COASTAL PLANNING AND MANAGEMENT
A Case Study of Goa.

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MASTER OF PHILOSOPHY

ANIL KUMAR JHA

POLITICAL GEOGRAPHY DIVISION
CENTRE FOR INTERNATIONAL POLITICS
ORGANISATION AND DISARMAMENT
SCHOOL OF INTERNATIONAL STUDIES
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NEW DELHI - 110 067
INDIA

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जवाहरलाल नेहरु विश्वविद्यालय
JAWAHARLAL NEHRU UNIVERSITY
NEW DELHI - 110067

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CERTIFICATE

Certified that the dissertation entitled "COASTAL PLANNING AND MANAGEMENT : A CASE STUDY OF GOA" submitted by Mr. Anil Kumar Jha in fulfilment of Nine credits out of total requirements of Twenty-four credits for the award of the degree of Master of Philosophy (M.Phil.) of this University, is his original work and may be placed before the examiners for evaluation. This dissertation has not been submitted for the award of any other degree of this University or of any other University to the best of our knowledge.

(Prof. S.C.Gangal)
Chairperson

(Prof. R.C. Sharma)
Supervisor

GRAM : JAYENU TEL. : 667676, 667557 TELEX : 031-73167 JNU IN

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CHAPTER-I

INTRODUCTION

The Coastal Zone: A New Area for Public Policy

The study of geography in today's world offers several almost commonplace images: population of the globe packed along with coast, instead of in the interior of the continents; consequent parallel density of economic and industrial activities in the same zones; desire of nations to possess or reach one or more seaports; and so on. Furthermore, there are other images, more or less futuristic, connected with developments in deep-sea mining, off-shore floating workshops or even the concept of sea-city and marine ecumenopolis (Pozzo: 1987: 18(7): 376-7). Thus these images of "man-sea relations" gave birth to a new object of enquiry: the coastal zone in 1970s.

The civilisations have grown along the waterfronts and sea coast. The large metropolitan cities of the world which have greatly influenced the global history and development are situtated along the coastline. A few examples from different countries are New York, Mexico, Tokyo, Hongkong, Singapore, Calcutta, Madras, Bombay, Karachi, Aden, Amesterdam and London. The sea coast and the waterfront are

most dynamic environment. Along the coastline, the interaction of land, air and sea produce a moderate climate, a highly productive coastal region. The coastal waters also have a large natural capacity to degrade and recycle the wastes by continuous wave and tidal action. Above all the buildings facing the sea coast due to panormic view and fresh air have a higher commercial value. These advantages have resulted in a continuous pressure on the coastal zone, which all over the world, have become centre for growth of trade, commerce, industry resulting in fast population growth. The excessive growth has resulted in increased and conflicting uses of resources such as pleasure, recretion and tourism, and waste disposal comprising of sewage, industrial effluents and oil. In addition, historically, and even today the coastline plays a major role for setting up of defence and naval installations.

The strip of land and sea that has been the spatial setting of the modern world system; has only recently been identified by planners and scientists as a spatial area which requires special study and treatment. The changing orientation of human activities and an increasing awareness of environmental issues have given the birth and evolution of coastal zone management and planning. The spreading of human activities off-shore by means of permanent or semi-

permament installations such as harbour terminals; floating wqorkshops, pipe-lines, living and non-living resource exploitation from marine waters, growing density of settlements on shore, etc. stimultes a growing demand for coastal planning and management, based on unprecedented integration between shore and off-shore systems. This leads to the identifications of a "sea-land area" which, on a geographical basis, may be classified as coastal region, thus becoming the object of regional planning [Ibid]. The coastal planning and management involve the identification of coastal problems, policies and programmes for addressing the problems and the actual carrying out of the programmes identified in coastal plans.

Further, global warming and possible effects of sea level rise, storm surges and cyclones posing a threat of submerging the coastal cities, islands, and increase in the area of bays, creeks and coastal saline soils and acquifers have further added responsibility and strengthened the concept of coastal planning and management.

Delineating the Coastal Zone

The identification of space over which coastal policy applies is a matter of great interest and concern, mainly due to the great diversity of coastal areas. Although one

can have a general idea of what is meant by a "coastal zone", when it comes to precise definition in space the task becomes quite difficult. One can identify a linear element, the shoreline, which is a function of the level of the sea. The level of sea water, however, is by no means constant in relation to the shore, due to tidal action. The area between the mean high and the mean low tides is often referred to as the wet-sand area or foreshore. The area extending towards the sea beyond the mean low tide line, is often called offshore; its extent is a function of the wave action and the depth of water. Finally, the area extending beyond the mean high tide line inshore, is known as the backshore or dry sand area. Its inland extent is usually defined by the presence of vegetation (excluding dune grass) or a change in the physiography of the land.

The identification of such subareas within the shoreline area is quite important for coastal planning, as public ownership and use rights are often defined in relation to these terms. Any change affecting their size or location will most likely have important implications for planning purposes. The coastal zone may extend much further beyond the landward or seaward limits of the shoreline area but it is an ill-defined area as no clear definition or consensus exists.

The Federal Coastal Zone Management Act of 1972 in the US defines the coastal zone as the "coastal waters (including the land therein and thereunder) and the adjacent shorelands (including the water therein and thereunder) strongly influenced by each other [Ketchum, B.H. (1972), pp.1-33]. In the US the seaward limit is the outer boundary of the US territorial sea. The landward limit is discretionary. The territorial waters are the crucial areas, where dynamic interaction, resulting in growth on one side and environmental damage on the other, is continuously taking place and the influence of coastal process generally extends upto 50 km on either side of the coastline. However, in case of large estuaries, the influence of sea extends far much longer distance towards the upper reaches of the rivers. In large estuaries like Hooghly-Malta, Godavari, Narmada, Mondovi-Zuari, etc. the estuarine influence is seen almost upto 125 Kms. from the coast [Dwivedi, S.N. (1989), pp. 5-12].

Using various criteria (morphological, landuse, ecological or economic), one can identify a series of different zones. Obviously, when using such criteria, the width of the coastal zone varies from one area to another, depending on the spatial extent over which the critrion used is most applicable. Furthermore, the delineation of the

boundary often requires a great deal of judgement and common sense.

The Value and Attractiveness of the Coastal Zone

Most coastal ecosystems provide a habitat for marine associated organisms and nesting and feeding areas for migratory waterfowl and shore fauna. Especially dunes and beaches function as natural buffers against flooding, erosion and storm wave damage, while the estuaries contribute directly to the productivity of commercial and recreational fisheries and are nursery areas for finfish. Uncontrolled coastal development may cause destruction of coastal ecosystems and consequently reduction and change of their productivity.

The coast is unique and valuable as a resource not only from an ecological perspective but also from a socio-economic view. The economic value of coastal marine resources has long been widely acknowledged, particularly in relation to fishing, mining and oil drilling. Coastal land resources have held a key role in this planet's economic and social development, particularly in relation to settlement, industries, tourism, mining, ports and communication facilities etc.

Pollution, ecosystem destruction, envionmental degradation express the conflicts among the uses of coastal resources. Pollution is particularly threatening, as it affects not only the ecological value of the coast but also its development potential. Among pollutants, heavy metals carried by rivers, industrial and urban wastes, radioactive material dumping, toxic fuel pollution, sewage, fertilzer runoff etc. present severe threat.

Nevertheless, pollution is only one aspect of environmental degradation in coastal areas. The destruction of coastal ecosystems due to human interference is equally important. Coastal dredging, landfilling, port facilities and the extraction of sand and gravel destroy the immediate benthic area and can affect more distant zones, threatening the ecological equilibrium of coastal areas. Finally, the loss of valuable land for public recreation or agricultural activities, due to pressure from urbanisation, is another major issue. Thus the essential coast character is its intricate, indisputable interconnection. [Simon, A. (1980), pp.5-12.]

An Integrated Approach to Coastal Zone Management

The current and expected value and attractiveness of the delineated coastal zone has established the need for

effective coastal planning and management. The existing problems, although serious in many areas, are not insurmountable as a whole, and future problems are visible so that one can prevent rather than cure. In the coming two decades, there will be a dramatic growth in coastal development. Population pressures will lead to rapid rates of coastal settlement and urbanisation. Rivers emptying into estuaries will be dammed to ensure adequate supplies of water for burgeoning metropolitan areas, agriculture and hydropower. Rising GNPs and energy demand will encourage the expansion of coastal industrial facilities. Offshore dredging for landfill, improved port and waterway facilities, and construction material can be expected to continue. Marine transportation will increase. Thus the existing port facilities will have to be expanded significantly and corresponding increase in secondary and tertiary economic activities and urban settlement in coastal areas can be anticipated.

The combined effect of these activities presents a real danger, not only to ecological balance of the sensitive coastal environment, but also to economic development itself. Thus the development and protection of environment in coastal zone must be approached simultaneously in a integrated way.

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 which can be observed in the model given below: [Lee, N. (1982), pp. 108-113]

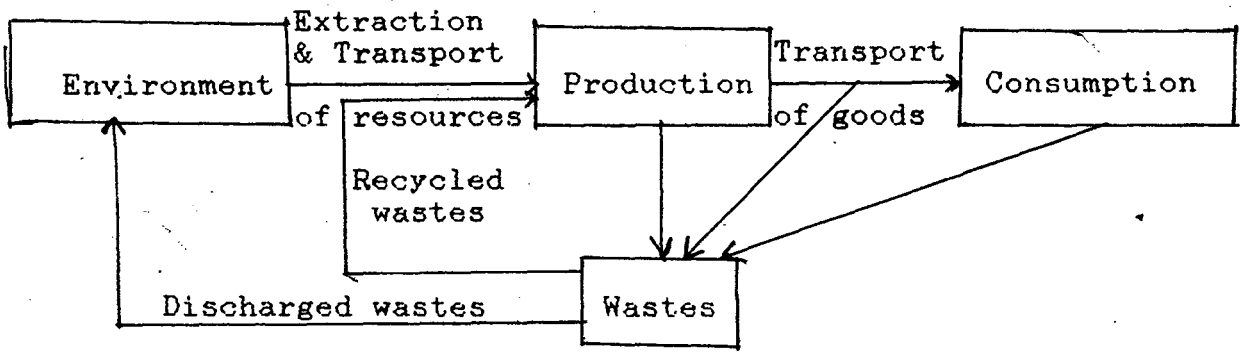

Fig. 1: Relationship between Economic and Environmental System

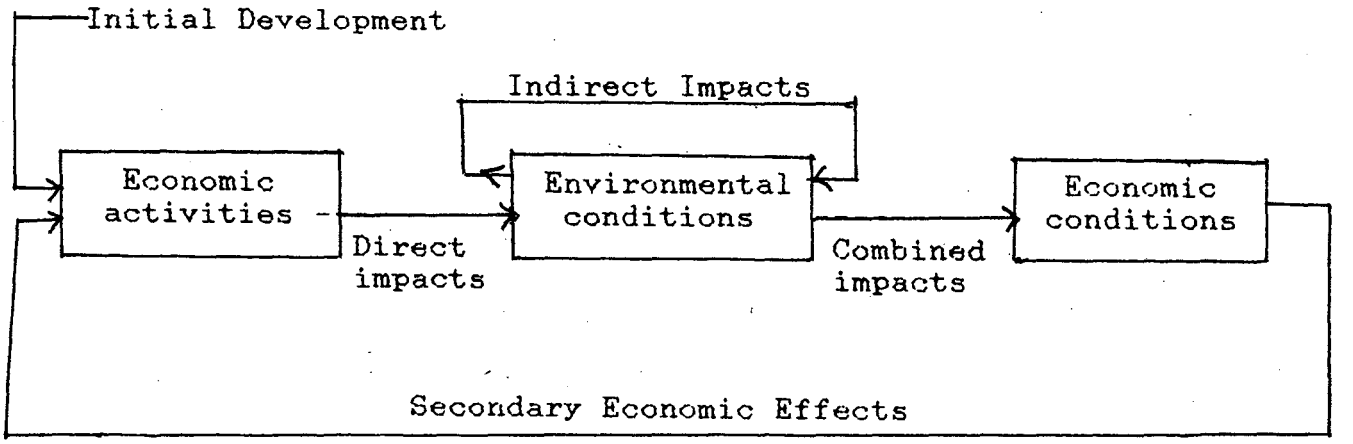

Fig. 2: Change and response in economic and environmental conditions

Because of this "feedback relationship", there is a need for an integrated approach to the planning and management of the coastal zone. An important issue in the integrated planning is the multiplicity and fragmentation of responsibilities of the authorities involved in coastal areas. Solutions to this problem range from the establishment of a new authority or agency to the simple creation of planning study groups with representatives of the different authorities involved. Thus the integrated coastal zone management plan provides the framework for identifying, describing and explaining the coastal problems. It also provides the basis for identifying and evaluating alternative strategies for dealing with coastal problems.

Objectives

The objective of coastal planning and management is to ensure the orderly and balanced utilisation of all living and non-living resources in order to maintain, and where possible, restore and enhance the environmewntal quality of the coastal zone. Coastal zone management in the real conceptual terms seems to be unknown to Indian planners and policy makers. However, recently they have felt the need of coastal planning and management. Thus it is a recently new phenomena in India as well as in many other developing countries; and has been necessitated by a deterioration of the coastline and necessary developments taking place on

the coastal zone. Since colonial times the centre for trade and commerce has increasingly been in coastal areas. At present more than 25% of the total Indian population lives and works in the coastal belt of the peninsula [Qasim, S.Z. and R. Sen Gupta (1988), pp. 100-106]. The trade and commerce that provided the impetus for coastal communities in colonial times has been supplemented by fishing, tourism, communication and a host of other important economic activities.

The increase in the coastal population and economic activities has resulted in increased competition for the use of coastal land in development activities that degrade or deplete natural coastal resources faster than they can be naturally renewed, in increased exposure of people and property to natural hazards such as flooding, coastal polution, and in the loss of traditional rights of access to beach fronts.

With these basic thoughts in mind, the present study is being accomplished, of course, by no means an exhaustive one. It may be taken as a preliminary study in the complex field of coastal planning and managaement. Goa as a part of the coastal zone of India has been chosen for the study. In regional scale of analysis appropriate to the Indian situation, the study area is comparable to a micro-region.

Chapterisation:

The present study is divided into ~~five~~ Six chapters including this introduction and the conclusion. This introductory chapter deals with the conceptual framework of coastal planning and management which initiates and directs the course in dissertation writing. It also provides philosophical and concepatual underpinning to the dissertation. And thus it provides the framework and chapterisation scheme of the dissertation.

The second chapter deals with the International perspective and Indian experience in the coastal planning and management exercise in general briefly.

The third chapter deals with the rationale behind the selection of case study area, Objectives, Methodology, Data base and limitations of the study briefly.

The Fourth Chapter deals with the assessment of resource potentials, current state of development of economic activities, human settlements and environmental changes.

The fifth chapter discusses strategy for economically sound and environmentally harmonious development of the Goan

coastal region. The last chapter deals with conclusion, suggestions, etc.

It is hoped that the present study which is conducted under constraints of time and ~~and~~ basic requirements of the M.Phil. degree, that is, the course work and dissertation, satisfy the much needed exercise in marine geographic analysis.

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CHAPTER II

INTERNATIONAL PERSPECTIVE AND THE INDIAN EXPERIENCE

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.

Developed countries:

The majority of developed countries, with a long experience of the effects of industrialization and urbanization 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 county councils to identify coastal protection areas . This led to the "Heritage coast" programme which aimed to protect and preserve the country's outstanding coasts [Waite, C (1982), pp 124-127]. These now represent about 40% of the total undeveloped coastline The planning and management of coastal areas in England and Wales 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 a significant part in the management of the unspoiled coastline. In England and Wales, the early coastal protection areas extended to wherever the coast was visible, while the coastal preservation areas vary from 300 meters to 8.3 kilometers.

The Netherlands have a long history of an integrated approach to coastal development, an issue of life and death for more than half of the total population of the country [Koekebakker, P and G Peet (1987), pp 121-134]. The basis for planning and management in the Netherlands dates back to the middle ages and is closely related to the protection of land against the sea. Originally, the system was highly decentralized. Gradually, national authorities took a supervising role, but in principle the whole system still operates in a decentralized manner. The system is based on the so-called "waterschappen", in which landowners and tenants cooperate, each holding a number of votes in proportion to their property or the land used. Todate these bodies still have certain legal powers regarding water management within the area under their jurisdiction. The "waterschappen", are supervised by the provincial administration (the Netherlands has 12 provinces) and at the

national level the system as a whole is supervised by the Ministry of Transport and public works through an executive agency, "Rijkswaterstaat". The "Rijkswaterstaat" is in charge of a multitude of tasks, such as construction of national motorways, the construction of dikes, the "Zuyderzee Plan" and the "Delta plan", and several other tasks.

At a later date a system of integrated planning and management of land use was developed, parallel to the above system of water management. This landuse planning system evolved from town planning and developed into a very sophisticated system of land-use planning for the Netherlands.

The Netherlands has three levels of administration: the local/municipal, regional/provincial and national. The planning system relates to these three levels and was given legal basis in the (recently amended) Physical Planning Act of 1965. The Dutch system of planning and management has a highly regulatory character. It allows only those developments that are contained in the various (local and regional) plans. The "Ijsselmeer" and "Waddenzee" regions provide two good examples of approaches of planning and management in the Dutch coastal zone in the strongly rooted tradition of coastal defense and water management, and the

protection of the ecological resources of this area respectively based on the Physical Planning Act.

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 the coastal zone [Camhis, M and H Coccossis (1982), pp.92-97]. The "Conservatoire du Littoral" is responsible for coastal land policy and has proceeded to the acquisition of several sites throughout the country. Among the more distinct features of French coastal policy is the development of sea-water use plans (SAVM) as a tool for decision makers, and the elaboration of Regional Coastal plans to serve as guidelines for planning activities within the region In France there is a 100 meter zone where construction is generally prohibited. However for planning purposes the zone considered is much wider.

Sweden has integrated a coastal protection programme in its physical landuse legislation. In 1972, the Swedish Parliament, on the basis of a Government Bill, laid down guidelines for land and water management in areas with

intense competition for physical resources, such as coastal areas [Ibid] These guidelines were further elaborated in a 1979 report by the Ministry of Housing and Physical Planning. The responsibility in regard to use and protection of marine resources rests with the county administrations and Swedish Marine Resources Commission.

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 [Cullen, P (1982), pp 183-212]. Other states followed this lead and in most parts of Australia a strip of coastal land, often only 100 meter 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 of management in some states.

The Port Phillip Authority, Australia's first coastal management agency, was established in 1966. Since then Australian states have developed some form of coastal zone management programmes. A recent inquiry by a Federal Parliamentary Committee found that state and local

government authorities have recognized the sensitivity of the coast, but often lack the resources to undertake comprehensive research or preparation of management plans. Now the Australian Coastal Management Council coordinates and supervises the coastal planning and management issues in the country. Australian states have taken 400 meters land ward from high tide line as the landward boundary of Costal Zone.

Above the center door of the parliament buildings in Ottawa Canadian capital, is inscribed the phrase "And at Her Gates the wholesome Sea" [Harrison, P. and J.G. Michael Parkes (1983), pp. 1-12]. 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. The Canadian coastal zone is administered and managed by a host of federal and provincial government agencies. Many of these agencies focus on particular sectorial 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 issues.

The United States of America recognizing 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 areas. [Archer, J.H. and R.W. Knecht (1987), pp. 103-120]. In view of the considerable experience developed in coastal resources, policy and management over the years, the US coastal zone management programme not only focuses on planning of coastal activities but on comprehensive coastal resource management. It has been given a substantial boost by the reauthorisation of the National Coastal Zone Management Act in 1986. The presidents approval of the new legislation concluded a year-long effort by the coastal states, environmentalists. local officials and citizens to preserve the national and state CZM programmes.

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In the US 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 other countries the seaward limit may extend to 6 or 12 miles. The landward limit is discretionary up to the individual states, although

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intertidal areas, marshes, etc. are normally included, the variety of definitions used by the US 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 metres respectively. Alabama's definition is a function of the 3 meter contour line above the mean tide level.

Among the other developed nations, Japan seems to be advancing towards the development of coastal zone management programme. Coastal area management is emerging as an increasingly important policy issue in modern Japan [Shapiro, H.A. (1984), pp. 1-9]. 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 growth ethic that dominated industrial policy in postwar 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 if it is given a high priority. Institutionally, however, Japan is constrained by lack of coherent policy to provide a consistent basis for cooperation among the numerous agencies with jurisdiction over coastal areas and uses occurring in them.

Prior to the middle of the 19th century, coastal area management was the exclusive purview of the Emperor. Ownership of the shore and coastal waters was vested in the Emperor as represented by his feudal lords. Traditional use rights in coastal fisheries were granted by these feudal lords to coastal community organisations called "urakumi". During the Meiji Era (1868 - 1912) the govt. nationalized all the water areas and carried out fisheries reforms. After an initial period of confusion, a system of granting traditional fishing rights to fisheries cooperatives developed and has remained virtually intact until the present time. The Japan has 20% of its total area as coastal plains.

By the early and middle of 1970s came the realisation that there were competing demands for coastal areas.

Urbanization and industrialization in the postwar period led to rapid increase in coastal pollution. Recreation, scenery and water quality were increasingly important to the financially better off and more leisure oriented population created by Japan's economic miracle. However, coastal area management in Japan is hamstrung by the lack of overall planning authority and policy guidelines because of the sectorial approach that currently exists and the lack of comprehensive national legislation.

Developing Countries

The US Coastal Zone Management Act of 1972 is about the earliest comprehensive national legislation developed with respect to planning and management of coastal zone effectively and efficiently. But coastal planning and management is a comparatively new recent concept in the developing countries.

Coastal resources are of major economic significance in developing countries. The majority of LDCs are coastal states or islands, and their coastal ecosystems contain rich natural resources capable of supporting a variety of activities and serving diverse human needs for food, energy, shelter and other commercial development. Development opportunities occur in many sectors: fisheries, energy

development, including mangrove fuel, offshore oil and gas, wind generated and offshore thermal energy conversion. coastal agricultural development, tourism, transport facilities, port and harbour development, industrial facility siting and mining sector opportunities.

Economic planning and development in many countries have not included sufficient analysis of long term and coincidental consequences of action upon natural coastal resources and environment in general. One reason for this imbalance in decision making is the inadequacy of information about impacts on coastal resources and environment for technological change.

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 sectorial interests that plan development independently and do not adequately consider the effects of one form of exploitation upon another development activity. Consequently many coastal resources are succeptible to negative impacts, and the potential is great for severely reducing the long-term productivity of the system. To

ensure that renewable resources remain available to future generations, resource management should be directed towards sustained utilization of natural resources; i,e., the level to which a resource should be harvested, extracted or utilised should not be more than that amount which can be either produced or renewed over the same period. 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 coordinated development of coastal resources can provide the basis for accelerated and sustainable economic growth that will have major employment generation, production and equality benefits.

The need for an integrated and management oriented programme for the development of the coastal areas in Sri Lanka was recognized only in the early 1970s [Amarsinghe, S.R. (1989), pp. 65-78]. Until recently, various coast protection works were stimulated by increasing incidence of sea erosion and consequent damage to property and solutions were engineering oriented, the responsibility for such coast protection works were fragmented within several governmental agencies.

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 engineering solutions alone were not sufficient and that a more comprehensive approach of integrated coastal zone management was required. Sri Lanka is one of the very few developing countries, which has enacted legislation specifically directed towards coastal zone management. The coast conservation act no 57 of 1981, which became operative in october 1983 contains the comprehensive legislative and executive measures to safeguard the coastal zone of Sri Lanka. Thus Sri Lanka has well established department of coast conservation dealing with coastal planning and management. The landward limit of coastal zone is 500 meters from high mean tide line.

There are eighteen independent coastal nations and one semisovereign 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 [Sorensen, J. and A. Brandani (1987), p.1-26]. The region encompasses a great diversity of ecosystems and climatic zones, from polar cold to coastal deserts to tropical rainforests. Large portions of the region remain unaffected by human intervention, while many areas are severely degraded,

usually by natural resources exploitation or pollution from development and urbanization. Generally, coastal resources are being developed at an increasing rate throughout the region. Two notable examples are fisheries development and the conversion of mangroves to aquaculture ponds. Latin American countries, with the exception of Peru, have increased their fish harvests by 167% between 1968 and 1980. In the last ten years, Equador has allowed the conversion of approximately 75000 hectares of its mangrove ecosystem (over 42% of the nations total ecosystem resource) to shrimp aquaculture ponds. The increasing rate of resource development is a reflection of both the need to improve socioeconomic conditions as well as the need to keep pace with a burgeoning population growth. The average annual population growth rate in coastal nations of Latin America from 1971 to 1982 was 2.15%. In comparison,the average annual population growth rate in the United States is 0.94% only (1980 - 1985). The richness and diversity of resources, the presence of many devastating coastal hazards, the mixed pattern of pristine and degraded ecosystems, and the rates of coastal resource development and coastal population growth, when viewed collectively, present tremendous challenge for the practice of coastal area management.

All Latin American countries use sectorial planning to manage various coastal resources or activities. It is routinely used for managing fisheries; oil and gas extraction; tourism; ports and harbour development, naval defense and coastal security and navigation. Sectorial planning fails to consider the coastal systems perspective. The designation of protected area is also used as a management strategy by all the countries in the region. They have created national parks or reserves for the specific purpose of preserving coastal or marine environments. Shore -land restrictions is practiced by four nations: Chile, Costa Rica, Mexico and Uruguay. Costarica's coastal area management programme is essentially a shoreland restriction strategy on an ambitious scale. In 1977, the legislation was enacted that declared the first 200 meters inland from mean sea level to be part of the national heritage. The legal framework which the most valuable one for the coastal management in Mexico today is the "Zona Federal Maritimo Tererestre," "ZFMT". Article 27 and 49 of the General law on the National Welfare of the 1917 National constitution defines the ZFMT as [Merino, M. (1987), pp. 27-42]:

> "Waters of the territorial seas, interior waters, lagoons, lake and rivers are all property of the nation. The nation has direct dominion over all the resources of the continental shelf and sea bottom around the islands. Land gained from the sea and other

waterbodies is also included as property of the nation. A strip of land including: a) in the case of beaches, all the intertidal zones plus the 20 adjacent meters inland; b) in the case of cliffs or rocky shores, these formations and the twenty meters inland adjacent to the first freshly transitable points on the top of the cliffs or rocky formations; and c) in the case of water bodies communicating with sea or containing sal water, the twenty meter strip adjacent to the highest annual water level."

The Ministry of Urban Development and Ecology controls the Zon Federal Maritimo Tererestra (ZFMT). Adequate control of most coastal activities requires a much wider area than 20 meters.

In 1983 the organisation of American states(OAS) convened a meeting on coastal resources management in Argentina [Brandani, A. (1987), pp. 43-60]. One spin-off of the meeting was the creation of the "Interdisciplinary Commission for coastal zone management" by the govt. of Buenos Aires province. Its objective is to identify, the relevant coastal resource management issues for the province. The Federal government looks after the coastal zone through sectorial planning measures.

Thus nation wide or state wide coastal planning and management are rarely used in Latin American coastal areas. It is due to lack of development and inadequate planning resources. However, Latin American countries are trying to

prepare coastal zone management plan by various way such as the designation of protected areas, Environmental assessment programme, shoreland restriction, special area plans and compilation of a coastal atlas or data banks etc. appear to be a growing practice in the region.

The marine waters and coastal areas of the ASEAN (Brunie, Indonesia, Malaysia, Philippine, Singapore and Thailand) are threatened by both the forces of nature as well as by human activities [Gomez, E.D. (1988), pp. 166-169. Foremost among these threats are siltation, pollution from domestic and industrial wastes; heavy metals; agrochemicals; particularly pesticides; pollution resulting from oil spills from tankers and from onshore 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 ecosystems of mangrove forests, coral reefs, and intertidal flora and fauna of the region are threatened by the reclamation of land for multipurpose uses and by recreational activities.

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 Departments/Bureau/Division of Harbour/ Ports/Coast guard. Legislations are there to control the source pollution e.g. land-based, vessel-based, onshore and offshore activities. But there does not seem to be any national policy and institutions in any countries of the region for comprehensive coastal planning and management of the coastal problems. However, sectorial planning approach has been adopted by the countries. To avoid the conflicts that arise from the competitive use of coastal land and marine resources, it is obvious that a more integrated and systematic planning and management exercise is needed. Although several countries in Southeast Asia have implemented restrictions on haphazard coastal developments in specific areas through zoning or environmental impact regulations, integrated coastal zone management is still in the developmental stages.

As countries realize the interdependence of protection and development policy, coastal management and planning schemes are likely to increase in number. The overview of the national experiences in coastal management and planning identifies three major axis of similarities/dissimilarities among the 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 in the planning, management and implementation system employed which is a function of the other two. The thread, however, linking them is the common aim and a commitment to the integrated management of coastal resources.

International Cooperation

The increasing awareness during the 1970s and 1980s, of the importance of the 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, directories, protocols, conventions and conferences reflect the interest of many international organisations in coastal issues. National governments are rapidly becoming aware of the necessity to protect and preserve biological diversity in the region and to maintain ecological balance by means of national management of resources. International efforts are helping to improve this awareness. UNESCO and the UNEP are playing active roles in Promoting national and international concern for sustainable development of the coastal and marine resources of different countries and region all over globe.

Among the developing countries, involvement in coastal management and planning has been through the initiative of the various UN agencies and particularly UNEP. The UNEP, in response to the 1972 Stockholm conference call for the protection of the marine environment, developed a regional approach to ocean management through the "Oceans and coastal areas programme activity center (OCA/PAC)" [Camhis, M. and H. Coccossis (1982), pp. 92-97]. The Regional seas programme now covers eleven regional seas, with 120 countries participating worldwide from the Caribbean to the south pacific. Among these programmes, the Mediterranean Action Plan and the Caribbean Action Plan are the most advanced.

In addition to these actions several other international organisations have also been involved in coastal matters. Worth mentioning are: the work of WHO/UNEP on environmental impact assessment for coastal areas; FAO's cooperation with UNEP on the pollution of the marine environment in relation to fisheries and aquacultures; UNESCO's work on "Ocean and Coastal marine systems" as specified in its 1981 - 1986 programme; 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

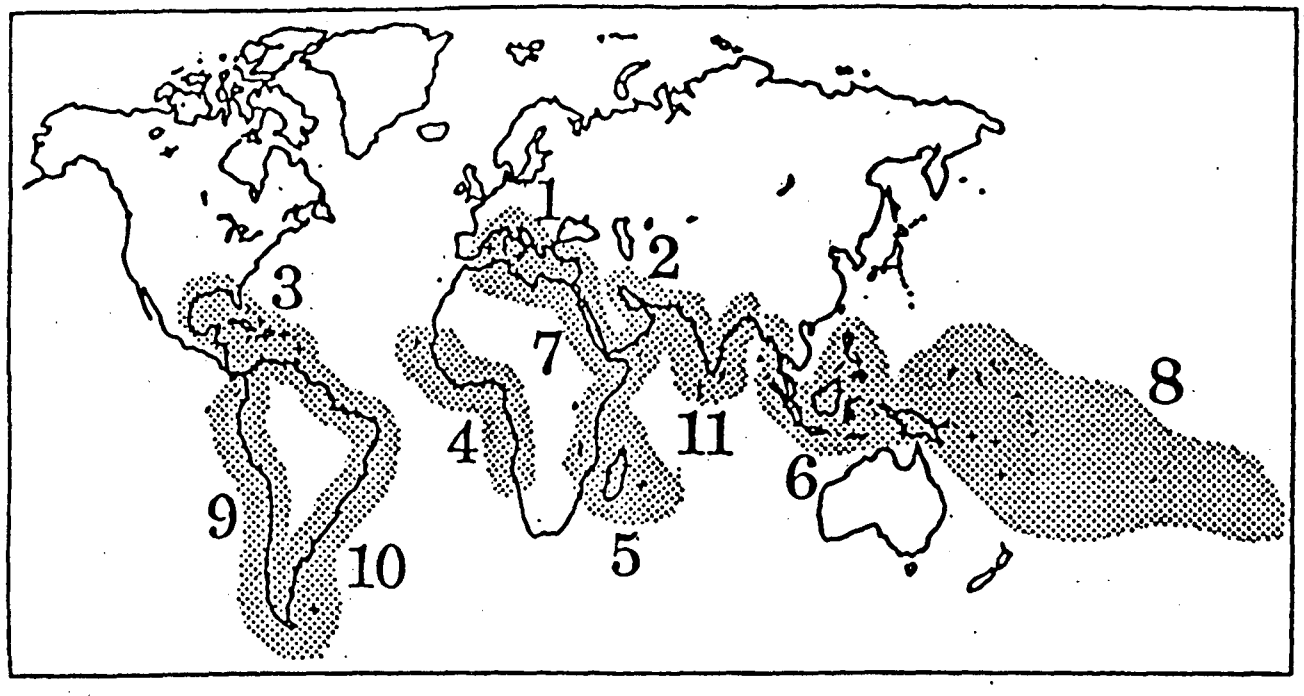

Fig.II.1: UNEP REGIONAL SEAS PROGRAMME
GEOGRAPHICAL COVERAGE

1. Mediterranean Region	Action Plan adopted:1975;	Regional Convention signed: 1976
2. Kuwait Action Plan Region	Action Plan adopted:1978;	Regional Convention signed: 1978
3. Wider Caribbean Region	Action Plan adopted:1981;	Regional Convention signed: 1983
4. West and Central African Region	Action Plan adopted:1981;	Regional Convention signed: 1981
5. Eastern African Region	Action Plan adopted:1985;	Regional Convention signed: 1985
6. East Asian Region	Action Plan adopted:1981	
7. Red Sea and Gulf of Aden Region	Action Plan adopted:1982;	Regional Convention signed: 1982
8. South Pacific Region	Action Plan adopted:1982;	Regional Convention in preparation
9. South-East Pacific Region	Action Plan adopted:1981;	Regional Convention adopted: 1981
10. South-West Atlantic Region	Action Plan preparation to be initiated	
11. South Asian Seas Region	Action Plan preparation initiated	

guidelines for international cooperation in relation to ocean resource management, jurisdictional problems, on pollution problems etc. beyond coastal waters.

It is interesting to note that the recent work of international organisations is shifting away from the general declarations and principles of the early 1970's towards more concrete action, specific laws and a quest for implementation the problem that often arises is that there is a lack of communication both within bodies at the international level and between these and bodies at the national and regional/local levels. Better coordination and communication could avoid unnecessary overlaps and repetitions of work already carried out and be more effective in policy implementation.

The Indian Experience

India's coastline was practically free of any stress conditions imposed by human activity during pre-colonial times. The centers of civilization 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 and geopolitics existed on the basis of the self sustaining agricultural economy. Though strategically located it did not had significant and

decisive travel and maritime trade relations with the rest of the world. Hence the interest in maritime areas and activities was minimal. While the coastal zone was free of intense human activities during this period, 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 south west and east coasts. 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 phenomena that cause changes in the physical stability and productivity of the coastal zone.

These and other changes with a much longer periodic cycle such as subsidence, changes in the sea level etc. have changed and shaped the size of peninsular India though not in a extreme fashion and abrupt manner. A neotectonic and morphogenetic tilt between 12th and 16th century resulted in an uplift of western part of Ganga towards the Padma and hastened the deltaic formation [Jhingran, A.G. and P.K.

Chakrabarti (1989), pp. 85-87]. West Bengal, consequently, does not receive much deltaic sediments as before. However the Hoogly system has brought enough sediments and about 0.405 million hectare have been reclaimed. The beaches and inlets, creeks and mangrove, swamps, mudflats, coastal dunes and sandflats are the characteristics of the area. There is a clear evidence of accretion and consequent building of beaches in some patches of Maharastra, Goa and Orissa coastline while progressive erosion along the south west coast (Kerala and Karnataka) has diminished the size of the coastal area along this seaboard. The finding of historical Dwarka town in Gujarat coastal water by marine archaeologist is an important example in this direction.

The advent of the western colonizers - the Portuguese in 1498 AD, the Dutch in 1602 AD, the British in 1600 AD and the French in 1664 AD caused a profound change in man's attitude towards the Coasal Zone in India. Coastal bastions were established to affirm their footholds on the country. Canals, roads and railway were cut to establish communications between such bastions and trade assumed importance. The rich natural resources of India attracted the attention of these invaders and the export of such resources to enrich their own economics necessitated the establishment of anchorages and harbors as well as access

routes to the hinterland. The coastal zone provided the platform for such exploitation and underwent radical change. The interior population migrated from the traditional areas to coastline to provide services to new masters. Coastal lands suitable for the cultivation of export crops were utilised for that purpose. The culture of Indian population changed radically. Trade assumed increasing importance and consequently the coastal areas attracted those in search of opportunity, for example, in calcutta, Bombay and Madras, population centers were established along the coast 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 independence in 1947 attracted more people to the coastal cities. Opportunities in public administration, commerce, industry coupled with better opportunities in education were the catalysts in such migrations towards the city. With this the population in the coastal zone increased and so did the utilization of its resources. These in turn imposed stress on the coastal environment.

Table 1 : Statewise particulars of coastline and shelf Area

State/UTs	Length of Coastline in Kms.	Continental Shelf Area upto 50 m depth (Sq Km)	up to 200 m depth (Sq. Km)
West Bengal & Orissa	600	27001	46421
Andhra Pradesh	970	16607	31044
Andaman & Nicobar	1500	-	16056
Tamil Nadu	960	23255	41412
Pondicherry	NA	NA	NA
Laccadive Is.	-	-	4336
Kerala	560	12569	35941
Karnatka	270	7936	25473
Goa	105	2849	9984
Maharastra	600	25512	104758
Gujrat	1500	64810	99373

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

The vast coastal zone of India is now being utilised for the development of ports and harbours, fisheries, beach resorts, land reclamation, location of shorebased industrial complexes, human settlements, agriculture, disposal of wastes etc. The coastal states of India are presently

confronted with the problems of coastal erosion. Pollution in estuaries and near shore waters is becoming a serious problem requiring scientific solution due to the increase in population and industrialization and steadily increasing tourist traffic, there is an ever growing demand for more and more recreational beaches tourist resorts and scenic spots along Indian shoreline. The super power presence in the Indian ocean and consequent rivalry has forced Govt. of India to establish more naval and defense installation so that it could safeguard the country's security and protect maritime affairs.

