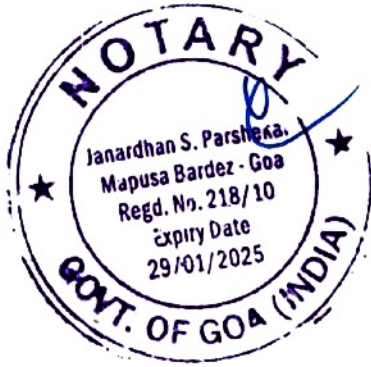


**BEFORE THE HON'BLE NATIONAL GREEN
TRIBUNAL, WESTERN ZONE BENCH AT PUNE**



O.A. 09/2023 [WZ]

BETWEEN:
THE GOA FOUNDATION

...APPLICANT

AND

THE MINISTRY OF ENVIRONMENT,
FOREST AND CLIMATE CHANGE AND ANR.

...RESPONDENTS

**AFFIDAVIT IN REJOINDER ON
BEHALF OF THE APPLICANT**

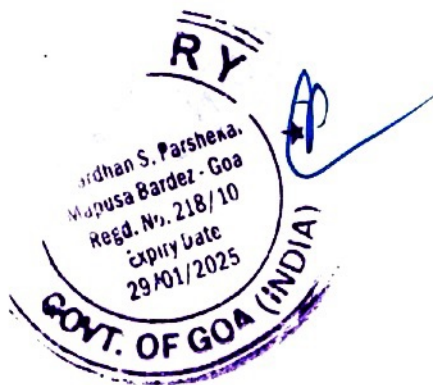
I, Dr. Claude Alvares, Secretary of the Goa Foundation, the Applicant herein, do hereby state on oath as under:

1. I say that I have read and understood the affidavit filed by the Respondent No. 1. I state that I am not replying to each and every statement and averment made in the affidavit filed by the Resp. No. 1, and nothing may be deemed to be admitted unless the same is specifically admitted herein but should be treated as though the

A

same has been set out seriatim and denied and disputed specifically.

2. On pg. 15 of the Reply, the Ministry avers that the Applicant has falsely stated that 'turtle nesting beaches in Goa are dropped.' A plain reading of the CRZ 2019 notification will show that the four turtle nesting beaches named in the CRZ 2011 notification have been dropped. The Applicant therefore vehemently denies that any false statement is made, as averred by the R. 1. It is an admitted fact that the CRZ 2019 notification does not specifically mention the names of the four turtle nesting sites/beaches, which the CRZ 2011 took special care to mention by name. In other words, the four turtle nesting beaches in Goa are no longer protected by name by the 2019 Notification. The Applicant submits that State Govts are notorious for denying the presence of turtles or other creatures of the sea in areas where they would like to promote tourism. Hence it is very important that the sanctity of these specific beaches should have been maintained by naming them in the CRZ 2019, especially because it is only the protection afforded by the CRZ Notification that has led to the exponential growth of turtle nests on the four beaches from just 24 nests with 2004 eggs and with 1450 baby turtles released in 1999, reaching a total of 603 nests, a total of 64,067 eggs and 42,994 baby turtles released in 2020. No explanation has been proffered by the R. 1 as to why the 2019 notification



drops the names of the four turtle nesting beaches in Goa.

3. Similar protection by name ought to have been given to the Khazans, a uniquely special ecosystem in Goa that has evolved over several centuries, enabling the inhabitants to protect and harness land taken from the sea for agricultural purpose. The Ministry's explanation on pg. 16 of the reply, that all areas affected by salt water ingress beyond bund or sluice gate are classified as CRZ-1A – including khazans – does not answer the challenge raised by the applicant to its exclusion from the 2019 version as the notification seeks to protect the mangroves, but not the fields into which they expand and proliferate due to the breakage of the embankments which hold back the sea water. People are then quick to exploit the situation by filling up the marshy khazan lands and putting them up for development purposes. It is only the CRZ 2011 which protected these khazans by giving Goa special status and by demanding that a khazan management plan be prepared and implemented.



4. With regards to the issue of the date of applicable town planning regulations, i.e. 2019 or 1991, the justification provided by the R1 for making existing town planning regulations as on the date of the CRZ Notification 2019 [18.01.2019] applicable to CRZ areas (as opposed to the regulations existing in 1991) is to purportedly

Sh

remove the disparity between regulations applicable in CRZ and non-CRZ areas, which is hindering development and causing hardship to the public. Further, the disparity has been removed to facilitate decent housing facilities for the public.

5. In this context, the Applicants submit that the justification provided by the Ministry is shocking and antithetical to the very spirit and objective of the CRZ Notification. The purpose of enacting a special law for CRZ areas was to ensure their protection and the maintenance of ecosystems forming a part thereof. CRZ areas form a distinct and separate category from non-CRZ areas, and there is bound to be a difference in the applicable law and restrictions to both these areas. Thus, no question arises of removing any disparity in the law applicable to both these areas, for the simple and obvious reason that over the past 30 years, there had been a conscious decision by the legislature to freeze development in CRZ areas as per the Town Planning Regulations applicable and in force as of 1991. The decision taken by the Ministry to allow the Regulations existing as of 2019 applicable to CRZ areas therefore is driven entirely by factors beyond the purview of the CRZ Notification, is contrary to public interest, contrary to the objectives of the CRZ notification and is not at all in line with S. 3 of the E.P. Act which requires measures to be taken for the purpose of protection and improving the quality of the



[Handwritten signature]

environment. Further, such a provision is wholly inappropriate in view of Sea Level Rise brought on by climate change.

6. On pg. 30 of the Reply, the Ministry deals point wise with the detrimental features of the CRZ 2019 as stated by the Applicant. We refer to only relevant issues below where the Ministry has offered some explanation, and not just reiterated the provisions of law.

a. Re reduction of NDZ along mainland and inland islands to 20 metres

The R.1 states that this provision of the CRZ 2019 [Para 10.2(ii)] cannot be challenged by the Applicant, as no challenge is raised to the Island CRZ Notification, 2019, which Ministry states Para 10.2 actually flows/originates from. In this regard, the Applicant submits that the link attempted to be established by the R.1 is incorrect. Para 10.2 (ii) is distinct and separate from cl. (iii). The former deals with the applicable HTL restrictions for islands, while the latter deals with the preparation of the CZMPs. Thus, the submission of the R.1 that the absence of a challenge to the ICRZ 2019 notification precludes a challenge to Para 10.2(ii) is without basis and incorrect.



