Chapter three

GEO-PHYSICAL SETTING
Introduction:

Goa's history since time immemorial owes a great debt to its distinct topography. Geography plays a very dominant role in the life of humans. The climate, rains, rivers, hills, valleys, mountains, flora, fauna have influenced their way of life and thus their history. In Goa, the long stretch of coastal belt, Sahayadri slopes and tablelands on hilltops have encouraged human settlements leading to urbanization.

This chapter enables us to reconstruct the ancient urban maritime history of Goa from a geographical point of view. It provides a clear picture of the geo-physical setting of Goa in general and the port-capitals in particular. Geo-physical studies on a single city can be rarely explained without taking into consideration the overall geographical scenario in the other parts of the region.

The main intention here is to understand how the geo-physical setting of Goa was conducive for the growth and development of urban centres and maritime trade and later responsible for its decline. Where did urban centres grow? What are the determinant factors that influence location of ports and growth of port cities? What climatic and geological conditions are conducive for the patterns of trade?

As Marc Bloch has rightly stated, "History is the science of men in time" that is, a proper understanding of the past geo-physical setting of Goa is possible only with the proper knowledge of the present status of Goa.

In order to reconstruct the past from the present it is essential at first to have a total picture of Goa in mind while looking at any of its parts. Every region is inter-related with every other in a complex form and changes in any one form are bound to have a consequent effect on the others. If time is continuous, change is also a continuous process, time brings with it change and this change can be
slow or fast. It is thus essential to examine the changes which took place in the geo-physical setting of Goa in time, form and space.

Goa, a mirror of India’s rich heritage, is well known around the globe as a “tropical paradise of the tourist” sandwiched between the Arabian Sea on the western seaboard of India and eastern up-Ghat region. (ch.3, Map1) (ch.3, Plate 1)

**Location:**

Presently, the territory of Goa is located between 14° 53’ 57° N and 15° 47’ 59° North latitude and between the meridian 73° 43’ 54° and 74° 20’ 11° East longitude on the west coast of Peninsular India.¹ It is situated along the western seaboard of India almost midway between the key economic areas of Gujarat to the north and Malabar to the south covering an area of 3701 sq. kms. It is 105 kms. long in the north-south direction and 60 kms. wide in the east-west direction.² It comprises of coastal lowlands south of Konkan between the crest of Western Ghats in the east and the Arabian Sea in the west it extends from the river Tirachol in the north to the Sadashivgad range in the south.

**Boundaries:**

Goa is naturally protected by the river Tirachol to the north sharing its boundaries with Maharashtra, Arabian Sea to the west, Sahayadri to the east and the Kalanadi creek and Polem Ghat to the south sharing its boundaries with Karnataka.³

A peep into the ancient and medieval history of Goa reveals that the position, area, boundaries which once enabled certain maritime settlements to flourish did not have the same distinctive features as they do today owing to a process of change in form, space and time. It strongly depended upon the political prowess wielded by the different dynasties striving to be supreme powers by expanding and reducing their area and boundaries to the north, south and east.
Here are some of the instances which are cited as evidences to justify that the boundaries of Goa stretched towards the north, south and east.

- The *Sahayadri Khand* of the *Skand Purana* narrates the Parshurama legend associated with the creation of Goa. As the myth goes, Parshurama the 6th incarnation of lord Vishnu faced with an order of banishment from the land that he had once conquered, set seven arrows fly from atop the Sahayadri mountains to push back the sea and create a stretch of land that he could claim for himself. The sea god acceded to his request and created the Shurparakadesh.\(^4\) This land reclaimed from the sea extended from the Vaitran river to Kanyakumari called Parashuramashetra\(^5\) and is divided into seven sections one of which is identified with Goa. However, Shurparakadesh is associated with North Konkan and Sopara while Gomantak is the name given for south Konkan.\(^6\) The territorial limits of Goa adjusted themselves within and also outside these boundaries.

- Gomanchal is equated with Goa, the ancient name of Goa given in the *Konkannakhyana* to the region in between the Gangas, referring most probably to the river Damanganga in the North and Gangvalli in the south thus the ancient boundaries of Goa can be traced between the river Achra in the north and Gangavalli in the south including Banda, Kudal, Sadashivgad, Karwar and Ankola.\(^7\)

- Hiuen Tsang, the Chinese traveller mentions that after covering a distance of 300 miles from south west to north west the territory of Konkan begins.\(^8\)

- During the Mauryan period Goa was identified as Aparant or the land beyond. Thus the name is given to the coastal region which stretched from Broach in the north to the northern borders of the Murla river in the south Aparant is regarded as an umbrella term for Konkan to which
Shurparakadesh in the north and Gomantak in the south with the river Kundalika serving as a dividing line between the two.9

- During the 4th century Goa was ruled by the Bhojas10 who were semi-independent rulers of the Deccan and the Konkan in feudal allegiance to the Mauryan empire of Pataliputra11 with its capital at Chandrapur including Antruz, Salcete, Bardez and Goa.12

- Under the rule of the Chalukyas, Goa was part of Revatidvipa (Reddi) and comprised of a narrow strip of land stretching along the coast from Sawantwadi embracing Vengurla, the southern part of Malwan, Goa down up to the Kalawali River.13

- Emperor Vijayaditya mentions the Konkan as Mahasaptama consisting of Karatam, Viratam, Maratam, Konkanam, Havygam, Tulavam and Keralam and the region of Konkanam was the region called Goa.14

- During the 8th century Goa was ruled by the southern Shilahara dynasty and extended their territorial limits comprising of the present day Goa along with the Iridige tract, and the coastal tract up to Thana, Konkan 900 with Gopakapattana as their capital and Vallipattana as their port town.15

- From the 10-13th century the Kadambas initially acquired the territory south of the island of Goa including a large part of Salcete and a strip of land approaching the Sahayadri with Chandrapur as its capital.

