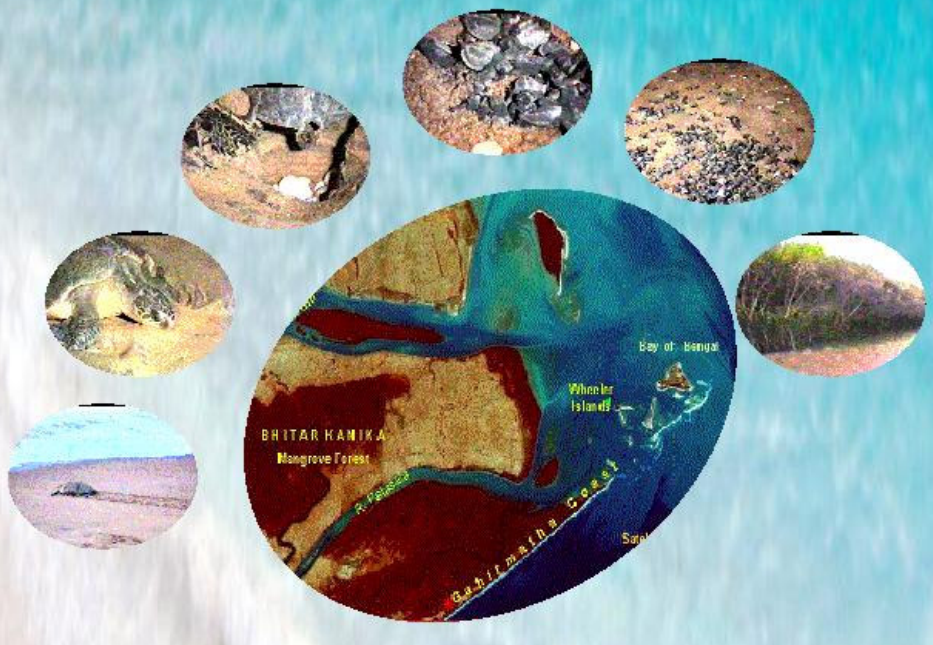
CRITICAL HABITAT INFORMATION SYSTEM OF GAHIRMATHA - ORISSA



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Integrated Coastal and Marine Area Management
Project Directorate, Chennai
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1. Introduction

The coastline of India extending to over 7,500 km, harbours a variety of specialised marine ecosystems like coral reef, sea grass, mangroves, nesting and feeding grounds and lagoons, supporting a variety of resources.

Bhitarkanika is one such unique ecosystem (mangroves, nesting and breeding grounds for turtles) situated on the east coast of India in the state of Orissa. The coastline of this region is sandy in nature and free of rocks and stones. The area includes Bhitarkanika Wildlife Sanctuary and Gahirmatha Marine Sanctuary, which are of International repute. Gahirmatha beach located in the Bhirtarkanika Wildlife Sanctuary supports the largest known nesting ground of olive ridley turtle in the world. (Bustard, 1976; Kar and Bhaskar, 1982; Dash and Kar 1990). About 0.2 to 0.7 million olive ridley turtles visit this beach during December - April for mass nesting every year. However, in the last 20 years, large scale mortality and shifting of nesting is being observed.

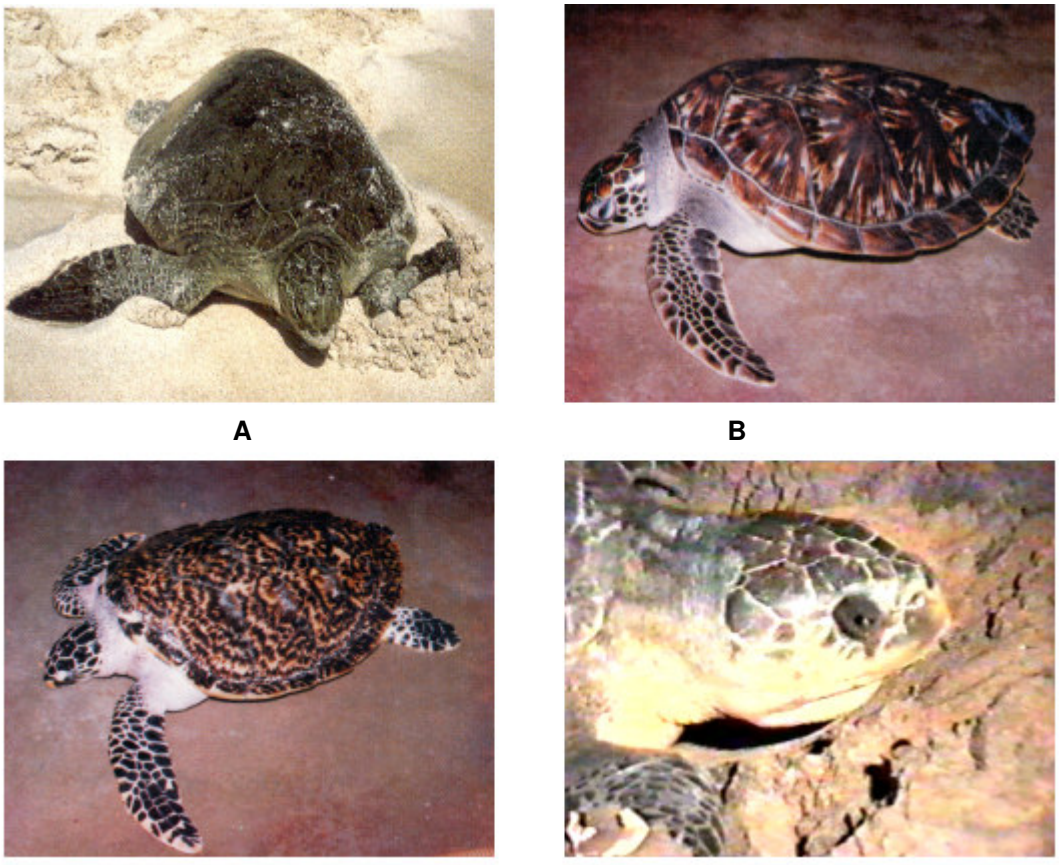
The uniqueness of the topography of this area lies in the manner in which the region is criss-crossed by a network of rivers and flanked by the sea on one side. The region is home to a wide variety of spectacular plant and animal species. The vegetation varies from deltaic mangrove forests to deciduous and semi-deciduous forests.

