

**GOVERNMENT OF INDIA**  
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**SENSITIVE COASTAL MARINE AREAS OF INDIA ESPECIALLY**  
**FOR OIL SPILLS**

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## Introduction

India has a coastline of about 5500 km in the mainland and about 2000 km in its offshore islands. The coastal area of the country is blessed with vast network of back waters, estuaries, creeks, lagoons and specialized ecosystems like mangroves and coral reefs. It has vast beaches all along the coast. The biodiversity in the coastal waters, Gulf of Mannar and Kutch, in the waters of Andaman, Nicobar and Lakshadweep islands and in the specialized ecosystems like Chilka Lake, mangroves along east coast are significantly high. More than 5000 species of marine flora and fauna have been recorded so far the coastal and marine waters of the country. There is an urge to preserve, conserve and protect the coastal habitats and the marine environment from all man-made activities. The country is blessed with vast stretches of beaches along its coastline. The beaches and the adjoining land are being extensively used for recreation, relaxation and for creating attractions like amusement parks etc. Oil spills that occur during the accidents of ships/tankers, their grounding, rupture of seabed and onshore oil pipelines, offshore oil production and exploration platforms etc, do affect these habitats, beaches and their adjoining land and cause irreversible damage to the biodiversity as well as create an unaesthetic appearance.

The present section identifies locations of ecologically sensitive areas, beaches of commercial and recreational importance, historical and pilgrimage sites along the coastline of the country for protecting them against oil spills. Names and locations of these areas are indicated in Fig 1. The degree of sensitivity of these areas in terms of oil spill risks and development of a model to understand the movement of oil during oil spills and their likely impact on flora and fauna have also been described.



Fig.1. Map showing the ecologically sensitive and other areas need to be protected from oil spills

## **A. SENSITIVE AREAS ALONG THE COASTLINE OF INDIA**

### **I. GUJARAT**

#### **1. Gulf of Kachchh**

Gulf of Kachchh, the largest coastal habitat in the West coast of India in the state of Gujarat (20° 15' to 23° 35' N and 60° 05' to 70° 22' E) is encompassing over 1000 km long shoreline covering an area of 7350 sq.km (Fig.VI.2). It is a shallow water body with depth extending from 60 m at the mouth to less than 20 m at the head of the Gulf. While the average depth is 30 m, the minimum depth is upto 5 m, around Lushington island. The Gulf is delimited in the north by the Kachchh region and in the south by the Saurashtra region. The Marine National Park and Marine Sanctuary are situated along the southern shore of the Gulf from Okha (22°30'N, 69°00'E) eastwards to the vicinity of Khijadia (22°30'N, 70°40'E). This include 42 islands and a complex of fringing reefs backed by mudflats and sandflats, coastal salt marsh and mangrove forests, sand and rocky beaches which support a great diversity of fauna and flora. The area also has many islands fringing with corals and mangroves which provide a disturbance free habitats for many species of nesting birds. Besides these islands there are a number of wavecuts, eroded shallow banks like the Pirothan, Deda, Donna, Sankhodhar Beyt, Paga, Adatra and Boria, which accounts for coral islands. The tidal amplitude is from 3-5m.

The spectacular Gulf of Kachchh is the home for more than 800 species of organisms; 32 hard (Scleractinia) and 12 soft (Alcyonaria) corals, 150-200 species of fishes, more than 100 species of algae, great diversity of sponges and worms, brittlestars, marine turtles and other reptiles, over 200 species of migratory and resident bird species and also the rare and endangered marine mammal, the dugong. The Gulf of Kutch produces 95% of the salt requirements of the country. Salt pans are located close to inter-tidal area and deep into the land.

The area is home for intermediate and major ports like Kandla, Adani, Okha and Salaya. Kandla is one of the major ports that receives imported oil from ships and tankers. Besides, there are 4 Single Point Moorings where oil is drained from large tankers through under sea pipelines for landward transport of oil. The Asia's largest oil refinery is located at Jamnagar in the Gulf of Kutch. Considering the quantity of oil handled and transported, the area is most vulnerable for oil spills. A few minor incidences of oil spill have occurred in the past.

## Oil Spill Risk

Since the area has major and intermediate Ports, has four SPMs and located along the shipping line, the risk on oil spill is **very high**.

## 2. Beach of South of Dwarka

Dwarka, a submerged port city of historical and Mahabharata fame, is said to have been founded by Lord Krishna on the ruins of an earlier settlement known as Kusasthali after reclaiming from the sea. The identification of the remains of a 15th century BC township destroyed by the sea in the Dwarkadish temple complex overlooking the Arabian sea, increased the possibility of finding the submerged remains of the city in the sea. The temple of the Sea God (Samudra Narayana or Varuna Devata) near the junction of the Gomti river with the sea, marks the entrance to the ancient harbour of Dwarka. Pilgrims regularly visit the temple and the beach. The area is in the vicinity of shipping route and therefore any oil spill occurring will affect aesthetics of the beach.

## Oil Spill Risk

Since the area is away from the shipping line, the risk on oil spill is moderate.