- Gopakapattana, the island of Goa and Konkan 900 formed part of Goa under the rule of Shasthadeva I.

- Jayakeshi I termed himself as the lord of the Konkan rashtra and included Goa as well as Kapardikadivpa in his territories.
During the reign of Guhaladeva II Kapardikadvipa and Iridige was lost to north Konkan Shilaharas but Goa formed part of Halsi, Gopakapattana, south Konkan, Palasige12000 and Konkan 900.

Jayakeshi II the Kadamba empire attained the pinnacle of glory it stretched from Thana in the north to south Kanara in the south with the eastern most limits of the present day district of Belgaum and Dharwad in the east. It included Konkan 900, Palasike 12000, Unukul and Sabbi, Kontakuli 20, 500 of Hanumgal, 30 of Utsugrame and Kadarravalli 30 of Palagunde, 70 of Velugrame, 500 of Haive and Kavadidvipa one lakh and a quarter.

During the time of Vijayaditya II the territorial boundaries started shrinking and later Beluvadesa was added by Jayakeshi III.16

Vijayanagara rulers acquired Malerajya and Palasige of the Goa Kadambas

1356 the Bahamanis acquired Konkan 900 of the Kadambas and Goa was constantly in feud between the Bahamani and Vijayanagara rulers

1378 Goa formed part of the Aragagutti rajya whose capital was Govapuri although at times it was shifted to Chandragutti, Tiswadi, Salcete, Ponda Satari, Bardez, Bicholim, Pernem were included.

1391 Goa became part of Sawantwadi.

1448 Chandragutti was separated from Goa.

1472 Goa was merged with the Bahamani province of Junnar for administrative purpose
• Vijayanagara province included Ponda, Panchmahal which formed part of the Kudal division of the Subha of Dabhol so did, Pernem, Bicholim and Sattari.

• 1508 Goa was part of the Bijapur kingdom of Adil Shah.

• 1510 Goa stretched from Banda to Sadashivgad when it was conquered by Alfonso de Albuquerque with the help of Timaji.

• 1543 Goa consisted of Bardez, Salcete and Tiswadi measuring around six or seven leagues.

• During the mid 16th century Pernem, Bicholim, Sattari, Chandravadi, Bali, Canacona and part of Konkan formed part of the Adilshah kingdom except Goa of the Portuguese.

• During the mid 17th century Ponda and Sawantwadi formed part of Chatrapati Shivaji’s province.

• 1689-1763 north, south and south eastern part of Goa was controlled by the Bhosles and King of Sonda.

• 1763-1781 Ponda, Sanguem, Quepem and Canacona became part of the state of Goa.

• Goa included Pernem, Bicholim, Sattari and Portuguese Goa.

• 1788 The present day boundaries of Goa were demarcated consisting of the ‘Old Conquests’ and the ‘New Conquests’.

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Physiography:
Physiographically, Goa is divided into three geographical divisions but during the course of my research I have come across epigraphic, numismatic and sculptural evidences of the major dynasties located in these areas which extended the territorial boundaries beyond the Ghats, thus Goa can be divided into four physiographical divisions:

- The up-Ghat region which forms part of the western Ghats is located in Karnataka and Maharashtra.

- Mountainous Sahayadri in the up-Ghat region that forms part of the western Ghats is lateritic and has an elevation of 300-1000 mts. above mean sea level covering about 45% of the area of Goa. The Sahayadri hills slopes downwards to Ponda in central Goa, Sattari in the north and Canacona in the south. These hills were a rich source of bio-diversity are today facing the human onslaught as a result of geological changes, deforestation and mining leading to changes in the climate and also accelerated the degree of soil erosion in recent times.

- Plateaus of the mid-region or the sub-Ghat region sandwiched between the coastal region and hilly region consisting of undulating uplands having gentle to moderate slopes intercepted by concave depressional landscape comprising valleys which are under paddy cultivation containing red loam soil with elevations ranging from 50-300 mts. above mean sea level and covers about 30% of the area of Goa.

- Sandy coastal and sub-coastal region along the western seaboard comprising of sandy beaches, estuaries, khazan lands, lagoons, offshore bars, cliffs, ridges, tidal flats, spits consisting of alluvium, saline and non-saline soils with elevation varying between 0-50 mts. above mean sea level and covers 25% of the area of Goa.
I propose to shed more light on this area as the coast greatly appealed to human beings not because of its aesthetic beauty but because the coastal belt offers ecological and economic advantages to humans such as favourable bio-physical, climatic conditions together with the ease of communication and navigation leading to the concentration of habitations along the coastal areas since prehistoric times.

Presently the coastal tract of Goa covers an area of 105 km. extending from the Tirachol River to the north and the Kalinadi River to the south along the western sea board. It consists of various geomorphologic features categorised as fluvial, marine and Aeolian.  