Realising the importance of this coast as a mass nesting ground for turtles, Integrated Coastal and Marine Area Management (ICMAM), Project Directorate selected Gahirmatha coast as a critical habitat for developing a Critical Habitat Information System (CHIS). The major objective of this study is to create information about the nesting site, coastal geomorphology, land use/land cover, shifting of nesting places and mangrove vegetation of this region using Geographical Information System (GIS). This would help in effectively managing and monitoring the breeding and nesting grounds in this region.

2. Marine turtles – species composition

Marine turtles are found in tropical and temperate seas throughout the world. Adults of most species are found in shallow coastal waters, bays, lagoons and estuaries. Some also venture into the open sea. There are eight species of sea turtles found in the world. They are *Chelonia mydas* (green turtle); *Chelonia agassizii,* (black turtle); *Caretta caretta* (loggerhead); *Lepidochelys kempii* (Kemp's ridley); *Lepidochelys olivacea* (olive ridley); *Eretmochelys imbricata* (hawksbill); *Natator depressus* (flat back turtle); and *Dermochelys coriacea* (leather back).

In Indian coastal waters five species of sea turtles are known to occur namely *Lepidochelys olivacea, Eretmochelys imbricata, Dermochelys coriacea, Chelonia mydas* and *Caretta caretta* of which four species occur in the coastal waters of Orissa and Gahirmatha coast. In the order of abundance, they are *Lepidochelys olivacea, Eretmochelys imbricata, Dermochelys coriacea* and *Chelonia mydas* (Fig - 1).



A **B**

C **D**

Figure : 1 **A** - *Dermochelys coriacea,* **B**- *Eretmochelys imbricata*
C - *Chelonia mydas* **D** - *Lepidochelys olivacea,*

3. Gahirmatha coast – General Description

Gahirmatha is a sandy coast situated (Lat 20° 52 ' to 20° 72' N and Long 80° 77' to 87° 05' E) in Kendrapara district, Rajanagar taluk on the northeastern part of Orissa state in India (Fig 2). The area extends approximately along 35-40 km stretch of the coastline from Maipura river mouth in the North up to Hansua river mouth in the south. The beach is more or less flat with scattered sand dunes of 2-3 m height. The average beach width is 80 m above the high tide line although in some places the width exceeds 100 m. The vegetation consists of scanty growth of *Ipomoea sp.* and *Spinifex sp*. The area comprises wetland, backwater and brackishwater region.

Fig. 2 - Map of Gahirmatha coast

4. Climatology

The regularity of the occurrence of the olive ridley turtles and their nesting along the Gahirmatha coast suggests the prevalence of favourable ecological and topographical conditions for inducing seasonal migration of olive ridley turtles to Gahirmatha coast and their nesting.

(a) Rainfall

In the present study (1998) the minimum average rainfall of 3.0 mm was observed in January and a maximum average rainfall of 318 mm in September. The average rainfall data for 1995 and 1998 are given in table-1.

Table 1- Annual rainfall in Gahirmatha (in mm) 1995 and 1998

Month	1995	1998
January	5.0	3.0
February	40	9.0
March	29	117
April	16	93
May	228	15
June	154	101
July	140	137
August	293	228
September	202	318
October	229	273
November	261	100
December	-	-

(b) Temperature

Temperature plays an important role in the nesting behaviour and incubation of hatching process of sea turtles. The average monthly air temperature data in Gahirmatha for 1995 and 1998 are given in Table 2.

Table 2 - Monthly Max-Minimum Temperature recorded in the Gahirmatha coast

Month	1995		1998	
	Min ° C	Max ° C	Min ° C	Max ° C
January	14.6	25.9	16.9	27.8
February	18.9	31.7	19.1	31.3
March	22.6	34.3	23.1	34.0
April	25.9	38.5	25.5	36.4
May	27.2	35.4	27.7	38.6
June	27.4	34.0	28.7	36.5
July	26.7	32.1	26.9	33.9
August	26.7	32.5	27.0	32.8
September	26.8	30.9	26.0	32.8
October	24.7	30.9	26.0	32.2
November	20.9	28.8	22.4	30.6
December	16.4	29.0	15.9	29.1

(c) Humidity

Humidity is important for inducing the nesting activity and construction of nest for the turtles. In the present study, the humidity value was observed to range from 64% to 87% during 1998 in the Gahirmatha coast. The average monthly humidity values recorded are given in table 3.