## 3. Gulf of Khambat

Mangroves in Gulf of Khambat are dominant near Bhavnagar, Devla in Bharuch, Mangrol, Pardijankri, Dashariphalia and Dandi in Surat (Fig.2). Piram Island, Ghogha and Mahuva showed high density of *Avicennia marina*. Mangroves in the intertidal mudflats are stunted and sparse particularly near Mahi, Dhadhar, Kim and Sena estuaries. A patch of *Avicennia* is observed in Aliya Bet at the mouth of the Narmada estuary. At most of the places, the growth is stunted and horizontal. Some tall trees were observed at Piram Island. Districtwise details of Mangroves of the Gulf are as follows:



Bhavnagar	-	15.57 km <sup>2</sup>
Ahmedabad	-	2.96 km <sup>2</sup>
Bharuch	-	22.91 km <sup>2</sup>
Surat	-	8.52 km <sup>2</sup>
Navsari	-	3.41 km <sup>2</sup>
Islands/Islets	-	0.57 km <sup>2</sup>
<b>Total</b>	-	<b>53.94 km<sup>2</sup></b>

Fig.2. Mangroves of the

The total mangrove area estimated is well in agreement with 52.46 km<sup>2</sup> for the period November 1999 (Singh, 2000). Mangroves of Ghogha Jetty, Bhavnagar creek and coastal Ahmedabad district are scrubby, expanding gradually to the surrounding areas due to plantation carried out by the Forest Dept. *Avicennia marina* dominated as a single species in most of the mangrove patches. *Sonneratia apetala* is found either scattered or in dense patches in a few places

### **Oil Spill Risk**

Since the area is close to the shipping line, the risk on oil spill is high.

## **II. MAHARASHTRA**

The state having a coastline of 653 km is blessed with vast beaches and very few ecologically sensitive zones. The details are:

### **1. Beaches of Mumbai**

Mumbai has beaches like Juhu, Versova which attract a number of day visitors. Oil spills caused by ships and tankers calling at Mumbai and Jawaharlal Nehru Ports will affect aesthetics of the beach.

### **Oil Spill Risk**

Since the area is close to Mumbai and JN Ports and located along the shipping line, the risk on oil spill is high.

### **MALVAN COAST**

The Malvan coast occupies in Sindhudurg district, a part of Konkan coast along the West coast of India. The coastal features of Malvan are rocky, dissected mainland with rias and lava promontories, occasional presence of overhanging cliffs, projecting headlands, stacks and reosion platforms, rocky shoals, several submerged coral reefs and boulders in a ria type coast particularly towards south. The Sindhudurg fort constructed by King Shivaji is located on the coast. The area is regularly visited by tourists.

### **Environmental Sensitivity**

The area is of ecological, historical and tourism importance by the presence of intertidal corals and the fort. Movement of oil due to spills occurring in the offshore will affect the ecology of area.

### **Oil Spill Risk**

The area is away from the Ports. However, located along the shipping line and therefore, the risk on oil spill is **moderate**.

### **III. GOA**

Goa is the tourist's paradise with clean beaches throughout its 105 km coastline. With natural forestry in adjoining hills of Western ghat, it attracts 11 million tourists every year. The Marmagao port which handles iron ore and small quantum of oil is visited by ships and tankers.

#### **Environmental sensitivity**

The coastal waters are clean and extensively used for beach tourism and regularly visited by locals and tourists. A few oil spill incidences that occurred in the past have affected the aesthetics of the beaches.

### **Oil Spill Risk**

The oil spill risk of beaches close to Marmagao port is **high**. It is **moderate** in other areas.

### **IV. KARNATAKA**

#### **1. Coastal Area of Gokarn**

Gokarn, famous for ancient temples, is an important coastal town located along this coastline. An interesting feature of this coast is that the Western ghat (hill ranges) run almost parallel to the coast and form cliffs in several places. Near Mahabaleswara temple close to estuarine mouth (north of Gokarn), the coast is characterized by rocky edges. The area is likely to be affected by drifting oil from offshore which occur in the event of oil spills.

#### **2. Beaches of Karnataka**

The state has long virgin beach areas close to Malpe, Karwar and Mangalore which are enjoyed by local residents.

### **Environmental Sensitivity**

The beaches are regularly visited by the local population. Oil spills affect the aesthetics of these beaches

### **Oil Spill Risk**

Since the area are away from the Ports except Mangalore and located along the shipping line, the risk on oil spill is moderate. The risk of oil spill on beaches of Mangalore coast is high.

## **KERALA**

Kerala coastal zone is famous for its beautiful beaches, backwaters and lagoons. The coastal belt, a narrow strip of lowland, is the most picturesque region of Kerala, interspersed with extensive backwaters, lagoons and canals and flanked by luxuriant coconut groves and green rice fields. The lagoons and backwaters are never far from the sea and at several places they have established a permanent connection with it. The backwaters, rivers and the canal system form a navigable waterway of about 1,920 km. This offers an unique ecological niche with great potential for brackish water fish farming in the state. The sea off Kerala is one of the most productive zone for marine fish. Kochi is the major port located along the coast.

### **Environmental Sensitivity**

The entire coastline is of natural beauty with vast beaches. The tidal implications are felt deep into inland areas through the network of backwaters. They have high utility for fishing, navigation and boating. Since the oil spills may cause extensive damage to beaches, the entire coast requires protection from oil spills.

### **Oil Spill Risk**

Except Kochi the area is away from the Ports and located along the shipping line, the risk on oil spill is moderate. The risk on oil spill for Kochi backwaters and beaches are **high**

## **VI. Tamil Nadu**



Tamilnadu with a coastline length of 906 km has a number of sensitive areas like mangroves, coral reefs, bird sanctuaries, historical sites, pilgrimage areas and beaches. The most that need protection from oil spills are:

### **1. Kanyakumari**

It is one of the most popular destinations for tourists in the country. The Vivekananda rock memorial which is 1 km offshore and the beaches of the area are the major attractions. It is visited throughout the year by tourists from all over the country. The area has rocky shore and extensive beaches with temples nearby. The area is of historical importance.

#### **Environmental sensitivity**

The waters of the coastal areas are regularly used by the tourists for bathing and the beach for recreation. Oil spills will affect the water quality thereby prohibiting bathing and it will provide unaesthetic appearance to the beaches.

#### **Oil spill risk**

The area is close to the international tanker routes and oil spills will damage the rock memorial and the beaches. It can be categorized as a **high risk** area.

### **2. Thiruchendur**

Thiruchendur is an important pilgrimage areas in the state of Tamil Nadu. It is regularly visited by the devotees who take bath in the sea.