In order to understand the urban maritime history of Goa in its totality it is essential to understand past environmental conditions at a particular time and place which played a crucial role in shaping the history of human beings. Things have not always been as they are today there have been short-term and long-term changes This would include the changes in shoreline due to variations in sea level, level of sedimentation leading to the formation of alluvial plains, climatic changes and other geomorphic changes which will enable us to understand the dynamics behind the rise, development, shift and decline of ports, problems faced by early seafarers as well as displacements of urban settlements along the coast.

Unfortunately, detailed studies on the above aspects in case of India are too meagre and lacking in case of Goa to draw firm conclusions.

Reconstructing earlier coastline, coastal waters, river channels and weather experienced at a particular time and place is a complex matter since the effects of a number of interacting variables have to be estimated.

Scholars have studied sea-level changes, climatic changes during the quaternary periods but the historical periods especially the ancient and medieval periods of history has been in total darkness due to lack of evidences which has to
some extent proved to be a lacuna to the present study. Thus, it is necessary to talk in terms of probability and likelihood of what could have been the situation in early centuries.

The information pertaining to the sea-level changes in northern India is better investigated while southern coast is full of gaps. Thus, according to S.S. Merh (1992) the Indian coastline is sporadic, qualitative and mainly pertaining to the strandline generated erosional and depositional features.  

Kale, Guzder, Ghate, and Rajguru have documented various evidences of strandline fluctuations on the Konkan coast by reconstructing the late quaternary transgressional and regressional history of the west coast by plotting radiometric date of beach rock and beach dune complex formation from the Konkan and other shore zone from Goa, Karwar, Kerala and offshore dates from Bombay to Karwar. They obtained a curve showing the trend of sea level changes from the closing phase of Pleistocene to late Holocene period.

The study of sea-level changes are necessary because it provides information on temperature, salinity, density of seawater, currents, atmospheric pressure, wind effects, evaporation, precipitation, hydrology, water discharge from rivers, geology, land uplift, subsidence, astronomy, gravitation, tide generation forces and seismology.

Geo-morphological, archaeological and literary evidences can be used as one of the indicators to study shoreline changes as a result of sea-level variations. For instance,

- Availability of stone tools and sea shells along the coast can provide useful hints to trace shoreline changes.
- Geo-morphic features of fluvial, marine and aeolian along the coast
- Literary and oral evidences in the form of the Parshurama legend and proverbs

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According to De Souza (1965) the coastline of Goa is a coastline of submergence of the “ria” type which has now reached the late youth stage of development. While Ahmed (1972) is of the opinion that the coast as submergent rocky indented because of the high degree of indentation marked by “ria” like shore, rocky promontories, headlands, cliffs, rocky plains, sea caves, stake and rocky islands. Wagle (1989) supports this view and states that abundant sea cliffs 1-2 kms. in length from present shore beach rock, weathered sea caves, sea arch are seen beyond the present highest high tide indicating lowering of the sea level coastline.

Also the presence of lateritic beds along estuaries at a depth of 20, 27 and 34 mts. below present sea level indicates rise of sea level during the quaternary periods giving rise to a drowned valley. This is based on the disposition of landforms. The coast with broad beaches, old and recent dunes, old beach ridges indicates the progradation of the coast along the beaches while the coast with cliffs and wave cut terraces under formation indicates that the hilly regions of the coast are under coastal attack of the wave causing erosion and as a consequence of retrogression of the coast.

The present level is neither higher nor lower but represents an intermediate level. No doubt the coast is subjected to submergence in the quaternary period followed by partial emergence during recent times. This is based on the following evidences.

- Drowned valleys are reported along the west coast for example, Goa Velha and Chandor.
- Islands of St. Estevan, Chorao, Divar, Kumbarjuve along the coast were possibly earlier inselberg and they too show evidences of submergence.
- Presence of vast alluvial plains adjacent to river beds as well as the surrounding hillocks which were once islands show presence of marine sediments 2-7 kms inland.
- Abrasion platforms well above the present sea level and the beach rock along the coast are striking evidences of emergence of the coast.  
- Occurrence of marine conches and fossils at Chicalim, Bambolim, Marmugoa, Chapora, Mapusa, Zuari and Siridao estuaries which indicates a fall in the sea level.

Geology:
Goa forms part of the Karnataka craton of south India. The rocks of Goa are correlated to the Chitradurg group of the Dharwad super group of Archean-Proterozoic age except the Deccan traps of the upper cretaceous to lower Eocene age that covers small narrow strip along the north eastern borders of Goa. The rocks included in the Goa group which extend in a general north-west and south-east trend are represented by metamorphosed basic and volcanic rocks and sediments at the base overlain by greywacke suite of rock.

In the Goa group all the schistose rocks of Goa commencing from basic and acid metavolcanic followed by metagreywacke and tilloid, ferruginous pink phyllites with chaemogeric precipitate a younger metagreywacke are included. The Goa group is divided into four formation processes such as Vagueri, Bicholim, Sanvordem and Barcem. The Dharwad Group is represented by quartzite, phyllites, slates, chlorite, biotite, schists, granite, gneissas, meta basalts, banded hemalite and intrusions by basic dykes. Thus Goa possesses a very rich geological history and heritage as the oldest rock is found in Goa at Charrasta, Canacona belonging to the trondhjemite gneiss.