Table 3 - Humidity data in Gahirmatha (in %)

Month	1995		1998	
	08.30 hrs	17.30 hrs	8.30 hrs	17.30 hrs
January	75	63	80	67
February	81	64	82	64
March	73	58	78	64
April	71	61	77	65
May	79	73	73	67
June	82	81	78	73
July	86	78	84	81
August	87	81	87	84
September	87	84	86	81
October	83	85	84	85
November	82	79	81	78
December	81	72	78	67

5. Hydrological Parameters

Physico-chemical parameters were studied during May 98, Nov. 98, and May 1999 in six locations viz., Maipura river, Maipura estuary, Maipura (seaside), Wheeler island, Dhamra river and Ekakula (seaside) region of Gahirmatha coast.

a) Surface water temperature

The surface water temperature varied from 21.2° C to 31° C. While low temperature was recorded in September '98 (monsoon) and high temperatures were recorded in May '99 (summer).

b) Salinity

The overall salinity ranged from 12.5 to 33.37 during 1998-99. Lower salinity values were recorded during monsoon and post monsoon period. Seasonal and station wise, salinity values is given in Table.4(a) .

Table 4 (a) - Salinity values in Gahirmatha coastal waters (in ppt)

Station	Season (Month)		
	May-98	Nov-98	May-99
Maipura river	16.24	12.5	13.69
Maipura estuary	16.63	15.75	32.43
Maipura (seaside)	-	21.14	31.98
Dhamra river	9.85	-	-
Wheeler Island	28.63	14.99	32.54
Ekakula (seaside)	-	20.87	33.37

(c) Dissolved Oxygen

The dissolved oxygen (DO) is an indicator of health of water quality. It ranged from 6.9 mg/l to 12.9 mg/l at Wheeler Island (seaside). Seasonal and station wise, Do value is given in Table-4(b).

Table 4 (b) - Dissolved Oxygen values in Gahirmatha coastal waters (in mg/l)

Station	Season (Month)		
	May-98	Nov-98	May99
Maipura river	11.6	12.5	9.2
Maipura estuary	10.4	8.8	11.6
Maipura (seaside)	-	10.4	9.8
Dhamra river	7.4	-	-
Wheeler Island	12.9	7.4	6.9
Ekakula (seaside)	-	11.2	9.8

(d) pH

pH varied from 7.49 (Wheeler Island – seaside) to 8.27 (Maipura – sea side).

(e) Suspended Matter

Suspended matter varied from 4.80mg/l at sea side of Ekakula to 230.71 mg/l at Wheeler Island. In summer, suspended solids are generally higher than in other seasons. Table 4(c) shows in Suspended Matter in Gahirmatha coastal waters during 1998-99.

Table 4 (c) - Suspended Matter in Gahirmatha coastal waters (mg/l)

Station	**Season (Month)**		
	May-98	**Nov-98**	**May-99**
Maipura river	24.2	15.82	68.95
Maipura estuary	23.1	61.32	87.26
Maipura (seaside)	-	15.92	66.32
Dhamra river	34.0	-	-
Wheeler Island	75.3	230.71	93.22
Ekakula (seaside)	-	4.80	64.77

(f) Nutrients

i. **Nitrite**: Nitrite content in water varied from 0.08 μmol/l (at Ekakula) to 12.9 μmol/l (at Maipura estuary). The Nitrite concentration of Gahirmatha coast is given in Table 4(d).

Table 4 (d) - Nitrite concentration of Gahirmatha coastal waters (in μmol/ l)

Station	Season (Month)		
	May-98	Nov-98	May-99
Maipura river	0.64	3.14	0.49
Maipura estuary	0.40	5.99	12.9
Maipura (seaside)	-	1.45	0.36
Dhamra river	4.85	-	-
Wheeler Island	1.37	5.42	0.84
Ekakula (seaside)	-	0.08	0.10

ii. **Nitrate** content in water varied from 0.10 μmol/l to 5.57 μmol/l in Maipura river. Nitrate concentration is higher at river/estuarine zone compared to neritic zone. The Nitrate concentration of Gahirmatha coast is given in Table-4 (e).

Table 4 (e) - Nitrate concentration of Gahirmatha coastal waters (in μmol/ l)

Station	Season (Month)		
	May-98	Nov-98	May-99
Maipura river	0.10	5.57	0.24
Maipura estuary	0.21	1.80	1.14
Maipura (seaside)	-	0.74	0.42
Dhamra river	0.40	-	-
Wheeler Island	0.20	1.89	0.18
Ekakula (seaside)	-	0.16	0.94

iii. **Phosphate**: It varied from 0.33 μmol/l (at Maipura-seaside) to 2.11 μmol/l (Dhamra river). The Phosphate concentration of Gahirmatha coast is given in Table-4(f).