Table 2 : General Information Regarding Coastal Zone of India

1.	Area Covered by Oceans	:	361×10^6 Km^2, 71% of the Earth Surface.
2.	Area of Indian 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.	Coastal Population (25% of the total)	:	188 million
8.	Average Surface temperature	:	25°C
9.	Average surface water salinity	:	35%

10.	Estimated Reserves of Shell deposits in Indian Ocean	
	a) in vembanand	: $1.7 - 2.6 \times 10^6$ tons
	b) in Kdarundi	: 4.5×10^6 tons
	c) in Pulle & Thatpalli Rivers	: 1×10^6 tons
11.	Area covered by pollymetalic Nodules in Indian Ocean.	: $10\text{-}15 \times 10^6$ Km^2
12.	Estimated polymetalic Nodules resource	: 1.5×10^{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 Population.	: 11.14 million tons
15.	Total Annual fish catch at present in India	: 3.1 millions tons (1987)
16.	Total Marine Fish catch at present in India.	: 1.75 million tons (1987)
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 (1986-87)	: 20.6 million tons : (9.9 m tones onshore)
24.	Estimated Mineral deposits.	: 163 million tons
25.	Production of Mineral deposits (1981)	: 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.	Rinfall per year (entering the bay of Bengal)	: 6.5×10^{12} m^3.
30.	Rainfall per year (entering the Arabian Sea)	: 6.1×10^{12} m^3
31.	Domestic Sewage added to the sea by Coastal population per year at 60 L.per head day^{-1}	: 4.1×10^9 m^3.
32.	Industrial wastes added to the sea by Coastal industries Yr^{-1}.	: 0.41×10^9 m^3.
33.	Sewage and effluents added by the rivers to the sea Yr^{-1}.	: 50×10^6 m^3.
34.	Solid waste and garbage generated by coastal population Yr^{-1} (at 0.5 Kg per head day^{-1}.	: 34×10^6 tones
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.	Synthectic detergents used Yr^{-1}.	: 125,000 tones
38.	Oil transported from Gulf countries Accross 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 (1985)	: 215 million tons
41.	Oil transported to east (1985)	: 232 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 India	: 351.91 billion m^3
	(1980) off Shore (Bombay high)	: 5.2 - 29.5
44.	Production of Natural gas in India (1987-88).	: 11.47 billion M
	Off Shore	: 4.12 billion M
45.	*Heavy Mineral placers on India's coast (Onshore) Reserves	
	Ilemenite (1977)	: 1380,00000 tones
	Rguntile (1977)	: 70,00000 tones
	Zircon (1979)	: 220,0000 tones
	Monazite (1975)	: 40,8000 tones
	Garnet (1979)	: 9000 tones
	Heavy Mineral Placers - Onshore Production	
	Ilemenite (1979)	: 165000 tones
	Rutile (1979)	: 12000 tones
	Zircon (1979)	: 10000 tones
	Monazite (1979)	: 2800 tones
	Garnet (1979)	: 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 (1987)	: 43,370 hectares.
48.	Exports of Frozen prawns from Major Indian Ports (1986)	: Rs. 3799789,000
49.	No. of Fishing villages in Indian coastal zone (1980 cencus).	: 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 Acutal fishing (1980).	: 474731.

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

Fig.II.2(a) Distribution of Zinc

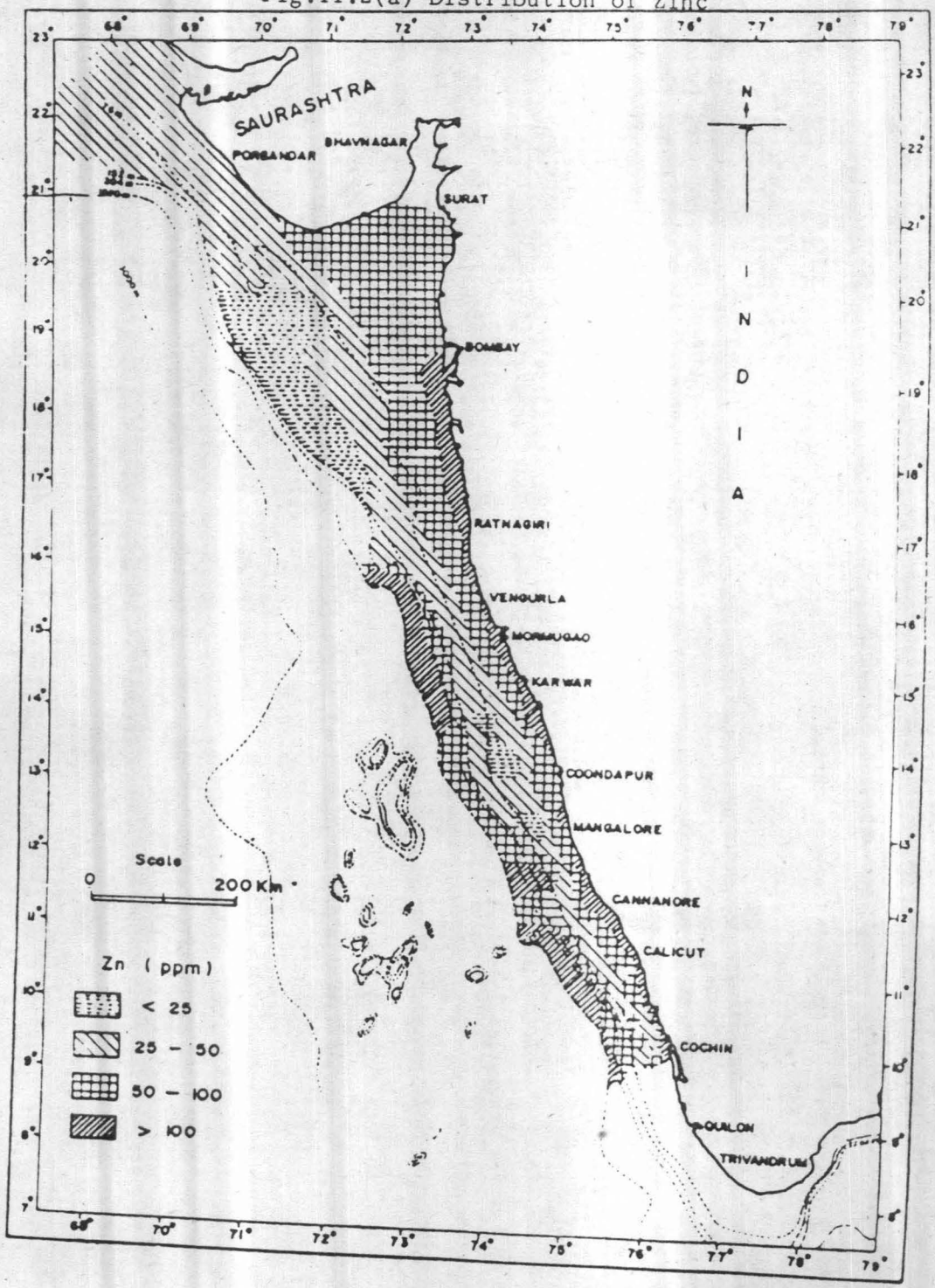

Fig. 2(a). Distribution of Zinc

Fig.II.2(b): Distribution of Al_2O_3

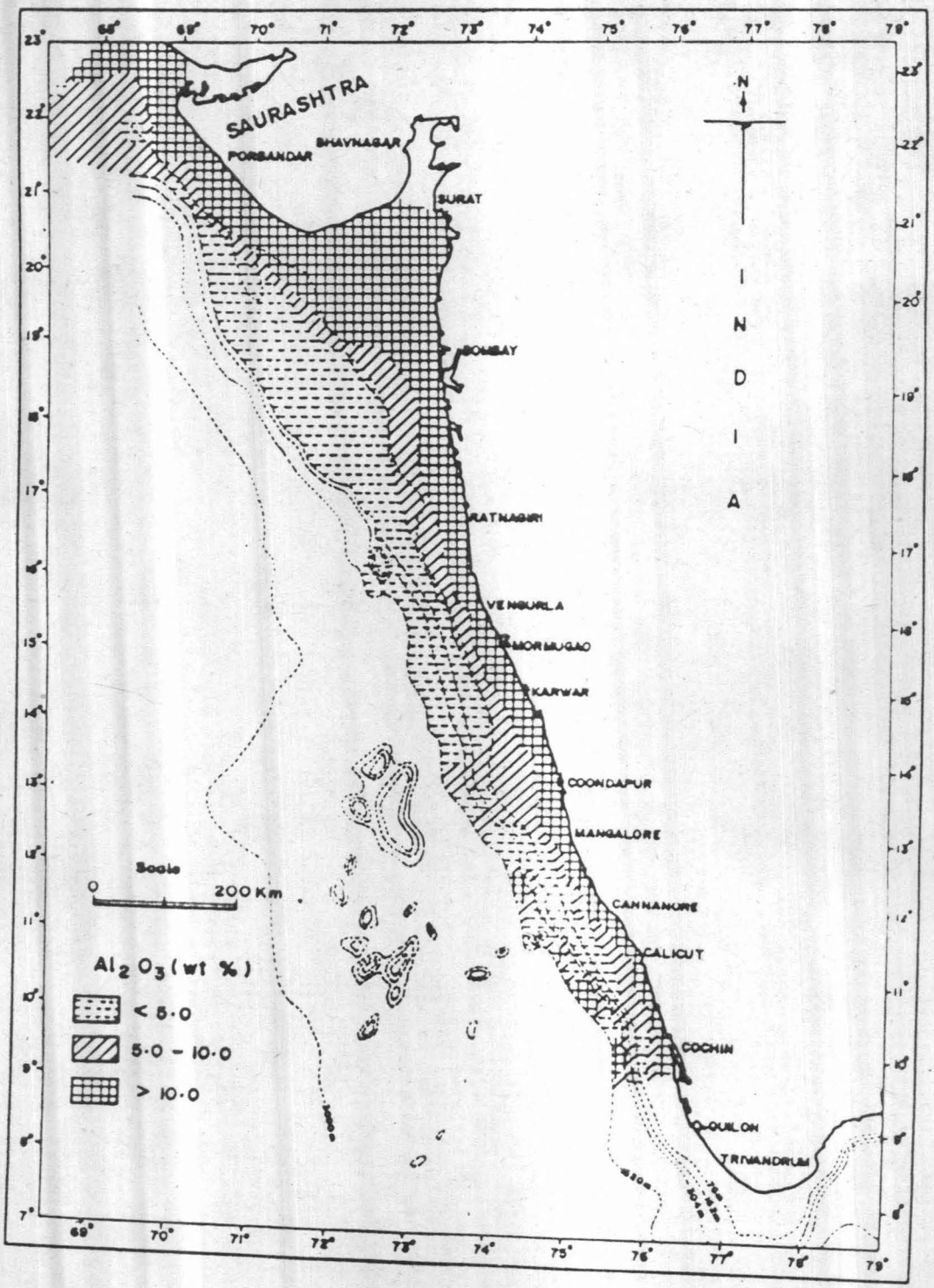

Fig. 2(b). Distribution of Al_2O_3

Fig.II(c): Distribution of total Iron

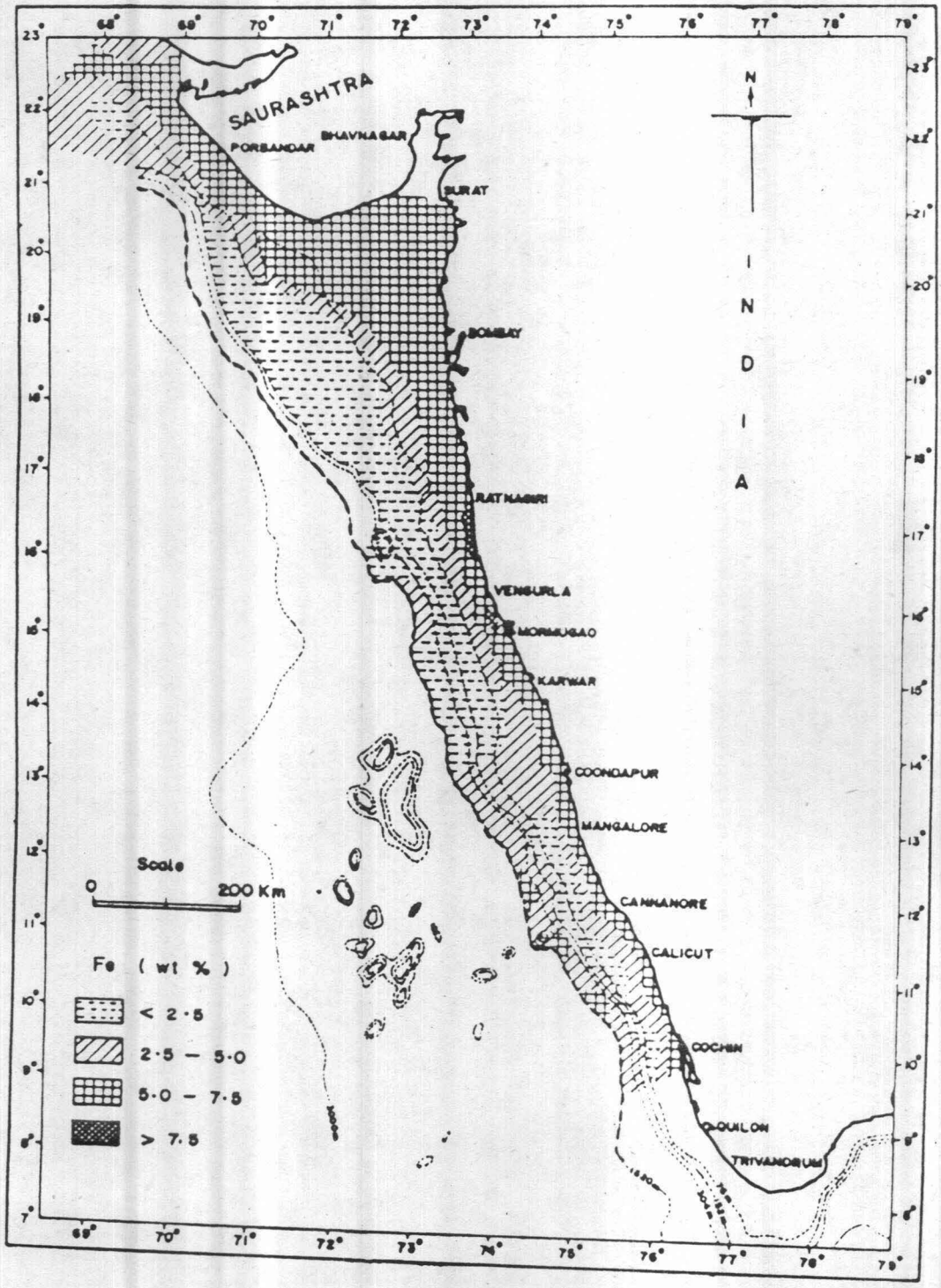

Fig. 2(c). Distribution of total Iron

Fig.II.2(d): Distribution of TiO_2

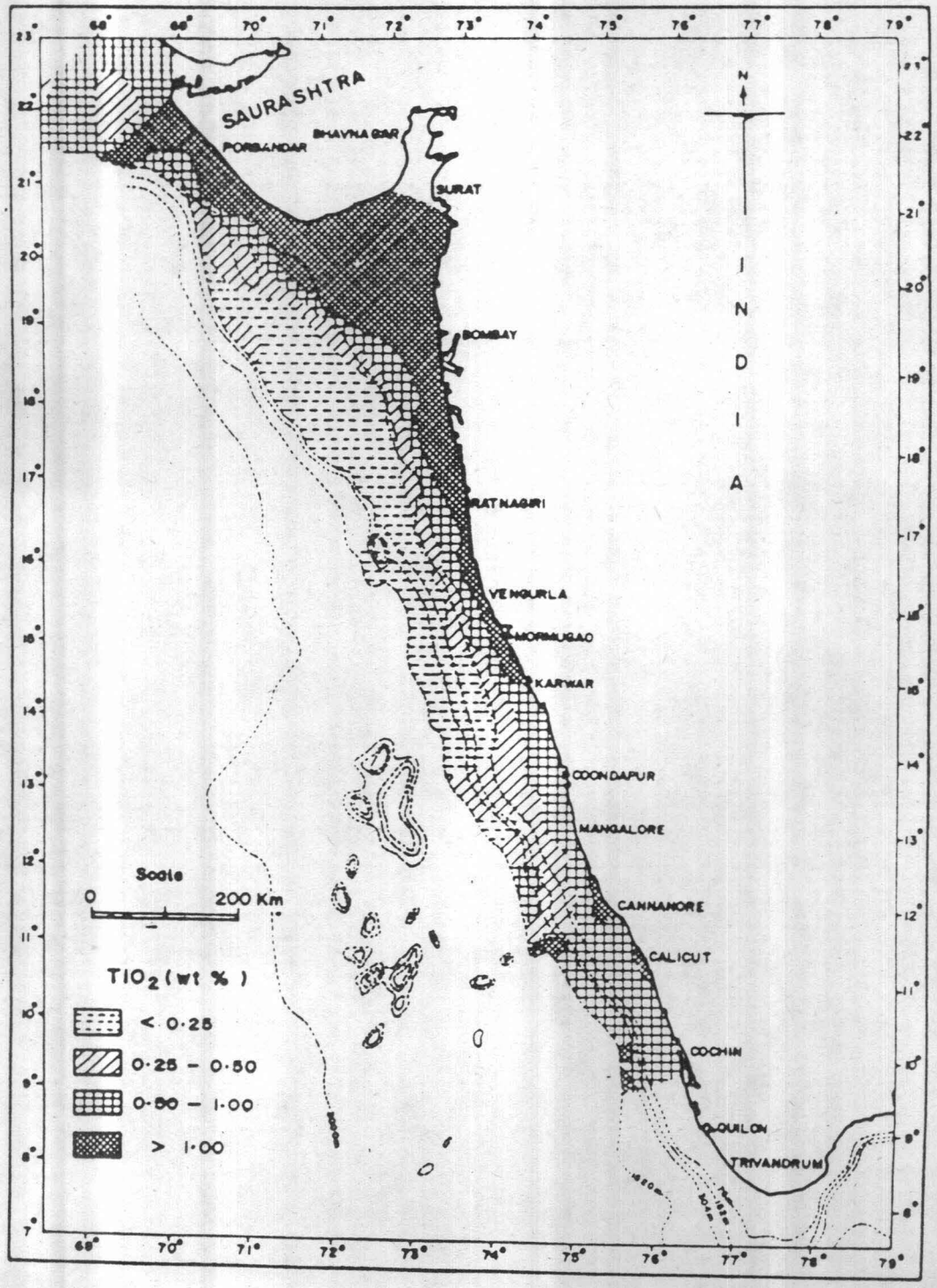

Fig. 2(d). Distribution of TiO_2

Fig.II.2(e): Distribution of Mn

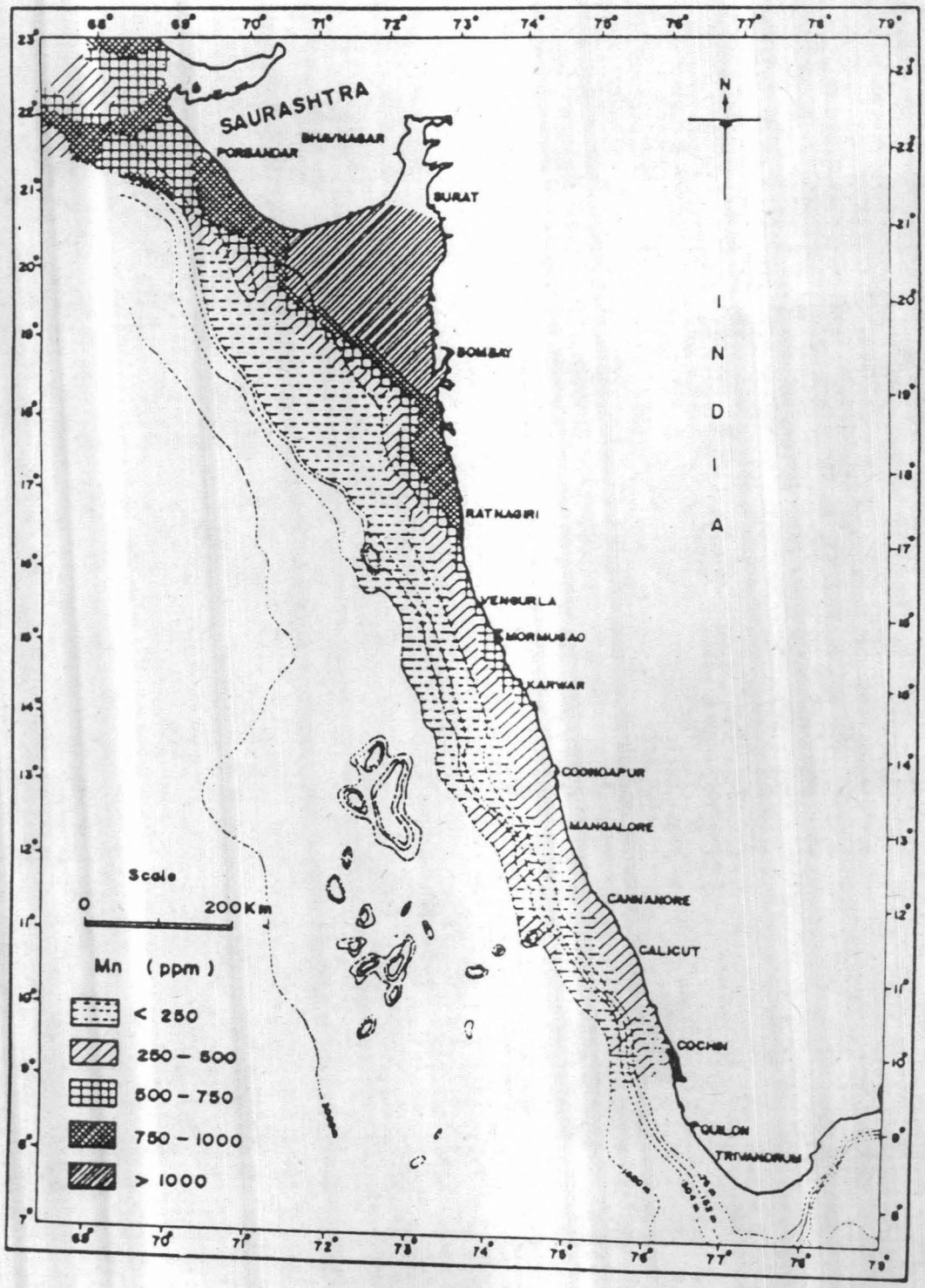

Fig. 2(e). Distribution of Mn

Fig.II.2(f): Distribution of Copper

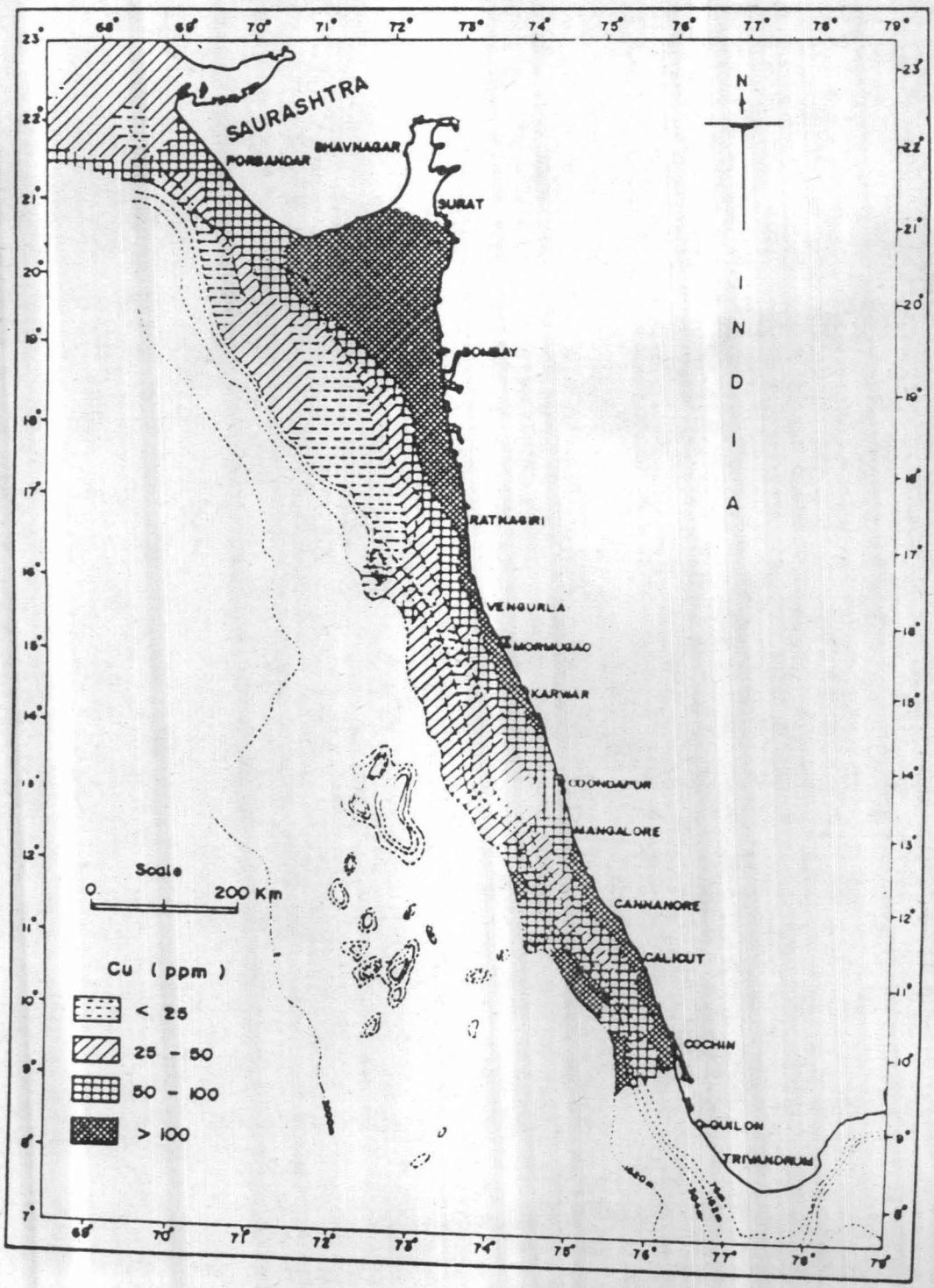

Fig. 2(f). Distribution of Copper

Fig.II.2(g): Distribution of Nickel

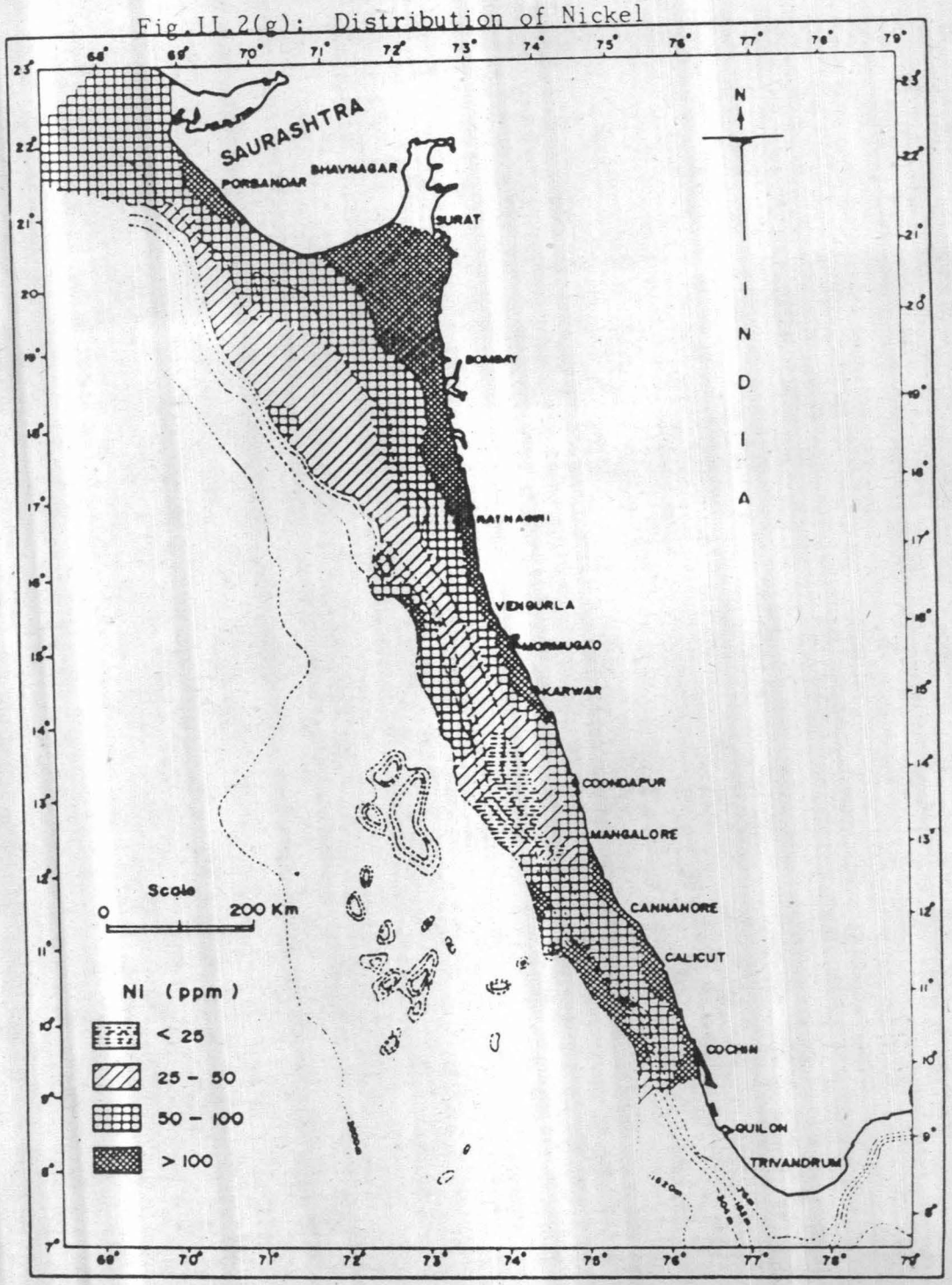

Fig. 2(g). Distribution of Nickel

Fig.II.2(h): Distribution of $CaCo_3$

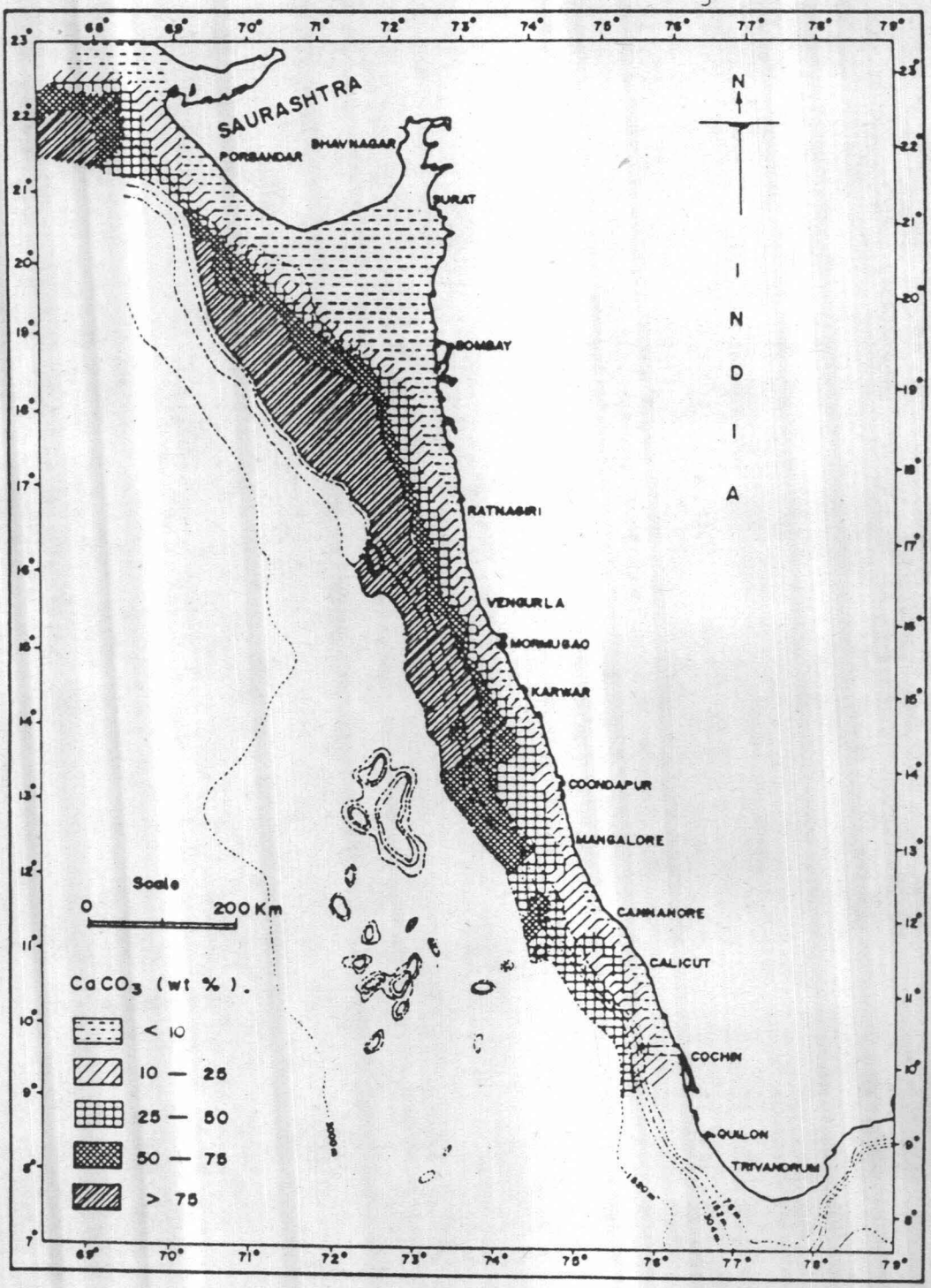

Fig. 2(h). Distribution of $CaCO_3$

Fig.II.2(i): Distribution of Organic Carbon

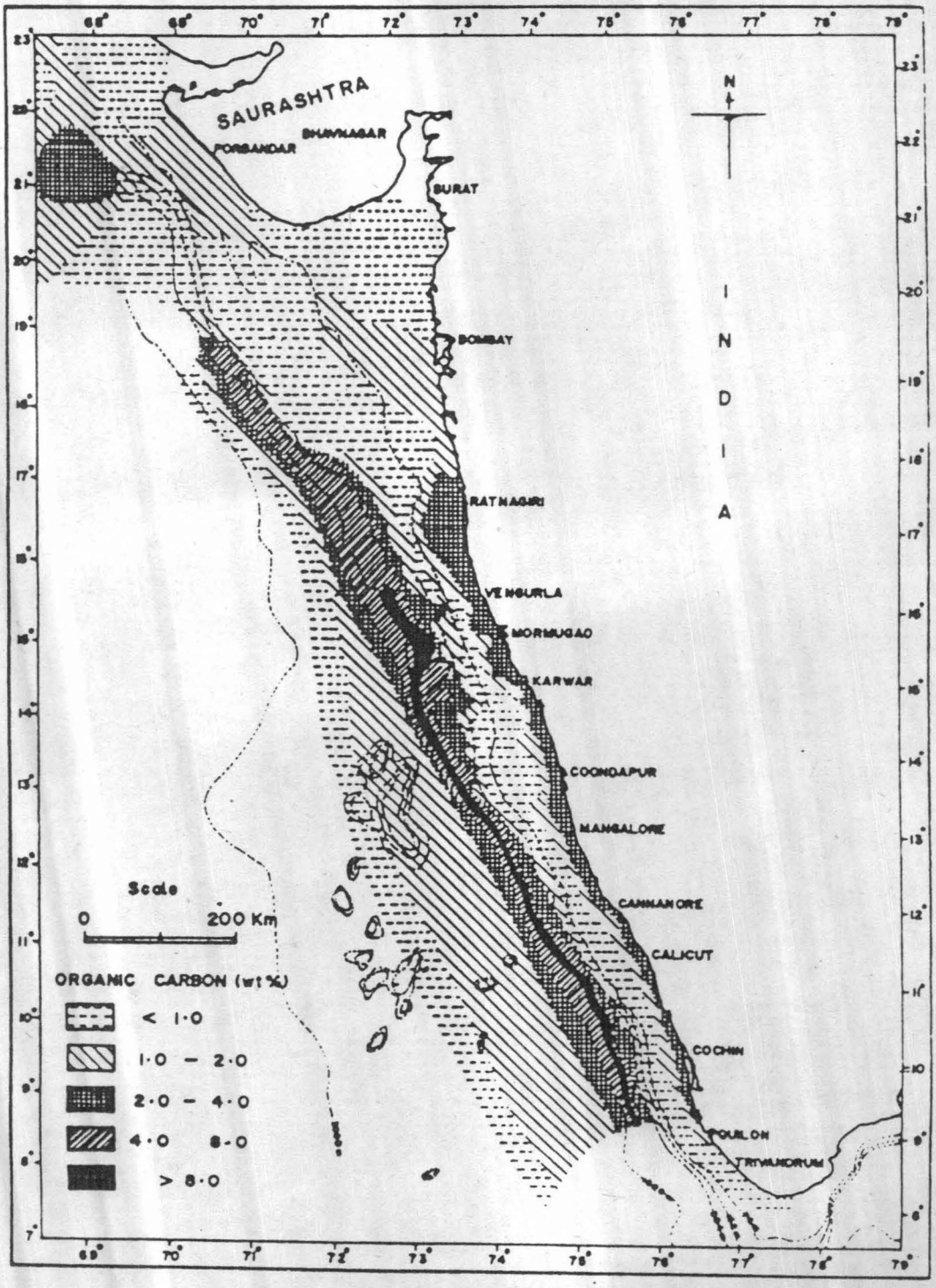

Fig. 2(i). Distribution of Organic Carbon

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

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Source: 1. Sinha, P.C. (1985), "Perspectives on Mineral Resource Development of India's EEZ", Unpublished M.Phil. Dissertation, J.N. University, New Delhi, pp. 19-21.

2. Silas E.G. et al. (1986), "Exploitation of Marine Fish Resources and its Contribution to Indian Economy:, CMFRI Spl. Publication No.29, Cochin, India.

3. Qasim, S.Z. and R. Sengupta (1988), Some Problems of Coastal Pollution in India", Marine Pollution Bulltin, vol.19, No.3, pp.100-106.

4. Khanna, S.S. and M.C. Deviah (1989), "Strategy to Enhance Fish, in Particular, Prawn Production in India", Yojna, April 1-15, vol. 33, No.6, pp.19-22.

More over, the increase in offshore activities for oil and gas extraction, fisheries, mining of sea-bed minerals, extraction of renewable energy from the sea, shipping and marine transportation etc. poses special problems in the coastal zone since it would be necessary to provide special onshore facilities in harmony, with the coastal ecology and environment in order to cope with the new demands on the coastal zone.

Fig.II.3(a)

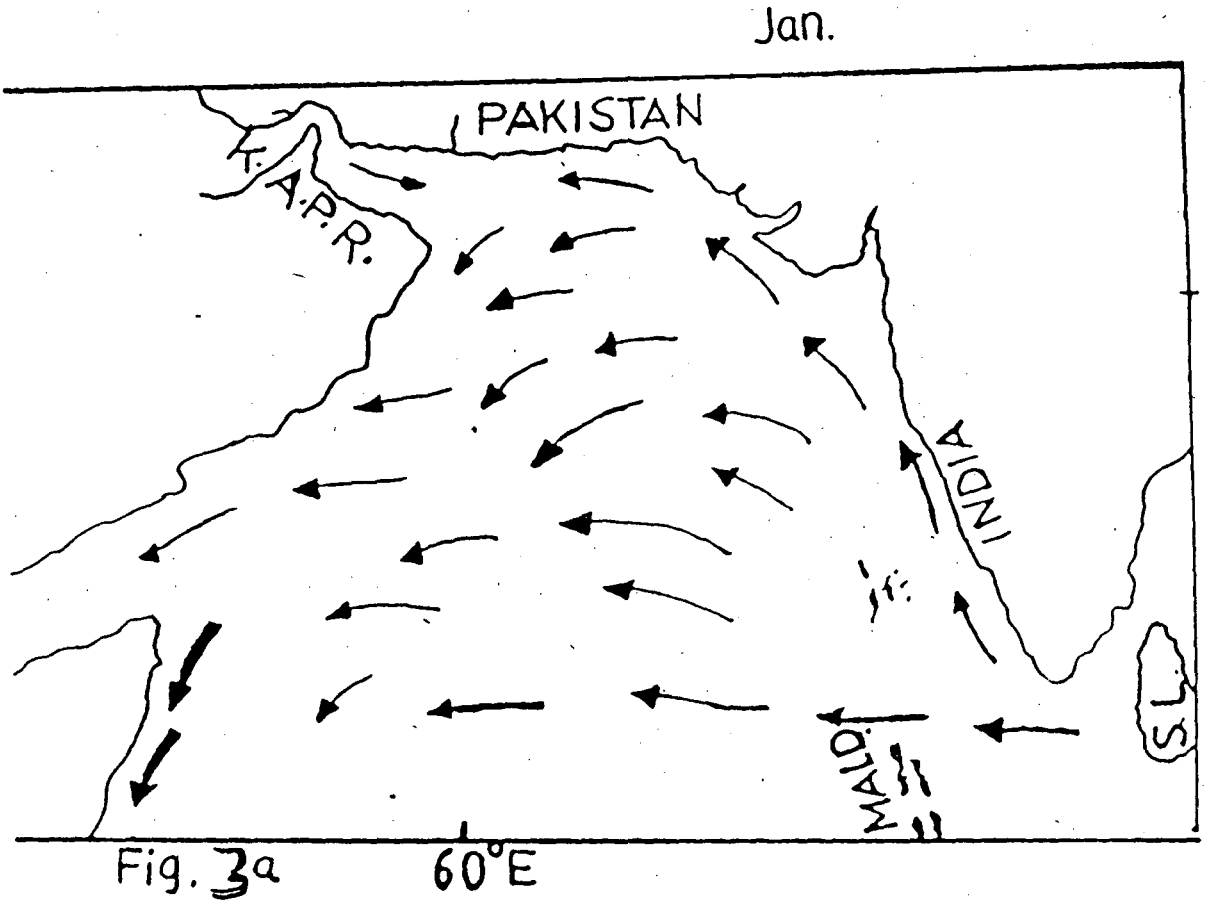

Figure 3a: Current patterns in the Arabian Sea in the month of January (counterclockwise; representative of the NE Monsoon pattern of currents).