#### **Environmental Sensitivity**

Being known for pilgrimage, the beach the sea is in constant use for bathing by visitors. The tidal amplitude around 80cm. The littoral drift governs near coast circulation. In the event of oil spills occurring close to the coast in the months of March to September, the tidal and long shore currents will transport the oil along the shore affecting the beaches and contaminating sea water.

#### **Oil Spill Risk**

The area is away from the Ports and however, being located along the shipping line, the risk on oil spill is **moderate**.

### 3. Tuticorin

Tuticorin is situated 607 kms south of Chennai (Lat. 8°45'- 9°00' N and Long. 78°15' E) on the eastern coast of southern Tamil Nadu. It has a major port and reasonably industrialized. There is a thermal power plant on the coast with a generation capacity of 3 x 600 MW. The sea is part of the Gulf of Mannar.

#### Ecological Sensitivity

Tuticorin and adjoining sea areas have following biologically important aspects:

**Pearl Banks:** The maximum concentration of pearl banks is found in the region off Tuticorin. The region between Tuticorin and Kanniyakumari have extensive pearl banks. There are about 10 pearl banks. The most preferred species of pearl oyster is *Pinctada fucata*. There are about four species of pearl oysters. *P. fucata* is the most abundant variety found off Tuticorin coast. The other common species is *P. chemnitzii*. In the region near Tuticorin their concentration is found even at depths of about 37 mts at 8°47' N and 78°25' E. The maximum concentration is along the depth contour of about 16 to 20 mts. Nearabout Van Thivu and Koswari Thivu there are pearl banks at depths of 11mts to 15mts. The pearl oyster fishery yields easily about Rs.4 - 6 lakhs as gross revenue per annum when fishery is in operation. Pearl fishing operation is conducted throughout the year. The usual season is between November and May. The pearl culture industry using artificial seeding of oyster for propagation of pearls is catching up.

**Corals:** The reef framework is complex. The coral reefs and patches that are found around the various islands off Tuticorin are as follows:

- a. Kariyashuli island 16 kms off Tuticorin coast has coral reef around the island upto a distance from 500 m to 1 km.
- b. Koswari Island 7 kms off Tuticorin has live corals in the southern side 500 mts to the shore.
- c. Hare Island now connected to the mainland 6 kms from Tuticorin has fringing reef on eastern side upto 0.5 kms.

**Chank Beds:** The sacred chank *Xancus pyrum* is found in fine or soft sandy substrates. The chank beds are very productive. The industrial uses of chanks are many. The Valampuri chanks which have sinistral coiling fetch more than Rs.20,000/- for a perfect chank of 65 mm or greater diameter. This sinistral form is used in worship in the Hindu temples.

The water quality in the marine environment around the coral reef areas except the one close to the Thermal power plant are good. Any oil spill by ships visiting the port will

affect the corals, chank and pearl oyster beds and cause immense damage to ecology and local economy.

#### Oil Spill Risk

Since the area is close to the Tuticorin Port, the risk of oil spill is **very high**.

#### 4. Gulf of Mannar

The Gulf of Mannar is situated between India and Sri Lanka. It runs on its Indian side, at its head from Pamban Islands southern coastline which includes the famous pilgrim centre of Rameswaram to Kanniyakumari along the mainland's coast, to a distance of about 170 nautical miles. The Gulf of Mannar is spread on the Indian side along longitude from 78°08'E to 79°30' E and latitude from 8°35' N and 9°25' N. There are about 21 islands that extend from Pamban area to Tuticorin (Fig 3.). The Gulf of Mannar has been declared as a Marine Biosphere reserve by the Government of India. The biological wealth of Gulf of Mannar has been studied in detail since 1903.