Table 4 (f) - Phosphate concentration of Gahirmatha coastal waters (in μmol/ l)

Station	Season (Month)		
	May-98	Nov-98	May-99
Maipura river	0.92	0.63	0.49
Maipura estuary	1.40	0.54	0.88
Maipura (seaside)	-	0.33	0.88
Dhamra river	2.11	-	-
Wheeler Island	1.33	1.96	1.8
Ekakula (seaside)	-	0.58	0.88

6. Gahirmatha Marine Sanctuary

The massive arribada nesting of the olive ridley turtles along the Gahirmatha coast in Orissa is an unique phenomenon and is one of the most interesting features in the animal and biological realm. To provide protection and proper management for olive ridley turtle breeding and nesting ground of Gahirmatha, the Government of Orissa has declared it as a Marine Sanctuary. The notification for declaring the Marine Sanctuary was published in the extraordinary issue No.1268 of the Orissa Gazette dated 17th October 1997. The fishing area of Gahirmatha coast became restricted in 1993 and fishing was completely banned in this area in 1997, when Gahirmatha was given the status of a Marine Sanctuary.

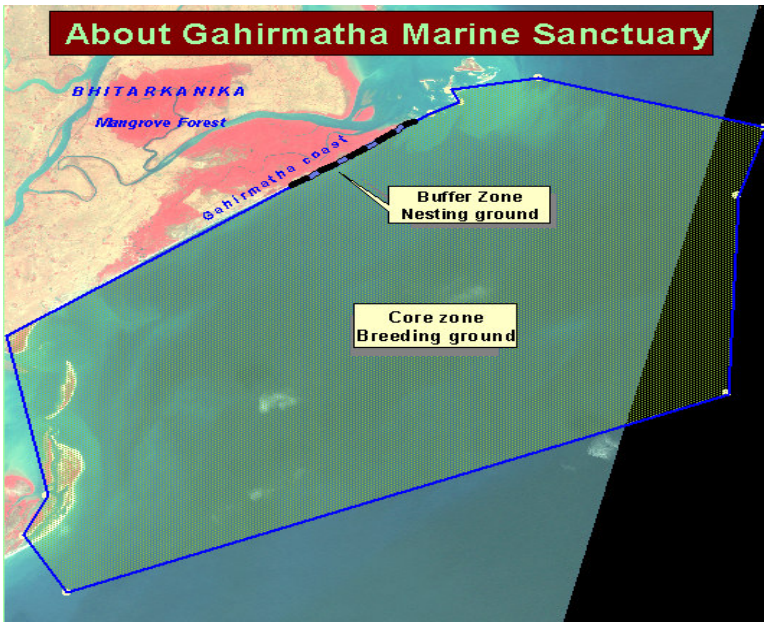


Fig. 2 - Boundary of Marine Sanctuary in Gahirmatha

The core area of the sanctuary is 725 sq. km where fishing is prohibited throughout the year. This has an average width of 11 km offshore of Ekakulanasi in the North – East and an average width of 10 km from Barunei muhana to Mahanadi muhana.

The Buffer zone stretches over an average width of 10 km where fishing is restricted during the nesting season from December to April.

7. Development of the Resources Information System

The Resources Information System of Gahirmatha developed by ICMAM Project Directorate, integrates the existing diverse coastal and environmental data collected by various organisations on biodiversity. Nesting ground, nesting population of this coast along with data about the land use, geomorphology, shifting of nesting sites and causes for shifting

of nesting sites in relation to turtle breeding and nesting were developed to facilitate monitoring and management of breeding and nesting grounds of olive ridley turtles in Gahirmatha coast.

The information system incorporates the following:

- Identification and mapping of sea turtle rookery in Orissa coast.
- Present status of nesting population and hatchlings.
- Present status of distribution of phytoplankton, zooplankton and benthos.
- Mapping of distribution of mangrove vegetation.
- Possible causes for shifting of the nesting site.

Remote sensing and RDBMS (Relational Database Management System) along with field survey were used in developing the Resources Information System for Gahirmatha Coast. Field and satellite data were selected as primary sources of information and GIS and RDBMS were used as tools to analyse and develop the complete information system. Data were collected on distribution of phytoplankton, zooplankton, benthos, and turtle nesting population. The collection methodology varied with respect to parameters studied.

7.1 Components of Information System

(a) Remote Sensing

The present observation was made using IRS ID LISS III January 1998 data (Fig. 4).

The Survey of India toposheet was used to rectify the digital data. Base map was digitised using toposheets and onscreen digitisation of the same was also done in order to get an idea about the present location of the coastline of Gahirmatha. Thematic maps on land use, Geomorphology and Shoreline were derived by from IRS LISS III January 1998 data.

Digital image processing was carried out using ERDAS – IMAGE 8.4. GIS was developed using ARCINFO 8.0.2 and ARCVIEW 3.2. Tables were created and stored in ORACLE 8.0 database with DEVELOPER 2000 as the front-end. Scripts were written using AVENUE programming language. Finally, Resource Information System for Gahirmatha (RISGA) was presented in ARCVIEW since it is a powerful and easy-to-use tool that has the capabilities to visualize, explore, query and analyze the data spatially.