Fig.II.3(b)

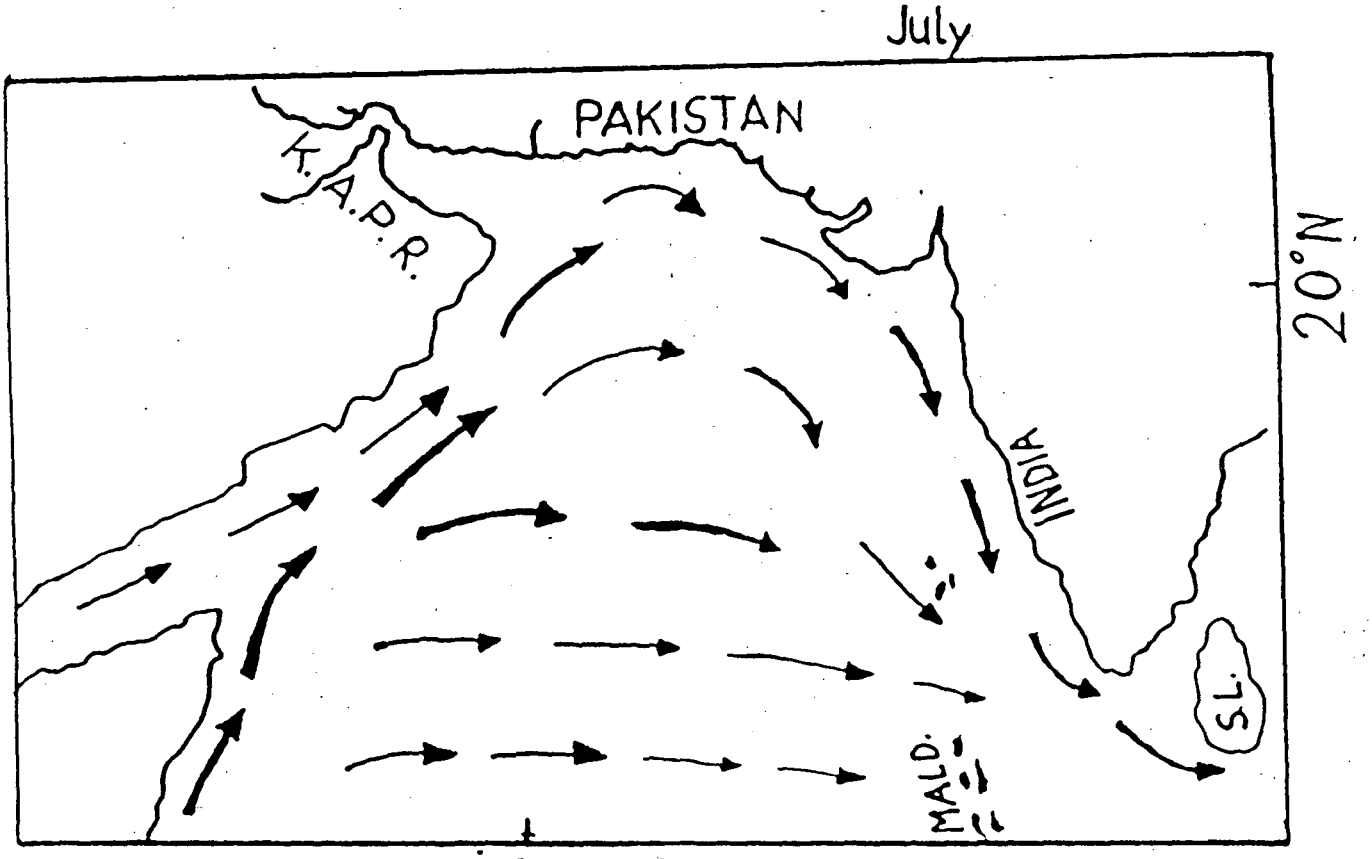

Figure 3b: Current patterns in the Arabian Sea in the month of July (clockwise; representative of the SW Monsoon pattern of currents). K.A.P.R. denotes the Kuwait Action Plan Region; the Somali Current is represented by dark strong arrows on the East coast of Africa and near the Gulf of Aden.

Table 3 : Situation of Waste Water Generation, Collection and Disposal in Coastal Cities and Towns

Sl.	State/U.T	No of Coastal cities*	No of Coastal Towns*	Total population (lakhs)	Waste Water Flow			Mode of Disposal
					Generated MLD	Collected %	Treated %	
1.	Andhra Pradesh	3	3	8.6	64	NIL	NIL	-
2.	Goa, Daman & Dui	-	1	0.6	6	50	50	Estuary
3.	Gujarat	2	3	6.6	64	81	49	Estuarine and Field
4.	Karnataka	1	-	2.2	18	93	93	Estuary
5.	Kerala	5	4	17.4	176	30	2	Sea Shore and Estuary
6.	Maharashtra	3	-	89.1	1275	55	48	Sea Shore and Estuary
7.	Orissa	1	1	1.9	11	NIL	NIL	-
8.	Tamil Nadu	3	1	35.2	183	90	26	Sea Shore and Estuary
	Total	18	13	161.6	1797	50**	37**	

Note: Estuary includes the lower reaches of the river and river mouth regions.

* Cities - Population above 1 lakh , Towns - Population between 0.5 and 1 laks.
** Taking into account the industrial waste water also.

Source: Josant, V. and B.N. Desai (1985), "Waste Water Disposal in Coastal Waters", in R.C. Sharma (Ed.). The Oceans: Realities and Prospects, Rajesh Publications, New Delhi.

Thus the coastal zone is subjected to multiple use leading thereby to conflicting demands for the exploitation

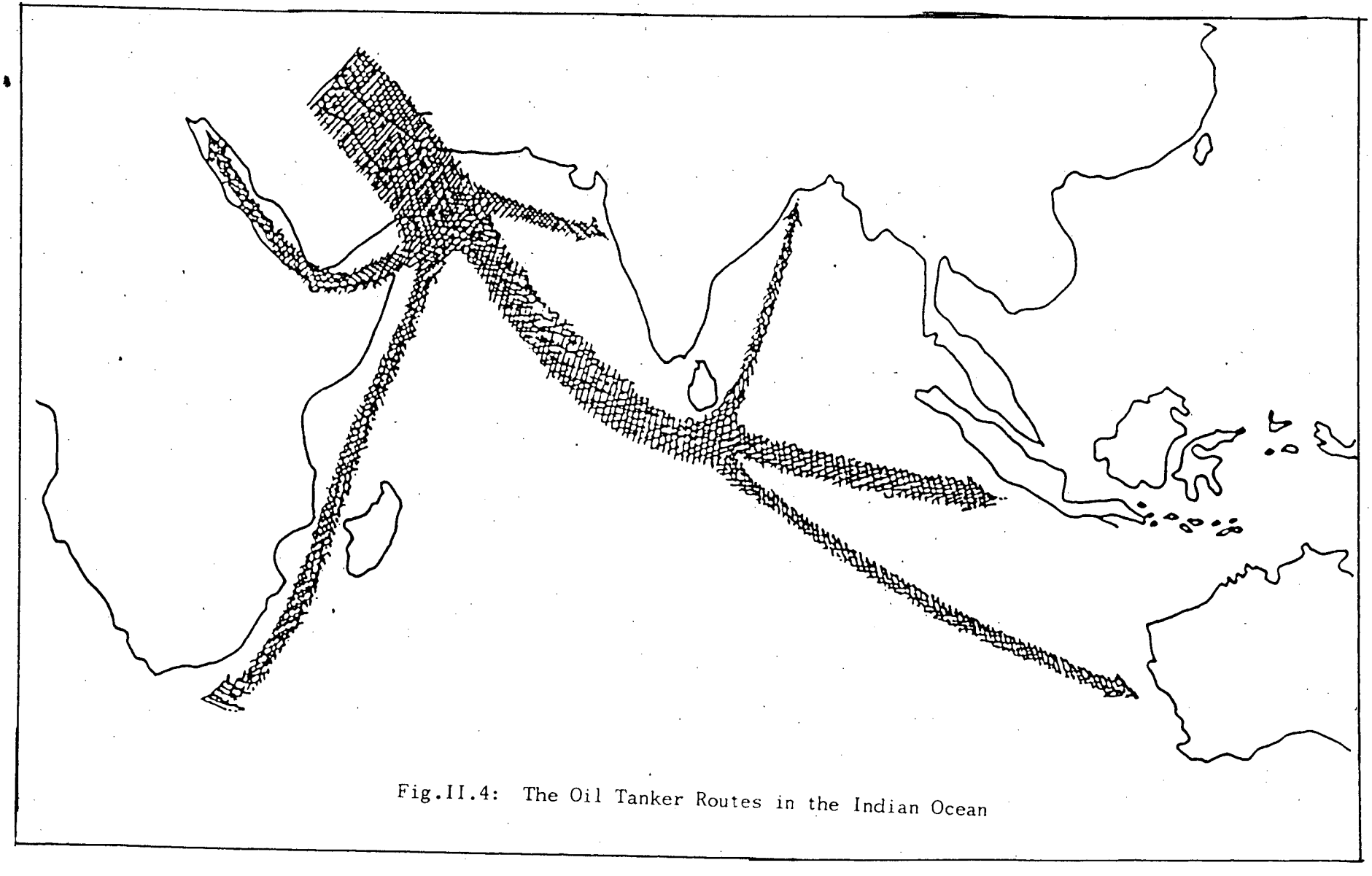

Fig.II.4: The Oil Tanker Routes in the Indian Ocean

of the various coastal resources by different interest groups and user agencies. It has therefore become very ~~valuable~~ vulnerable to the destructive forces, caused by pollution and several other man-made changes. There is consequently a need for a comprehensive national policy and guidelines with requisite enforcing powers for managing the various coastal development activities in India.

Further more, the greenhouse effect and consequent sea level rise and natural hazards, storm surges and cyclones pose severe threat to coastal zone of India. Realizing the importance and problems of coastal zone, the recent discussions of the heads of state/govt. of SAARC countries at Islamabad, had expressed concern about problems and threat associated with sea level rise, coastal erosion flooding and other environmental issues.

Legislation specifically directed towards coastal zone management does not exist in India today [Environmental Problems of Marine and Coastal Area of India: National Report, No.59, UNEP,1985, pp.16-17]. Provision for some measure of development appraisal and control within the coastal zone, however, exist in the general regime applicable to land use planning environmental degradation and pollution control. The legislations which is in force

as of now are the following:

- the water (prevention and control of pollution) Act, 1974.
- the Coast Guard Act; 1978.
- the Air (prevention and control of pollution) Act, 1981.
- the Territorial waters, continental shelf, exclusive economic zone and other maritime zones Act, 1976.
- the Maritime zones of India (Regulation of fishing by foreign vessels) Act, 1981.
- the insecticides Act.
- the industries development and regulation Act.
- Indian ports Act.
- Merchant shipping Act.
- the prohibition and Regulation of small mechanized boats from fishing in the 10 km area from the coastline (by all Maritime States, UTs) Act.

Permissible limits for the discharge and release of pollutants to air, water and soil have been laid down and are being periodically modified and updated by the Indian standards Institution.

India is signatory to several international conventions and protocols to control marine pollution of the high seas and the coastal region. Some of them are:

- 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.

- the ratification of International convention for the prevention of pollution from ships, 1973 and protocol 1978 is under active consideration by the Govt. of India.

These provisions are sectorial in nature and they neither take into account the dynamic physical nature of the coastal zone nor its intricate and complex environmental and socio-economic characteristics. Thus there does not exist any comprehensive legislation for development and control of activities in the coastal zone in India.

All the maritime states of India have developed their various planning mechanisms for the proper management of their coastal resources. These are based on the aspects of income, resources and planning potential. The different approaches and mechanisms which exist and being practiced by maritime states and even federal government for coastal planning and management are: the designation of protected areas; Marine parks or reserves; environmental impact

assessment projects along the coastline; shoreline restrictions and zoning varying between 200 to 500 meters landward from the high mean tide level; special area plan consisting economic development plan; and compiling of a coastal atlas etc. Thus it is observed that there does not exist any coastal planning and management authorities either at federal, state or local levels responsible for coastal development and control specifically in India.

However, institutions such as Ministry of Environment and Forests, Department of Science & Technology, Department of Fisheries, Mining, Industrial Development and Tourism etc. both at federal and state/regional level try to redress the problems of coastal zone sectorally. Many educational centres and research institutes, also contribute a bit in this direction. National Institute of Oceanography (NIO), Goa, Central Marine Fisheries Research Institute (CMFRI), Bombay and various Port Trust Authorities and Coast Guard work in this direction in their respective field. There is a need for national policy and institutions to address the coastal problems and thereby integrate it into national economic and spatial planning for better development of economy and people in the coastal zone.

In the recent past, scientists had been aware of this problem and a first workshop on "Multiuse of coastal zone"

was held in Bombay during 1974 [Dwivedi, S.N. (1989), pp. 26-31]. This was then followed up by a workshop on ocean management in 1978. UNESCO has also put up programmes for management of mangroves and other problems of the coastal zone of India. Very recently, with a renewed view to understand the problems of the coastal zone and to develop a scientific approach for their management Indian Association for Advancement of Science with active collaboration of the Department of Ocean Development, Govt. of India and UNESCO had organized a workshop on "Coastal Zone Management and Sea Level Rise" in Jan 1989 at New Delhi. The workshop has put forward action plan, resolutions and a number of recommendation for effective planning and management of coastal zone in an integrated framework. It is hoped that it will help planners, scientists and policy makers to initiate the thinking and work for the realisation of the objectives and recommendations of the workshop in the framework of either US Federal Coastal zone Management programme or Sri Lankan Department of Coast Conservation would show the way in concretizing the initiatives.

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CHAPTER III

THE GOAN COASTAL ZONE : DESIGN OF STUDY

The Study Area*

From a geographic perspective Goa is a Coast-oriented state of India since it has about 105 Km (north-south length) Coastline and lies between Western ghats and the Arabian sea (Maximum east-west stretch 60 km). It 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 and tourism. Natural harbour, mineral ores and good climate attracted the Portuguese colonialists before and now explains the increasing urbanization, industrialization, tourist traffic and thus the high density of population today. The onshore and Offshore activities have been very intense recently. It occupies an area of 3700 sq. km and lies midway along the west coast of India.

The State of Goa has registered remarkable progress in ~~in~~ various fields since its liberation from the

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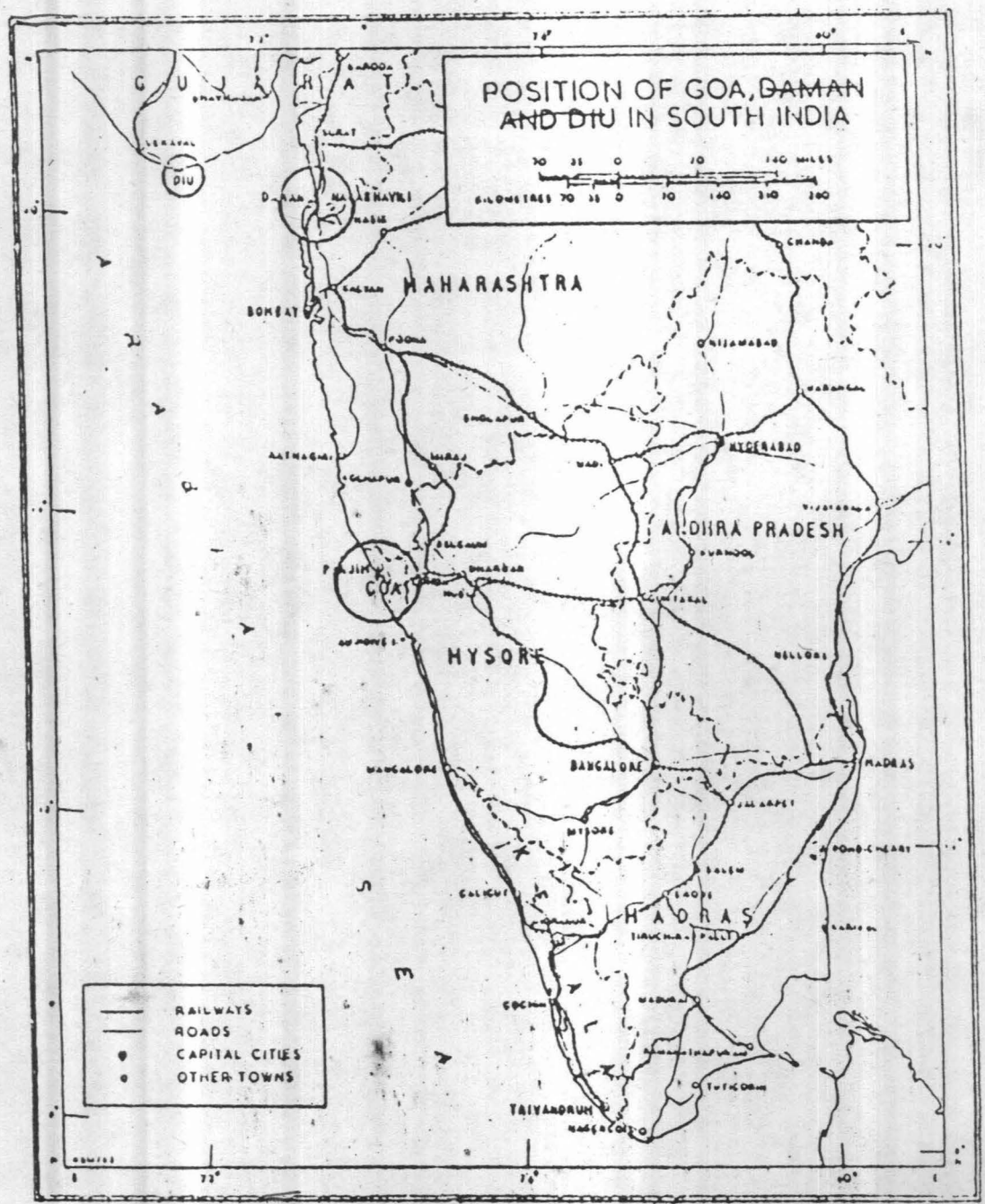
*Coastal zone of Goa comprises seven talukas out of the total of eleven in the Goa State. The seven are - Pernem, Bardez, Tiswadi, Marmugao, Salcete, Quepem and Cannacona.

Fig.III.1



source I.e. survey

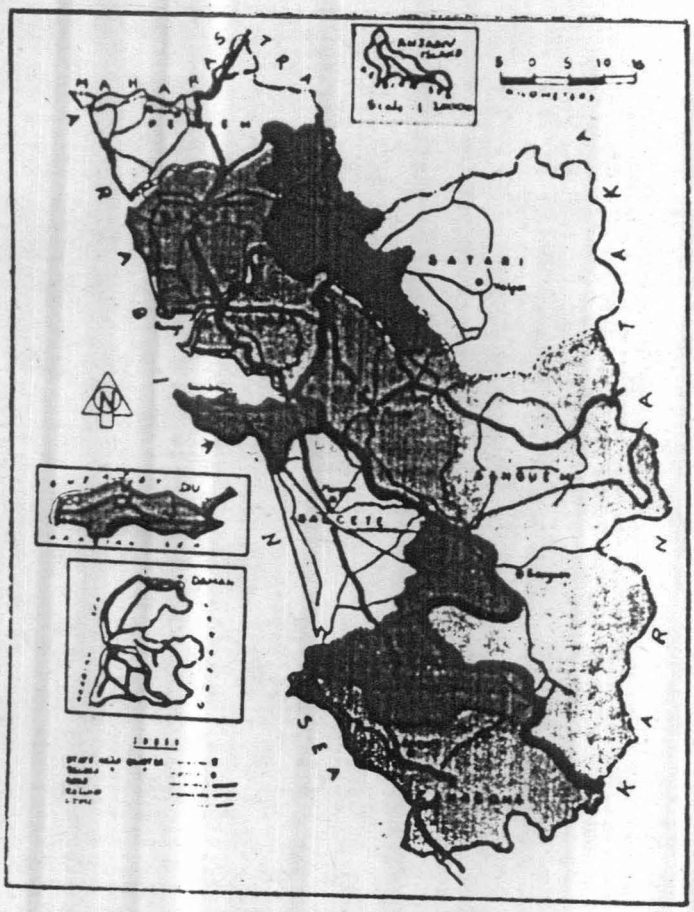


Fig.III.2: Coastal Zone of Goa

Portuguese in 1961. While the development in different sectors of the economy has contributed to the economic upliftment of the people of this historically and geo-economically important Coastal zone of India, it has quite often adversely affected the environment leading to ecological imbalance. Goa's ecological charms are being systematically deflowered. The magnificent forest canopy which once covered half of its area, in the past 25 years shrunk to a mere quarter of its original size mainly due to its flourishing mining industry which has exported 118.5 lakh tonnes of mineral ore in 1988. It is true that Goa accounts for 32% of the country's iron ore production and 55% of its exports. It has been observed that this has to a greater extent resulted in destroying agriculture lands below and polluting all the rivers, water springs, coastal waters and even the groundwater. Mining projects pose danger to the surroundings by way of erosion; siltation; water pollution and a host of other eco-environmental disturbances. Mangrove forests have been denuded to the effect that the level of fish feeding and marine ecology have been disturbed.

The urbanization rate is escalating very rapidly from 26% to 32% (1971-81) within a short span of one decade followed by fast industrial development and tourists

arrival. The number of Industrial units in Goa which was a meagre 66 in 1964 has increased to 4170 by 1988 consisting of large scale industries of which many are water polluting and subsidiaries of multinationals producing dangerous chemicals, pesticides and fertilizers and also air pollutants.

Further more, other developmental activities such as tourism development, marine fisheries development: port development and other infrastructure development activities in association with natural hazards such as coastal erosion and flooding have compounded and created the problems in the Goan Coastal Zone. The extent of Goan Coastal zone problems can be emphasized from a letter written by the late Prime Minister of India to the Chief Minister of Goa in 1981 which reads as given below:*

> "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 area 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 lovely Coastline and its beaches remain unsullied".
>
> (- Indira Gandhi 1981)

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*Report of the Task Force on Eco-Development Plan for Goa, Govt. of India, Planning Commission, New Delhi, 1982, pp.136.

Man and nature are equally important because they are truly inseparable. The process of economic development which separates man from nature is not beneficial in the long run, as it leads to lack of awareness and a feeling for nature. Protection of environment and preservation of ecological balance must, therefore assume paramount importance in programmes for economic development of this territory which God has endowed with such breathtaking natural beauty and charm.

Rationale

It is important to know the rationale behind the selection of Goan Coastal Zone as a case for study. The reasons are as follows:

a. The economic progress of Goa has been quite remarkable. In the process of development there has been intensive use of natural resources of the territory since liberation from Portuguese rule in 1961. Very often, the process of development has adversely affected the environment leading to ecological imbalance. It is in the light of this experience gained over the past 25 years of post-liberation period that the importance of conserving and enhancing the environmental assets and developmental activities that the need is felt for Coastal planning and management.

b. Goa is one of the most representative models of coastal zone problems of India. In regional scale of analysis appropriate to the Indian situation, the study area is comparable to a micro region. Further more, the district level planning is going to be the base on which the 8th five year plan of India is going to be formulated. Decentralization of planning process has been emphasized by the Govt. of India seeking "below to top" model in place of existing "top to down" model of planning in India.

c. The Coastal Zone of each maritime states of India has distinct characteristic features and specific local problems and need specific studies. For this collection of informations - data maps, illustrations and literature for its interpretation and full understanding is must for planning and management exercises. Time and resource constraints enhance the difficulty in collection of information for a big region. Goa, being small in area but very vibrant socio-economically and environmentally, provides clear focus for research and becomes easier in terms of collection of information for the purpose.

d. Goa as planning region is viable one and it is capable to achieve the plan objectives. It has also the

government administrative machinery to implement the plan recommendations.

e. Oceans are the frontier of resources. Goa, having a very important Marmugao harbour, has a very rich hinter-land for the coastal and maritime activities, keeping in mind India's new status as "Pioneer Invester" in Indian ocean and increasing development in marine science and technology.

For the above mentioned reasons, Goa has been selected as a representative model for the Coastal Zone planning and management programme keeping in mind that "small is beautiful".

Objectives:

The study has set the following two main objectives

a. To asses the Present and potential Coastal resources, hazards and pollution of the region.

b. To suggest suitable strategies for economically sound and environmentally harmonious management of the problems and resources of the Coastal Zone in an integrated frame work.

Delineating the Coastal Zone

The following are the prime considerations in delineation of the coastal zone for the study purpose:

a. The existing institutional context of taluka or the district.

b. To include the talukas that share the boundary with the Arabian sea directly.

c. The town and country planning department of Goa Govt. has prepared a "Regional Development plan for Goa - 2001 AD". In this document the state is divided into three sub-planning region based on aspect of physiography, income, resources and planning potentials. These are:

   i. Coastal Talukas.
   ii. Midland Talukas.
   iii. Ghat (hilly) Talukas.

d. The recommendation of the currently held national seminar on "Coastal Zone Management and Sea Level rise". January 1989 at New Delhi in this regard has also been considered which reads as follows:

"The coastal Zone includes the seaward coastal area of about 12 nautical miles (20 Km) and landward Coastal

area of 20 km from the shoreline. It is a very sensitive area which needs special care to protect it from over exploitation and destruction due to coastal hazards and pollution. The extent of coastal zone may be defined as the landward and seaward area of 20 km from the shorelines for reference and effective management".

Thus the Goan coastal zone has been delineated for the planning and management purpose keeping in mind these points.

Methodology

Following is the methodology that has been followed in the study:

a. General literature survey to understand the conceptual frame work of coastal planning and management and its practices in developed and developing countries of the world.

b. Based on various secondary sources of informations such as monographs, reports and statistical data available upto date, the general geoecological character of the coastline of Goa has been studied.

c. The pattern and trends of coastal resources, hazards and pollution of the Goan Coastal Zone have been studied and are supported by various available scientific and statistical informations in the form of tables, graphs, maps etc.

d. Some general statistical techniques such as percentage method, growth rate, projection formula etc. have been used to support the analysis. Some cartographic techniques such choroplething technique, diagrams etc. have been used to give the analysis a spatial focus and easy comprehension wherever needed.

Data Base

The data and information for this study have been derived from secondary sources only. Inadequate and lack of up-to-date data and information at various levels posed serious constraints on the present study. The major sources of data are listed below:

a. Census data and plan reports

b. Data collected by town and country planning department, for planning purposes.

c. Various publications of the Directorate of planning, statistics and evaluations, Govt. of Goa.

d. Various other govt. publications and report.

e. Data regarding coastal hazards and pollution have been collected from National Institute of Oceanography, Goa.

f. Various journals, reports and books have also been consulted for conceptual clarity, data, maps, illustrations etc.

Limitations

Considering the importance of the subject at least in the case of National interests and experience, there seems a dearth of adequate and up-to-date information base, however, if there could be more time, one could go to the various nodal points and collect much more primary and secondary informations, although the question of reliability and comparability would have complicated the whole effort.

Furthermore, the study is theoretical and descriptive in nature. The author wishes to undertake this kind of study at the Ph.D. level and would like to prepare an integrated action plan for Coastal Zone development, using various statistical, econometric and scientific techniques and methods. This preliminary theoretical exercise has further increased the interest in this field of Marine Geography.

CHAPTER IV

THE COASTAL ZONE OF GOA : RESOURCES, HAZARDS AND POLLUTION

Physical Setting

The Goan coastal zone forms a contiguous part of the Arabian sea. It comprises of seven talukas out of the total of eleven in the territory. The delineation criteria applied are: they share boundary with the sea directly, and they are within the 20-30 Km landward limit from the high tide line. In fact, within this limit that the coastal space experiences intense strain and stresses of all kinds. It covers an area of 1760.3 sq. km. and has a population of 729030 as per 1981 census. It constitutes only 47.55% of the State's area but accommodates 72.34% of the total population. It is densely populated having density of 415 persons per sq. km. as against the average of 272 persons in the state. The coastal zone is urban in character with 88.7% of Goa's urban population lives in this region and 39.3% of the population of the coastal zone reside in urban areas.

The Goan coastal zone is characterized by plain to gently sloping lands occasionally dotted with residual hills being contiguous to the foot slopes of Sahydris hill range.

Fig.IV.1

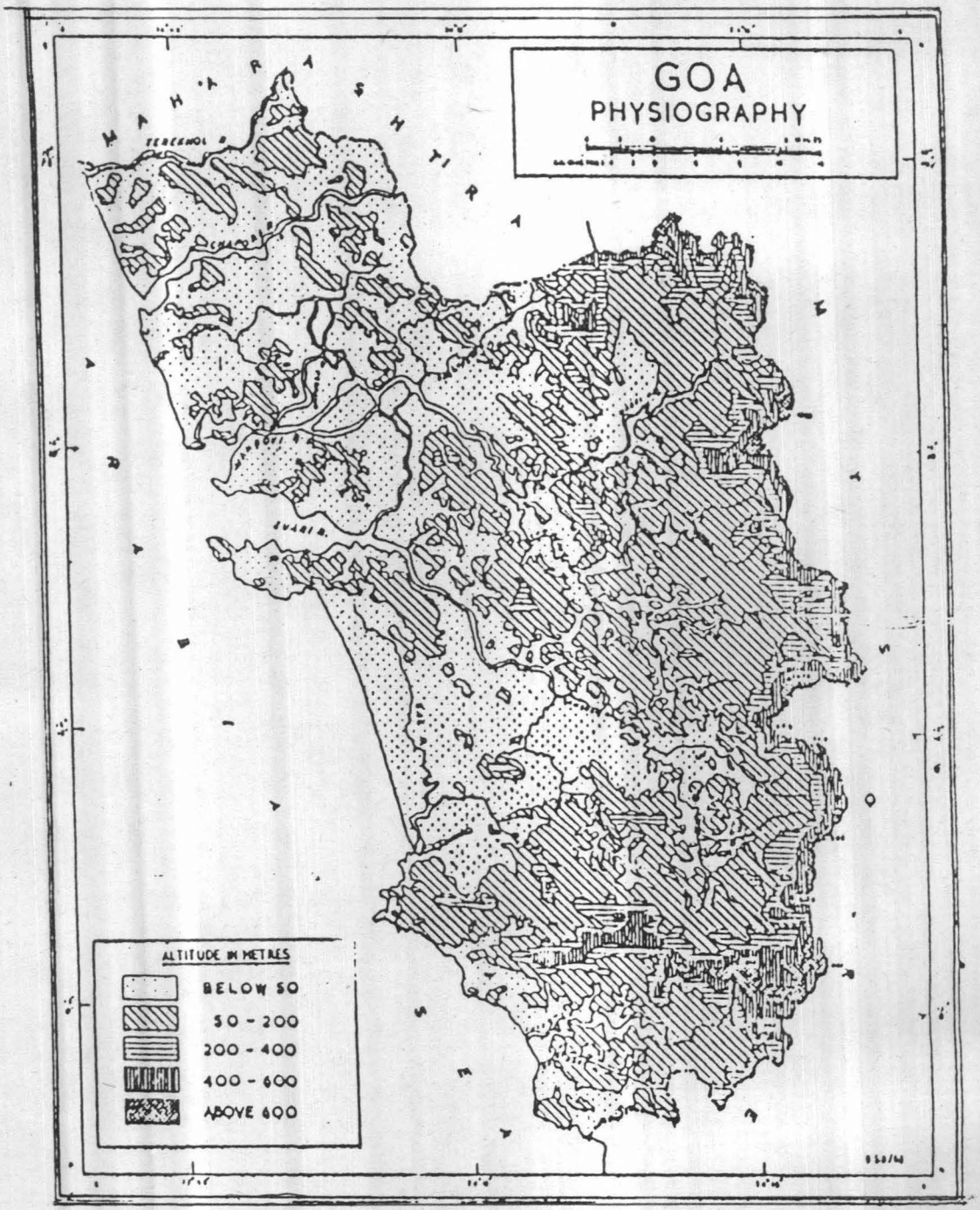
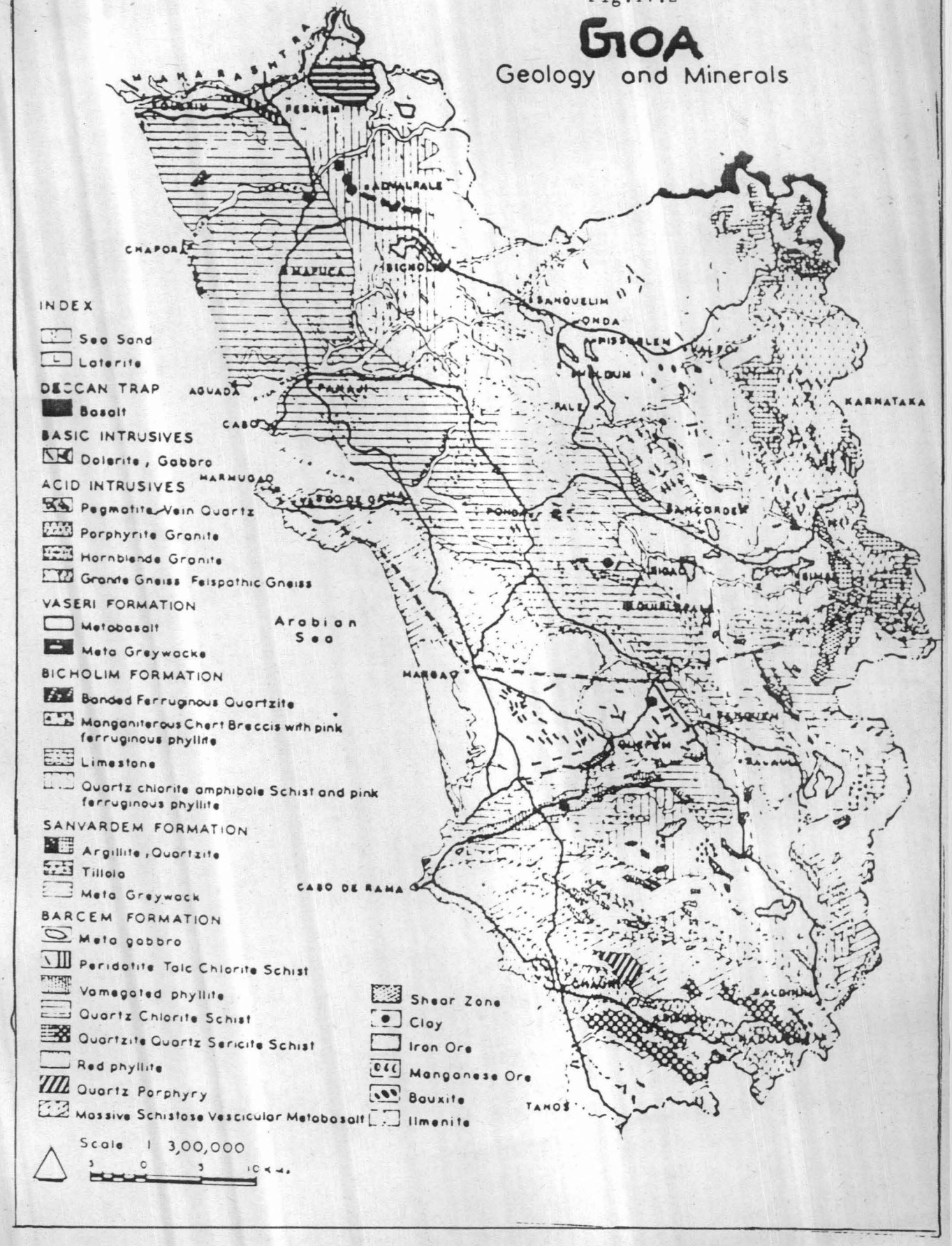

GOA
PHYSIOGRAPHY
ALTITUDE IN METRES
BELOW 50
50 - 200
200 - 400
400 - 600
ABOVE 600

Fig. IV.2


GOA
Geology and Minerals
MAHARASHTRA
KARNATAKA
Arabian Sea
CHAPORA
BICHOLIM
SANQUELIM
ONDA
AGUADA
PANAJI
CABO
MARMUGAO
VASCO DE GAMA
PONDA
MARGAO
QUEPEM
CANACONA
CABO DE RAMA
SALCETE
TANOS
INDEX
Sea Sand
Laterite
DECCAN TRAP
Basalt
BASIC INTRUSIVES
Dolerite, Gabbro
ACID INTRUSIVES
Pegmatite, Vein Quartz
Porphyrite Granite
Hornblende Granite
Granite Gneiss Felspathic Gneiss
VASERI FORMATION
Metabasalt
Meta Greywacke
BICHOLIM FORMATION
Banded Ferruginous Quartzite
Manganiferous Chert Breccia with pink ferruginous phyllite
Limestone
Quartz chlorite amphibole Schist and pink ferruginous phyllite
SANVARDEM FORMATION
Argillite, Quartzite
Tillite
Meta Greywack
BARCEM FORMATION
Meta gabbro
Peridotite Talc Chlorite Schist
Variegated phyllite
Quartz Chlorite Schist
Quartzite Quartz Sericite Schist
Red phyllite
Quartz Porphyry
Massive Schistose Vesicular Metabasalt
Shear Zone
Clay
Iron Ore
Manganese Ore
Bauxite
Ilmenite
Scale 1 3,00,000

It runs parallel to the coast line from from north to south direction covering a length of 105 km. The elevation ranges from below 50 meter to 200 meters. Height increases from west to East. But some high strips are also found on the coastline itself. The coastal zone of Goa is highly indented with sea cliffs, notches and promontories alternating with rivers and estuaries. The presence of laterite bed at a depth of 26 to 35 m below the present sea level along the estuaries of Goa indicates the drowned valleys [Jagtap, T.G. (1986), Unpublished Thesis, pp.13-35].