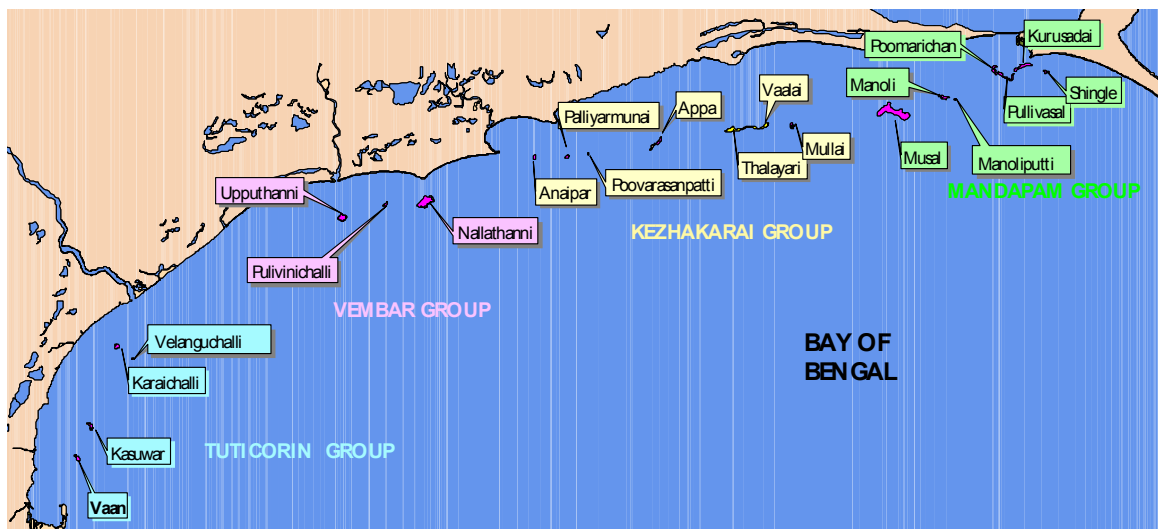


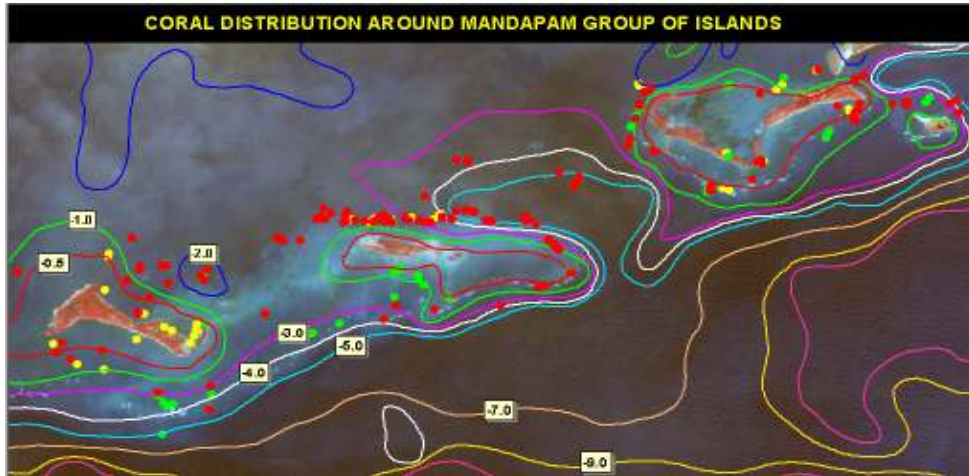
Fig.2. Gulf of Mannar and its 21 islands

The islands have been divided into Mandapam, Keelakarai, Vembar and Tuticorin groups due to their proximity to these places and also the population in and around these areas depend on the waters of these islands to meet their livelihoods. The islands are banned for inhabitation.

#### Coral Reefs

On Gulf of Mannar both fringing and patch coral reefs occur. With the help of calcareous algae in shallow sea, the Hermatypic corals build primary reef formation with

secondary detrital reefs in deeper water. The corals occur from a distance of 200-600 mts from the outer edges of these islands. The depth at the outer edge of the reef is about 5 mts. The density of corals vary from 0.3 sq km to 18 sq.km. For eg. Distribution of coral reefs in the Mandapam group of islands is given in Fig.3.



**Fig.3.** Distribution of corals in the Mandapam group of islands. Red colour are areas of live corals; Yellow colour areas of dead corals and Green colour are areas of Sea grass. Numbers in the depth contour line indicate the depth.

In the Gulf of Mannar Islands, the eastern side of the islands would appear to have a greater expanse of living coral reefs. The human exploitation of the coralline stones is concentrated on the northern and western sides. Hence the eastern sides remain now relatively free of human influence and interference and so exploitation is less. Recently the Government of Tamil Nadu has prohibited quarrying of corals after considerable loss of reefs to the point of extinction.

**The coral genera of Gulf of Mannar and their status**

Genus	Status	No. of Species recorded
<i>Acropora</i>	xxx h	12
<i>Astraeopora</i>	x h	1
<i>Balanophyllia</i>	x a	1
<i>Culucia</i>	x a	4
<i>Cycloseris</i>	x a	1
<i>Cyphastrea</i>	xx h	2
<i>Dendrophyllia</i>	x a	2
<i>Echinopora</i>	x h	1
<i>Endopsammia</i>	x a	1 (single record)
<i>Favia</i>	xx h	6
<i>Favites</i>	xx h	6

<i>Galaxea</i>	x h	1
<i>Goniastrea</i>	xx h	2
<i>Goniopora</i>	xx h	3
<i>Heterocyathus</i>	xx a	1
<i>Heteropsammia</i>	xx a	1 (deep water)
<i>Hydnophora</i>	x h	2
<i>Leptastrea</i>	xxx h	2
<i>Leptoria</i>	x h	1
<i>Madracis</i>	Deep water	1
<i>Merulina</i>	x h	1
<i>Montipora</i>	xxx h	17
<i>Mycedium</i>	x h	1 (single record)
<i>Ooscinaraea</i>	x h	1
<i>Pachyseris</i>	x h	1
<i>Paracyathus</i>	x a	1
<i>Pavona</i>	x h	4
<i>Platygyra</i>	xx h	1 or 2
<i>Pocillopora</i>	xxx h	3
<i>Polycyathus</i>	xx a	1
<i>Porites</i>	xxx h	6
<i>Psammocora</i>	x h	1
<i>Pseudosiderastrea</i>	x h	1
<i>Siderastrea</i>	x h	1
<i>Symphillia</i>	x h	1
<i>Tubastraea</i>	x a	1
<i>Turbinaria</i>	x h	3

**x - rare / xx - common / xxx - most common / h - hermatypic / a - ahermatypic**

### **Algal Resources**

The Gulf of Mannar area is well known for its algal wealth. A number of seaweeds are found in abundance in this area. The total productive area estimated is around 10,000 ha. with a standing of more than 18,000 tons. The mean algal density varies from as high as 1.16 Kg/l to 0.38 Kg/l. The common seaweeds found here are *Ulva*, *Sargassum*, *Gelidiella*, *Gracilaria*, *Caulerpa*, *Halimeda*, *Padina*, *Hypnea*, *Turbinaria*, *Chondrococcus*, etc. About 160 species of algae have been recorded so far from this region. Out of which some 30 species form the edible seaweeds.

### **Seagrass Ecosystem**

The Gulf of Mannar area is also very rich in seagrasses. The species composition of seagrasses is as follows: A. Hydrocharitaceae (*Enhalus acoroides*, *Halophila ovalis*, *H. ovata*, *H. beccari*, *H. stipulacea*, *Thalassia hemprichii*); B. Potamogetonaceae (*Cymodocea serrulata*, *C. rotundata*, *Halodule uninervis*, *Syringodium isoetifolium*)

### **Mangrove Vegetation**

The Gulf of Mannar islands possess unique mangrove vegetation, consisting of species belonging to *Rhizophora*, *Avicennia*, *Bruguiera*, *Ceriops*, *Lumnitzera* etc. Many halophytes belonging to *Suaeda*, *Arthrocnemum*, *Sesuvium*, *Atriplex* are also present. The mangrove trees are not very tall, perhaps the height is curtailed due to strong winds prevailing here.