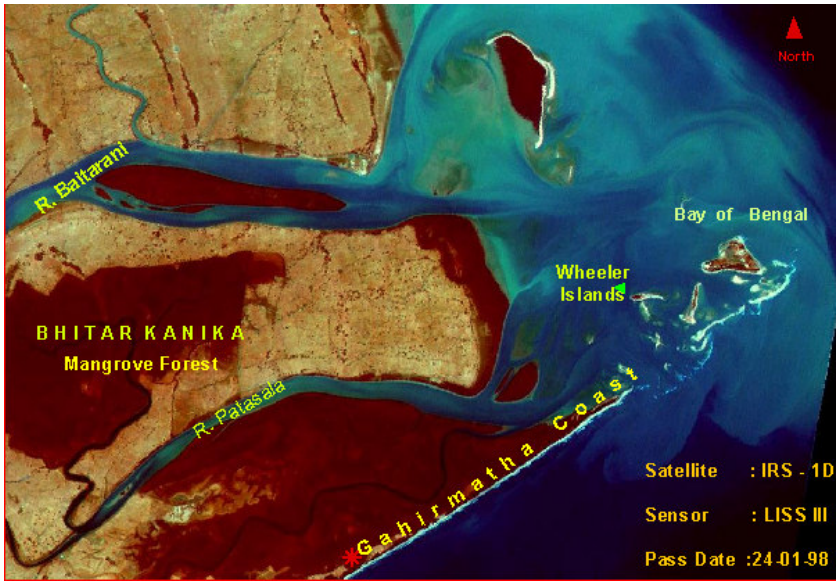


Fig. 4 - Satellite Imagery of Gahirmatha coast

(b) Relational Data Base Management System (RDBMS)

RDBMS is the acronym for "Relational Data Base Management System" and is essentially a set of collecting data stored in the form of tables and a set of programmes to access it.

(c) Data collected from various organisations

Data on physico-chemical parameters, phytoplankton, zooplankton, benthos and nesting population of olive ridley turtles were collected by Regional Research Laboratory, Bhubaneswar during May 1998, September 1998 and May 1999. Phytoplankton collection was carried out using a standard phytoplankton net for qualitative and quantitative analysis. Zooplankton samples were collected by half-metre mouth diameter bolting nylon net (0.33 mm mesh size) and volume of zooplankton was measured by displacement method. Nesting population of olive ridley turtles was surveyed during nesting season (December to April).

Data on all these attributes collected from the various sources were stored as separate tables in the oracle database and linked using common identities. Tables were created to hold information on:

- Physico-chemical details
- Culturable and non-culturable bacteria
- Flora and fauna
- Socio-economics

(d) Geographical Information System

Geographical Information System (GIS) is a system for capturing, storing, checking, manipulating, analysing and displaying data, which are spatially referred to the earth. GIS is used for wide application including planning, land-use, geomorphology of the land and coastal areas. Satellite data were selected as primary source of information and RDBMS was developed using field data collected by Regional Research Laboratory, Bhubaneswar. Remote Sensing, GIS and data were used to analyse and develop the complete information system.

8. Geomorphology

The coast of Gahirmatha is a low laying sandy area with commonly occurring tidal creeks and mud flats. A number of sandy islands are found along this coast and the presence of barrier ridge (barrier island) is an important feature, which protects the sandy island from erosion.

The coast is a low lying area and drained by the river Baitarani, Brahmani, Dhamra, Maipura, Bansgarh and Ranhahansua. The geomorphology of Gahirmatha coast is shown in fig 5.

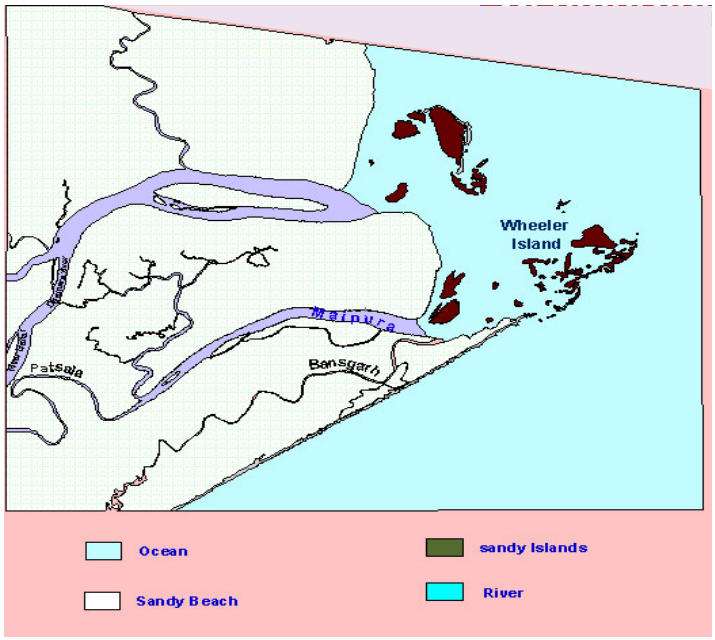


Fig. 5 - Geomorphology of Gahirmatha

9. Land use / Land cover

The landuse/land cover could be classified into mangroves (136 sq. km), sandy islands (12 sq. km), open shrub (17 sq. km) and settlement areas. Dense mangrove vegetation is found in and around Gahirmatha coast (Fig 6). Cultivation is entirely rainfall dependent. A small part of the land is used for paddy cultivation.