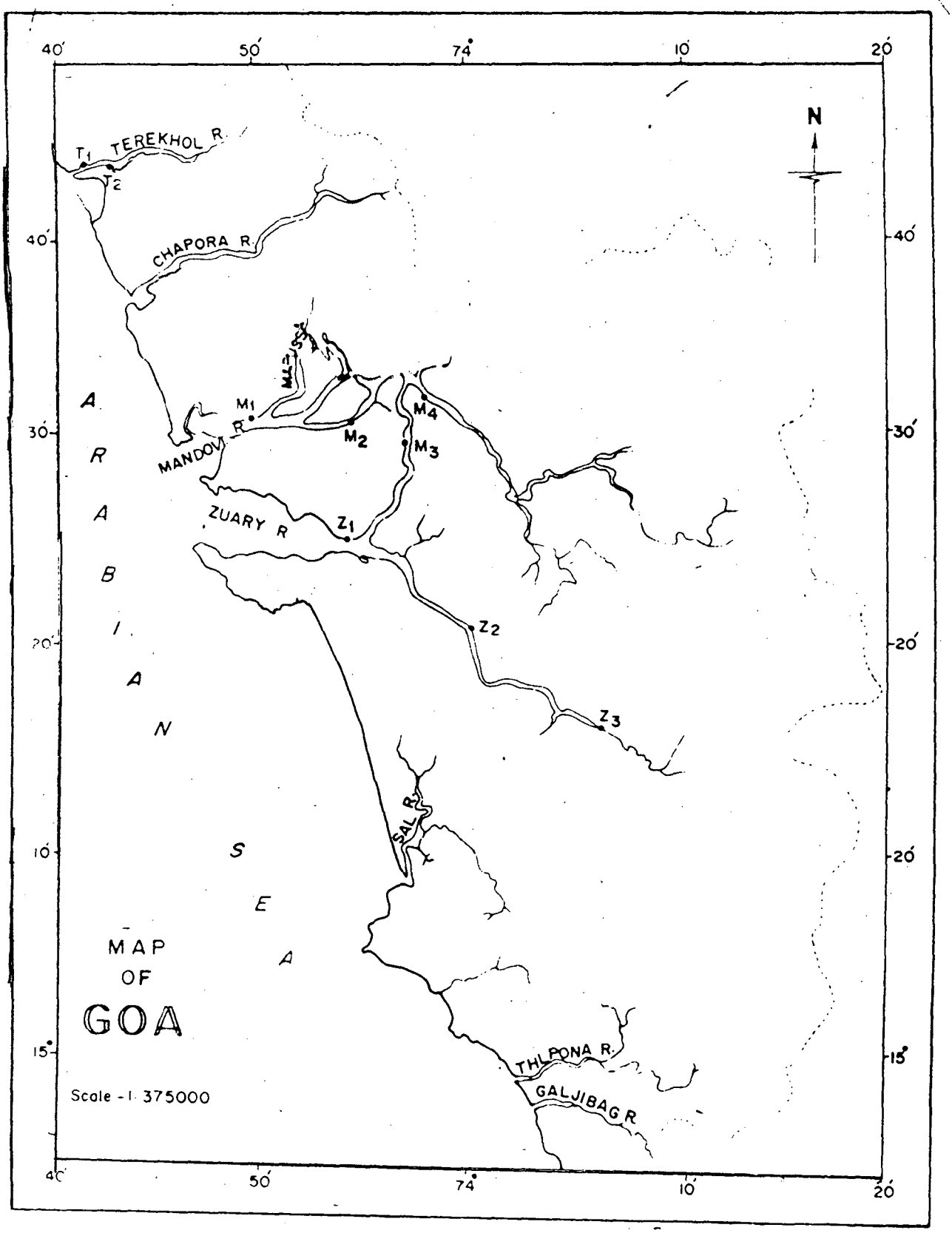
Geomorphological evidences show that the coastal track of Goa has undergone epireogenic movements, headward erosion, recession of scarps, superposition of the streams, cauterization, submergence, emergence, progradation and retrogression after the outpouring of deccan traps [Ibid]. The pre-cambrian Dharwar and Cuddapah rocks occupy a quartzites phyllites, chlorifeschists, gneisses metabasalt, metagraywacks and banded harmatite quartrites. Most of the ferrogeneous quartzites are the result of replacement into laterite and give rise to iron and manganese ores. Strata of the Cuddapah age occur along the northern coast of Goa from the Terekhol river to the Mormugao headland. The regional trend of the pre-cambrian rock is NNW-SSE in the north and veers to E-W in the south. The pre-cambrian rocks

and traps are covered by about 30 to 40 m thick laterites on the coast, which thins to the interior [Ahmad, E. (1972), pp.162-215].

The coastal area is drained by various rivers and stream. Seven major rivers exist along the Goa coast of which the Mandovi and Zuari along with Camburzua canal form the largest esturine complex. Freshwater runoff during the rainy season causes heavy erosion and sedimentation takes place at the mouth regions. Mandovi and Zuari river basins cover about 69% of the total geographical area of Goa and are called "life line" of the territory [National Institute of Oceanography (1981), No.79, pp.4-12]. They are mainly used as water ways to transport enormous quantities of iron and ferro-manganese ore in barges throughout the year. They are also used for fishing activities practically throughout the year and particularly during the monsoon months when the marine fishing gets suspended.

River Zuari originates from the Dighi Ghat of the Karnataka part of the Sahyadri hills and often flowing through a stretch of about 67 km meets the Arabian sea near the Mormugao-Dona paula point. Its width at the mouth of the estuary is 5.5 km while, upstream, it narrows down to less than 0.5 km. It is fed by monsoon and also receives discharges from a catchment of about 550 Km^2. The quantity

Fig. IV.3: River Basins of Goa



of freshwater discharge during pre and post monsoon period is negligible (about 0.03Km^3/gr) and therefore their flow during these seasons is regulated by tides of semi-diurnal type having a maximum range of 2.3 meter. Maximum distance of penetration of water of 0.5% salinity inland at about mid-depth, is about 65 Km away from the mouth during the month of May. It gets reduced to a minimum of 20 Km during June and July following the onset of the monsoon.

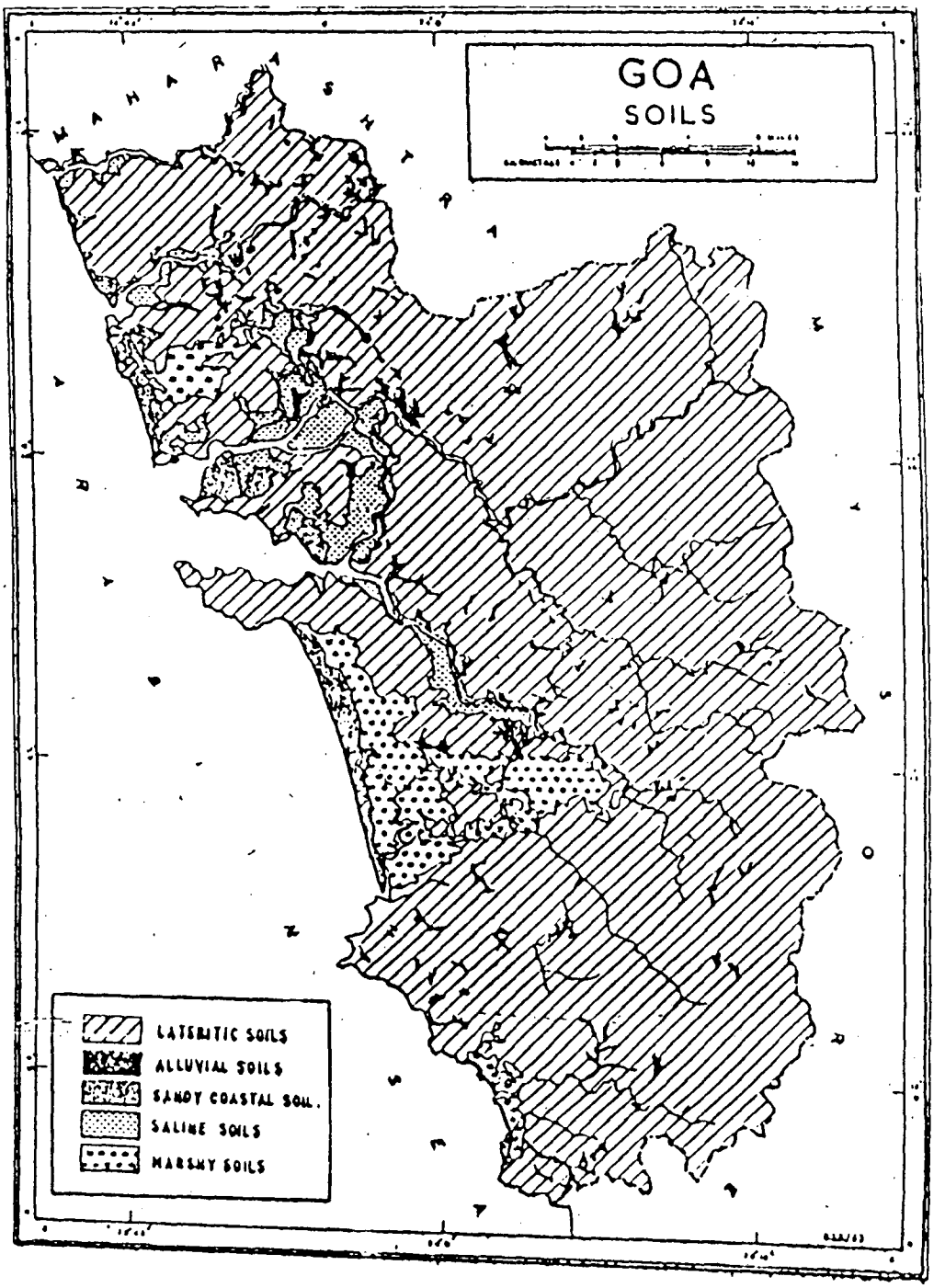
River Mandovi originates from the Parwa Ghat of the Karnataka part of the Sahyadri hills and after traversing a stretch of about 70 Km joins the Arabian sea through the Aguada bay near Panaji. Its width at the estuary is 3.2 Km while, upstream, it narrow down to 0.25 Km. Like Zuari river it is also fed by monsoon precipitation and has the discharge from a catchment area of about 1150 Km^2. Its pre- and post monsoonal flow (about 0.06 Km^3/year) are also regulated, like the Zuari, by the semi-diurnal tide having a similar range [Ibid, p.6]. But the Manodvi has larger tributary system and along its course it has a number of islands, narrow bend, and shallow depths. As compared to the Zuari it has a lower average salinity which is evident from variation in the distance of sea water penetration inland of 0.5% chlorinity at mid-depth. From a maximum of 67 Km in May the salinity intrusion comes down to a minimum

distance of about 10-11 Km in June which persists through July. The mouths of the two estuaries of Zuari and Mandovi rivers are separated by a promontory between them at Cabo.

The two rivers are connected by a canal called Cambarjua canal about 14 and 11 Km away from the mouth of the Mandovi and the Zuari estuaries respectively demarcating the island of Panjim in between. The canal is about 17 Km in length and 0.5-0.7 Km in width. It is narrow and shallow at the Mandovi end, while it is appreciably wider and deeper at the Zuari end. The northern side of the canal has two other narrow channels which merge together before meeting the river. Mandovi further stream. Although not of natural origin, the Camrburjua canal is an interesting example of two estuaries interacting dynamically through a common channel. During the monsoon months when all barge and boat traffic along the river. Mandovi gets suspended as navigation is rendered hazardous by the formation of shoals/bars (popularly known as Aguada Bar and Reis Mages Bars) at the entrance of the Aguada bay (Mandovi estuary), the Cambarjua canal becomes the only waterway for all barge and boat traffic to Mormugao harbour through the Zuari river [Ibid, p.8].

The Goan coastal zone has a mixture of lateritic and alluvial soils. Soils of the tidal flats consists of silt

Fiv.IV.4


GOA
SOILS
LATERITIC SOILS
ALLUVIAL SOILS
SANDY COASTAL SOIL.
SALINE SOILS
MARSHY SOILS

sand or siltclay with abundant organic water covering 4.7% of the land in Goa. Alluvial soils are found in fillings and low lying lands. Marshy soils are found along rivers in Bardez, Salcete and Canacona talukas and get affected by inundation of saline water. Sandy soils is found in narrow strip all along the coastline. Lateritic soils are found in the elevated plateaus and valleys. Lateritic soils of Goa contain very high percentages of iron and ferro manganese.

Table 1: Monthly and Annual Rainfall Averages for Stations in Goa

(mm)

	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Canacona	1.3	0	0.7	12.1	157.7	816.4	998.4	606.1	267.4	134.9	39.2	20.1	3054.3
Panjim	1.3	0.5	0.4	15.5	89.1	841.5	887.8	448.7	272.6	101.3	22.1	9.5	2690.3
Valpoi	1.3	0	1.4	13.4	104.3	917.4	1497.3	877.1	289.2	217.4	51.4	10.4	4080.6
Sanguem	0.6	0	1.6	15.4	96.1	961.7	1472.2	734.8	375.8	215.0	63.6	7.2	3944.0
Ponda	0.2	0.1	0.1	17.9	132.1	912.4	1295.9	670.9	320.7	186.1	44.2	9.9	3590.5
Quepem	0	0	0	20.7	119.1	915.8	1120.1	600.3	404.3	153.4	8.3	64.4	3406.6
Marmagoa	0.4	0	0	10.3	86.4	740.8	836.4	403.0	272.9	86.4	49.9	30.5	2517.0
Margao	0	0.7	0	7.0	136.2	902.0	1107.3	580.0	302.4	138.8	47.1	18.4	3239.9
Mapusa	1.1	0.2	0.1	2.7	77.3	880.9	999.0	517.5	273.0	142.1	36.1	13.2	2943.2
Colem	0.8	0.4	2.1	25.5	67.3	1058.0	1719.1	1031.0	518.3	271.2	49.9	13.5	4756.9
Pernem	0.9	0.2	0.6	11.7	57.2	905.0	1217.7	605.0	269.0	139.8	31.8	2.4	3241.3

Sources: Eco-Development Plan for Goa, Planning Commission, New Delhi, ~~19~~ 1982.

Fig.IV.5

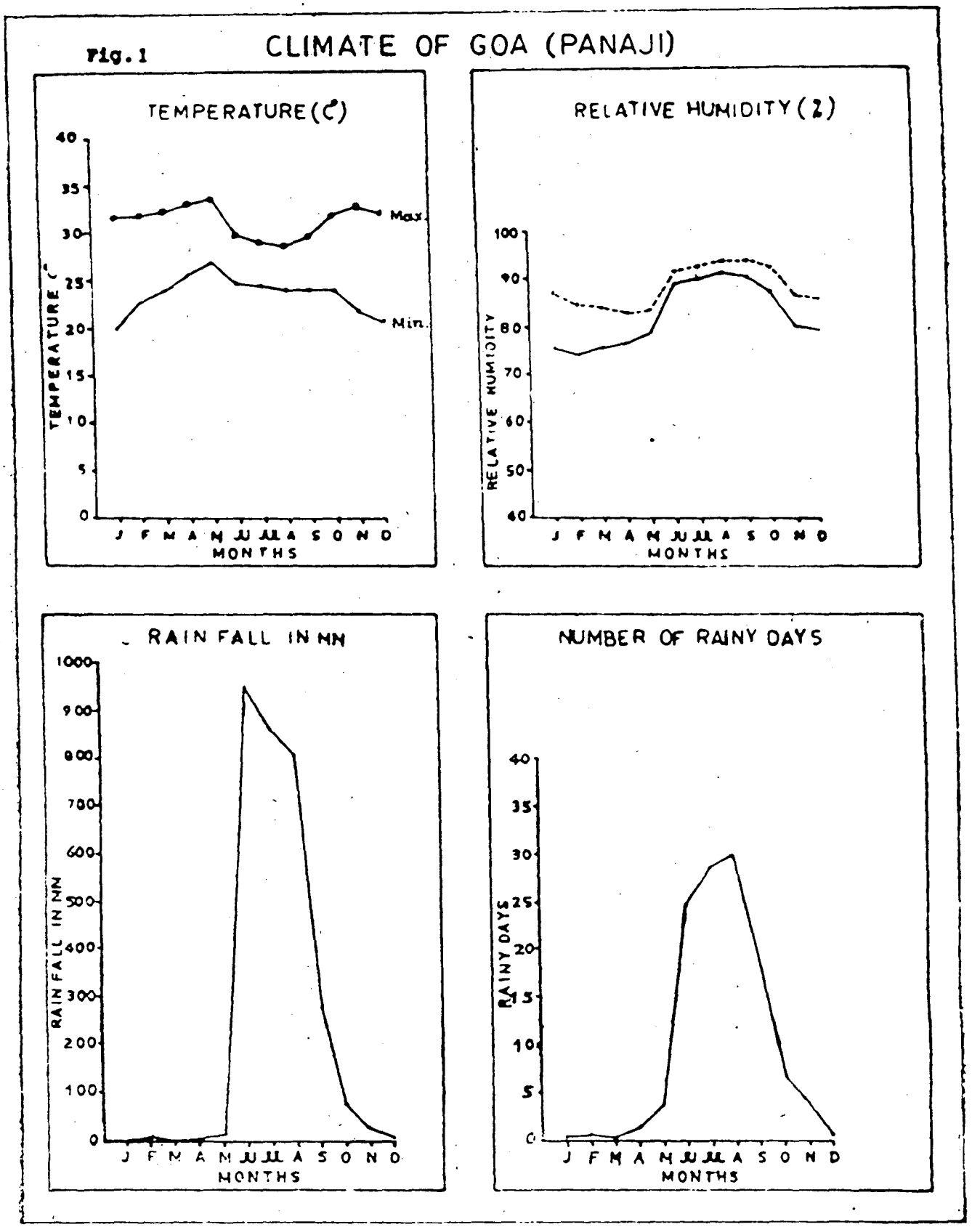


Fig. 1
CLIMATE OF GOA (PANAJI)
TEMPERATURE (C°)
TEMPERATURE C°
40
35
30
25
20
15
10
5
0
Max.
Min.
J F M A M J J A S O N D
MONTHS
RELATIVE HUMIDITY (%)
RELATIVE HUMIDITY
100
90
80
70
60
50
40
J F M A M J J A S O N D
MONTHS
RAIN FALL IN MM
RAIN FALL IN MM
1000
900
800
700
600
500
400
300
200
100
0
J F M A M J J A S O N D
MONTHS
NUMBER OF RAINY DAYS
RAINY DAYS
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D
MONTHS

The climate of the Goa coast is warm and humid. The total annual rainfall in 99.6 days is about 2600-3000 mm and most of the rainfall occurs during the south-west monsoon (June to September). The atmospheric temperature ranges from 18.5°C to 34.3°C, minimum in December & January and maximum during May. Humidity ranges from 61% to 87% with average of 74.5%. Humidity is high during May to October when the cloud cover is greater. Wind speed varies from 9.5 to 23 Km $hour^{-1}$ with an average of 13.6 Km $hour^{-1}$. The wind speed attains a peak in the month of July.

All the estuaries in Goa are classified as microtidal estuaries, as the tidal level is below 2 m. Along the Goa coast, the tidal amplitude varies from 0.01 to 2.44 m with a mean sea level of 1.3 m. During the monsoon, the tidal hight may reach upto 4 to 5 m [Jagtap, T.P. (1986), Ibid, pp.13-36]. The seasonal variation (mean for 1979-84) of tidal range for Goa coast is depicted in the Fig II.7. Tidal currents are usually stronger than esturine flow.

During the premonsoon period, the flood current is found to be dominating the ebb current in estuaries of Mandovi and Zuari. However, during the monsoon, the ebb flow dominates the flood velocity. The current velocities are maximum (212 cm sec^{-1} and 160 cm sec^{-1} respectively)

Fig.IV.6

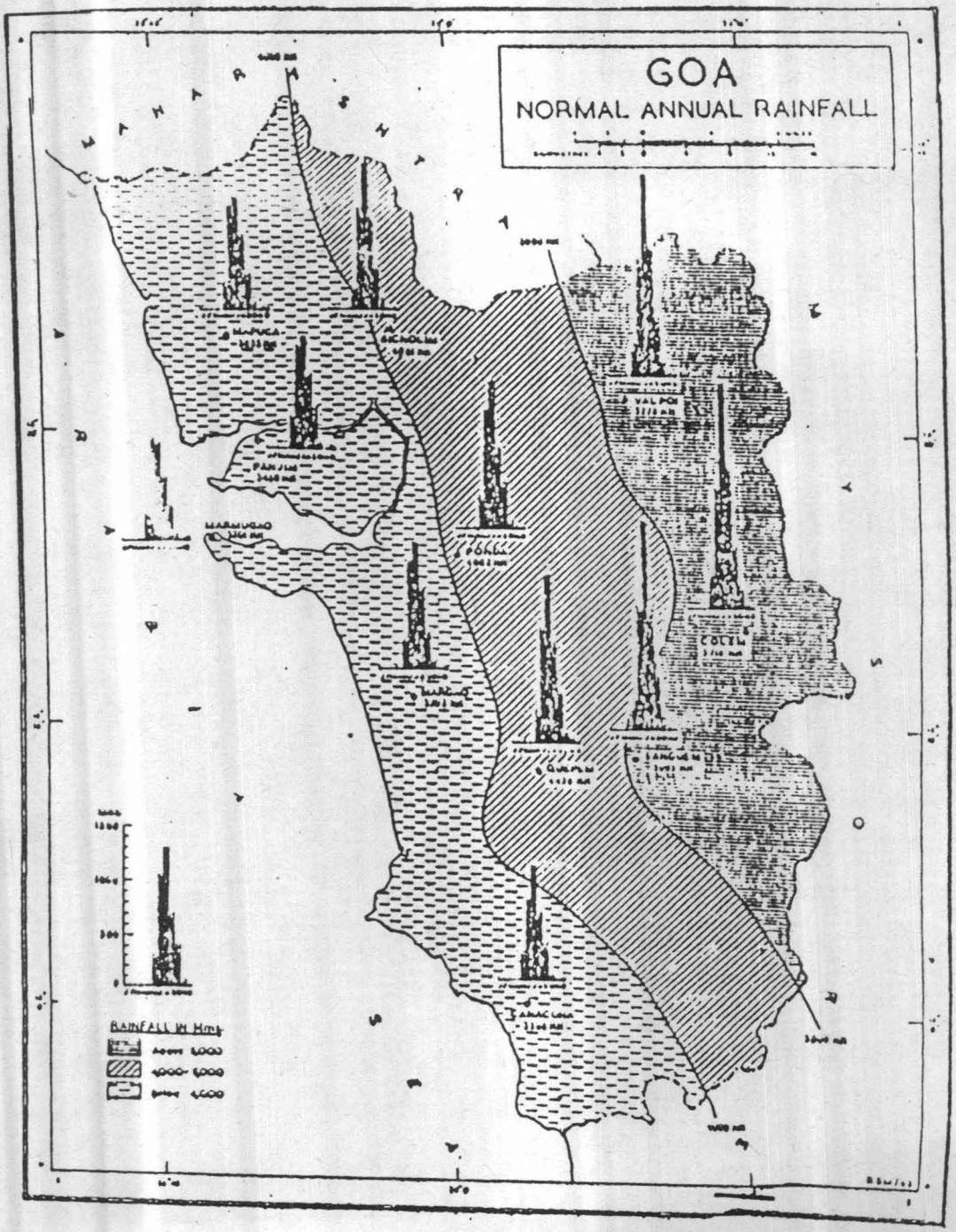
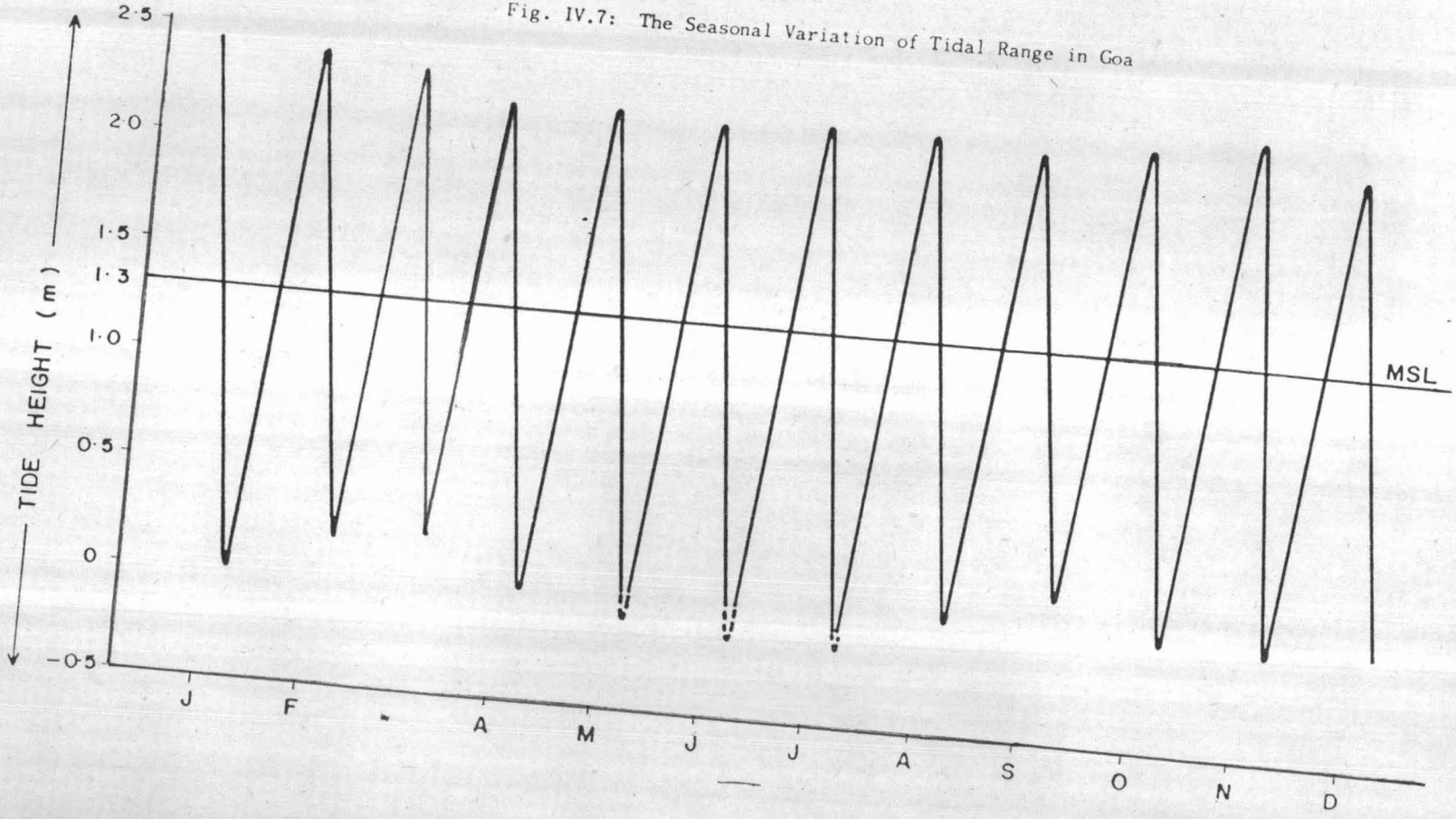


Fig. IV.7: The Seasonal Variation of Tidal Range in Goa

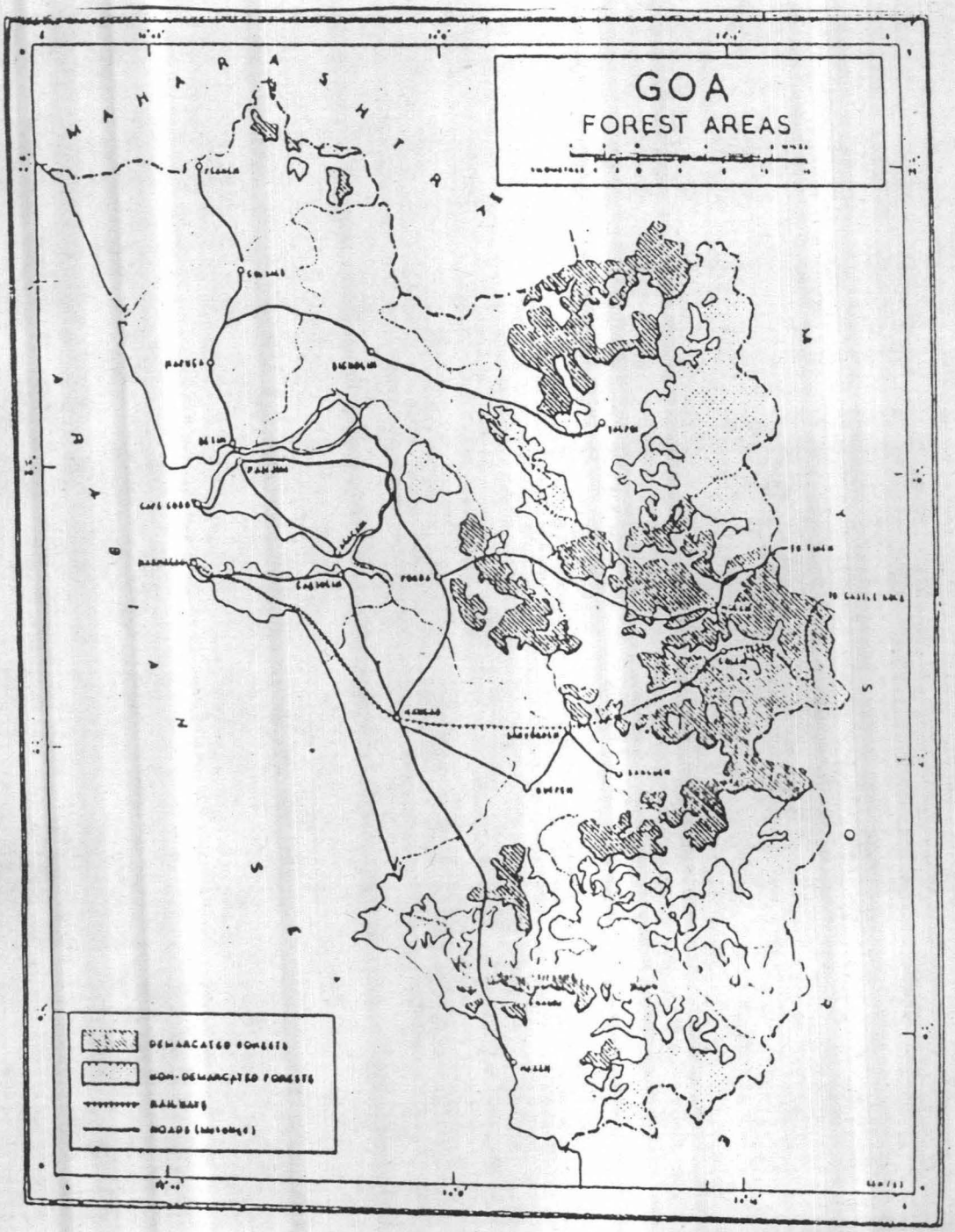


during the monsoon period at the surface and bottom [Ibid]. However, the same may not be true for all the estuaries in Goa.

The heavy precipitation and hilly terrain have helped luxurious growth of vegetation in the coastal zone. But forest cover decreases towards the coastal plain and low land. In the coastal talukas of Tiswadi, Bardez, Salcete and Mormugao, forests are almost non-existent. The evergreen forest occur mostly in pockets along the side of the streams and on high rocky slopes. Economically, valuable species found in these forests are teak, eucalyptus, bamboo, cashew and other minor forest produces such as coconut etc. on the coastline.

Mangrove forest is also found in the coastal zone. The fringing mangroves formation along the drowned estuaries of Goa is due to a rising coast [Ibid]. The deltas of Mandovi and Zuari estuaries along the Goa, coast, are mainly soft and loamy soil, which favours better establishment of mangroves. The remainder of the estuaries along the Goa coast have poor mangrove vegetation because of sandy soil in their deltas. The formation of mangroves is influenced by the nature of the coast, climate, physical nature of the substratum, degree of wave, current, action, salinity and

Fig. IV.8


GOA
FOREST AREAS
DEMARCATED FORESTS
NON-DEMARCATED FORESTS
RAILWAYS
ROADS

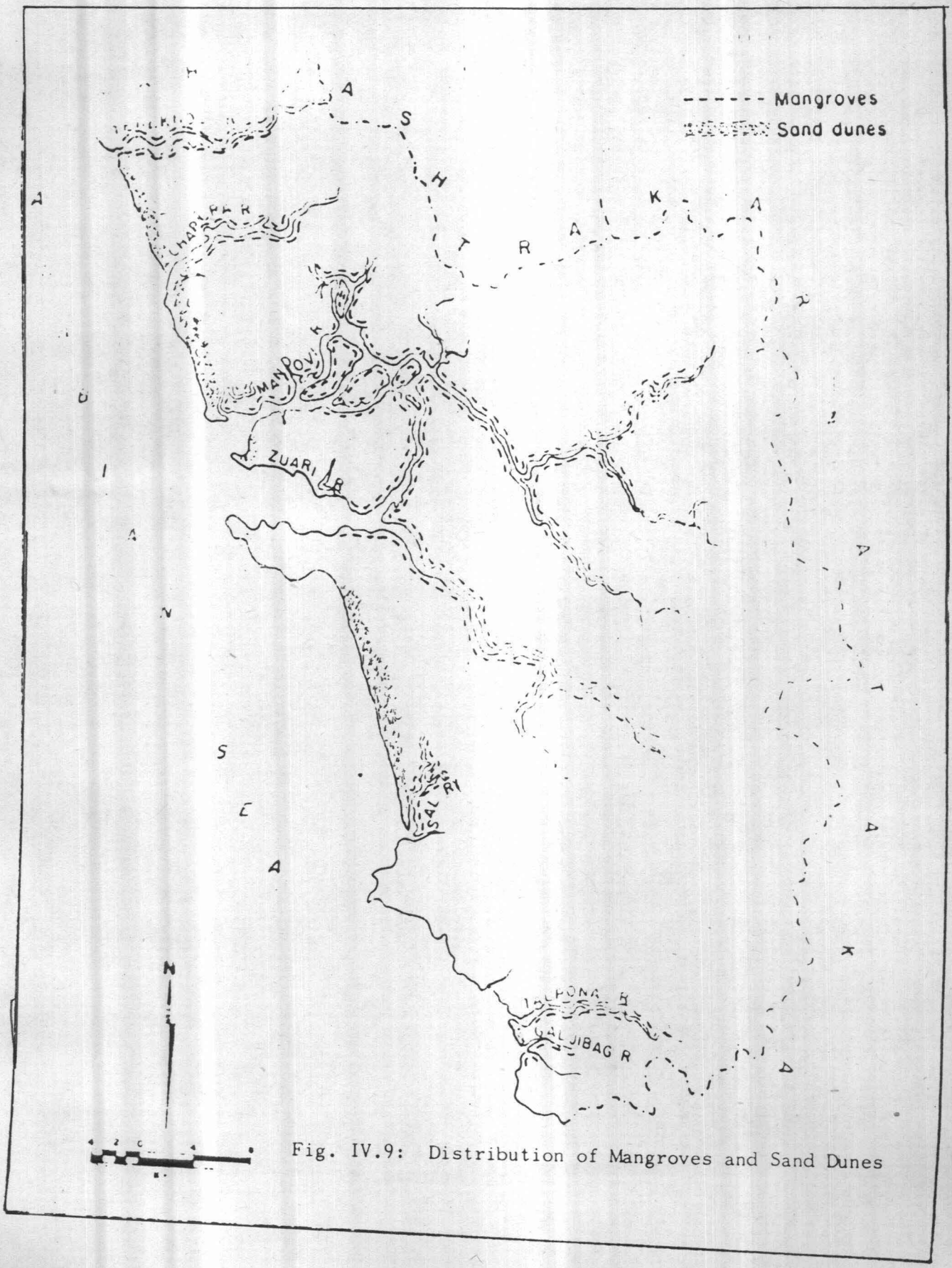


Fig. IV.9: Distribution of Mangroves and Sand Dunes

tidal range. However, the central west coast of India is characterized by steep slopes of western ghat merging into the sea and the estuaries are flanked by hills, supporting poor mangrove formations compared to the East Coast of India.

Population

The coastal zone of Goa had a population of 729030 persons in 1981 which constituted nearly 73% of the total population (10.07 lakhs) of the state as a whole. Tiswadi, Bardez, Salcete and Mormugao talukas accounted for about 79.3% of the coastal zone's total and remaining is shared by three undulating and hilly coastal talukas of Pernem, Quepem and Cannacona respectively.

The coastal zone is characterised by quite high density of population. In 1981, the average density was 415 persons per sq Km as against 272 for the state as a whole. The coastal talukas of Bardez (604), Salcete (661), Tiswadi (667) and Mormugao (930), in fact, are more densely populated as compared to Pernem (246), Quepem (175) and Canacona (102) talukas of the region respectively. The comparatively low density of elevated talukas is due to the fact that large area is under such uses which make habitation somewhat difficult. About 36% increase in the density of coastal zone is registered between 1961-1981.

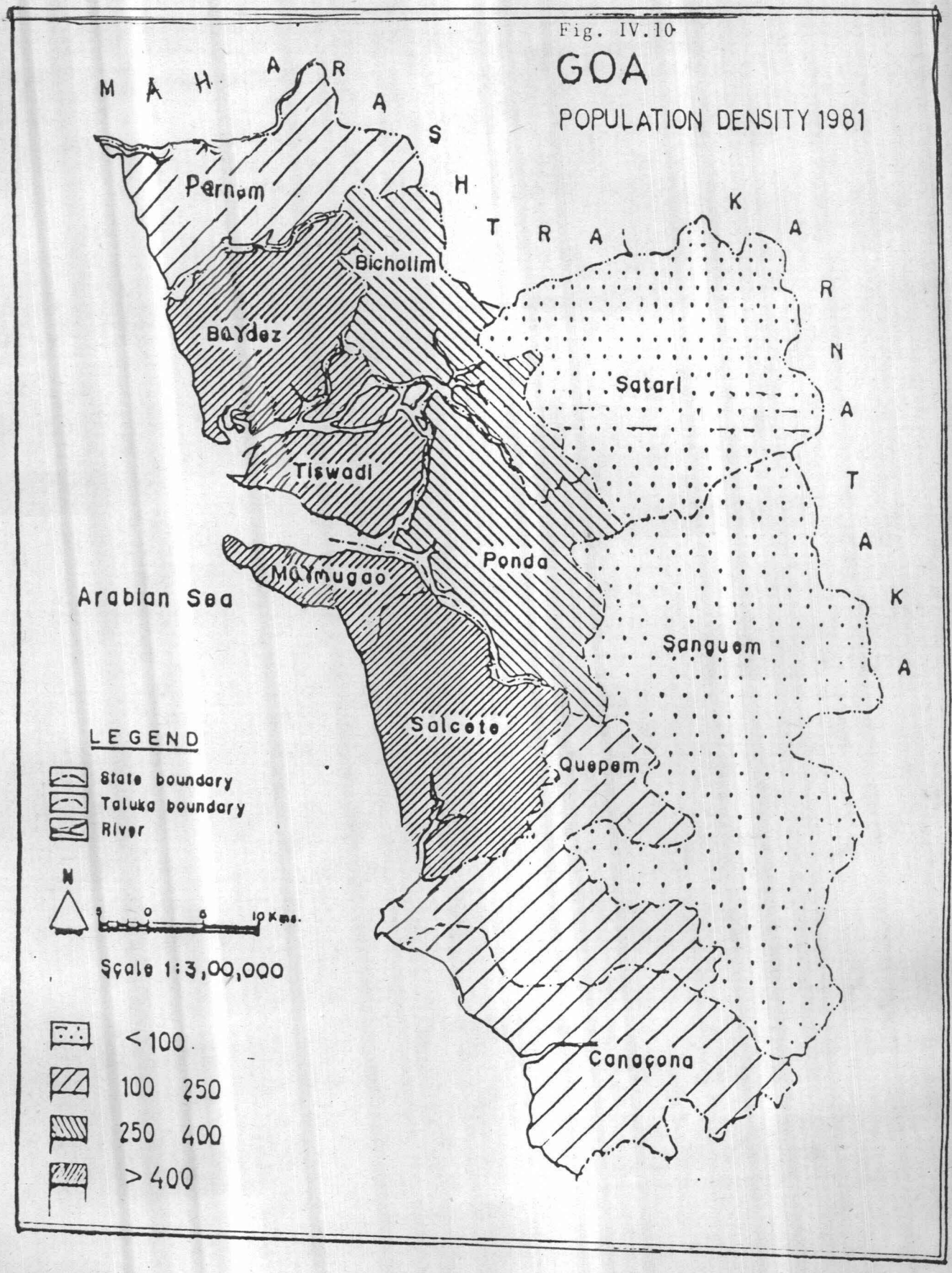
Table 2 : Population and density of Goa in 1960, 1971 and 1981

Talukas	Area in sq.km km.	Persons 1960	Persons 1971	Persons 1981	Density per sq.km. 1960	Density per sq.km. 1971	Density per sq.km. 1981
Tiswadi	197.0	79400	105809	131941	401	535	667
Bardez	255.0	97725	124103	153913	383	487	604
Pernem	241.0	12238	52906	59352	175	220	246
Bicholim	233.4	6221	58389	74089	194	250	317
Satari	499.0	23693	32515	40838	47	65	82
Ponda	287.6	61890	84590	107888	213	294	375
Sanguem	879.4	33289	44588	55904	38	51	64
Canaconna	351.1	22648	29486	35935	64	84	102
Quepem	317.3	31354	41547	55593	99	131	175
Salcete	293.01	117994	155676	193755	403	531	661
Marmugao	105.9	35100	65511	98541	331	619	931
Goa	3660.6	589997	795120	1007740	159	217	275

Source: District Census Handbook, 1981, Goa.