### **Sacred Chank Beds**

The sacred chank, *Xancus pyrum* also occurs in the Gulf of Mannar. The chank beds are productive and form a potential fishery in this area.

### **Pearl Banks**

The pearl banks are concentrated in the Pandiyan tivu, Van tivu, Upputhanni tivu and Nallathanni tivu. Normally they occur in depths between 10 - 20 m. The pearl culture industry for artificial propagation of pearls has been established. The other molluscs found in abundance are *Perna viridis*, *Meretrix*, *Katelysia*, *Anadara*, *Donax* and *Dentalium*.

### **Other Fauna**

A variety of marine invertebrates are found in abundance in this area. The Krusadai island in this region is commonly known as "The Paradise of Biologists". The seacow *Dugong dugong* is found in abundance in this area. It is an endangered species and has to be conserved. Gorgonids are very valuable marine resources because of their pharmacological values. Common forms belong to the following genera, *Echinogorgia*, *Thessia*, *Juncella*, *Subergorgia*, and *Leptogorgia*.

### **Environmental Status**

The Gulf of Mannar Marine National Park was established in the year 1983 to conserve and restore the ecosystems of Palk Bay and Gulf of Mannar. Generally the coastal waters are relatively unpolluted. Eventhough the shipping lines are far away from the gulf area, considering the wind direction esp from June to Sep, any oil spill occurring from

ships/tankers moving from Indian Ocean towards Colombo or Tuticorin, would result in movement of the oil towards the Gulf of Mannar. Since the volume of traffic in that area is not significant, no major incident of oil spill has been reported so far. However, this would not be scenario all the times especially when the volume of traffic are proposed to increase in the ports of Tuticorin and Colombo.

### **Oil Spill Risk**

Since the area is close to the Tuticorin and Colombo ports in the eastern side of the Gulf, the risk of oil spill is **very high**.

### **5. Vedaranyam :**

Vedaranyam is one of the Coastal blocks of Thanjavur district. It is located along the coastal shipping line moving towards Chennai port. It is situated 102 km east of Thanjavur. It falls within the co-ordinates of 10°15'N to 10°35'N and longitude 79°20'E to 79°55'E.

Vedaranyam or Point Calimere is one of the six major wild life sanctuaries in Tamil Nadu extending over an area of 17.29 Km<sup>2</sup>. It is the migration place of birds. It is one of the major wintering grounds for the migrant birds from North India, Europe, Asia and Africa. November to January is the peak migratory period. Twenty to thirty thousand Flamingoes can be seen at a time during season. The sanctuary includes reptiles like monitor lizard, chameleon, sharred tortoise, cobra, saw scaled viper, green viper snake and olive ridley (sea) turtle.

### **Environmental Status**

A small part of the area is protected in the Point Calimere Wildlife Sanctuary gazetted in March 1968, but the most important wetlands are unprotected. However the wetland has been proposed for designation as wetland of international importance under the RAMSAR Convention. The area is free from major settlements and industrialization. The water quality of sea area is good. Since it is located along the shipping route, oil spills will affect the water quality and in turn will affect the feeding of birds which depend on aquatic fish for nutrition.

### **Oil Spill Risk**

The area is away from the Ports . However as it located along the shipping line, the risk on oil spill is **moderate**.

## 6. Pitchavaram Mangroves

The Pitchavaram mangrove realm (Lat. 11° 26' N; Long. 79° 48' E) near Parangipettai, is situated on the South East coast of the peninsular India and represents a heterogenous mixture of mangrove elements. It lies in between the Northern Vellar and Southern Coleroon estuarine systems and along with Killai lagoon, is referred to as the Vellar Coleroon estuarine complex. Covering an area of approximately 1,100 hectares, it is represented by 51 islets, waterways, channels, gullies and rivulets and account for 40% of the total area of the mangrove, of this 50% is forest and the remaining part consists of mud flats and sandy plains. This ecosystem is well known for its luxuriant growth of mangrove plants with high productivity and diversity of fauna and is provided with rich detritus, nutrient salts, vitamins, trace elements etc.

### Aquatic Fauna and Flora

The aquatic fauna comprise of juveniles and adults of finfishes, shrimps, molluscs, crabs and benthic invertebrates. Seaweeds such as *Enteromorpha*, *Cladophora*, *Chaetomorpha*, *Padina*, *Gracilaria* and *Hypnea* occur in the vicinity of mangroves. The seagrasses, *Halophila* and *Halodule* also occur near here and gross production of the seagrass community ranges from 0.313 to 1.380 g C Sq.m/day. The floristic survey during the study period revealed 81 species of Angiospermic plants belonging to 39 families in the mangrove islets. Another 5 species belonging to 4 families are recorded in the mudbank regions of the mangrove forest. Of the 86 species, 24 are trees, 21 shrubs, 28 herbs, 7 climbers, 3 creepers and 3 parasites. The plants are distributed in varying degree of abundance in the mangrove forest. By the degree of abundance, *Avicennia marina* is the most common species. Followed by it are *Rhizophora apiculata*, *R. mucronata*, *Bruguiera cylindrica* and *Aegiceras corniculatum* in that order. *Xylocarpus granatum* is the rarest species. Prawns, crabs, molluscs and fishes are abundant in the mangrove area

### Environmental Sensitivity

The Coleroon estuary forms as a major source of sea/brackishwater for the Pitchavaram mangrove. The estuary being located along the shipping line from Tuticorin to Chennai, any oil spill occurring or moving close to Coleroon mouth will affect the mangroves by way of way blocking pores of mangrove plant roots. The water quality of the area is good. Eventhough, the mangroves are located about 1-3 km away from the coast, any oil spill that occur will affect the mangroves.