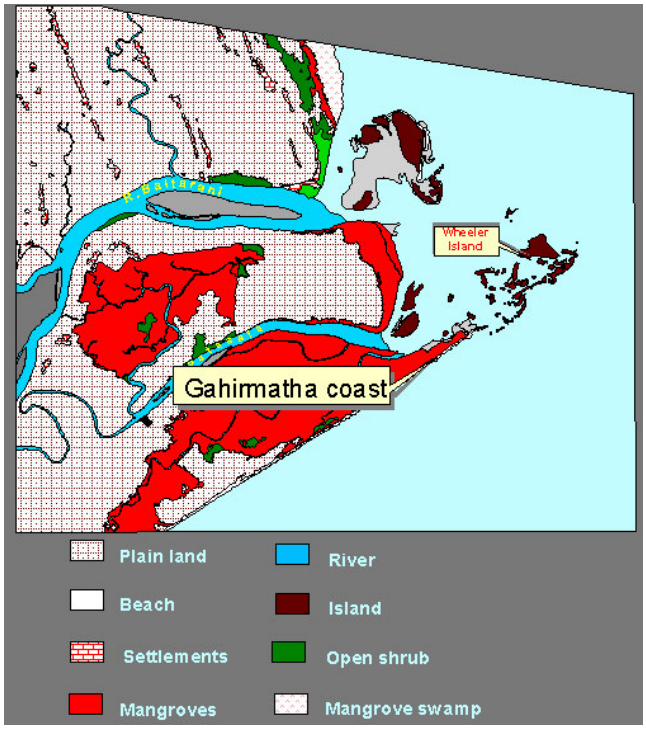


Fig. 6 - Land use / Land Cover of Gahirmatha coast

10. Factors influencing Beach selection for nesting of turtles

Site selection and condition for nesting depends on the topography and substrate of the coastal environment. Mortimer (1982) has observed heaviest nesting along unlit beaches with no obstacles in the offshore approaches and beaches, which are sandy in nature with 3-4 m elevation from high waterline and easily accessible from the sea. The substrate must be most and fine enough to prevent collapse of the egg chamber during construction. Mortimer (1981) has found an optimum range of grain size for hatching and construction of nest and nests could fail if sand is too fine or too coarse. Bustard (1972) has reported the green turtle nesting, when a good amount of beachfront vegetation including large bushes and trees are present. Hawksbill is known to nest beyond the sandy beaches amongst vegetation (Frazier, 1975; Mortimer, 1982). The biotic factors such as beaches between estuaries and sand banks off open beaches may also have a role to play in nest selection by the turtle. Human

interference such as lighted beaches, physical structure on beaches, anti-erosion work, beach mining, etc., are known to have adverse effects on the nesting habits of sea turtle as well as on the emerging hatchlings.

The first mass nesting of olive ridley turtles in Gahirmatha coast was reported by Bustard (1976) who drew international attention to this nesting site. He found that the mass nesting was restricted to only a few kilometres in the southern part near Maipura river. This mass nesting occurs due to the availability of suitable nesting environment like sandy beaches, elevation, soil texture, presence of wetland, backwater and brackish water and mangrove vegetation in Gahirmatha coast (Fig 7a & b)

The other studies of nesting habits and intensity of breeding activity of the olive ridley turtles in Orissa coast were reported by Biswas et al. (1977), Davis and Bedi (1978), Kar (1982), Biswas (1981), Kar and Bhaskar (1982) and Silas et al. (1983, 1984 and 1985).

Fig. 7a & b - Nesting site of Gahirmatha Beach

The average beach width is 80 m above the high tide line, although in some places the width exceeds 100 m. The beach elevation is about + 4.45 m above chart datum in the place of Dhamra Jetty region and ground elevation on the mainland is about + 3.5 m. However, Kar and Dash (1984) and Silas et al. (1984) have reported severe beach erosion in Gahirmatha coast to affect the mass nesting of olive ridley turtles every year.

11. Sea turtle rookery in Orissa coast

Olive ridley turtles (*Lepidochelys olivacea*) are the most common species of sea turtle occurring along the east coast of India. These turtles migrate every winter to nest en mass at three major rookeries in the Orissa state. They are:

(i) The Gahirmatha rookery located along the northern Orissa coast (Fig - 8), hosts the largest known nesting concentration of olive ridley turtles. (Bustard 1976; Dash and Kar, 1990; Pandav, et al., 1994). The rookery extends 35-40 km of the coastline from Maipura river in the north and Hansua river mouth in the south.

Fig. 8 - Gahirmatha Rookery

(ii) Devi river mouth (Jatadhar "Muhana" to Kadera river mouth) (Fig – 9), Cuttack district, 100 km South of Gahirmatha (Kar, 1982).