The population of the coastal talukas increased from 426459 persons in 1961 to 729030 persons in 1981, thereby registering an increase of 41.5% during 1961-81 in comparison to the territory's growth rate of 41.45% . The high growth rate of the state may be attributed to influx of

Fig. IV.10

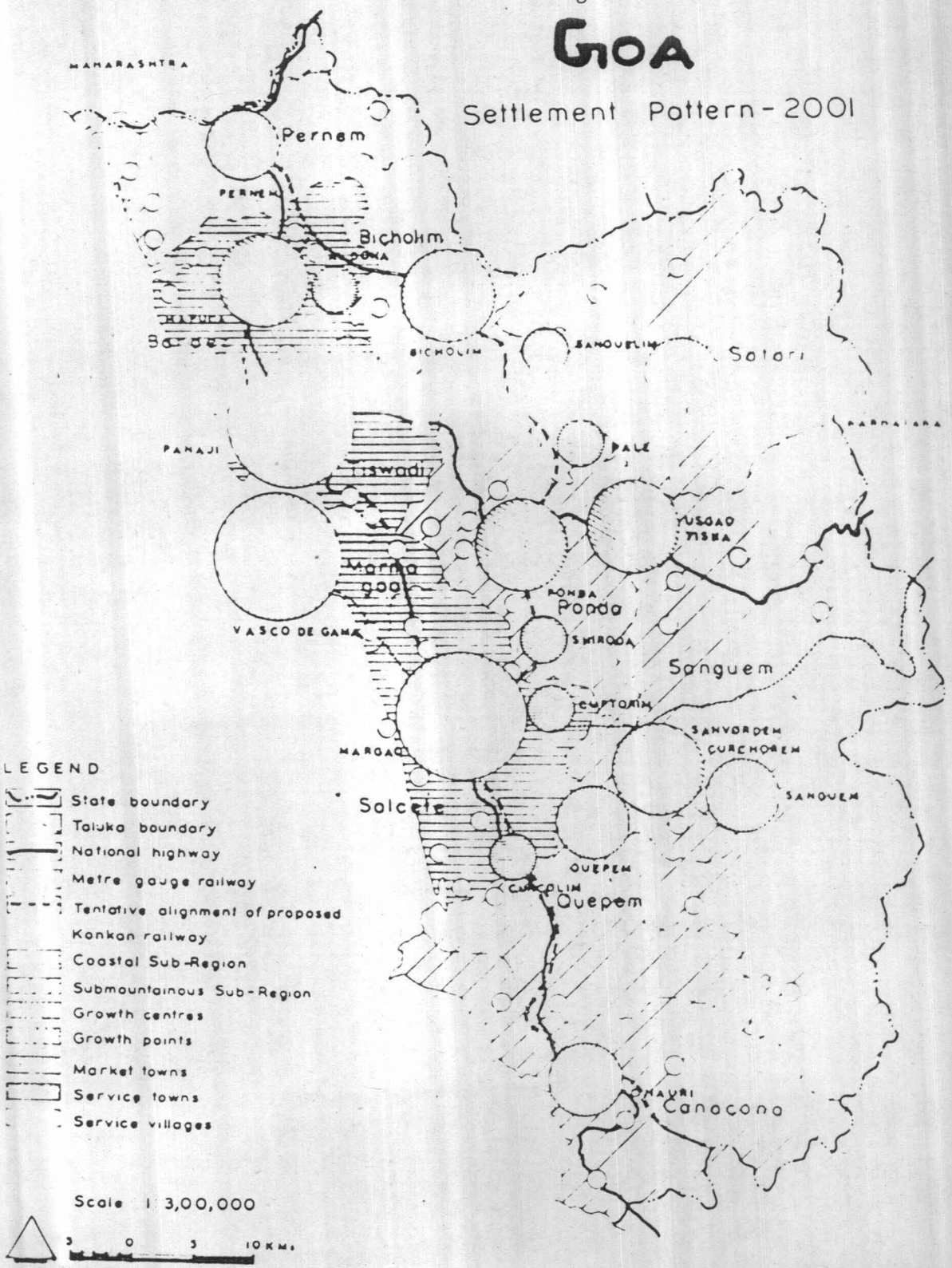

GOA
POPULATION DENSITY 1981
MAHARASHTRA
KARNATAKA
Pernem
Bicholim
Bardez
Satari
Tiswadi
Ponda
Maimugao
Arabian Sea
Sanguem
Salcete
Quepem
Canacona
LEGEND
State boundary
Taluka boundary
River
N
0 5 10 Kms.
Scale 1:3,00,000
< 100
100 250
250 400
> 400

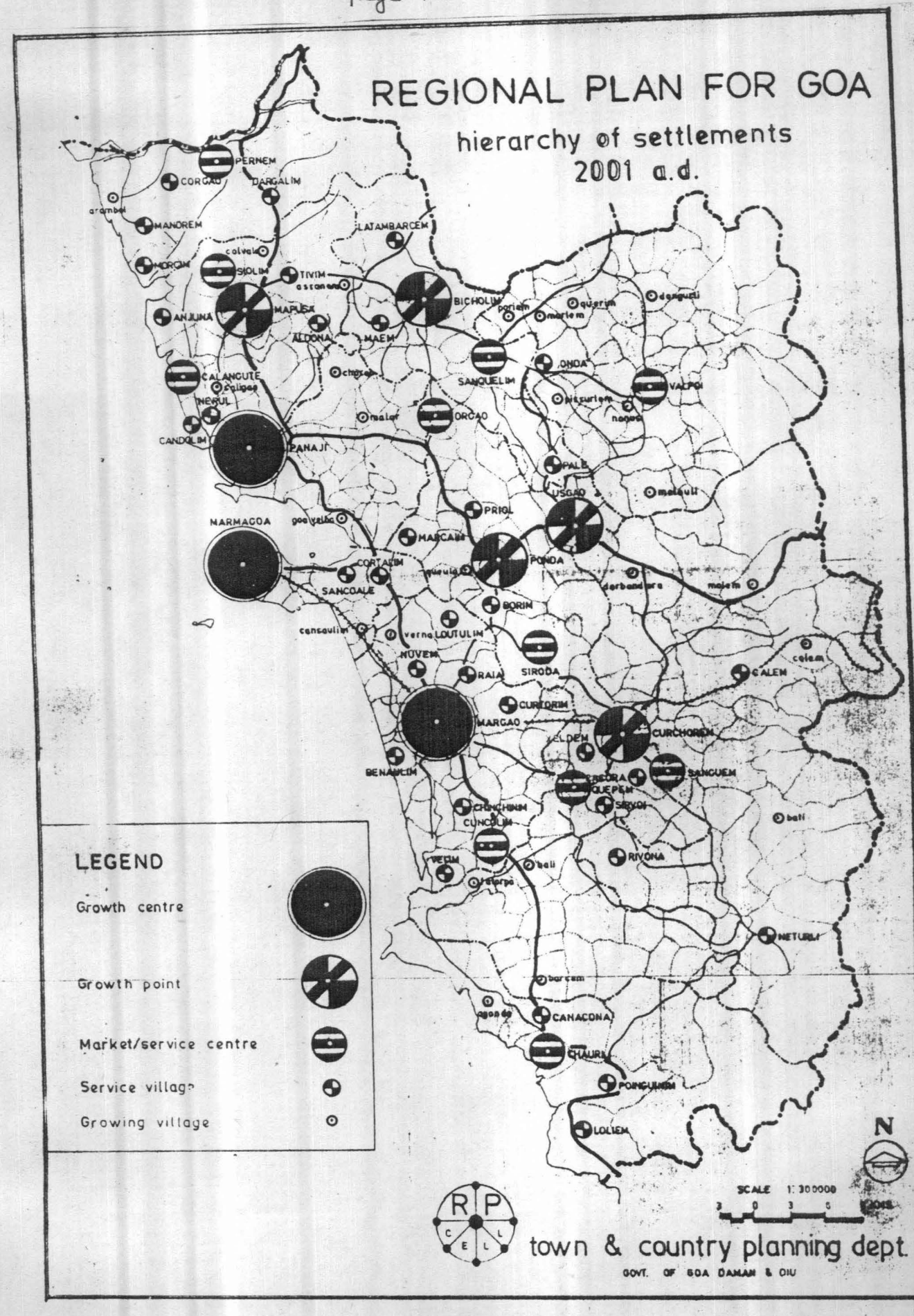
immigrants from the adjoining states of Karnataka and Maharastra after Goa's liberation from the Portuguese rule. The constituent talukas of the coastal zone displayed extreme variation in population growth during the 1961-81 census respectively. Mormugao taluk recorded the highest rate of growth (64.38%) followed by Qupen (43.60%), Tiswadi (39.82%), Salcete (39.10%), Canacona (36.97%), Bardez (36.50%) and Pernem (28.83%) respectively between 1961 and 1981. The comparatively faster population growth in the region during 1961-81 may be due to the heavy immigration from the adjoining areas of Karwar district of Karnataka as well as spurt in the port activities of the Mormugao port providing more employment opportunities.

The urbanization process in the region has been very high registering an increase of 75.86% during 1961-81. The constituent talukas of the region displayed variation in Urban growth during these two decades. Mormugao taluka recorded the highest rate of growth (90.7%) followed by Quepem (90.3%), Bardez (81.5%), Salcete (80.2%), Cannacona (72.4%), Tiswadi (54%) and Pernem (49.8%) respectively.

Rapid growth in urbanisation was closely linked with the growth in the secondary and tertiary sector of economy, Mormugao was in an enviable position. A big fertilizer complex at Sancoale on the outskirts of the Mormugao town, a

Fig.IV.11


GOA
Settlement Pattern - 2001
MAHARASHTRA
Pernem
PERNEM
Bicholim
BICHOLIM
SANQUELIM
Satari
PANAJI
Tiswadi
DALE
PONDA
Ponda
SHIRODA
VASCO DE GAMA
Marmagoa
MARGAO
Salcete
Sanguem
CURTORIM
SANVORDEM
CURCHOREM
SANGUEM
QUEPEM
CURCOLIM
Quepem
SANAURI
Canacona
LEGEND
State boundary
Taluka boundary
National highway
Metre gauge railway
Tentative alignment of proposed Konkan railway
Coastal Sub-Region
Submountainous Sub-Region
Growth centres
Growth points
Market towns
Service towns
Service villages
Scale 1:3,00,000
5 0 5 10 KMs.


REGIONAL PLAN FOR GOA
hierarchy of settlements
2001 a.d.
PERNEM
CORGAO
DARGALIM
arambol
MANOREM
LATAMBARCEM
colvale
MORGIM
SIOLIM
TIVIM
asconem
BICHOLIM
ANJUNA
MAPUSA
ALDONA
MAEM
poriem
querim
marlem
dangueti
CALANGUTE
caligao
SANQUELIM
ONDA
VALPOI
nesurlem
nagerli
NERUL
CANDOLIM
PANAJI
ORGAO
PALE
USGAO
melauli
PRIOL
MARMAGOA
goa velha
MARCAIM
PONDA
CORTALIM
SANCOALE
querula
derbandora
marlem
BORIM
cansaulim
verna
LOUTULIM
NUVEM
RAIA
SIRODA
calem
CURTORIM
MARGAO
CURCHOREM
ELDEM
BENAULIM
SANGUEM
QUEPEM
SERVOI
CHINCHINIM
CUNCOLIM
bali
VETIM
RIVONA
sarpe
NETURLI
borcem
agonda
CANACONA
CHAURI
POINGUINIM
LOLIEM
N
LEGEND
Growth centre
Growth point
Market/service centre
Service village
Growing village
SCALE 1: 300000
town & country planning dept.
GOVT. OF GOA DAMAN & DIU

new industrial estate to subserve the need of this major industrial units and a number of new range repair workshops and other ancillary units that had come up in the 1970s, coupled with the location of the second biggest port of the country, had made this taluka as the most industrialized in Goa state. The port of Mormugao, which provided excellent export facilities for the entire mineral ores extracted from the mines in Goa, had a very large employment potential. Other talukas such as Tiswadi, Salcete, Bardez etc. experienced rapid rate of urbanisation because Panaji, capital of Goa, and business centers like Margao, Mapusa etc are located in these talukas. They have a number of govt. offices, many private and public institutions, business houses, commercial activities and also marine fishing activities and rich agriculture with large paddy and Coconut cultivation, thus attracting both non-agricultural and agricultural sectorial employment. About 70% of large and small scale industries and developed industrial estates are located in the region.

The estimation of future population of Goa for 2001 AD is designed not only to find out the aggregate population but also the emerging pattern of its distribution in the different settlements of the talukas of the region [Regional Development Plan for Goa (1986), pp.10-19]. The weighted

mean ratio of growth of population was only 0.5% per annum, during the last five decades before liberation, while the corresponding figure during the last two decades (1961-81) shot up to as much as 3.08% per annum. This drastic change is mainly due to the reduction in the rate of outmigration and large scale influx of labour in the region attracted by tremendous increase in job opportunities resulting from the sudden spurt in economic and social activities after liberation.

Table-3: Quinquennial Estimates of Population Projection for Goa From 1950 to 2001 A.D.

Name of Talukas	1950	1960	1971	1981	1986	1991	1996	2001
Bardez	103668	97725	124103	153913	172383	189621	208583	224227
Tiswadi	73123	79400	105809	131941	148236	164542	180996	179286
Mormugao	27237	35100	6511	98541	118249	135986	149585	164544
Salcete	118585	117994	155676	193755	217393	243480	267828	294611
Pernern	42684	42238	52906	59352	62913	70463	77509	83322
Quepem	26786	31354	41547	55593	64988	74736	82210	89609
Canacona	20994	22643	29486	35935	39870	43857	47804	52106
Total of coastal Talukas	413077	426454	575038	729030	824032	922685	1014515	1105705

Bicholim	36728	46628	58389	74089	84017	95275	105755*	116311
Ponda	54157	57540	84590	107888	122453	137760	154291	168177
Satari	20514	26136	32515	40838	46065	50672	56753	61861
Sanguem	22972	33239	44588	55904	63004	71006	78817	85911
Total inland Talukas	134371	162543	220082	278719	315539	354713	395616	432280
Grand total	547448	589997	795120	1007749	1139571	1277398	1410141	1537985

Note : The figures for Goa Dist. are subject to the approval of the Registrar General and Census Commissioner of India, while the figures for Talukas are aggregated from the setttlement wise estimates and then adjusted with mean growth rate.

Source : Regional Development plan for Goa, 1986-2001 AD, Town and Country planning Department, Goa

The population projection for the year 2001 AD is attempted taking in view the two major components of natural increase and migration characteristic of the population. The method used here is empirical involving subjective segment of settlement-wise estimates of population by 2001 AD based on the rate of growth during 1971-81 and also their individual growth potential during the next two decades incorporating the effect of stabilization of population increase which would result during the next two decades due to stabilization in the socio-economic scenario [Ibid., p.18]. The estimates of taluka-wise population are given in the table above.

Land Utilization

The pattern of existing surface utilization and its evolution during the last two decades (1960-81) shows a high degree of regional imbalance between the coastal talukas and inland talukas. The existing trends show a rapidly changing scenario of competing landuses and their pressures resulting in change of uses in available lands. Urbanisation and industrialization also reflects this front of unbalance in the coastal region where 88% of the Goan urban population and more than 70% of the industrial and tertiary activities are concentrated.

Table 4: Pattern of Generalised surface utilisation , 2001. AD (Area in ha)

Name of Taluks	Year	Settlement area	Industrial area	Cultivation area	Marshy land/ Water body / fishfarm/salt pans/reservoir area/sandy area	Orchand including pasture	Natural cover/ Govt forest	Wastland	Miscellaneous	Total	Settlement density persons/ha
Coastal Taluks											
Bardez	1981	3775 (14.80)	40 (0.16)	5905 (23.16)	2460 (9.65)	7025 (27.55)	-	5262 (20.64)	1029 (4.04)	25496 (100.00)	41
	2001	5521 (21.66)	61 (0.24)	6986 (35.24)	2460 (9.65)	6521 (25.58)	1547 (6.07)	-	400 (1.56)	25496 (100.00)	41
Tiswadi	1981	2790 (14.10)	165 (0.83)	5122 (25.88)	5417 (27.38)	5364 (27.10)	-	580 (2.93)	352 (1.78)	19790 (100.00)	47
	2001	4204 (21.24)	167 (0.84)	6229 (31.48)	5417 (27.38)	2514 (12.70)	734 (3.71)	-	525 (2.65)	19790 (100.00)	47

contd...

Moraugao	1981	1132	75	1328	3200	723	98	1527	2511	10594	87
		(10.69)	(0.71)	(12.54)	(30.21)	(6.82)	(0.92)	(14.41)	(23.70)	(100.00)	
	2001	3364	199	1015	3200	709	621	-	1486	10594	49
		(31.75)	(1.88)	(9.58)	(30.21)	(6.69)	(5.86)	-	(14.03)	(100.00)	
Salcote	1981	5662	167	93	1790	5332	-	6160	798	29300	34
		(19.33)	(0.57)	(32.05)	(6.11)	(18.20)	-	(21.02)	(2.72)	(100.00)	
	2001	9717	379	112	1790	2602	2307	-	1305	29300	30
		(33.16)	(1.29)	(38.23)	(6.11)	(8.88)	7.89	-	(4.46)	(100.00)	
Perree	1981	799	-	9446	1250	8795	1196	5260	2357	24103	74
		(3.31)	-	(18.45)	(5.16)	(36.49)	(4.46)	(21.82)	(9.78)	(100.00)	
	2001	1780	224	6576	1250	9985	3934	-	354	21403	47
		(7.38)	(6.93)	(27.28)	(5.19)	(71.43)	(16.3)	-	(1.47)	(100.00)	
Quepem	1981	1140	-	4455	500	6455	9779	6820	2577	31726	49
		(7.38)	-	(14.04)	(1.58)	(20.35)	(30.82)	(21.5)	(8.12)	(100.00)	
	2001	2585	223	6972	500	9317	1129	-	895	31726	35
		(8.15)	(6.72)	(21.97)	(1.58)	(29.37)	(35.39)	-	(2.82)	(100.00)	
Canaconna	1981	680	-	3399	650	5780	11080	7987	5531	35107	53
		(1.94)	-	(9.68)	(1.85)	(16.46)	(31.56)	(22.75)	(15.75)	(100.00)	
	2001	1625	31	5710	650	5927	20826	-	338	35107	32
		(4.63)	(0.09)	(16.27)	(1.85)	(16.86)	(59.32)	-	(0.96)	(100.00)	
Total Coastal Taluka	1981	15978	447	34046	15267	39474	22153	33596	15155	176116	
		(9.07)	(0.25)	(19.33)	(8.68)	(22.41)	(12.58)	(19.07)	(8.06)	(100.00)	
	2001	28796	1304	44688	15267	37575	41198	-	5303	176446	
		(16.35)	(0.74)	(25.37)	(8.68)	(21.33)	(23.40)	-	(3.01)	(100.00)	
Inland taluka											
Bichalim	1981	1040	2	4383	1050	9994	302	4650	1719	23340	71
		(4.45)	(0.01)	(18.78)	(4.50)	(42.82)	(1.29)	(20.78)	(7.37)	(100.00)	
	2001	2269	158	7523	1050	9671	2295	-	374	23340	51
		(9.72)	(0.68)	(32.23)	(4.50)	(41.44)	(9.83)	-	(1.60)	(100.00)	

contd...

Ponda	1981	1771	155	2891	1130	11842	4685	5460	822	28756	61
		(6.16)	(0.54)	(10.05)	(3.93)	(41.18)	(16.29)	(18.99)	(2.86)	(100.00)	
	2001	3318	833	3600	1130	12034	7132	-	709	28756	51
		(11.54)	(2.90)	(12.52)	(3.93)	(41.85)	(24.80)	-	(2.46)	(100.00)	
Satari	1981	510	-	4584	1200	15820	17877	6240	3272	49503	80
		(1.03)	-	(9.26)	(2.42)	(31.96)	(36.12)	(12.60)	(6.61)	(100.00)	
	2001	2093	137	5897	1900	9833	29468	-	175	49503	30
		(4.23)	(0.28)	(11.91)	(3.84)	(19.86)	(59.53)	-	(0.35)	(100.00)	
Sanguan	1981	638	-	4678	1190	11320	43887	16176	9958	87847	88
		(0.73)	-	(5.32)	(1.35)	(12.89)	(49.96)	(18.41)	(11.34)	(100.00)	
	2001	2597	179	7029	2690	15670	59510	-	172	87847	33
		(2.96)	(0.20)	(8.00)	(3.06)	(17.84)	(67.74)	-	(0.20)	(100.00)	
Inland total	1981	3959	157	16436	4570	48976	66751	32726	15771	189446	
		(2.09)	(0.08)	(8.67)	(2.41)	(25.85)	(35.23)	(17.27)	(8.32)	(100.00)	
	2001	10277	1307	24049	6770	47208	98405	-	1430	189446	
		(5.42)	(0.69)	(12.69)	(3.57)	(24.92)	(51.94)	-	(0.75)	(100.00)	
Goa State	1981	19937	604	50582	19837	88450	88904	66322	30926	365562	51
		(5.45)	(0.17)	(13.84)	(5.42)	(24.14)	(24.32)	(18.15)	(8.46)	(100.00)	
	2001	39073	2596	70737	22037	84783	139603	-	6733	365562	39
		(10.69)	(0.71)	(19.35)	(6.03)	(23.09)	(38.19)	-	(1.84)	(100.00)	

Source : Regional Development Plan for Goa, 1986 - 2001 AD, Town and Country Planning Department, Goa.

Landuse pattern in the coastal zone is entirely different from that of inland talukas. Orchard including pasture is the predominant user of land in the region, where as natural cover and government forest is dominant in the inland talukas. Around 19% of the reporting area is under

Fig.IV.12

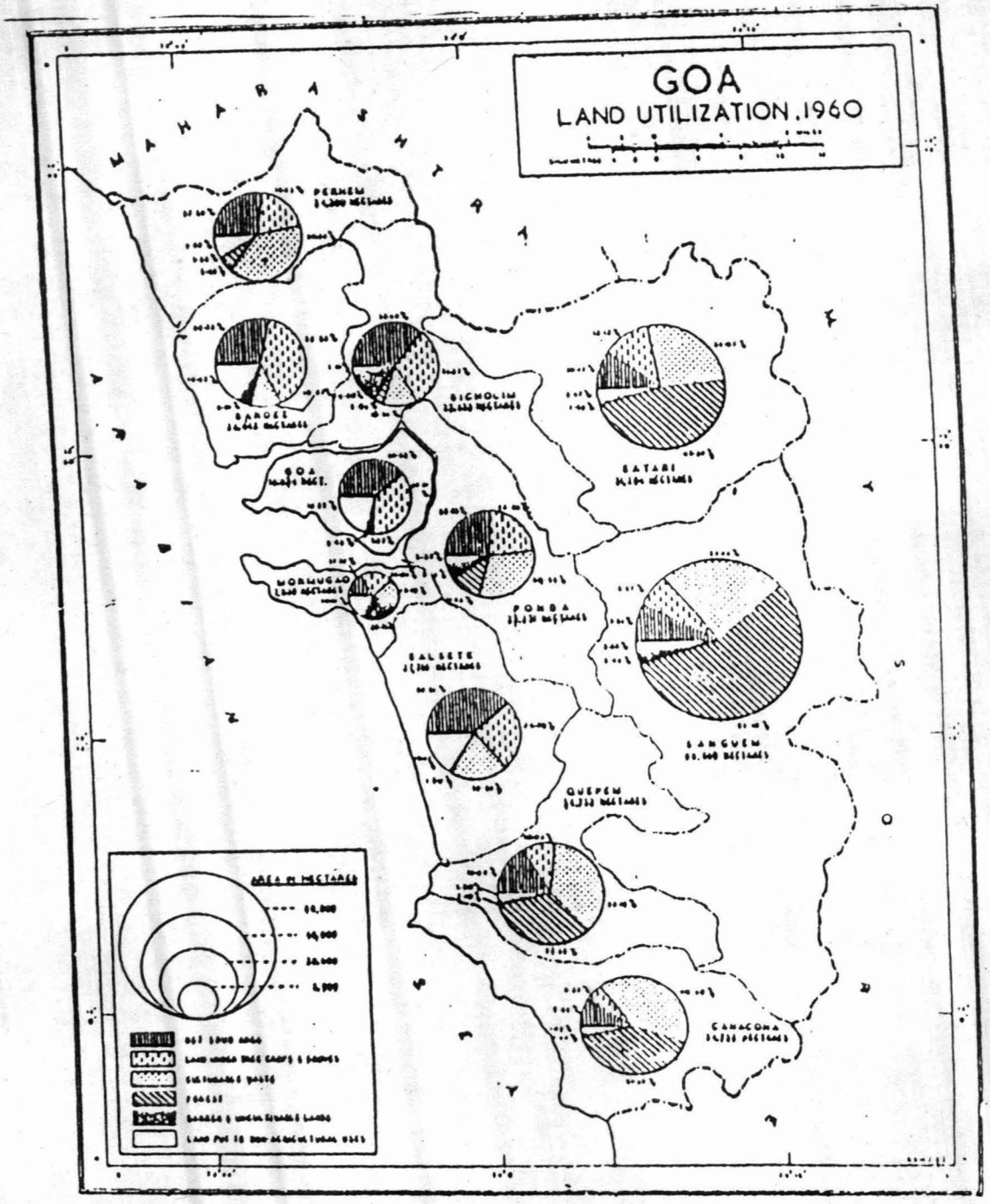
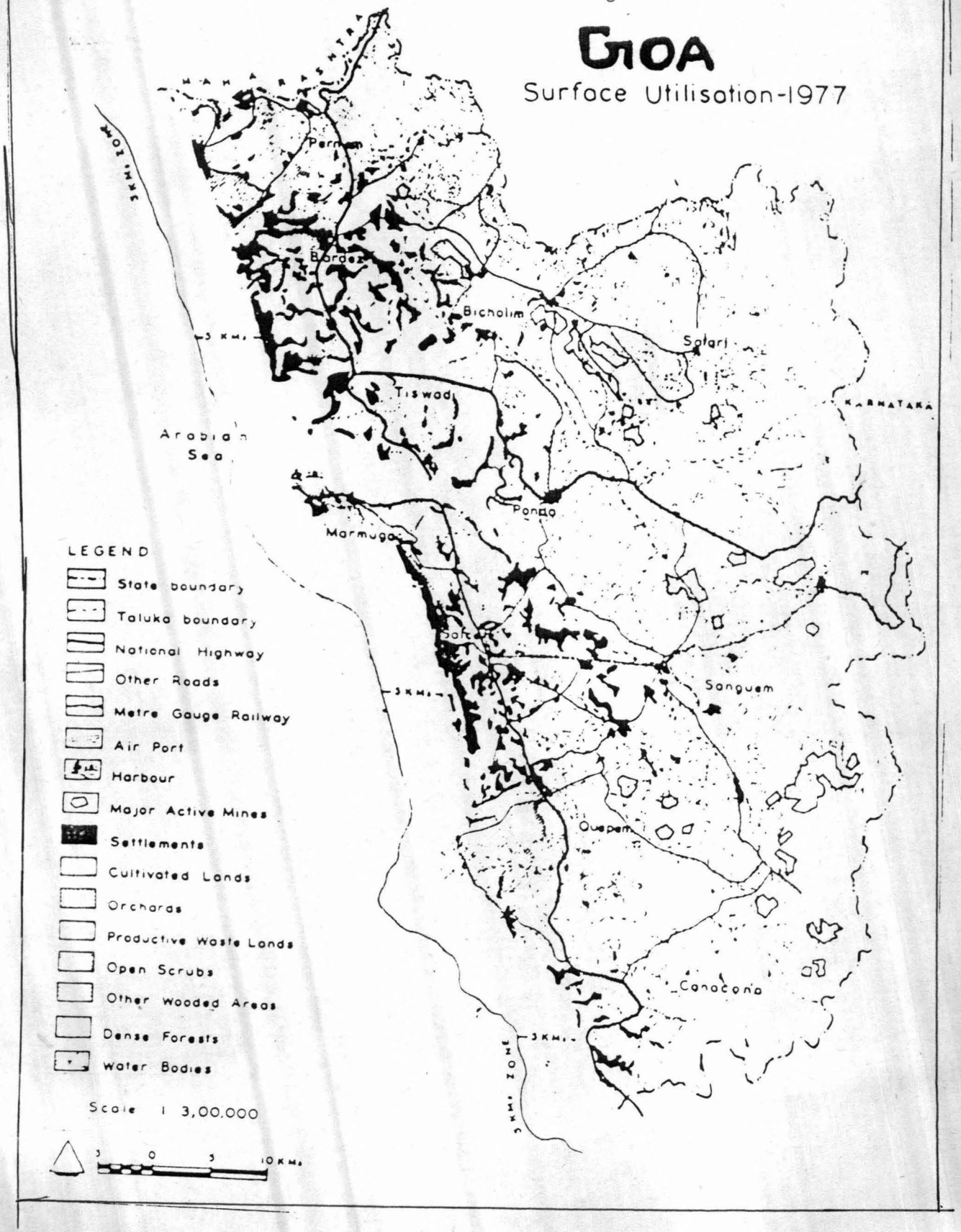

GOA
LAND UTILIZATION, 1960
MAHARASHTRA
PERNEM
BARDEZ
BICHOLIM
SATARI
GOA
MORMUGAO
PONDA
SALSETE
SANGUEM
QUEPEM
CANACONA
AREA IN HECTARES
10,000
5,000
FOREST

Fig.IV.13


GOA
Surface Utilisation-1977
MAHARASHTRA
Pernem
Bardez
Bicholim
Sattari
Tiswadi
KARNATAKA
Arabian Sea
Ponda
Marmugao
Salcete
Sanguem
Quepem
Canacona
3 KMs.
3 KMs. ZONE
LEGEND
State boundary
Taluka boundary
National Highway
Other Roads
Metre Gauge Railway
Air Port
Harbour
Major Active Mines
Settlements
Cultivated Lands
Orchards
Productive Waste Lands
Open Scrubs
Other Wooded Areas
Dense Forests
Water Bodies
Scale 1 3,00,000
5 0 5 10 KMs.

cultivation in the coastal talukas while it is just 8.67% in the inland talukas. Proportion of cultivable wasteland is also comparatively higher in the region than the inland talukas and the state's average. A considerable proportion of (9.07%) land surface is also utilized for settlement in the coastal talukas while it is only 2.09% in the inland talukas. Besides physiographic and physical conditions, political history of Goa state has also relevance to such contrast in the landuse pattern of the coastal and inland talukas.

The existing pattern of land utilization reflects the intensity of land pressures by the growth of rural and urban settlements because of sharp increase in population since liberation. Infact, the area under settlements has almost doubled and also projected to be doubled in the coastal talukas and in inland talukas during the last two decades (1961-81) and coming decades (1981-2001AD). In the proposed surface utilization plan for Goa, the future requirements of additional settlements areas have been carefully assessed by making population projection (by 2001 AD) for each and every unit of urban and rural settlements and also by assuring a low density development [Ibid., p.22]. Ranking on the basis of proportion of area under various uses reveal that orchard including pasture is the principal user of land in the

coastal talukas followed by cultivation area, wasteland, natural, cover/govt., forest, settlement, marshy land/waterbody/fish farms/salt pans reservoir/sandy area etc. The picture is quite different in different talukas. Cultivation is the first user of land in Salcete (32.05%) followed by Wasteland (21.02%), settlement (19,33%). In case of Mormugao and Tiswadi talukas, Marshyland/waterbody etc is the first user of land followed by miscellaneous use in Mormugao and Orchard including pasture in Tiswadi and cultivation and wasteland respectively. It may be inferred from the table that after liberation of Goa in 1961, there has been overall increase in the area under agriculture at the cost of wasteland. It appears that foresting, cultivation and plantation crops will continue to dominate the overall landuse pattern of the coastal zone and obviously settlement area due to increasing rate of urbanisation and industrialization.

Agriculture

Agriculture is one important activity in the Goan coastal zone. It possessed 61.83% of the total cropped area of the state (1986-87). The coastal zone has 70.12% main workers in the state and 24.33% of it are engaged in the agriculture as cultivator and agricultural laborers, in 1981. The state has 52902 hectare of land under paddy

cultivation out of the total reported area of 361113 hectares. Paddy is the main cultivation in the coastal zone. Paddy has the share of 40.51% in the total net cropped area of the state. The 70.40% of the total paddy cultivation of the state is done in the coastal talukas (1986-87). Salcete taluka alone has the share of more than 20%. Paddy cultivation is followed by cashewnut and coconut cultivation in the coastal zone of Goa. Many other crops are also grown in the region such as oil seeds, sugarcane, millets & pulses ete. In 1987-88, the yield of rice (Karif) was 1900 Kg/hectare and rice (Rabi) was 2489 Kg/hectare in the coastal zone of Goa. Goa had an irrigated area of 13383 hectares of which 41.62% was found in the coastal zone only. Agriculture is mainly dependent on monsoon and party on irrigation.

Table 5: Agriculture in Goa 1986-87.

Name of Talukas	Total Reporting Area (ha)	Total Cropped Area (ha)	Area under Paddy (ha)	Area under Cereals/ millets/ pulses etc (ha)	Area under Sugercane (ha)	Area under Coconut (ha)
Tiswadi	16611	12179	6533	351	Nil	1474
Bardez	26480	16857	6469	958	Nil	2632
Pernem	24200	14506	4400	2260	117	1444
Canaconna	34736	7846	3356	354	95	1568
Ghepum	34731	8068	4958	176	229	1915

Sakete	27719	18717	10399	390	6	5804
Marmugal	7831	2564	1131	116	Nil	1172
Total Coastal Zone	172308	80737	37246	4605	446	16009
Bicholim	23633	13179	4364	451	41	4393
Satari	51284	12928	3084	535	243	756
Ponda	25228	10876	4768	137	79	2238
Sargiem	88660	12855	3440	72	891	2585
Total Inland	188805	49838	15656	1195	1234	6972
Goa State	361113	130575	52902	5800	1700	22976

Name of Talukas	Area under Arecanut (ha)	Area under Cashewnut (ha)	Area under Vegetables (ha)	Area under Garden crops (ha)	Area Irrigated (ha) 1984-85	Average yeald of Rice per (ha) (1987-88) Kharif	Rabi
Tiswadi	4	3982	630	226	972	2591	2701
Bardez	2	5885	2110	143	636	1694	2593
Pernem	1	6812	324	41	813	1546	2313
Canaconna	25	2590	160	859	861	1676	2445
Quepum	28	1807	55	467	780	2205	3054
Salcete	Nil	1460	842	1325	1557	1917	2185
Mormugao	2	290	34	86	221	1669	2144
Total Coastal Zone	62	22826	4155	3147	5570	1900 Avg.	2489 Avg.
Bicholim	54	6994	320	136	1631	1855	3215

Satari	282	8384	60	313	1077	1489	3373
Ponda	861	2871	114	221	2744	2375	2890
Sanguen	45	5813	45	585	2361	1268	2337
Total Inland	1242	24062	539	1255	7813	1746 Avg.	3178 Avg.
Goa State	1304	46888	4694	4402	13383	1837 Avg.	2739 Avg.

Source: Goa at a Glance, 1988, Directorate of Planning, Statistics and Evaluation, Goa.

In 1984-85, the production of rice in the state (rice being the main crop) registered a figure of 1.55 lakh tonnes which is more than the actual requirement of 1.49 lakhs tonnes to feed the population of 11.78 lakhs [Goa, Daman & Diu, Silverjublee Celebrations (1986), p.12]. The increase has been possible on account of increase in the area under high yielding varieties of paddy. During the year 1984-85, an area of 43225 hectare were covered under HYV paddy. About 95% of the coastal zone paddy cultivation and others are covered under heavy dose of chemical fertilizers. However, use of pesticides is limited. Data for this is not available talukwise. One can imagine the situation by seeing the data available for the state as a whole and thus infer the probable result of heavy use of fertilizers and pesticides in the agriculture as seen in the tables & charts.

Fig.IV.14

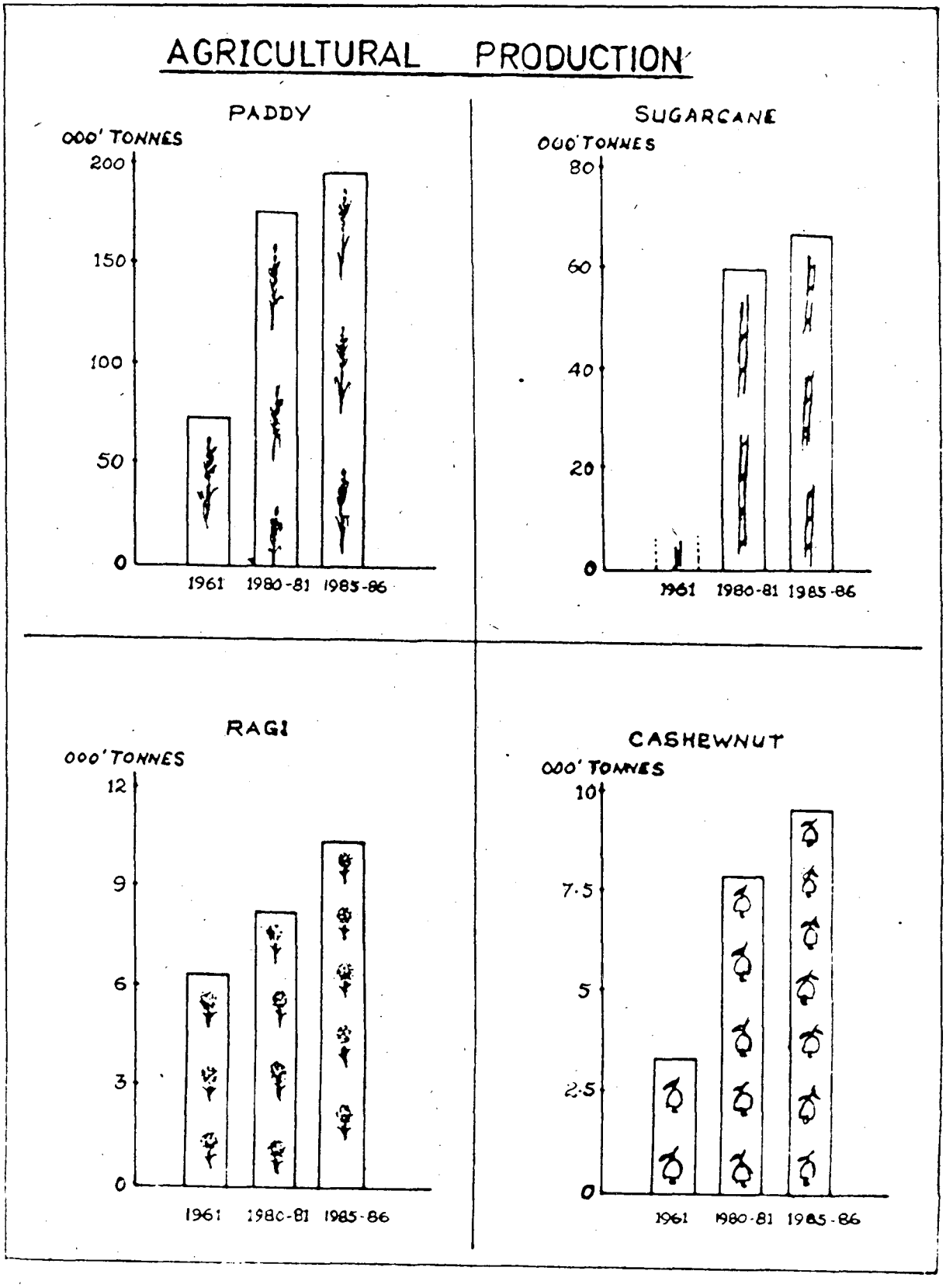

AGRICULTURAL PRODUCTION
PADDY
000' TONNES
200
150
100
50
0
1961
1980-81
1985-86
SUGARCANE
000'TONNES
80
60
40
20
0
1961
1980-81
1985-86
RAGI
000'TONNES
12
9
6
3
0
1961
1980-81
1985-86
CASHEWNUT
000' TONNES
10
7.5
5
2.5
0
1961
1980-81
1985-86

Table 6 : Cropwise irrigated area treated with different chemical fertilisers and their average rates of application during 1981-82 in Goa.