The geological structure of Goa blessed the state with abundant mineral resources such as iron ore, manganese, bauxite and silica. The Mandovi, Zuari and Cumbarjua canal served as the key sources of transporting and maintaining the economic viability of Goa's mining activity. As a result of its excessive depletion of mineral resources through the ages has affected the landscape causing siltation and other diverse effects on the present day environment.
Soil:
The most basic natural resource for human survival and its socio-economic
development is soil. Climate, physiography, geology, landforms, organic and
inorganic matter has led to the formation of the soils of Goa. Thus 81% of the soil
is lateritic formed as a result of the humid climate with high intensity of
precipitation and temperature. They are sandy loam to silt loam in texture, well
drained and highly acidic with pH of 5.5 to 6.5. They have moderate organic
carbon but are poor in phosphorous and potash. About 11% of soils along the
west coast and estuaries are sandy to sandy loam and 8% of the soils are alluvial
and very fertile in nature.

Classification of soil:
According to the soil taxonomy the soils of Goa are broadly classified into four
orders consisting of Inceptisols 68%, Ultisols 13%, Entisols 8%, and Alfisols 6%,
seven sub orders, 13 great groups and 16 sub groups.

Physiographically the soils can be divided as follows:

- The Sahayadris with clayey, loamy, skeletal erosion and stoniness
- The coastal plains with fine aquic ustropepts.
- The coast with beach and beach ridges is ustipsamments texture

Soil series of the Mandovi and Zuari river basins:

- The Mandovi soil series is very deep, poorly drained, greyish brown to
  very dark greyish brown, loamy sand surface soil. Very dark greyish
  brown to dark greyish brown, loamy sand to sandy loam sub-soil 1 to 3%
  slope, lightly eroded mixed typic psammaquents
- The Zuari series are deep, imperfectly drained, dark brown to dark
  yellowish brown, sandy loam to sandy clay loam surface soil and dark
  grey to very dark greyish brown, clay loam to clay sub-soil with canubic
  horizon and distinct brown mottles, 0 to 3% slope, slight salinity in
  patches, fine aquic ustropepts.
Khazans:
Presently, the landscape of Goa is the result of the reclamation of the land through the centuries by our ancestors who first developed this system of drainage. The earliest evidence of reclamation goes back to the Parshurama legend related to the creation of the land of Goa from the sea. The khazans of Goa covers an area of approximately 2000 km.\(^{35}\) The term khazan is commonly used in Konkan and Goa for coastal saline soil. While, in other parts of India such as West Bengal (bheri), Orissa (gheri), Kerala (pokkali) and in Karnataka as khar or gazani lands.

Khazans are understood as traditionally integrated agro-aquatic ecosystem found in Goa with paddy and fish forming the basic ecosystem cycle. These are mangrove areas, marshy areas reclaimed over centuries using a system of dykes, canals, sluice gates, outer and inner embankments developed by ancient settlers who reclaimed the marshy lands in the food plains of Goa's rivers and estuaries using their traditional knowledge of climate, tidal cycle, geomorphology, monsoon precipitation, sediments dynamics, soil properties and drainage characteristics of estuaries lands.\(^{36}\)

Khazans helps to control flooding of agricultural fields and villages during high tide, provides natural absorptive capacity, controls erosion of soil and retention of sediments, controls nutrients leaking and cycles soil nutrients. It shelters salt tolerant fauna and flora such as cyanobacteria and salt resistant varieties of grasses, shrubs, medicinal plants and bacteria. All these uses have given rise to a number of occupations such as cultivation of paddy, coconut, toddy tapping, vegetable and fruits tuber crop, extraction of mud for bricks, extraction and exploitation of shells for lime making, exploitation of oysters, crabs, shellfish, manufacture of salt and the like.

Topography:
Topographically, the state of Goa consists of secondary topographic features which are carved out as a result of erosion in the primary elements and are covered by erosional debris. It includes the hilly terrain mainly on the eastern side.
in the vicinity of the Sahayadri range these mountains after skirting a considerable portion of the north eastern and south eastern boundaries branch off west wards across the state with many spurs and ridges.

The raised plateaus, lower hills, broad valleys in the central part of the state followed by the low lying regions intersected by a network of rivers, springs, lakes, streams, estuaries drains the state of Goa.\textsuperscript{37} If one views the coastal part of Goa one can see it's drowned topographical features as well as formation of large islands as a result of heavy siltation. These undulating features provide a unique ecosystem to this land of Goa.

The main purpose of this study is to observe the various features in the coastal belts and then attempt a geomorphological interpretation by collecting geomorphic data of the coastal tract of Goa from various platforms available. Such as topographical maps, aerial photographs, satellite imagery, soil maps, hydrographical maps, field observations and interpretation of human and natural factors responsible for changing the coastal features over a period of time.

**Climate:**

Goa experiences a tropical moist climate with the south-east monsoons slashing Goa from June to October and during the rest of the year it experiences tropical weather. The annual rainfall is in the order of 300-350 cms. humidity of 80% and above and annual temperature of 26.4 degrees and annual mean precipitation of 3265 mm.\textsuperscript{38}

The rainfall, relative humidity, temperature, the rate of evaporation, intensity and direction of the winds are subjected to seasonal fluctuations and orographical influences\textsuperscript{39} for as one moves into the mountainous interior temperatures vary and rains are also heavier. Pernem, Bardez, Tiswadi receives annual rainfall of 3000 mm, south Goa it decreases and to the east it increases to 3500-4000 mm.\textsuperscript{40} Water is a source of life and livelihood thus rainfall forms the basic element of climate.
A study of past monsoon was attempted by Nigam and Khare by examining marine sediments which could tell about climate variability during different periods. He tried to reconstruct the past monsoon for the last 2500 years.