A

With reference to the reliance placed by the R.1 on the S.C. order dt. 19.08.2015, the Applicant submits that the particular order in question accepting a 20m NDZ setback for the islands of Lakshadweep was based on a Report of an Expert Committee constituted by the Supreme Court, which carried out extensive studies over a period of time in Lakshadweep, and made certain recommendations specific to the Lakshadweep islands, including a 20m NDZ. The acceptance of that report by the S.C. in the facts and circumstances of that case cannot thus be generalized as an endorsement of a 20m NDZ for islands across the country.

b. Re reduction of NDZ rivers to 50 metres



The R.1 has failed to deal with the fact that this blanket relaxation of the NDZ to 50 metres was never recommended by the report of the Shailesh Nayak Committee, which the Ministry is otherwise more than happy to quote in defence of other impugned provisions of the CRZ 2019, and that amendments of this very same nature were struck down by the Hon'ble S.C. in *Indian Council for Enviro- Legal Action v. Union of India, [1996] 5 SCC 281*. It weakly states that the reduction to 50 metres will be subject to the final CZMP and safeguards therein.

h

c. Re roads in NDZ, and activities on both sides of road; and temporary tourism facilities within 10 m of the HTL

The R.1 states that as the applicant has not challenged the Central Govt notification dt. 12.07.2019 which permits various facilities such as beach towers, pathways and temporary tourism facilities upto 10 m from the HTL to aid in achieving International Blue Flag certification, it cannot now challenge the CRZ Notification on this count. Applicant submits that the 12.07.2019 notification is independent of the provisions of the 2019 CRZ Notification, and a lack of challenge to the former does not preclude a challenge to the 2019 Notification itself.



d. Re. eco-tourism activities in CRZ-IA areas

Contrary to the perception of the R.1, the Applicant clarifies that the statement about 'new residences' in the CRZ 2019 include tree huts for tourists to reside in, whereas in the two previous CRZ Notifications of 1991 and 2011 only those genuinely entitled to a residence close to the sea, i.e., fisherfolk, were permitted a new residence.

e. Re CRZ 2019 protecting only 'active' sand dunes, and temp. tourism activities on sand dunes

The Ministry's weak response to the petitioner's objection to protection of only 'active' sand dunes by CRZ 2019 is that there is no provision permitting activities in non-active sand dunes. This is no answer to the petitioner's challenge.

Apart from this lies the fact that there is no definition of what an 'active' sand dune is, nor has the R.1 provided any explanation or justification as to why only dressing or altering of 'active' sand dunes is prohibited by the CRZ 2019 [Cl. 4(ix)], as opposed to all sand dunes, active or otherwise. It is also relevant to note that this concept of 'active' sand dunes finds no mention in the Nayak Committee Report, and has not been so recommended.



A scientific report published by the N.I.O. Goa in 1998 titled 'Coastal Sand Dune Ecosystems of Goa: Significance, Uses and Anthropogenic Impacts' makes it clear that sand dunes over a period time, and dependent on environmental conditions, undergo changes in their nature, height and location. The report notes that existing sand dunes 'become stable or inactive as they are

d

no longer fed by sand', and that 'Sand dunes are sometimes mobile and hence shifting in nature.'

The report makes specific reference to the shifting sand dunes found in Mandrem Goa, where it notes as follows : *'The entire coastal stretch is protected by continuous 5 – 6 m high sand dunes with dune vegetation. Some of the sand dunes are shifting in nature as can be observed in Mandrem where new dunes, presently low in height, are being formed; this makes the area a prograding coast. In this stretch, two major creeks which open into the sea are lined with mangroves with a luxuriant swamp a little inland, all of which are found behind the sand dunes (Figure 1A); these are some of the exotic areas found along the north Goa coastal belt.'* [Emphasis added]



Thus there is absolutely no reason to introduce an artificial distinction prohibiting activities only on 'active' sand dunes, as has been done in the 2019 notification. Such a distinction is bound to lead to ambiguities and open up further risks for damage to non-active sand dunes. The term 'non-active' is ill-suited to what in fact are nothing but 'stabilised' dunes, essential green infrastructure for protecting the coast in a regime of climate change and sea level rise.

For the same reason the Applicant is opposed to temporary tourism facilities even on stilts to be located on dunes. Such facilities remain fixed or permanent for the entire 'season' i.e., 9-10 months and impede the movement of the dunes and its interaction with the sea.

Annexed hereto and marked as 'Annexure R-1' are the relevant extracts of the Report on 'Coastal Sand Dune Ecosystems of Goa: Significance, Uses and Anthropogenic Impacts,' by Dr. Antonio Mascarenhas of the National Institute of Oceanography.

f. Re removal of restrictions for beach resorts

The Respondent's reply to the Applicant's challenge to the removal of the 2 main restrictions removed, i.e., minimum plot size of 4,000 m², and hotels not being permitted in the 200m NDZ is that FSI does not get diluted and that hotels are permitted only on the landward side of the NDZ, and not everywhere. The Applicant submits that the Ministry has not answered the challenge at all, which is that unless the plot is of a decent size to enable all facilities to be contained in the hotel, innumerable number of 'hotels' will mushroom all over the CRZ crowding the area, leading to noise pollution, garbage issues, sewage pollution, water shortages leading to illegal wells, etc.



[Handwritten mark]

g. Re demarcation of Hazard line being done away with, and lack of guidelines for HTL in CRZ 2019

The Ministry's response that Hazard lines are already mapped in CZMPs prepared earlier does not meet with the petitioner's challenge to its absence in the CRZ 2019, as there is no provision for the Hazard Line to be marked in the new CZMPs when they are prepared. The concept of a Hazard Line emerged due to awareness of climate change and sea level rise and that threat is all the more evident now.

7. I state that the contents of paragraphs 1 – 6 (p) are in the nature of facts true to my own knowledge and as per official documents/records, and my submissions made on legal advice which I believe to be true and correct. No part of it is false and nothing material has been concealed therefrom, and the annexures enclosed are true copies of their originals.



Solemnly affirmed on the 6th day of November, 2024, at Mapusa, Goa


 THE GOA FOUNDATION
 Reg. No. 23/GOA/88
 APPLICANT/DEPONENT

VERIFICATION

I, Dr. Claude Alvares, Secretary of the Goa Foundation, the Applicant herein, hereby verify that the contents of paras 1 - 7 of my above affidavit are true to my knowledge and belief, and that no part of it is false and nothing material has been concealed therefrom.

