. A glass and ceramic factory at Barang, ferro-chrome factory at Jajpur road and a railway workshop at Khurda road are important. This zone is quite linked to Paradeep through rail, roads and the Taladanda canal.

ORISSA

MINES AND FACTORIES IN COASTAL DISTRICTS (1987-89)

Districts	No. of reported factories (1987-88)	No. of salt factory (1989)	No. of mines working (1989)	Area covered by mines (in hect.)	Prod. of salt in MT
Orissa	1236	6	406	94998	103221
Balasore	94	-	-	-	-
Cuttack	203	-	23	8357	-
Ganjam	98	-	1	2878	-
Puri	266	-	6	339	-

Source : Statistical Abstracts 1991, Directorate of Economics & Statistics, Orissa, Bhubneswar, 1991.

The Aska-Barhampur-Sumandi zone is located in Rushikulya river plain and the industries here are of a medium type. At Aska a sugar industry is operating. Sunandi has a East Coast salt and chemical factory, while at Ganjam a caustic soda plant is located.

The growth of industries at Paradeep is immense. It has a steel plant, a fertiliser plant, ship building yard etc. in addition to its normal port activities. A rare earth plant is located at Gopalpur coast. It is evident that most industries of cosatal Orissa are locates along Mahanadi-Brahmni catchment, Rushikulya catchment, Paradeep port and on Gopalpur coast. The number of reported factories in 1987-88 was highest in Puri districts (266), followed by cuttack (203), Ganjam (98) and Balasore (94) respectively.

Ports : The Orissa coast is primarily aggradational and the recent upliftment has made it even more shallow. The strong monsoon winds have developed sand bars. These have restricted and checked the establishment of ports. However, it has one major port at Paradeep and few minors ports at Chandbali, Gopalpur, Bahabalpur etc. Paradeep which was declared a major port in 1966 has been developed to handle 6.05 million tonnes of traffic while Gopalpur which was declared a seasonal port in 1987 has been developed to handle 5.25 lakh tonnes of traffic.

The Paradeep port has an artificial lagoon type harbour protected by two breakwaters, 538 metres long in north and

1217 metre in south. It has approach and entrance channels with a draft of 12.25 metres, and a turning basin with a diametre of 520 metres. This port mainly handles iron-ore export and import of coal and fertilisers.

Settlements : Coastal Orissa has 18501 inhabitied villages and 44 towns. Cuttack district has largest number of villages (6036), followed by Puri (4448) and Gajam tops the number of urban settlements. The maximum number of big villages are found in the coastal districts. Big villages are only 2 per cent of the rural population lives in them. About 80 per cent of population is rural.

The settlement pattern is generally linear clinging to the roads and river leaves, avoiding flood prome areas. In the shore areas settlements have developed in between the coastal sand ridges which run almost parallel to the shore. The villages are compact and houses are mostly thatched.

In coastal Orissa, there are two urban belts - one containing Cuttack, Bhubneswar, Chowdwar etc. and other smaller one consisting of Berhampur, Chhatarpur, Gopalpur etc. Other towns like Balasore, Puri, Chadbali, Paradeep are rather isolated centres. The coastal towns have 50 per cent of the urban population.

Transport Network : Coastal Orissa has well-integrated transport network. Roads radiate from six focal points - Balasore, Bhadrak, Jajpur, Cuttack, Bhubneshwar, Berhampur. The coastal district had 400 km of National Highways (NH)

LENGTH OF DIFFERENT TYPES OF ROADS IN ORISSA (in km.) 1988-89

	National highway	State highwat	Express ways	Major dist. roads	Other dist. roads	Classified village roads	Munici-pal roads	Forest roads	Irri-gation roads	OSEB roads	Panchyat Samiti roads	Gra Pan
Orissa	1624	2928	68	6396	2643	7333	8697	6942	2294	46	25490	137
Balasore	106	52	-	501	129	220	1171	59	58	5	1719	3
Cuttack	193	106	59	649	454	973	898	234	219	2	3392	9
Ganjam	87	299	-	721	379	533	718	580	262	-	1718	4
Puri	109	266	-	1038	316	476	1410	525	181	-	1703	18

Source : Statistical Abstracts 1991, Directorate of Economics & Statistics, Orissa, Bhubneswar, 1991.

and 725 km of state highways and Cuttack had 59 km. of Expressways in 1988-89. In the coastal zone due to heavy pressure of population, mettled road per 0.1 million people are substantially low about 40 km. of mettled roads per lakh population while road density per thousandsq.km. of area is taken into account the Cuttack district has the maximum (115 km.) length of raods, followed by Puri (112 km.), Ganjam (107 km.) and Balasore (105 km.). All these districts are well developed so far as the road is concerned.

The spatial distribution of railroad in coastal zone is more or less uniform. It has about 700 km. of railroute. The coastal railway handles about 81 per cent of the passenger traffic of the state and links the maximum urban centres. Inland waters ways are not prominent now. Only Taladanda canal serves middle and northern coastal plains substantially. Most of the rivers are having navigational use and they carry goods and passengers during monsoon months like Mahanadi, Brahmni, Baitarni, Salnadi, Devi Nadi etc., coastal shipping (local) is also very limited except for small traffic of fish from Bahabalpur, Gopalpur etc.

Coastal Tourism : The sea beach of Chandipur, the Bitarkanika sanctuary, Dunghmal crocodile project, Satbhaya turtle rookery, Dhamra confluence, the beaches of Astaranga, Konark and Puri, Sun temple at Konark and Jagannath temple at Puri, the beaches of Aryapali, Barkul Gopalpur-on-sea etc. are significant tourist spots. Chilka, the largest brackish water lake in Asia is a great tourist attraction for fishing, boating, bird watching etc.

NUMBER OF TOURIST BUNGLOWS, TOURISTS VISITED AND INCOME FROM TORUISTS IN ORISSA (1988)

Tourists Centres	No.of room	No.of beds	Guests Checked In Indian	Foreigner	Total	Total income (in Rs.)
Orissa	258	556	47427	2547	49974	4094016
Puri	49	106	12380	410	12790	870642
Panth Bhavan (Puri)	9	18	1806	30	1836	134878
Cuttack	34	68	4185	67	4252	445776
Chandipur	11	30	4219	543	4762	274207
Konark	9	22	2487	246	2733	80018
Traveler's Lodge (Konark)	4	8	639	44	683	24166
Barkul	18	36	4643	139	4782	169068

Source : Statistical Abstracts 1991, Directorate of Economics & Statistics, Orissa, Bhubneswar, 1991.

All these tourist centres attracted 30359 domestic tourists and 1500 foreigners and total income from rooms and beds were Rs. 21 lakh in 1988-89. This income ways 50 per cent of the total for the state. The tourism potential of the coastal zone is immense. The tourism as an industry has still long way to go in Orissa. Modern hotels and luxury boardings are coming up recently but without regard for environmental protection.

THE ANDHRA PRADESH COASTAL ZONE

The Andhra coastal zone is rich in natural resources (both land and water) and experiencing intense man-environment interaction. The most intense feature of Andhra coast endowed with estuaries and delta of Krishna and Godavari is intese agriculture, port activities, urbanisation and industrialisation, fishing etc. The 750 km. long coastline has wide continental shelf which varies between 35 and 40 km except off Krishna and Godavari rivers where it is only about 15 km wide. Several mineral deposits including the oil and gas have been reported in the coastal and off shore regions of Andhra Pradesh.

Land Utilisation : In coastal Andhra the largest proportion of land is under net sown area (3722314 hectares), about 40.23 per cent of the total geographical area indicating the imporatnce of agriculture as an economic activity. The forest occupies 17.20 per cent, land put to non-agriculture use 11 per cent, barren and uncultivable land 9.70 per cent, current fallows and other fallows 13.23 per cent, permanent pasture 3.27 per cent etc of the available land in 1986-87.

Vishakhapatnam is covered by 41.50 per cent forest and 26.40 per cent net sown area in 1986-87. The highest proportion of barren and uncultivable land is found in Vishakhapatnam. The highest proportion of land is under net sown area in Krishna (57.21 per cent) followed by West Godavari (54.58 per cent).

ANDHRA PRADESH

LAND UTILISATION IN COASTAL AREA 1986-87

Land Utilisation

Sl. No.	District	Forests	Barren and uncultu-rable land	Land put to Agricu-ltural uses	Culturable Wastes
1.	Srikakulam	70391	62792	74454	11950
2.	Vizianagaram	111661	84420	73599	7318
3.	Visakhapatnam	470835	176854	77853	14741
4.	East Godavari	323148	84236	107815	31644
5.	West Godavari	81186	50320	89205	41834
6.	Krishna	66301	67220	104108	45327
7.	Guntur	156100	42934	145979	63605
8.	Prakasam	212066	131334	145300	93068
9.	Nellore	98852	196485	199783	62840
Coastal Andhra		1590540	896595	1018096	372327

District-Wise, 1986-87 **(Area in Hectares)**

Permanent Pastures and other grazing lands	Land under Misc.tree crops and groves,not included in in net area sown	Current fallows	Other fallow lands	Net area sawn	Geographical area by village papers
2394	3753	26356	12299	319901	584290
5957	8912	15075	6628	316468	630038
6899	13018	51533	23172	299359	1134284
32855	9776	55943	24646	411780	1081843
24873	8574	40095	25891	417560	779538
21945	6685	67195	24255	476658	879694
25935	45969	21473	33347	597482	1132824
61143	12468	246009	240342	572332	1714062
120481	16363	121481	189003	310754	1316042
302482	125518	645160	579583	3722314	9252615

Agriculture : As in the Orissa coast, rice is the dominant crop in Andhra coastal zone also, which accounts for 47.7 per cent of the total net area sown in the coastal districts, mainly in the delta districts of West Godavari (75 per cent) East Godavari (63.5 per cent), Krishna (55 per cent), Srikakulam (52.5 per cent) in 1986-87, Bajra is mainly concentrated in Vishakhapatnam (14 per cent). Jowar is concentrated in Prakasham (14.5 per cent). Krishna (23.5 per cent) and Guntur (23.8 per cent) are main producer of Pulses. Vizinagaram has 21.2 per cent area under groundnut. Prakasham has 7.5 per cent area under Tobacco and Guntur with 16.3 per cent area is the top producer of cotton in the coastal zone of Andhra in 1986-87. The cropping pattern of this coast has adjusted itself ot the existing pattern of irrigation, soils and rainfall facilities.

The four irrigated districts of Vishakhapatnam, East and West Godavari and Krishna have high intensity (135 per cent) of cropping. The yeidl per hectare of rice in coastal Andhra is quite high (2033 kg/per hectare), sugarcane (5513 kg/hectare), Tobacco (1868 kg/hectares) etc. in 1986-87. Guntur East Godavari, Krishna have the high yields pattern. Coastal Andhra produced 4630250 tonnes of rice (70.25 per cent of the state total) in 1986-87. Thus it is not only the "rice bowl" of state but of the country too.

The consumption of chemical fertilisers (NPK) is quite high in Coastal Andhra, more than national average of 65 kg/hectare.

Irrigation : The coastal Andhra is rich in irrigation facilities. The Godavari ancient and Krishna anicut canals irrigate 0.7 million hectares as far as Koleru lake. Canals forms a network of irrigation and navigation. The Krishna east bank canal irrigates about 5 lakh heactres. The pennar cannal system irrigates about 68000 hectares. Thus 75 per cent of the irrigated area in coastal Andhra is irrigated by canals.

ANDHRA PRADESH

NET AREA IRRIGATED BY SOURCES - DISTRICT-WISE, 1986-87

Sl. No.	District	Net Area Irrigated By: Canals	Tanks	Tube wells	Other wells	Other sources	Total	Area Irri-gated more than once.	Gross Area Irrigated
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Srikakulam -	83403	92435	3320	10361	3454	192973	7100	200073
2.	Vizianagaram -	30485	95148	509	4585	2518	133245	9607	142852
3.	Visakhapatnam -	52113	42722	2263	3585	15810	116493	14504	130997
4.	East Godavari -	200303	32826	21294	3990	4417	262830	153480	416310
5.	West Godavari -	219259	41982	71147	4413	7970	344771	203864	548635
6.	Krishna -	278795	35760	15685	7212	10221	347673	96010	443683
7.	Guntur -	312613	2831	14145	1808	4916	336313	7655	343968
8.	Prakasam -	95253	25669	1600	34168	10380	167070	26092	193162
9.	Nellore -	71054	94416	36969	32976	4121	239536	23073	262609
Coastal Andhra	-	1343278	463789	1669326	103098	63807	2140904	541385	2682289

The total gross area irrigated in 1986-87 was 2682289 hectares in coastal Andhra. Tanks and wells dominate Srikakulam Vizinagaram, Vishakhapatnam, Praksham and Nellore districts.

Froestry : Tropical moist deciduous and littoral forests are found in Godavari districts, Vishakhapatnam, Nellore etc. Guntur has 8564 sq.km. of reserved and protected froests, Vishakhapatnam 6545 sq.km. and Rajmuhandry has 4707 sq.km. respectively in 1986-87. Major forest produce are Timber, firewood, bamboos, etc. Mangrove forests also play dominant role in forestry activity. The Coringa island mangrove is quite famous (1200 sq.km.).

ANDHRA PRADESH

FOREST AREA UNDER THE CONTROL OF FOREST DEPARTMENT - CIRCLE-WISE, 1986-87

(Area in Sq. Kms.)

Sl. No.	Circle	Reserved	Protected land	Unclassed	Total
(1)	(2)	(3)	(4)	(5)	(6)
1.	Guntur	8109	450	5	8564
2.	Warangal	4561	1634	68	6263
3.	Visakhapatnam	3374	3081	90	6545
4.	Rajahmundry	3900	807	..	4707
	Total	**50099**	**12245**	**1431**	**63775**

Source : Chief Conservator of Forests, Andhra Pradesh

ANDHRA PRADESH

VALUE OF MAJOR FOREST PRODUCE IN Rs.

Sl. No.	Circle	MAJOR FOREST PRODUCE		
		Timber	Firewood and Charcoal	Total
(1)	(2)	(3)	(4)	(5)
1.	Guntur	1355	2093	3448
2.	Warangal	29076	3012	32088
3.	Visakhapatnam	8207	5258	13465
4.	Rajahmundry	75603	17242	92845
	Total	**239901**	**43243**	**283144**

Source : Chief Conservator of Forests, Andhra Pradesh

Fishing : With a coastline of 980 km, continental shelf at 31000 sq.km. discharge of two large rivers - Godavari and Krishna, rivulets and estuaries; and enjoying copious rainfall of both monsoons, fishing is the primary economic activity almost all along this coastal stretch. The annual marine fish catch is about 1,26,000 tonnes and accounts for 9.4% of the total marine fish production in the country. The most common marine fishes are seer, silver belies, starks, mullets, cat fish, perches and pomfrets etc.

There are nine coastal districts with a total of 453 fishing villages and 280 landing centres. The total fishermen population is 3.30 lakhs in 74000 households. About 26 per cent of the population is actively engaged in fishing activities. There are about 580 trawlers and 36000 non-mechanised boats in the state. Catermarn (62 per cent) dominate amongst the non-mechanised crafts followed by plank-built boats (31 per cent) and dug-out canoes (5 per cent). The fisheries harbour at Vishakhapatnam, Kakinada, Nizampattnam, Krishnapattnam, have infrastructural facilities catering to the small and large mechanised fishing vessels. Pelagic varities dominate the catch.

The brakishwater fish culture in Andhra coastal zone is picking up. It has brought 220 hectares under prawn culture out of potential area of 1,50,000 hectares. In Kollelu lake area, the villagers practices aquaculture of fresh fish in 7000 acres of tank.

Mining : Mining activities are carried on in many coastal districts. Vizinagaram produces limestone (46141 tonnes), maganese (50746 tonnes), Vishakhapatnam produces Apatite (4050 tonnes), Graphite (58 tonnes), Mica waste (9 tonnes) and quartz (241 tonnes) in 1986-87. West Godavari produces ballclay (40069 tonnes) chronite (20 tonnes), Kaolin (12696 tonnes) felsfar (3 tonnes), fire clay (4591 tonnes). Prakasham produces bayrites (194 tonnes), Quartz (539 tonnes), Silicasand (458 tonnes), and slate (420 tonnes) in 1986-87.

Industrialisation : The coastal stretch of Vizianagaram and Srikakulam districts is not much industrialised. However, one paper mill, M/s. Vamsadhara Paper Mills Ltd. at

Napadapam in Srikakulam district is situated nearly 16 km. from sea shore and this industry discharges about 3120 m^3/day effluents into the river Vamsadhara which ultimately joins the sea at Kalingapatnam. At Naupada, there is another East Coast Marine Chemicals Ltd. dealing with magnesium salt recovery.

ANDHRA PRADESH

INDUSTRIES AND TRANSPORT 1987-88

Districts	No. of Industries	No. of Vehicles on Road
Sri Kakulam	172	8442
Vizinagaram	203	7816
Vishakhapatnam	269	60160
East Godavari	656	73046
West Godavari	512	49755
Krishna	568	71735
Guntur	872	30329
Prakasham	383	7072
Nellore	193	13014

In the Vishakhapatnam coastal stretch industrial activity is concentrated around Vishakhapatnam city only. The major industries are Hindustan Polymer Ltd., Hindustan Zinc Ltd., Hindustan Petroleum Ltd., Coramandal Fertilisers Ltd., Coastal Chemicals Ltd., Vishakhapatnam dairy, Bharat Heavy Plates and Vessels and the industries concerned with Naval Defence are located. These industries are discharging their effluents amounting to about 4 lakhs m^3/day into the Mehandrigedda drains which drains into the sea through harbour channels. The Vishakhapatnam steelplant with a capacity of 3 million tonnes is discharging its effluents (approximately 7680 M^3/day) into the sea.

In East Godavari district coastal stretch, there is no idnustrial activity noticed except at Kakinada. However, two fertilisers industry with a capacity of 9 lakh tonnes of urea, DAP per year are located. Intense salt pan activity using underground water is also found at Coriage island. In Krishna and West Godavari stretches too, no industries are located on the coast, but large number of industries are located on the banks of river Krishna and its rivulets towards inland, thereby discharges reach the sea after traversing long distances. Salt pan activity is observed at Machilipattnam.

Prakasham and Guntur coastal stretches do not have any notable industries unfriendly to environment. However, salt pan activity is observed at Kottapattnam. There are few industries located in the Nellore coast on the banks of river Pennar. These include Circar Paper Mills, Nellore Thermal Power Plant, Indo Nation Ltd. and a Sugar industry which discharge their effluent into the river. The latter ultimately reaches to the coastal waters. Indo-Natinal Ltd's (Nippo Battery Plant) effluents drain finally to Pulicut Lake.

Ports : There is one fishing harbour with a channel length of 750 metres and a width of 50 metres at Bhavanpadu in Srikakulam. There is a major port constituting inner and outer harbour at Vishakhapatnam, handling about 11.7 million tonnes of cargo materials. The principal cargo handled are iron ore, maganese, steel materials, sugar, almunia, fertilisers, petroleum products, cement, coking coal machinery etc. There is one fishing harbour adjacent to the outer harbour.

There is a port at kakinada which handles about 1.15 million tonnes of cargo every year. The cargo materials handled are fertilisers, rice bran, tobacco, pulses, grams, and fruit products. There are two ports at Machilipattnam, the old one and the new one. The old one is exclusively used for repair of boats and fishing trawlers. The new port is used for cargo handling. Nizampattnam in Guntur district is having a fishing harbour with loading and unloading facilities, sorting platforms, boat repair facilities and storage godowns.

Settlements : The rural settlement in Andhra coast (Krishna and Godavari delta), there has a tendency to form small nucleations along canals and on high grounds or levees to avoid floods. There are linear settlements evenly distributed along the coastline and transport limes. Urban settlements have the tradition of european powers such as Michillipattnam, Kakinad, Nizampattnam etc.

There are about 21 coastal villages with a total population of 63,278. There is no town close to the coast on Nellore coastal stretch. However, Nellore town with a population of more than one lakh is situated 29 km from the seashore. The untreated domestic sewage of Nellore is let out into the Zafar Sahib canal which ultimately joins the sea but because of long distance the sewage does not reach the coastal waters.

Prakashan and Guntur coastal stretch have 33 coastal villages with a total population of 37,020. There are three towns, Ongole, Chirla and Kottapattnam along this coastal stretch having a population of around 1.25 lakhs each. However, the domesitc sewage of these towns do not reach the coastal waters.

Krishna West and East Godavari coastal stetch has 76 villages with a total population of 2 lakhs. Machillipattnam and kakinada are two important city along this stretch and have a population of 2 lakhs and 2.5 lakhs respectively. Machillipattnam has no sewerage system and the domestic effluents is being letout into small drains in different places of the town, where it percolates into the soil. Domestic effluents of kakinada are being discharged into kakinada canal which ultimately joins the sea near port area. Other town are Antarvedi, Rajamundary, Elleru, Bheemavaram, Vijayvada etc.

Vishakhapattnam coastal stretch has 59 coatal villages with a population of 64753. Vishakhapatnam is the major coastal city in this stretch with a population of about 10.52 lakhs in 1991. There is not sewage system and the domestic sewage also finds its entry into coastal waters through the Mehandrigedda drain. Bhimunipatnam is another coastal town situated about 30 kms north of Vishakhapatnam.

Vizianagaram and Srikakulam coastal stretches have about 124 coastal villages having a population of 102174. Small towns of Bavanpadu, Nampada, Narasanpatta, Kalingpattnam etc. are located in this stretch. Sewage from Kaligapattnam and Gopalpur-on-sea town are drained to sea.

Transportation : The Andhra coastal zone has well developed infrastructure and other facitlities. Roads connect both the small and large towns making most the region accessible. Railway network is quite developed. There are about 23 large and medium canals in the Krishna-Godavari deltas including the Buckingham canal, but most of them are out of use for transportation.

ANDHRA PRADESH

ROADS MAINTAINED BY THE P.W.D. (R.&B.) - DISTRICT-WISE, 1986-87

(In. Kms.)

Sl. No.	District	Cement Concrete	Black top or Asphalt	Metalled (W.B.M.)	Un-mettalled	Total length of Roads
1.	Srikakulam	..	927	152	18	1097
2.	Vizianagaram	..	735	186	42	963
3.	Visakhapatnam	..	1012	232	27	1271
4.	East Godavari	..	1695	204	37	1972
5.	West Godavari	..	1384	296	19	1699
6.	Krishna	..	1554	412	236	2202
7.	Guntur	..	1735	287	212	2234
8.	Prakasam	..	1583	258	208	2051
9.	Nellore	..	1460	116	40	1616
	Total		12085	2179	839	15103

Source : Chief Conservator of Forests, Andhra Pradesh

Coastal Andhra had 15103 kms of roads in 1986-87. Guntur, Krishna and Prakasham had more than 2200 km of road respectively in 1986-87. About 45 per cent of the total road length (35382 km) in state is found in coastal Andhra. These road length are maintained by state PWD exclusively.

Coastal Tourism : The coastal tourism in Andhra is not much developed. However, beach recreational activity in Nellore coastal stretch is noticed at Maipadu, which is about 20 km from Nelore town. Patlapalayam is another coastal village. Where Vellankanni church is existing. Nellapattu bird sanctuary in Pulicat lake is an attractive tourist spot.

Kottapatnam in Prakasham and Guntur coastal stretch is a tourist place and during festival days more than 4 lakhs people come to this place for sea bathing. Vadarevu beach, 7 km from Chirta town is another tourist place. Gundaypalam coastal village, where the Gundlakamma river joins the sea, is proposed to be developed as tourist centre.

Krishna and Godavari coastal stretch have Manginapudi beach at Machillipattnam is only one recreational beach. Antarvedi, the confluence point of Vaisistata Godavari river, is a pilgrim centre, where lord Lakshmi Narasima temple is situated. During festival days lakhs of people visit this place for sea bathing. Kolleru lake bird sancturary is another tourist spot.

The Kakinada beach and Carriaga Island wildlife sanctuary are the most important recreational centres in the

East Godcavari district coastal stretch. Bhimunipatnam beach situated about 30 km from Vishakhapatnam city where Gosiani river joins the sea and Vishakhapatnam beach are places of recreational tourism in this sector. Recreational beach activity is also found at kalingapattnam attracting large number of tourists in Srikakulam coastal strech.

Thus an excellent potentialities exist along the Andhra coast for beach tourism in near future, especially Vishakhapatnam coast which can be better utilised for recreational activities.

THE PONDICHERRY COASTAL ZONE

The Pondicherry coastal zone comprising of four small district of Pondicherry, Karaikal, Yanam and Mahe (on the west coast of India) has been quite active in man-environment interaction since European arrivals., The intense population pressure and multiple use of coastal resources are likely threat to the symbiotic relatioinship, bewteen man and environment in this coastal stretch. Mahe (3714 persons/sq.km.) are highly urbanised and industrialised districts.

Land Utilisation : The netsown area (63.16 per cent of the total area) indicates the significance of agriculture in this coastal stretch. The land put to non-agricultural use (for settlements and urbanisation and industrialisation 23.91 per cent of the total area) is quite notable. When compared among the four units. Mahe has the highest proportion of net sown area (85.56 per cent) followed by Karaikal (73.76 per cent). Proportion of land put to non-agricultural use is highest in yanam (41.09 per cent) and this may be because census reports it as totally urban. Forest does not exist in this territory.

Agriculture : Pondicherry coast is also an important rice cultivating area. Three crops of rice are normally raised annually. About 64.92 per cent of the total cropped area is under paddy cultivation with a total production of 78,306 million tonnes forming 87.41 per cent of the total food grains production of this union territory. The other important crops grown are ragi, pulses, spices, cashewnuts, topioca, onion etc. Plaintain and mangoes are grown mainly among fruits cultivation. Among commercial crops, sugarcane (4.25 per cent of the cropped area), cotton (1.18 per cent), groundnut (5.62 per cent) are important.

Irrigation : Tube wells dominate the irrigated area (43.03 per cent of net irrigated area 25714 hectares), followed by canal irrigation (42.28 per cent). Tank and ordinary wells irrigate 13.86 per cent of the total irrigated area. The other sources are springs, channels ponds etc. Mahe and Karaikal have the largest area under irrigation compared to Pandicherry and Yanam.

Fishing : There are 26 fishing villages and as many landing centres in this centrally administered area; the breakup being karaikal - 04, Pondicherry-15, yanam-1, and Mahe-1. total fishermen population was 25000 in 4600 households and 22 per cent of the population is actively engaged in fishing. The total landing from the area was 23000 tonnes in 1989. The contribution of mechanised boats was 40 per cent and the rest by the non-mechanised boats. Pelagic varieties formed 60 per cent of the catches and the demersal 40 per cent. Other sandines, carangids, anchories, perches, Indian meckerels, silver bellnies, crabs etc. were the main contributor to the total catch.

Fishing constitutes an important economic activity for the people of Pondicherry. Pondicherry and Karaikal together produces 75.83 per cent of the total marine catch followed by yanam (15 per cent) and lastly Mahe (10 per cent).

Industrialisation : Pondicherry draws power from the Pykara and Mettur projects of Tamilnadu. There is notable mining activity. But industrially, it is quite prominent. There are six textiles, two sugar, one paper, one caustic soda unit and one ceramic units in this coastal stretch of Pondicherry. Pondicherry distillery is also important. There are 19 medium scale industries that provide employment to 2000 persons.

Tourism : Pondicherry is a living monument of French culture in India. Situated on the Coromandal coast it reposes in the eternal embrace of the tidal waves. Thus the territory attracts tourists in its places such as beach, Auroville

Palace, Aurbindo Ashram, Ousteri lake, Joan of Arc. square, churches and temples. Recently it is noticed that Pondicherry beach is threatened by dischanges from Pondicherry distillery and municipal sewage dischanges of the city.

Settlements and Infrastrucutre : The whole territory has 291 inhabitated villages and six urban centres. Pondicherry township has all the urban facilities and famous educational and cultural centres. It is also the industrial hub of the area.

THE TAMILNADU COASTAL ZONE

The Tamilnadu coast has a length of approximately 1000 km, from Ennore to Cape comorin in Kanyakumari district. The beaches, historically important sites, mangroves and wild life sanctuaries at Pichavaaaraam, the Pulicat lake, bird sanctuary at Point Calimere, are important sites that need to be presesrved for posterity. The intense agricultural and fishing activities, ports at Madras. Tuticoran, Cuddalore, Bagapattnam are major features of the Tamilnadu coastal zone. Besides this, there are four district headquaarters along the coast and hundreds of villages and townships with the population subsisting on sea-based economic activity.

The Tamilnadu Coast has generally been known to have a clean environment for centuries and stood as an example of sustainability. However, in the last two decades, in the wake of urbanisation and industrialisation, the coast has been subjected to environmental stesses like polllution by oilspills, sewage and industrial liquid and solid wastes. It seems the man-environment interaction is quite intense in this coastal zone.

LAND UTILISATION:- The land utilisation picture of Tamilnadu coastal zone reveals 5.44 percent of the total area under forests, 4.38 percent barren and uncultivable, 18.97 prercent of the land put to non-agricultural and urban uses, 3.07 percent cultivable wastes, 1.22 percent under pastures and 17.72 percent are fallow lands. Thus 46.10 percent of the land is under net sown area and this proportion is much less compared to Kerala or Orissa coast.

Among the districts, Kanyakumari has the highest proportion of land under forests (32.55 percent), 100 percent of the total land of Madras is under urban landuse, followed by Puddukottai district (27.30 percent). Cultivable waste is highest in Tirrunvelli district (5.35 percent), whereas fallow lands are the greatest in the Ramanathpuram (24.15 percent). The proportions under permanent pasture is negligible in all districts.

The net sown area is highest in Thanjavur (64.96 percent), known as the granary of south India, followed by S.Arcot (53.33 percent), Changalpaattu (31.26 percent), Rananathpuram (48.20 percent), Puddukottai (41.351 percent) in 1986-87.

TAMILNADU

LANDUSE IN COASTAL DISTRICTS 1986-87

Districts	Total Geog area (in hect)	Forest	Barren and in-cultiv-land	Land put to non-agri. uses	Cultiv-able waste	Permanent pastures	Total cropped area
1. Madras	17097	-	-	-	-	-	-
2. Chagalpattu	785606	43098	34871	203297	18692	27097	284370
3. South Arcot	1089984	71276	94491	143715	32323	7361	739568
4. Thanjvur	821249	11725	36093	151153	20309	3844	803924
5. Puddukotti	466329	23738	9812	122954	14253	5305	203508
6. Ramanathpuram	421779	4181	4961	79860	4311	856	211037
7. Tirnveli	681629	123801	25456	93618	39274	13233	150719
8. Chidambarnar	459054	12756	16406	68447	19394	8583	234074
9. Kanyakumari	167327	54393	3368	24051	113	100	91737

Note : Net soun area in Tamil Nadu coast is 2155954 hect. and Paddy area 1309216 hect.