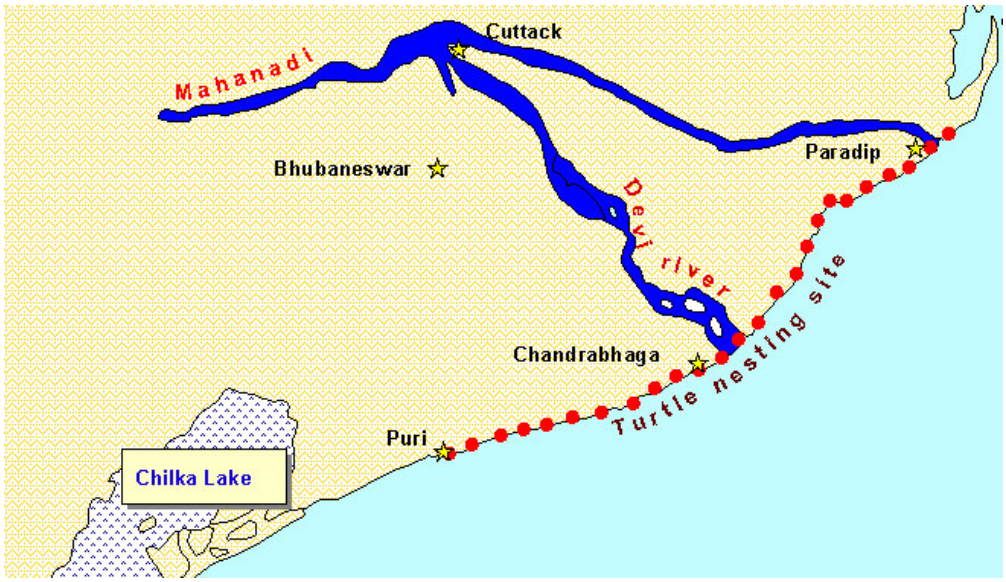


Fig. 9 - Turtle nesting site in Devi River

(iii) Third rookery is Rushikulya River (Fig – 10), 300 km South of the Gahirmatha mass-nesting beach. The rookery extends to 6 km from Paruna Bandha village (1 km north of the Rushikulya river mouth) to Kantiagada village.

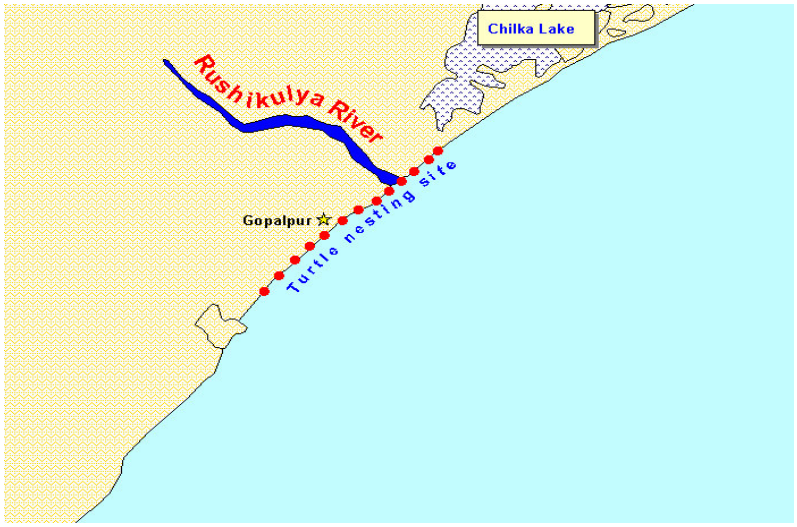


Fig. 10 - Turtle nesting site in Rushikulya River

The nesting beach is 1 km east of the Chennai – Calcutta National Highway No.5 and South Eastern Railway line near Ganjam town. It is 8 km North of the Gopalpur Port. The nearest large city is Berhampur, 30 km away.

(a) Nesting Period

Nesting season commences from December to the end of April, with a peak in the middle of March. Nesting time of olive ridley turtles usually was observed during night time.

(b) Nesting Population

The nesting population of olive ridley turtles along the east coast, particularly along the Gahirmatha coast was studied by Bustard (1976); Kar and Bhaskar (1982); Silas et al (1983, 1984 and 1985) and found there is a good amount of variation in the number and intensity of arribada from year to year. The Table-5 and Chart 1 show the number of nesting population of olive ridley turtles in Gahirmatha coast from 1976 to 2000.

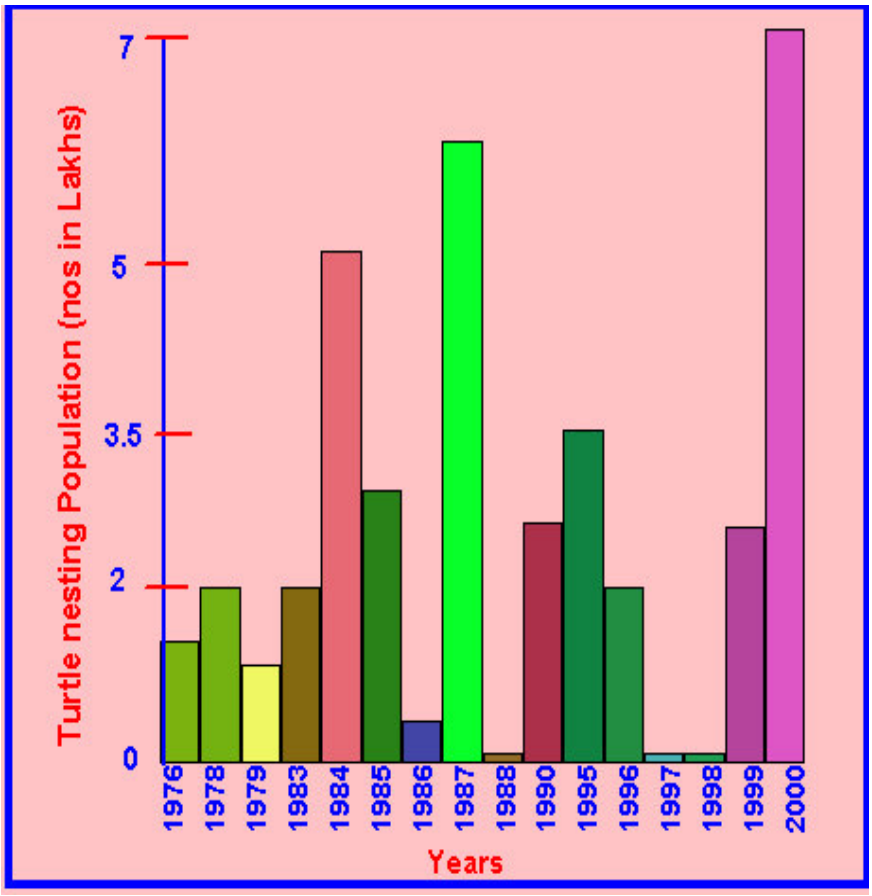


Chart 1 - Nesting Population year wise (1976 – 2000)