Verified on the 6th day of
November, 2024, at Mapusa, Goa


THE GOA FOUNDATION
Reg. No. 23/GOA/86
APPLICANT/DEPONENT

Solemnly affirmed before me by
Dr. Claude Alvares.
Who has been identified by,
who has appeared before me personally

5658/24/11/024




JANARDHAN S. PARSHEKAR
NOTARY AT MAPUSA, BARDEZ - GOA.
STATE OF GOA (INDIA)

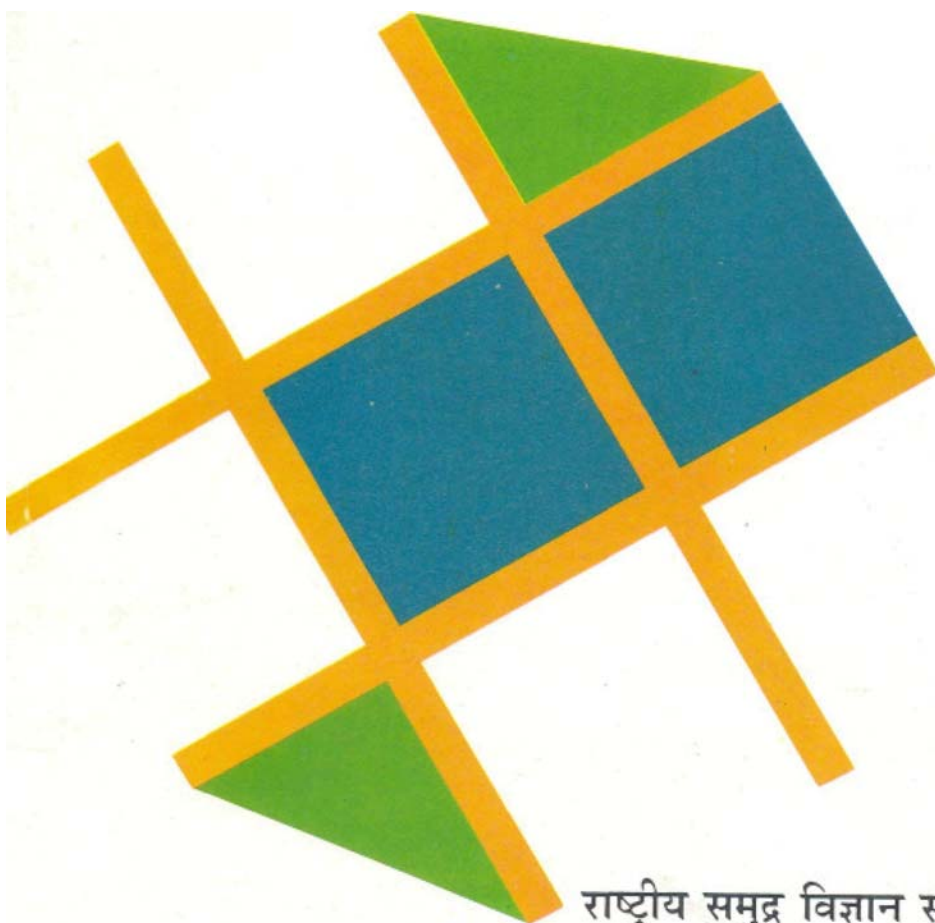
[Extract of Report]

Study of Goa and its Environment from Space

A Report on

Coastal Sand Dune Ecosystems of Goa :
Significance, Uses and Anthropogenic Impacts

March 1998



राष्ट्रीय समुद्र विज्ञान संस्थान



NATIONAL INSTITUTE OF OCEANOGRAPHY

DONA PAULA, GOA - 403 004, INDIA

STUDY OF GOA AND ITS ENVIRONMENT FROM SPACE

A REPORT ON

**COASTAL SAND DUNE ECOSYSTEMS OF GOA:
SIGNIFICANCE, USES AND ANTHROPOGENIC IMPACTS**

ANTONIO MASCARENHAS

NATIONAL INSTITUTE OF OCEANOGRAPHY

DONA PAULA 403004, GOA

March 1998

PREFACE

Until the 1970's, the coastal zone of Goa was largely pristine. However, the advent of tourism and the resultant construction boom along the coastline have induced large scale changes in the geological and ecological set up of the coast. It is observed that the sand dune ecosystems of Goa which are over 6000 years old have borne the maximum brunt of this "development".

The beach - dune environment is a highly organized system. Sand dunes which generally back wide beaches, are features of extreme fragility and sensitive to anthropogenic stress. Sand dunes are *Nature's line of defense* from the forces of the ocean. They also serve as "sand banks" maintaining the dynamic equilibrium of the beach. When vegetated, they support a large variety of plant and animal life, thus adding to the biodiversity.

The present report is the first comprehensive document which addresses human interference on coastal sand dune complexes. This work forms a part of the project "Study of Goa and its environment from space". The results have clearly brought out that anthropogenic activities such as constructions in sandy areas, beach resorts, coastal roads and sand mining are the major factors which have led to the desecration and consequent elimination of sand dunes.

The report discusses the present state of coastal dune belts and suggests measures for their restoration and management. It is hoped that the report will prove useful for microplanning of coastal development.

E. DESA
Director

GOA AND ITS ENVIRONMENT

The project called 'Study of Goa and its environment from space' was sponsored by the Department of Ocean Development, New Delhi. The aim of the project was to monitor changes occurring in Goa's environment due to both natural and man-made factors using past and present satellite images. The work was done jointly with the Department of Science, Technology and Environment, Government of Goa.

Following the liberation of Goa in 1962, the socio-economic development of Goa has been rather fast compared to many other regions in India. Mining, tourism, fisheries and other small scale industries saw a rapid expansion over a relatively short period of time. This required matching developments in other sectors such as transport, river navigation, housing, power supply and freshwater distribution. The land-use patterns also underwent significant changes during this period due to increasing economic activities. This led to the fast degradation of the delicate coastal, marine and terrestrial ecosystems in Goa. Incursion of saline waters into the main lands, disappearance of sand dunes, shallowing of rivers, flooding of residential and commercial areas, marginalization of grazing lands, spread of malaria and other diseases, accumulation of tar balls on beaches are but a few examples.

The present project studies various aspects of Goa's environment with special emphasis on changes that have occurred in them over time. This report" deals with the anthropogenic impacts on coastal sand dune ecosystems of Goa. Other reports under the project are:

- Status of Goa and its environment
- Mapping of sand dune vegetation from space
- Weather and climate of Goa
- Sea surface temperature distribution around Goa.
- Erosion and accretion in Goa
- Coastal geomorphology of Goa
- Mangrove environment of Goa
- Forestry in Goa
- Agriculture in Goa
- Water resources and industrial pollution in Goa
- Mining in Goa
- Urbanisation patterns of Goa

It is hoped that these reports will serve as important baseline documents for future environmental studies in Goa and for planning eco-friendly development in the region.