AGRICULTURE :- A large number of crops are cultivated in the Tamilnadu coast. These include paddy, Combu, Cholam, ragi, maize, pulses, oilseeds, condiments and spices, sugarcane, ginger and cotton. Besides, a wide variety of fruits and vegetables are also grown.

Rice is by far the most important crop covering 6.0 percent of the net sown area of Tamilnadu coastal districts (1309216 hectares) in 1986-87. Thanjavur has the largest in 1986-87. Thanjavur is also the leading pulses producer. It is attributable to the fertile Kaveri deltaic soils and high technology input in cultivation. Puddukottai has the largest portion of land under groundnuts (21.58 percent), whereas the Tirunvelli has the highest proportion of cotton growing lands among the coastal districts.

Thanjavur produced 13.19 lakh tonnes in 1986-87 (25 percent of the state production) alone, followed by S. Arcot (10.22 lakh tonnes). South Arcot was the largest producer of Cholam and Combu. Ramanathpuram leads in ragi, Thanjavur in pulses, South Arcot in Groundnut and Tirunvelli producing 15590 bales (170kg equals one bale) was the highest producer in 1985-86. The average yield of rice was 2728 kg/hectare.

IRRIGATION:- Numerous tanks haave been constructed in the coastal districts for irrigation. Canal irrigation is important in Kaveri delta. Thanjavur has the highests area under canal irrigation, Ramanathpuram under tanks, wells irrigation in Kanyakumari and South Arcot districts. The highest amount of gross irrigated area is found in Thanjavur district.

FORESTRY:- About 6.44 percent of the total area of coastal districts is under forest cover, the highest being in Kanyakumari (32.50 percent) in 1986-87. The major forest produce are timber, fuelwood, cashew, honey, wattle, etc.

TAMILNADU

AREA UNDER FORESTS IN COASTAL DISTRICTS in Sq.Km. (1986-87)

Districts	Reserved Forests	Reserved Lands	Un-classed
Madras	271	30	-
Changalpattu	34501	8805	5324
South Arcot	65038	47511	12371
Tanjavur	17127	2551	320
Puddukottai	15609	17438	5462
Ramanathpuram	-	-	-
Tirunvelu	110756	23878	2702
Chidambarnar	-	-	-
Kanyakumari	44786	19	3605

Source : Chief Conservator of Forests, Madras

FISHING:- Marine fishing is extremely important economic activity in this coastal stretch. Tamilnadu has the unique distinction of facing three major seas - the Arabian sea, the Indian ocean and the Bay of Bengal, and has the benefit ofboth south-west and north-east monsoons. With a coastline of 1000 km, a continental shelf of 35000 sq.km. and an estimated offshore area of 2.2 lakh hectares, this state ranks third/fourth among the maritime states in marine fish production.

There are nine coastal districts with 422 fishing villages and 352 fish landing centres. The fishermen population is estimated to be 3.96 lakhs in 75721 households. The total marine catch was 2.67 lakh tonnes in 1989-90. The demersal varieties dominated (55 percent) over the pelagic ones(45 percent) in the total landings. Major fisheries included silver bellies, other sandines, anchories, corokers, ribbon fishes penaeid prawns, crabs etc.

TAMILNADU

ESTIMATED MARINE FISH PRODUCTIONS BY COASTAL DISTRICTS (1986-87)

Districts	**Fish Landings (in tonnes)**
Madras	1854
Changalpattu	5787
South Arcot	7251
Thanjavur	21170
Puddu Kottai	1372
Ramanathpuram	6917
Tirunveli	17971
Kanyakumari	33224

Source : Commissioner of Statistics, Madras

The total number of mechanised craft was 2757 (2614 traawlers and 143 gill netters). Nonmechanised crafts totalled 43343, of which 11527 were catamarans. It accounted for 60 percent of the catches. Infrastructural facilities included 9 fishing harbours, a number of landing jetties, 55 freezing and ice plants, two canning plants, three fish meal plants and two seaweed processing plants. There are 14 boat building yards all over the coastal stretches.

MINING:- Mining of Fireclay is done at Changalpattu and South Arcot and they produced 735 tonnes and 22175 tonnes respectively in 1985. Changalpattu also produced Sulphur (305 tonnes). South Arcot also produced lignite, ball clay, kaolin etc. Tirunvelli produces limestone (1124000 tonnes in 1985). Kanyakumaarai produces garnet and sellimante of considerable value. Grovel, sandstone etc are produced in most of the coastal districts. Ordinary sands are quite available in Kanyakumari, Tirunvelli, Chidambannar etc.

TAMILNADU

PRODUCTION OF MAJOR MINERALS IN COASTAL DISTRICTS (1985)

Districts	**Minerals**	**Quantity (Tonnes)**
Chengalpattu	Fine Clay	735
	Sulphur	305
South Arcot	Lignite	6982000
	Ball Clay	590
	Fire Clay	22175
	Kalin	1450
Tirunveli and Chidmbarnar	Limestone	1124000
Kanyakumari	Garnet	5296
	Sellmanite	160

Source : Controller Generall, Indian Bureau of Mines, Nagpur

Although coral quarrying is stoped now in the gulf of mannar, about 250 m of reaf were removed earlier. It is fast deteriorating.

INDUSTRIALISATION :- The Tamilnadu coast is fairly well industrialised due to availability of power - thermal, hydro-electric and atomic at Kalpakkam. The Madras and its surrounding and Tutikoran are the main centres of industrialisation. The major industries at Madras are rubber factory, textiles mills, LPG cylinders factory atomic power stations etc. In the Manali area, major industries include a refinery, three fertiliser plants, a benzene processing unit, few engineering units, acid chloraikali plants etc are found. Tuticoran area has phosphate fertilisers plant, caustic soda units, thermal power unit etc. The Vedanarayan area has magnesium processing plant and Bromine plant. The Ennore area has superphosphate plant, thermal power plant, pesticides plant etc.

TAMILNADU

INDUSTRIES AND TRANSPORT IN COASTAL DISTRICTS 1986-87

Districts	**No. of Industries**	**Length of Surfaced Roads (in Km.)**	**No. of Motor Vehicles on road**
Madras	1444	1962	380498
Changalpattu	1274	3762	32574
South Arcot	204	3591	20122
Thanjavur	360	3927	34880
Ramanathpuram	1054	1344	4101
Tirunveli	1035	4073	16563
Kanyakumari	286	1035	11391
Puddu Kottai	124	1466	6172

Source : Transport and Industries Commissioner, Madras

A number of missleneous industries have come up around, Madras, Ramanathpuram, Tirunvelli. There are about 5781 factories widely spread in coastal disstricts but the least industrialised is Puddukottai(124 factories) and South Arcot(204 factories) in 1986-87.

PORTS:- The Tamilnadu coast has two major ports : Madras and Tuticoran, and few minor ports such as Cuddalore, Nagapattnam, Rameswaram, Pamban, Kanyakumari, Velinokkam, Kilakaral etc. Million of tonnes of goods are handled at all these ports in a year. The coastal economy is thus strongly supported by marine supporting services.

Madras is one of the oldest ports on the east coast of India. The traffic handled at this port consists of mainly of crude oils and iron ores. Tuticoran ports handles mainly coal traffic. The quantum of exports through the Tamilnadu ports was 141774 lakhs of rupees (12.11 per cent of All India) in 1986-87 and imports were in the tune of Rs. 290683 lakhs (16.97 per cent) in the same year. Imports constitute machinery, iron and steel, transport equipment, electrical machinery, petroleum products, rock phosphate, sulphur, drugs and chemicals and other commodities. Exports comprise of leather, tobacco manufactures, onions, handlooms, coffee green, cashew kernels, Tummeric, cotton yarn and thread, granite and others.

TAMILNADU

QUANTUM OF FOREIGN TRADE BY SEA PORTS
in Rs. Lakh (1986-87)

Name of the Ports	**Imports**	**Exports**
Madras	226625	74793
Cuddalore	1960	35
Nagapattnam	444	800
Tuticoran	34758	19568

Source : Commissioner of Statistics, Madras

The essential facilities like berths, cargo-handling equipment, port crafts and other infrastructural requirements are quite good both at Madras and Tuticoran. The existence of ports has led to accelerated industrial activity in the hinterland which, in turn, has nourished the ports.

Transport : In Tamilnadu coastal zone, Madras is the strongest regional nodes. State highways run towards coastal towns of Cuddalore, Ramanathpuram, Nagapattnam and Tuticoran. Most of the settlements lie within 5 kms from the surfaced roads. Chengalpatthu has 213 km. of National highways, Tirunvelli-Chidmbarrar 187 km., south Arcot 155 km. and kanyakumari has 64 km. The length of road network is nearly 1.14 lakh km. including about 1000 km. of national highways.

The railways are mainly metre gauge in the coastal zone. One line running close to the coast from Madras to Rameshwaram. Branch lines extend eastwards to Pondicherry, Cuddalore, and Nagapattnam. The norhtern coastal zone of Chigalpattu and South Arcot are well connecte by railways. Transportation and electricity supply network in coastal Tamilnadu is well developed.

Settlements : There are 9056 inhabited villages and 220 towns in Tamilnadu coast. South Arcot had the largest number of Villages (2280) whereas the Chengalpattu has the largest number of urban settlements (66). About 0.25 million of the population live on the Tamilnadu coast.

The rural settlements are generally nucleated and compact. A typical settlement has a rectangular pattern of streets oriented to a temple or tank. The houses are arranged in rows along the streets. There is usually an open space between the house and the street. Most of the houses have thatched and tiled roofs.

The Tamilnadu coast being more expansive with rich and fertile soils, ancient political and merchantile activities through ports enjoy a deeper root of urbanisation. Important urban settlements in the coastal zone are Madras, kanchipuram, Cuddalore, Thanjavur, Rajapalayan Tuticoran, Nagercoil etc. The Changalpatu is highly urbanised with 45 per cent of total population in 1991. It is distressing to note that none of the villages, townships and municipatlities has comprehensive sewerage treatment facilities.

Coastal Tourism : The Tamilnadu coastal zone with its beautiful beaches, wild life sanctuaries and park and magnificent temple towers has vast tourism potential. Notable beach resorts are Madras (Marina and Eliot), Kovalaur Mamallapuram, Cuddalore, Nagapattna, Velankanni, Rameswaram Vattakottai, Kanyakumari etc. Pulicat is also an excellent picnic spot. Chidambaran and Rameshwaram are also pilgrim centres.

The foreign tourists arrived in these places were 4.74 lakhs in 1990 and about 86.01 lakhs were domestic tourists. Tourism is proposed to be expanded with a veiw to bring prosperity to the area and as also to earn some foreign exchange. The geographical contigninty and the rail and road connections between the tourist centres are the favourable factors for the development of tourism on the coastal stretches of Tamilnadu.

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CHAPTER - 4

ENVIRONMENTAL PROBLEMS OF THE COASTAL ZONE IN INDIA

Historical Perspective :

Next to the Himalaya, which has affected Indian history more than any other geographical factor is the Indian Ocean.[1] India has a coastline of about 7500 km. It's two ocean frontages, together with a great variety of morphological features and a resource complex of grandeur, beauty and value; produce a broad spectrum of coastal environments.

India's coastline was practically free of any stress conditions imposed by human activity during pre-colonial times. The centres of civilisations were mostly inland and the coastal zone was considered a buffer against invasion from abroad. The Indian peninsula located strategically in the East-West sea lanes existed on the basis of the self-sustaining agricultural economy. Though strategically located it did not had very significant and decisive travel and maritime trade relations with the rest of the world. Hence the interest in maritime areas and activities was minimal.[2]

While the coastal zone was free of intense human activities during the pre-colonial days, nature was the primary change agent influencing the coastal zone. Nature itself imposed severe anomalies on the maintenance of the stability of the country's coastline. The south-west monsoon with its ocean fetch creates a wave climate that attacks the coast with great intensity and regularity and dissipates its energy along the western and eastern seaboard. The North-East monsoon blows over the more limited fetch of the Bay of Bengal and accordingly attacks the coastline. Sediments brought by various rivers from inland, storm surges caused by cyclonic winds and blocking of river outlets by the formation of sandbars and floods are all phenomenon that causes changes in the physical stability and productivity of the coastal zone.[3]

The advent of the western colonisers - the Portuguese in 1498 A.D., the Dutch in 1602 A.D., the British in 1600 A.D. and the French in 1664 A.D. caused a profound change in man's attitude towards the coastal zone. Coastal bastions were established to affirm their footholds on the country. Canals, roads and railways were cut to establish communications between such bastions and thus trade assumed importance. The rich natural resources of India attracted the attention of these invaders/colonialists and the export of such resources to enrich their own economies necessitated the establishment of anchorages and harbours as well as routes to the hinterland. The coastal zone provided the platform for such exploitation and underwent radical change.[4]

The interior population migrated from the traditional centres to coastline to provide services to new masters. Coastal lands suitable for the cultivation of export crops were utilised. The culture of Indian people changed radically. Trade assumed increasing importance and consequently the coastal zone attracted those in search of oppurtunity, for example, in Bombay, Calcutta, and Madras. Many population centres appeared on the coastal stretch and more intensive exploitation of coastal resources to provide sustenance to such centres came into being. The opening of the transport and communication network accelerated this process. Hence man's presence began to exert pressure as a dynamic change agent on the coastal zone.

The rise in the aspirations of people since the attainment of independence in 1947 attracted more people to the coastal cities. Oppurtunities in public administration, commerce and industry coupled with better education facilities and modernism were the catalysts in such migration towards the coastal cities. With this the population in the coastal zone increased and so did the utilisation of resources. These in turn imposed stresses on the coastal environment.

The environmental problems of India's coastal zone can be summarised as follows :-

Changing Coastline

It is evident that the world's coastline undergoes changes form time to time. Some of the factors responsible for changes in coastline are subsidence, rising sea-level, storms and storm surges, sediment input from rivers, sediment redistribution and artificial structures along the coast. Approximately 55 per cent of the Indian coastline is fringed with beaches. While about 25 per cent is prograding, mostly near river mouths and in deltaic areas; the beaches, in general, are either stable or have been receding in the past few decades.[5]

The present coastline of India is for the most part emergent; however, indications of subsidence exist at several locations. One example of submergence can be seen in West Bengal. Hence, at several locations in the vicinity of Calcutta, a peat bed, 6-13 m below the surface and below mean tide level, contains roots of the Sundari tree.[6]

Another example of subsidence occurs along India's Kerala Coast. In the port city of Cochin in South-West India, situated on an artificially developed island, geodetic levelling, from the 1970s, indicates 2.2mm difference in the tide gauge recorder datum. This difference is believed to be a result of subsidence at the coastline.[7]

The Gulf of Cambay in Gujrat is an area of continuing swampy progradation and, around and between the estuaries of Narmada, the Tapti, and the Ulhas, there is a large sediment discharge derived partly from gulf eroding the coastal plains. Gradual accretion of silt and clay has been observed on islands at the mouth of the Narmada.[8] In Goa the coastline was prograding along the beaches while retreating along the cliffs and headlands.[9]

On the East coast, the chief prograding sectors are on the deltas of Krishna, Godavari, Mahanadi, and Ganges where these rivers supply large quantities of sediment. These deltaic shorelines are generally muddy, but where sand is present beaches and spits have been formed. The Hoogly system has brought enough sediments and about 0.405 million hectare has been reclaimed.[10] The beaches, swamps, sand flats and dunes are the characteristic features of the area. The general progradation of the Krishna delta was interrupted by the erosion during the cyclones. On the Mahanadi delta, alternate advance and retreat were observed. While the coastline bordering the Brahmni river mouth has recently undergone erosion. The artificial structures of the harbours along the east coast have affected the sediment movement along the coast and beach erosion has been reported near these harbours.

One of the main factors for change of sediment input to the coast by river is the increasing damming and diverting of the rivers draining into sea. The total river discharge into the Bay of Bengal is about 1529 km^3 including Ganga and Brahmputra. The total discharge along the west coast is about 298 km^3. Probably, one of the causes for erosion along Kerala Coast may be the changes in the input of sediment due to damming of rivers.[11]

It is reported that the Kerala coast has eroded at a rate of upto 6 m/year. In a beach profile study along a 150km stretch of the Kerala coast, 96.8 m3/linear meter of beach had eroded during a 12 month study period. The beaches are not extensive and beaches wider than 50 m are rare. Although one-third of the Kerala coast is fortified by structural engineering works, only 15 per cent of the entire coast is considered stable from erosion.[12] It means at least 85 per cent of the Kerala coast is vulnerable to erosion.

Erosion is active at different parts on the east an west coasts of India. The notable ones are : Ghoga, Bhagwa, Dumas, Kaniar, Kolak and Umbergaon along the Gujrat coast; Versova, Revandar, Vashi, Malvan along the Maharastra coast; Miramar and Calangute in Goa; Belekeri, Ankola, Bhatkal, Malpe and Manglore along the Karnatka coast; most of the Kerala coast; Kanyakumari, Rameswaram, Cuddalore, Mahabalipuram, Ennore along Tamilnadu coast; Kakinada, Vishakhapatnam and Bhimunipattnam along the Andhra; Gopalpur, Paradip and Satbhaya on the Orissa coast; Digha, Bankiput and Gangasagar areas along the West Bengal coastline.[13] The causes and intensity of erosion varies from site to site.

Global Warming and Sea Level Rise :

Global change caused by increased atmospheric trace gas loading is a topic of considerable concern. Included in this global change will be various associated responses, such as rise in sea levels, changes in storm climates, changes in precipitation patterns, and alteration of ocean circulation patterns on at least some spatial scales. Whereas the exact magnitude, timing and geographic distribution of these climate responses can not be predicted accurately with the level of present understanding, computer models allow for generalised predictions of the impacts of these changes.[14]

Scientists and researchers believe that global warming of the atmosphere will result from build-up of atmospheric trace gases. The most effective gases at heating the atmosphere include carbon dioxide, nitrogen oxide, tropospheric ozone, chloroflurocarbons, water vapour, and methane, all of which contribute to trapping of infrared radiation. Methane, about 20 times more effective per molecule as a direct contributor to global warming than CO_2, has been increasing at about 1 per cent year since 1951, mostly from anaerobic biological processes such as rice/paddy agriculture.[15] As concentration of these gases increase, there will be increased global warming of some magnitude coupled with an intensified hydrologic cycle, and likely tropical circulation changes; corresponding regional and global effects from such changes may be of economic and social significance.

The global warming will have an impact on sea levels through direct ocean warming and through a melting of continental and alpine ice sheets. Both effects will lead to an increase in the volume of the oceans and, in the absence of other influences, relative sea level will rise. Regional causes of relative sea level change include long-term changes in atmospheric pressure, temperature, currents, wind patterns as well as land subsidence and emergence.

The historical trend in global sea-level rise is calculated by some to be on the order of about 10-15 cm during the past century. At present, sea level appears to be rising at a rate of 1-2 mm/yr, although sea level exhibits large temporal and spatial variability. On examining the tide gauge records from Bombay, Madras, Cochin and Vishakhapatnam since 1881, no uniform rising trend was found, except at Bombay between 1940 and 1986 (0.8 mm/yr) and at Madras from 1910 to 1933 (0.4 mm/yr). These results are not necessarily due to global warming.[16] For the future, imprecise projections are that global warming of 1.5 - 4.5^{o}c could lead to a sea-level rise of 20-140 cm during the 21st century.[17]

Other estimates of the extent of relative sea-level rise vary. Mid-range estimates prepared by the US Environment Protection Agency (EPA) anticipate an average global rise of between 72cm and 216cm for the next century.

By 2025, the EPA projected global ocean levels will be between 13cm and 39cm higher than today. Revised estimates for the next 35 years range between 11cm and almost 21cm rise in global sea level.[18] These estimates all address the absolute global rise of the ocean. Relative sea-level rise is the combination of rise of the sea and movement of the land. Studies of historical rates of relative sea-level rise in the South-Asian seas region using tide gauge records derive an average relative sea-level change of -0.67 mm/yr. It is reported that during the past half century or so, relative sea levels in the region have ranged from a land emergence of 1.33 mm/yr. to a submergence of 2.27 mm/yr.[19]

EPA Estimates of Global SLR (in cm.)

	Years				
	2000	**2025**	**2050**	**2075**	**2100**
High	17.1	54.9	116.7	211.5	345.0
Mid range-High	13.2	39.3	78.9	136.8	216.6
Mid range-Low	8.8	26.2	52.6	91.2	144.4
Low	4.8	13.0	23.0	38.0	56.2

(After Hoffman et.al., 1983)

Historical temperature change contains a large amount of spatial and temporal natural variability. While our knowledge of global mean temperature change is still uncertain, even in the present era of instrumental meteorology, researchers calculate that the mean annual temperature has steadily increased by about 0.4^{o}c in India during the past century, although more recent analysis indicates relative temperature stability; and global mean warming since 1880 has been about 0.5 - 0.7^{o}c.[20] on a local scale, the west coast of India has shown a warming of about 0.6^{o}c during the past hundred years.

Various scenarios predict total rises ranging from 11cm to more than 2 m by the end of 21st century. When it is added to regional subsidence, it is possible that several areas along the Indian coast will experience submergence. Along the Indian coastline, the region most vulnerable to the consequences of the anticipated sea level rise is the Lakshdweep archipelago and Andaman and Nicobar islands. The east coast of India is more vulnerable than the west coast and likely to suffer from increased storm surges. The coastal beet between 12^{o} and 18^{o}N on the west coast appears to be the least vulnerable.[21] The expected consequences of sea level rise are land loss and property damage due to submergence, accelerated coastal erosion, increased damage by storm surges and coastal flooding, damage to aquifers from salt and water intrusion, increased salt water intrusion into rivers, coastal inlets and agricultural lands, damage to coastal ecosystems, habitats and fisheries.

To identify the exact area likely to be affected by the sea level rise, the Ministry of Environment and Forests, Government of India, has decided that a general rise of one meter and two meters by the end of 21st century may be taken at the first stage of impact assessment. The estimate of future sea level rise as given by Hoffman were taken into consideration. However, due to practical difficulties in contour mapping because of non-availability of large scale maps, aerial photographs and satellite imageries, Hoffman's scheme could not be adopted ipso facto.[22]

The main area of investigation lay in comprehending the nature of physical and human resources along the coast and analysing the implications of sea level rise. The focus of analysis were :

i) the estimates of population along the coastal areas, likely to be subjected to the sea level rise;

ii) concentration of settlements, economic activities of the people, infrastructure network, and land use and land productivity.

Coral Mining : Coral mining is one of the most serious environmental problems within our coastal zone. This has been a traditional activity in which a significant percentage of population are engaged. In fact, uncontrolled exploitation has already seriously damaged some of our best reefs, particularly, in the Gulf of Kutch.

In Indian waters, reef building corals occur at Palk bay, Gulf of Mannar, gulf of Kutch, Goa and parts of Maharastra coast, Andman-Nicobar islands in the bay of Bengal and Lakhdweep islands in the Arabian sea. Coral sands to the extent of about a million tonnes are dredged annually in the Gulf of Kutch which led to the destruction of about 50 per cent of coral life.[23] In the Gulf of Mannar, selective over exploitation of massive corals has already affected several reefs. Coral mining has also led to shore erosion in Lakhdweep islands.

Coral blocks and sand are heavily exploited by man for commercial use - as a soil ameliorant to reduce acidity in agricultural lands, as a building material and as a chemical in certain industrial processes. Due to the increasing industrial requirements, over and erratic exploitation of these resources is taking place at an unprecedently fast pace. Besides, the coral skeletons and the reef organisms are also harvested for their shells of ornamental value, aquaria and also as edible products. Further fishing of juveniles and other immature organisms for local consumption by the dependent communities is clearly observed near Rameswaram and adjoining islands in Tamilnadu.[24] Because of this, the ecosystem is fast degrading, and immediate measures to stop indiscriminate and over-exploitation of these resources need to be undertaken to save this rich ecosystem from a man-made disaster.

Sand Mining : While coral mining has received much public comment and debate the effect of sand mining has not received the attention it deserves. Traditionally sand has been regarded as a free resource and the only value assigned to it has been the cost of mining. Mining at beach and rivers sand especially in the lower reaches of rivers has now assumed critical proportions. The activity is spread right along our coastline and is most intensive in the areas close to big towns. Besides construction, the major plunder of sand has been for industrial purposes. Tonnes of sand from Goa have been extracted for foundries in Bombay-Pune-Chinchurad belt.[25] Fine sand is used as a catalyst in producing iron costs, as mixing in sand helps faster heating and quicker melting of iron. Sand is also used in glass foundries and brick making units.

About 48176 million tonnes of sand were extracted in 1978 alone in Goa.[26] The ecological devastation that follows the destruction of sand dunes is clearly one case where ignorance can 401 longer be claimed as an excuse. Sufficient evidence from other parts of the country and Goa itself has long been at hand to warn us.

More than 320 kms of the 580 km long Kerala coastline faces the heavy attack of waves and tidal overflow, thanks to decades of sand extraction since the Travancore period. This has resulted in constant loss of land, at the rate of four meters per year. The removal of large volumes of sand from beaches disturb their equilibrium.

Mangroves Degradation : Coastal wetlands are considered to be highly productive areas because of their high detritus content and rich biota. Mangrove swamps along with their flora and fauna are ecologically and economically important ecosystems. However, as a result of many natural and man-made changes such as geological processes, climatological disturbances, deforestation, reclamation and pollution in the past few centuries, vast mangrove areas in India have been degraded.

The estimated mangrove areas along the Indian coast is about 679800 hectares. It has been further estimated that the total wetland area converted to other uses is about 40 million hectares in India.[27] Thousands of hectares of mangroves forests at Gangetic Sunderbans, Cochin backwaters, Bombay, Gulf of Kutch, Sindhudurg coast, Chorao island of Goa and other regions have been reclaimed for the purpose of either agriculture or urban development. Mangrove areas have been used for discharge of industrial effluents, sewage and garbage etc. As a result, the general productivity of the mangrove waters decreases. The industrial effluents have destroyed the mangrove forests along Bombay coast at Mahim creek.

Sandbar formation Across River and Lagoon Outlets : The formation of seasonal sand bars across the mouths of streams, rivers and lagoons is a common phenomenon in India. The effects of such closures affects the productivity of the estuary by decreasing salinity levels, siltation, concentrations of pollutants beyond acceptable levels. It also causes upstream flooding and prevents navigational access to and from the sea.

An example of the productive lagoon that is likely to become a dead lake is Chilka lake on the east coast of India. The total volume of silt carried into Chilka today is an incredible 13 million tonnes a year.[28] At this rate Chilka would not survive for even one decade because river discharge into the lake has reduced due to silt at the river mouth and the flow of saline water from the Bay of Bengal has lessened because of sand accumulation at the Berm mouth. Silting in the lake has shrunk its size, from 906 sq.km. to 800 sq.km., and the average depth has dropped from 2.4 meters to less than 1.5 meters. Sand bar formations at the Magarmukh mouth near Arakhakinda (35 km channel) are serious. Now the channel's width has shrunk from one mile in 1780 to barely about 100 meters in some places.[29] The drifting sand bars and islands can also be seen along the West Bengal coast.

Construction of Maritime Structures : Whenever anti-erosion measures (such as groins, rivetments and breakwaters) are taken at a particular spot to protect the property on the shore, intensified erosion occurs at some adjoining areas, and accretion - the sea receding because of the deposition of silt at others. This is because the silt carrying "littoral" currents are disturbed by the protective structures.

Along the Indian coast, Vishakhapatnam and Madras are tow examples. In Madras, the present expanse of the Marina beach is the result of the harbour protection works executed after the port was opened in 1876. Within the first eight years alone, the sea had receded from a 26 acre area following heavy deposition. On the other hand, there was heavy erosion in the area to the north of the port, which led to more protective structures.[30]

Construction of sea walls and groyanes to check erosion at one place have resulted in erosion at other parts along the Kerala coast, Karnatka coast etc. Damage to vegetation and private property provoked the government into constructing engineering works to protect the coast. In a luxury resort complex of type planned on the Konark-Puri beach in orissa, investment by hoteliers alone would be of the order of hundreds of crones of rupees. Naturally, they will demand protective structures at the first sign of erosion and this will set off a chains reaction in the adjoining areas. Even the Konark temple, which stands about a kilometer from the water, may be in danger.[31]

Disposal of Contaminated Sediments, Mine Tailings and Solid Waste : There are 11 major, 16 intermediate and 78 minor ports in India. All these ports have navigation channels which are dredged continuously. The dredge spoils are dumped not very far from shore and may contain material toxic to marine life. During flood tides, part of this may be washed back. As a result of this dumping activity, fisheries near several harbours have either been depleted or have disappeared. Monitoring of these areas needs to be undertaken.

In coastal areas of India, occasional deposits of ilmenite placers and monazite sands have been located and are being mined. Intense mining activity is in progress in some estuarine regions. Mining of iron ores in Goa is a notable example. Ten of the large mines are located in the Zuari basin while the remaining 27 mines are in the Mandovy basin. Besides, the Raddi mines, situated on the southern tip of Maharastra's coastline is another example. Between 10-15 million tonnes of rejects have so far been dumped into the sea, disturbing the marine ecology and the beaches.[32] The result is that even at present, with mining activities at a stand still the coastal water is red and turbid and beaches at Reddi have now been completely destroyed by black ore. Depletion of fisheries, particularly shell fish and benthic fauna due to mine tailings and mining rejects and washings, have been observed at places in India causing irreversible ecosystem instability.