Name of selected crop.	Irrigated area under each corp	sulphate		Super phosphate		Urea		other	
		% area treated	Qty Kg/ha	% area treated	Qty Kg/ha	% area treated	Qty Kg/ha	% area treated	Qty Kg/ha
Paddy	100.00	-	-	-	-	80.9	83	78.5	151
Wheat	100.00	14.5	242	9.3	320	49.0	233	-	-
Sugarcane	100.00	-	-	-	-	15.9	350	68.6	176
Arecanut	100.00	-	-	-	-	-	-	19.5	72
Coconut	100.00	-	-	-	-	42.2	97	54.3	242
Cashewnut	100.00	-	-	-	-	-	-	100.0	300

Source: Agricultural census, Report on Input survey , 1981-82. Directorate of planning, Statistics and evaluation, Goa.

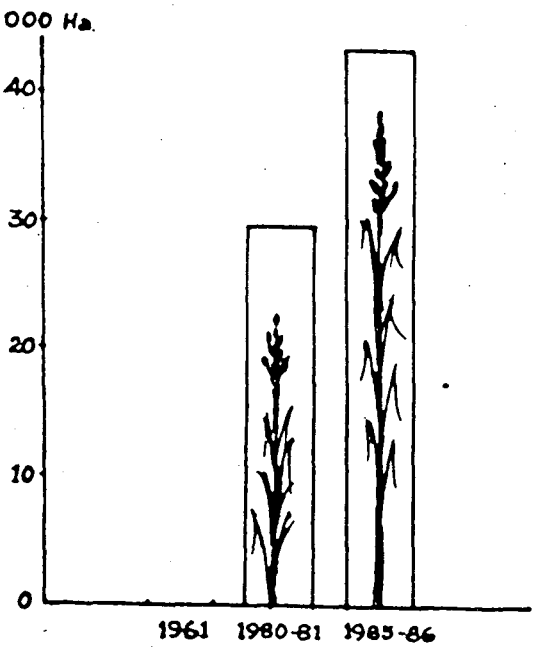
Table 7 : Cropwise percentage area (unirrigated) treated with different chemical fertilisers and average rate of application during 1981-1982 in Goa.

Name of selected corp	Unirrigated area under the crop	Ammoniun sulphate		Super Phosphate		Urea		Others	
		% area treated	Qty kg/ha	% area treated	Qty kg/ha	% area treated	Qty Kg/ha	% area treated	Qty Kg/ha
Paddy	100.00	2.5	161	1.2	57	65.1	85	53.1	137
Sugarcane	100.00	25.1	469	-	-	62.9	193	100	1850
Coconut	100.00	0.3	126	0.3	654	3.8	139	15.3	652
Cashewnut	100.00	-	-	-	-	-	-	8.1	133
Arecunut	100.00	-	-	-	-	-	-	9.9	436
Ragi	100.00	-	-	-	-	29.0	44	59.2	70
Jawar	100.00	-	-	-	-	33.1	246	-	-
Bajra	100.00	1.4	371	5.1	383	46.6	312	-	-

Source: Agricultural Census, Report on Input survey, 1981-82, Directorate of planning, statistics and avaluation, Goa.

Fig. IV.15

AREA UNDER HIGH YIELDING VARIETIES OF PADDY



IRRIGATION

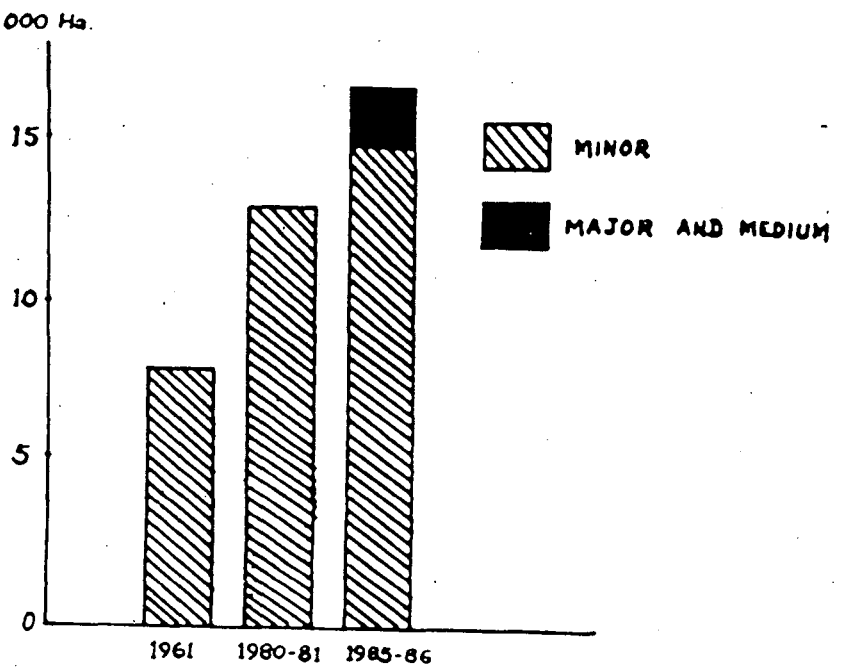


Table 8 : Percentage of holdings and percentage area treated with chemical fertilizers, Organic manures and pesticides in 1981-82, Goa.

Name	% of holdings	% of benifited
Chemical Fertilisers.	69.0	41.3
Organic Manners.	52.0	32.1
Pesticides	9.0	4.4

Source: Agricultural Census, Report on Input Survey, 1981-82. Directorate of Planning, Statistics and Evaluation, Goa.

When chemical fertilizers are applied to the land, many of the elements contained in them are retained by the soil, adding to the clay humus complex. However, certain ions are not retained, and among them is nitrite, an important constituent of most fertilizers, nitrite is being added to the soil from fertilizers and nitrogen-fixing plants at a much faster rate than it can be broken down by demitrifying agent in the soil. Being soluble, it is rapidly leached out into rivers, lakes etc. In case of Goan coastal zone, large quantities of phosphate, nitrite etc are being leached to Mandovi and Zuari estuaries and thus to coastal waters during the monsoon season every year. The increased nitrogen input permits the accelerated growth of plants,

algae and other phytoplankton: this chemical enrichment resulting in increased productivity is called "eutrophication". Unfortunately, in extreme form the outcome is ultimately harmful, since the plants and organism die and decompose at such a rapid rate that oxygen levels fall until aquatic life becomes impossible [Bryant, R.H. (1976), pp.298].

Mineral Resources

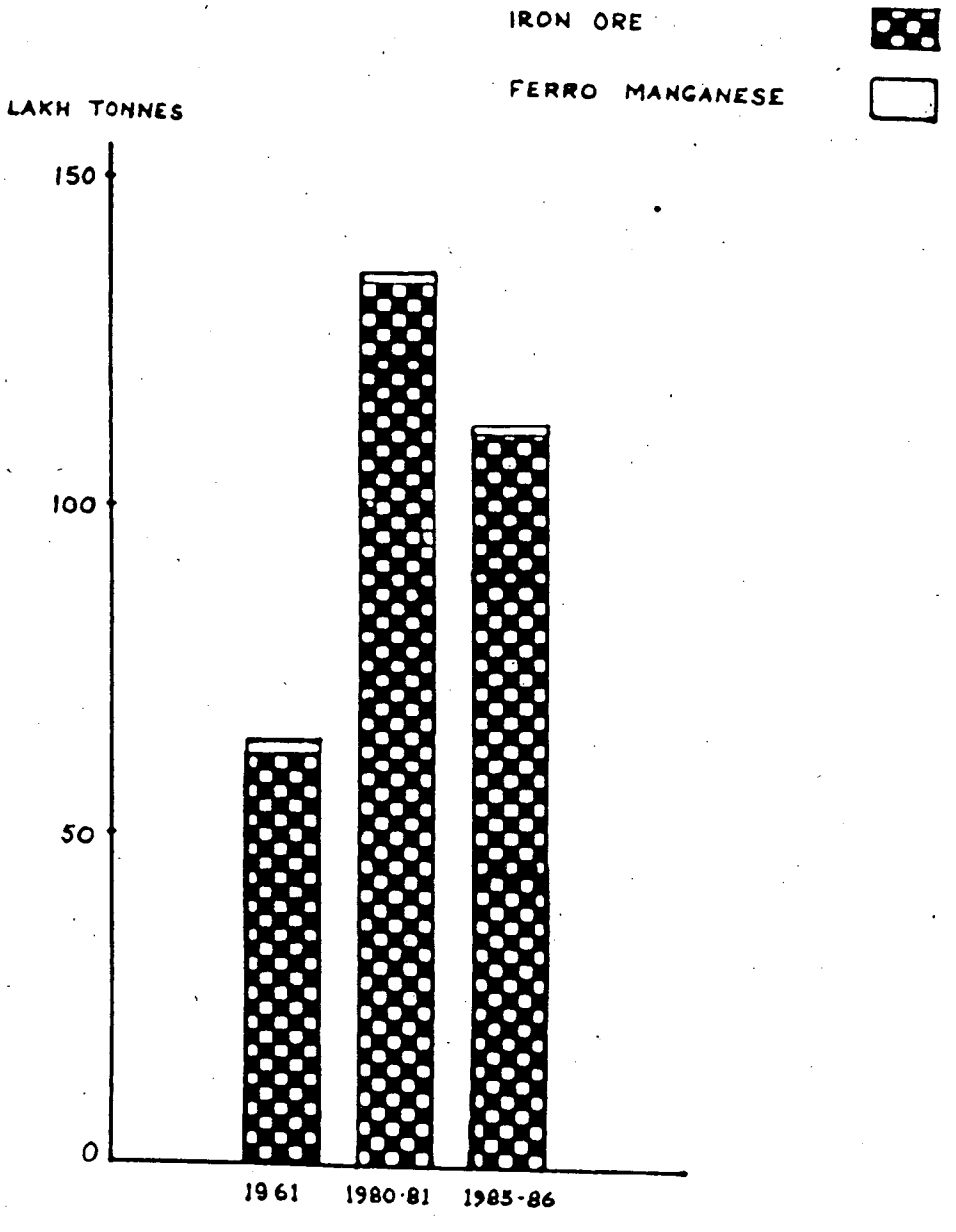
The important mineral resources of Goa are iron ore, manganese ore, ferro-manganese, bauxite. Apart from these, meager quantum of industrial clay, limestone, silica sand etc. are also available. Among all the minerals, the production (116.97 lakh tonnes in 1988) of iron-ore pre-supposes more in share around 99% of total mineral production in 1985. The iron-ore exported from Goa in 1988 was 116.97 lakh tonnes which constitutes 55% of total iron-ore exports of India.

Table 9 : Production of Minerals in Goa (in '000 tonnes)

Year	No. of Mines	Iron ore	Manganese ore	Ferro-Manganese	Bauxite	Silica	China clay	Total
1961	270	6395.4	49.4	121.5	-	-	-	6566.3
1966	201	6718.1	22.1	66.7	-	-	-	6806.9
1971	241	10234.8	4.8	203.3	46.5	31.0	-	10520.4

Fig.IV.16

MINERAL ORE PRODUCTION



1976	260	14795.1	206	89.3	0.2	50.5	-	14937.7
1980	211	13829.5	5.3	93.2	17.7	49.3	0.3	13995.3
1981	197	11950.5	4.3	113.0	40.0	47.3	0.2	12145.3
1982	197	12433.4	5.1	70.3	8.6	37.8	0.2	12555.4
1983	185	10413.4	4.5	43.3	20.6	59.4	-	10541.2
1984	149	14795.8	8.5	65.3	16.2	68.2	0.2	14952.2
1985	148	11312.0	3.4	57.2	5.8	NA	-	11378.4

Source : Directorate of Industries and Mines, Goa.

The iron ore deposits are more in the total estimated minerals in Goa in which its grade is 58 Fe content. The total iron-ore deposits are found in the inland and Ghat talukas only, especially in Bicholim. In other words, coastal talukas do not have iron ore mines except some deposits in Quepem and Canacona talukas.

Table-10: Taluk-wise Mining Area in 1973 and 1981 in Goa

Name of Talukas	Area in Sq. km.	1973 Mining Areas in Sq. km.	1973 % to total area	1983 Mining Areas in Sq. km.	1983 % to total area
Bardez	255.0	11.2	4.4	11.9	4.7
Tiswadi	197.0	7.5	3.8	6.5	3.3
Mormugao	105.9	0.1	0.1	0.2	0.2
Salcete	293.0	16.1	5.5	17.8	6.1

Pernem	241.0	7.2	3.0	7.9	3.3
Bicholim	233.4	107.7	46.1	103.3	44.3
Ponda	287.6	46.1	16.1	45.5	15.8
Quepem	217.3	50.3	15.4	51.0	16.0
Satari	499.0	72.9	14.6	73.8	14.8
Sanguem	679.4	314.8	35.8	312.3	35.3
Cannacona	351.1	20.1	5.7	20.7	5.9
Total	3660.6	654.0	17.9	650.9	17.8

Source : Thomas, P.J, (1985). " Main Activity Patterns and its enviornmental impacts - The case of Goa. "Unpublished Dissertation, School of Planning, Centre for Environmental Planning and Technology, Ahemdabad.

Table - 11: Reserves of Important Minerals in Goa
[in lakh tonnes]

S.No.	Minerals	Total	Grade
1.	Ironore	4114.3	58% Fe
2.	Ferro-Maganese	6.00	do
3.	Bauxite	71.70	45-50% Al_2O_3
4.	Limeston	800.00	Magnisium limestone
5.	Cina Clay	1.3	N.A

Source : Minerals in Goa, Daman & Diu, 1972, Geological Survey of India, 1967.

Bauxite is exclusively found only in coastal belt of Quepem and Canacona talukas. These bauxite have the fineness of 45 to 60%. The other mineral like limestone, clay, silica seeds etc are found both in inland and coastal zone of Goa. The entire production of iron-ore from Goa is exported, in particular to Japan mostly. Most of the mineral ores are transported by barges owing to the navigational facilities in the two rivers of Mandovi and Zuari to Mormugao port. There were 161 barges in 1964 and now has increased to 212 in 1985 as per the information provided by the Goa mineral ores exporters association.

Table - 12: Merchandise-wise Traffic (exports) Handled at Mormugao Port during 1984-85 and 1985-86. (in, 000 tonnes)

Commodity	1984-85	1985-86
Iron-ore	12643	14188
Maganese ore	377	247
Bauxite	--	--
General Cargo	130	59
Total Exports	13150	14494

Source: Statistical Pocket Book Book of Goa, Daman and Diu, 1986; Directorate of Planning, Statistics and Evaluation, Goa.

The traffic of ores in Mormagao port has also been enhanced continuously since liberation. Thus mining activity has been intensified by increased export to countries like Japan, Rumania etc. through easy navigable rivers Mandovi and Zuari without any hindrances, and proximity to natural harbour of Mormugao etc.

Mining contributes a lot to both Goan and Indian economy. But very intensive and unscruplous mining has caused enviornmental havoc on the forest, the lithosphere, agriculture and hydrosphere which comprises rivers, groundwater and marine system in case of Goa.

INDUSTRY

Industrialisation in a region is considered as an indicator of economic development. This largely depends upon the general physical characteristics, location and availability of nature resources, factors of production (land, labour, capital, management, etc.) and the level of infrastructural development in the region.

The State of Goa is blessed with many physical and locational advantages and also endowed with abundant resources like iron ore, ferro-manganese, bauxite, clay, sands, forest, and marine resources coupled with a good

infrastructure, transport and communication facilities. The recent trend in the growth of small, medium and large scale industrial units in the region supports this view.

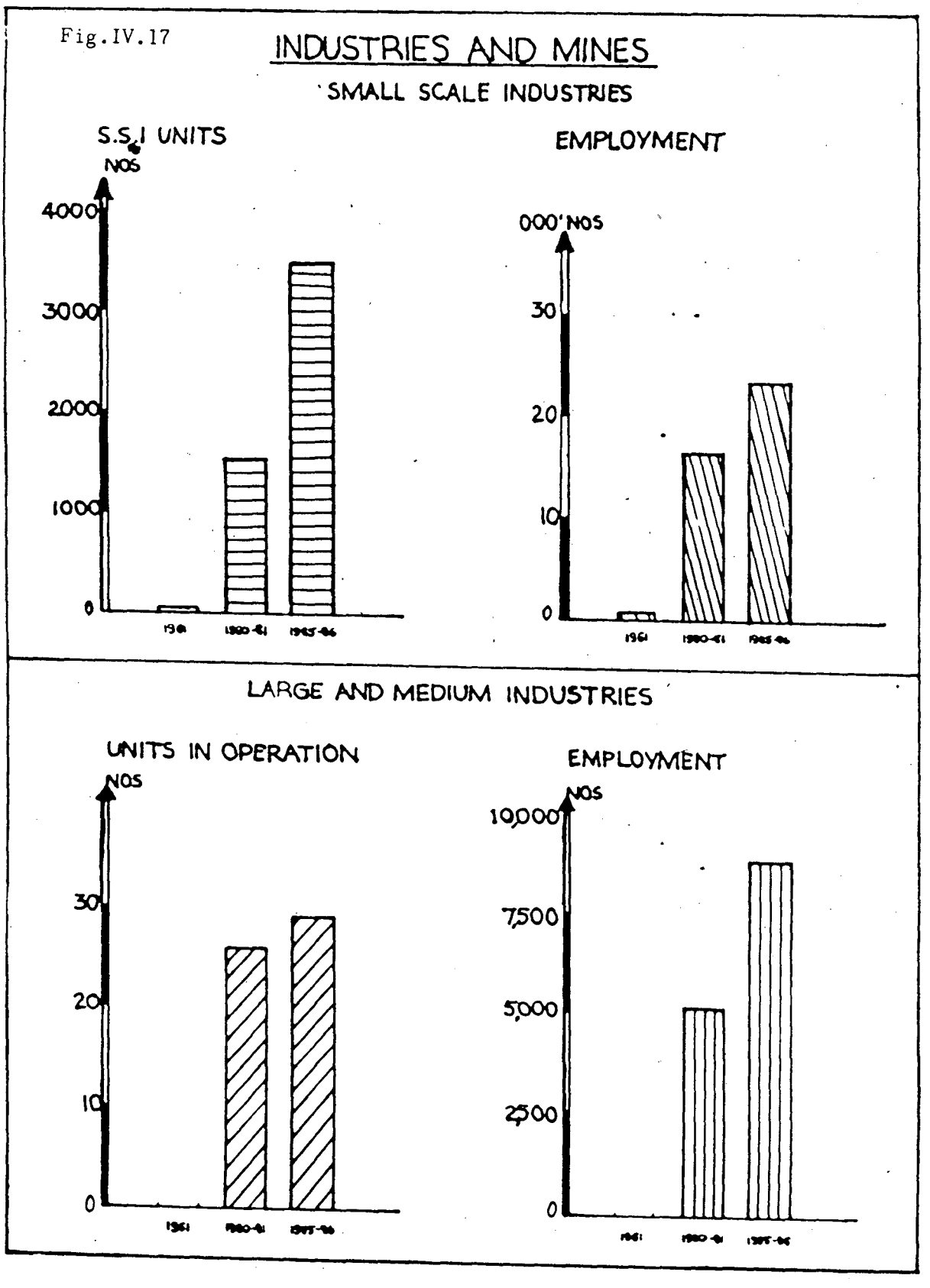
Table-13: No. of Registered Industries in Goa

No.	Industries Groups	No. of units in 1965	No of units in 1974
1.	Agrobased	9	419
2.	Forest Based	2	88
3.	Steel,Furniture,metals, workshop and barge repair	33	220
4.	Chemical and allied industries	8	77
5.	Stone crushing clay and Ceramics	1	59
6.	Non-ferous metals	1	7
7.	General engineering	2	24
8.	Leather works	1	36
9.	Rubber and rubber products.	1	25
10.	Miscellenous	11	194
Total		69	1149

Source : Directorate of Industries and Mines, Goa.

A study of industrial development in the territory reveals two distinct Goas, one as the "industrial Goa" comprising the coastal talukas where about 90% of the small

Fig.IV.17


INDUSTRIES AND MINES
SMALL SCALE INDUSTRIES
S.S.I UNITS
NOS
4000
3000
2000
1000
0
EMPLOYMENT
000'NOS
30
20
10
0
LARGE AND MEDIUM INDUSTRIES
UNITS IN OPERATION
NOS
30
20
10
0
EMPLOYMENT
NOS
10,000
7,500
5,000
2500
0

scale industries and almost all the large and medium industries are located, and other "Empty Goa" comprising the inland talukas (western ghat foothills) which is almost devoid of industrial development except the midland taluka of Ponda. The pattern of industrial growth in the entire territory shows that industries have agglomerated at those urban centres where infrastructural facilities are already available whereas in other centers which are lacking in these facilities have made very slow industrial progress. For instance, in 1974, about 80% of the total number of industrial units were concentrated in the five coastal talukas, while the remaining six talukas of the territory accounted for only 20%. The same situation continues even today.

Table-14: Talukwise Growth of Small Scale Industries in Goa.

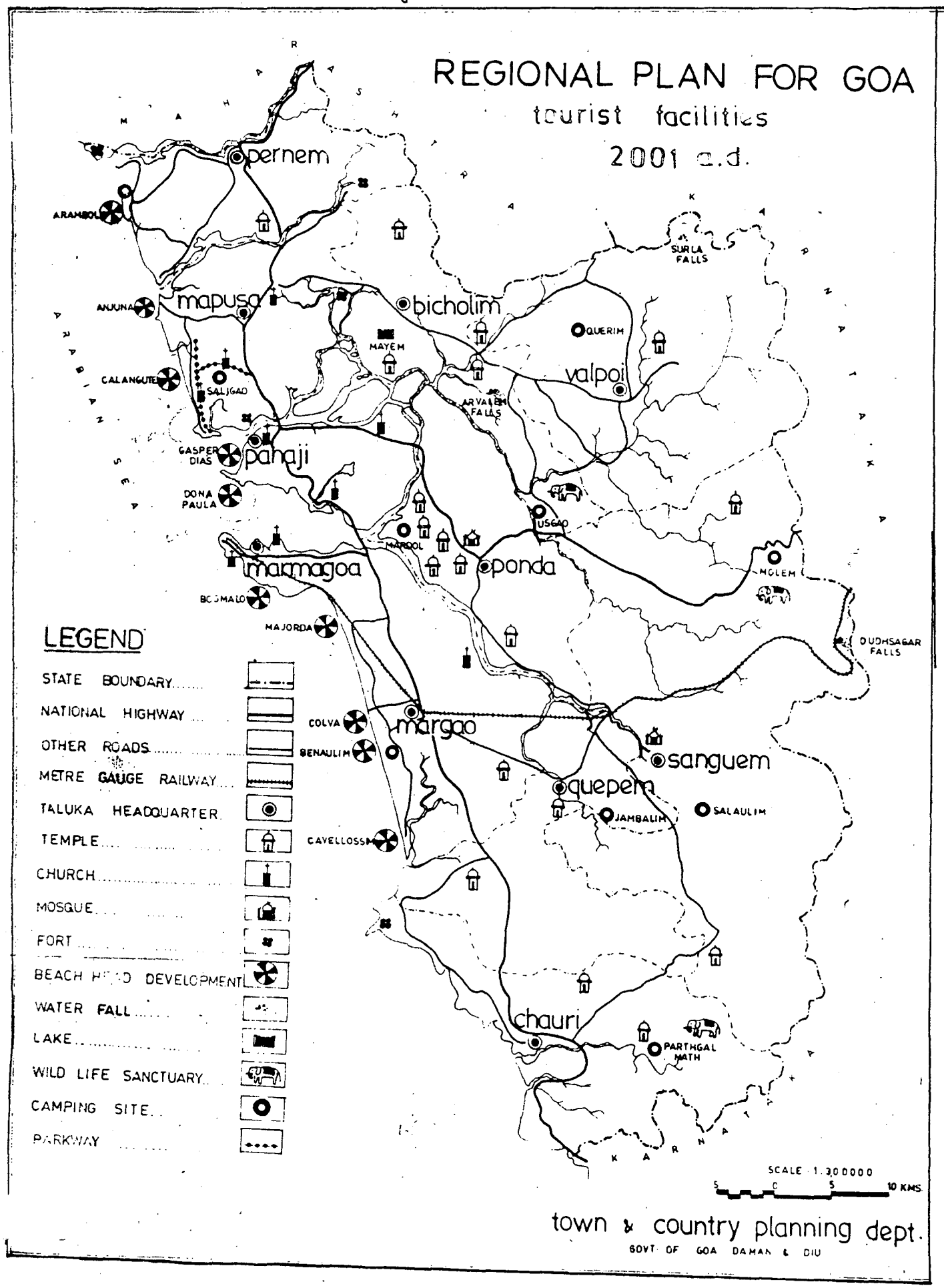
	Taluka	1965	1974	1980	1984	1988	% to Total
1.	Tiswadi	11	125	261	404	678	17.38
2.	Bardez	14	115	234	385	778	19.95
3.	Pernem	1	10	19	49	129	3.31
4.	Canacona	1	1	10	21	71	1.82
5.	Quepem	7	53	78	105	191	4.90
6.	Salcete	13	178	318	476	856	21.95

7. Mormugao	1	39	89	175	276	7.08
Total coastal talukas	48	526	1009	1615	2979	76.38
8. Bicholim	8	77	111	160	293	7.51
9. Satari	-	12	21	38	72	1.82
10. Ponda	2	88	145	252	492	12.61
11. Sanguem	1	9	20	25	64	1.64
Total inland talukas.	11	186	297	45	921	23.62
Goa state Total	59	712	1306	2090	3900	100.00

Source : Directorate of Industries and Mines and Goa at a Glance, 1988, Directorate of Planning, statistics and Evaluation, Goa.

At present (as on 31.3.1988),* there are 3000 industrial units employing 24748 persons in the coastal zone of Goa. Out of these, 856 units of small scale and 5 units of large and medium industries are located only in Salcete taluka followed by Bardez (778 and 5). Tiswadi (678 and 3), Mormugao (276 and 5) respectively. A broad classification of industries into major industrial groups (as in 1984) for Goa state shows that out of the total of 2251 units of small

*Goa At a Glance (1988), Directorate of Planning, Statistics and Evaluation, Goa.


REGIONAL PLAN FOR GOA
tourist facilities
2001 a.d.
pernem
ARAMBOL
mapusa
ANJUNA
bicholim
SURLA FALLS
QUERIM
MAYEM
valpoi
CALANGUTE
SALIGAO
ARVALEM FALLS
GASPER DIAS
panaji
DONA PAULA
USGAO
MARDOL
marmagoa
ponda
MOLEM
BOSMALO
MAJORDA
OUDHSAGAR FALLS
LEGEND
STATE BOUNDARY
NATIONAL HIGHWAY
OTHER ROADS
METRE GAUGE RAILWAY
TALUKA HEADQUARTER
TEMPLE
CHURCH
MOSQUE
FORT
BEACH HEAD DEVELOPMENT
WATER FALL
LAKE
WILD LIFE SANCTUARY
CAMPING SITE
PARKWAY
COLVA
BENAULIM
margao
sanguem
quepem
JAMBALIM
SALAULIM
CAVELOSSIM
chauri
PARTHGAL MATH
SCALE 1:300000
5 0 5 10 KMS.
town & country planning dept.
GOVT OF GOA DAMAN & DIU

scale industries, the share of food products industries, processing cashewnut and fish, was 21.10% of the total number of units, followed by manufacture of metal products and parts (14.26), manufacture of wood and wood products, furniture and fixtures (9.82%), repairing services (8.44%), manufacture of paper and paper products, printing and publishing (8.12%), rubber, plastic, petroleum and coal products (7.90%) beverages (6.23%) and so on.

Table-15: Trend of growth and percentage increase in small scale Industries in Goa (1981-84)

Sl. No.	Type of Industry	No of units in 1981	No of units in 1984	Increase in no. of units.	% increase
1.	Manufacture of food products.	315	475	160	50.79
2.	Manufacture of Beverages,Tobacco products	85	140	55	64.71
3.	Manufacture of Jute, textile, hemp Mesta	4	4	0	00.0
4.	Manufacture of textile	41	55	14	31.89
5	Wood,Wood products,Furniture and fixtures	173	221	48	27.75
6.	Paper, paper products, printings, publishing	122	183	61	50.00
7.	Leather & leather products.	14	15	1	7.14
8.	Rubber, Plastic, Petrolium & coal products.	118	178	60	50.85
9.	Chemical products	92	139	47	50.08
10.	Basic metal & alloy industries	27	34	7	25.93

11. Non-metalic Mineral products.	109	142	33	30.28
12. Metal products and parts.	203	321	118	58.13
13. Machinery and tools.	7	14	7	100.00
14. Electrical goods & appliances.	32	58	26	81.25
15. Transport equipments & parts.	38	52	14	36.84
16. Repair services.	152	189	37	24.34
17. Others.	17	31	14	82.35
Total	1549	2251	702	45.32

Sources: Dirctorate of Industries and Mines, Goa.

The proliferation of agro-based and food processing units (especially fish) seems to be due to abundant availability of agricultural and marine resources. Minerals exports explain the presence of large repair unit, metal based units etc. Similarly, the growth of forest based industries like saw mills, wood works, beverages etc. in the region is mainly due to large scale availability of forest and plantation resources. Talukwise distribution of industries by type are not available but one can imagine the nature of industries found in the coastal talukas since 90% of the total industrial units is located in the coastal zone keeping in mind the available factors of production in the Goan space economy.

Table 16 : Talukwise Distribution of large and medium scale industries in Gao in 1984-1988.

Name of Taluka	No. of units in 1984	No. of units in 1988	% to the Total	Employment in large medium units 1988
Tiswadi	4	3	8.10	580
Bardez	1	5	13.57	277
Pernem	1	1	2.70	158
Canacona	-	-	-	-
Quepem	1	1	2.70	858
Salcete	9	5	12.51	438
Mormugao	5	5	13.51	3142
Total of coastal Talukas.	21	20	54.05	5723
Bicholim	5	1	2.70	98
Satari	1	2	5.40	472
Ponda	7	11	29.73	2119
Sanguem	1	3	8.10	214
Total inland Talukas	14	17	45.95	2903
Goa State	35	37	100.00	8626

Source : Goa at a Glance, 1984 and 1988, Directorate of Planning, Statistics and Evaluation, Goa.

Large and medium scale industries are of recent origin in Goa. At present, there are 37 large and medium scale units in the Goan territory. The coastal talukas possess about 20 of them in which the share of Salcete, Mormugao and Bardez talukas have five each as on 31.3.1988. The existing large and medium industries unlike the small units are mainly engaged in the production of modern sophisticated items such as chemicals, fertilizers, pharmaceuticals, automobiles, breweries and distilleries, barge repairs and ferrous metal works, sugar, rubber and textile factories, pelletisation and ore benefication plants etc.

Though the large and medium scale industrial units account for only 1.6% of the total number of industrial units in Goa, they are one of the most largest sectors in the region in terms of investment, employment output, power and water consumption etc. A study of the relative importance of the different sectors of Goan economy, based on their contribution to the regional income, reveal that the contribution of the industrial sector, including the mining, transport and tourism is to the extent of almost 45% to state domestic product (SDP) as against 16% of the agricultural sector.

Thus it can be concluded from the above analysis that the Goan coastal zone has experienced high level of

urbanisation and industrialisation, which on the other hand has given birth to present and potential problems of congestion and pollution in the coastal zone.

TOURISM

Tourism, as it exists today, is one of the significant developments since World War II. Today, millions and millions of people travel for their holiday to get a respite from frantic industrialisation, sprawling cities, pillaged environments and to quench their desire to learn more about the other parts of the world. Tourism is encouraged in all countries of the world and has since become a way of life. It is an accepted fact that tourism is not only a pleasure and economic activity but an important medium of strengthening national integration, international understanding and world peace.

In the context of modern day tourism this small state of Goa has emerged as the foremost centre of tourism in the country, both in relation to domestic and international tourist traffic. Goa today occupies a privileged position in the tourism map of India and figures in the world tourist map. Tourism, which is particularly oriented towards coastal zone, has both positive and negative impacts on the economy - society of the region and its coastal environment.

Every year the need for open space and leisure attracts lakhs of people to the Goan coastline.

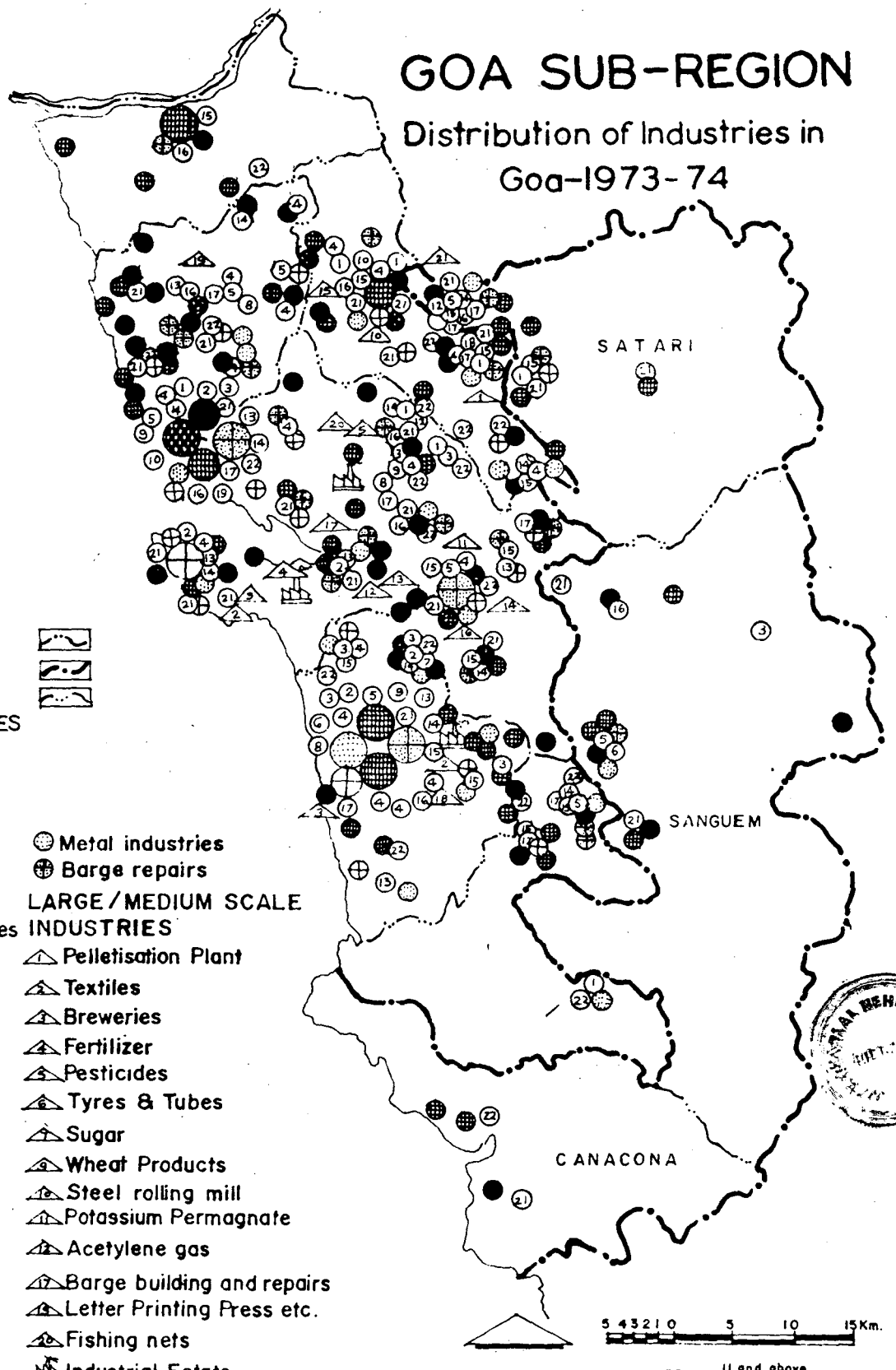
The major tourism resources of the Goan coastal zone can be classified under three categories: a) Natural Resources consisting of beaches and inland waterway and islands, b) Man-made resources consisting of churches and monasteries, Forts, towns and villages, c) socio-cultural resources.

The 105 kms. coastline of Goa consists of largely long beaches separated by promontories and estuaries, backed by interminable coconut plantations. The popularity of these beaches ranges from extremes like Calangute and Colva which are heavily frequented by both tourists and local people to isolated and almost undisturbed beaches of Arambal and Palalem. By and large tourists prefer to go to such beaches which are not very far from major towns and where infrastructure facilities are well developed. On the other hand, hippies and other adventure-loving people prefer to venture into such areas are relatively inaccessible and away from cities. In terms of attraction beaches are easily number one on almost everybody's list.

Secondly, Goan coastal zone is intersected by a number of rivers flowing into the Arabian sea and full of inland

GOA SUB-REGION

Distribution of Industries in Goa-1973-74



REFERENCES

- District boundary
- Sub-Regional boundary
- Taluk boundary

SMALL SCALE INDUSTRIES

1. Cashew nut processing
2. Canning industries
3. Breweries & Distilleries
4. Chemical industries
5. Plastic industries
6. Confectioneries
7. Insecticides & Pesticides
9. Non-ferrous metals
12. Pharmaceuticals
13. Storage batteries
14. Rubber products
15. Readymade garments
16. Clay and Ceramic products
17. Printing press
- Forest products
- Aerated Water
21. Leather Works
23. Paper conversion industry
- Mineral industries
- Rice, flour and oil mills
- Metal industries
- Barge repairs

LARGE/MEDIUM SCALE INDUSTRIES

1. Pelletisation Plant
2. Textiles
3. Breweries
4. Fertilizer
5. Pesticides
6. Tyres & Tubes
7. Sugar
9. Wheat Products
10. Steel rolling mill
11. Potassium Permagnate
12. Acetylene gas
17. Barge building and repairs
18. Letter Printing Press etc.
20. Fishing nets
- Industrial Estate

water. Tiswadi taluka which consists of group of island, big and small, is embraced by the two principal rivers of Goa, the Mandovi to the north and the Zuari to the south. Both the capitals of Goa (the old and the new) are situated along the bank of Mandovi, the islands having a tourist traffic and potential are Divar and Chorao. These inland water ways and island's tranquil setting offer facilities for water sports and picnic spots.