P. V.SATHE
Principal Investigator

The main purpose of this notification which lists various rules and guidelines, was to control and minimise environmental damage to coastal stretches including estuaries and backwaters. Accordingly, all coastal states of India were bound to formulate coastal zone management (CZM) plans classifying coastal stretches as coastal regulation zones, based on the nature of existing ecosystems and/or development. The CZM plans (Anonymous, 1996, a) prepared by the state of Goa were rejected (Anonymous, 1996, b) as the document contained several flaws and some misleading information. In the meantime, flagrant misuse of coastal spaces of the country forced some environment conscious citizens to file a public interest litigation based on which the Supreme Court of India validated the CRZ Notification on 25 April 1996. In June 1996, The MEF requested the National Institute of Oceanography, Goa, for information on the ecosensitive areas of coastal Goa. After a detailed survey, all data was submitted to them, in August 1996 in the form of an unpublished report (Anonymous, 1996, d). The final approval of the plans, with certain modifications to be incorporated, was issued in September 1996 (Anonymous, 1996, e). This is the prevailing law which governs developmental activities along the coasts, rivers and backwaters of Goa.

With the formulation of CRZ, India can be classified amongst the first few countries in the world to take legal steps to protect its beaches and sensitive coastal ecosystems from unplanned development and to demarcate specific areas for conservation. This objective has been achieved by categorising coastal stretches under CRZ I, CRZ II, CRZ III and CRZ IV.

4. METHODOLOGY

This document is based on extensive field observations and surveys along the entire coastal zone of Goa over the last two years. Field checks were carried out in July and August 1996, and January, April and December 1997; this work is still continuing. Existing toposheets, aerial photographs and recent satellite imageries were consulted to delineate sandy stretches including pocket beaches. More than 200 sites were inspected and surveyed; detailed ground truth data has been collected with which the areas of concern can be identified. Various types of geological samples of different landforms including dune sands were also collected. The photography of natural features of various coastal ecosystems has been undertaken to justify their ecological importance and their intrinsic value, and also to depict the present coastal scenarios. Violations of coastal zone environmental regulations have been noted where they exist; this exercise mostly consists of identifying man-made structures in wrong places along the coastal tracts. Various official and other reports, published and unpublished, have been made use of for comparison with our data. Discussions with respective officials, planners, bureaucrats, scientists, politicians concerned with coastal issues are of immense use from the point of view of planning and management. Similarly, the talks with natives / locals throw details about the past scenarios along the shores as these inhabitants have lived on the coast since long.

5. COASTAL SAND DUNE ECOSYSTEMS OF GOA

The coast of Goa consists of a combination of beaches, rocky shores and headlands which protrude into the sea. Of the 105 km long coast, more than 70 km

comprise sandy beaches (including those within estuaries), all backed by several rows of sand dunes (Figure 1). The following is a brief account of the sand dune complexes along the coastal zone of Goa; for seasons of simplicity and for the purpose of this report, the entire coast is subdivided into four major sectors and some small parts:

Querim - Morjim:

At Querim, the coastal area from river Tiracol southwards is characterized by a long belt of stable sand dunes (Figure 1A), is well preserved in its pristine form and hence can be termed a virgin area. Casuarina vegetation is very prominent. The Government of Goa has acknowledged Querim as one of the most beautiful beaches in Goa (Anonymous, 1996,a). The southern part of Querim comprises a rocky coast. At Arambol - Mandrem, in the northern part, a sweet water body is located adjacent to the beach at the base of a hill, being one of the two such ecosystems in Goa. The entire coastal stretch is protected by continuous 5 - 6 m high sand dunes with dune vegetation. Some of the sand dunes are shifting in nature as can be observed in Mandrem where new dunes, presently low in height, are being formed; this makes the area a prograding coast. In this stretch, two major creeks which open into the sea are lined with mangroves with a luxuriant swamp a little inland, all of which are found behind sand dunes (Figure 1A); these are some of the exotic areas found along the north Goa coastal belt. At Morjim, a long strip which terminates at the mouth of river Chapora is marked by extensive rows of sand dunes with dune vegetation, being more pronounced in the southern part. The coastal stretch is thickly populated by coconut trees. The Morjim area which is so far free from major construction activity, has been acknowledged as sensitive and important as sea turtles come to nest here; this is an annual post-monsoon event that has been demonstrated this year (Anonymous, 1997,a).

Chapora - Sinquerim:

Below the Chapora fort, and especially at Vagator, low sand dunes are common over a limited stretch. Dune vegetation with coconut trees are also seen. The southern part of Vagator comprises a rocky coast with some sandy pockets. Similarly, at Anjuna, south of the main tourist point, there are extensive sand dunes with vegetal cover along the coast. Many dunes are found to be degraded and altered. Coastal erosive processes, as evidenced by chaotic strandlines, are observed at several places along the shoreline in this sector. Anjuna beach terminates against a rocky headland which continues further south. The Baga - Calangute stretch consists of sand dunes, with diverse dune vegetation (Figure 1B). A large number of dunes are severely altered and some razed, levelled and eliminated as this belt is extensively and haphazardly built up. At Calangute, although this zone is the main point where tourists converge, sand dunes, with dune vegetation and casuarina, in various stages of degradation are found north and south of the Tourist Hostel. The Calangute - Sinquerim stretch up to the Aguada headland is marked by a continuous chain of 5 - 6 m high sand dunes with diverse dune vegetation and coconut trees. As in the north, this area is also overbuilt. Several roads, perpendicular to the coast and across dune