They studied 17 cms long shallow water sediment core near the mouth of the estuary of the Kali river at 22 m. water depth by considering river influx as an indicator of monsoonal precipitation and foraminifera traces of paleomonsoon e.g. Planktonic foraminifera and angular asymmetrical morpho-group of benthic foraminifera. They tried to find out the wet and dry periods in history during different periods. An attempt is made to calculate further the dry and wet periods from the 4th -15th century A.D.

Drainage:
Rivers form part and parcel of the entire ecological cycle. They are life giving and sustain for centuries. Goa is drained by rivers which originate from the Sahayadri ranges and have reached their base level of erosion within a distance of 20 to 30 kms. Initially these rivers have a tremendous head ward erosion capacity and later they are under tidal influence for most of their length towards the coast. It is observed that the drainage pattern of Goa is structurally controlled and follows the trends of major fold axis, faults, fractures and master joints and it is consequent to the west coast faulting in the post Deccan trap which has evolved in the mid tertiary period of Goa. It proceeds in two directions a) directly to the sea from east to west b) northwest or north-northwest direction in accordance to the geological structure.

The coastal plains to the west of Goa is intersected by numerous rivers rising from the western Ghats and debouching itself in the Arabian Sea. It is drained by eight main drainage systems which are in the form of estuaries. Estuaries are formed as a result of drowning of river valleys unused during the late Pleistocene period when the sea level was low. Sedimentation in some has kept pace with the gradual inundation but others are adjusting to the new
equilibrium which is further complicated by human interference in natural balance.

- Tirachol river basin: It originates in the Karnataka side of the Sahayadri with its main tributaries Torxem, Khadshi, Pernem, Harmal and Mandrem.

- Chapora river basin: It originates in the RamGhat hills in Belgaum district its tributaries are Salnalla, Kalna, Virnoda, Parcem and Baga river.\(^{45}\)

- Mandovi river basin: Mandovi, called (Gomati) (Madei) rises in the eastern Sahayadri region in the forest of Karnataka and empties itself in the Arabian sea in the Aguada bay. It is 81 kms and drains the entire region forming a no of beaches, islands such as Divar, Chorao and Tiswadi, waterfalls and springs bringing about a change in the topography of the region. It finally empties itself in the Arabian Sea carrying with it enormous sediments and alluvial deposits creating a very fertile soil for cultivation and salt tapping.\(^{46}\)

- Zuari river basin Zuari, called (Aghanashni) or Sanguem river is the southern part of the Mandovi. It rises in the Dighi Ghats of Sahayadri hills in the Karnataka state and is 167 kms in length. It flows through Sanguem, Quepem, Salcette, Ponda, Mormugao and Tiswadi Taluka. Besides it is also criss-crossed by small rivers navigating the entire territory of Goa such as Chapora, Kushavati or Paroda, Tirachol, Talpona which empties itself into the Arabian sea near Mormugao harbour. It covers about 68% i.e. 2500 km. of its total area.\(^{47}\) The Zuari and Mandovi river are connected by a canal called Cumbarjuve about 14 km. and 11 km. from the mouth of the Mandovi and Zuari demarcating the city of Panjim hence they are together called as the lifeline of Goa.

- Talpona river basin: 31 kms. It originates from Ravona Dongar and consist of four tributaries Nadkenalla, Goandongram nalla, Bhatpal, Khalwadanalla
• Galgibag river basin: 15 kms. It originates from Karnataka and has Marxem and Lolium nalla as its tributaries

• Sal river basin: It originates near Verna and runs southwards including Navelim Nalla and Cuncollim Nalla.

• Saleri river basin: 12 kms. It originates near Barcem and Gocoldem including the tributaries of Padinalla, Agondanalla and Molorem.

Lakes constitute a scenic feature in Goa most of them are used for irrigation to paddy fields and betel nuts gardens the most important lakes of Goa are Mayem, Chimbel Carambolim and Calapur. Islands of Chorao, Divar, Tiswadi, Kumbarjuve, Khorjuve and Anjediva. These islands are divided into two

• Alluvial formed as a result of siltation
• Rocky formed by separation due to faulting of the mainland

Goa is famous for its silvery sand and golden coastline: The coastline of Goa is a scenic alternation of bays and headlands significantly broken by the Mandovi and Zuari estuaries and interspersed with minor rivers. They are places of interaction between marine and land environment of the bays the Baga and Calangute and Colva are extensive curved stretches.

Thus the coastal plains are characterized by short stretch of beach formation with ancient beach ridges, small embayment bounded by promontory cliffed coast, submerged, emerged coastline, estuaries, tidal flats seen in the Mormugao and Aguada bay at the confluence of the two rivers of Zuari and Mandovi.
Flora:
Flora forms an invaluable environmental resource that influences the economy of the region. They offer wide variety of products like timber, fuel, grasses and other minor products like raisin, lac, oils, herbs and other medicinal plants having social, religious and economic advantages. It forms a blanket of vegetal cover which serves as a protection for erosion of soil and a suitable habitat for many wild species.