Human population and related data together with
some estimates of waste material (pollutants)
entering the sea around India (as in 1986)

Population	750×10^6
Coastal population (25% of the total)	188×10^6
Area of the country	$3.276 \times 10^6 km^2$
Agricultural area	$1.65 \times 10^6 km^2$
Exclusive Economic Zone	$2.015 \times 10^6 km^2$
River runoff (annual mean)	1,645 km^3
Rainfall per year (on land)	$3.5 \times 10^{12} m^3$
Rainfall per year (entering the Bay of Bengal)	$6.5 \times 10^{12} m^3$
Rainfall per year (entering the Arabian Sea)	$6.1 \times 10^{12} m^3$
Domestic sewage added to the sea by coastal population per year (@ 60 litres per head/day)	$4.1 \times 10^9 m^3$
Industrial waste added to the sea by coastal industries per year	$0.41 \times 10^9 m^3$
Sewage and effluents added by the rivers to the sea per year	$50 \times 10^6 m^3$
Solid waste and garbage generated by coastal population per year (@ 0.5 kg per head/day)	34×10^6 tonnes
Fertilisers used per year (@ 30.5 kg/ha.yr)	5×10^6 tonnes
Pesticides used per year (@ 336 g/ha.yr)	55,000 tonnes
Synthetic detergents used per year	125,000 tonnes
Tar deposition on beaches along the west coast of India per year	750-1,000 tonnes

Source: Qasim & Sen Gupta, 1988

Generation of solid waste and garbage is not very high in India. Calculating at the rate of 0.5 kg per head per day the coastal population of India can be expected to generate $34x10^6$ tonnes of solid waste per year.[33] Near urban and metropolitan areas these are used as landfills and for land reclamation from the sea. The major portion of these wastes is generated in urban areas.

Other solid wastes which pollute Indian coastal waters are : garbage including plastics from the tourism industry, scrap material from ship-breaking yards; damaged and rejected fishing nets and other gear; and the disposal of unwanted trash fish by trawlers. However, quantitative data on these are lacking. But this problem is spread and visible all along the Indian coast.

India has a fast developing exploration and exploitation programme for offshore oil fields. The formation water from such operations is 34000 barrels/day containing 40 ppm of oil.[34] The volume of drilling mud and its oil content are not accurately known and their impact on the environment is being evaluated gradually.

India is also actively engaged in exploration of the sed bed in the Central Indian ocean to assess qualitatively and quantitatively the pollymetalic nodules deposits. However, environmental impact studies for eventual deep-sea mining opeartions are being conducted simultaneously.

Salinity Ingression : Salinity ingression is also a notable problems in the coastal zone of India. The over exploitation of ground water especially in coastal belt creates the problem of water logging, salinity and alkalinity, as a result the irrigation problem severely crops up which ultimately hinder to the agricultural production. Depending upon the hydro-geological and geophysical conditions, salinity ingres-surface sea-water ingress and sub-surface sea water ingress in the coastal belts of Gujarat, Kerala, Tamilnadu, West Bengal etc. had drastically degraded the ecological and environmental systems. In some parts of Gujarat coastal zone, total dissolved salts (TDS) range from 1000 to 6000 ppm whereas the desirable limit for TDS is 500 ppm only.[35]

According to Government of India estimates, the coastal area affected by salinity is 30 to 40 thousand sq.km., the major area of attention are the Sunderbans of West Bengal, delta areas of Krishna, Godavari and Kaveri, Khar land of Maharastra and coastal areas of Gujarat and Pan areas of Kutuch. The salinity ingression in the narrow coastal plains of Saurashtra have affected vast areas of the fertile and productive tract.[36]

Due to low reliability of the monsoon rainfall and lack of adequate surface water irrigation system, these areas in Gujarat have traditionally used ground water irrigation. Introduction of motorised pumping led to the brake of delicate ecological balance between the recharge and discharge interface between the fresh water body and the underlying saline water of aquifer systems. An overdraft condtion was established and the ground water quality determinated and consequently the area got affected by the salinity.

The most affected region lies within a coastal strip of 160 km. in length from Madhavpur and Una which includes the talukas of Mangrol, Molia, Verabal, Kodinar and Una of Junagarh district. The area affected adversely with saline ground water has increased from 35000 hectares to one lakh hectares from 1971 to 1988.[37] Some one hundred and twenty villages with a populaiton of four lakhs have been affected. It was found that each year about 0.5 to 0.1 km. of the area from the coast line inward, the salinity is increasing in ground water.[38]

The effect of salinity was immense. Wells went out of operation rendering cultivable land useless for want of fresh water supply, reduction of the yield/unit area and migration of local people.

Disposal of Urban and Industrial Waste Waters : An estimate of sewage and other pollutants added to the seas around India is presented. Three of the four Indian major urban areas are located either on or close to the sea with associated industrial belt. Currently only 45 cities with a population of one lakh or more have sewage treatment

Diurnal variation of H_2S - S and dissolved oxygen (DO) at Mahim Creek on 5 January 1984

Time (hr)	H_2S-S (µg-at/l)	DO (mg/l)
0700	33.2	0.0
0800	83.3	0.0
0900	85.4	0.0
1000	93.2	0.0
1100	17.8	0.0
1200	1.5	0.0
1300	0.0	1.8
1400	0.0	2.1
1500	7.8	0.0
1600	12.5	0.0
1700	13.4	0.0

From : Sabnis (1984)

facilities in India. The consequences of the dischanges of sewage and effluents are not very perceptible along all the Indian coast. However, in nearshore areas of a few metropolitan cities which have large industrial complexes the effects are, indeed, becoming alarming. An increase of about 14 per cent of phosphate-phosphorous concentrations in the nearshore waters of Bombay from 1959-84 (o.82 to 2.0 umo 1.1^{-1}) has been observed.[39]

Similarly, dissolved oxygen concentration has decreased from 4.71 $ml.1^{-1}$ in 1959 to near zero in 1983. Higher concentrations of phosphate-phosphorous, as compared to earlier data, have also been observed in the nearshore waters off Madras. This deterioration is evidently the result of uninterupted discharge of untreated sewage and other effluents. Bombay city discharges about 365 million tonnes of sewage and effluents to the sea every year. Similar discharges from Calcutta city to the Ganges estuary total about 396 million tonnes. These figures illustrate the environmental stress the coastal waters of India are subjected to.[40]

One of the most polluted areas on the Indian coast is the waters around Bombay. The Mahim bay alone receives about 64 million tonnes of municipal sevage and 0.9 million tonnes of industrial wastes every year.[41] In the beginning, these wastes were discharged untreated, but now these are partially treated. The contribution from Mahim river is only

Composition of the total volume of waste entering the coastal waters at two sites of Bomabay (t yr^{-1}). Modified from Sabnis (1984) & Zingde (1985)

	Bombay	Mahim Bay	Mahim Bay/ Bombay %
Dissoleved solids	635100	92619	14.6
Suspended solids	105850	15643	14.8
BOD	113150	16480	14.6
Sulphate	32850	4791	14.6
Chloride	255500	37495	14.7
Nitrogen	14600	2236	15.3
Phosphorus	2628	383	14.6
Manganes	1107	162	14.6
Iron	13	2	15.4
Cobalt	35	5	14.3
Nickel	48	7	14.6
Copper	110	16	14.5
Lead	4.7	0.7	14.9
		Mean	14.7

15 per cent of the total wastes received by the coastal waters of Bombay. The release of the effluents containing hydrocarbons has so heavily contaminated the creek, so much so that it has become a common practice to recover oil by soaking absorbents. There was a time when this region had good fisheries, flourshing oyester beds, lush-fringing mangroves and migratory birds. Now the fisheries are non-existent as no fauna can survive there and birds are hardly seen there. Thane creek, Bassein creek, Ulhas river etc. which also receive large quantitities of industrial waste and are quite polluted.

Several estuaries in Gujrat state have been studied recently. Damanganga, Kolak, Par, Ambika, Tapi and Mindola estuaries which mainly received industrial wastes through point discharges have been found to be grossly polluted. Not only the fish catch has decreased considerably, but in some estuaries the fish die during low tide due to restricted dilution of waste water and concentrated dose of pollutants to which the animal is exposed.

The Hoogly estuary in West Bengal is probably on of the most polluted estuaries in the world. Ninety six (96) factories manufacturing almost everything producing hazardous wastes-paper, pestides, chloroalkalies, alcohol, yeast, rayon, cotton, thermal power vegetable oils, fertiliser, antibiotics etc. are nearby and discharge almost half a billion litres of untreated wastes into the estuary every day.[42]

Comprehensive studies of the environmental conditions in the Ganga river and Hooghly estuary were done in 1960 and 1988 and showed that chloride concentrations and alkalinity had increased in rivers during this priod, while oxygen had decreased. But the nutrients had increased significantly in the river and, surprisingly there were no major chages in the chemical parameters in the estuary during the same period. Regular flushing by tidal water had evidently taken all wastes out ot sea and the estuary itself had not changed significantly.

Tamil Nadu is quite heavily industrialised, 80 per cent of its 12000 units located close to the coast. The industrial pollution is worst in the heavily industrialised

INDUSTRIES ON TAMIL NADU COAST DISCHARGING TREATED/UNTREATED EFFLUENT INTO SEA

Sl. No.	INDUSTRY	Products	Pollutants	Volume of waste water	Effluent Disposal into Sea
1.	E.I.D. Parry (India) Ltd., Ennore	Superphosphate Sulpuric Acid	PA P	1728 kld	Cooling water
2.	Ennore Thermal Power Plant, Ennore	Power 90 million units	SS Trace Metals	18000 kld 136000 kld	Fly ash slurry Cooling water
3.	I.C.I. Ltd., Ennore	Pesticides Garamaxone	Pesticides	72 kld	Treated effluent
4.	Kothari Chemicals (P) Ltd., Manali	Caustic Soda Chlorine Hydrochloric Acid Ammonium Chloride	pH Cl_2 TDS NH3	900 kld	Backwaters
5.	Tamilnadu Petroproducts Ltd., Manali	Alkyl Benzene	ABS	1016 kld	Backwaters
6.	Indian Organic Chemicals, Manali	Methanol Polyester fibre	pH, TDS BOD	1000 kld	Backwaters
7.	Manali Petrochemicals Ltd., Manali	Propylene Oxide Propylene Glycol Polyol	Aromatics Phenols TDS	2400 kld	ETP treated effluent
8.	Shri ram Fibres Ltd., Manali	Nylon Magnesium Stearate Cuprous Chloride	BOD, Cu TDS SS	350 kld	ETP treated effluent
9.	Carborundum Universal Ltd., Thiruvottiyur	Engineering	SS, TDS	21000 kld	ETP treated effluent
10.	National Carbon Co.	Dry Cells	SS, TDS	10 kld	ETP treated effluent

11.	Madras Rubber Factory	Rubber Products	SS, TDS	170 kld	ETP treated effluent
12.	Madras Corporation	Sewage	BOD, SS, N, P	7000 kld	Untreated sewage
13.	India Processing Mills (P) Ltd., Palavakkam, Madras	Textile Dyeing	Dyes, TDS, SS, BOD, N, P	50 kld	ETP treated wastewater
14.	Balaji Cylinders (P) Ltd.	LPG Cylinders	SS	34 kld	ETP treated wastewater
15.	Madras Atomic Power Station Kalpakkam	Power	TDS, SS	280 mld	Cooling water
16.	Indian Steel Rolling Mills Nagapattinam	Engineering	SS, TDS, Fe	12.5 kld	ETP treated wastewater
17.	Wimco Ltd., Vedaranyam	Bromine	pH, Br, TDS	568 kld	ETP treated wastewater
18.	Mettur Chemical and Industrial Corporation Ltd., Vedaranyam	Bromine	pH, Br, TDS	2566 kld	ETP treated wastewater
19.	T.N. Magnesium & Marine Chemicals, Thanechaiyan	Magnesium	Mg, pH, TDS	1000 kld	ETP treated wastewater
20.	SPIC Ltd., Tuticorin	Phosphatic Fertiliser	N1P, BOD F, TDS		ETP treated wastewater
21.	Tuticorin Alkali Chemicals, Tuticorin	Caustic Soda	TDS, N	1680 kld	ETP treated wastewater
22.	Tuticorin Thermal Power Station, Tuticorin	Power	TDS, BOD N, P	75 mld	ETP treated wastewater
23.	DCW Ltd., Tuticorin	Caustic Soda Chlorine	TDS, pH Fe	500 kld	ETP treated wastewater

Madras area in the north, with high concentration of heavy metals found in water and sediments. Surprisingly, the concentration of metals in sea food are still well below health limits.[43] Bacterial contamination at seawater is most prominent in the coastal areas around Madras also.

The marine environment of Orissa is still in a good condition. Algal booms occur occasionally, but are not toxic to marine organisms. A marine monitoring programme was started in 1990 and bottom samples are collected in the main river mouths twice a year. Rather large amounts Hg and P_6 have been found far from possible industrial sources. Complicated current patterns evidently transport these pollutants long distances. Analysis of mercurry in fish down stream a chloro-alkali industry in the Rushikulaya estuary showed values well above the limit of 0.5 mg./kg. wet wet recommended by World Health Organisation.[44]

In Chilka lake in southern Orissa, significant environmental degradation has taken place. The main problem are the proliferation of weeds in the lake and heavy siltation causing decreased water exchange with the sea.

The coir industry of Kerala is very important economic activity. Retting of the coconut husk in saline backwaters, leading to the separation of leathery exocorp from the fibrous mesocrop is the traditional method of natural retting. A rise in trubidity, gas formation, foul smell, depletion of oxygen are associated with retting process. The worst impact of retting is reported to be on fishing. Many of the species of fishes and prawns are completely absent in the retting zone.

The major polluting industry discharging its waste water directly into the coast is Travancore Titanium products near Trivendrum which discharged about 100 tonnes of sulphuric acid alongwith 50-60 tonnes of iron sulphate per day into the shore rendering about three kms of coastal stretch rusty in appearence.[45] The waste water also contains titanium salts.

The Vemband lake is another polluted water bodies in Kerala coast. The present use of Vemband include navigation, fishing, husk retting, industrial cooling, recreation, controlled waste disposal and harbour. The major sources of pollution of backwaters apart from coconut husk retting and pealing of prawns are discharges of industrial wastewater. The total volume of wastewater discharge is of the tune of 260,000 m^3/day containing variety of pollutants like acidity or alkalinity, flurorides, free amonia BOD, insecticides, mercury, zinc, hexavalent chromiuim, lead and other metals.[46] On the other hand, the Periyar estuary is also highly polluted.

Concentration of Toxic Heavy Metals and Organochlorine Residues : Regualr data on monitoring of metals in coastal waters are lacking. Measurements are carried out in Zooplankton, fish and sediments. Zooplankton hauls from different areas are analysed in India for several "essential" and "non-essential heavy metals. The concentrations ranges in ppm wet weight are 2.12-31.95 (Cu); 3.01-6.99 (Mn); 7.78-367.09 (Zn); 36.36-426.49 (Fe); 0.23-3.12 (Ni); ND (Hg); 0.69-5-99 (Cd); and 4.27-31-87 (Pb). The most significant observation is the total absence of mercury in all the Zooplankton samples.[47]

Available data on the concentrations of Hg, Cd, Pb and cu in the muscles of several fish from the northern Indian ocean are summed up in table. These are very common food fish in India. The fish were caught different places along the coastline. Higher concentrations were observed in larger fishes. In general, the values appear to be well within the maximum permissible limits for the metals.

Examination of data on several metals in dissolved, suspended and particulate forms in the estuarine regions of the river Ganges indicates very interesting results. About 85 per cent of the dissolved metals settle within the river leaving only 15 per cent to flow out. Ten per cent of the suspended and particulate metals settle within the estuary, 50 per cent at the confluence of river water with sea water and 40 per cent finally flows out to the open Bay of Bengal.[48]

Concentrations of Hg, Cd, Pb and Cu (ppm wet weight) from 1978 - 1982 in muscles of some fishes from the Northern Indian Ocean. (Modified from Kureishy et al, 1978, 1983; Kureishy, 1985).

Fish	Metal	1978	1979	1980	1981	1982
Skipjack Tuna	Hg	0.160	0.03-0.22	0.04	0.028	0.01
Katsuwonus pelamis	Cd	-	ND-0.34	2.0	ND-0.93	0.90
(Linnaeus)	Pb	-	1.0-1.19	ND	ND-2.63	0.62
	Cu	-	0.28-1.28	2.69	0.47-1.24	0.81
Bluefin Tuna	Hg	0.120	-	0.14	-	-
Kishinoella tonggol	Cd	-	-	ND	ND	-
(Bleeker)	Pb	-	-	ND	ND	-
	Cu	-	-	0.46	0.63	-
Mackerel Tuna	Hg	-	-	0.11-0.13	-	-
Euthunus affinis	Cd	-	-	0.75-1.12	-	-
(Canter)	Pb	-	-	ND-0.25	-	-
	Cu	-	-	0.66-0.70	-	-
Seer fish Acanthocybium	Hg	0.101-0.151	0.89	-	-	-
Solandri (Cuvier)	Cd	-	0.43	-	ND	-
	Pb	-	1.50	-	8.12	-
	Cu	-	0.57	-	0.43	-
Dolphin fish	Hg	0.072-0.140	0.01-0.042	-	0.11	-
Corryphaena hippurus	Cd	-	ND-0	-	ND-1.19	-
(Linnaeus)	Pb	-	1.0-2.09	-	ND-8.54	-
	Cu	-	0.24-1.45	-	0.27-0.74	-

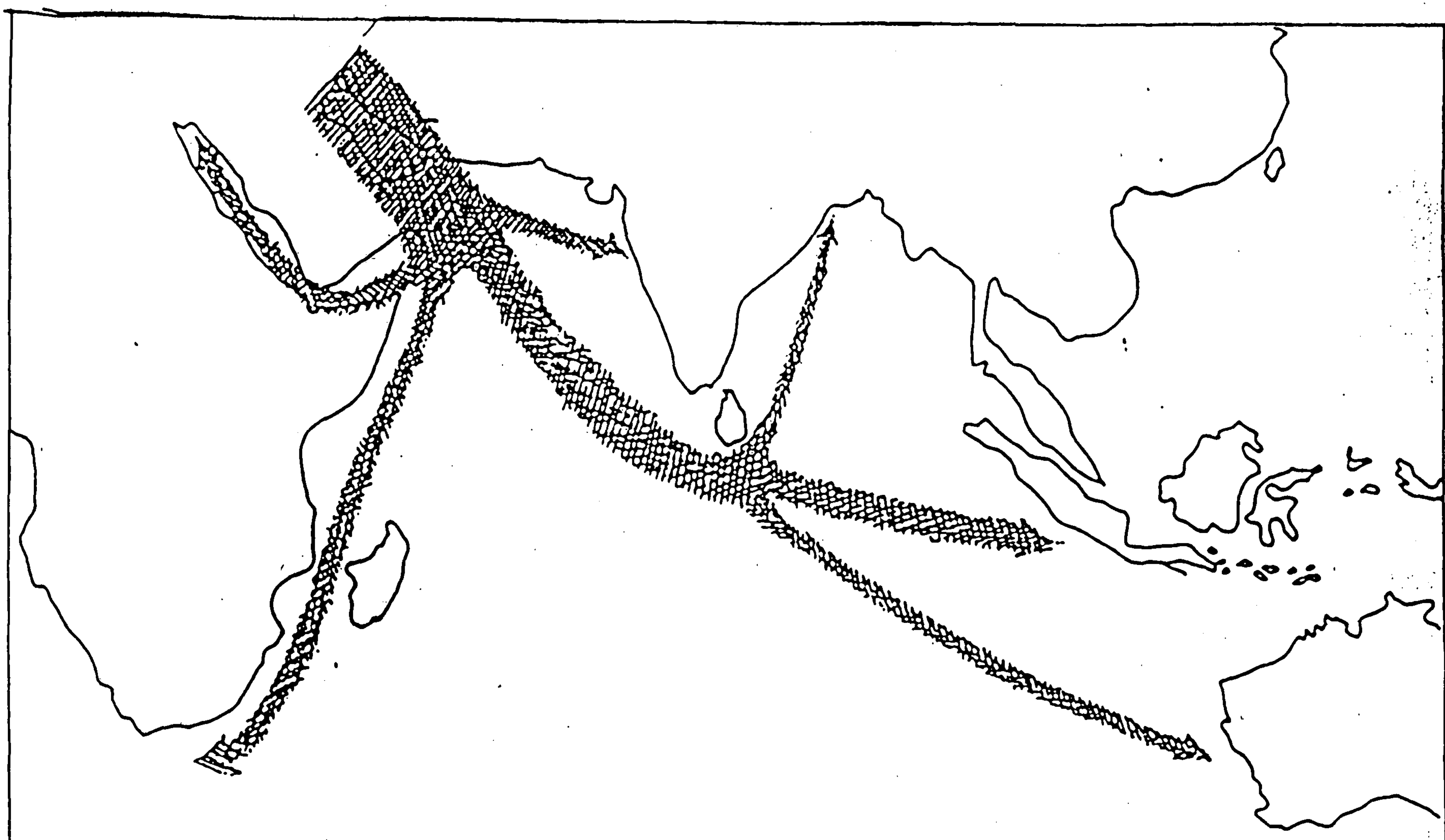
Coastal India being agricultural in character, consumption of fertilisers, pesticides, insecticides etc. can be espected to be considerable in the region. The annual consumption of pesticides is supposed to be 55000 tonnes in India. Concentration were higher near urban areas whereas they were not significant near agricultural regions. Values of t-DDT in Zooplankton decrease seawards. This is possibly due to the effect of river-borne pesticides. Pesticides in the sediments along the Indian coast are presented here. These indicated that apart from DDT and its isomers, residues of Gamma - BHC, Aldrin and dieldrin were also present at a number of places. Their individual concentrations were, at times, higher than t-DDT. the most interesting feature is the difference in the order of concentrations between the east and west coasts of India. All the major rivers in India are east flowing through vast tracts of agricultural land, naturally receiving more organochlorine residues through runoff.

The annual use of pesticides in Andhra Pradesh exceeds 26000 tonnes - a third of the total used in India.[49] Residues are found in shrimp, bivalves, gastropods, moluses, and fishes. But considering the amount released, the concentrations are surprisingly moderate. One reason could be that pesticides are volatlised into the atmosphere the marine environment in Andhra Pradesh is still in a good condition and no great threats to fisheries have been identified.

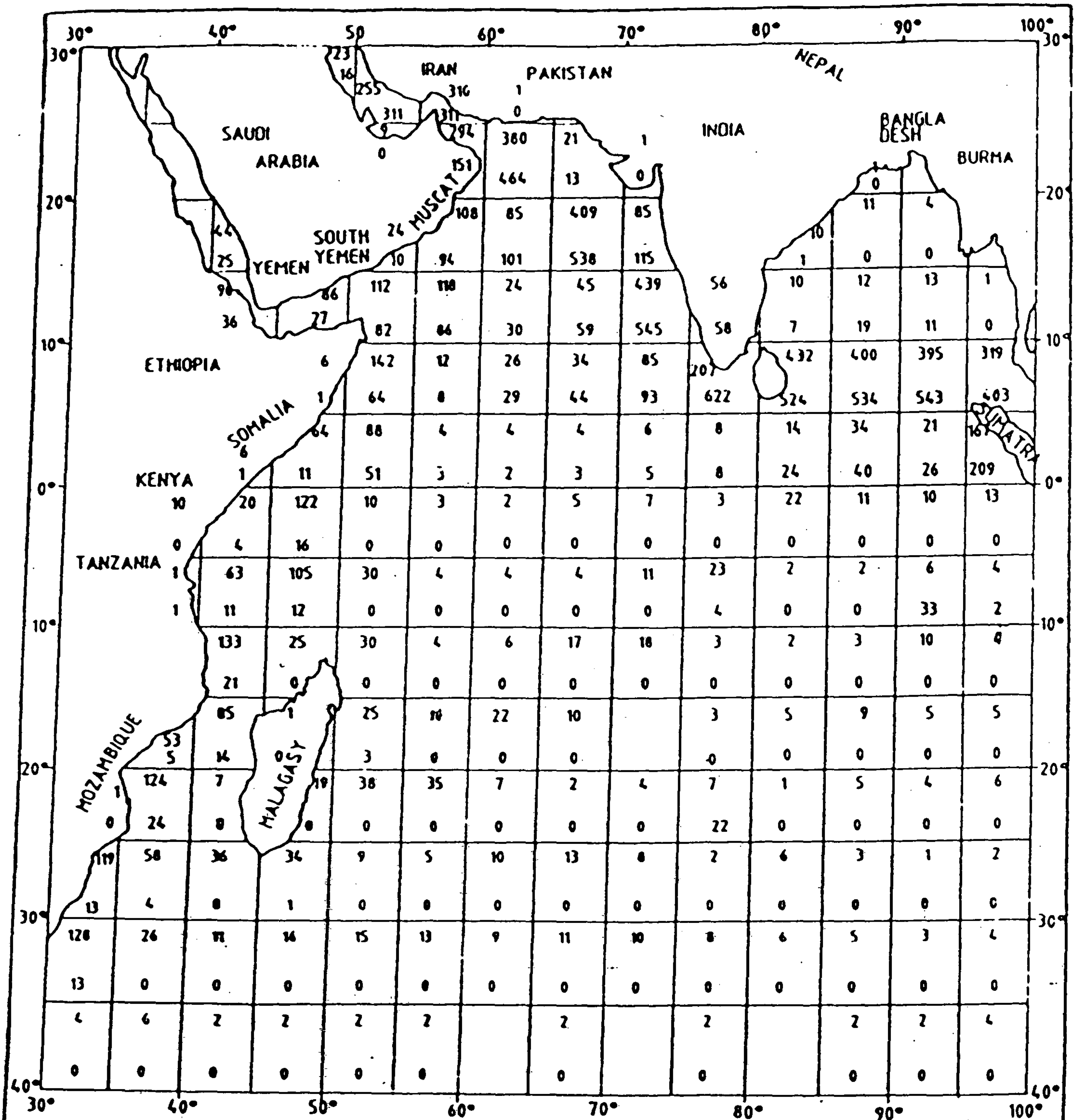
Oil Pollution : Transportation of about 60 per cent of the world's crude oil and its products along the oil tankers routes across the Indian Ocean has rendered the Indian seas prone to oil pollution. Oil pollution in seas occur either from maritime accidnts due to fire, collision or grounding, international discharge of oil or oily wastes or by accidential spillages. Added to this is the oil production activities in the Indian coastal seas. The total record of accidental oil spills in the Indian Ocean is 15 tanker disasters and three blow outs between 1970 and 1982.[50]

Available data show that marine transport of oil from the Middle east countries is gradually decreasing. Consequently, the volume of tanker traffic has also decreased considerably. As a result of the reduction in traffic an apparent reduction in oil pollution from 1978 to 1985 can be deduced from data for the tanker routes across the Arabian sea and Bay of Bengal.[51]

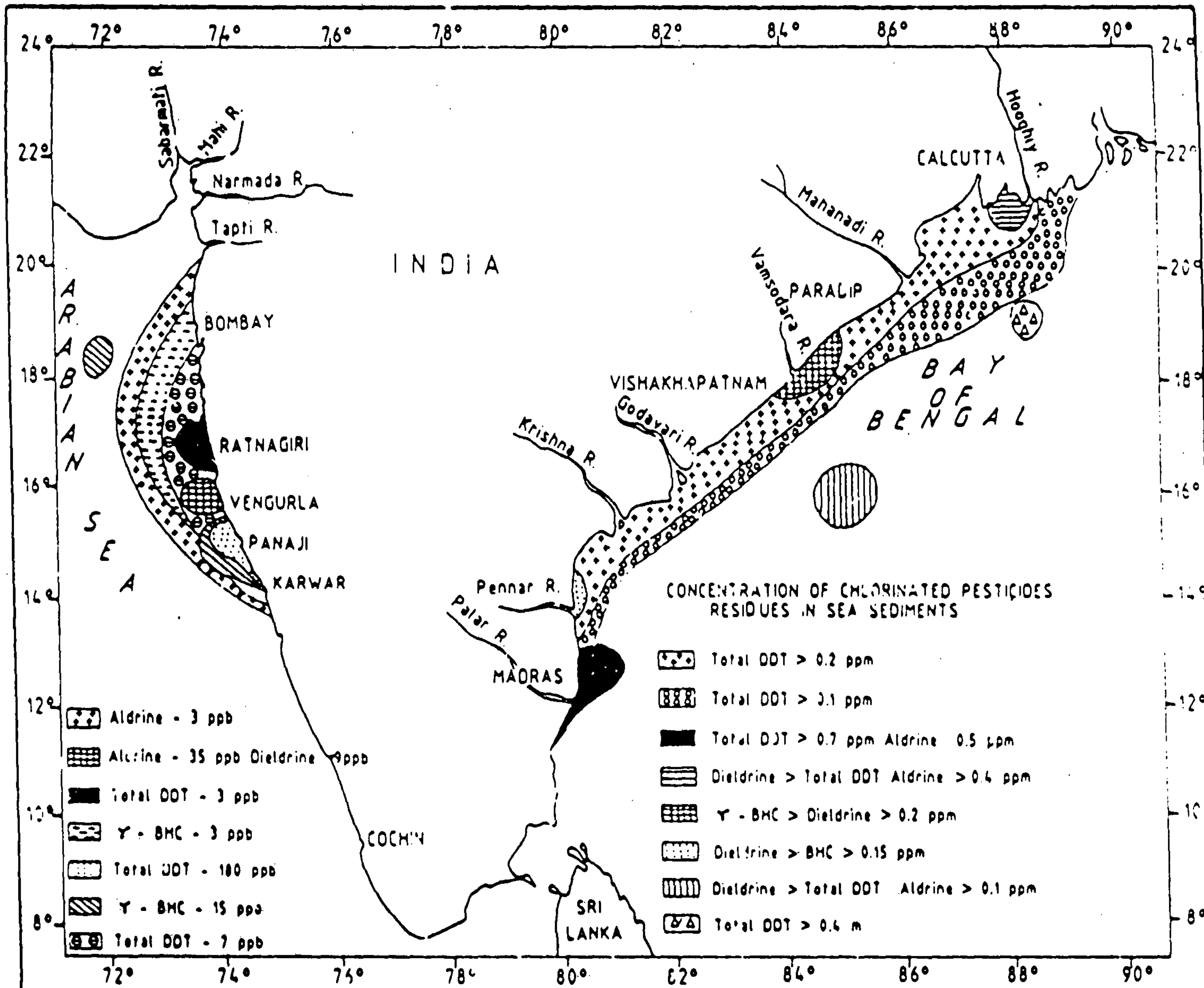
Observation of oil slicks and other floating pollutants over the entire Indian Ocean down to 40^{o}s latitude is not very alarming. The data have been divided in 5^{o}-squares. Numbers at the top indicate the total number of 0 nil observations while those at the bottom are the numbers of occassions when oil slicks are sighted. A close look at the figures will indicate that oil slicks are mostly along the tanker routes while south of the equator in the open Indian Ocean there is hardly any visible trace of oil pollution.