840

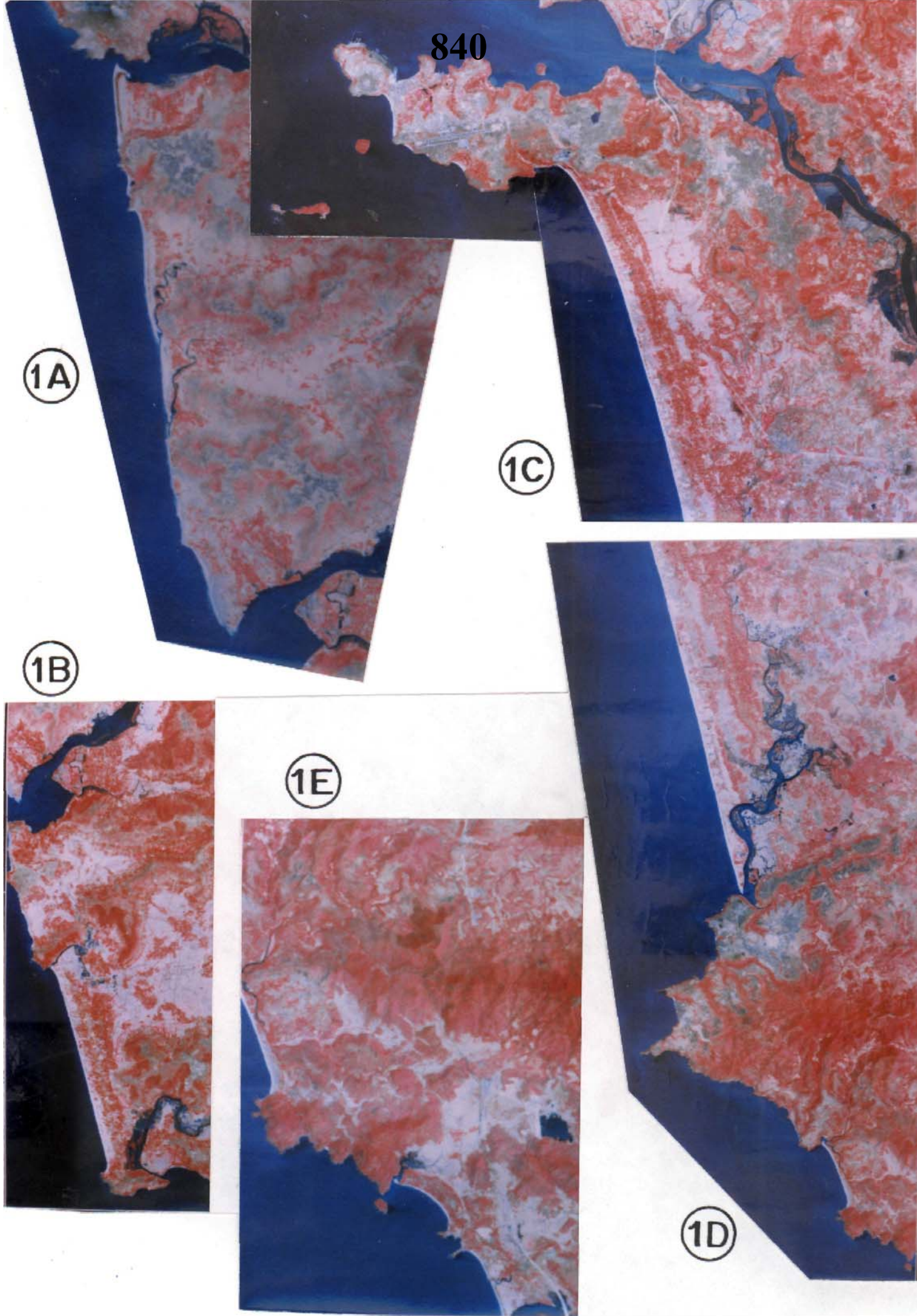
1A

1C

1B

1E

1D



belts, have been constructed in these areas. To the south, the Aguada coast is rocky and barren up to mouth of the Mandovi estuary.

Dona Paula - Caranzalem - Miramar (Mandovi estuary):

A prominent sand dune belt is found backing the Caranzalem - Miramar beach. New dunes, presently low in height and capped by vegetation, are in the process of formation along the upper reaches of Miramar - Caranzalem beach; it terminates against the wooded hill slopes of Cabo promontory. However, sand dunes are progressively being destroyed. At Campal, due to severe erosion, the primitive beach no longer exists, except for a small portion near Panjim city. Instead, a sea wall, almost 2 km long, has virtually replaced the beach; this concrete / stone wall is placed in the intertidal zone. The opposite Nerul (Coco) protected beach does not show any significant dunes. The Miramar - Caranzalem strip is the most prominent dune belt within the estuaries of Goa.

Dona Paula - Agassaim (Zuari estuary):

This strip mostly consists of several pocket beaches backed by wooded hill slopes, now in various stages of degradation (Dona Paula). Notable sandy beaches are found at Vainguinim, Odxel, Bambolim, and particularly at Siridao where dunes are low. The opposite side of the estuary is generally devoid of beaches except the sandy portion at Vasco.

Vasco - Bogmalo:

The sea front comprises rocky headlands, sparsely wooded, with only two major beaches: the one at Baina is severely degraded whereas the one at Bogmalo, lined by dense coconut trees, is more natural. Here, low sand dunes are present but some of them are obliterated. To the south, the coast is mostly rocky (Chicolna, Dabolim) with a few pocket beaches and secluded coves such as the one at Hollant.

Velsao - Mobor:

This linear stretch with a very wide beach is backed by the largest and the longest strip of sand dunes of the entire coastal zone of Goa (Figures 1C and 1D). Dunes are mostly concentrated within 500 - 600 m from the shore (Lobo, 1988) but are often seen to extend as far as 5 km from the coast as is the case near Margao.

At Velsao, the coastal area is characterized by thick coconut plantations; sand dunes are low. Most of the shoreline is under threat of erosive processes as evidenced by eroded berms and uprooted trees. The Cansaulim - Arossim part consists of very prominent 6 to 8 m high vegetated sand dunes. Many dunes have been levelled. The Utorda - Majorda - Consua - Betalbatim coastal zone is marked by long strips of sand dunes, some as high as 8 m, with associated vegetation. Coconut plantations are prominent. At several places in this stretch, sand dunes have been flattened and obliterated. Severe beach erosion is observed near Majorda beach resort. At Colva, sand dunes, 5 to 6 m in height, with dune vegetation and coconut plantations are still

seen on either side of the main beach point which has turned into a crowded area. A small seasonal lagoon along the beach is an annual hydrodynamic feature at Colva. The Sernabatim - Benaulim - Varca - Cavelossim - Mobor coast is the most prolific as it is packed by protective sand dunes, varying in elevation from 3 to 10 m (Sriram and Prasad, 1988), with associated vegetation including luxuriant casuarina plantations as in Varca. Here, several dunes have been flattened and even removed. A similar situation is observed at Cavelosim and particularly Mobor where sand dunes are severely damaged. Large dune areas have been razed. Sand extraction is rampant in the entire stretch. Several new coast perpendicular roads have been built during the last few years. The Cavelossim - Mobor coastal strip, a unique sandy peninsula about 250 m wide found between the ocean and the river Sal, is being built up at an exceedingly fast rate. The stretch from Velsao up to Mobor peninsula, characterized by the most majestic sand dunes, is the most exquisite dune belt of the entire coastal zone of Goa.