- According to the physical division of the land it can be divided into the following Deciduous forest of the Sahayadris containing trees such as Michelia, Bischofia, Rubeacca, tabaceu Carcinia, Matti, kindal, goting, savaimatti, sissum, asoka, onwal, vad, hirda, nano, apto, saton, bayo, jamun.
- Grass and scrubs on the laterite plateaus in the mid region with small forests around consisting of Carissa, Vitex etc
- Extensive vegetation along its coastal belts with Mangroves, roots of Rhizophora, Kandelia etc.

Fauna:
All these three belts consisting of a wide variety of trees and vegetation provide an habitat for the wide variety of birds and animals ranging from the small insects, reptiles both poisonous and non poisonous, such as wild boar, slender coris, leopards, deer’s, jackals, gaur, soth bear, porcupine, pangolin, stripped hyaena hog deer wild boar sambar, chital, shenkaro, mouse deer, otter, flying squirrel fruit bat, jungle cat, blind snake, python, shaw, naneti, divad, pasko, pansarp, malaun, phurshem, king cobra, insects, butterflies, bees, wasps, bugs, beetles etc. all form part of Goa’s natural biodiversity.31

The earliest evidences of faunal remains are found in the sub-Ghat regions on the banks of the Kushavati river in the Dudhsagar valley located in the Sanguem and Quepem taluka. The prehistoric man who are regarded as hunter artist have displayed their skills through the rock engravings at
Usgalimal/Pansaimol, Kajur and Mauxi. Local fauna such as the zebu bull, deer, antelope, bison, wild goat, hyena and monkey, intercoiled snakes, x-ray animals provide information of past fauna.  

**Geo-Physical Setting of the Port-Capitals**

The western sea board of India has a long chequered history of ports and maritime activity since prehistoric times. The strategic location and the drainage network of Goa along the coast led to the development of naturally designed ports since ancient times.

This unique natural topographical features of Goa attracted rulers of different dynasties to build capital cities located ideally at port sites of Chandrapur (Chandor), Gopakapattana (Goa Velha) and Ella (Old Goa) these ports had a long activity of sea trade right from the 4th -15th century not only having contacts with the west coast of India but also beyond the Arabian sea and the Ghats.

Here it is necessary to understand the location, the physical characteristics of the landscape such as rivers, mountains, plains, lakes, role of the place in the evolution of the culture of the people of the region, the interconnections between cities on the economic and social sphere in the peripheral region of the city. The location of the city is thus a significant aspect in itself and cannot be ignored in any study of urbanisation.

**Sindabur/Chandrapur/Chandor**

Chandrapur, once an erstwhile capital of Goa has originated from the word Chandra which is either related to Chandragupta Maurya or the Chalukya ruler Chandraditya and the suffix pura which would mean a city or a town.

Today, Chandor is a silent village located on the banks of the Kushavati river in the new conquest of the Portuguese in the Salcete taluka of South Goa. It is well known in the past as Chandrapur, a capital city serving rulers like the
Bhojas, Shilaharas and Kadambas. It is 9 kms. to the east from Margao which is famous as a commercial hub of activity.

It includes the three hamlets of Kott/Cotta (Fort), the old citadel of the Kadambas, Kouddi (Cavorim) (Gate), the main gateway of the ancient fort built by the Bhojas and Giddhli (Guirdolim) (land full of trees). Presently, it covers an area of 337 sq. kms. But during the earlier period the capital city covered an area of one square mile protected with mud wall fortification.\(^{53}\)

**Boundaries:**
The ancient port-capital of Chandraura is located at the confluence of the three rivers namely Kushavati, Sanguem and Rishi, meeting at a point called the *teen mukha* (the mouths of the three rivers). It is bounded to the west with St Jose de Areal or Nessal, to the east by the Paroda or Kushavati River, a tributary of the Zuari River, to the North Curtorim and Macasana village and south by Paroda and Mulem of Quepem taluka.

**Physiography:**
Geographically it can be divided into the following:

- The rocky mountainous regions consisting of the Chandranath mound of 384 meters above sea level
- The low lying hillocks, hill slopes covered with abundant greenery and flat land with cover of laterite.
- The coastal region consisting of the flood plains and alluvial flats near the river converted into khazan lands.\(^{54}\)

**Geology:**
Chandor belongs to the proterozoic age of rocks consisting acid intrusives of pegmatite, veinquartz, porphyritic granite, hornblende granite, granite gneisis and felspathic gneisis besides traces of basic intrusives of dolerite and gabbro. Chandor belongs to acid intrusive consisting of granite gneisis and felspethic gneisis as well as basic intrusives consisting of dolerite. Chandranath parvat forms part of the granite gneisis.\(^{55}\)
Climate:
Chandor is surrounded on three sides by the Kushavati river system and mountain on the other as a result it has abundant rainfall ranging between 400 cms with pleasant, cool and warm weather even during the summer months.

Rivers:
Its main river is the Kushavati or the Paroda River or Sanguem River, a tributary of the Zuari drainage system. With small rivulets such as the Rishi river which flows around the moat and is now dried up. It originates from the jungle of Nune and runs through Danoli and Quepem to meet the Zuari River. It is 45 kms in length with a huge stretch of alluvial land forming a subdued topography.