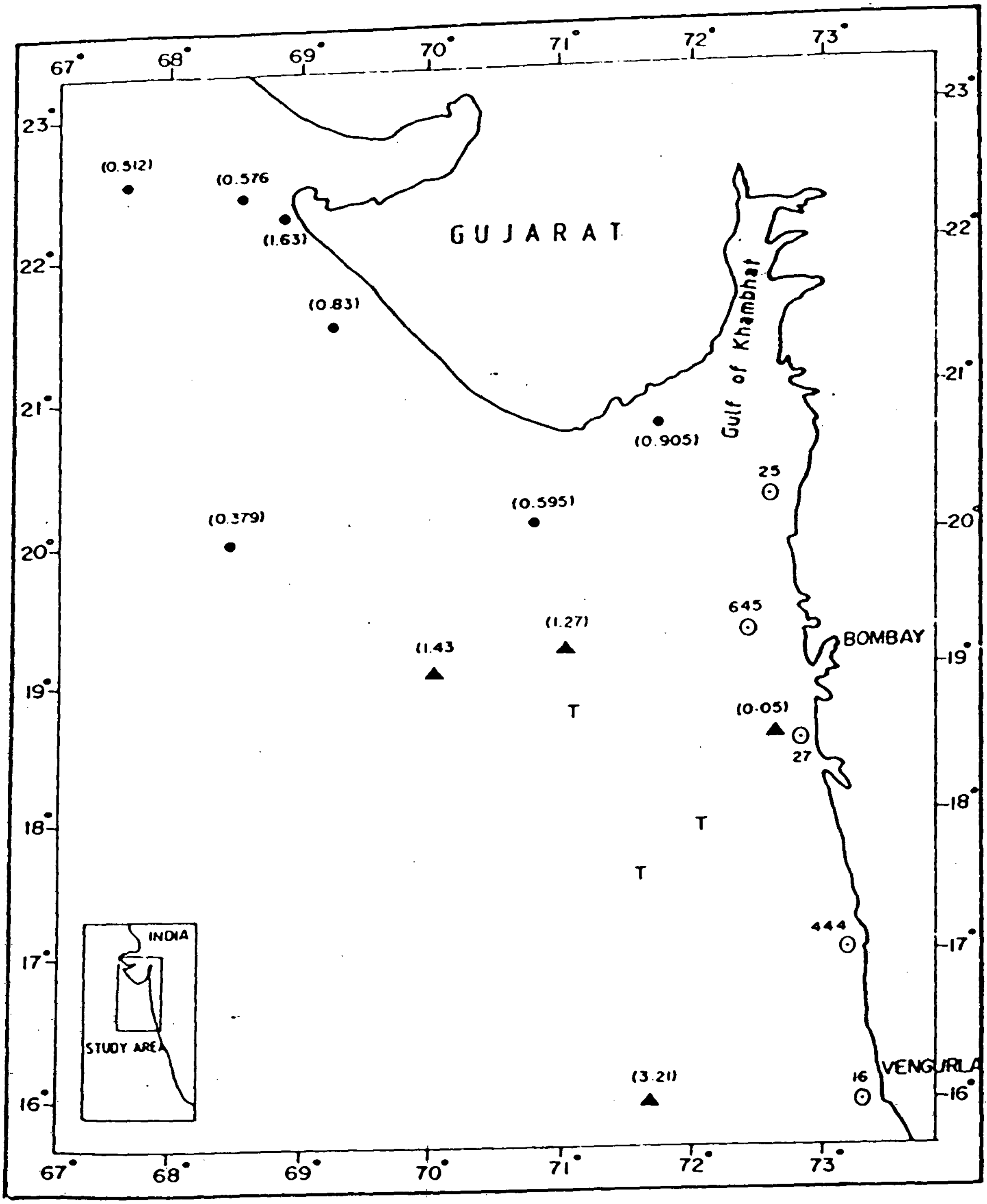
The Oil Tanker Routes in the Indian Ocean



Observations on oil slicks and other floating pollutants every 5° square in the Indian Ocean. The upper values indicate occasions when oil slicks were absent while lower values indicate occasions when oil slicks were sighted. Data collected 1975-1980, updated to 1984. (Courtesy: Japan Oceanographic Data Centre)



Concentration of chlorinated pesticides residues in the
sea sediments along East and West of India
(modified from: Qasim & Sen Gupta, 1988; Sarkar & Sen Gupta, 1987)



▲ t-DDT in Zooplankton in 1978 (ppm)
● t-DDT in Zooplankton in 1987 (ppm)
⊙ t-DDT in Water (ng/l)

, Pesticides residue in water and zooplankton in the Arabian Sea (modified from: Kureishi et al., 1978; Sarkar & Sen Gupta - 1989)

An indication of the effect of oil exploration activities on the marine environment can be obtained from the concentrations of dissolved and dispersed hydrocarbons in the range of 2-46 ug/1 in the water and 4-32 ug/g dry weight in the sediments taken from the vicinity of the Bombay high oil fields.[52] A near catastrophic event took place in the Bombay harbour region, where, after a tanker fire accident, the concentration of dissolved and dispersed hydrocarbons rose from 27 to 105 ug/1 in water and in the sediments it increased from 1-26 mg/g dry weight to 4-512 ug/g after the accident. The values, however, recovered to background level within a few weeks.[53]

Cargo ships and oil tankers visiting Indian ports often cause oil pollution in harbor waters by operational or accidental discharges of oil and oily ballasts during loading and unloading. These oil discharges may end up as despositions of tarry lumps on nearby beaches and occasional mortality and frequent oil-tainting of the benthic fauna, particularly shellfish. The heavy tarry lumps which are so frequently found during May-September on the West coast of India beaches are stirred up because of the development of strong shoreward component of the currents during May-September along the west coast of India. Observations on several west coast beaches conducted during 1975-1976 gave the average tar deposition of 28 and 20 g/m^2 respectively. This means that about 1000 tonnes of tar are deposited on

Dissolved and dispersed hydrocarbons in the upper 20 m of the Arabian Sea and the Bay of Bengal

Year	ARABIAN SEA			BAY OF BENGAL			
	Transport (M/T)	Concentrations (µg/l) Range	Concentrations (µg/l) Mean	Transport (M/T)	BB/AS %	Concentrations (µg/l) Range	Concentrations (µg/l) Mean
1978	975	0.9 - 42.5	24.31	323	33	0 - 28.2	17.14
1979	1010	10.4 - 41.6	24.48	351	35	-	-
1980	869	2.4 - 9.0	5.28	308	35	1.2 - 27.4	12.47
1981	725	-	-	247	43	0 - 2.8	1.40
1983	513	0.0 - 17.7	5.02	222	43	-	-
1984	489	-	-	252	51	0 - 3.4	1.70
1985	447	0.65 - 31.0	7.64	232	52	-	-
1986	-	1.0 - 23.5	7.50	-	-	-	-
Net decrease (%)	54	-	-	-	28	-	-

Source : Qasim & Sen Gupta (1988)

the west coast alone.[54] Deposition of tar balls is also considerable on the east coast beaches during December-January.

All these studies indicate that the indiscriminate release of sewage, industrial and other wastes has created pockets of pollution along the Indian coasts affecting the ecology and environment.

Eutrophication : The untreated sewage from the cities located on the Indian coast as well as unrestricted industrial discharges have made some water bodies oxygen deficient. A clear example of this is the Mahim creek where the diurnal variations of H_2S-S and dissolved oxygen (DO) are presented here. Reduction in DO concentrations off Bombay region over the last 15 years has been observed. Similar situations are also observed off Cochin and Madras.

The short renewal time of intermediate waters and the related observed short-term temporal variability in denitrification idicate that the oxygen-poor, denitirifying layer in the Arabian sea is an unstable, time variable feature. It is not yet clear if the variability occurs either as a result of productivity or circulation. One or both these controlling factors are probably reflected in the intensity and horizontal extent of denitrification. Thus, there is an alarming possibility that anthropogenic, climatic or environmental perturbations (global warming resulting from increasing inputs of fossil fuel CO_2 to the

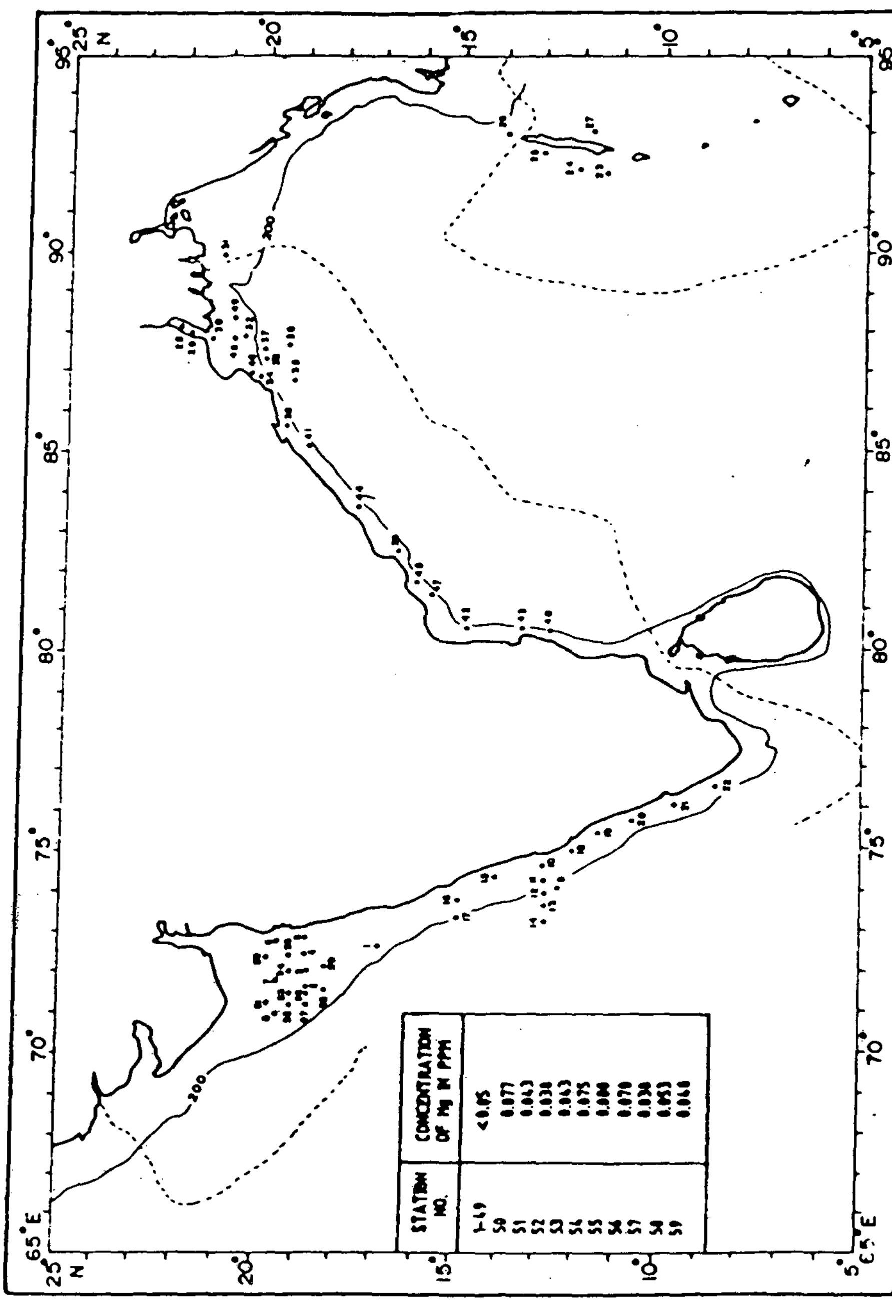


Fig. 3 Distribution of Hg in sediments (ppm dry wt).

atmosphere or an increase in the downward flux of the organic carbon associated with pollution) could disturb the precarious balance between oxygen consumption and its supply, and may well lead to the appearance, or a reappearence, of hydrogen sulphide.[55]

Nuclear Power Plants Along the Sea : Nuclear power generation units along the sea in India normally release 50 per cent of their generated heat to the coastal marine environment.[56] Flora and fauna in the tropical warm waters live dangerously close to their upper lethal limits of temperature, particularly during the warm summer months. It does not need a large deviation from this limit to result in an environmental catastrophe. Fisheries near such power plants are receding further and further away from the shore. On the other hand, thermal power plants result in discharge of fly ash slury and causes damage to fisheries.

The Kalpakkam nuclear power plant has caused waste heat addition, chlorine and other chemicals, mechanical stress on marine life due to impingement, and radioactive discharges. A rise in mean temperature by $1^{o}c$, increase in seston content, decrease in water transparency, a decrease in net productivity increase in silicates and possibly phosphates are the major changes observed after the power station has gone operational. A rise in mean temperature could possibly be the reason for the reduction in net productivity.[57]

The data on temperature tolerance limits of the aquatic species common along the coast of India is not adequate enough. However, scientists contend that at discharge points (within a few hundred metres) the temperature should be limited to around 35^{o}c always. Or, at discharge point, a discharge temperature of 5^{o}c above ambient in winter, and 3^{o}c above ambient in summer may be good enough to protect aquatic life along Indian coastline except bioreserves where most stringent norms are to be adhered to.[58]

Exploitation of Living Marine Resources : The marine fisheries in India is concentrated in the nearshore waters upto a depth of about 60 metres.[59] The capture fisheries in the coastal zone appears to be on the decreasing trend. Total fish production is rising, the present figure being 1600 thousand tonnes per annum. However, marine fish landings are decreasing and about 40,000 tonnes are being harvested from culture fisheries per annum.[60] This is attributable either to pollution or over exploitation. In the busy ports and harbours, pollution from ships and dredgeing reduces the availability of oxygen in bottom waters rendering condition near anoxic. Benthic fauna is badly depleted resulting in significant loss of fisheries. Fisheries near Bombay harbour are, for example, receding further and further from shore and fishermen have to go beyond 10 kms. from shore. Fisheries in the nearshore and estuarine regions at few locations also appear to have depleted considerably along the coasts of India due to pollution from industrial effluents and sewage disposal as mentioned in earlier sections.

The untreated sewage and unrestricted industrial discharges into the coastal environment have made some water bodies oxygen deficient. The biological effects of pollutants in the marine environment of India are not very well studied. However, the effects at the population and community levels have been noticed in restriced environments along the coast, estuaries and creeks. Studies on the effects of mining activities on clam fisheries and bottom founa at Goa estuaries indicated a reduction of 70 per cent in less than 10 years in clam production, near extinction of resident fauna and the reappearence of a low diversity bottom fauna comprising at tolerant but vagrant species.[61]

It has been reported that the extent of organic pollution in some areas in Cochin backwaters is well above tolerence level of estuarine fauna. Although, at present, the impact of pollution on marine fisheries, in general, is not alarming, the sign of damage to the living resources as evident in certain pockets may emerge in serious proportions in the near future if unchecked.

The Government of India has introduced legislation to demarcate zones of operations for non-mechanised traditional boats, small mechanised boats and deep-sea fishing trawelers. While foreign vessels are not permitted within the EEZ, most of the maritime states of India have enacted legislation which prohibits even small mechanised boats from fishing within 5-10 km. from the coastline.[62] This legislation, in addition to safeguarding the interests of the traditional fisherman, will also help to protect ecological values of coastal waters from the ravages of mechanised fishing.

Cyclonic Storms and Floods : Year after year catastrophic cyclones and floods have dealt a crippling blow to the coastal community of India. A study by the Indian Meteorological Department on the cyclones formed in the Bay of Bengal from 1891 to 1987 over a period of 95 years depict that about 500 cyclones/depressions have occured in Bay of Bengal and out of them about 126 were severe.[63] Similarly, according to the information by the Union irrigation ministry, the average damage per year amounted to about Rs. 10480 million during the five years ending 1981, whereas it was Rs. 512 million in the 1950s and Rs. 922 million in the 60s and Rs. 1524 million in the early 70s and Rs. 2600 million during 1976-78.[64] Recent studies indicate that Orissa, Andhra Pradesh, West Bengal, and Tamilnadu are worst hit by cyclones and floods.

East coast of India is usually prone to floods due to crossing of cyclonic storms over the east coast in or near the deltas. Depending upon the severity and size of the cyclones the areal extent of flood extends into the inland.

It has been found that majority of the cyclones that crossed over east coast laterally spread rainfall to a radius ranging from 150 to 250 kms. from the eye of the cyclones.[65]

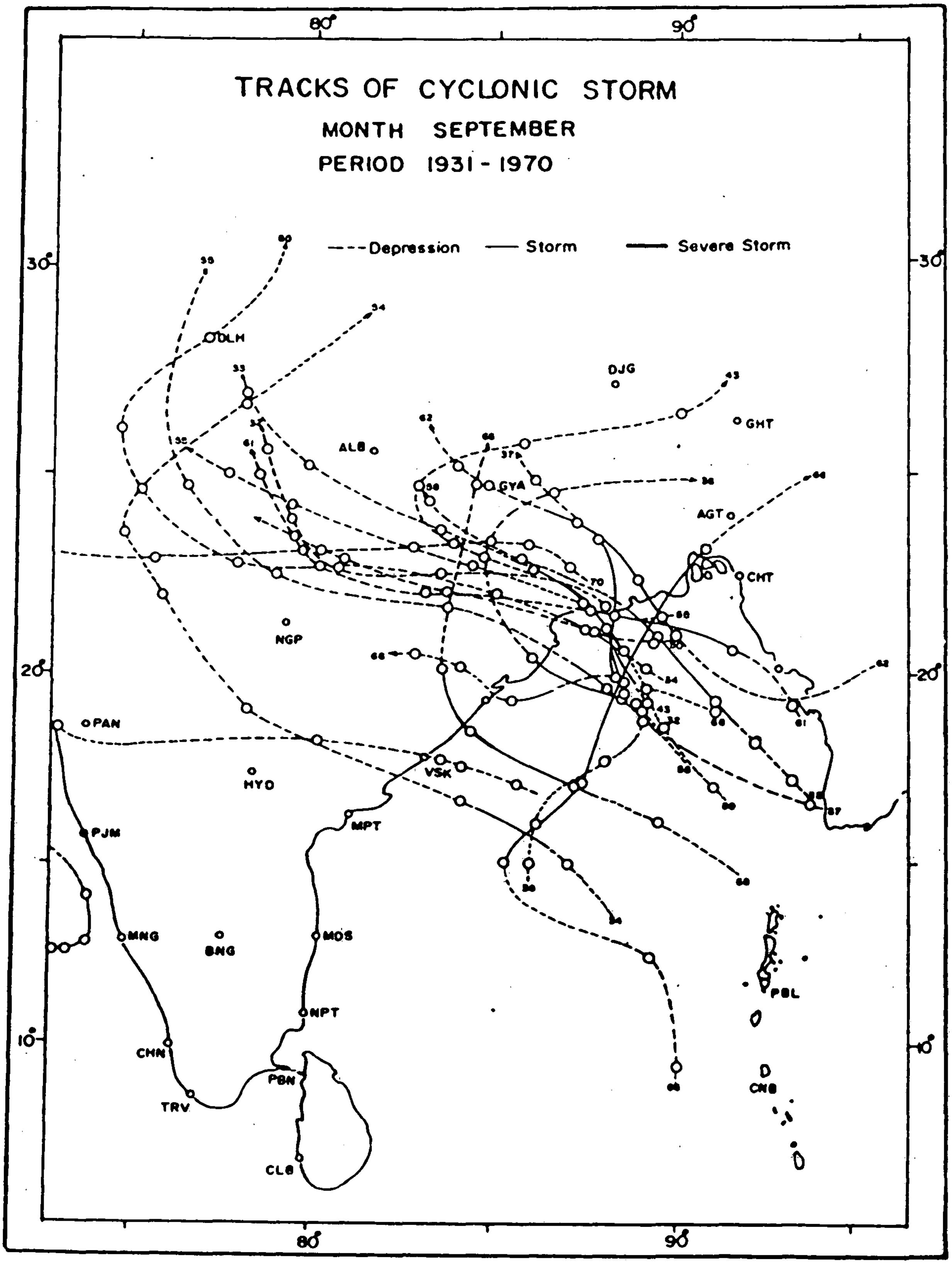
FREQUENCY OF TROPICAL CYCLONES MONTHWISE OVER BAY OF BENGAL AND ARABIAN SEA (1891-1970).

(Figures in brackets are severe cyclones)

Month	Bay of Bengal	Arabian Sea
January	5 (1)	2 (0)
February	1 (1)	0 (0)
March	4 (2)	0 (0)
April	19 (8)	5 (4)
May	39 (26)	16 (13)
June	35 (4)	15 (10)
July	38 (7)	3 (0)
August	26 (1)	2 (0)
September	32 (10)	5 (1)
October	62 (26)	20 (7)
November	68 (33)	25 (19)
December	34 (14)	5 (1)
Total	**363 (133)**	**98 (55)**

Source : P. Koteswaram (1984)

As per the information, the wind velocity during the cyclone in October 1985 was 85-100 km. Sometimes it is also observed that this velocity increases upto 120-150 kms. per hour. An analysis of the cyclonic crossings over the coast depict that the cost in between Vishakhapatnam and Mahanadi delta is prone to cyclones formed in Bay of Bengal during south-west monsoon.[66]



Tracks of cyclonic storm along the Indian coast

The area normally exposed to river flooding and saline inundation, for example, in Orissa is about 687800 hectares, largely in coastal districts. The intensity seems to be more in the Mahanadi delta because the delta is formed of more river borne landforms. If we take into considerations the economic losses and cost incurred to restore the vast devastation caused by cyclones and floods, it is really unthinkable to bear the losses every year. The response to these problems has come upo in the form of adjustment and abatement or protection. The responsive governments of maritime states have started constructing community shelter halts at higher levels in the coastal villages. Plantations of different crops have been made in huge quantity in the pockets where tidal waves have encroached the land surface. The cyclone and flood mapping have also been done in addition to scientific forecasting of the disaster and its management practices.

From the above analysis, it can be concluded that the pollution load on the coastal marine environment of India is on the increase. The main reason for this increase is population growth at the rate of about 2 per cent per year. To sustain this growth, agriculture and industry are also growing. The present trend is towards increasing urbanisation and industrialisation. However, people are becoming more and more aware of the value of a clean environment. It can, therefore, be optimistically expected that, though stress on the environment will increase, its quality wil not deteriorate.

Sewage and other effluents problems are the most important in India. They are at present discharged into coastal marine waters mostly in partially treated form. This, occasionally results in fish kills, damage to coral reefs, destructions of mangrove habitats, etc. A large amount of silt is added every year by river runoff from India. This silt naturally carries a considerable amount of pollutatnts from inland. Deleterious effects of tourism are also a significant problem.

India is developing and needs to develop further and faster. Agriculture has to be mechanised, more and more fertilisers and pesticides have to be applied, industries have to be set up and tourism has to be developed. All these are essential for the economy of the country but will definitely add stress on the environment. Therefore, the necessity is judicious planning. Ways and means have to be found to protect the environment without ignoring development. Environment and development must exist side by side and should go hand in hand.

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CHAPTER - 5

IMPACT OF POSSIBLE SEA LEVEL RISE : A CASE STUDY OF PARADIP COAST, ORISSA

Introduction :

For over a century scientists have known that the carbon dioxide and water vapour in the atmosphere warm our planet by absorbing outgoing infrared radiation. This feature of the climate is commonly known as the "Green House Effect". Gases that absorb infrared radiation are known as green house gases. Without this effect earth would be much colder than it is today.

Among the immediate concerns regarding the environmental effects that may result from this change in climate, is a rise in sea level. Impact of sea level rise will be more severe than a corresponding global warming of atmosphere; as due to CO_2 induced climate change we are not going to be fried rather we will be drawned.

Since the realisation of irreversible effects of sea level rise, research in this field has gained considerable momentum in the last decade particularly in western countries. At the same time the research trend seem to be shifting from causes towards the impacts direction.

Area of Case Study :

The area chosen for the study of impacts of possible sea level rise is Paradeep and its adjoining areas located in Cuttack district of Orissa. The area forms a part of the low coastal plain along the East coast of India situated in the Mahanadi delta surrounding the mouth of the river.

Objective :

Attempt has been made in this work to study the geomorphic impacts and effects on population and land use of the area due to future rise in sea level. In the geomorphic studies the influence of local factors and processes which may be operating actively have not been taken into account, those are magnitude of sediment discharge from rivers to the sea, local tectonic activities, subsidence of nearshore bottom due to increased water load, atmospheric parameters etc. Also for the population and land use studies the current data only has been examined. It does not take into account the future measures, adaptive responses or future changes in the distribution of population and land use. Hence the result is a rough approximation of the future stakes. The area is a low coastal plain made up of alluvial sediments. In the geomrophic study, the total area to be submerged due to sea level rise and the resulting effects have been discussed. Then the erosion potential of the beaches has been determined. Following this, the impacts on population and land use have been dicussed. Throughout this study all the figures and discussions given are for the future impacts only.

Importance of the Study :

The present topic has been choosen keeping in view the disastrous consequences of future rise in sea level. Because of its immediate impacts on many aspects of human life, it necessitates the involvement of scientists and scholars in this study. And also this type of work helps in one or other way in coastal planning and management by the government and other agencies working for the betterment of coastal communities.

Secondly, slope is the chief controlling factor with regard to horizontal shoreline displacement. Along the East coast of India slopes are gentler and areal extensions of deltas are more compared to those of West coast. So the severity of the effects due to sea level rise will be more in the East Coast.

Study Approach :

In the present study two types of study have been undertaken : geomorphic impacts and the effects on population and land use. Two scales of future scenarios of sea level rise have been used in this case study. The first one is : to show the area of submergence and the effects on populaiton and land use for which two scenarios were examined. The more optimistic scenarios assumes a future 1 meter rise in sea level. The more pessimistic high figure assumes a 3 meter rise in sea level.

Then coming to show erosion potential another scale has been adopted, i.e. the world-wide rate of eustatic sea level rise (1.2 mm/yr.).

Preparation of Flood Map :

Paradeep and its adjoining areas have been taken as the area of focus. The final map of this area was prepared with the help of maps given in the Census Handbook. The flood map (showing area of submergence and relief) was procured from Deptt. of Geography, Utkal University. In that map heights of the contours are given in feet. Those were converted to metres and the one and three meter lines were drawn which are taken as the future shorelines as the sea level rise by 1 meter and 3 meter respectively. The new shorelines were drawn from the present high water line. Hence the 1 meter and 3 meter lines represent the limit of highwater rather than the mean sea level.

Estimation of the Area of Submergence :

The areas that are going to be submerged when the new shorelines of one meter and three meter were projected on the study area, were estimated by planimeter.

Application of Bruun Theory :

The Bruun rule of shore erosion has been applied to estimate the erosion potential of this area due to sea level rise. According to Bruun rule as the sea level rises material eroded from the upper beach is deposited on the nearshore bottom. As the sea level rises by "a" unit the quantity of material needed to reestablish the same bottom depth over a width of shelf "b" is "b" times "a" (i.e. ba). The quantity "ba" is derived from the shore erosion. This will give rise to a shore recession of "x". If the elevation of the shore is "e' the quantity eroded above the shore is "xe'. Meanwhile, to reastablish the original bottom profile, the entire profile must be moved shoreward by the same distance "x' upto a depth "d" at distance "b' from the shoreline. The balance between eroded and deposited quantities is expressed by x(e+d) + ab or the magnitude of shore recession

$$x = \frac{ab}{e+d}$$

To apply this rule, the three variables, "b", "d" and "e' ("a" is the rate of sea level rise) are to obtained from the beach profile.

Beach profiles at four locations were procured from Paradeep Port Trust Authority. With these beach profiles future erosion potentials were calculated applying Bruun rule.

Effects on Population and Land Use of the Area :

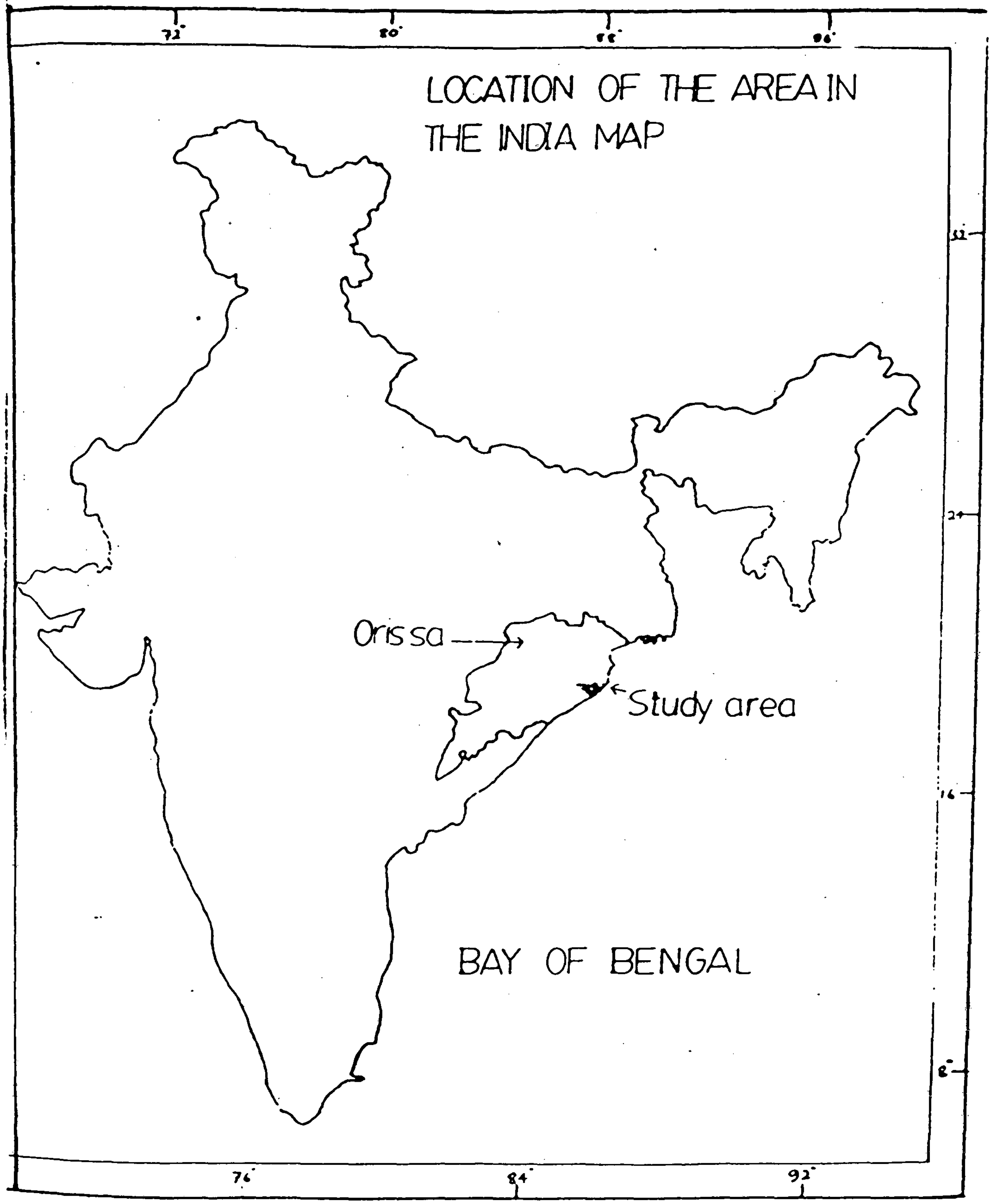
The effect on population and the land use of the area have been examined village wise. The map showing distribution of villages in the study areas was prepared with the help of Census Handbook. Then the earlier prepared flood map (showing one meter and three meter shorelines) was superimposed on the village map.