Cola - Agonda - Palolem:

At Cola, the northern and southern parts have numerous small sandy pockets and beach fronts, all located within promontories which consist of evergreen hill slopes that extend into the sea (Figure 1E). The area displays an outstanding natural beauty (Anonymous, 1996,a). The Agonda area which comprises a kilometer long secluded beach between two wooded headlands is backed by low sand dunes in the southern part only. The complete shoreline is prone to erosive forces. This is more evident in the northern part of the beach which appears to be a geologically dynamic shoreline, is prone to monsoon inundation and has been subjected to severe erosion as seen from a large number of uprooted trees lying on the beach. In the northern extremity, two sheltered creeks with luxuriant mangroves makes it an unique ecosystem adjacent to the open sea. Palolem is another popular protected beach between two thinly wooded rocky headlands. The entire coastal area consists of luxuriant coconut groves; low sand dunes are seen in the southern part being less prominent in the north. Although localised, this shoreline is eroding and retreating at a fast rate. Further south, the virgin Koloma beach between two promontories, and the pristine Rajebag beach backed by dunes and with a sweet water lagoon at one end, are the two noteworthy sandy areas.

Talpona - Galgibaga:

The Talpona river mouth area comprises a unique ecosystem with prominent sand dunes and associated casuarina vegetation along the northern sea front, a luxuriant growth of mangroves within the estuary and a headland with a thick forest cover in the south. The Talpona - Galgibaga stretch comprises a linear beach with a minor wooded headland in between. The entire belt is characterized by majestic sand dunes, some as high as 6 - 8 m. At some places, close to the existing parallel road, high dunes have been blatantly razed and obliterated. The southern extremity of this beach stretch is marked by casuarina trees. The Galgibaga river mouth is almost identical to the Talpona estuary with sand dunes and casuarina vegetation in the northern side, mangroves within the estuary (Maxem) and a lush green wooded headland forming the southern part.

Maxem - Polem:

Except for the mangrove clad Maxem backwaters, the entire shore up to the southern border is rocky but with vegetated slopes jutting into the sea. Pocket beaches and sandy patches are found along this stretch, the most prominent being the secluded Xendrem beach with a rocky shore, and Polem beach less than a kilometer long and well protected with promontories; sand dunes are now consolidated and hence appear to be very ancient.

6. FORMATION, SIGNIFICANCE AND USES OF SAND DUNES

6.1. Formation And Evolution Of Coastal Dune Systems

The main prerequisites for the formation of sand dunes are wind, sand and vegetation, three elements with complex and dynamic interactions (Carter, 1988). Wind plays the most important role; its direction, frequency, duration and speed are to be considered as only winds with a speed greater than 16 km/hour can lift, displace and transport fine dry sand (Paskoff, 1989, 1994). This is more so along low gradient beaches particularly when they are subaerially exposed at low tides, and when strong winds blow perpendicular to a particular coast.

The vegetation which constitutes inland plants that grow immediately behind the beaches also play a key role in dune formation since these objects act as wind breakers due to which wind is forced to drop sand along its path. Vegetation thus traps and stabilises moving sand. These plants are adapted to an inhospitable environment characterized by a mobile substrate, saline atmosphere and a regular bombardment of moving sand (Paskoff, 1989).

The first step in the formation of a dune, by plants tolerant to salt, is a berm which is an accumulation of sand brought up by the waves on the beach at a point just above the highest high tide (Figure 2A). These plants flourish with the organic matter brought by high waves during storms or heavy winds. The berm swells due to the eolian import of sand. Thus these small sand mounds which form, finally develop into a continuous chain of sand dunes. These eolian bedforms can be symmetrical, several meters in height and can vary in size from place to place. Their dimension depend on the degree of evolution and the aptitude of vegetation to trap and retain sand.

The evolution of a coastal dune system strictly depends on the sedimentary budget of the beach which refers to the relation between the quantity of sand brought in by winds and the sand removed by tides and littoral currents. Their evolution is also dependent on the conditions of the sea level which can be stable, or in increasing or decreasing mode. Based on the above criteria, four major typical models can be proposed (see Figures 2B - 2E):

When the sea level decreases, the subaerially exposed beach area increases; the sand budget is positive and hence the beach progrades and advances towards the sea (Figure 2B). The surplus sand that is available forms a new sand dune seaward of the