Topography:
It has a unique topographical feature which is in the form of a bowl as it is surrounded on three sides by the river Kushavati, Rishi and Sanguem and mountain of Guirdolini, Paroda and Macazana giving it a look of a subdued topography. (ch.3, Map 2,4,5,6,8) (ch.3, Plate II)

Flora:
Agriculture is the main occupation due to the fertile land and paddy is most commonly grown which is irrigated by the lake and rivers. It also consist of palm trees, mango, jackfruit and coconuts. The Shilahara king Aiyaparaja is said to have bathed in coconut water near Chandor. Gidhili means a village full of trees such as teak, mango, jackfruit, tamarind chikoo, custard apple, chillies, sweet limes, bitter gourd, watermelon, mush melon, ladyfinger and brinjals. There are natural lakes, springs which helps in irrigating the place.

Fauna:
The earliest evidence of fossilised faunal remains was found at Chandor. Presently displayed at the Goa State Museum. Besides, it provides shelter too animals also present in the rest of the state.
Govapuri/Gopakapattana/Goa-Velha (Voddlem Goem)

Gopakapattana as mentioned in the Sanskrit inscriptions, Govapuri as known in the *Suta Samhita* was the capital of the Kadamba rulers. To trace the origin of any place it is necessary to understand that the place gets its name from the ruler or importance of the place. The termGovapuri with the suffix puri would mean a holy city and Gopakapattana with the suffix pattana means a commercial city, which became prosperous due to its port situated on the banks of the river Zuari that attracted traders from different parts of the country and foreign lands.

Today, Goa Velha or Vodlem Goem as it is known, is a store house of antiquities and other structural remains buried under silt and needs immediate attention of the Archaeological Survey of India and other organisations to reveal its rich buried heritage and save it from further scavenging. It is famous as fishing and farming village known for sweet potatoes, rice fields and palm groves with memories of the past rich heritage in the minds of the old generations.

**Location:**

Gopakapattana (Goa Velha) is situated at the mouth of the Siridao creek in the Zuari estuary at long 73° 51' 36 E and 15° 25' 40 N in the Tiswadi *taluka* of the Goa state. It lies approximately 10 kms. south east of Panjim in the Tiswadi *taluka* with an area of 1012.96 along the NH17. It has an area of 145 sq. kms. Surrounded by a number of villages many of which are located in and around Siridao, Pilar lowlands in the southwest, north east, and north west slopes of Bambolim, Chimbel, Panvel, Vainguinim hill ranges.

**Boundaries:**

It is bounded by Pali Talauli in the west, Karmali in the North, Neura in the East and Agashi in the south. To the south of the river Zuari and north of Agashi there is a hillock in the centre called Pilar.
Divisions:

Geographically it is divided into

- Low lying coastal plains which are mostly *khazan* lands consisting of soft, marshy soil and formed reclaimed villages such as Morombi, Renovadi, Durgavadi, Corlim, Calapur, Neura, Mencuri, Azoshi, Carambolim formed by excessive sedimentation over the years.

- The elevated plateau of Bambolim, Curca, that are in the form of dissected tableland 50 metres high from sea level and covered with laterite.

- Hill slopes of Pilar, Ella, Mandur, Gancim, Gouli Moula etc. (Appendix VI)

Geology:

It belongs to the Dharwad super group of rocks of the Archean Proterozoic age belonging to the Savordem formation of rocks chiefly consisting of Argillite, Quartzite, Tilloid, Meta greywacke and grey argillite. Goa Velha where the ancient city of Gopakapattana was located forms part of this formation represented by Meta greywacke and Basic Intrusives of Dolerite.

Rivers:

The river originates from the streams of the Talauli, Gouli-Moula region and runs 8 km. to join the Zuari at Goa Velha. This river is called in the Portuguese maps as *Rio de Bati*. The 13th century Marathi Inscription mentions the word Juva-hari means a delightful or captivity islet in the river of govem nagar. (ch.3, Map 3,4,5,6,7,8) (ch.3, Plate III)

Flora:

The coastal plains are surrounded by rice fields, coconut grooves and marine vegetation besides other domestic plants like the mango, jackfruit, tamarind and wild species of plants.
Fauna:
Faunal environment bears similarities to the other parts of the state consisting of domestic and wild species of reptiles, insects and birds which visit the lake at Pilar.67

Elegrama/Ella/Old Goa/Velha Goa

Ella is blessed by its natural, strategic location and its scenic landscape. A small self sufficient hamlet and a pilgrimage centre for the Catholics all over the world.

Even today, we find evidences of Ella having left behind the footprints of its rich heritage in the form of the remains of the Brahmapuri, once a centre of learning for the Brahmins, the Madhav tirth, Goraksh math, the Madhava temple, a pilgrimage centre or the tirth-shetra of the Hindus, centre for shipbuilding because of the easy availability of timber and commercial trade centre through its port known for the trade in horses which attracted merchants of all nations leading to the prosperity of the city.

The city is said to have been flourishing with several magnificent edifices of rulers, gardens, streets, storehouses, fortresses that were existing when the Portuguese took it over in 1510. It thus, served as a gateway not only to the earlier rulers of the Vijayanagara, Bahamani and Adil Shah but later of the Portuguese who converted it into the Rome of the orient.