Goa has a rich historic past and the four and a half centuries of Portuguese rule has left a distinct architectural heritage in its ancient towns, churches, temples and its domestic architecture, the character and appearance of which it is desirable to preserve and enhance. These are areas which afford a cultural and traditional identity to the locality.

To the east of Panaji town lies the old capital, Velha Cidade or old Goa with its famous churches and monasteries. Once the seat of an opulent culture and luxurious wealth and acclaimed as "Rome of the East", today is redeemed from total oblivion by the presence of the uncorrupted remains of St. Francis Xavier.

The Portuguese have gone leaving behind their monuments to speak of their presence. The most striking landmark of

their long stay on the coast of India are forts. Goa was always in danger specially of the Dutch and the British who were making repeated attempts to capture Goa. As a measure of defense many forts were erected at different strategic locations. Among the most famous and prominent are Aguada fort, Terekhol to the north, Chapora, Aloma, Reis, Magos, and Cabo de Rama to the south.

Each society has its own festivals and other cultural characteristics that make it different from any other. Goa, with its blend of Indian and Latin culture, is a very good example of this. The yearly "carnival" festival and Christmas attract lot of visitors to the region.

The planning concept, to be practical, would need to take into account all these resources. The basic impact on an area is influenced by the number of visitors, their length of stay, how much they spend and their taste and desires. The attractive features of an area are responsible for the desire of a tourist to visit the area. Similarly, the location is equally important in influencing the type and a number of tourists that may visit. The desire and tastes are generally associated with age, background, education, profession and region or country of residence.

The demand for goods and services like food, lodging and sports activities vary according to the background, age, socio-economic status and place of origin. Similarly, different tourists spend different amounts of money, which generally has different effects upon the tourist industry.

Table 17 : Tourists Arrivals in Goa (1973-86)
Domestic

Month	1973	1975	1977	1979	1981	1983	1985	1986
January	10332	22925	23364	33056	40433	51719	67262	71737
February	7985	15973	20924	26535	31570	39279	51471	58410
March	8991	15859	22922	23497	30532	34809	65280	62852
April	9776	15236	25341	26079	30532	34809	65280	62852
May	129351	22910	36551	34725	44227	47697	64303	80460
June	8430	12803	24047	30089	37655	43076	43463	52514
July	6867	9782	12174	15461	19551	35781	38962	42955
August	7180	9419	12164	17018	20253	24224	40578	48537
September	8200	9841	13391	20256	23109	26629	51875	54070
October	13458	16911	22785	32597	41742	47404	62512	68598
November	12299	21544	29605	28361	39436	48568	61958	65844
December	12934	25776	26260	37110	52387	60380	90700	72331
Total	119387	198979	269498	324814	409715	496440	682545	736548

Note : Data also consist of Daman & Diu

Source : Department of Tourism, Govt. of Goa, Panaji.

Fig.IV.18

TOURISM

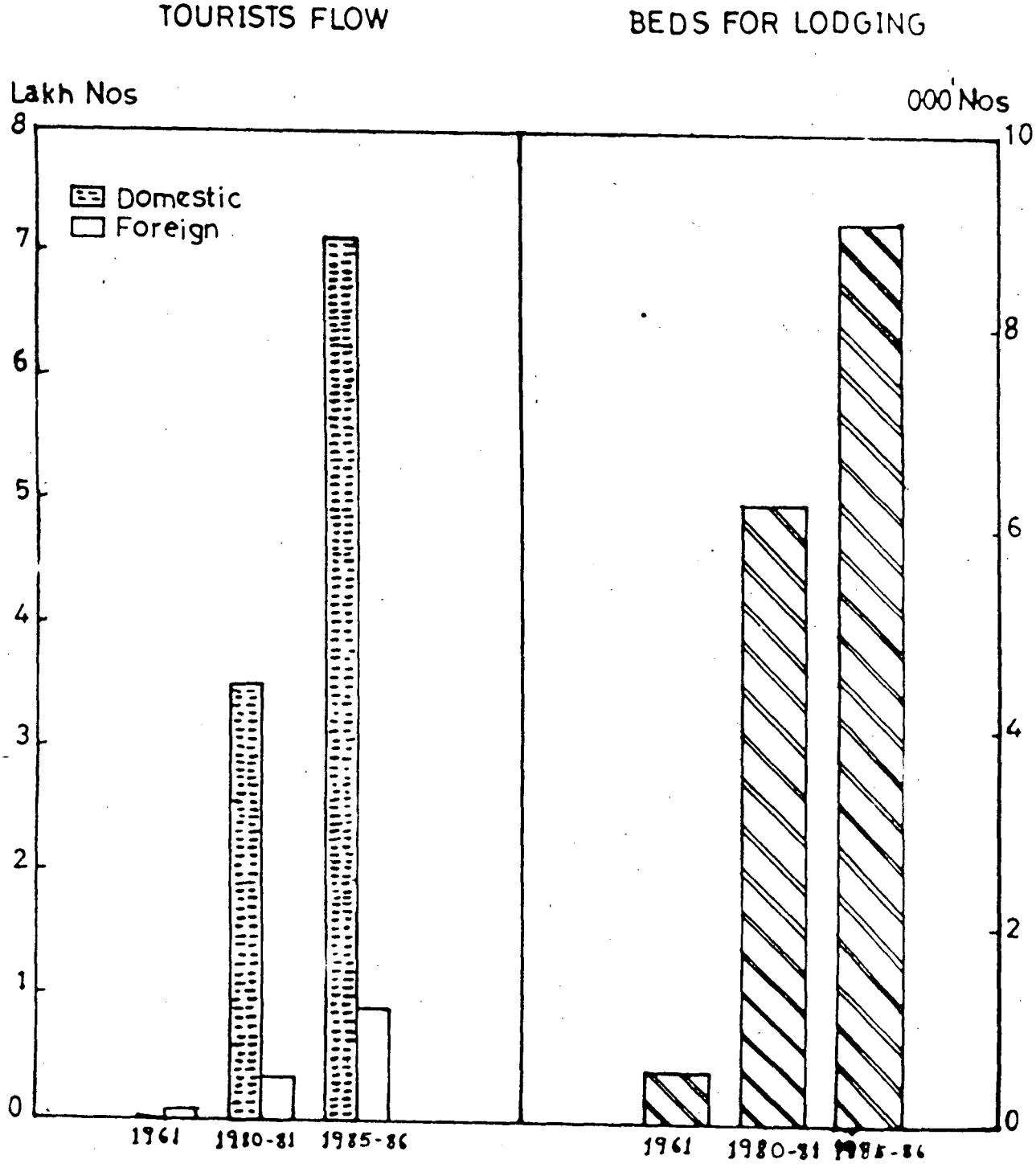


Table 18: Tourists Arrival in Goa (1973-86)
International

Month	1973	1975	1977	1979	1981	1983	1985	1986
January	1161	1856	3024	3339	5426	4842	13843	13240
February	1036	1472	2540	3910	4206	3846	18882	14889
March	979	1160	2011	2868	3632	3247	9370	10157
April	623	923	2065	2036	2577	2336	8026	9132
May	237	571	1291	1298	1241	1380	6622	9095
June	251	548	1135	1168	1035	927	2893	4253
July	282	451	1032	1188	919	757	1703	3914
August	605	514	1453	1688	1584	1589	2510	5131
September	617	705	1034	1737	1362	1309	5667	5758
October	647	942	1383	2162	1793	3349	5839	7214
November	818	1264	1715	4765	2178	4123	7764	7886
December	1115	2088	2123	4669	2247	5847	9548	8584
Total	8371	12494	20806	30778	29300	33575	92667	97533

Note: Data also consist of Daman and Diu.

Source : Department of Tourism, Govt. of Goa, Panaji.

Statistics available on tourist traffic in Goa over the last 13 years, reveal that Goa is experiencing a tourist influence from international tourists as well as domestic tourists. These figures have shown a considerable increase

over the years in both these categories. The flow of international tourists from 1973 to 1986 has shown an increase from 8371 in 1973 to 97, 533 in 1986. Similarly, the flow of domestic tourists has registered an increase from 119387 in 1973 to 73548 in 1986 as seen in the tables.

Table-19: Geographical Distribution of Domestic Tourists in Goa 1986.

Taluka	Hotels No. of tourists	%age to total	Hired Houses No. of tourists	%age to total	Total no.of tourists	%age of State's Total
Bardez	132476	91	13095	9	145571	20
Tiswadi	292364	96	11327	4	303691	42
Mormugao	70264	93	5425	7	75689	11
Salcete	135762	93	983	7	145635	20.5
Ponda	30811	90	3420	10	34264	4.5
Others	14166	100	-	-	14166	2
Total	675876	94%	43140	60%	719016	100%

Table-20 : Geographical distribution of International tourists (1986) in Goa.

Taluka	Hotels No. of tourists	%age	Hired Houses to total no. of tourists	%age	Total to total no. of tourists	%age of State's total
Bardez	33090	73	12421	27	45511	37.5
Tiswada	26207	96	1121	4	227328	22.5
Salcete	21604	79	5641	21	27245	22
Marmugao	14108	95	729	5	14387	12
Perneux	332	10	3138	90	3470	3
Canncona	-	-	2690	100	2690	2
Others.	506	100	-	-	506	1
Total	95847	79	25740	21	121587	100

Note : The numbers perttain to Goa only.
Source : Tourism Department, Govt. of Goa, Panaji.

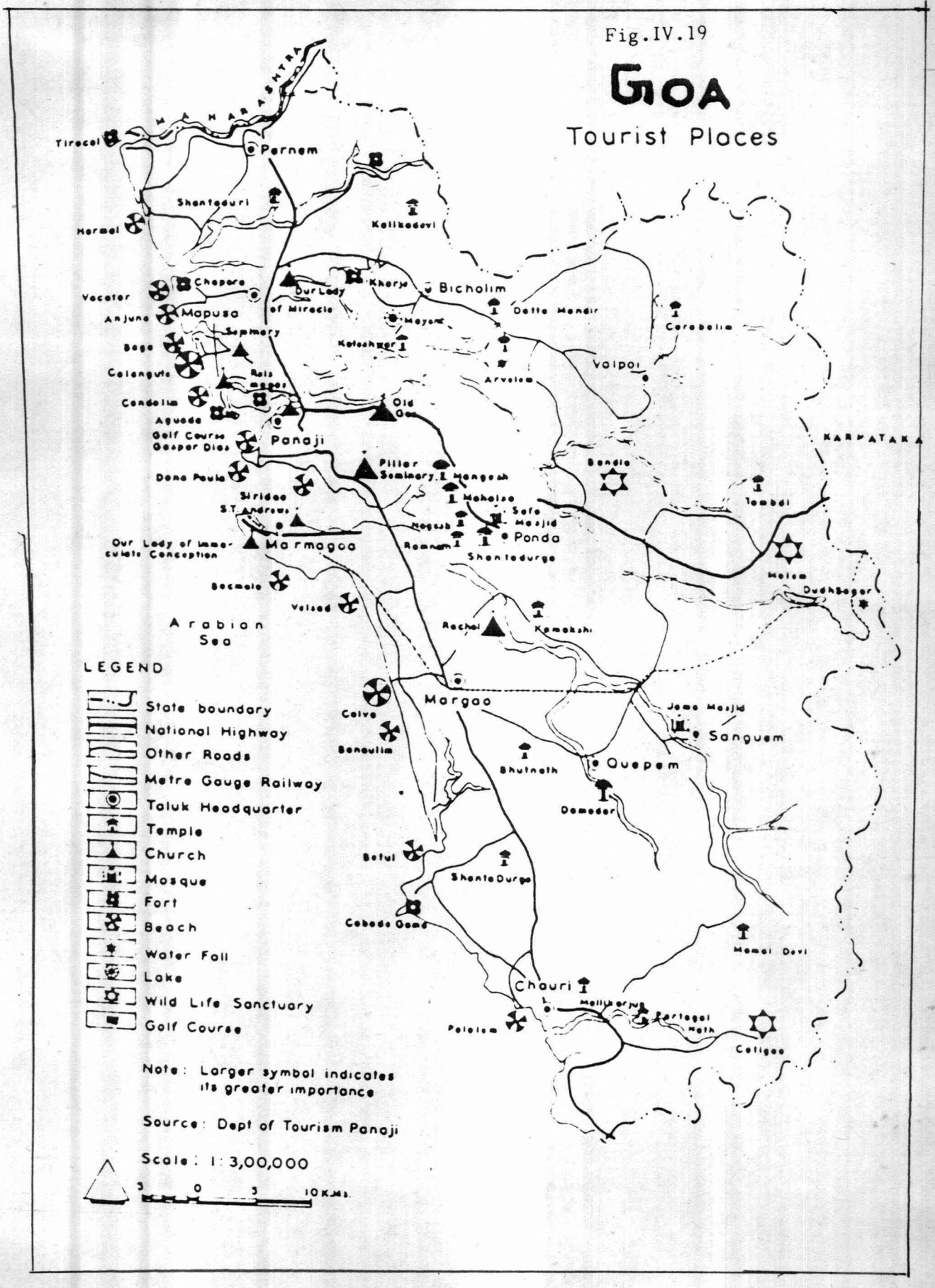
Distribution of tourists according to domicle status based on the finding of the survey with respect to domestic tourist indicates that the major tourist flow is from the North India region comprising 63%, south Indian region accounts for 22% and the north-east region 15%. In the international tourist category the highest population is from Europe 75%, followed by Asia 13.4%, North America 11%, South America 0.4%, and Africa 0.2%. The majority of domestic tourists are Hindus and foreigner Christians.

The 21-30 years age group is dominating both domestic and foreign tourists arrival (50%, followed by the age group of 31-50 years), 37% in both the class. As far as mode of travel is concerned, 43% of domestic tourists opt for bus journey, 20% rail, 15% air, 14% ship, 3.5% own vehicles and 1.5% chartered buses. Majority of foreign tourists i.e. 38% prefer air journey whilst 33% travel by ship, 21% by road and 8% by rail. Majority of tourists in both categories come for holiday and pleasure, 70% and 95% respectively of the total.

The climatic conditions specially during the monsoon period are not very favorable for tourist activity. Only periods from the month of December to April attract large number of tourists. The tourist traffic in Goa discloses not only seasonality but also geographical concentration in selected coastal talukas. The figure of 1986 reveal that the four coastal talúkas of Bardez, Tiswadi, Salcete and Mormugao and the inland taluka of Ponda received almost all the tourists in Goa. Among the five talukas, Tiswadi in which lies the state capital of Panaji is preferred by the domestic tourists 42%, followed by Salcete 20.5%, Bardez 20%, Mormugao 11% and Ponda 4.5% and others 2% only.

However, with respect to international tourists, its preference lies for Bardez where Calangute Beach is located

Fig.IV.19


GOA
Tourist Ploces
MAHARASHTRA
Tiracol
Pernem
Shantedurl
Kalikadevi
Hermal
Chopora
Vagator
Anjuna
Mapusa
Our Lady of Miracle
Khorjuvem
Bicholim
Datta Mandir
Mayem
Sanquelim
Bage
Colangute
Calangute
Candolim
Aguada
Golf Course
Panaji
Old Goa
Arvalem
Valpoi
Carambolim
KARNATAKA
Pillar Seminary
Mangesh
Bandia
Dona Paula
Siridao
ST. Andrew
Mahalsa
Safa Masjid
Tambdi
Our Lady of Immaculate Conception
Marmagoa
Mogesh
Ponda
Ramnath
Shantadurga
Molem
Dudhsagar
Becmale
Velsao
Arabian Sea
Rachol
Kamakshi
LEGEND
State boundary
National Highway
Other Roads
Metre Gauge Railway
Taluk Headquarter
Temple
Church
Mosque
Fort
Beach
Water Fall
Lake
Wild Life Sanctuary
Golf Course
Margao
Jama Masjid
Sanguem
Calve
Benaulim
Bhutnath
Quepem
Damodar
Betul
Shanta Durga
Cabado Goa
Mamai Devi
Chauri
Mallikarjun
Portogal Math
Poloiem
Cotigao
Note: Larger symbol indicates its greater importance
Source: Dept of Tourism Panaji
Scale: 1:3,00,000
5 0 5 10 K.Ms.

with almost 37.5% of the total international tourists followed by Tiswadi 22.5%, Salcete 22%, Mormugao 12%, Pernem 3%, Cana Cona 2% and others 1%.

On the whole, from the picture which emerges, it seems that the coastal talukas receive far more tourists than the other inland talukas. The reason being that apart from accommodation, food and shopping facilities, these coastal talukas, have also good accessibility and more intimate relations with the people from the rest of India and the outside world.

Table-21: Talukwise distribution of tourists in Goa (2001 AD)

Taluka	Expected tourist traffic by 2001 AD	Area which could be earmarked for development of tourism.
Tiswadi	336,000	Panji, Dona Paula Suburbs and old Goa.
Bardez	224,000	Mapusa and along the coast.
Salcete	224,000	Margao and along the Coast.
Mormugao	112,000	Vasco, chicalim (Airport Area) and along the coast.
Pernem	27,200	Pernem town, Tiracol and along the coast (Harmal, Morjim and Keri).
Quepem	11,200	Quepem Town, Curchorem and Betul.
Cannacone	11,200	Along the coast (in particular cabo de Raina, Agonda, Pololem, Talpona Galgibhag and Pollem)
Ponda	140,800	Ponda town, Farmaguddi and temple areas.

Bicholim	11,200	Bicholim town and Mayem.
Satari	11,200	Anjunem, Surla (on the road to Belgaum) Vagheri hill.
Sanguem	11,200	Sanguem town and Salauli.

Source : Regional Plan for Goa, 1986-2001 AD, Town and Country Department, Govt. of Goa, Panaji, Goa.

Foreign tourism represents an important currency source to the country as well as a source of employment to the people in Goa. Tourism development has also enjoyed strong government support over the last several years in the state. It is seen that from the point of view of attractiveness, the beaches are way ahead of any other resources. It is precisely because of this reason that till now most of the development activities whether big or small have had a tendency to concentrate along the coastline. These developments pose present and potential threat to the unique coastal environment in various ways.

MARINE FISHERIES

The exploited marine living resources of Goan coastal zone comprises of a variety of finfishes and shellfishes, harvested from the Open sea, estuaries and the backwaters. Traditionally, 90% of the Goans are fish eaters and hence

the demand for any type of sea-food is considerable. There are 61 marine fishing villages and the total fisherman population is about 39,912. About 2500 country crafts and nearly 900 mechanised boats are used in Goan coastal zone fisheries [Silas, E.G. et al. (1986), CMFRI Spl.Publ., pp.1-26].

Table - 22: Some information on Goan Marine Fisheries

1.	Coastline	105 km
2.	No. of fishing villages (1980 census)	61
3.	No. of Landing Centres (1980 census)	39
4.	No. of Fishermen Households (1980 census)	6725
5.	Fisherman population (1981 census)	39912
6.	No. of fisherman engaged in actual fishing	8871
7.	Average annual contribution (tonnes) of marine fish landings by mechanised and non-mechanised units in 1981-83	
	a) Trawl	19530
	b) Purse-Seine	8430
	c) Others	1352
	Total Mechanised	29312
	Total non-mechanised	6097
8.	Value of average annual marine fish landings at landing Centre [price in million Rs.(1981-83)]	179.8

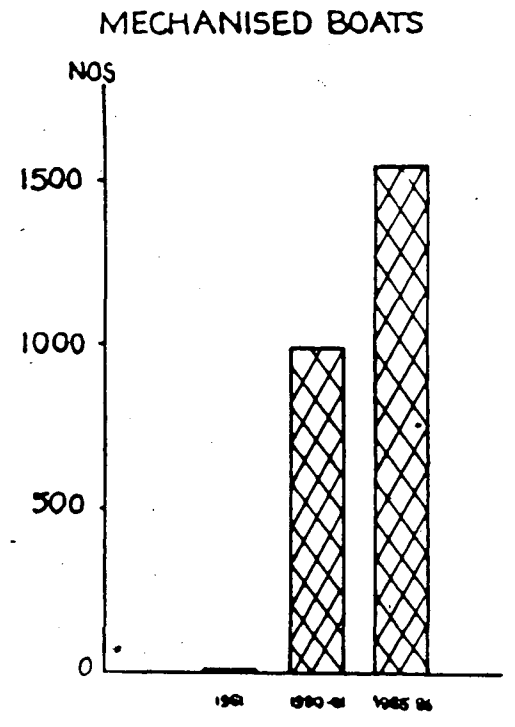
9.	No. of fishing crafts	
	a) Mechanised (1980 survey)	908
	b) Non-Mechanised (1980 survey)	2513
	c) No.of fishing gears (1980 survey)	8976
10.	No. of persons engaged in capture fisheries	24763
	a) Artisanal	17681
	b) Small Mechanised Boats	5446
	c) Infrastructure facilities	96
	d) Transportation facilities	1540
11.	No. of persons engaged in culture fishery activities	3600
12.	Annual fuel consumption ('000 tonnes) and its cost ('000 Rs.) in marine fishing operations:	
	a) Diesel	9461
	b) Other Oil	152
	c) Cost	36490
13.	Percentage of fish eating population	90
14.	Availability for local consumption (tonnes)	29089
15.	Annual per capita availability (Kgs)	30.94
16.	Annual demand (tonnes) at 10 kg per head	9400
17.	Total marine fish production in 1988 (tonnes)	45000

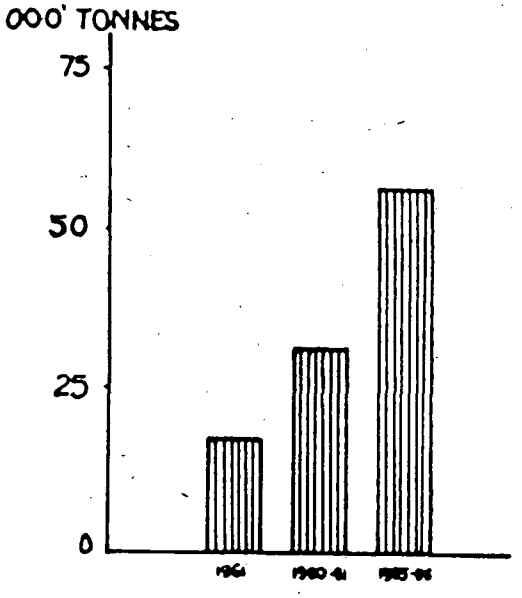
Source: CMFRI, Special Publication No.29, November 1986

Yojna, 1-15 April, 1989.

Fig.IV.20

FISHERIES





The fish production in Goa has shown wide fluctuations ranging from 15740 tonnes in 1973, 34968 tonnes in 1976, 38063 tonnes in 1984 to 45000 tones in 1988 Provisional with an overall average yield of 30000 tonnes. A major part of the yield comprises of pelagic fishes like sardines and mackerals, which together contribute about 70% but with widely fluctuating records.. The demersal catch, contributing about 30% represented by shrimps and other varieties of finfishes like butterfish, pomfrets, scienenids and silver bellies. The demersal fishes in contrast to pelagic stock exhibit less annual variations and there is a steady increase in demersal fish landings, possibly as a result of considerable increase in mechanised fishing.

Incidentally, the number of mechanised boats have gone up from 10 in 1963-64 to about 900 in 1980-81. Most of the mechanised boats are less than 45 feet in length and accordingly their range of operation is very much limited to a narrow coastal or inshore zone, within the 20 fathom depth line. In view of this, the most extensively fished area is about 2000 sq.km. In spite of the increased mechanised fishing - trawling, purse-seining and trolling lines - the fisheries of Goa are largely dependent on non-mechanised crafts like dugout canoes, plank built canoes and rompani boats, using traditional gear like cast nets, drag nets, gill nets, hook and line etc.

Besides the open sea fishing, on an average about 1800 tonnes of fish, shrimp, clams, mussels and oysters are harvested from creaks, estuaries and backwaters of Goa, spreading over an estimated area of about 200 sq.kms.

The utilisation of fish is 81% fresh, 9% sundried, 5% salted and 5% manuring. Since 1967, a part of the catch mainly frozen shrimps, canned fish, besides the freshly iced mackereals and sardines are being exported either to international or national markets. The quantum of exports which has about 60 tonnes in 1967 has gone upto 663 tonnes in 1973, 278.3 tonnes in 1980 and 1362 tonnes in 1985 (P) voluming Rs.756.80 lakhs mostly to Japan and Singapore. The export is showing steady progress.

The present level of exploitation of marine living resources yielding an annual catch of about 40000 tonnes is mainly confined to a narrow coastal areas which accounts for only 20% of the total fishable area off the 105 km Goan coastline. Though the marine fish landings in Goa have shown steady increase since liberation in 1961, the optimum sustainable yield which is about 60% of the total exploitable yield, is still not been achieved.

The assessment of the potential estimates of living resources of any marine biotype is done by

- computation from primary and secondary organic production;
- Exploratory fishing survey,
- Calculating the sustainable yield potential from actual fish landing figures as the base.

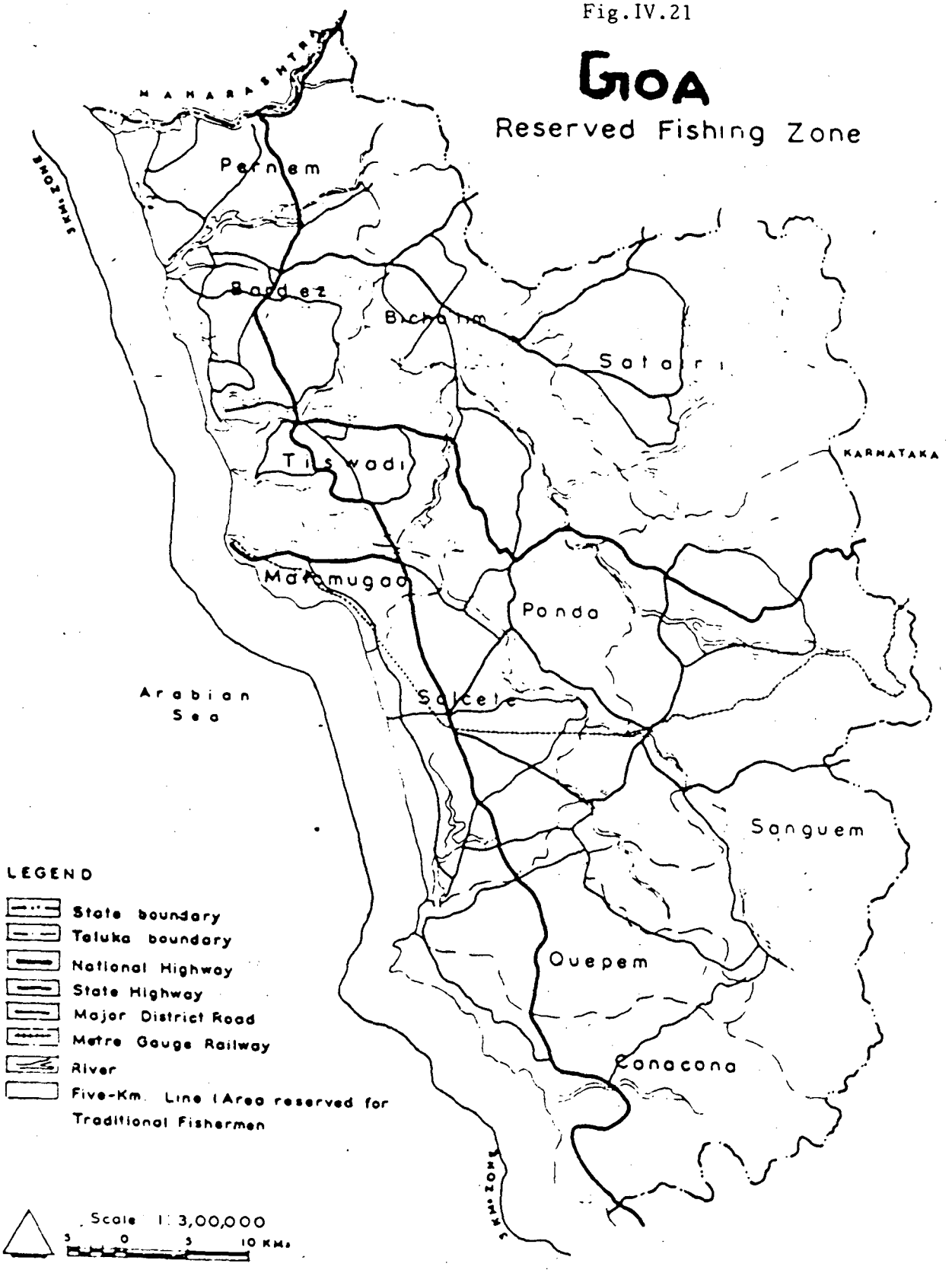
On the basis of available published data on biological productivity, the estimated yield (potential and sustainable) is assessed and given below for Goa area :

Depth in meters	Area in sq.km.	Annual organic production in tonnes/year	Estimated potential yield in tonnes/year	Estimated sustainable in tonnes/ year
50	2849	7×10^5		
		9×10^5	69,600	41,760
50-200	7135	6×10^5		

Source: National Institute of Oceanography, Goa (1978)

The estimates of potential and sustainable yield arrived at are more relevant to pelagic fishes having dependence on column productivity for food.

Fig.IV.21


GOA
Reserved Fishing Zone
MAHARASHTRA
Pernem
Bardez
Bicholim
Satari
Tiswadi
KARNATAKA
Mormugao
Ponda
Salcete
Arabian Sea
Sanguem
Quepem
Canacona
3 KMS. ZONE
5 KMS. ZONE
LEGEND
State boundary
Taluka boundary
National Highway
State Highway
Major District Road
Metre Gauge Railway
River
Five-Km. Line (Area reserved for Traditional Fishermen
Scale 1:3,00,000
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Based on secondary (benthic) production, the potential yield of demersal fish for the shelf of Goa has been estimated to be 32 kg/hectare, as against the present rate of exploitation of 95 kg/hectare and accordingly the potential and sustainable yield has been projected to be 48000 tones per year and 30000 tonnes per year respectively (NIO, Goa, 1980). Thus the estimated sustainable yield of fish (pelagic and demersal) will be 70,000 tonnes (41760 pelagic and 29000 demersal) thus enabling more than one and half fold increase in the annual yield.

The exploratory fishing survey data show a wide range of values of 19.3 kg per hectare, 30.10 kg/hectare and 47.8 kg/hectare respectively as reported by different scholars and scientists of NIO, Goa, 1973. These data are also not comparable as there is no uniformity in the extent of area surveyed, season of survey, gear used and duration of survey. However, findings of Rao and Dorairaj (1968) appear to be more realistic as the survey covered wider shelf area using a standard gear and a statistically valid sampling techniques. The potential yield of demersal fish as per the estimates of Rao and Dorairaj was 47558 tonnes with an estimated sustainable yield of 28535 tonns from an area of 15798 sq.kms mainly off Goa.

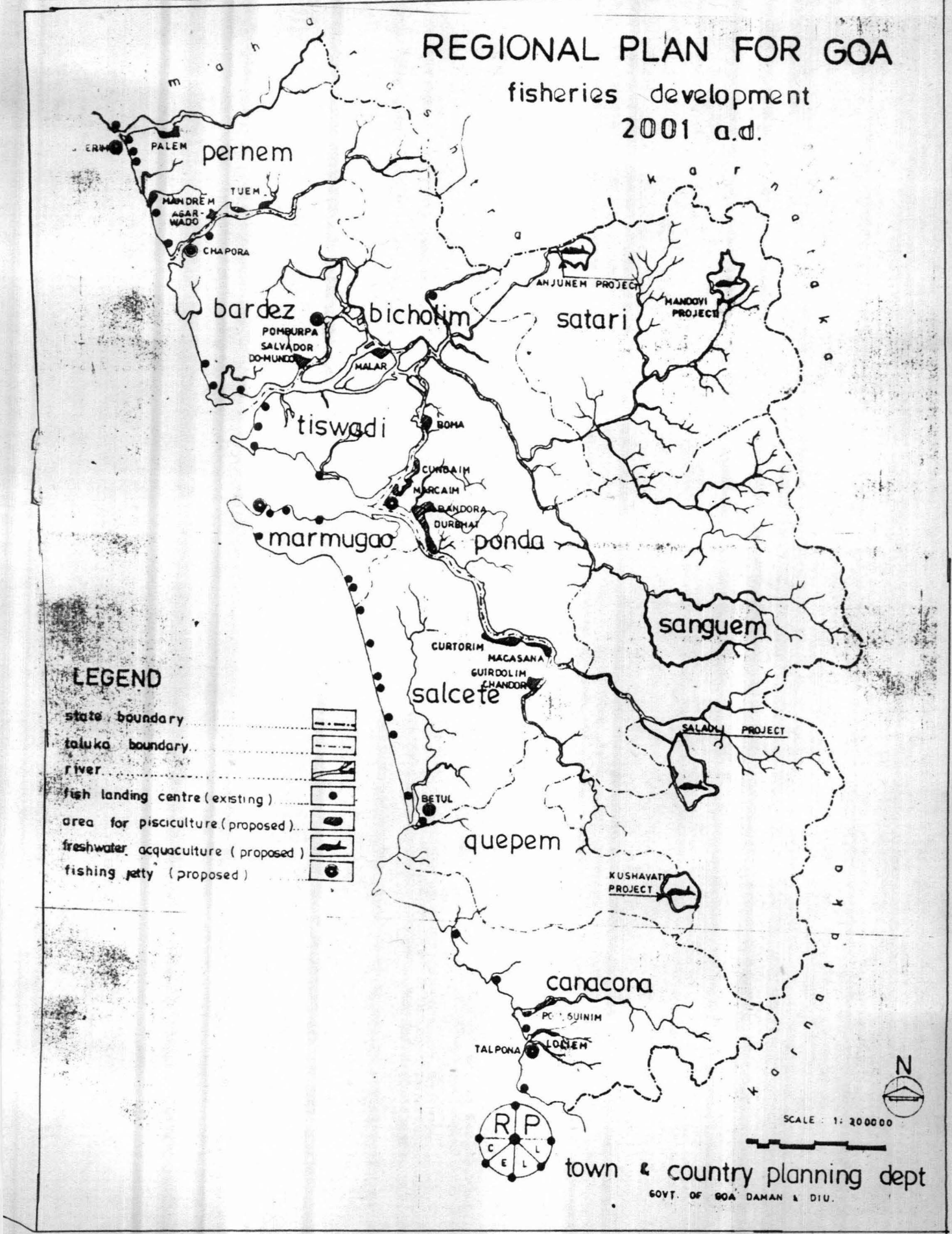
Besides the exploited fishery resources, there are other marine living resources which at present are either under-exploited or unexploited. Some of the important under-exploited living resources are the shell-fishes like clams, mussels and oysters which have an estimated exploitable potential of over 5000 tonnes per year (NIO, Goa, 1980). Similarly, other unexploited resources are the seaweeds, having an annual production potential of about 2000 tonnes (wet weight).

COASTAL AQUACULTURE

There is a general agreement that from the traditional inshore (upto 40 m depth and 15 to 20 km away from the coastline) fishing grounds, the conventional marine fisheries, any further increase in the fishing effort will not substantially enhance the fish catch. Deep-sea fishing technology, involving high cost and relatively low yield, may not provide all the fish that is needed for supplementing the protein deficient diet of the growing human population. Thus apart from expanding the activities relevant to the increased exploitation of marine living resources, there are other promising avenues of fisheries development like aquaculture or fish farming.

In this context, it needs to be emphasized that coastal aquaculture by traditional methods involving composite culture of wild stocks of prawns, mullets, milkfish and pearl spot is in practice in the estuaries and backwaters of Goa. Presently, about 20 km of estuarine water-spread involving a manpower of around 400 and producing 80 tonnes per year of prawns and finfishes is under "mass" and "agar" type of fish farming in Goa. The common fish farming practices include "permanent fish farms", "salt-cum-fish farming" and "paddy-cum-fish farming". The permanent fish farms involves round the year operations but other two types essentially include seasonal activities of rather secondary importance. The annual yield varies from 350 kg/hectare in a salt-cum-fish-farming to 1060 kg per hectare or even upto 2000 kg/ha in a permanent fish farm.

The low lying paddy fields which are stretched all along the inland water ways upto the point of salinity intrusions are locally known as "Khazan lands". It is estimated that about 20000 hectares are covered under Khazan lands in Goa. Khazan land fish farming in Goa has been declining because of prevailing statutory regulations restricting the intake of saline water in the low lying wet lands for fish and prawn farming.


REGIONAL PLAN FOR GOA
fisheries development
2001 a.d.
pernem
PALEM
MANDREM
AGARWADO
TUEM
CHAPORA
bardez
bicholim
satari
POMBURPA
SALVADOR DO-MUNDO
MALAR
ANJUNEM PROJECT
MANDOVI PROJECT
tiswadi
BOMA
CUMBAIM
MARCAIM
PANDORA
DURBHAT
marmugao
ponda
sanguem
CURTORIM
MACASANA
GUIRDOLIM
CHANDOR
salcete
SALAULI PROJECT
BETUL
quepem
KUSHAVATI PROJECT
canacona
TALPONA
LOLIEM
LEGEND
state boundary
taluka boundary
river
fish landing centre (existing)
area for pisciculture (proposed)
freshwater acquaculture (proposed)
fishing jetty (proposed)
N
SCALE : 1: 200000
R P
C E L L
town & country planning dept
GOVT. OF GOA DAMAN & DIU.

The scope for the expansion of coastal aquaculture in Goa appears to be good as there are vast stretches of low-lying lands in the coastal talukas bordering the estuaries and the mangrove vegetation. A plot of low lying land measuring about 110 hectares on the Chorao deltaic islands at the confluence of the Mandovi and the Narora rivers, is to be developed for coastal aquaculture on the basis of industrial estate/horticultural estate.

With a view to develop a scientific culture system for the brackish water varieties of fish and prawn, a fish farm covering an area of about 5 hectare water area was established by the Department of Fisheries at Ela, Dhauij. Extensive culture experiments of all the varieties of fish and prawn available in Goa have been undertaken, and it has been possible to develop a culture technique to suit the local conditions. The culture technique for the production of about 400 to 500 kgs of prawn per hectare per crop of four months duration and about 2500 kgs of fish per hectare per year has been developed at this farm. The farm also extends training and demonstration facilities to the farmers and entrepreneurs in brackish water fish farming.

COASTAL HAZARDS

The coastal zone of Goa is subject to flood and erosion problems particularly during the south-west monsoon. Erosion is noticed during May to September and varies from 0 to 68 mm month^{-1}. Although floods and erosion have been occurring since time immemorial, it is in recent years that the problem is aggravated.

The low-lying areas of the coastal talukas are used for paddy cultivation, and settlements since historical times. Lands being low-lying need protection against the sea ingression and floods. These areas have been protected by constructing and maintaining the protective bunds, sluice gates etc.

Agriculture was the primary occupation of people in Goa until the early 1960s when the mining activity started taking shape. Ore reserves in Goa are estimated to be at the order of 400 million tonnes. Extraction of one tonnes of good ore is expected to generate about 1.5 tonnes of rejects. Over the years, considerable quantity of such rejects has been produced which besides damaging agricultural lands, have given rise to siltation of water courses, to which these rejects are ultimately put during rainy seasons. Most of the ore mines are located in the

vicinity of river systems and transport of ore to the Mormugoa port is being effected through mechanised barges plying through inland water ways. Movement of mechanised barges has further weakened and damaged the protective bunds with the impact of waves. Mining activity has also aggravated flood problems because of indiscriminate cutting of forests in the mining areas and the resultant uncontrolled erosion, resulting in silting of water courses, making drainage problems more severe.