The population and land use of the villages were estimated that are to be submerged due to one meter and three meter rises in sea level. The village wise population and land use data were obtained from the same Census Handbook.

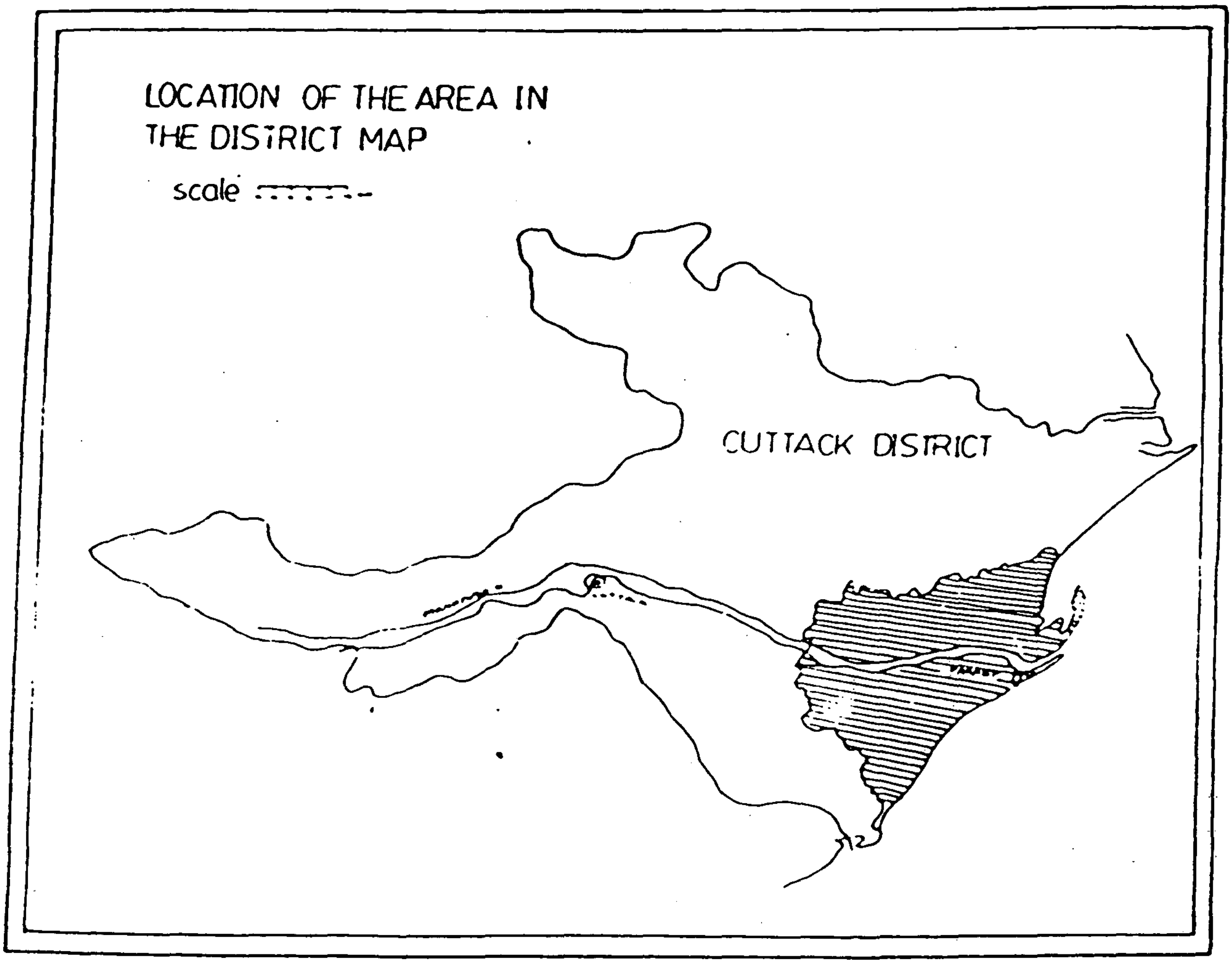
Geographical Setting :

Location. : For the present work studies were undertaken for Paradeep town and its adjoining areas. The area lying between 20^{O} 1′ and 20^{O} 31′ N and 86^{O}15′E and 86^{O}46′E constitutes most of the coastal tract of Cuttack district. It also forms a significant part of the Mahanadi-Kathojori delta system located along the Bay of Bengal, the area consists of four P.S. areas. Paradeep is located at the mouth of the Mahanadi river and of four police stations areas Ersama and Tirtol lie south of Mahanadi river and Patkura and Mahakalpara to the north. All these five areas (Maakalpara, Patkura, Ersama, Tirtol and Paradeep) taken here as the sub-areas of the whole study area. Paradeep is 120 km away from Bhubneshwar, the state capital.

Climate : The climate of the area is humid and tropical in nature. There are three distinct seasons in the area, the winter season from November to February is followed by summer from March to mid-June and the third from mid-June to October is the monsoon period. During the last mentioned

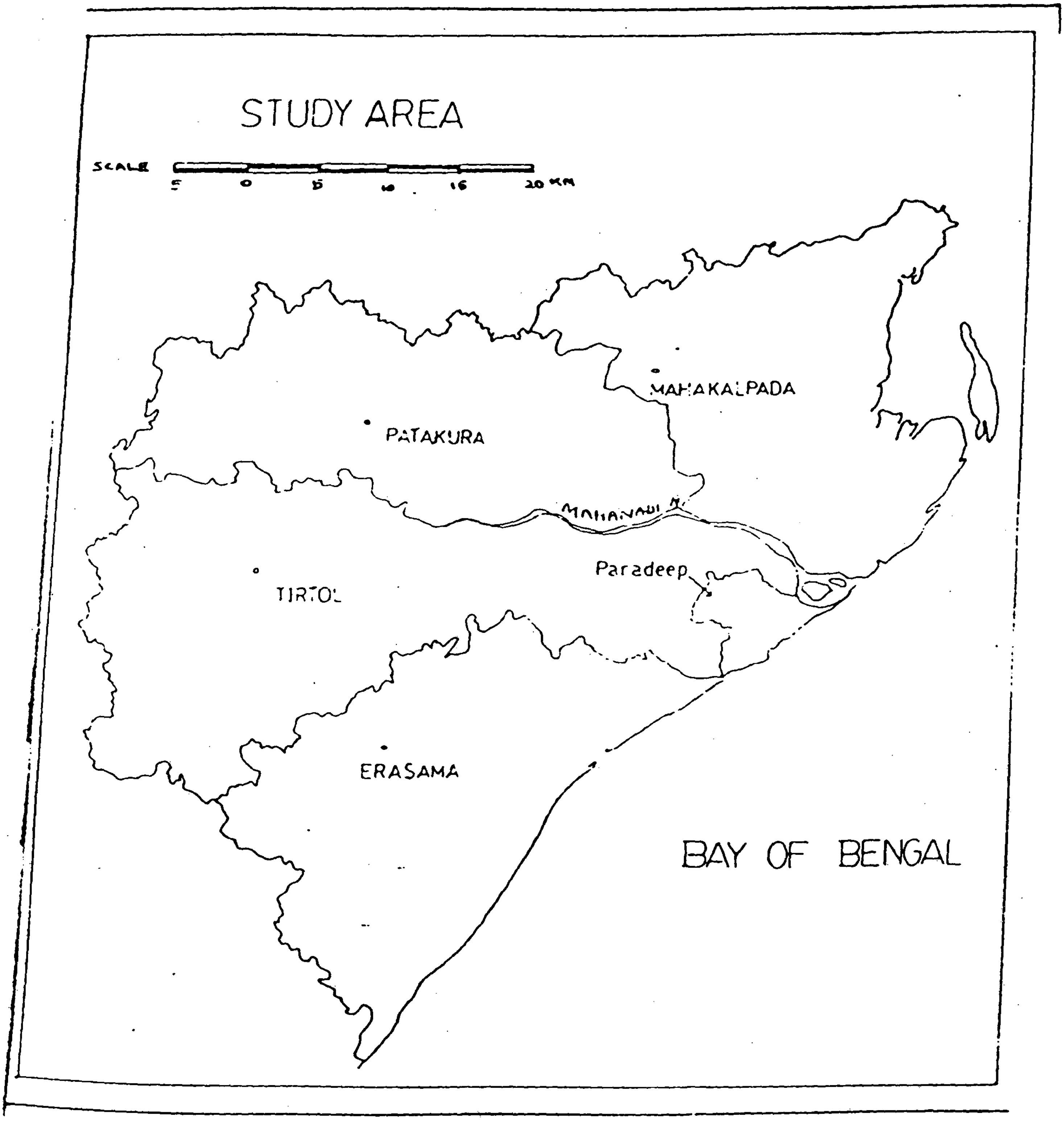


LOCATION OF THE STUDY AREA (DARKENED) IN THE INDIA MAP



LOCATION OF THE STUDY AREA (SHADED) IN THE DISTRICT-MAP.

SOURCE : DISTRICT CENSUS HANDBOOK, CUTTACK DISTRICT.



. MAP OF THE STUDY AREA.

SOURCE: DISTRICT CENSUS HANDBOOK, CUTTACK DISTRICT.

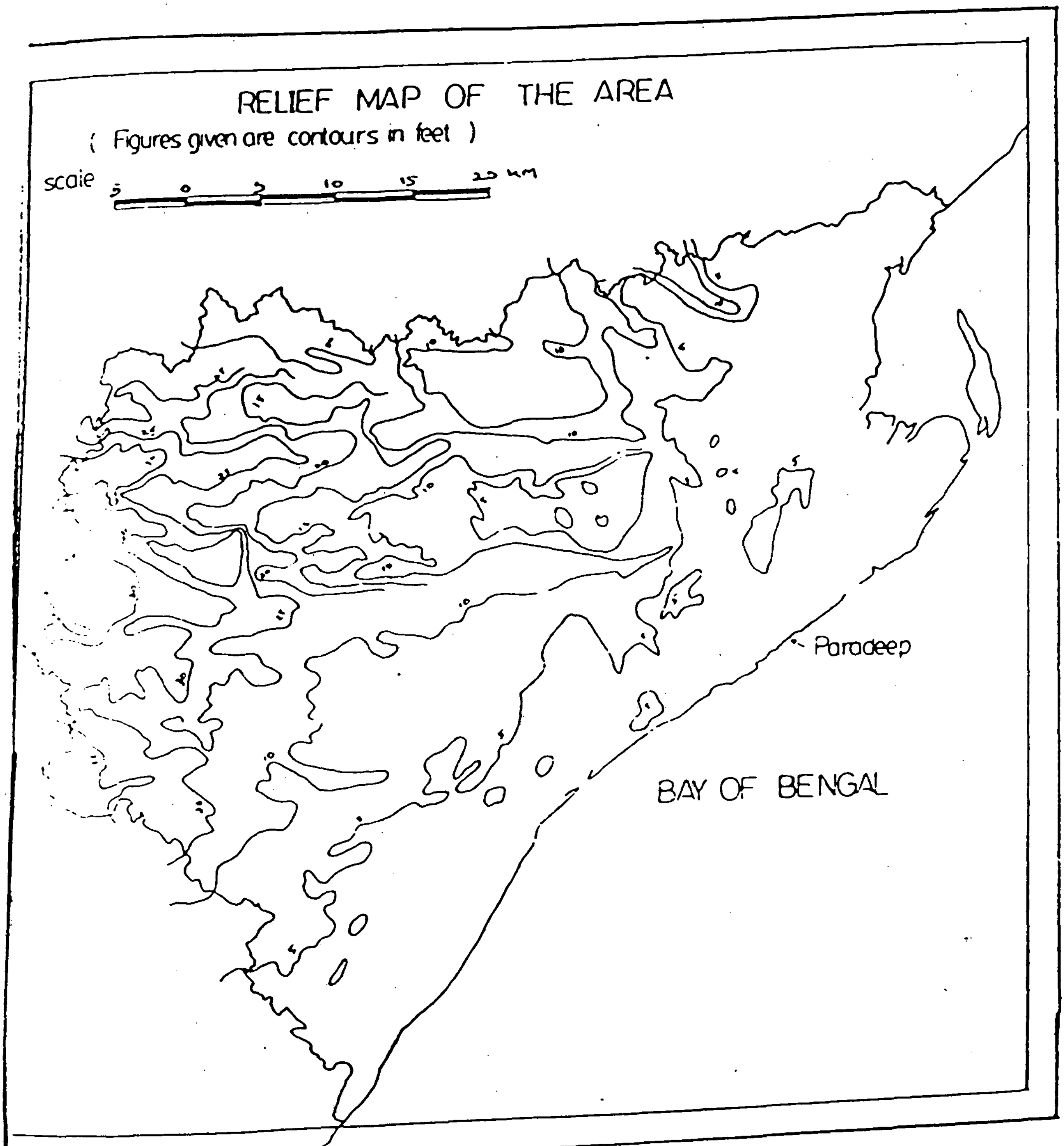
period the area experiences heavy rainfall by south-west monsoon. The spring autumn and dewy seasons are actually of very short duration and also are least felt.

The average annual rainfall is about 1572 mm falling mostly during SW monsoon from June to Sept (73%) and during NE monsoon from October to December (17%). Uncertainty in the distribution of rainfall prevails even in the monsoon months. Inundations due to occasional high floods keep many areas water-logged and swampy besides bringing damage to life and property.

Temperature and humidity are high throughout the year. The mean maximum monthly temperature ranges from 29^{O}C to 43.4^{O}C and mean minimum tempearture from 1'2^{O}C to 24^{O}C. The mean monthly humidity ranges from 41 per cent to 86 per cent.

The mean monthly wind speed varies from 2.6 kmph to 26.2 kmph. However, the area is sometimes subjected to severe cyclonic storms which arise out of depressions formed in the Bay of Bengal. Here the wind speed may rise upto 200 kmph particularly in the coastal belt. This is sometimes accompanied by tidal bores of 6 m to 7 m high and very heavy rainfall in the affected areas.

Special weather phenomenon like hail storm, dust storm, fog, thunder storm etc. occur at times and are sporadic in nature. But the area is not prone to any of such weather vagaries.



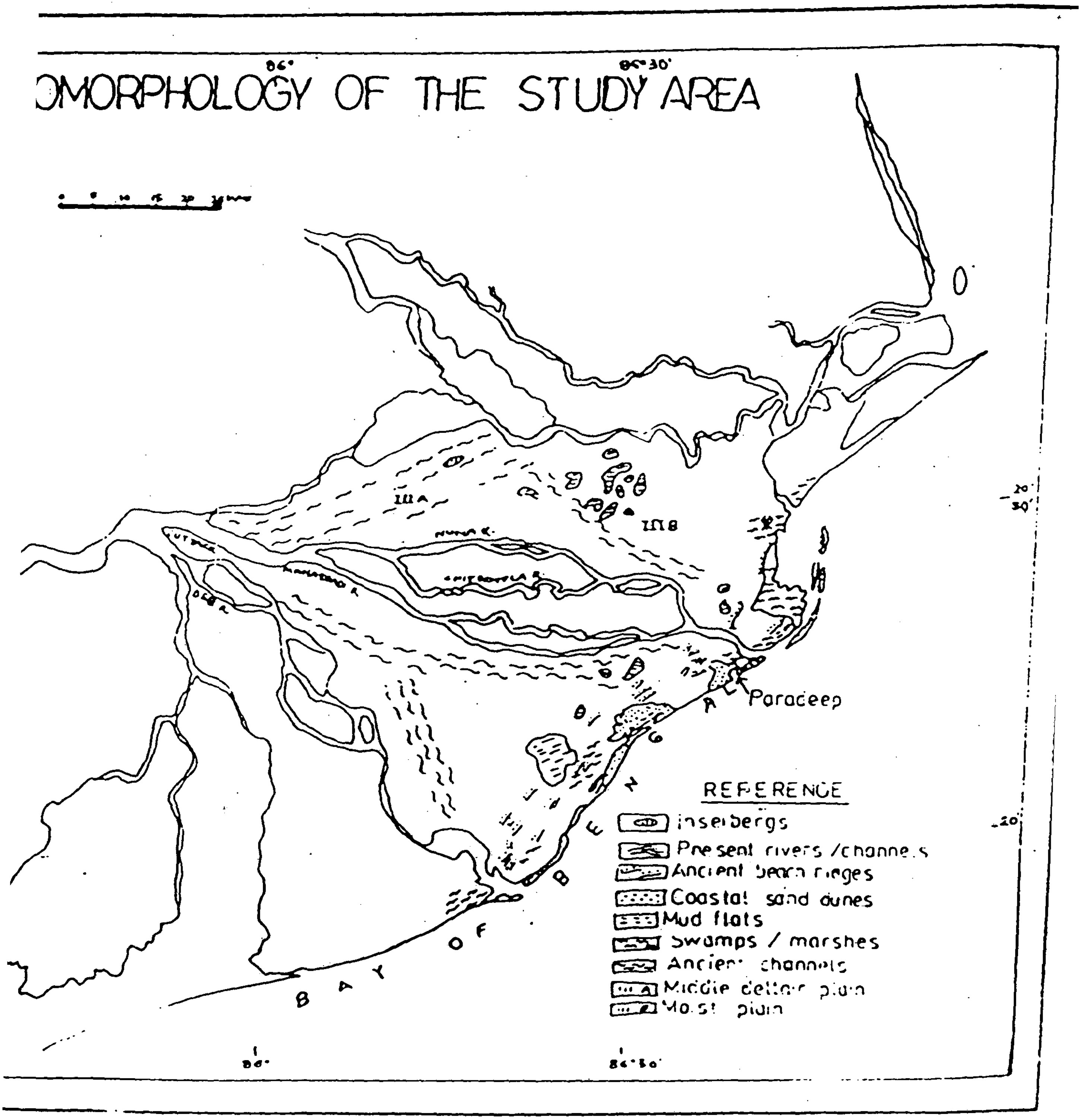
RELIEF MAP OF THE AREA CONTOUR HEIGHTS ARE GIVEN IN FEET.

SOURCE: DEPARTMENT OF GEOGRAPHY, UTKAL UNIVERSITY.

Topography : The flatness of the area is due to its deltaic nature. The highest lands are located generally along the river branches which dissect the delta, forming doabs (area between two rivers). The doabs tend to slope down from the top of the delta apex to the bottom at the coast. The slopes in the doabs are generally in the range of 1:500. The land form is quite flat but broken by numerous small and large natural drainage lines, minor depressions and slightly elevated areas. Small streams and creak in the doab interior flow into the larger streams and provide the primary natural drainage for the doab.

Geomorphology : The geomorphology of the area comprises of varied regional and local landforms and belongs to different ages and modes of origin. The western part of the area which more or less belongs to the Mahanadi delta head is controlled by weathering, erosion and mass-wasting processes. In the fluvial plains sediments are deposited in fluvial environments by rivers and along the west both fluvial and marine processes operate together. Wind has been an important co-agent working with both fluvial and marine agents to give rise to many geomorphic features like river channels dunes, beach dunes, beach sand dunes etc.

The distributory system has formed at lower reaches of the delta and ultimately meets the sea at several discharge points. Both fluvial and marine forces operate to distribute the river-borne sediments, the result has been the growth of



MAP SHOWING GEOMORPHOLOGY OF THE STUDY AREA.

SOURCE : N.K. MAHALIK, UTKAL UNIVERSITY

a vast detaic plain partly fluvial, partly marine and partly mixed.

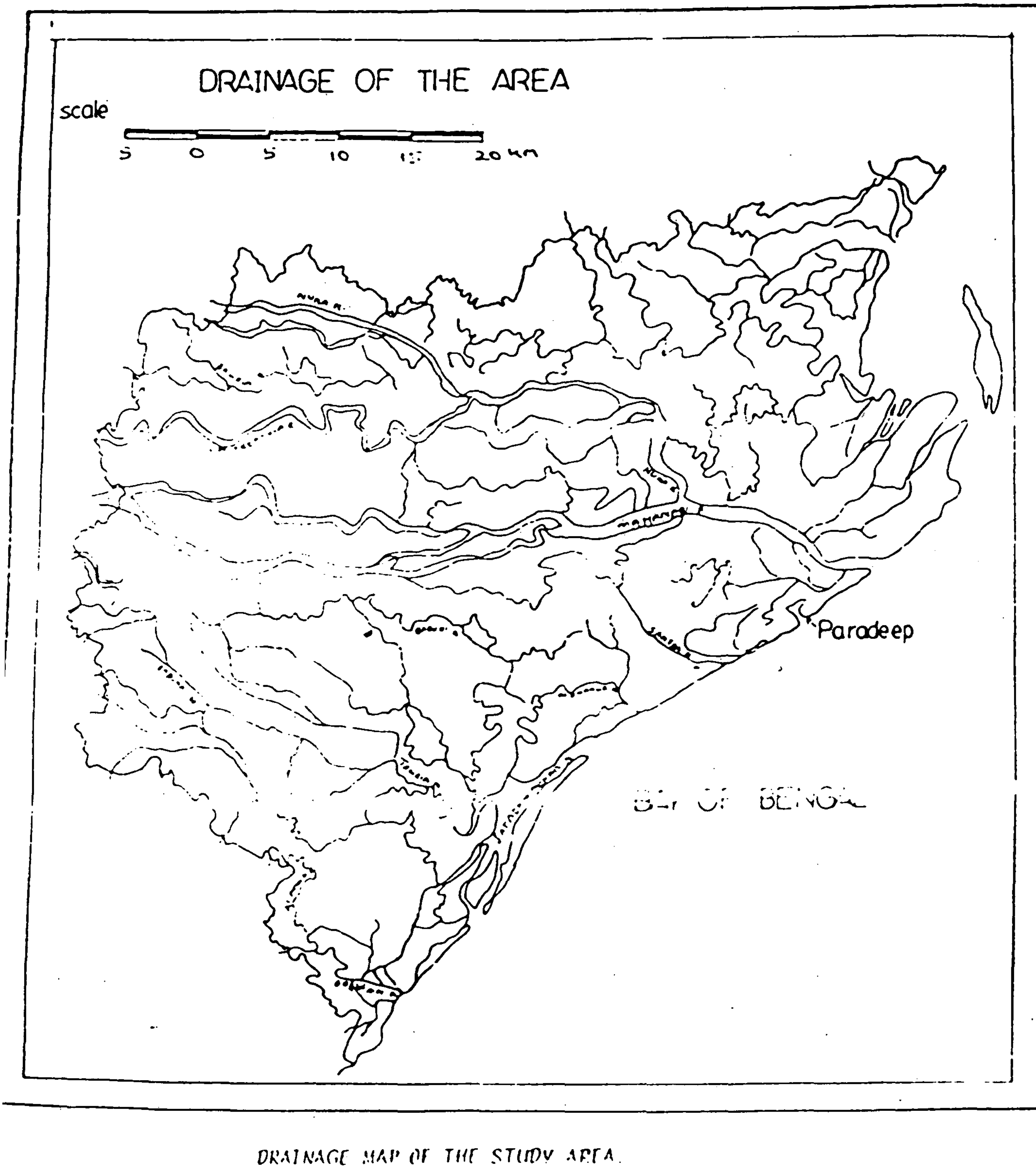
The ill-drained areas (swamps) lie in the centre of all doabs and constitute important geomorphic features in the alluvial flood plains. They are the lowest areas in between the present day active distributaries and there is difficulty in natural drainage of these areas.

Drainage : Different from early mentioned channels, another class of channels are also observed in the area, which carry water that accumulate in the flood plain either due to rain or excess spill from the active distributaries during floods. They occupy the lowest contours of the doabs and carry very little sediment. They are termed as drainage chanells. Some important channels are :-

i) The drainage channel Gobri is observed along the Birupa-Brahmni-Nuna doab.

ii) Hansada-Bodnala-Saulia drainage channel draining at Jatadharmuhan to the sea.

The drainage pattern in the Mahanadi delta is radial and parallel. Most of the rivers take significant turns close to the sea. The main rivers Mahanadi and Devi turn at right angles in a anticlockwise direction and run parallel to the west before meeting the sea. All the drainages in the Mahanadi Devi doab run parallel to the west in a SW-NE directions. The Jatadharmuhan is an example of such drainage parallel to the coast. The bends in Mahanadi and Devi might



DRAINAGE MAP OF THE STUDY AREA.

SOURCE : DEPARTMENT OF GEOGRAPHY, UTKAL UNIVERSITY be due to effects of longshore currents and presence of ancient beach ridges.

Soils : The soils in the area are mostly river transported alluvial soils which are moderately sandy along the rivers to sandy clay loam in the low lying areas. In general, the soil becomes heavier and deeper from river edges to the doab interiors and delta close to the sea. In the lower areas the soils are moist and pole yellow in colour. They are moderately fertile and slightly acidic.

Vegetation : A very small percentage of this area is under forest. Most of the flat low lying areas are devoted to agriculture. Natural vegetation is in the form of littoral forests, marshes and swamps scrub woodland etc. Tropical wet deciduous forests in a haphazard manner are found here. Littoral forests occur in a narrow strip along the sea coast.

Agriculture : Paddy is the primary crop of this area covering nearly all the irrigated area in the Kharif season and some 28 per cent area in the Rabi season. Although the soil is ideal for paddy cultivation, potential for high productivity depends primarily on elevation (which have less flooding and water logging damage) and intensity and duration of inundation during each season. There are also considerable areas of relatively light soils, well-suited for diversified cultivation, but productivity here also tends to be limited by poor-drainage condition.

The paddy yield in the delta is very low, which for irrigated rice is among the lowest in India. Prior to the construction of Hira Kund dam in the early 1960s, the yield was still lower.

State of Knowledge :

Literatures on sea level change has grown exponentially in the last twenty-five years.

Effects of Climatic Change : As a result of increasing rate of modernisation and industrialisation, atmospheric concentration of CO_2 etc. are increasing at an alarming rate while due to wide-scale deforestation mostly in the developing countries absorption of rate of CO_2 has come down substantially.

The combined effect is an increasing rate of concentration of CO_2 CH_4, CFC NO_2 etc; the impact of which is many faceted. The areas which need immediate attention as the impact is going to be severe are green house effect, ecological impact, effects in agriculture and forestry and sea level rise.

Recent measurements show that the concentration of CO_2 CH_4, CFC, NO_2 and other gases released by human activities are increasing at an alarming rate. Because these gases can trap infrared (heat) part of the insolation, scientists expect the earth to warm subustantially. Although some scientists have indicated some under-defined factors which may help reduce warming rate. The National Academy of

Science, USA has ruled out all such possibilities. The trapping of solar heat by the atmosphere in a manner somewhat analogus to the glass panels of a green house, is known as greenhouse effect. Without the greenhouse effect the earth would be approximately 33^{o}C colder than it is today.[1]

Although people may adapt to climatic changes upto a considerable period, other species which are going to be affected may not be able to control their habitats. The changes in climate would place multiple stresses on some species which would become extinct resulting in a significant decline in biodiversity. The warming could also affect agriculture and forestry by altering water availability, length of growing season and the number of extreme days.

The most disastrous consequence of a global warming would be a rise in sea level. A few degree warming could be expected to raise the sea level in the future as it has done in the past.[2]

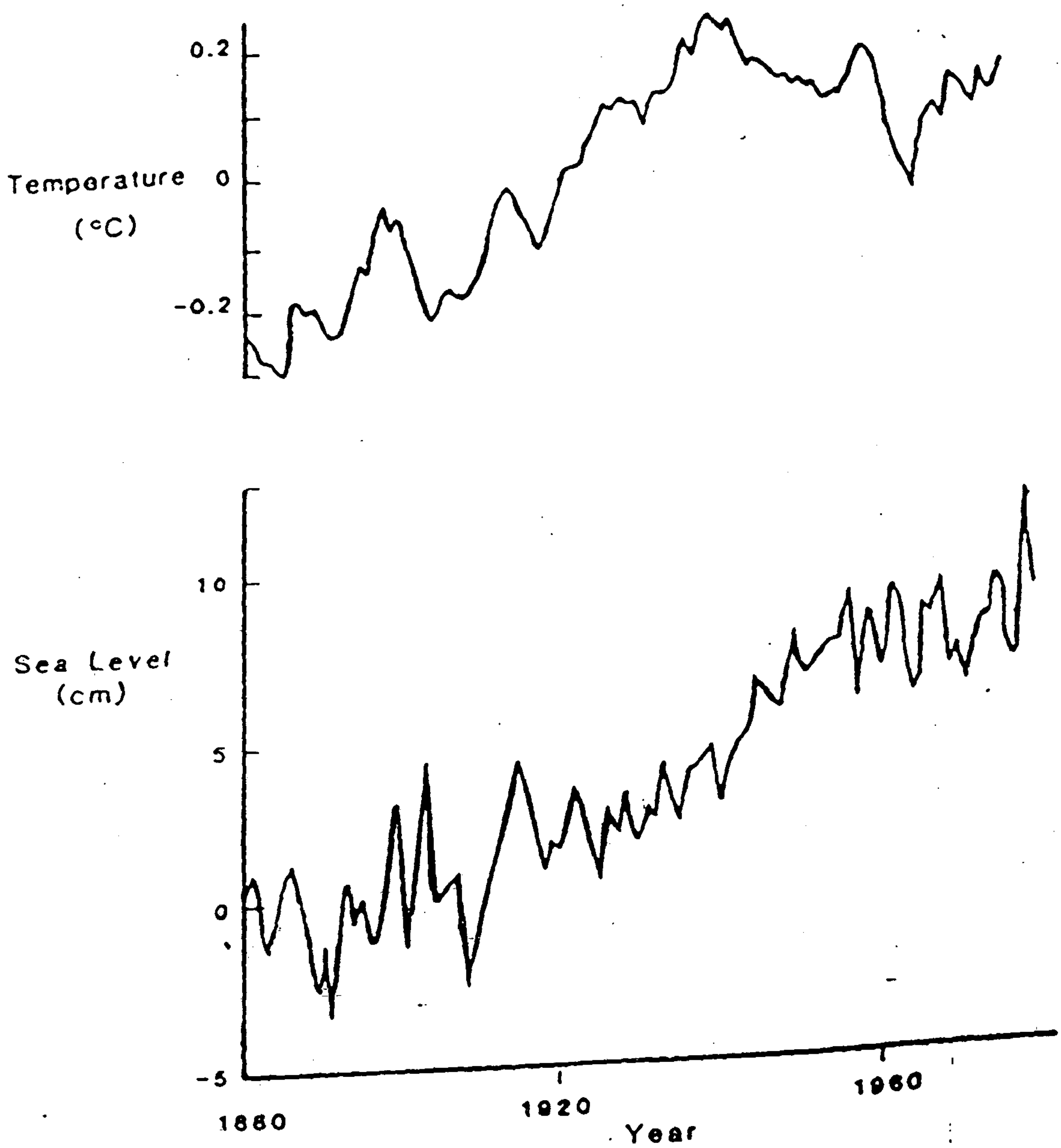
Causes of Sea Level Change : Global warming results in sea level rise in two ways, by thermal expansion of ocean water and deglaciation of the ice masses.