### **Oil Spill Risk**

The area is away from the Ports . However as it located along the shipping line, the risk on oil spill is **moderate**.

## **7. Mahabalipuram**

Mahabalipuram (Lat. 12°37' N; Long. 80°12' E) located 58 km south of Chennai, covers an area of about 8 Km<sup>2</sup>. It was once a port of the Pallava dynasty. The Pallavas had created many marvelous monuments at this place which attract tourists from all over the world and about 500 tourists visit this place every day. The popular beach and holiday resort are internationally renowned for their fabulous stone monuments dating back to the 8th century A.D. Mahabalipuram otherwise known as Mamallapuram has been declared as a World Heritage site by UNESCO. There is a shore temple which is protected from sea erosion by dumping large boulders of stones on the seaward side.

### **Environmental Status**

The area has Archeological significance and beach is enjoyed by tourists. Since the area is in the vicinity of shipping line towards Chennai port, any incident of oil spill will affect the beaches.

### **Oil Spill Risk**

The area is away from the Ports . However as it located along the shipping line, the risk on oil spill is **moderate**.

## **8. Sandy beaches in and around Chennai**

The sandy beaches of East coast road from Mahabalipuram and upto Marine beach in Chennai city is enjoyed by beach lovers, holidayers and is a major area of recreation. Oil spill incidents in the area will immensely affect the dependent population and the tourists.

### **Oil Spill Risk**

The beaches other than Marina are away from the Chennai Port and located along the shipping line, the risk on oil spill is **moderate**. However, since the Marine beach is close to the Chennai the risk of oil spill is **high**

## **VII. ANDHRA PRADESH**

Andhra Pradesh has a coastline of 974 km. The coastal areas are blessed with lagoons, mangroves and vast beaches. The mangrove Ecosystems of Krishna estuary (Nizampatnam and Machilipatnam), and Godavari estuary (Coringa areas) are the prominent ones in the state.

### **1. Pulicat Lake**

Pulicat lake is located 40 Km north of Chennai city and 1/3 of the lake belongs to Tamilnadu and 2/3 to Andhra Pradesh. It is the second largest brackish water lake in India after Chilka lake. Situated between 13°24' and 13°43' N latitude and between 80° 03' and 80° 18' E longitude, the lake is about 60 km in length and 0.2 to 17.5 km in breadth. It has a high water spread area of 460 Km<sup>2</sup> and low water spread area of 250 km<sup>2</sup>. Due to deltaic deposits, the lake is extensively shallow with an average depth of about 1.5 meters. The lake is separated from the Bay of Bengal, by an inland spit called the Sriharikota island. The lake belongs to both Tamilnadu and Andhra Pradesh. About 17,250 ha of the Andhra Pradesh portion of the lagoon lies within the Andhra Pradesh Pulicat Lake Sanctuary (58,000 ha), established in September 1976. The entire portion within Tamil Nadu (6000 ha) was declared as a Sanctuary in October 1980. The lake is confluent with the Bay of Bengal across a bar of about 3 Km from the Pulicat light house on the Tamil Nadu side. The resources of the lake forms as a livelihood for nearly 40,000 fisherfolk.

### **Environmental Sensitivity**

The lake is an extremely important area for a wide variety of resident and migratory waterfowl, notably pelicans, herons and egrets, storks, flamingos, ducks, shorebirds, gulls and terns. Pulicat is the third most important wetland for migratory shorebirds on the eastern seaboard of India, and is especially important during the spring and autumn migration seasons. The water of the Pulicat lake is very rich in population diversity and density of planktonic organisms. The rooted and submerged aquatic macrophytes and filamentous algae constitute the benthic flora of this lake. They are generally seen in shallow regions and around islands.

The area is in the vicinity of Ennore and Chennai ports. Any oil spill close to the area may affect the water quality of the lake and the fauna. It may lead to a major socio-economic problem.

## Oil Spill Risk

Since the area is close to Ennore and Chennai ports the risk of oil spill is **high**

## 2. Mangrove ecosystems of Godavari and Krishna estuaries

In Andhra Pradesh, the occurrence of mangroves is observed in East Godavari, Krishna, Guntur and Nellore districts. The lower reaches of Godavari, Krishna and Penniar rivers support these mangrove ecosystems. The Godavari-Krishna deltaic mangroves owing to their geographical proximity have been treated together as they lend themselves admirably for unity in approach and for our understanding and appreciation.

### Machilipatnam (Krishna Delta)

The Machilipatnam mangrove area lies between latitude  $16^{\circ} 0' - 16^{\circ} 15'N$  and Longitude  $81^{\circ} 10' - 81^{\circ} 15' E$ . The northern distributary of the Krishna river drains in this area and this tributary brings in a lot of sediments and freshwater which has enabled the luxuriant mangrove growth.

### Coringa (Godavari Delta)

The Godavari- Gautami riverine systems form an extensive network of backwaters leading to formation of luxurious growth of mangroves. The Coringa Wildlife Sanctuary (23,570 ha) was established in the year 1978.

### Ecological Sensitivity

32 species of mangrove and mangrove-associated plants belonging to 26 genera and 18 families are recorded in Godavari and Krishna mangrove ecosystems. Two species i.e., *Scyphiphora hydrophyllacea* (Godavari mangroves) and *Aegialites rotundifolia* (Krishna mangroves) are regarded as rare species. The area is rich in plankton, various types of benthic organisms

## Oil Spill Risk

The Krishna area is away from the Ports. However, located along the shipping line and therefore, the risk on oil spill is **moderate**. In the case of Coringa mangroves, as it is located close to the Kakinada port (an intermediate port), the risk of oil spill is **high**.