Apart from above causes, breaches are also caused deliberately by farmer or if natural, are not promptly reported as the inflow of saline water enables prawn fishing.

Goa has a coastline of 105 kms. Although the Goan coast is not subjected to heavy cyclones, as experienced along the east coast of India, heavy sea erosion is being experienced over the last 25 years or so. The nature of coastal erosion is understood by studying the prevailing pattern and energy of waves, tides, currents, beach profile, sediment transport, wind data etc. Along the Goan coastline, the sediment load is observed in the range of 0.003 to 0.373 g l^{-1} and it was generally high from April to August. Along the Terekhol mangrove, the suspended load varied from 0.003 to 0.266 gl^{-1}. In Mandovi it was in the

range of 0.02 to 0.373 gl^{-1} while in Zuari it was 0.003 to 0.272 gl^{-1} [Jattap, T.G. (1986), Ph.D. Thesis, pp.13-36].

Accretion is observed from October to April in the range of 0 to 23 mm $month^{-1}$. Erosion is noticed during May to September and varied from 0 to 68 mm $month^{-1}$ [Ibid, p.20]. Maximum erosion occurs during June to August.

Erosion is caused by the processes of nature, sometimes aggravated by man-made development along the shoreline or by direct removal of material from the beaches and dunes by man for commercial purpose. A number of rivers intersect the shoreline to join the Arabian sea in Goa carrying a large quantity of sediments which constitute a major source of sediment supply. Damming these rivers could significantly deprive the coast from its natural supply of sand previously available. This is one of the causes of erosion in India. construction of coastal structures could also lead to serious man-made erosion problems if they are not planned and constructed properly.

Waves have enormous energy and most of this energy is dissipated in the surf zone by breaking. Sediment movement and beach changes are, therefore, very rapid in this surf zone. It is well known that heavy storm during the monsoons

generating high and steep waves cause severe erosion of the shoreline. The change in water level caused by tides and storm surges is also important in sediment transport since at higher waterlevel, waves attack higher regions of the beach profile. Higher waves break further offshore, widen the surf zone and set more sand in motion [Ibid., p.20].

Usually the threat to the marine and estuarine environment is maximum on the borderline where the ecosystems merge with water bodies. Almost all the estuaries merge with water bodies. Almost all the estuaries in the Goa coastal zone are fringed with a specialised ecosystem-mangroves. These amphibious plants generally grow in the intertidal region. Being economically important, they are utilized for various purposes like timber, tannin, charcoal, paper and pulp. The mangrove swamps are rich in detritus and ideally suited as breeding and nursery grounds for marine as well as estuarine organisms. The densely formed mangrove roots, popularly known as pneumatophores - increase the rate of accretion and minimize the coastal erosion. Thus, the mangroves are well known as coastal stabilisers.

According to a recent survey with the help of Aerial photography, Untawale et al. (1980) have estimated that about 2000 hectares of the estuarine intertidal region in

Goa is covered by mangrove forests [Ibid., p.20]. There are about 25 species of mangroves and also several associated species. These area of mangroves are rich in estuarine fauna also. Particularly, species of prawns, crabs, detritivorous species of various fishes are abundant in these areas. All these organisms feed on the detritus for which magrove is the major source.

It has been observed that large scale cutting of these mangroves is undertaken in Goa specially for firewood. The mangrove soil is also excavated and used for paddy fields and coconut plantations. As a result of these activities, mangroves along the estuaries of Goa are gradually diminishing. Taking into considerations their importance as a supporting ecosystem for fisheries and coastal stabilisers, some strict protective measures are urgently required.

Along the Goan coastline of about 105 km, about 73 km are is covered by the sandy beaches. There are several sandy shores of varying length and width. The longest bach is at Colva which is about 25 km, while the famous Calangute beach is about 7 km. These sandy shores are dynamic in nature and change their profiles according to the seasonal changes in the nearshore environment. The sand-dunes

ecosystem is nature's barrier and defence line against tidal waves and sea erosion. The sand dunes system with the dune vegetation play a major role in protecting the coastline. However, with recent spurt in construction activity in Goa and especially, the extraction of sand from the sand dunes for development works has lead to re-exposing the coastal area to erosion which are likely to cause considerable damage to the environment.

COASTAL POLLUTION

Practically all the human settlements on the Goan coastal zone utilise the sea or coastal water bodies as receptacles for a variety of wastes. This use of the coastal waters generates pollution and adverse ecological alterations. Studies on environmental pollution in and around the Goa were initiated in 1970 when the NIO (National Institute of Oceanography) was transferred to Panaji from New Delhi. Since then, the scientists of NIO have monitored all the aspects of aquatic pollution at a few sensitive places.

During 1977-78, a study to prepare a Master Plan for pollution control of the rivers Zuari and Mandovi funded by the Central Board for the Prevention and Control of Water Pollution was carried out by NIO. The basins of these two

rivers occupy 70% of the total area of Goa, house about 50% of its population and have most of the industrial activities of the territory. Therefore, a study of these two river basins will broadly give a generalised picture of the status prevailing in Goa.

The main sources of pollution in any coastal waterbody are discharges from land. This includes domestic sewage, agricultural and industrial effluents carried mostly by the rivers. The average annual rainfall varies from 3.73 m at the uppermost reaches of the rivers to about 3 m downstream. Most of this rainfall is carried along the nine rivers, which rise in the western ghats and flow towards the Arabian sea through Goa. No definite data of river run-off is available. But roughly, it is assumed that it will be slightly more than the annual figure of 25 km^3 for Mandovi and Zuari together [Eco-Development Plan for Goa (1982), pp.67-79]. The flow occurs only during south-west monsoon and during the rest of the year the rivers become arms of the sea.

Extrapolating from the data available for Panaji, and with the assumption that the rate for rural areas will be half of that for urban areas, it has been computed by the scientists at NIO that around Goa would annually receive about 14.3 million cubic meters of domestic sewage. With

similar assumptions the yearly figure for industrial and agricultural effluents come to about 7.5 million meters^3 [Eco-Development Plan for Goa (1982), pp.76]

It has been estimated that so far, 300 million tonnes of mining rejects are generated in Goa. These rejects are eroded by flood waters during the monsoon and are transported by the rivers when about 11% will be lost to the sediments at 0-5% salinity and about 21% will be lost at 15-20% salinity.

Goa has a coastline of about 105 km. The oil tanker route from the gulf ports to Far East and Japan passes off this coast. In 1980, 313 million tonnes of oil and its products were transported along this route. Ships sailing along this route discharge their oily ballasts and bilge washing. After evaporation of the lighter fractions of oil and photooxidation, the heavier fractions gradually form into tar balls. Driven by winds and currents these tar balls are deposited on the beaches. The life of these tar balls out on the sea varies from 38 to 58 days, while on the beach it is not yet known. However, due to the half yearly change in surface circulation, these tar balls are deposited along the beaches of the west coast of India, only during the south west Monsoon months. Estimates from two years

data gave a figure of 40 tonnes for the yearly deposition of tar balls on the beaches along the coast of Goa [Eco-Development Plan for Goa (1982), pp.76] The dissolved/dispersed hydrocarbons in waters off Goa has a range of 17 to 42 ug/g. Plankton in this area have been estimated to concentrate from 19 to 61 ug/g on dry weight basis. The sediments received 5 to 9 ug/g on dry weight basis [Eco-Development Plan for Goa (1982), pp.76].

On the few occasions thick patches of floating oil have been observed offshore and recent observations indicated that oil pollution may be on the increase in the Indian coastal waters of the Arabian sea. The concentrations of oil and grease in the waters inland Goa range from 0.2 to 9.2 mg/litre with occasional high values [Ibid, p.76].

Toxic, non-toxic metals and metalloids - these pollutants are added to water bodies through sewage and effluents. Magnified through different stages of the marine food chain, they may ultimately reach human beings. A close watch on some of these metals and metalloids is being maintained by analysing them in different phases and forms, their range of concentration in water (marine and estuarine) zooplankton, fishes, caustaceans and molluscus seaweeds and rain water are presented in the table. Several species of fishes, crustaleans, molluscus and seaweeds were analysed.

From this table, it is concluded that the concentrations of metals in all forms are within the safe limits.

Table 23: Concentration of Heavy Metals in the Environmental Samples from Goa

	Cu	Fe	Zn	Co	Ni	Mn	As	Hg	Pb	Na	Mg	K
Water (ug/l)	3-70	7-67	3-43	0-7	0-11	6-102	1-67	58-225	-	-	-	-
Plankton Avg. (ppm dry wt.)	95	886	1162	0	0	-	-	-	-	-	-	-
Fishes (ppm wet wt.)	0-2	0-22	3-23	0-4	0-6	0-4	0-3	0.12-0.41	-	-	-	-
Crustaleans & Molluscus (ppm dry wt.)	9-728	-	15-2800	-	-	3-21	3-25	-	-	-	-	-
Seaweeds (ppm dry wt.)	3-80	130-1800	3-204	3-15	0-34	25-3400	1-14	-	3-34	-	-	-
Rain (ug/l)	5-9	3-6	10-17	0.1	0.1	-	-	-	8-35	5-21	520-940	450-780

Source: National Institute of Oceanography, Goa, 1980.
[Master plan for Pollution Control in Mandovi-Zuari River in Goa]

Regular monitoring of the effluents at the discharge point of Zuari Agro-chemicals Ltd., revealed the existence of periodically high concentration of arsenic and ammonia. The concentration ranged from 3-700 ug/litre for arsenic and 0.1 to 2.4 mg/litre of ammonia [Eco-Development Plan for Goa (1982), pp.78] However, occurrences of the high values were few and far between and they were well below the toxic limits of the components.

Examination of the data collected from Mandovi and Zuari 1977-78, reveal that except for the total suspended solids and oils and grease values for all the other relevant components are much below the maximum tolerance limits as prescribed by Indian standard specifications (IS 2490 - Part-I, 1974) [Eco-Development Plan for Goa (1982), pp.74].

Waters at the upper reaches of Mandovi and Zuari are of fairly good quality. Except for BOD_5, phenolic compounds, oils and greases, all other relevant constituents are well within the maximum tolerance limits for inland surface water for use and raw water for public water supply (IS-2296, 1974).

BOD_5 originates from untreated or partially treated domestic sewage while phenolic compounds result from domestic, industrial and mining sources. About 1000-5000 kg of explosives are used per mine per month which is a very significant source of phenolic compounds.

In general, it can be said that the aquatic environment in and around Goa has a fairly good water quality. Extreme care should be taken at least to maintain the present water quality, if not improve upon them.

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CHAPTER V

STRATEGY FOR HARMONIOUS DEVELOPMENT IN THE COASTAL ZONE

The basic objective of coastal planning and management is to make the optimum use of coastal resources and at the same time ensuring economically sound and environmentally harmonious development of the coastal zone. The interlinkages of economic developments with the local ecosystem are complex in a hilly and coastal region like Goa. Thus there is an imperative need to assess each and every developmental activities for its direct and indirect impact on ecology of the area.

Measures Taken by the Government

Now after outlining the coastal resources and the present and potential state of hazard and pollution in the Goan coastal zone in the wake of its economic development since liberation, it is very necessary to discuss the measures taken by the Government to arrest further damage to the ecosystem, to restore the damaged areas to their original state and to enrich Goa's natural beauty and cultural ethos. Realizing the need for not only keeping the ecological balance but also improving the environment, a Task Force was constituted in May 1981, under the

chairmanship of Dr M.S. Swaminathan, Member Planning Commission to prepare the Eco-Development Plan for the territory. The task force considered in detail the more important aspects of eco-development such as mining, transportation, land and water use, afforestation, conservation of flora and fauna, and coastal area planning and submitted its report in March 1982, recommending eco-development strategies for the territory to ensure development without its deterioration and destruction. In pursuance of the recommendations of the task force, an Eco-Development Council, with Lt. Governor as its Chairman and Chief Minister and other Ministers as members has been set up to take policy decisions and give guidelines/directions for the Eco-Control in territory.

A functional Eco-control Committee under the Chairmanship of the Chief Secretary has also been set up to screen proposals for development and to ensure that the same, conform to the guidelines envisaged by the government policy and the Eco-Development Council.

Separate departments of Science and Technology and Environment have been created in the secretariat in order to coordinate the activities of the various government departments and agencies in the matter of development of science and technology as also environmental control. A

Council of Science and Technology has also been set up which has scientists, senior officers and other persons of eminence from the public as its members. It is chaired by the Chief Secretary. The Council offers technical advice and guidance to the administration mainly in regard to the schemes for arresting environmental deterioration in the territory. It also encourages research by various expert bodies into specific problems connected with pollution-control, utilization of non-conventional energy sources and the like.

Measures to control and regulate felling of trees on private lands were strengthened through enactment of Preservation of Trees Act, 1984. Now, nobody can cut even a single tree on private or public land without permission of the competent authority.

Mangrove forests play an important role in coastal areas and act as breeding ground and nursery for marine fish. These had also been recklessly exploited in the past for collection of firewood. Steps have been taken to protect the existing mangrove forests in the estuaries and for re-stocking of the bank areas by resorting to artificial regeneration. Social forestry which is already quite popular in the territory is being further encouraged and strengthened.

An Eco-Mining Board has already been established under the chairmanship of the Chief Minister to oversee that the mining activity of the territory is carried out without destruction of the environment. An ambitious programme for restoration of ecology in mining areas and on the dumps of mining rejects by terracing and planting of trees, has also been started.

The important need for preservation of the scenic beauty of the sea-beaches which are a major attraction for the tourists, both domestic as well as foreign, has also been kept in view. A committee headed by the Chief Secretary with senior officers from the concerned departments, Navy, Coast Guard and the National Institute of Oceanography as its members, is there to examine each case of pollution in the sea, beaches and to preserve their good health.

As far as development work with the sea-land system is concerned, National Institute of Oceanography (NIO) has undertaken and completed various R and D projects in Goan coastal zone. It first started with the survey of Fishery resources of Goa in 1971. This survey meant to plan fishing operations in Goan waters, was conducted all along the coast at different depths which resulted in estimating the fish yield. Since then 30 projects sponsored by public and

Fig.V.1

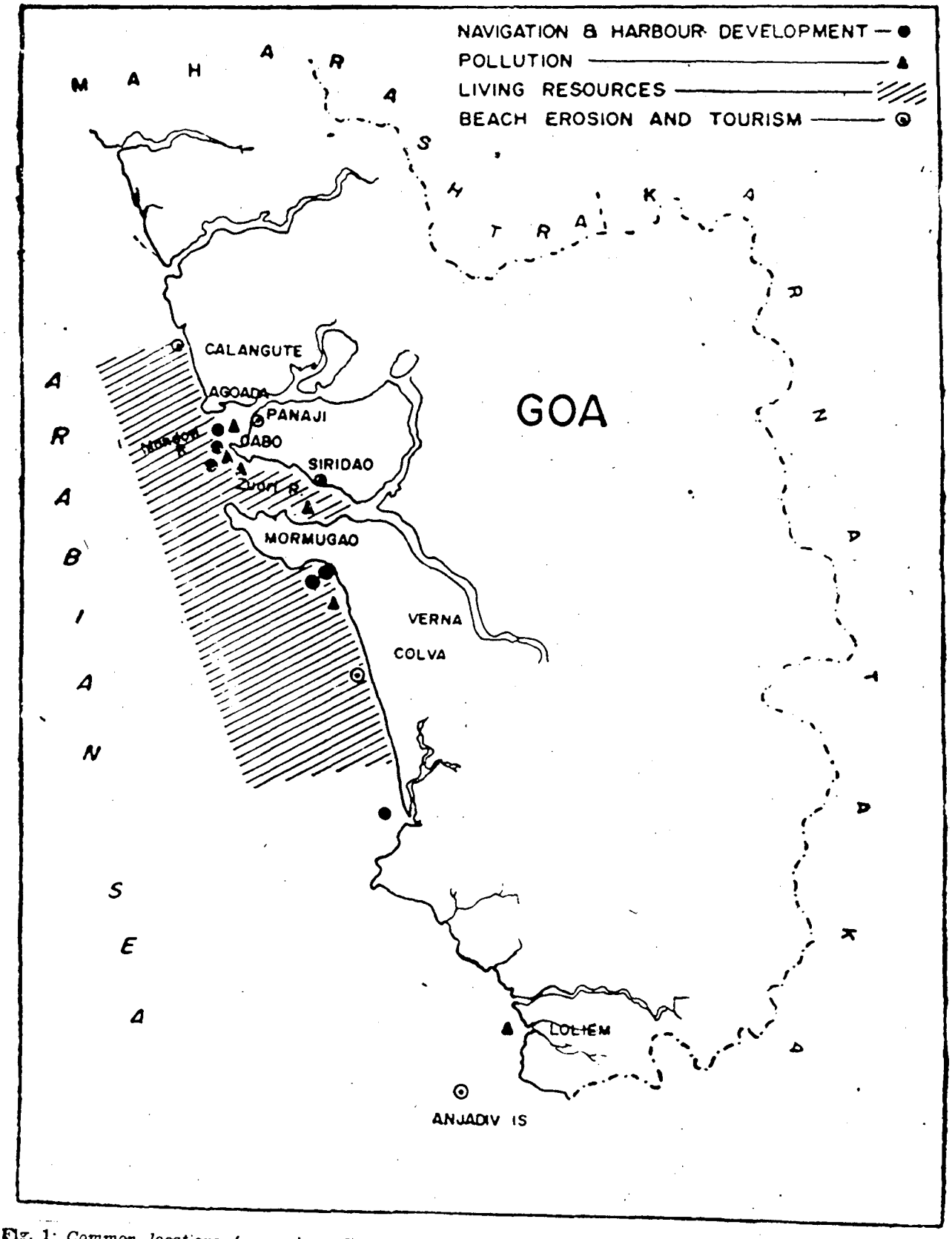

Fig. 1: *Common locations for various Oceanographic work done in Goa*

(N.I.O. - Goa)

private organizations have been completed in the following major areas:

a) **Living Resources Survey**

Two projects have been undertaken -- one on fisheries and other on seaweed resources of Goa coast. Both were sponsored by the Government of Goa. The seaweed surveys indicated economically important species, their distribution, potential yield and utilization for industrial purposes.

Presently NIO, has taken up a field demonstration of mussel culture on ropes to the concerned authorities and people to augment the mussel production in Goa. This technology if practiced will increase earnings, employment and the marine food production.

b) **Marine Pollution**

A major project was taken up under which a Master Plan for pollution control in Zuari and Mandovi rivers and coastal region of Goa was prepared for Central Board for Prevention and Control of Water Pollution. In addition to this, a number of projects have been undertaken in the

waters around Zuari Agro-Chemical Ltd. factory from time to time suggest the discharge sites, water analysis and effects of effluents on marine organisms, etc.

c) **Beach Management**

Coastline is affected by erosion due to currents, waves, tides, etc. NIO has studied several problems at various beaches in Goa like Campbal, Singuerim, Siridao, Colva, Calangute and Naguna, etc. This has resulted in control of erosion, safe swimming and preparation of feasibility reports for hotels, tourist resorts, and recreation, showing direct impact on the development of the Goan coastal zone. Naguna beach has been studied for the development of water sports.

d) **Harbour Development and Navigation**

The Aguanda sand bar is an yearly phenomena hampering navigation during monsoon months. Similarly, the siltation and other factors in harbour area of Mormugao adversely affect the development. In this regard NIO has studied sand bar formation, hydrographic, bathymetric and magnetic surveys and other associated parameters in the harbour area

and other places for improved navigation and development of harbour. Hydrographic surveys were also conducted at Loliem for its suitability for the location of an Atomic Power Plant. M/s Gammon India Ltd., while constructing the Zuari bridge consulted NIO for placement and location of its piers. In addition, many projects have been carried out for the Indian Navy, Port Trust, Goa Government, etc. to help preserve the coastal environment and coastal communities in their well-being.

The Marmugao Port Trust is also active in fighting pollution in the port area. Environmental and pollution control unit attached to the Directorate of Health Services has been equipped with latest instruments etc., with view to keeping a check on the pollution to the environment through disposal of industrial effluents and wastes.

An empowered committee with the Chief Secretary as its chairman and having representatives of the Planning commission and the Ministry of Home Affairs, Government of India, as some of its important members, is also monitoring the implementation of the various recommendations of the Task Force mentioned in their report on Eco-Development plan for Goa.

Special care is taken to ensure that the Annual Development plans are formulated in harmony with the need for preserving and developing the ecosystem of the territory.

The government has decided to totally discourage polluting industries and to promote setting up of pollution-free industries preferably those involving high technology such as electronic industry, so that employment opportunity and prosperity may increase without any destruction of the environment. The government has also taken suitable measures to ensure that the tourism industry also flourishes. The Town and Country Planning Department has prepared Regional Plans for the territory as also city development plans for the important towns in the territory so as to ensure orderly and healthy development of these towns and regions. The Municipal bye-laws are being revised from time to time with the concern for preservation and improvement of ecological assets.

Thus it can be concluded that preservation and improvement of coastal environment is one of the main challenges to be met while planning for economic development and prosperity of this region. The government is doing its best to preserve the ecological balance and to bring about

economic development in harmony with the need for preservation and development of the ecosystem.

Strategy for Conservation

Goa's economy is developing at a fast rate and needs to be properly guided and channelised by choosing the right options in the process of development. The realistic stand would be to strike a right balance between going in for comfortable development projects on one hand and thus maintaining ecological balance on the other.

Intensive exploitation of natural resources with little regard to environment in many parts of the Goan Coastal Zone has adversely affected the natural environment and ecology. The Eco-Development plan for Goa, therefore, rightly recommends that while exploiting natural resources, care should be taken to maintain ecological balance and to minimize the inter-sectoral conflicts, eg., the conflicts between mining and forestry, agriculture and fishing, tourism and forestry, etc. It is obvious that to eliminate such conflicts and optimize the benefits of development of all sectors collectively, a comprehensive coastal zone management plan is needed. Some strategies of conservation hence is based on the concept of comprehensive planning to incorporate the ecological factors.

The coastal zone management plan provides the framework for identifying, describing and explaining the coastal problems. It also provides the basis for identifying and evaluating alternative strategies for dealing with these problems.

The coastal zone management plan is both a process and product. As a process, the plan involves identifying and evaluating strategies for dealing with coastal problems. This process is partly technical. Scientists in a variety of fields must be consulted to ensure that the problem dynamics are well understood and the proposed mitigation strategies will have the intended effects. However, the process necessarily involves the development of mutual understanding with other government agencies and concerned individuals to determine if optimal resources management strategies are acceptable and practical.

As a product, the plan will be a framework which can guide resource managers, direct national and international investments in research, training and education, direct public investments in coastal land reclamation, tourist development and coastal works, and guide the activities of other agencies whose regulatory or investment activities have an impact on coastal problems.

No coastal management plan can be truly comprehensive. There are far too many decisions by individuals and pubic agencies affecting the coastal zone to hope that any one document can guide all such activities and resolve all conflicts over alternative resource uses. However, the proposed plans should be coordinated in the best sense of that over worked form by indicating processes which should be followed if the most effective and efficient uses of the coastal resources are to be made.

The coastal zone management plan should be based on some management and planning principles. The management principles that require consideration include:

a) The coastal zone is a fragile and vulnerable area that requires specific management.

b) The coastal front is common heritage of the nation and every citizen has access right to it.

c) The control, custody and management of the coastal zone is vested in the Republic.

d) The state accepts liability to maintain and when possible to improve the quality of its coastal zone by means of regulation, acquisition, investment or other strategies as may be

consistent within the needs and interests of all the people, including future generations.

e) In accepting responsibility for the management of the coastal zone, the state and its agents recognize that there are limits to that management responsibility. The coastal zones of India are ecologically vulnerable and inherently instable areas subject to natural processes as well as human intervention. Not all impacts of natural processes can be controlled and some such attempts may result in social, economic and environmental costs that are prohibitive.

f) Any person, whether an individual, private or government agencies, wishing to undertake a development activity within the coastal zone must accept liability to carry out such activity in a manner that would not significantly affect the stability, quality, or productivity of the zone.

g) Fishing on which a significant percentage of the nation depends for a livelihood will have priority over other activities in the allocation of the coastal resources.

The planning principles that require considerations include the following:

a) The coastal zone management plan will be done in phases.

b) Each phase of the planning process will involve a detailed analysis of coastal problems including their causes, scope, severity and duration.

c) Each phase will involve an analysis of existing laws, regulations, and institutional responsibilities for dealing with casual factors in coastal problems.

d) Alternative strategies for managing each problem will be identified and evaluated.

e) The choice of problem mitigation strategies will take into consideration how best to work within the existing legal and institutional frameworks.

f) Each problem mitigation strategy will be regarded as a policy experiment to be continued, modified or abandoned based on implementation experience and on-going evaluation.

g) Each problem mitigation strategy will require careful review and comment by the relevant agencies and individuals prior to implementation to ensure its practicality and acceptability.

Keeping these principles of coastal zone management plan in mind, a comprehensive strategy for the conservation of coastal resources of Goa can be formulated.

Goa is endowed with one of the most beautiful beaches of the world. In order to preserve their intrinsic scenic beauty and tourism potential as well as highly fragile ecosystem, all sorts of building and development activities should be strictly regulated. The existing 200 meters "preservation line" from the high tide line should be suitably modified according to the rate of shore recession and shore geomorphology at the various stretches of the Goan coastline. Constructions between the 200 meters "preservation line" and 500 meters from the high tide line should be strictly controlled as directed by the Eco-Development Council of the state. However, it is observed that these shoreline restrictions or zoning are being violated in the region and thus it deserves strict implementation.

There are about 71 kms. of sandy beaches of varying length and width. The longest beach is at Colva-cavelossim which is about 25 kms, while the famous Calangute beach is about 7 kms. These sandy shores are dynamic in nature and their profile changes according to the seasonal changes in the nearshore environment. There is a continuous supply of sand from the subtidal and intertidal region. The best way to control the movement of sand or dunes, and also to protect the inland region is to develop a coastal shelter belt. In order to preserve the ecology and ability for binding the sand, suitable sand dune plants should be grown which would minimize the sand movement. Besides plantation of trees like coconut, casurina, etc. should be planted which function as wind barriers.

All sorts of extraction of sands, shells and shingles in the coastal belts should be strictly controlled and a policy earmarking specific areas for such activity needs to be worked out and enforced properly.

The development of human settlements in the estuaries should be regulated. Mangrove swamps and vegetation being ecologically important has been subjected to large scale depletion. Strict protective measures are urgently required to preserve mangrove vegetation where it exists along the estuaries. The utilization practices of inter-

tidal stretches, salt pans for both agricultural and aquaculture is appropriate and should continue by reducing the use of chemical fertilizers.

From the pilot study of the Zuari-Mandovi basins, it has been evident that the mining activity is the main cause of pollution of the coastal zone water resources. Statutory measures have to be taken in order to ensure that stacked rejects and overburden do not find their way into the streams by providing necessary bunds, terraced vegetation etc. Barge loading operations should also be regulated. Furthermore, necessary precautions should be taken in not permitting outflow of affluent wash water from the mines directly into the stream.

Although industrial water pollution is now subject to certain controls, the monitoring system should be improved and that sensitive parameters like BOD, COD, responded materials etc. should be monitored at regular intervals. There should, further, be no dumping of solid wastes or garbage in the river at any time of the year and discharge of treated effluents should also be checked regularly. Control should also be exercised on the addition of suspended matters, oils and greases and phenolic compounds from mining activities.

So far as industrial locations are concerned, it is unsafe to locate it in the coastal zone. It is advised that it should be located in the inland talukas and all pollutant activities should be localized at certain specific sites so as to treat the effluents on a combined basis. Indiscriminate disposal of untreated domestic sewage effluents into the rivers and coastal waters directly and also the garbage dumping from the fish landing centers, are other polluting factors which also need to be regulated.

Due to heavy pressure of development along the coastline, and other allied activities, it is becoming difficult to preserve and conserve them. Under any circumstances, it is needed to be preserved and conserved with appropriate landscaping. Since the land belongs to private people it is difficult to prevent its development. In this context, policy guidelines need to be formulated along with control rules and regulations under the statutory acts, providing for an effective control and implementing agency.

The settlement areas already cover a very large portion of the water-front, and human settlements would inevitably lead to or aggregate other associated problems such as encroachment of sandy beaches, destruction of mangroves, swamps, vegetation, and estuaries and offshore pollution

including fecal contamination., The first objective of the development control should be to ensure that the future development of settlements is extended only in an inland direction. Further, the density of settlement areas near the water front should be kept as low as possible.

In order to increase the infrastructure facilities for efficient handling of the fisheries resources, fishing harbours and Jetties with all ancillary facilities like fish storage, fish processing, repairs and maintenance for the fishing boats etc. should be planned and exempted keeping in mind the conflict of tourism vs. fisheries development seaweed cultivation and aquaculture deserve encouragement.

A systematic survey of sea-bed mineral resources off Goa is essential on the assumption that the rich ore-bearing strata of the western ghats may have a sea-ward extension. Possibilities of utilization of wave energy potential along the Goa coast should be explored since it is perhaps, the major renewable and non-polluting resource at our disposal.

The coastal areas need to be demarcated for rational development of fisheries, tourism and industries. A preservation line of 500 meters along the shoreline has to be followed and regulatory steps are to be strictly

implemented. Land use pattern should be decided and should be strictly adhered to while taking up projects for tourism such as hotels, beach resorts, etc.

Furthermore, the level of aquatic pollution is not so alarming in the Goan coastal zone. However, the on-going monitoring of the coastal/aquatic environment by NIO should be continued. In this regard the NIO, Goa would play very crucial and helpful role.

For comprehensive coastal zone development planning, a 20 Kms. inland boundary from the high tideline should be established for the purpose. For this, therefore, there is a need of setting up of a Coastal Zone Development Authority with jurisdiction over the entire coastline and riverine areas of Goa. Sectoral development activities should be coordinated by this body. This body should have the legal and statutory mandate in the areas earmarked for comprehensive development of the coastal zone.

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CHAPTER - VI

CONCLUSION

The coastal zone constitutes a complex ecosystem. It is viewed as a unique resource 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% 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 of many coastal 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 continuity 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 multisectoral effort. The coastal planning and management programme has a geographic boundary that defines a space which extends from the ocean environment across the transitional 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.

India has coastline of about 7000 Kms. In the last four centuries following foreign occupation and also since independence the country's development has been closely related to maritime activities. Population centers (coastal population 25% of the total Indian population in 1986) are established along the coast and exploitation of coastal resources to provide sustenance to these communities and others have been intensified. The opening of railways, airways and roads accelerated this process and increased the importance for coastal zone. The trade and commerce that provided the impetus for coastal communities have been supplemented by fishing, tourism, oil and natural gas extraction and exploration and a host of other important economic activities.

Indian coastal zone consists of a diversity of shoreline and nearshore habitats, coral reefs, estuaries and lagoons, salt marshes, beaches, spits and dunes. These habitats support the nation's coastal fisheries and in their natural state provide the nation with its first line of defense against the erosive forces of ocean. In addition, there are many man-made resources like human settlements, transportation networks, harbours and ports, defense installations, and urban industrial and tourism facilities. These resources support a number of economic activities such as fisheries, mining, tourism and industries.

Development in the coastal zone within the last few decades has resulted in many problems -- increasing conflicts over coastal uses, the depletion and degradation of coastal resources, coastal pollution and loss of access to the shoreline. Loss of life and property due to natural hazards and calamities (cyclones, erosion by wave and tides, tectonic forces, etc) continue to occur in the coastal region. In addition, several development activities that have been undertaken recently in inland areas and coastal waters have resulted in environmental problems along the coast. Some of these developments include construction of dams, industrial developments, large scale filling up of low lying areas, mining of mineral ores and fuels, oil spilling in the tanker routes and large use of fertilizers and pesticides in the coastal region's agricultural development.

The prominent areas of ecological stress in India are:

a) Gulf of Kutch and the coast of Gujarat face the problems of the natural sedimentation due to erosion of the coast, deposition of wind born sand, dredging of the soil for industrial use, pollution from salt pans, destruction of mangrovers for firewood and fodder.

b) West coast of India from Bombay to Kerala face disturbances due to oil drilling, oil spill from

tankers, pollution from industries, runoff from uplands, invasion of "salvinia" as in Kerala, destruction of mangroves, exploitation of fossil and living bivalves and dredging for deepening the navigation channel.

c) Gulf of Mannar and Palk bay along the south-east coast: Quarrying of corals for industrial use has resulted in partial to total destruction of fringing reefs in the area. At present the area is declared as a Marine park and total ban on quarrying of corals has been imposed.

d) Andhra-Orissa and Bengal coast face problems of severe cyclonic destructions, erosions, pollution, mangroves destruction etc.

e) Lakashdweep: Excessive siltation in lagoons. Blasting of the lagoon reefs and dredging of lagoons. Construction along the coast. Deforestations in Minicoy.

f) Area needing survey is Andaman and Nicobar islands and all the estuaries of India.

The importance and problems of the coastal zone have been recognized by the people and the governments in the South Asia. The recent discussions of the heads of

state/government of SAARC countries at Islamabad had expressed concern about the coastal problems and threat associated with the sea level rise. Consequently, they have recognized the need for comprehensive coastal planning and management. But the state of art of the coastal planning and management theory and practice is pitiable in the region except Sri Lanka. Thus there is consequently a need for comprehensive national policy and guidelines with requisite enforcing powers for managing the various coastal developmental activities in India.

Coastal management is not considered a separate component within the general plans and coherent programs of the Government of India and its states. However, if one looks through federal and state programmes and projects undertaken to resolve conflicts among coastal uses and preservation, a number of management strategies can be identified. There are the measures taken by sectorial plans, for examples, offshore oil and natural gas extraction, fisheries, coastal tourism, etc. environmental protection throughout the coastal zone by the Ministry of Environment and Forests, shoreline restrictions programme for development and protection of specific areas such as marine parks, regional development plans. etc.

The coastline of Goa is about 105 Km. long and oriented roughly in a north-south direction. The coastal belt has several river valleys and it is endowed with lovely beaches and beauty spots, making Goa a tourist paradise.

Due to geopolitical forces of the past, and mainly due to tremendous boom in economic activities in the post-liberation period, the level of development of the coastal talukas has been disproportionately much higher than that of the inland talukas. The population distribution is in a high degree of regional imbalance. More than 57% of the population of Goa resides in the four coastal talukas of Bardez, Salcete, Tiswadi and Marmugao only. Also these talukas exhibit high population density and it is almost 2-1/2 times the Goa's average of 272 persons/sq. Km. Urbanization and industrialization also reflect this trend of regional imbalance and a preponderance in the coastal talukas.

The pace of urbanization has been much faster in Goa compared to the adjoining states. The percentage of the urban population had shot up from 14.8% in 1961 to 32.03% in 1981. Within Goa, the coastal talukas had the highest concentration of the urban population (as much as 83%) covering 8 out of 15 towns of the state. As urbanization is

closely associated with growth in secondary and tertiary sectors of economy, the four coastal talukas exhibit a pronounced spurt in these activities. About 70% of large and small scale industries and developed industrial estates are located in the coastal talukas.

The port of Mormugao, situated on the southern side of Zuari river estuary, is one of the best natural harbours along the west coast. It is the second biggest port in India, handling more than 10 million tonnes of iron ore for export annually. Marshy paddy filed, called Khazan lands, are situated near the river banks in the area. The soils of these marshy lands are very fertile and constitutes the "rice bowl" of Goa.

The exploited marine resources of Goa comprises a variety of fin-fishes and shell-fishes, harvested from the open sea, estuaries and the backwaters. Goa produces about 45000 tonnes of marine fishes and has a potentiality of about 80,000 tonnes annually. Fisheries and tourism are bedrock of the Goan economy. Goa receives about 10 lakhs of tourists annually. The tourism development has taken place very rapidly. Thus the coastal resources development has created multiple use conflicts in the coastal zone and consequent developmental stress has resulted in the degradation of coastal ecology, pollution, etc.

The sources of pollution include domestic sewage and other effluents carried mostly by the rivers, agricultural and industrial effluents, mining rejects wash off, oily ballasts and tar balls, toxic metals and mefalloids and effluents of Zuari Agro-Chemicals Ltd. Furthermore, the coastal hazards such as erosion, flooding and siltation and dredging of navigation channels and harbour have resulted in the destruction of the coastal ecological habitats.

Ever since the liberation of Goa in 1961, a number of measures has been taken to arrest the coastal environmental degradation and use conflicts and restore and preserve the coastal zone for sustainable use and developments. But at many places and times, encroachments have taken place on the shore and river banks. In view of considerable changes taking place in the Goan coastal zone, the NIO (National Institute of Oceanography), Bech Erosion Control Board, Central Pollution Control Board, etc. have been monitoring environment in and around Goa on the request and support from the Government and private sectors. It is further necessary to leave a strip of land along the coastline without any type of construction and development activities to ensure that sufficient area is left free along the shoreline for the forces of sea to play with and thus natural and aesthetic beauty and charms of coastline

remain intact for tourism development in association with better ecological order between plants and animals and birds.

The late Prime Minister Mrs Indira Gandhi had directed that there should be no building and construction activity on the beaches within 500 metres from the water at the maximum high tide in 1981 realizing the problems facing the coastal zone of Goa. But recently after becoming state in 1987, the Goa government has reduced the preservation line of 500 meters to 200 meteres only under pressure from industrialists, businessmen, etc. These greedy and needy people have no respect for the coastal environment and Goan culture and believe only in short-term direct benefits and profits. This decision of the government is uncalled for. It should again restore the preservation line to 500 meters keeping in mind the shore geomorphology.

Coastal Area Management is also not considered a separate component within the general plans and coherent programmes of the Goan government. However, it has constituted Ecological Development Council to coordinate programmes and resolve conflicts among coastal uses and environmental degradation and pollution. However, it has been managing the coastal zone by various sectorial plans such as mining and industries, tourism, agricultural

department, port development trust, town and country planning department, etc. But there does not exist any coastal planning and management authority to regulate, control, plan and manage coastal zone problems and development activities. There is no comprehensive legislation directed towards coastal zone planning and management. However, it has been implementing the general legislations related to environmental protection and other controlling measures sectorally.

The preceding pages of the dissertation have stated the importance of coastal resources for the nation and Goa, and need for improved coastal management approaches. Since fisheries, tourism, oil and natural gas extraction, industries, ports and agriculture are the strongest economic activities in the coastal zone, need for integrated coastal management appears to be economically justified. Both fisheries and tourism depend to a great extent on a high level of environmental quality, and both can easily be lost or seriously degraded by oil extraction, mining and industrial activities in the nearshore environment.

There are some impediments to the creation and effective development of integrated coastal management programme in India. They are: lack of recognition of the

issues, poor coordination, administrative discontinuity and inefficiency, diversion of resources, and inadequate information.

The complex interaction of factors and activities that characterize the coastal zone has not been strongly appreciated by the government and people. Coastal problems are not viewed from an integrated or systems point of view, but rather from each of the specific sectors involved. The coastal zone is not recognized as a distinctively different part of the nation with clear cut definition and with particular characteristics requiring a specific set of management strategies. Coastal management is not considered a national objective in itself.

In virtually all scientific areas, developing countries do not have sufficient funds for the scientific research they need, and marine and coastal research is particularly costly. However, this problem is not much severe in case of India although being a developing country. It has started off successfully and has been collecting scientific information concerning coastal resources, pollution levels, and interaction between resources, natural processes and human actions in the coastal zone which would provide base for adequate management programmes. . During the last ten

years, important support and efforts have been channeled to marine and coastal research, including the vessels acquisitions designed specifically for oceanographic research and Antarctica research.

In view of the impediments, integrated coastal planning and management programmes is very difficult to establish. But analysis presented here indicates that advances in coastal management might be achieved by modest incremental improvements in existing management strategies, such as broad-scope sectorial planning, impact statements, special area plans, and regional development programmes.

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