Apart from global warming, other less significant factors also need to be mentioned. These factors influence the sea level mostly in local and regional scale. One of such factors is terrain subsidence due to crustal downthrust and/or sediment compaction. The work of Newman et.al.[3] suggests that the value of sea level increase can simply be correlated with a typical subsidence rate. Paulmbo and Mazzarella[4] have classified some other factors as external and internal sources of sea level rise. These factors mostly effect short term variations in sea level. These sources include atmospheric pressure, rainfall, evaporation rate, surface water density etc.

Records of Past Rises : Sea level has risen and fallen by over 300 meter throughout the geologic history. It has been established that during the last age (15,000 years ago) mean sea level was approximately 100 m lower than the present level when the global temperature was 50^{O}C colder than the present temperature.[5] Sea level rise was most rapid upto 6000 years ago after which the rate became quite slow.

The last century has witnessed that mean sea level has maintained a steady rise on a global scale, much in consonant with the steady rise in the concentration of atmospheric green-house gases. Combined studies have concluded that the average world-wide sea level has risen 10-15 cm in the last century.[6] This has been attributed to ocean water expansion and meltwater from mountain glaciers.

Future Estimates : Groups of workers have attempted to project the future rises in sea level which have some direct relationship with the global warming.



Global Temperatures and Sea level rise in the last century.

SOURCES : Temperature curve from Hansen et al 1981, Sea level curve adapted from Gorniz et al 1982.

Bruun[7] has given an early estimates that the complete deglaciation of the existing ice mass (of approximately 37.5 x 106 cu cm) would cause a sea level rise of 95 meter. But due to oceanic crustal .lowering and to the fact that the rising sea would spill over a enormous coastal lowlands, the final level of the ocean might be perhaps only approximately 50 meter above the present level.

According to Revelle[8] on the basis of a global warming of 3-4^{O}C in the next century thermal expansion of ocean water would result a 30-50 cm rise in sea level and deglaciation of Greenland and mountain glaciers would contribute 10-30 cm each (assumed that no Antarctica deglaciation would take place in this period).

Hoffman et.al.[9] estimated that sea level was likely to rise between 26 and 39 cm by the year 2025 and between 91 and 137 cm by 2075. Later in 1986 they revised their projection and estimated the rise by 2025 to be between 10 and 21 cm and by 2075 to be between 36 and 91 cm. According to Thomas, the total sea level rise by 2100 is estimated to be 0.9 to 1.7 meter with a preferred value close to 110 cm.[10]

Although the impact of Antarctica is unknown it is generally agreed that a complete deglaciation of west Antarctica ice sheet would result a 5-7 cm rise in sea level which could take 3 to 5 centuries. Thomas estimated that the Antarctica contribution resulting from a 4^{O}C warming would most likely to be 28 cm, but could be as high as 2.2 meter.

Contributions to Future Sea Level Rise in the Year 2100 (in centimeters)

Study	Thermal Expansion	Alpine Glaciers	Greenland	Antarctica	Total
Hoffman et al. (1986)	28-83	12-37	6-27	12-220	57-368
Thomas (1985)	--	--	--	0-229	--
Meier (1984)	--	10-30	--	--	--
Hoffman et al. (1983)	28-115	b	b	b	56-345
Revelle (1983)[a]	30	12	12	c	70

[a] Contribution in the year 2085.

[b] Hoffman et al. assumed that the glacial contribution would be one to two times the contribution of thermal expansion.

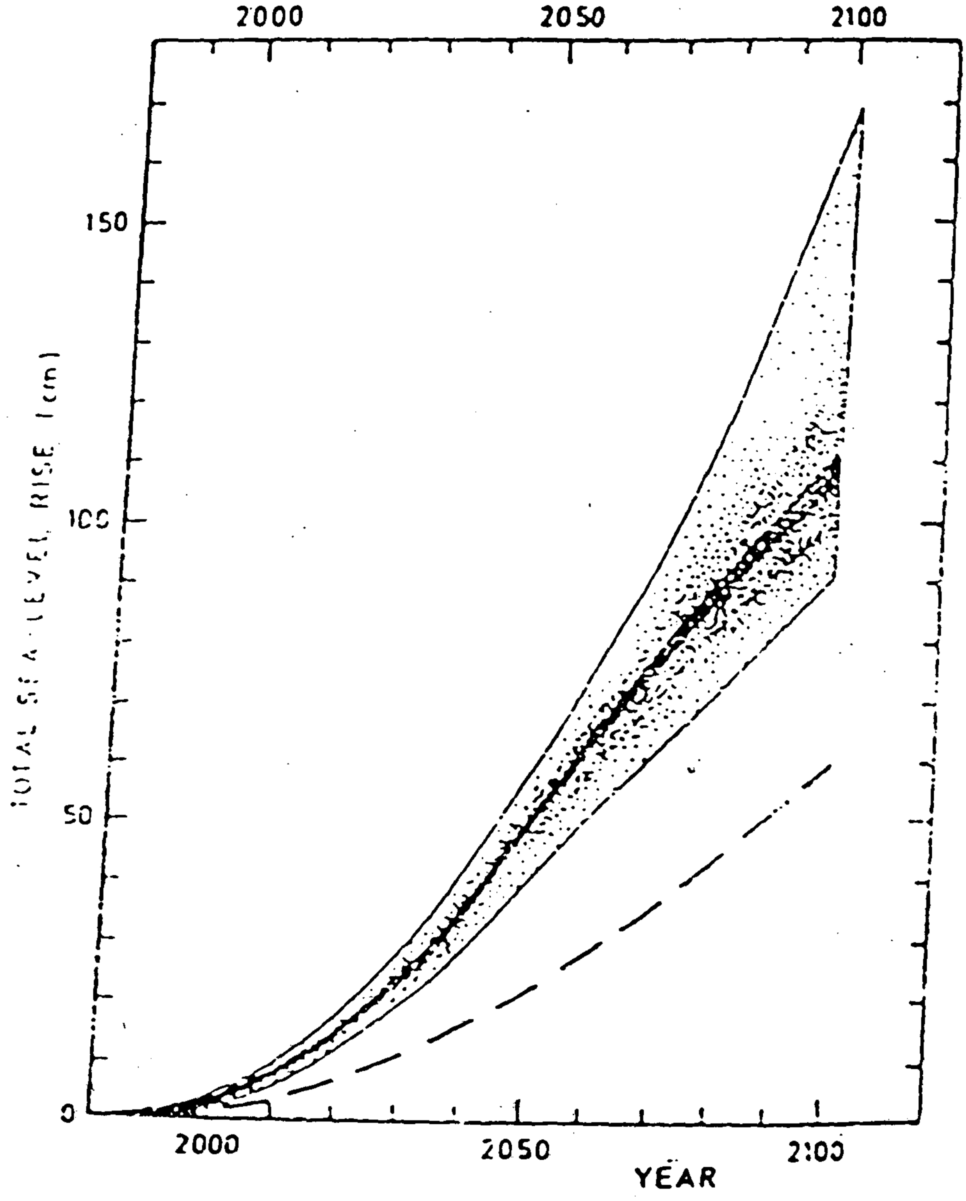
[c] Revelle attributes 16 cm to other factors.

TABLE - 3.2

Temporal Estimates of Future Sea Level Rise (in centimeters)

Study	Year				
	2000	2025	2050	2075	2085
Hoffman et al. (1986)					
Low	3.5	10	20	36	44
High	5.5	21	55	191	258
Hoffman et al.(1983)					
Low	4.8	13	23	38	--
Mid-range low	8.8	26	53	91	--
Mid-range high	13.2	39	79	137	--
Revelle (1983)[a]	--	--	--	--	70

[a] Other studies only provided an estimate for a specific year.



Total Sea Level Rise During the Next Century

The dark shading indicates the most probable response to the climate scenario. The broken line depicts the response to a warming trend delayed 100 years by thermal inertia of the ocean. A global warming of 6°C by 2100, which represents an extreme upper limit, would result in a sea level rise of about 2.3 m, but errors on this estimate are very large.

SOURCE : Thomas 1986.

General Effects of Sea-Level Rise : A sea level rise tends to cause a general recession of the shoreline due to inundation and/or erosion except where this trend is totally off-set by an adequate influx of sediment. Inundation is the submergence of the unaltered shore, while erosion is the physical removal of the shore material.

By submergence uplands are slowly converted to marsh lands. For this Kanna et. al.[11] have given drowned valley concept. Here slope is the chief controlling variable. Steep slope areas will experience little horizontal shoreline displacement with each increment of water level rise, while gently slopping shores will undergo a much broader area of flooding for a given sea level rise.

The relationship between the rising sea level and beach was first formulated by Bruun.[12] This is known as Bruun theory, which holds that assuming a profile of equillibrium, as the sea level rises, material eroded from the upper beach is deposited on the nearshore bottom. Quantitative relationship in this exchange are as follows :

a) There is a shoreward displacement of the beach profile as the upper beach is eroded.

b) The material eroded from the upper beach is equal in volume to the material deposited on the nearshore bottom.

c) The rise of the nearshore bottom as a result of this deposition is equal to the rise in sea level, thus maintaining a constant water depth in that area.

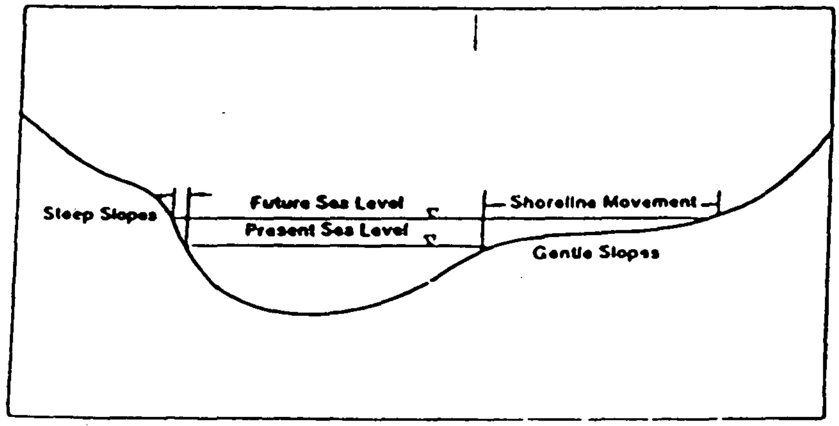
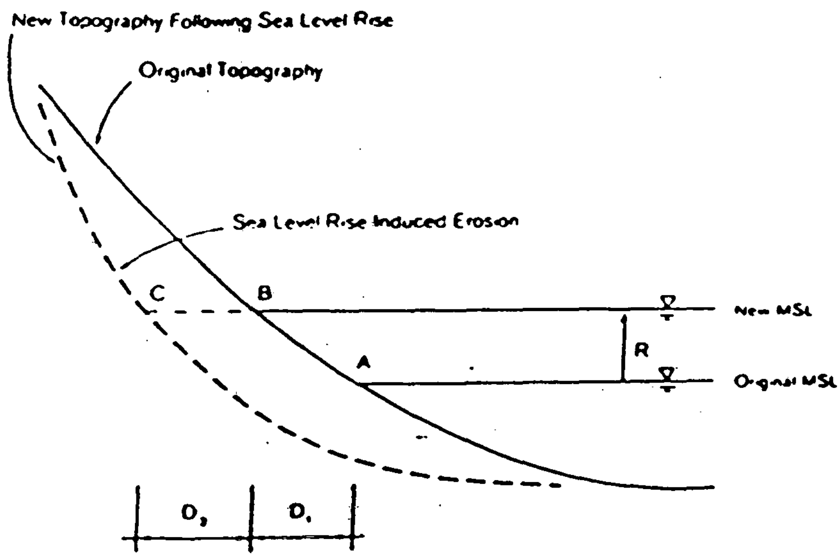


Fig. 3.3 - Drowned valley concept

SOURCE : Kana et al (1984)



- Combined effects of submergence and erosion

SOURCE : Leatherman (1984)

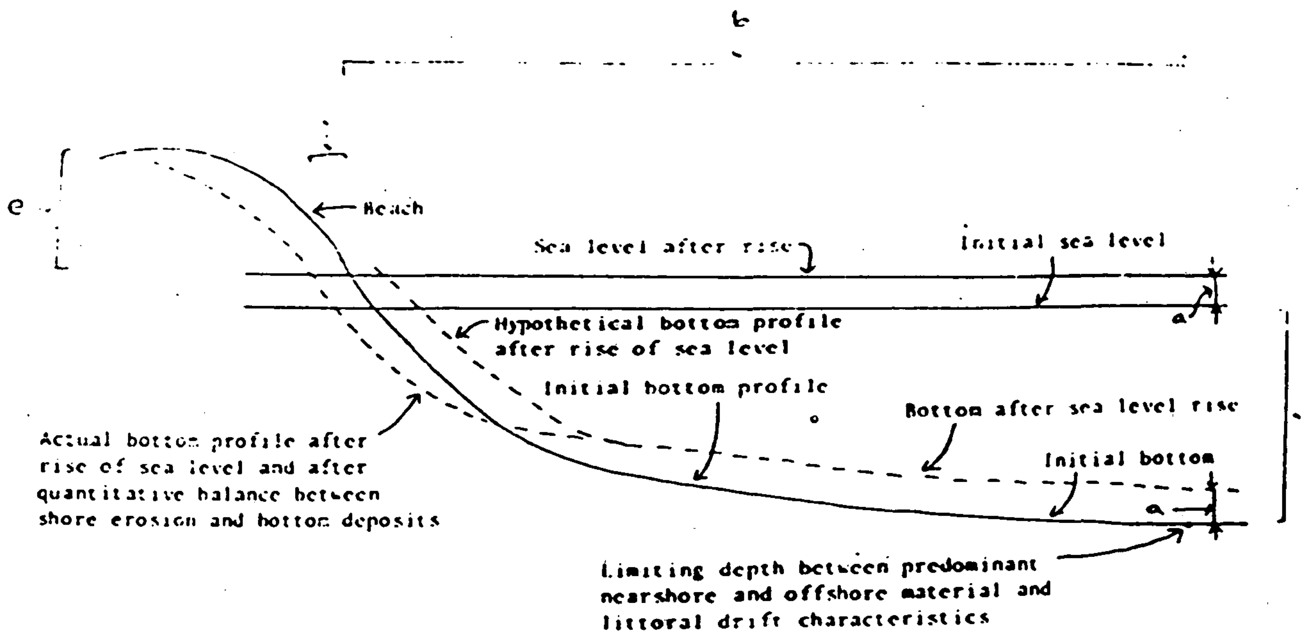
Thus it is a two-dimensional quantitative relationship. Bruun applied his rule in Florida coast and Gulf coast (Santa Rosa Island) to test the validity.

After the publication of this theory, several workers have performed regional tests, most of which have been ended up with fair degree of accuracy. The regional tests which need mention are those of Schwartz[13] at Cape cod beaches (Massachussats) and Rosen[14] at Virginia Chespeake Bay etc.

With sea level rise both the processes erosion and submergence may act jointly. Leatherman[15] has illustrated this combined effect. The term D_1 represents the landward movement of the sea due to simple submergence of the land, for which the response time is instantaeous. The second displacement term D_2 refers to coastal erosion. Thus D_1+D_2 represents the combined effect due to the sea level rise.

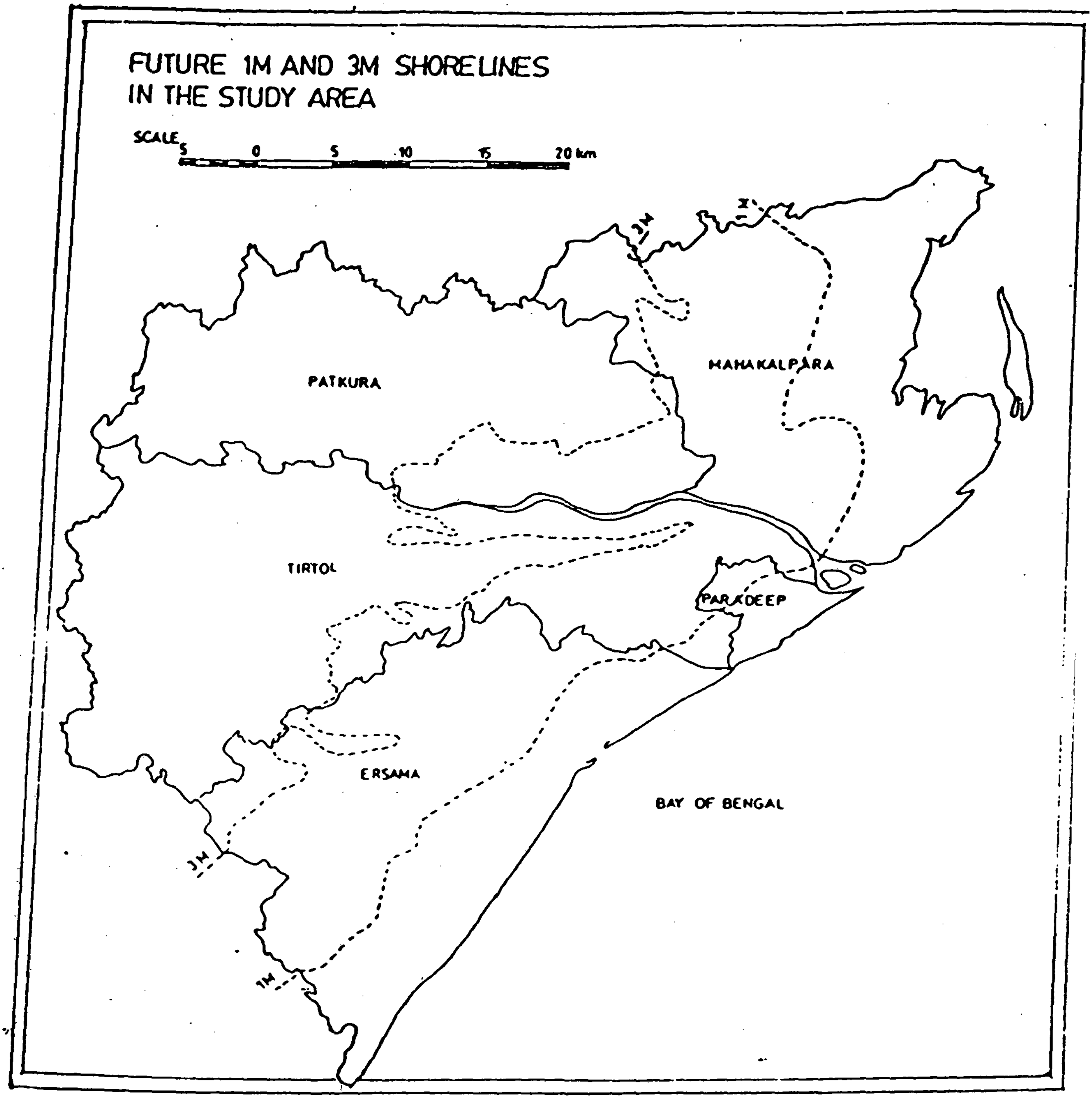
Sea level rise would also result coastal floading in many ways Titus et.al. observed.[16] Natural drainage would be decreased because of higher ground water table, decreased hydraulic head on the surface etc. More areas will be floaded by spring tides.

The effects will be more pronounced in the coastal lowlands where the population land-use and economic set-up will get severely affected.



1 - Influence of sea-level rise on the development of beach and offshore profile.

SOURCE : Bruun (1962)



Area of submergence in 1m and 3m rise in the sea level in the study area.

Impact of Possible Sea -Level Rise on Study Area :

The area forms a part of the coastal plain which slopes gently seaward. Therefore, a slight rise in the sea level could cause a significant horizontal displacement of the shoreline. With a one meter rise of sea level the area of submergence will be 335.67 sq.km. which is 19.9 per cent of the study area and with three meter the figures are 905.52 sq.km. and 53.7 per cent respectively.

Effects on Wetlands : The one meter shoreline will submerge all the wetlands lying around the mouth of Mahanadi river and more than three-fourth of the wetlands present around the Jatadharmuhan river. These lands normally store flood water and provide protection from storm surges and high tides (allowing excess water to spill over there). With the loss of these lands new lands of relatively lower elevation thatn the surrounding areas may be converted to wetlands. In other words wetland loss would remove an imnportant barrier to storm surges etc. The three meter shoreline will submerge all the remaining wetlands in the area.

Coastal Flooding and River Damming : The sea level rise causes coastal flooding in two ways : storm surge and backwater effect, the effective area to be affected will be more than what is estimated, when storm surges (which takes place in the vicinity of the coast) will cross the future shoreline (1m or 3m).

TABLE 5.1. AREA OF SUBMERGENCE (IN SQ.KM.)

Sub areas	Total Area	for 1m	for 3 m	Unaffected area
MAHAKALPADA	376.77	151.71	340.1	36.68
PATKURA	380.26	0	69.14	311.12
ERSAMA	382.5	145.59	357.35	25.09
TIRTOL	523.49	19.27	115.62	407.87
PARADEEP	23.31	19.1	23.31	0
TOTAL	1686.33	335.67	905.52	780.76
PERCENTAGE	100	19.9	53.7	46.3

The floodwater from upstream backs up along the river because of a rise in seal level at the basin outlets. This is known as backwater effect. This will be hard-felt particularly along the major rivers like Mahanadi, Santara etc. in this area. Again the flatness of the area will enhance this problem. The result will be flooding of river water across the levees. This effect will diminsh gradually towards upstream direction. The flatness which exists along the upper reaches of the major rivers would bring fear that the future rises of sea level would threaten more areas than portrayed in the present scenerios. These flat areas now frequently experience severe flooding (mostly during the monsoon seasons). If the scenerios, discussed here unfolds, flooding might intensify in these regions.

The sea level rise will also effect damming of the river courses resulting in the reduction in sediment discharge to the sea. Thus the deposition of excess sediments enroute would add to local subsidence due to overloading and sediment compaction.

Effects on Drainage : The area is marked by high drainage density. This surface drainage will again be increased when the rise in sea level would result. Rise in ground-water table which in turn would reduce underground drainage. Increase in the water levels in the rivers and high tides would cause substantial lowering of hydraulic head (the difference in elevation between source to sink) along the slopes which will further slow down the drainage process.

Decreased flow rates along the channels would allow more siltation and deposition. Thus the effective capacity of the river would decrease. All these would ultimately result a higher drainage density (which will include new chanels), slow and poor drainage in the area.

Shore Retreat Due to Erosion : The erosion potential of the study area due to sea level rise has been determined applying Bruun rule, at four beach locations.

The locations are :

Beach Profile No. 1 - It is 2.25 km south of Paradeep port along the shore.

Beach Profile No. 2 - It is 1 km north of Paradeep port.

Beach Profile No. 3 - It is 3.75 km north of Paradeep port.

Beach Profile No. 4 - It is 8 km north of Paradeep port

According toBruun rule the rate of shore erosion

$$X = \frac{ab}{e+d}$$

where a = rate of sea level rise
b = width of the shelf
e = shore elevation
d = depth at distance 'b'

In all the following calculations the rate of sea level rise (the quantity 'a') has been taken as 1.2 mm/year which is the world-wide eustatic sea level rise rate. For the quantity 'd', it is the 18 meter depth; the limiting depth between the nearshore and off-shore material.

$$\text{So } 'a' = 1.2 \text{ mm/year}$$
$$'d' = 18 \text{ meter}$$

For sandy open sea shores Bruun assumed the value of 'd' as 18 meter, the depth contour which forms some kind of limit between nearshore and deep sea littoral drift phenomenona. Again the slope of the shelf is of prime importance here. The transverse migration of eroded sediments is retarded by the gentle slope which exists at around 18 meter depth in most of the shores of open and sandy character. With a close look at the beach profiles drawn for the study area, it can be marked that the slope between 12 meter and 18 meter depths (approximately) is gentle enough to retard the transverse movement of the sediments. Hence the depth contour 18 meter has been taken here as the outer limit of nearshore sediment migration. This figure (for quantity 'd') is also approximately same for most other shores world-wide.

Shore retreat at location - 1

$$b = 9 \text{ km}$$
$$e = 2 \text{ km}$$

$$\text{Thus, } x = \frac{ab}{e+d} = \frac{0.12 \times 900{,}000}{200 + 1800}$$

$$= 54 \text{ cm/year}$$

At location - 2

$$b = 8.025 \text{ km}$$
$$e = 2.25 \text{ km}$$

$$\text{Thus, } x = \frac{0.12 \times 802500}{225 + 1800} = 47.6 \text{ cm/yr}$$

At location - 3

$$b = 8.35 \text{ km}$$
$$e = 1.9 \text{ meter}$$

$$\text{Thus, } x = \frac{0.12 \quad X\ 835000}{190 \quad + \quad 1800} = 50.35 \text{ cm/yr}$$

At location - 4

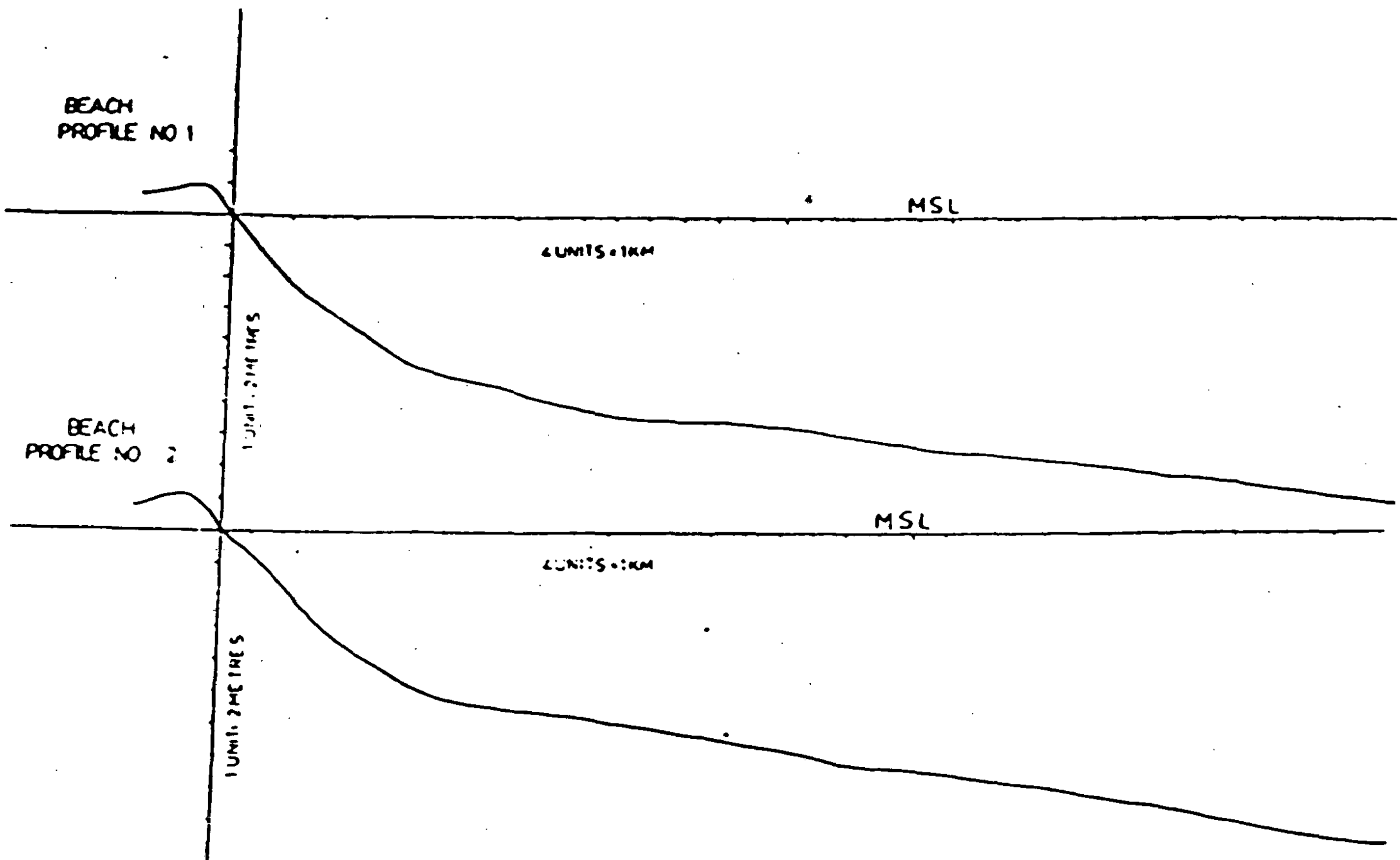
$$b = 8.05 \text{ km}$$
$$e = 2.2 \text{ meter}$$

$$\text{Thus, } x = \frac{0.12 \quad X\ 805000}{220 \quad + \quad 1800}$$

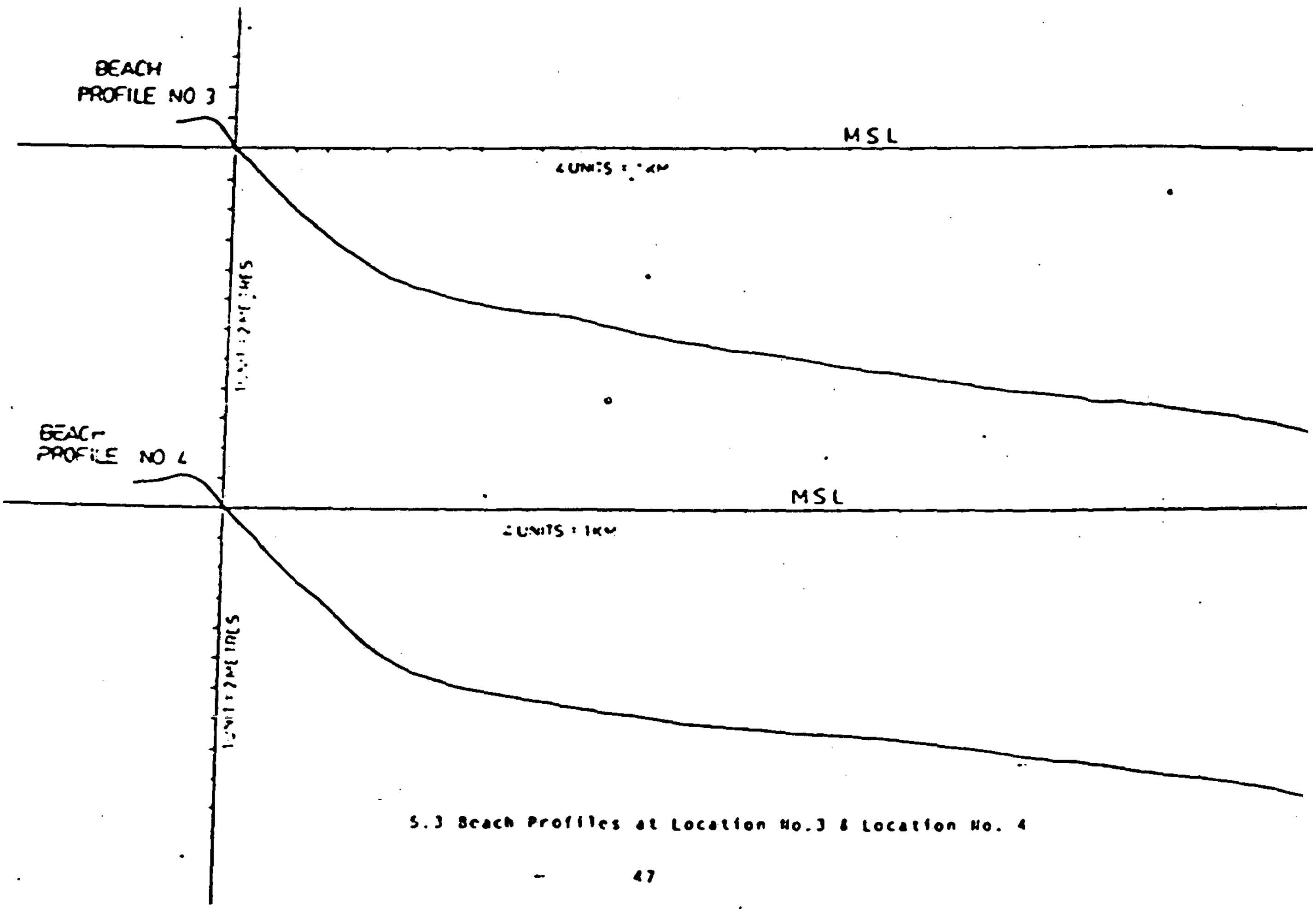
$$= 47.82 \text{ cm/year}$$

The magnitude of average shore retreat calculated for the present study area (approx .50 cm/yr) seems too high for this region. The factors which may be compensating for such a retreat are : high sediment influx from rivers, local tectonic movements, increased water load (resulting the subsidence of nearshore bottom) etc. The contributions of these factors have not been taken into consideration, which may set a sea level change rate for this locality far away from the rate adopted for the present study (1.2 mm/year).