### 3. Beaches of Visakhapatnam

The port city has extensive beach areas covering a distance of 10km which is used for recreation purposes. There are proposals for establishment of Amusement parks near the city. Any oil spill incident occurring will affect the aesthetic state of the beach.

#### Oil Spill Risk

Since the area is close to the Visakhapatnam port the risk of oil spill is **high**.

## VIII. ORISSA

The state of Orissa having coastline length of 476 km, is blessed with ecologically sensitive areas, lagoons and unexplored beaches. The industrially backward state, is environmentally the richest. It has three ecologically important coastal areas. They are (1) Chilka Lake, (2) Bhitarkanika mangroves and (3) turtle breeding grounds of Gahirmatha coast. The historical site includes Konark and holy site is Puri. Both are located on the coast and beaches are enjoyed by the tourists.

### 1. Chilka Lake

Chilka is the largest estuarine lake of the Bay of Bengal situated on the east coast of Peninsular India. It lies between 19° 30' - 19° 57' N latitude and 85° 5' 20" - 85° 29' 20" E longitude. The lake normally covers an area of 1055 sq.km but swells to 1165 sq.km during the rainy season and gradually shrinks to 906 sq.km during summer. Depth of the lake varies from 1.73 to 3.7 meters during the rainy season and 0.93 to 2.6 meters during summer months. The lake turns into a freshwater ecosystem from July to December due to monsoonal rains.

#### Environmental sensitivity

The lake is rich in benthic plants, seagrasses, planktonic and benthic organisms, prawns and fishes. The lake is also best known as a bird sanctuary. Birds visit the lake during October-December of every year. The annual fish output of the lake on an average amounts to 6,500 tons. Percentage composition of commercially important prawns, large mullets, *Bhekti* and *Kontia* are showing downward trend while *Kundal*, *Balargi* and *Jagili* are on the rise. There are about 114 fishermen villages inside and adjacent to the lake. The fishermen are about 52,000 and derive their livelihood from the resources of the lake. Oil spills occurring in the vicinity of the lake will affect the ecology and resources of the lake.

## Oil Spill Risk

The Chilka area is away from the Ports. However, located along the shipping line and therefore, the risk on oil spill is **moderate**.

## 2. Bhitarkanika

Bhitarkanika sanctuary is located on the east coast of India, in the state of Orissa (20°4' - 20°8' N and 86°45' - 87°50' E). It is one of the largest mangrove forest along the east coast well known for salt water crocodile, olive ridley sea turtles and king cobra. This was declared as a wildlife sanctuary by the State Government in the year 1975. It is situated near Chandbali town which is about 50 km from Bhadrak.

There are 6 six major species of mangroves. Among vertebrate fauna, King Cobra, Python, Kraits, salt water crocodile (*Crocodylus porosus*), Olive ridley sea turtle (*Lepidochelys olivacea*) are noteworthy. Besides these, Leopard, Chital deer, Sambar and wild boar are also seen in this sanctuary. Nesting colony of about 30,000 breeding pairs of open billed storks (*Anastomus oscitans*) has been discovered in this sanctuary. They nest on *Avicennia officinalis* trees in the midst of the sanctuary. This is assumed to be the largest colony on the east coast. Night herons, cattle egrets, cormorants and grey herons constitute other species of birds in the colony. Olive ridley turtles visit the coastal boundary area of the sanctuary in large numbers (1 to 2 lakhs) during December to February every year to lay eggs .

## Oil Spill Risk

The area is away from the Ports. However, located along the shipping line and therefore, the risk on oil spill is **moderate**.

## 3. Gahirmatha

The 35 km long stretch of coastline along the Orissa coast, forming the coastal boundary of Bhitarkanika sanctuary in the Cuttack district of Orissa is the Gahirmatha beach, well known for the nesting grounds of Olive ridley sea turtle (*Lepidochelys olivacea*). Gahirmatha coast extends from Ekakulanasi muhana (20° 52' N , 86° 77' E) which marks the northern extremity of Cuttack district to Barunei muhana (20° 72' N, 87° 5' E) along the coast of India.

Mass nesting by the Olive ridley sea turtle takes place along 10 km of coastline from Habialikhathi upto Ekakulanasi of Gahirmatha coast. Arrival of half to one million female Olive ridley sea turtle (*Lepidochelys olivacea*) is seen every year without fail during late December to January and again from mid March to April. Rookery (nesting ground) at Gahirmatha coast and another near Devi river estuary in Cuttack district together host one of the largest aggregation of Olive ridleys in the world.

#### **Oil Spill Risk**

The area is away from the Ports. However, located along the shipping line and therefore, the risk on oil spill is **moderate**.

#### **4. Beaches of Puri & Konark**

In the state of Orissa the two most important tourist attractions are Puri and Konark. Puri is one of the four most holy places of pilgrimage in India. Puri Jaganathan Temple is the most famous temple here. Konark has the famous exquisite carvings of 13th century Black Pacoda and Sun temple. Thousands of tourists visit this area. Oil spills affect aesthetics of the beaches and the tourism industry.

#### **Oil Spill Risk**

The chances of occurrence of oil spills along the coast of Orissa is **moderate to high** due to their location in the shipping line between Visakhapatnam and Paradip as well as to Calcutta.

### **IX. WEST BENGAL**

The state of West Bengal having a coastline length of 158 km has ecologically sensitive areas, large riverine system and few beaches. The major ones are:

#### **Sunderbans**

The Hooghly-Matlah estuarine complex supports one of the world's most luxuriant mangrove vegetation's viz. the Sunderbans mangrove forests. Mangrove swamps and backwater of the Sunderbans form fertile source of support to much of coastal West Bengal, the most important property of which is that it tends to accrete and extend the coastline. The forest resources of deltaic Sunderbans are used for firewood, timbers, food-resources, recreation and navigation. The benthic planktonic forms of the estuarine system, on which

depend many migratory shoals of commercially important fish, shrimps, prawns and other edible sea animals.