Location:
It is located at 15° 27' north latitude 73° 53' east longitudes that is about two miles to the north of the ancient Hindu city and six miles to the east of Panjim. It is situated on the hill slopes of the Tiswadi Island along the Mandovi River slightly inland from the coast of the Arabian Sea and 6-8 kms. from the old capital city of the Kadambas. It covers an area of approximately five square kms. extending from ¼ miles in length and ¼ mile in breath.68
Boundaries:
It is located along the coastal region of Goa, sandwiched between the Sahayadri and the Arabian Sea. To the north it is bounded by the Mandovi River, to the west by the present capital city of Panjim and the Arabian Sea, to the east by Carambolim and Kumbarjua canal and to the south by the old capital city of Gopakapattana (Goa Velha). It is surrounded by three hills namely hill of our Lady of Mount, hill of good view (Monte de Boa Vista) and the holy hill. 69

Physiography:
The intermittent rise and dip of the land profile relieving the surface into elevations, valleys and plains is geographically divided as follows

- The coastal region consisting of flood plains and alluvial flats that are formed as a result of erosion, siltation and excessive sedimentation cause by the river valley as a result of the mining activities in its course.
- The midland region consisting of the plateau area.
- The hill slopes covered by vegetation. 70

Geology:
It forms part of the Dharwad super group of rocks of the Archaean to Proterozoic of the Savordem formation in this formation there is a thickness of about 1,200m the formation extends in one continuous stretch. Ella forms part of this formation that is represented by meta greywacke and basic intrusives of dolerite. 71

Climate:
Ella, as a result of its location in close proximity to the Mandovi River and Cumbarjua experiences a cool weather, moist and humid with an annual rainfall of around 3000 mm. 72

Rivers:
Its main lifeline is the Mandovi River system. Mandovi, called (Gomati) (Madei) rises in the eastern Sahayadri region in the forest of Karnataka and empties itself
in the Arabian sea in the Aguada bay. It is 81 kms and drains the entire region forming a number of beaches, islands such as Divar, Chorao and Tiswadi, waterfalls and springs bringing about a change in the topography of the region. It finally empties itself in the Arabian Sea carrying with it enormous sediments and alluvial deposits creating a very fertile soil for cultivation and salt taping.\(^7\) (ch.3, Map 3,4,5,6,7,8) (ch.3, Plate IV)

**Flora:**
Ella is surrounded by a number of coastal trees and other forest trees as mentioned above.

**Fauna:**
The faunal remains of Ella are the same as found in other parts of the state of Goa.

Thus an overview to the geo-physical environment of Goa in general and the three port-capitals in particular is provided as it is one of the important factors influencing the rise, growth and development of ancient urban centres. It provides answers to questions such as where did urban centers grow? what geo-physical setting was necessary for the rise and development of urbanisation? and what topographical features attracted the rajas of several dynasties to set up their administrative headquarters, trade and well being of all other ports along the west coast and beyond?

**Notes and References:**


49. V.T. Gune, ed., op. cit., p.5.


54. Based on 1964 topsheet Interpretation

55. ERGD, pp.3, 5-6.
56. Based on 1964 toposheet Interpretation


58. Based on 1964 toposheet Interpretation of the island of Tiswadi.

59. Field visit to Chandor on 20th October, 2005.

60. Exhibits displayed at the Goa State Museum Gallery


62. Based on 1964 toposheet Interpretation of the island of Tiswadi.


64. ERGD., pp.3-5.

65. Based on 1964 toposheet Interpretation.


67. Field visit to Goa Velha on 13 November, 2005


70. Field visit to Ella on 12 August, 2005.
71. ERGD, p.6.

72. Soil Resources of Goa for perspective land use planning, op.cit., p. 20.

73. Claude Alvares, op.cit.,pp.11-12.
Map I: Map of Goa.
Map II: Salcette showing location, boundaries and river system of Chandor.
Map III: Tiswadi showing location, boundaries and river system of Goa Velha and Ella.
Map IV: Topographic features of the three port-capitals
map v: rainfall, soils, geology and physiography of Goa and port-capitals
Map VI: Geology and mineral deposit of Goa and port-capitals

SKETCH
GEOLOGICAL AND MINERAL MAP
OF
GOA

LEGEND

SUB RECENT TO
RECENT
UPPER CRETACEOUS
TO LOWER EOCENE
PROTEROZOIC?

ACID INTRUSIVES

DECCAN TRAP
BASIC INTRUSIVES

PROTEROZOIC

ARCHAEOAN
TO
PROTEROZOIC

SUPERGROUP

ARCHAEOAN
SUPERGROUP

ARDHAHAMA FORMATION

BARCEM FORMATION

BICHEUM FORMATION

MAHARASHTRA

MANGOREN FORMATION

GOA

VAJER FORMATION

MINERAL DEPOSITS

Iron ore
Manganese
Bauxite
Clay
Dimellite

MINERAL DEPOSITS

Quartz chlorite schist
Peridotite, Talc chlorite schist
Manganese ore
Quartzite and Quartzite schist
Red phyllite
Peridotite, Talc chlorite schist
Quartz chlorite schist and
Variegated phyllite
Quartzite and Quartzite schist
Red phyllite

Due to the complexity of the text and the detailed nature of the geological map, a natural text representation is not feasible. The map includes various geological features such as strike and dip of foliation, strike and dip of joint, vertical joint, cross joint, minor fold with plunge, fault, shear zone, and autochthonous conglomerate.
Map VII: Tiswadi in the 16th century
Fig VIII: Evidence of Variations of monsoon during the period of study

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14C Date: 2020 ± 40

Salinity
Plate I: Geo-Physical Setting of Goa
Plate II: Geo-Physical Setting of Chandrapur
Plate III: Geo-Physical Setting of Gopakapattana
Plate IV: Geo-Physical Setting of Ella