The rate of reaction (erosion) in response to action (sea level rise) will probably depend to a large extent on the slope of the offshore bottom as per Bruun rule. Steep profiles are sensitive to short term rises in sea level than the long term rises, whereas the gentle profiles respond to longterm changes and demonstrate a pronounced phase lag (the time gap between action and reaction). In case of Paradeep, the profiles have nearshore steep part as well as an



5.2 Beach Profiles at Location No.1 & Location No. 2



5.3 Beach Profiles at Location No.3 & Location No. 4

- 47

offshore flat part. The steep part will respond to short-term fluctuations whereas the profile as a whole including the flat portion will respond to the long term rises in sea level.

The erosion rates at the beaches north of Mahanadi river may exceed the estimated rate. The explanation for this is; the longshore drift direction hereis from south to north. The main river in this locality (Mahanadi) is also the major source of sediment supply. With the submergence of river mouth, the rate of sediment discharge will also come down. This gap in supply to the up-drift beaches will be filled up by increased erosion of these beaches.

Other factors and processes which may become operative to facilitate increased erosion are : increased wave attack resulting from the deepening of the nearshore bottom due to sea level rise, increased wave attack due to climatic change yielding a high frequency, duration and severity of storms in coastal waters. Sea level rise will also cause increased erosion resulting from the rise in water table, increase in rainfall or local drainage modifications rendering the beach sand wet and more readily erodible.

Effects on Population and Land Use : The future shorelines of one meter and three meter were projected on map prepared with the help of Census Handbook. The village wise population and land use were estimated separately for one meter and three meter rise, which are going to be affected.

1m SCENARIO IN THE SUB AREAS (AREA IN ACRES)

The Sub-areas		No. of villages	Pop^n	Total Area	Forest Area	Irrigated Area	Non-irri-gated Area	Culti-vable Waste	Notava-ilable for cult.
MAHAKALPADA	A	163	71861	92596	15068	3020	40094	25579	8835
	B	56	25502	49798	15068	809	11291	19708	2922
	C	-	35.48	53.8	100	26.8	28.2	77.0	33.1
PATKURA	A	278	173938	93217	0	3545	69322	9250	11100
	B	0	0	0	0	0	0	0	0
	C	-	0	0	-	0	0	0	0
ERSAMA	A	209	83577	95096	2702	440	63688	11687	16579
	B	33	23883	37942	2429	0	21845	4519	9149
	C	-	28.6	39.9	89.9	0	34.3	38.7	55.2
TIRTOL	A	487	215549	129399	1860	24877	69567	7924	25171
	B	7	142	4865	1025	1065	1326	187	1262
	C	-	0.1	3.8	55.1	4.3	1.9	2.4	5.0
PARADEEP	A	-	6705	5758	0	0	0	0	5758
	B	-	6705	5758	0	0	0	0	5758
	C	-	100	100	-	-	-	-	100

A - Total No. of villages, population and total area

B - Affected villages, population and area

C - Percentage

3 M SCENARIO IN THE SUB AREAS (AREA IN ACRES)

Sub Areas		No. of Villages	pop^n	Total Area	Forest Area	Irrigated Area	Non-irrigated area	Cultivable area	Area not available for cultivation
MAHAKALPADA	A	163	71861	92596	15068	3020	40094	25579	8835
	B	143	61728	84410	15068	2516	34938	25288	6600
	C		85.9	91.2	100	83.3	87.1	98.9	74.7
PATKURA	A	278	173938	93217	0	3545	69322	9250	11100
	B	57	26999	21521	0	0	16813	3568	1140
	C		15.5	23.1	-	0	24.2	38.6	10.3
ERSAMA	A	209	83577	95096	2702	440	63688	11687	16579
	B	188	76246	90129	2702	440	59647	11275	16065
	C		91.2	94.8	100	100	93.6	96.5	96.9
TIRTOL	A	487	215549	129399	1860	24877	69567	7924	25171
	B	100	56228	39980	1123	5371	24214	2761	6511
	C		26.1	30.9	60.4	21.6	34.8	34.8	25.9
PARADEEP	A	-	6705	5758	0	0	0	0	5758
	B	-	6705	5758	0	0	0	0	5758
	C	-	100	100	-	-	-	-	100

A - Total No. of villages, population and total area

B - Affected villages, population and area

C - Percentage

Although this study employs a detailed scale of data available to arrive at a meaningful characterisation of the present level of population and land use pattern in potentially effected areas, it does not take into account the future measures, adaptive responses or the future changes in the distribution of population and land use pattern.

Here the whole village is taken as affected area even if it is intercepted partially by the projected shorelines of one and three meters respectively. That is why for the same shoreline the total area affected, calculated village wise is more than the area going to be submerged.

The area that might be inundated in the low scenerios (one meter) represents approximately 23-24 per cent land of the study area, which contain 10.2 per cent of the estimated population of the area inhabited in 96 villages. The area that could be lost by flooding in the three meter scenerio represent about 58-59 per cent area inhabited by 41.37 per cent of the total population in 488 villages.

Nearly 66 per cent land of the study area is presently being cultivated (amounting 274533 acres) out of which 13.27 per cent will be submerged with the low scenerio and 52.47 per cent cultivable land for a three meter scenerio (these figures do not include cultivable wastelands). In this area rice accounts bulk of the total grain output of the net cropped area. It accounts more than 90 per cent land in

1m and 3m Scenarios for the whole study area

(Area in acres)

		No. of Villages	Pop[n]	Total Area	Forest Area	Irrigated Area	Non-irrigated Area	Cultivable Waste	Area not available for cultivation
For 1m	A	1137	551630	416066	19630	31882	242671	54440	67443
	B	96	56232	98363	18522	1874	34462	24414	19091
	C	-	10.2	23.6	94.4	5.9	14.2	44.8	28.3
For 3m	A	1137	551630	416066	19630	31882	242671	54440	67443
	B	488	227906	241798	18893	8327	135612	42892	36074
	C	-	41.3	58.1	96.2	26.1	55.9	78.9	53.5

A - Total No. of villages, population and total area

B - Affected villages, population and area

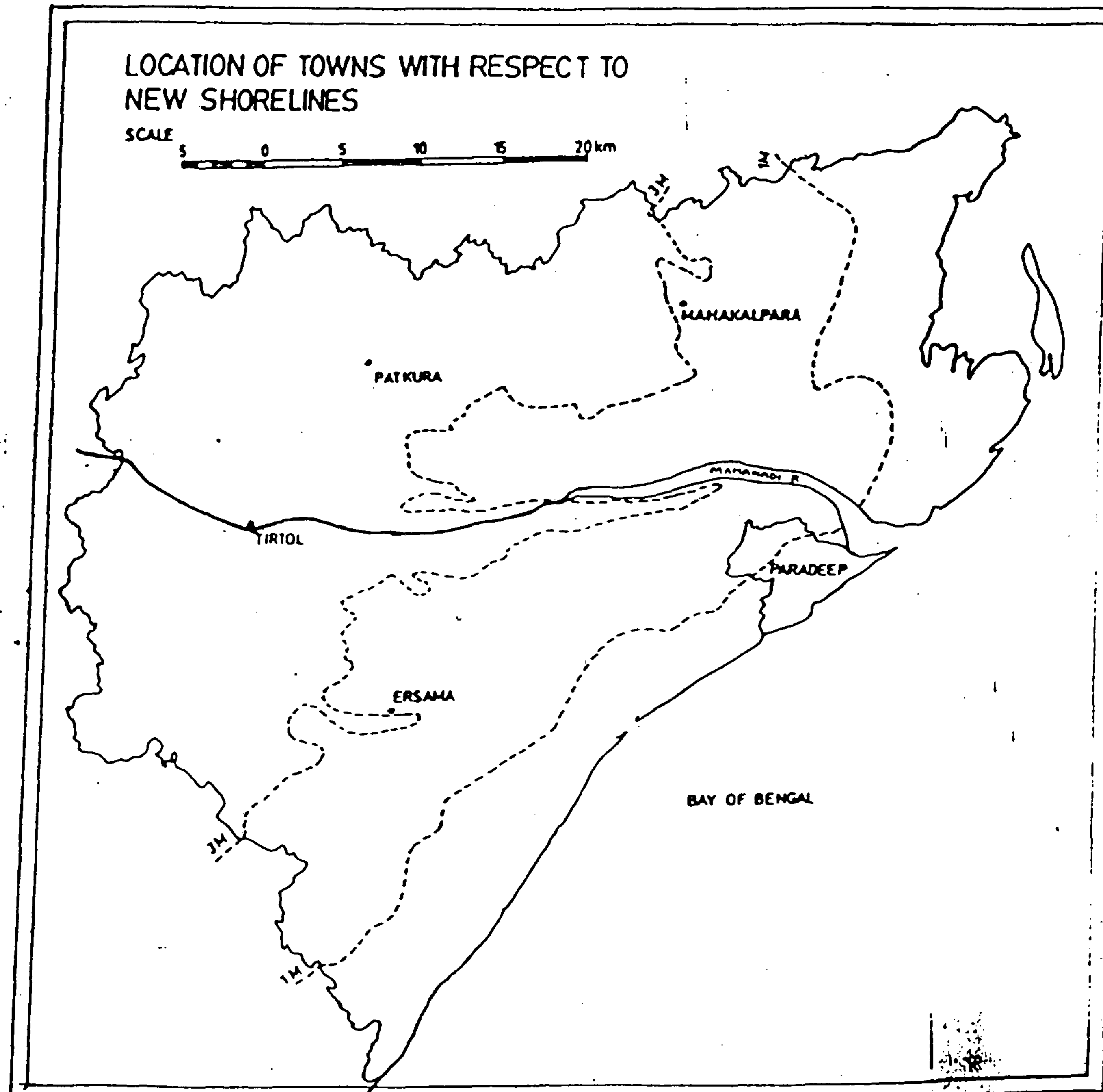
C - Percentage

the Kharif season and 28 per cent in the Rabi season. It will be difficult to imagine and replace the loss of croplands due to sea level rise because the area is already extensively cultivated. The cultivable waste areas which will remain unaffected evenafter a three meter rise is a negligible area (11548 acres) to compensate for the loss of total corplands which amounts 134939 acres. Adoption of strategies of intensive cropping and land utilisation may bring some promise as a compensation for the loss of agricultural lands.

Again an additional amount of agricultural land may become unsuitable for cultivation as the saltwater would transgress further landward with the encroachment of sea water over the land.

The major town in this area are Ersama, Mahakalpara, Tirtol, Patkura and Paradeep which also form the nuclie of relatively densely populated areas. Out of these, with the one meter level rise, Paradeep would be the only and most affected town area. More than 80 per cent of the area will be directly affected with the one meter rise and the rest would be submerged under the three meter rise. But for population and land use study, whole Paradeep is considered to be affected with the one meter rise.

With the three meter rise, two more towns i.e. Mahakalpara and Ersma will be submerged. However, Tirtol and Patkura will remain unaffected in these scenerios.



Location of major towns with respect to future shorelines of 1 m & 3m.

The ameities like storage, transport, communication trade and services, power, water, sanitation etc. are assumed to be distributed as population in this area. These activities and installations will also get affected due to sea level rise in a scale more or less same as population. The one meter rise would submerge 2 km of the Kendrapara canal which runs E-W in the north of the study area and an additional 8 km with the three meter rise. The other major canal which is to be affected is Taladanda canal running E-W at the centre of the study area will loose about 0.5 km and 5 km respectively with one and three meter rise in sea level. The NH-5 which joins Daitari and Paradeep is also known as Express Highway. Of this highway 6 km and 21 km will be affected with the one and three meter rise respectively. Paradeep is also connected with Cuttack by SE Railway's Cuttack-Paradeep branch. It would also be affected with 8 km and 14 km with the rises of one and three meter respectively.

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CHAPTER - 6

COASTAL ZONE MANAGEMENT IN INDIA : OPERATIONAL AND LEGAL RESPONSE

Coastal zones are one of the most dynamic areas of our planet, being the meeting place of the land, the sea and the air. Due to this, various changes take place here, either as cyclic or as random processes. Owing to the existence of a variety of resources and facilities, there has always been hectic human activity in this zone. This has led to a concentration of population and the consequent developmental activities. More than two thirds of the population in the world are living near the coastline today. For instance three out of four mega cities in India with rich colonial past - Bombay, madras and Calcutta are located along the coast apart from numerous other port towns and cities.

Of late, the developments are taking place in such a manner that the existence of the zone itself is threatened, leave alone the interests of mankind. The coastal areas are endagered with problems such as erosion, pollution, siltation, overpopulation, salinity ingression, devastation of natural habitats etc. More recently, it is feared that the rising of sea level due to green house effect and global warming may play havoc in the coastal areas. Thus being a very sensitive part of the biosphere, coastal zone management demands special care.

To combat these problems and for the rational development of the coastal areas, the concept of coastal planning and management has been evolved by many countries. However, the concept itself is relatively new in India. Here an attempt is being made to evoluate different issues of coastal planning and management practices in India in general and in the light of the recent notification regarding the Coastal Regulaiton Zone (CRZ); and the implication thereof on the development of coastal areas.

Defining Coastal Zone : There is no clear cut definition for coastal zone as such. However, as per the dictionary, it is a strip of sea or ocean and the adjacent land that influence and affect each other. According to the Coastal Zone Management Act, 1972 of USA, coastal zone is defined as the coastal waters and adjacent shore lands strongly influenced by each other and the proximity to the shoreline and includes islands, transitional and intertidal areas, salt marshes, wetlands and beaches. The landward portion is further defined as extending line for the shoreline only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters.[1]

According to the notification issued by the Ministry of Environment and Forests in February 1991[2], the Coastal Regulation Zone (CRZ) includes all the coastal stretches of bays, seas, estuaries creeks, rivers and backwaters which are influenced by tidal action (in the landward side) upto 500 metres from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the high tide line. However, this definition of coastal zone is very restricted in the sense, it is defined only to regulate the development activities. For all planning purposes, a much longer area has to be considered taking into account of the influence of the coast on the land and the vice-versa.

Issues : The important issues which are to be addressed by the coastal zone management plan are as follows :

i) protection of significant natural resources such as wetlands, estuaries, beaches, sand dunes, barrier islands, coral reefs etc.

ii) Protection and efficient use of marine resources with priority to the development of aquaculture.

iii) Conservation and restoration of sea water quality with priority for the areas which are suitable for public recreation or aquaculture.

iv) Protection and efficient use of coastal prime agricultural land forest resources.

v) Management of coastal development to minimise loss of life and property from floods erosion, salinity ingression and subsidence.

vi) Provide predictable siting processes for major defence energy , recreation and tranportation facilities.

vii) Preservation and restoration of coastal traditional settlements, archeological sites, historical buildings and underwater antiques.

viii) Maximizaiton of public recreation potential in the coastal zone and development of leisure activities which are compatible with environmental protection.

ix) Securing the rights of public access to beaches and the shoreline.

x) Allocation of development inputs according to national regional and local needs and the protection of environment.

Goals : The birth and evolution of coastal planning and management has been the result of two parallel developments : on the one hand changing orientation of human activities and on the other an increasing awareness of environmental issues. The main objective of coastal planning and management is the preservation of coastal resources and assets in the widest sense while at the same time satisfying the conflicting requirements of protection, development, usage and conservation. It, therefore, requires a full understanding of all environmental factors and processes which affect the nearshore and the shoreline.

Coastal Zone Management in India : Though India has enacted comprehensive environmental protection laws to controll water and air pollution, the country has yet to formulate a national coastal zone management policy in conjunction with its nine maritime states.[3] The Central Beach Erosion Board was constituted by the Government of India in 1971 to arrange general investigation, studies and research about the problem of coastal erosion and lay down general design principles and construction techniques for anti-sea erosion measures for the guidance of the state authorities.[4] This board was technical and focussing only one aspect of erosion.

Concerned with the deficiencies in comprehensive planning and development of coastal areas, in November 1981, the then Prime Minister Smt. Indira Gandhi had issued directives to the Chief Ministers of all the maritime states and union territories asking them not to allow any development on the beaches upto 500 metres of High Tide Line (HTL).[5]

> "I have received a number of reports about the degradation and misutilisation of beaches in our coastal states by building and other activity. This is very worrying as the beaches have aesthetic and environmental value as well as other uses. They have to be kept clear of all activities at least upto 500 metres from the water at the maximum high tide. If the areas is vulnerable to erosion suitable trees and plants have to be planted on the beach sands without marring their beauty. Beaches must be kept free from all kinds of artificial development. Pollution from industrial and town wastes must be also avoided totally. Please give thought to this matter and ensure that our ocastlines and its beaches remain unsullied".
>
> (**Indira Gandhi, 1981**)

In 1982, the Ministry of Environment had set up a working group to provide environmental guidelines for the management of beaches. The working group in its report (July 1983) enlisted the parametres for coastal area management, methodologies for environmental impact assesment, of development activities and over all management guidelines for the coastal areas.[6] Furhter, the working group on the environmental guidelines for ports and harbour projects in its report (1989) emphasized the use of Environmental Impact Assessment (EIA) and evolving Envirnmental Management Plan (EMP) for ports and harbour projects in the coastal zone.

Following the Prime Minister's directive and preparation of the environmental guidelines, the Coastal States/UTs were asked to initiate the preparation of environmental status reports followed by a master plan identifying the areas for conservation and preservation; and strictly regulate activities in the built-up areas which fall within the 500 metre limits.

Over the past several years, the states/UTs have been asked to expedite the preparation of status reports and management plans and enforcement of the directive through regional plans and regulations in respective states and UTs. No state/UTs except Goa has so far prepared the environmental management plans for the coastal stretches with their territories. There are cases where the state/UTs governments and local administrations, based on their own interpretation of beaches and coastal landforms, have allowed construction activities within 500 meters of the HTL. There are number of cases in the coastal cities/towns where constructions have been permitted near the coastline without prior assessement of their environmental implications and thus aggravated the problems of degradation and pollution of the coastal stretches.

Ministry of Environment and Forest Notification : In recognition of the above facts, and in order to ensure that the directive for regulation of activities within 500 metres of the HTL becomes binding, the central government in February 1991, declared the coastal stretches of seas, bays, estuaries creeks, rivers and backwaters which are influenced by tidal action (in the landward side) upto 500 metres from the HTL and the land between the LTL and HTL as Coastal Regulation Zone (CRZ) and imposes certain restrictions on the setting up and expansioin of industries, settlements, roads etc. in the said CRZ under section 3(1) and section 3(2)V of the Environmental Protection Act, 1986 and Rule 5(3)d of Environmental (Protection) Rules, 1986.[8]

The High Tide Line, for purpose of this notification, is the line upto which highest high tide reaches at spring tides. It has also been clarified that the distance on the high tide line to which proposed regulations would apply in the case of rivers, creeks and back-waters would be notified on a case by case basis, for reasons to be recorded, while preparing the Coastal Zone Management Plan (CZMP) and this distance should in no case be less than 100 metres, or the width of the creek, river or backwater whichever is less.

The notification has listed the prohibited activities in the CRZ, permissive activities to be regulated and the organisation and machiery for monitoring and enforcement of these statutory directions has been prescribed. Annexure-I of the notification are the guidelines for the classifications of CRZ into four major heads which the coastal states and the UTs are required to follow in categorising their coastal areas and Annexture-II relates to development of beach resorts/hotels in the designated areas of CRZ-III for temporary occupation of tourists/visitors with prior approval of the Ministry of Environment and Forests.

As per the notification the entire coastal stretches, depending on their importance have been divided into four categories as follows :

i) CRZ-I : Areas that are ecologically ssensitive and important such as national parks/marine parks, reserve forests, wildlife habitats, magroves, coral reefs, fish breeding grounds, historical and heritage areas, areas rich in genetic diversity, areas likely to be inundated due to sea level rise and the area between HTL and LTL.

ii) CRZ-II : Areas developed upto or close to the shoreline in the legally designated urban areas having drainage, approach and other infrastructure facilities.

iii) CRZ-III : Relatively undisturbed areas in the rural and within urban areas where substantial developments have not taken place.

iv) CRZ-IV : Coastal stretches in Andaman and Nicobar, Lakhdweep and other small islands excluding above three.

Regulations on Development : As per the notification, no construction is permitted within 500 metres of HTL in CRZ-I, while in CRZ-II buildings are permitted on the landward side of the existing or proposed roads or any authorised structures. In CRZ-III areas, upto 200 metres of the HTL are earmarked as no development zone, while the land between 200-500 metres of HTL is permitted for the construction of beach resorts/hotels in accordance with the guidelines stipulated in the notification. In CRZ-IV, no construction of building is permitted within two hundred metres of the HTL in Andaman and Nikobar islands. For permitting construction of buildings in Lakhdweep and small islands, the distance will be decided depending on the size of the islands.

Prohibited Activiites : Within the Coastal Regulation Zone (CRZ) the following activities are completely prohibited :

i) Setting up of new industries and expansion of existing ones, except those directly related towater front.

ii) Manufacture, storage and disposal of hazardous substances.

iii) Setting up and expansion of fish processing units including warehousing.

iv) Discharge of untreated wastes and effluents from industries, cities/towns and other settlements.

v) Dumping of city wastes/wastes from power stations, land reclamation, disturbing of natural course of sea water.

vi) Mining of sands, rocks and other substrata materials.

vii) Harvestng of ground water within 200 metres of HTL.

The following activities will reguire environmental clearence from the Ministry of Environment and Forests :

i) Construction activities related to Defence requirements for which foreshore facilities are essential.

ii) Operational constructions of ports, harbours and light houses, jetties, ship ways etc.

iii) Thermal power stations.

iv) All other activities with investment exceeding rupees five crores.

Under the section 3(i) of the said notification, the coastal states/UTs have to prepare the Coastal Management Plans, identifying and classifying the coastal regulation zone areas within their respective territories in accordance with the guidelines given in the notification and obtain approval from the Ministry of Environment and Forests, Government of India. It is further mentioned in section 3(ii) of the notification that within the framework of such approved plans, all development and activities within the CRZ other than those covered in para 3(2) of the notification shall be regulated by the state government, UT administration or the local authority as the case may be in accordance with the guidelines given in annexture I & II of the notification.

Implications : In the light of the fact that no developmental and housing related activities are permitted in the entire CRZ-I and upto 200 metres in the entire coast, it may pose conderable hardships in the implementation, as most of the land in this zone is being owned by private individuals. This policy also poses considerable problems in the case of islands especially in A&N and Lakhdweep as there is not much area beyond the 500 metres line. The notification should be flexible to develop the coastal areas according to the existing development, the future land requirements and of course the environemtal factors.

Integrated Approach : In the coastal zone the economic and environmental systems are highly interdependent. Any new development that changes the economic system affects the environmental system, and these changes have a feedback effect on the economic activities. Hence, there is a need for an integrated approach to planning and management of the coastal zone. It should include tow important aspects :

i) integrating the coastal zone with the much wider region including rural as well as urban settlements.

ii) integration of all the components of coastal region.

There are many organisations at present having overlapping jurisdictions which invite conflicts among the users and for managers. Lack of co-ordination among these agencies under a national/state policy is found to be major. hurdle in the implementation of coastal zone management policy. Inevitably, the different agencies addressing the problems will have to be co-ordinated and compelled to act only after considering the environmental impact of the proposed action in order to drive away many of the evils mounting the coastal zones.

Pilot Studies : In view of the fact that the state/UTs have not prepared the status reports/management plans, the Ministry of environment and Forests has sponsored the studies related to the preparation of Environmental Management Plans for the following coastal stratches :[9]

i) Dwarka-Jodiya in Gujrat.

ii) Digha in West Bengal.

iii) Puri-Konark in Orissa.

iv) Madras-Mahabalipuram in Tamil Nadu.

The Ministry of Environment and Forests has also sponsored the studies on Impact of sea level rise due to green house effect on different parts of Indian coast.[10] In addition, the Central Pollution Control Board is continuosly doing the coastal water quality monitoring programme and has already done the classification and zoning of coastal stratches.[11]

Suggested Approach for Coastal Zone Management in India :

Taking into consideration the unique socio-economic and political systems of India, each coastal district can be considered a unit to promote coastal zone management at the local level. State governments can set up effective coastal zone management committees for each coastal district. The chairman of such a CZM committee should be the administrative head of the district. Representatives from local academic institutions; state department of fisheries, tourism, forestry and minor irrigation, coastal residents, local interest groups, environmental protection groups, and members of the legislative assembly and parliaments from the coastal constituencies could compose this committee. These local committees should hold frequent meetings seminars, workshops, public hearings to educate the planners, administrators, and coastal residents on specific issues concerned with coastal development problems before arriving at nature-friendly solutions to such problems in the larger interest of the society. The local CZM committee can also decide about adequate financial or other compensation to local residents who are affected by the coastal problems associated with coastal erosion, harbour development or public facilities for recreation, tourism and industry.

Broad-based central and state Coastal Zone Management Authorities (CZMA) should be set up that would take up all matters pertaining to coastal zone management, including that of the functions of the existing Central Beach Erosion Board, Anti-Sea Ecorsion Committees of the maritime states; and the Central & State Pollution Control Boards. These CZMAs should develop a comprehensive national policy with statutory regulations for managing and administering all developmental activities in the coastal zone. District level CZM Committees should be given necessary authority and statutory power to plan and implement coastal developmental programmes in each of coastal districts in accordance with the policies laid down by the central and state CZMAs.

Legislative Response : Legislative response to control the environmental degradation and pollution in the coastal zone both from land based activities and marine based in India includes :[12]

- Indian Ports Act, 1908
- The Industries Development and Regulation Act, 1951
- The Insecticides Act, 1968
- The Water (Prevention and Control of Pollution) Act, 1981
- Merchant Shipping Act with MARPOL Amendments, 1985
- The Territorial Waters, Continental Shelf, Exclusive Economic Zone and maritime Zone Act, 1976

- Maharastra Marine Fishing Regulation Act, 1961
- The Orissa, Tamilnadu, Kerala Marine Fishing Regulation Act, 1980
- The Maritime Zones of India (Regulation of Fishing by Foreign Vessals) Act, 1981
- The Environment Protection Act, 1986.

These acts have enough provisions for strict punitive measures. Ships spilling oil in harbour areas have to pay a fine of Rs. 5 lakhs. Industries polluting air or water can have their licences suspended till they install pollution control devices. The objective of the marine fishries laws is to protect fishing zones, conservation of certain fish species, procurement of fair and equal oppurtunites to fishermen for fishing and above all better control over marine fishing.[13] Finally, the Environment Protection Act, 1986 is all encompassing one. This Act is empowered to lay down standards for emmission or dischrge of environmental pollutionts from various sources.

Permissible limits for the discharge and release of pollutants to air, water and soil, have been laid down and are periodically revised and updated by the Bureau of Indian Standards.

Indian is a signatory to several international conventions and protocols to control marine pollution of the high seas and coastal regions. some of these are :[14]

- Regulations for the disposal of radioactive wastes, safe transport for radioactive materials etc... of the International Atomic Energy Agency.
- International convention for the Prevention of Pollution of the Sea by Oil, 1954, as amended upto 1969, of the International Meritime Organisation.
- MARPOL (1973) Convention and Protocol (1978) of International Maritime Organisations.