### **Environmental Sensitivity**

Sunderbans houses a national park and tiger reserve. About 258,477 ha of the Indian Sunderban, including almost all of the mangrove forest, were declared a Tiger Reserve in 1974 under Project Tiger. The core area (133,000 ha) was declared a National Park in 1982. This region adjoins the Sunderban Wildlife Sanctuary of Bangladesh. The park and the tiger reserve are situated among the estuarine mangrove forests which is most suited to the tiger. It is also one of the most important Project Tiger areas and has the largest number of tigers in India. Conservation of the ridley sea turtles has also been undertaken by Project Tiger. The main wildlife include tiger, saltwater crocodile, estuarine and marine turtle, different species of birds and gangetic dolphin. The Lothian Islands cover an area of 3,885 ha and was established as wildlife sanctuary in the year 1976. The forest area of the Sunderbans with an expanse of 4,264 sq.km of the core area.

The Sunderban supports a major inshore and estuarine fishery; the fishing season lasts 4 or 5 months, and at least 10,000 fishermen are engaged in the fishing operations. There are many brackishwater aquaculture farms (bheris) particularly in the northern part of the delta. These are impoundments of naturally inundated areas, often of several hundred hectares in extent.

The tidal waters of Hooghly penetrate deeply into Sunderbans. As the Sunderbans is located in the vicinity of shipping and oil tanker line of Hooghly and the vessels call at Haldia and Calcutta Ports. Any oil spill occurring in the Hooghly estuary will affect the mangrove areas also.

### **Oil Spill Risk**

Since the area is close to the shipping line, the risk on oil spill is **high**

## **2. Digha**

Digha beach along the Bay of Bengal coast is one of the important tourist spots in West Bengal. This area has a large number of beach resorts and hotels. The water quality is very much influenced by the river Hooghly. Any oil spill occurring in the sea off Digha will affect the tourism beaches.

## **Oil Spill Risk**

Since the area is close to the shipping line, the risk on oil spill is **high**

## **X. ANDAMAN AND NICOBAR ISLANDS**

The Andaman and Nicobar islands comprise about 348 islands of volcanic origin situated between 6° to 14° N Lat. and 92° to 94° E Long. occupying an area of about 8249 sq.km., in the Bay of Bengal. It has a coastline length of 1962 km. The area of Andaman group of islands is 6408 sq.km and Nicobar group of islands is 1841 sq.km (Anon, 1994). The 10 degree channel divides the above group of islands. The coastline is irregular and deeply indented by innumerable creeks, bays and estuaries which facilitate the development of rich and extensive mangrove forests. The coastal area is generally rocky and muddy but in several cases sandy also. Mudflats with sand and coral rubbles promote the growth of mangroves and seagrasses. Enclosing the mangrove areas in the island are the elevated sandy beaches varying from island to island and spread along the coastline.

In the Andaman group of islands, North Andaman, Middle Andaman, South Andaman and Little Andaman are the only big islands. All other islands are tiny ones. In Nicobar group of islands, Great Nicobar, Little Nicobar, Katchel, Nancowrie, Triniket, Trerssa, Chowra, Trilonchang and Car Nicobar are the big ones.. Until recently, these islands constituted an almost undamaged and highly diversified natural environment, with luxuriant rain forests extending down from the hills to deserted beaches, fringing reefs, and rich coastal waters almost unpolluted by soil erosion and industrial activity.

The waters A &N islands are rich in biodiversity and fishery. The international tanker route is located south of Indira point at Greater Nicobar. Few oil spill incidences have occurred in the past in this area with major one during 1993. Considering the tanker traffic the area is highly vulnerable for oil spills. The spills will affect corals, virgin beaches, fishery and the mangroves.

## **Oil Spill Risk**

Since the area except Greater Nicobar is away from the Ports and located along the shipping line, the risk on oil spill is moderate. Due to its proximity to the international tanker route, the risk of oil spill is **very high** for Greater Nicobar



## **XI. LAKSHADWEEP ISLANDS**

Lakshadweep is an archipelago lying between 8°-12°30' N latitude and 71°-74° 'E longitude. It is a group of islands located about 300 km to west of the Kerala coast. It has 37 islands covering an area of 32 km<sup>2</sup>, of which ten are inhabited. They are Androth, Amini, Agatti, Bitra, Chetlat, Kadmat, Kalpeni, Kavaratti, Kiltan and Minicoy. Bangaram, uninhabited till recently, is now a tourist resort. Andrott is the largest with an area of 4.84 sq km. Minicoy atoll (8° 18'N and 73°E) is the southernmost atoll and the largest in the Lakshadweep. Bitra is the smallest of the inhabited islands with an area of just 0.10 sq km.

The islands are flat and scarcely rise more than two meters. The islands are coralline in origin and made up of fine coral sand and boulders, compacted into sandstones. The archipelago consists of 12 atolls, 3 reefs and 5 submerged banks. The coral reef area is estimated at 4200 km<sup>2</sup>. Almost all atolls of this archipelago have a NE-SW orientation with the island on the east, a broad well developed reef on the west and lagoon in channels. The shore of the lagoon side of the atolls are characterized with sandy beach, having medium to coarse coralline sand and beach rocks exposed during low tide. The coral growth in many islands is luxurious and highly diverse.

### **Environmental Sensitivity**

Since all the islands have extensive coral reef, oil spills affect corals and associated fauna especially the bite fish which is used for tuna fishing. Few oil spill incidences occurred in the past have extensively damaged the corals and associated fauna and the sea grasses.

### **Oil Spill Risk**

Due to its proximity to the international tanker route, the risk of oil spill is **very high** for all the islands of Lakshadweep.