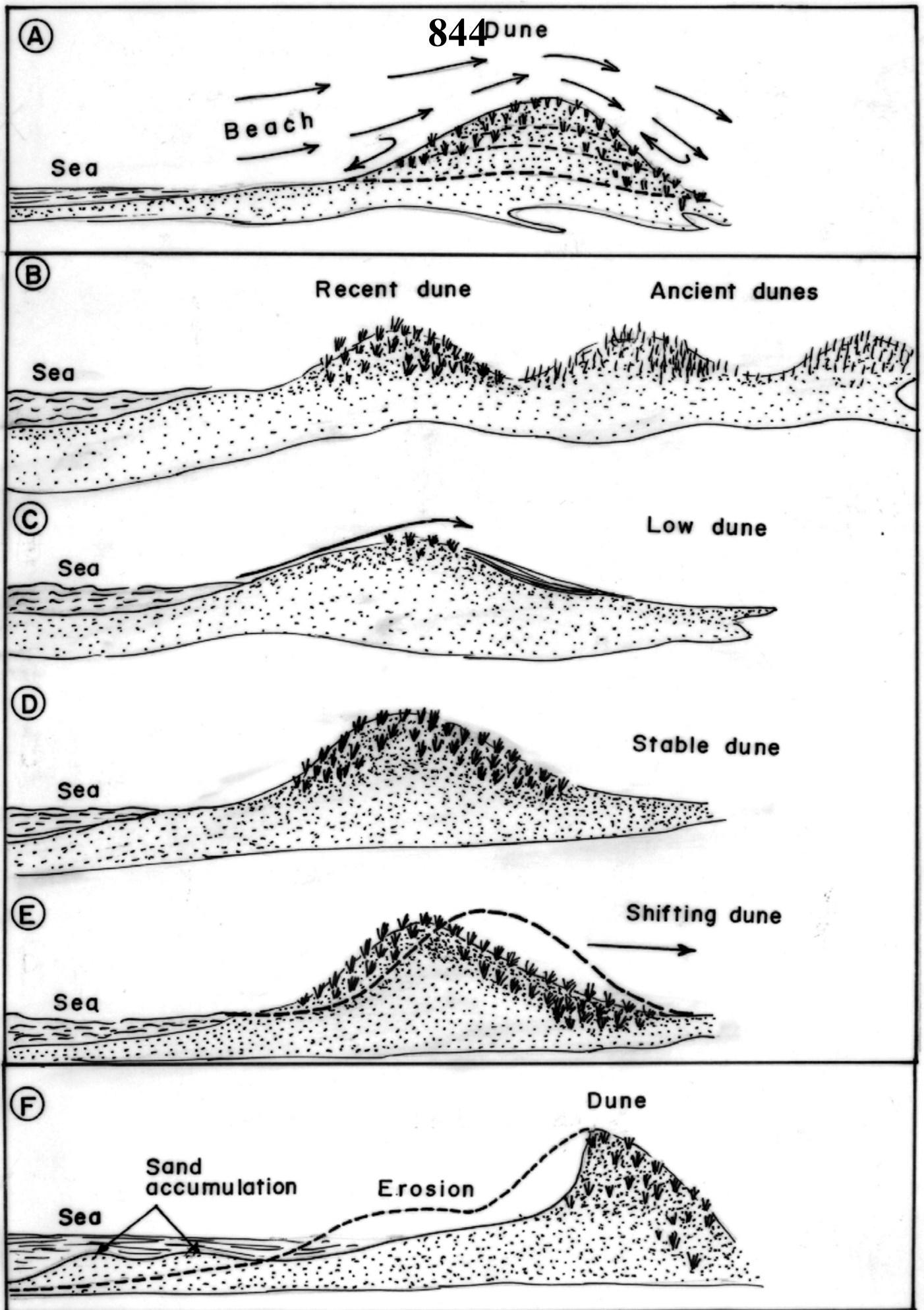


FIGURE -2

existing ones which become stable or inactive as they are no longer fed by sand. In this way, coast parallel new dune chains are formed. The inner limits of the new dune strip would signify the paleoshoreline as the coast advances.

When the sea level rises, beaches are flooded due to which they narrow down and thin out; thus, the sand budget is negative. In such a case there is hardly any possibility for the formation of new dunes; only a low berm with minor vegetation is normally found (Figure 2C). In such situations, high waves often wash over the dunes and is accompanied by erosion of the sand body.

When the sea level is stable, the sand budget is in a state of equilibrium. Therefore, the shoreline remains stable and so is the adjacent dune belt with individual dunes which are broad and high (Figure 2D).

When the sea level shows an increasing tendency, as is the case worldwide at present, the sand budget is slightly negative. In such a case, there is a consequent sediment starvation; high waves and stormy seas force the shoreline to retreat resulting in a landward migration of the sand dune and shoreline as well (Figure 2E).

The above models depict various stages of sand dune evolution and hence the evolution of the coastal landscape on a geological time scale, depending upon the environmental conditions. However, it is the model shown in Figure 2E which should generally be applicable at present, considering the fact that the global sea levels are on the rise. This criteria has to be considered and be given due importance in the planning and management of open sea fronts; these aspects are elaborated in the later parts of this report.

6.2. Temporal Geological History Of Sand Dunes

The temporal evolution and geological history of the sand dunes of Goa has never been studied in detail; but some pertinent facts are mentioned here (Figure 3). At Miramar, our unpublished data (Figure 3C) of two vertical sections (one of a dune and the other a road trench) indicate that, from the top downwards, the sediment is exclusively composed of medium sands only. The section shows colour contrasts in various shades of yellow evidently related to the climates which prevailed during the past. The most prominent feature of this section is the occurrence of a seam of black sands near the base of the sequence. This black layer rich in heavy minerals, about 10 to 30 cm thick, shows irregular but sharp top and bottom contacts (unpublished data). Detailed field observations revealed that this black sand layer has a significantly wide spatial distribution as it is found to extend from Campal to Miramar and even further to Caranzalem and Dona Paula; this layer thins out within a kilometer towards the hinterland. A similar black layer intercalated within dune sands has also been observed at Velsao. In the entire area, the black mineral seam is found at different depths from the surface.

Similarly, at Galgibaga river mouth, an indurated sandstone outcrop, resembling a beach rock, was identified at the base of a sand dune (Figure 3B). As this consolidated material was also found at another place in the vicinity, this rock

by insisting on proper integrated studies between beaches and dunes. Such an approach which involves the natural ecosystems and the socio-economic system can alone preserve the sanctity of coastal sand dune ecosystems of Goa.

10. SUMMARY AND RECOMMENDATIONS

A. Sand dune belts which back sandy beaches are the most characteristic features of the open sea front of Goa. These geomorphic edifices are most conspicuous from Querim to Morjim, Baga to Sinquerim, Miramar to Caranzalem, along the long linear stretch from Velsao to Mobor, and Talpona to Galgibaga. These dunes, often as high as 10 m, sometimes extend even beyond 500 m from the HTL. These geomorphic edifices, about 6000 years old and categorized as Nature's line of defense, are typical features of coastal stability. The dune environment is classified as fragile, sensitive and vulnerable due to its propensity for changes under even slight environmental stress. Therefore, sand dunes have to be preserved at all costs by maintaining free coastal spaces.

B. Our study reveals that (a) construction of resorts and buildings on dunes, (b) mining of dune sands and (c) roads on sandy strips, are the three major factors which are responsible for the degradation of sand dune vegetation, increase in the mobility coupled with a landward migration of loose free sand, impacts on dune stability, alterations of sand budget, risks of inundation and accompanying erosion. These factors collectively result in the large scale irreversible degradation and consequent elimination of sand dunes. Seasonal marine salt water ingress is beginning to show up in coastal aquifers; this is attributed to excessive pumping of ground water. In comparison, the effects of other human interference such as beach shacks, recreational activities and litter on beach - dune systems can be termed as minimal and are largely reversible.

C. During the last fifteen years, several management plans have been proposed. Of these, The Eco-Development Plan (1982), The Environment Management Plan (1988) and the Regional Plan (1988) indeed address sand dunes and the need to maintain open coastal spaces. On the contrary, the Tourism Master Plan (1987) and the Coastal Zone Management Plan (1996) recommend unrestricted development along the coast. Moreover, the CZMP has completely ignored sand dunes which are sensitive landforms along the open sea front, and in fact approves tourism related development along the entire 70 km long sandy beaches. Thus, planners and policy makers keep contradicting their own guidelines. Such a laxity has resulted in unauthorised structures and uncontrolled growth along the coastal zone. This proves that the environmental laws are rarely considered.

D. Blatant large scale violations of CRZ regulations are observed along the open sea front as well as the estuaries. Sand dunes have borne the maximum brunt and have suffered the greatest from indiscriminate anthropogenic pressures which mostly include haphazard construction activities. High dunes have been razed and obliterated to make place for hotels and roads. Some structures are seen even along the HTL. Unscientific dune sand extraction and ground water withdrawal is rampant and goes unchecked. Such anthropogenic activities have changed and are still altering

the configuration of the coast, factors which work against the ecological principles of the coastal zone.