There is adequate legislation existing in India. The problem lies with implementation. If implemented strictly, these laws would be able to mitigate the deterimental effects of population increase of its allied effects in the coastal zone of Inida.

The coastal zone in India is subjected to multiple uses, thereby leading to conflicting demands for the exploitation of various resources by different interest groups. Nearshore oceanography is an especially interesting and complex field because it encompasses an interface of water, land, and air, and each, in turn, influences the other. Despite the importance of the coastal zone for the socio-economic and political developments of the nation, comprehensive coastal zone management policy and its implementation are yet to be organised in India.

A National Coastal Zone Management Authority (NCZMA) needs to be established at the centre with a suitable agency in each of the maritime states to ensure proper interaction among various government agencies, voluntary organisations, and developers, as well as the public. Public participation should be encouraged in the decision making process to avoid conflicts.

One of the most important aspects of an effective coastal zone management programme is the utilisation of the most recent advances in ocean science and technology as the basis on which planning and development of a given coastal segment should be undertaken. This necessitates close working of planners, policy makers and scientists from various disciplines for wise resource management in the Indian Coastal Zone.

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CHAPTER - 7

CONCLUSION

The coastal zone constitutes a complex ecosystem. It is viewed as a unique resources which is of great importance to humanity. The marine and coastal habitats all over the world are being subjected to tremendous stress due to "marine revolution". Maximum stress in the coastal zone is felt where there is demographic explosion. Nearly, two-thirds of the world's population live near this area and over 60 per cent of the marine food harvested is from this zone. However, the coastal zone has also the unfortunate privilege of being the depository of all pollutants from the territorial environment, silt and sediments from uplands, residues of fertilizers and pesticides from farmlands, sewage and industrial effluents are all ultimately dumped into this habitat. In many parts of the world and even in our country, the highly productive coastal ecosystems like mangroves, estuaries and coral reefs are in one way or another threatened or endangered at present.

The coastal zone is the bank of dry land and adjacent ocean space (water and submerged land) in which land ecology and use directly affect ocean space ecology, and vice versa. Functionally, it is the broad interface between land and water where production, consumption and exchange processes occur at high intensity rates. Geographically, the landward boundary to the coastal zone is necessarily vague, but the seaward boundary is easier to define scientifically. However, coastal zones, being regions of interplay of many functions that vary considerably in space and time, form complex dynamic and sensitive environment all over the world.

The coastal zone has multiple use leading thereby to conflicting demands for the exploitation of the various coastal resources by different interest groups and user agencies all over the world. It has, therefore, become very vulnerable to the destructive forces caused by pollution, hazards and several other man-made changes. Long-term sustainable use of coastal resources is at risk because of poor understanding of the adverse effects of land based and other development activities on the coastal and marine environments. There is consequently a need for a comprehensive coastal planning and management for better and effective utilization of coastal resources. National governments and international organizations of the world today have started realizing the importance of the coastal zone and its problems and have initiated and taken many measures to protect and preserve the biological diversity of the coastal zone and manage the various coastal developmental activities since the early 1970s.

Over the last decade there has been a proliferation of interest in coastal area management. The interest and the practice have moved out from the developed nations to the developing nations. Coastal area management is viewed as an expression of integrated planning and resource management. Coastal resources are foundation blocks needed to support the construction of economic and social development programs. Thus the richness and diversity of coastal resources, the presence and diversity of coastal resources, the presence of many coasal hazards, the mixed pattern of pristine and degraded ecosystem, and the rates of coastal resource development and coastal population growth, when viewed collectively, present a tremendous challenge for the practice of coastal planning and management both in the developing and developed countries of the world.

Coastal planning and management is initiated by government in response to issues -- usually resource degradation, exposure to coastal hazards, multiple use conflicts, or socio-economic development needs. The effort has contnuity over time, it is not a one time project. The coastal planning and management needs the government structure to establish the policies and make decisions for allocation decisions. The government arrangement uses one or more management strategies to rationalize and systematize the allocation decision. The management strategies selected should be based on a systems perspective which recognizes the interconnections among coastal/environmental systems as well as public service system. The systems perspective usually requires that the design and implementation of management strategies be done as a multisectioral effort. The coastal planning and management programme has a geographic boundary that defines a space which extends from the ocean environment across the transitioal shore environments to some inland limit. There may be an exception for small islands, there may be no meaningful inland boundary.

Coastal problems are local in nature rendering solutions successful in one area not applicable to another. Underlying principles can, however, be derived and lessons learned in coastal zone development activities. These lessons are invaluable as they have been often obtained at the expense of serious environmental damages, technological developments and of several years experience in the coastal planning and management theory and practice of countries like the Netherlands, the USA and Sri Lanka, etc.

Fortunately, India is bestowed with a vast coastline of over 7000 kms. The advantages and disadvantages attached to this coastline and coastal zone are vast and varied. Hence, this large sensitive zone needs scientific management for optimal utilisation and in order to be protected from indiscriminate exploitation and destruction due to pollution, it demands a long term strategy for multi-use development.

The overcrowding of the coastal lands is a serious threat on the coastal zone. Along the coast, India has 59 districts, spread over 13 states/UTs. Most of the districts have population density of above 200 person/sq km. There are 11 major and 139 operable minor ports with an overall cargo load of more than 200 million tonnes. There are quite a few industrial cities on the coast and the number of places of religious and historical importance is more than 50. Some of these are important tourist spots attracting huge traffic all round the year.

The growing encroachment of the coastal lands would call for support platforms in consonance with the high population densities, airstrips, waste incineration, sewage treatment,power generation, ocean thermal energy conversion and the like. Delineation of various segments of the coastal areas depending on soil qualities, wave thrust and other lithological condition has also become imperative to effectively exploit the potential along the Indian coast and to manage the activities in an economic manner without being detrimental to the envrionmental aspects.

India's vast coastal margins in Bay of Bengal and the Arabian Sea are endowed with hydro-carbons and other mineral resources and the waters of the Indian Ocean within the EEZ of India, estimated at 453000 sq.kms. are said to have potential to yield about 40 million tonnes of fish and about one billion tonne of oil. The West coast region is said to contain 570 oil bearing structures of which 176 have been confirmed and 81 drilled.

India's premier offshore oilfield, Bombay High, is yeilding about 30 million tonnes of crude oil annually, saving precious foreign exchange for other developmental projects and are expected to continue to be productive for another 40 years.

Tidal power potential in India is estimated to be around 9000 mw of which around 7000 mw is in the Gulf of Cambay and the rest in Gulf of Kutch and Sunderbans in the Bay of Bengal.

The sands of our south western coasts are said to contain one of the world's largest reserves of thorium which is used as a fuel in fast breeder nuclear reactors and hence as technology in this area advances the benefits for a power starved country like India are enormous.

As of now, only one quarter of the fishing potential of the coastal waters is harvested. It is regretable that despite its vast coastline and EEZ plus 1.4 million hectares of inland water bodies and a shelf area of 5 lakh km., India produces about 3 million tonnes of fish against 93 million tonnes of world fish production - just 3.12 per cent of the global fish production. Fish resource estimates for Indian waters place the annual potential yield at 45 lakh tonnes. Of this 53 per cent lie in the depth zone of 0.50 meters (in shore), 36 per cent in 50-200 meters (offshore water) and 11 per cent beyond 200 meters depth in the deep sea. There are many regional imbalances in the availability as well as exploitation of different species due to various reasons.

Mangroves is the most important coastal vegetation. Mangrove areas and coastal wetlands serve as essential habitats, food producers, energy storage units, water purifiers, salt traps and shore stabilisers. If such areas are filled indiscriminately, they could greatly reduce the productivity of coastal areas. This would reduce the capacity of the coastal zone to absorb pollutants before they reach coastal waters and estuaries. Such areas also provide important breeding and rearing grounds for valued species. The total mangroves area along the Indian coast is estimated to be approximately 7 lakh hectares.

Aquaculture potential is very high in the Indian coastal zone. Rice-fish farming offers great scope for improving the economy of the rice farmers. The large water bodies of Kolleru and Pulicat in Andhra Pradesh and Chilka in Orissa have a great potential for development of fisheries. In the coastal districts of Krishna and West Godavari of Andhra pradesh, fish farming has seen an unparalleled growth, almost entirely propelled by private enterprises.

The coastal plains of India with a geographical area of 19.6 million hectares (East coast) and 7.3 million hectares (West coast) is a zone of intense agricultural production and productivity. The net sown area of the East coast plains is 85.80 lakh hectares and the gross cropped area 114.66 lakh hectares with corpping intensity of 134 per cent. West coast has a net sown area of 27.70 lakh hectares and a gross cropped area of 34.66 lakh hectares and cropping intensity of 125 per cent. Rice grown over an area of over 5.6 million hectares is the predominant crop of both the coasts. The productivity of various crops is also high due to high-tech agricultural practices and the Krishna-Kaveri delta is known as "rice bowl of India".

The Indian shipping industry has grown in fleet coverage, infrastructure and influence over the years. Not only the proportion of cargoes transported by the Indian vessels have recorded an upswing but also the total fleet size, crews and logistic involved. The two major ship-building yards i.e, the Hindustan Shipyard Ltd. and Cochin Shipyard Ltd. have started earning profit. On the other hand, the total capacity of Indian major ports has been estimated at 174 million tonnes and modern methods and technology are being used to increase the productivity.

The social life of the people of the coastal region is tailored according to their places of residence. Life of people in the ports, the industrial towns, the religious spots and tourists centres have their own advantages and disadvantages. Whereas the ports may harbour smugglers, the tourist centres often harbours drugs and immoral traffic.

Some of these places are health resorts, while others are dumping grounds of industrial wastes; for some life style has changed drastically while for others, things are at a stand still. However, generally the quality of life for the coastal communities has not improved much, their literacy levels, health conditions, housing conditions, disguised unemployment rate, purchasing power - are they were decades earlier if not worse.

Coastal resource development and space utilisation in India recently have resulted in many problems - increasing conflicts over coastal uses, the depletion and degradation of coastal land-water resources, coastal pollution and loss of access to the shoreline.

The fishermen regard the aquatic system as a community managed property and never damage it. However, recent intrusions in the form of militarisation, tourism, mining and damming have led to the destruction of unique aqua-human relations, loss of pristine cultures and harmonious resource-use pattern. In the name of beautification and providing comforts to the tourists, a lot of local fishermen were evacuated in Goa, Orissa and Tamilnadu. The missile testing range at Balliapal in Orissa has dislocated the life of local tribal and fishermen.

As regards pollution, large quantities of liquid and solid waste of domestic and industrial origin are being released in the rivers, bays and creeks which ultimately find their way into coastal waters. The industrial waste added to the sea by the industries along the Indian coast is estimated to be about 0.4×10^9 cubic meter/year. The domestic sewage added tothe sea by the coastal population is 4.1×10^9 cubic meter/year.

It has been estimated that approximately 5 million tonnes of fertilisers, 55000 tonnes of pesticides and 125,000 tonnes of synthetic detergents are used annually in India. A substantial portion of these find their way to the coastal waters. A considerable quantity of these substances are biodegradable while others are not. Their cumulative effect over a long time could be quite harmful to the coastal environment. These effects are not very perceptible generally on the Indian coast, but in the vicinity of metropolitan and industrial conglomerates, the effects are indeed alarming. For example, the phosphate concentration in the nearshore waters of Bombay increased from 0.82 to 2 u $moll^{-1}$ during the period from 1959 to 1988.

Several toxic heavy metals are expected to be transported to the sea by the rivers. An examination of the suspended and particulate metals in the estuarine region of the Ganges shows that about 10 per cent settles in the lower estuarine region, 50 per cent at the confluence of river water with the seawater and 40 per cent finally flows into the Bay of Bengal. Data collected on mercury in water, zooplankton fish and sediments along the Indian coast indicate a few localised "hot spots' off Bombay.

Recent studies on pesticides residues in sediments along the East and Central West Coasts of India detected nine organochlorine pesticides and their metabolities . Concentration of the residues of these compounds are found to occur at 'ppm' level on the East coast while they are in 'ppb' scale on the West coast. Concentration of pesticides residues in Zooplankton in the Arabian sea decreases away from the shore indicating their terrestrial origin and aerial transport.

Many estuaries, creeks and coastal water which recieve industrial and domestic wastes, sewage, litters etc. through point discharge are found to be grossly polluted on both East and West coast of India. Several other forms of pollution like dumping of dredge spoils and mining rejects in the marine environment affect the ecology. Depletion of fisheries and benthic fauna due to mine failing, rejects and washings in the estuaries have been observed causing damage to the ecosystem.

Several other wastes which pollute Indian coastal waters are garbage, scrap material from ship-breaking yards, damaged and rejected fishing nets and other gear, disposal of unwanted trashfish, waste generated by tourism industry etc. Quantitative data on these are however lacking.

Transporatation of about 60 per cent of the world's crude oil and its products along the oil tanker routes across the Indian seas are prone to oil pollution. Oil pollution in the sea occurs either from maritime accidents due to fire, collision or grounding, intentional discharge of oil or oily wastes or by accidental spillages. Observation on several West coast beaches show the tar deposition 25 gm./m^2 during May-September and along East coast beaches during December-January.

The phenomenon of global warming and consequential sea level rise is well known and it has been increasingly receiving attention of the scientific research personnel and the policy planners. Since the changing chemistry of the atmosphere is linked with the bio-chemical capacity on the oceans, another aspect that need to be looked into is the intensive local specific research on the capacity of the ocean coast. An attempt has been made in this thesis to study the impact of possible sea level rise on Paradeep coast of Orissa.

In this study area the one meter rise in the sea level would result in the submergence of 335.67 sq.km. which is 19.9 per cent of the totl area and for the three meter rise the figures are 905.52 and 53.7 respectively. The wetlands along the coast would be lost to these rises. There will be an increase in the backwater effect in the rivers and severity in the storm surges. Ground water table will also rise. This will allow the saltwater wedge to intrude further landward.

Beach profiles taken across the shore of the area have been examined to estimate the erosion potential. Applying Braun's theory it was found out that on an average beaches would be eroded at a rate of 50 cm./year approximately for a sea level rise rate of 1.2 mm/year (assuming neutrality of local modifying factors).

Most of the area around Paradeep coast is occupied with cultivation (especially of rice). So agriculture is going to be the worst effected field in the land use map. About 10.2 per cent of the estimated population in 96 villages are to be affected with the one meter rise. This also include 13.2 per cent of the cultivable land. With the three meter seneries 41.3 per cent population inhabited in 488 villages will be affected. The cultivable land to be affected is 52.2 per cent.

Cosidering the magnitude of human and economic stakes feared for the two sea level rise scenerios discussed, it is suggested that the private and public agencies involved in the development processess in this area should consider the possible effects of sea level rise in their long-range planning and project development.

Further, the enlarging spectrum of maritime activities has brought in new concerns such as the security of offshore platforms, rivalarys for ocean resources, terrorism at sea, island grabbing, poaching and smuggling. The other flash-points are movements by sea of narcotics, weapons, chemicals and fissionable materials. This in turn has led to fresh norms, conventions and rules encompassing the legal regime of the seas, maritime boundaries, naval arms control and the necessity to avoid the brinkmanship of the high seas.

The development and management of coastal areas is often a factor of the needs of the people living in and around the coasts and in the hinterland that could be economically served by the coasts. It is no doubt a difficult task to develop an integrated long term plan for the management of the entire coastal zone in view of the diverse natural characteristics of the area such as water depths, sea bed profiles, sediments/rocks, waves, tides, cyclones, weather variations etc. These apart, the complex coastline configurations over thousands of kilometers as well as the process of industrial and economic growth and the will of the implementing agencies are also important issues to be considered. Strong managerial inputs are required alongwith the efforts being made by the science and technology community for a conceptual development of coastal management which, in India, received a formal planned shape in 1985 (seventh plan) with the following objectives :

a) Developing and maintaining data base for assessement of coastal areas, islands, EEZ and its resources.

b) Developing marine resource potential of islands.

c) Technology demonstration in selected areas.

Since then, several structured programmes have been evolved by Department of Ocean Development (DOD), Government of India in collaboration with IITs, CSIR labs, Central Scientific agencies like DOS, CPCB and Ministry of Environment and Forests etc. and other operational sectors of the state and Central Government. A few such programmes are : marine Stallite Information Service (MARSIS), Coastal Ocean Monitoring and Prediction System (COMPAS), Wave Energy System, Island Development, Sea Level Monitoring and Modelling, Joint Global Ocean Flux Studies etc.

In recognition to coastal degradation and pollution, the Ministry of Environment and Forests issued notification under Section 3(i) and Section 2(ii) of the environment Protection Act 1986 and Rule 5(iii)d of Environment (Protection Rules) declaring coastal stretches as Coastal Regulation Zone (CRZ) and regulating activities in CRZ in 1991. With the coming into force of the UN convention on the Law of the Sea in 1994 and India's Ratification in 1995, India is now entitled to delineate the outeredge of the continental shelf upto the end of continental margin.

The Indian Coastal Zone is managed by a host of Central and State Government agencies. Many of these focus on particular sectoral issues such as fisheries, crude oil tourism etc., whereas the others like the Central Ministry of Environment and Forests have wider mandates encomassing composite phenomenon such as 'environment'. Hence, it is necessary to coordinate and harmonise the diverse activities which in most countries are usually vested in two or three ministries. In India, it extends to approximately 18 ministries and several autonomus agancies with diffused responsibilities and blurred linkages.

One area which is recognised as being of critical importance is centre-state relationship in the coastal zone management. Constitutionally, the states own their resources and have total responsibility for variety of functions. Most land based activities in the coastal zone is state prerogative. The central government, however, has general jurisdiction over the marine resources and environment. Clearly any effective coastal zone management must rely on continuous coordination between and as well as within different levels of governments.

A National Coastal Zone Management Authority (NCZMA) needs to be established at the centre with a suitable agency in each of the maritime states to ensure proper interaction among various government agencies, voluntary organisations and developers, as well as the public. Public participation should be encouraged in the decision making process to avoid conflicts.

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MAHAKALAPARA

Serial No.	Location code No	Name of the village
1	29	Sanarahama
2	30	Babara
3	34	Guludia
4	35	Kalatunga
5	36	Gogua
6	37	Baliganda
7	38	Doligan
8	39	Nanjara
9	40	Garjung
10	41	Panikhia
11	42	Bhuinpada
12	43	Sankhachit
13	44	Maladiha
14	45	Bhopal
15	46	Tantiapala
16	47	Singhapura
17	48	Sasan
18	49	Tamulia
19	50	Chakulidiha
20	51	Baro
21	52	Paunsiapala
22	53	Oliasal
23	54	Mundatalasaharakani
24	55	Ratpanga
25	56	Narsingpur
26	57	Banapara
27	58	Kandharapatia
28	59	Suniti
29	60	Kansarabadandua
30	61	Panchagachhia
31	62	Kantilo
32	63	Badapala
33	64	Sugal
34	68	Kansara
35	69	Pankapala
36	118	Baulakani
37	122	Badatotachhapaii
38	123	Cansapal
39	124	Bagagahana
40	125	Bhateni
41	126	Jamboo
42	127	Hukitola
43	128	Kansaradia
44	129	Baligad
45	130	Bhitarakharanasi
46	131	Kharinasi
47	132	Hariabanka
48	135	Petachhela
49	156	Badatubi
50	157	Sanatubi
51	158	Nipania
52	159	Jogidhanakud
53	160	Saralikuda
54	161	Hetamundia
55	162	Barakolikhala
56	163	Lighthouse

ERASAMA

Serial No.	Location code No	Name of the village
57	35	Kokakhanda
58	36	Kankardia
59	38	Badakantakandha
60	39	Trilochanpur
61	40	Badakandha
62	41	Abhaychandrapur
63	42	Kansaripatia
64	43	Dhinkia
65	44	Phirikichintakandha
66	45	Gobindpur
67	46	Panigadiakandha
68	47	Nuagan
69	48	Baianalakandha
70	124	Polanga
71	125	Noliasahi
72	126	Bhuyanpal
73	127	Jatadhartanda
74	128	Kankan

75	129	Dhobaijungle	83	183	Padanpur
76	130	Pinpudia	84	185	Asia
77	175	Gadabishnupur	85	205	Salio
78	178	Khatikholada	86	206	Goda
79	179	Ambiki	87	207	Garia
80	180	Pibarkani	88	208	Harispurgada
81	181	Jatadhar	89	209	Saharabedi
82	182	Barakuda			

TIRTOL

90	130	Musadiajungle	94	136	Chauliapalanda
91	131	Boitirakuda	95	137	Keruadiakandha
92	132	Kaudia	96	138	Kaduapalikandha
93	133	Udaychandrapur			

IB-VILLAGES UNDER 3M SCENARIO

MAHAKALAPARA

Serial No.	Location code No.	Name of the village
1	13	Basaghara
2	14	Andhuli
3	15	Kalapara
4	16	Ghantiapali
5	17	Balipala
6	18	Srichandanpur
7	19	Jasuapali
8	20	Balia
9	21	Mulabasanta
10	22	Sahoopara
11	23	Ramachandrapur
12	24	Potia
13	25	Chatar
14	26	Itakandia
15	27	Baradiha
16	28	Badarahama
17	31	Kakatapur
18	32	Kholanai
19	33	Bandhapada
20	65	Kharianta
21	66	Kusiapalla
22	67	Tarapada
23	70	Badamatha
24	71	Balabhadrapura
25	72	Radia
26	73	Badabaincha
27	[illegible]	Akalapur
28	75	Ranki
29	76	Arada
30	77	Kanpur
31	78	Maliancha
32	79	Baharsubala
33	80	Bardang
34	81	Jagati
35	82	Paiguda
36	83	Janra
37	84	Kiarbanka
38	85	Bijayanagar
39	86	Sankhapada
40	87	Sahobajpur
41	89	Chandiapalli
42	90	Amirabad
43	91	Deulapara
44	99	Reputa
45	100	Mahakalapara
46	101	Gamhan
47	102	Jaganathpur
48	103	Mangalapur
49	104	Baulapara
50	105	Dadhipur
51	106	Kumbharpara
52	107	Gajabandha
53	108	Bandhapada
54	109	Marichakani
55	110	Mahulakandha
56	111	Batakudi
57	112	Tithi
58	113	Jemadeipur
59	114	Nantara
60	115	Pareswarpur
61	116	Adoi
62	117	Kiabaria
63	119	Malladihi
64	120	Tankibelari
65	121	Bhitarasubala
66	133	Ramnagar
67	134	Brajabahakud
68	136	Kentia
69	137	Sarumuhi
70	138	Kochila
71	139	Bachhuria
72	140	Potakani
73	141	Chhadakani
74	142	Sathiabati
75	143	Gokhakhati
76	144	Lunamatia
77	145	Tentulikandha
78	146	Barakandha
79	147	Guptagiri
80	148	Rajendranagara
81	149	Bahargadabadadand
82	150	Nalitajoripala
83	151	Dasarajpur
84	152	Akhalsali
85	153	Palligar
86	154	Bahakud
87	155	Banabiharipur

PATAKURA

88	76	Samantsinghpur
89	77	Belar
90	78	Nuagan
91	92	Kalagar
92	103	Bhaganpur
93	226	Ramachandrapur
94	227	Balighai
95	228	Baripala
96	229	Batia
97	230	Potari
98	231	Madhusudanpur
99	232	Mangarajpur
100	233	Nachhipara
101	234	Potari
102	236	Alifa
103	237	Beruhan
104	238	Dhaniapada
105	239	Ratanpur
106	240	Nuagan
107	241	Tikhiri
108	242	Balisuan
109	243	Gopalpur
110	244	Bauda
111	245	Sireinpur
112	246	Ameipal
113	247	Madhuragandakhamar
114	248	Samjori
115	249	Nalidiapalanda
116	250	Badaghai
117	251	Mahangal
118	252	Raipur
119	253	Khurusia
120	254	Bandhakuda
121	255	Thantapalanda
122	256	Naladiasasan
123	257	Narayanpur
124	258	Gatanai
125	259	Koratapanga
126	260	Dekani
127	261	Khurusiapat
128	262	Patelipanka
129	263	Nalidia
130	264	Kodakana
131	265	Raghunathapur
132	266	Tekarpanga
133	267	Tiradeipur
134	268	Anantpur
135	269	Ramachandrapur
136	270	Paunsiapal
137	271	Chhanda
138	272	Purusottampur
139	273	Nandanpur
140	274	Raula
141	275	Subala
142	276	Madhusudanpur
143	277	Gararomita
144	278	Srirampur

ERASAMA

145	1	Bareikana
146	2	Rupakhandi
147	3	Nuadihi
148	4	Dasipur
149	5	Kiadingiri
150	6	Dhalipang
151	7	Digitari
152	8	Barabatia
153	9	Bilapokhariapada
154	10	Nalakani
155	11	Banipat
156	12	Baleipur
157	13	Guruguria
158	14	Nachhipura
159	15	Janardanpur
160	16	Narindrapur
161	17	Arjunkul
162	18	Balipari
163	19	Chatua
164	20	Pokhariapada
165	21	Jaganathapur
166	22	Chakulia
167	23	Aligarh
168	24	Sanagabpur
169	25	Badagabpur
170	26	Manapur
171	27	Parapada
172	28	Mulakani
173	29	Bamadeipur
174	30	Chharakandha
175	31	Jalapadakandha
176	32	Kuatarakandha
177	33	Banpatkandha
178	34	Balitutha
179	37	Sunadiakandha
180	49	Kandubelari

181	50	Gadakujanga
182	51	Badabuda
183	52	Bhitarsrichandanpur
184	53	Potaka
185	54	Jamukana
186	55	Barabelari
187	56	Painchiamania
188	57	Guamunda
189	58	Chadhaigahangharatakati
190	59	Uchanuagan
191	60	Bhegibaripachera
192	61	Kadakan
193	62	Rasakadapur
194	63	Bhitarandhari
195	64	Dasipurpaikasahi
196	65	Malipur
197	66	Bhainch
198	67	Dhuansahi
199	68	Mahimdeipur
200	69	Iribana
201	70	Achutdaspur
202	71	Japabhuyan
203	72	Katijanga
204	73	Sundarkani
205	74	Kendurisala
206	75	Mirjapur
207	76	Saintol
208	77	Bharisola
209	78	Sumuda
210	79	Mandira
211	80	Palikanta
212	81	Kanipada
213	82	Oriesal
214	83	Asarana
215	84	Arada
216	85	Oranal
217	86	Talakusuma
218	89	Kothi
219	90	Krushnachandrapur
220	91	Gangadharpur
221	93	Atimati
222	102	Rabhalochaka
223	103	Bhiranga
224	104	Gandhapur
225	105	Sihar
226	106	Jaipot
227	107	Jireilo
228	108	Manikundal
229	110	Erasama
230	111	Chandhurikuda
231	112	Pandiakan
232	113	Kaliakana
233	114	Kimilo
234	115	Ekagharia
235	116	Bartol
236	117	Sunadiakandha
237	118	Dhobei
238	119	Deika
239	120	Botigan
240	121	Kunjakothi
241	122	Khurantatutha
242	123	Kanaguli
243	131	Kiada
244	132	Kochilabedi
245	133	Sahadabedi
246	134	Badabelari
247	135	Saraba
248	136	Kuladanda
249	137	Nuapada
250	138	Oradilo
251	139	Srichandanpur
252	140	Bhajana
253	141	Kopalamandal
254	142	Asarana
255	143	Rurupada
256	144	Madhupur
257	145	Pokharipada
258	146	Alanavas
259	156	Sampur
260	157	Santol
261	158	Ghodadia
262	159	Kanjiakan
263	160	Garadmal
264	161	Kanpada
265	162	Lachhamakan
266	163	Balikani
267	164	Naradia
268	165	Tikarapada
269	166	Narasinghapur
270	167	Paniendula
271	168	Gobindpur
272	169	Sribantapur
273	170	Narayanaprasad
274	171	Gambharikan
275	172	Ganeswarpur
276	173	Talang
277	174	Dharijana
278	176	Biswanathpur
279	177	Gopalpur
280	184	Durgapur
281	186	Aunri
282	187	Birakiswarpur
283	188	Kadalibadi
284	189	Jasapur

285	190	Machhapada
286	191	Rajapur
287	192	Basudeipur
288	193	Balaramapur
289	194	Lachhmakan
290	195	Balabhadrapur
291	196	Janakdeipur
292	197	Sahada
293	198	Padanpur
294	199	Gateswarpure
295	200	Biswanathpur
296	201	Paikabati
297	202	Kuanrbedi
298	203	Ghosaghar
299	204	Souapat

TIRTOL

300	67	Chaudhurikuda
301	70	Parikudapalanda
302	72	Badapala
303	73	Kaladip
304	79	Paramanandapur
305	81	Madhapurdiapalanda
306	82	Sanabalikani
307	83	Zilladiapalanda
308	84	Jayasankhapur
309	85	Jillanasi
310	89	Tentulikhamara
311	90	Saharadia
312	91	Naladiapalanda
313	92	Bhandua
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316	100	Hasina
317	104	Nalidiapalanda
318	105	Bahartari
319	106	Bahartaridia
320	107	Bhutamundi
321	108	Jagati
322	111	Nunakua
323	112	Kothi
324	113	Narendrapur
325	114	Pitambarpur
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328	117	Koldia
329	118	Pipala
330	119	Telengadia
331	120	Thanaharadia
332	121	Singitali
333	122	Chakradharapur
334	123	Balidia
335	124	Paradipgada
336	125	Nuagada
337	126	Aganasi
338	127	Udayabata
339	128	Bijaychandrapur
340	129	Musadia
341	139	Kuabadi
342	140	Chaukimatha
343	141	Rangiagada
344	142	Niharuni
345	143	Nimidhi
346	144	Niharunikandha
347	145	Siju
348	146	Bagadia
349	147	Khasulidia
350	148	Pratapapur
351	149	Fatepur
352	150	Jhimani
353	151	Mangarajapur
354	152	Pangara
355	153	Gandakipur
356	154	Kharigotha
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358	156	Barunakandha
359	157	Gopiakuda
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362	160	Malipura
363	161	Jamukana
364	162	Mahakaladia
365	163	Baulanga
366	164	Badabandha
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369	167	Balia
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381	348	Pandua

382	349	Dhusala
383	350	Adhankur
384	351	Sirola
385	352	Lathang
386	353	Chandapat
387	354	Bailo
388	355	Patila
38[illegible]	356	Napang
390	357	Mithila
391	358	Parudi
392	359	Naiguan