E. Mandatory setback lines are imperative. Sand dunes are landforms essential for coastal stability, they are ecologically sensitive, they are sometimes mobile and hence shifting in nature; the threat of an impending sea level rise will make dunes act as Nature's line of defense. These factors collectively demand that coastal dune strips, as already defined by law, have to be compulsorily designated as no development zones.

F. Several areas along the open sea coast and also within estuaries are undergoing erosion. In some cases this process appears to be natural (Agonda), whereas in others it is man-made (Campal). All such places under threat call for (natural) protection under CRZ rules.

G. Hard options (sea walls) employed to control beach erosion are obsolete as they only magnify erosive processes leading to disappearance and consequent loss of sandy beaches, a phenomenon that can be observed at Campal where erosion continues unabated. What is required are soft options such as beach nourishment and more modern methods of beach management. The sea wall at Campal is a monumental human blunder.

H. Restoration of degraded sand dunes is a modern scientific method used for their management. Fencing of dune strips and planting appropriate vegetation is a simple and effective method in restoring dunes. Vegetation can often recuperate itself if dunes are left undisturbed; such dunes remain stable.

I. The crucial issue of predicted sea level rise has neither been considered nor visualised by local planners, although this factor is to be examined under CRZ rules. Since the sea levels are rising, coastal communities will have to adopt extensive measures to protect structures closer to the coast. In Goa, the beaches in general and the flat ones in particular are bound to be influenced by enhanced erosion. However, no matter what technique is applied, the protective measures would only be a temporary solution requiring continual upkeep accompanied by prohibitive expenditure. The most cost-effective long term solution is to set aside land for future marine transgressions; hence the need for open coastal spaces.

J. The sea front of Goa can be classified as overdeveloped, developed and undeveloped depending upon the modern activity observed after 1991, subsequent to the CRZ Notification. The first category includes the Baga - Calangute - Candolim sector in the north and Colva in the central part; the second category would include Anjuna, Caranzalem - Miramar, Bogmalo (part), Utorda - Betalbatim, Benaullim, Cavelossim - Mobor in particular and Palolem. All the remaining part of the coast can be said to be relatively undeveloped. In the last category, we observe that many stretches, within and outside CRZ, still remain unsullied and in a pristine form (Querim, Arambol - Mandrem - Morjim, Velsao - Cansaulim, Varca, Agonda and Talpona - Galgibaga).

K. Natural ecosystems comprising sand dunes backed by a river or creek which is in turn backed by mangrove swamps or marshes are found at a few places along the open coast. Such exotic settings can be designated as state parks and can be reserved for the purpose of ecotourism.

L. Proper management and sustainable development of the coastal zone of Goa is an issue of critical importance as more than half the population inhabits the coastal zone. Ecological considerations are being overstepped and sidelined so that demands can be met. We are therefore faced with a conflict: builders, planners, bureaucrats and politicians favor "development" under the banner of demands, whereas environmental scientists and NGO's insist on ecological and environmental principles. A lack of political will appears to be the main impeding factor.

M. The concept of "build here, build there, build everywhere" has created multiple use conflicts of coastal spaces. In view of various problems and impacts described above, it is imperative that an environmental impact assessment of the effects of human activity on the beach dune ecosystems of the entire coastal stretch be carried out so as to ascertain the health of the coastal zone.

N. We need a stringent enforcement of CRZ laws coupled with an integrated coastal zone management with a holistic approach which includes the natural ecosystems and the human socio-economic system. This exercise will undoubtedly be helpful in the preservation and protection of the remaining shreds of the coastal environment of Goa.

11. REFERENCES

Alvares, C, 1993. Fish, Curry and Rice: A Citizen's Report on the State of the Goan Environment, Ecoforum, Goa, pp. 260.

Alvares, C, 1996. Beach law breaches. The Navhind Times, 28 July.

Anonymous, 1982. Eco-development plan for Goa. Planning Commission, Government of India, 136 pp.

Anonymous, 1987. Master Plan for Tourism Development in Goa, Department of Tourism (Draft Report), Government of Goa, July 1987, 130 pp.

Anonymous, 1991. The Gazette of India, Notification, S.O. no. 114(E); The Ministry of Environment and Forests, February 20, 1991.

Anonymous, 1995. State files affidavit denying CRZ violations. Herald, 18 August, p. 1.

Anonymous, 1996,a. Coastal Zone Management Plans for Goa, Town and Country Planning Department, Government of Goa, pp. 69.

Anonymous, 1996.b. Delhi rejects Goas's coastal plans for constructions. Herald Illustrated Review, 96:1.

Anonymous, 1996,c. Court passes strictures against Calangute panchayat: illegal constructions within HTL. Herald, 10 April, p.1.

Anonymous, 1996,d. Comments on the Coastal Zone Management Plans of Goa. Report submitted to Ministry of Environment and Forests, New Delhi. National Institute of Oceanography, Goa, September, 1996.

Anonymous, 1996,e. Coastal zone management plans of Goa (approval notification). Ministry of Environment and Forests, No. J-17011/12/92-IA-III, September 26.

Anonymous, 1997,a. Sea turtles on the run as humans take over beaches. The Navhind Times, 20 February, p. 1.

Anonymous, 1997,b. Gross violations of coastal zone notification at Benaulim. Herald, 30 March, p. 8.

Anonymous, 1997,c. Supreme court upholds high court order on Piva resorts. Herald, 3 May.

Anonymous, 1997,d. Government allowing resort to come up on the bank of River Mandovi? Herald, 8 September.

Anonymous, 1997,e. Sand extraction threatens south Goa beaches. Herald, 21 November.

Arens, S.M. and Wiersma, J., 1994. The Dutch foredunes: Inventory and classification. Jour. Coast Res., 10:189-202.

Avis, A.M., 1989. A review of coastal dune stabilization in the Cape Province of South Africa. Land. Urban Plann., 18:55-68.

Babalonas, D. and Papastergiadou, E., 1993. Impact of the touristic development on the vegetation of Agios Mamas Lagoon (Macedonia, Greece). Greece Natural History Museum, 10 pp.

Bauer, B.O., Davidson Arnott, R.G.D., Nordstrom, K.F., Ollerhead, J. and Jackson, N.L., 1996. Indeterminacy in aeolian sediment transport across beaches. Jour Coast Res., 12:641-653.

Bigot, L., Picard, J. and Roman, M.L., 1987. Consequences of human interventions on natural sand areas of the seashore in the Rhone delta. Bull Ecol., 18:209-212.