Table 5 - Nesting population of turtles from 1976 to 2000

Year	Estimated number of nesting females	Source
1976	1,50,000	Kar and Bhaskar, 1982
1977	1,50,000	-do-
1978	2,00,000	-do-
1979	1,30,000	-do-
1983	2,00,000	Silas et al., 1983
1984	5,00,000	Silas et al., 1985
1985	2,87,000	Silas et al., 1985
1986	80,000	The Samaja (Orissa Newspaper)
1987	6,00,000	-do-
1988	50,000	-do-
1990	2,58,000	-do-
1995	3,39,500	-do-
1996	2,00,000	-do-
1997	50,000	-do-
1998	50,000	Forest Dept. & RRL Data
1999	2,53,000	-do-
2000	7,00,000	-do-

About 0.2 – 0.7 million turtles are estimated to be visiting this beach every year during early winter for mass nesting (Chadha and Kar 1999). However, the actual number varies year to year. During 1982, 1988, 1997 and 1998, only a few thousand turtles visited the coast for nesting. However, during 2000, maximum number of about 0.7 million turtles visited the Barrier island of this coast. The Barrier island (Barrier ridge) called Ekakulanasi is the main turtle breeding ground of this coast. Kar and Das (1984) observed that the first arribada is very intensive every year when compared to the second one. Silas et al. (1985) found that first mass nesting of 1984 lasted for about 13 nights during which period about 3,00,000 turtles visited Gahirmatha beach for nesting. The second arribada which took place during the same season at Gahirmatha from 24th to 29th March 1984, sixty days after the first mass nesting which commenced on 25th January 1984 and lasted until 6th February 1984. It is roughly estimated that about 2,00,000 turtles would have emerged for nesting during the second mass nesting. The total nesting females for both the mass nesting were estimated to be about 5,00,000 during 1984. Figure 11 a & b show the mass nesting of turtles in Gahirmatha coast.

The population data are usually based on the number of adult females that come to shore for nesting. Even then, the numbers are ambiguous, some females nest every two or three years, some may nest more than once on the same beach in a season and some females will visit more than one nesting beach in a season.

Fig. 11 a & b - Mass nesting of turtles in Gahirmatha coast

The total population figures are often unknown because juveniles and male sea turtles do not come to the shore and are difficult to count. Mortimer (1982) rely more upon the changing numbers of nesting females from year to year to determine population trends of increasing or decreasing number. Because of wide year-to-year fluctuations in the number of nesting females, short-term data are misleading and hence surveys for a decade or less may be insufficient to determine the population trend.

The number of nesting females at Gahirmatha has declined in recent years. Although intense offshore fishing activities may have played a role, it is also thought that this may be due to unsuitable beach conditions. The beach width has been severely reduced due to erosion processes. The other possibility is that artificial illumination created by construction work at the Missile testing range in the nearby Outer Wheeler Island has caused disturbance for mass nesting of olive ridley turtles.

(c) Nesting behaviour

Female turtles emerge at night to lay eggs. The turtles dig a pit of about 15-20 cm width and 40 cm deep for laying eggs (Fig 12 a & b). The depth of egg pit is equal to the length of the rear flipper. During egg laying the turtles breathe heavily, shed tears and raise their head with a great sigh.

Fig. 12 a & b - Construction of nest on Gahirmatha beach

Many nesting attempts are unsuccessful due to various factors such as disturbance on the beaches, pressure of predators, etc., along the sandy shore. Sometimes, the nesting site becomes unsuitable due to particle size (soil texture). The extremes of temperatures also affect the nesting. The time taken for complete nesting and laying of olive ridley turtles is about 1½ - 2 hours. The average number of eggs per clutch was found to be 111 (range 60 – 186) (Fig 13 a & b).

Fig. 13 a & b - Olive Ridley turtle laying the eggs

(d) Hatchlings

The emergence of hatchlings commences about 58 days after egg laying (Fig 14 a & b). In the area of mass nesting it was observed that about 6,000 hatchlings emerged from 53 nests in a 100 m stretch. The percentage of live hatchlings emerging from natural nests varied from 51.4 to 95.2 with an average of 74.5%. The percentage of live and dead in the pipping stage varied from 0.6 to 22.8 and 0.9 to 39.0, respectively. The percentage of dead hatchlings and spoilt and unfertilised eggs varied from 0.9 to 8.1 and 1.9 to 11.8, respectively. It could be observed that mortality occurred (to the level of 15%) mainly during pipping stage to the hatchlings (Silas *et. al.*, 1985). Figure-15 shows the mass hatched juveniles of olive ridley turtle.

Fig. 14 a & b - Emerged hatchlings of Olive Ridley turtle

Fig. 15 - Hatched juveniles

Fig. 16 - Hatchlings entering the sea

The hatchlings entering the sea(Fig - 16) during high tide were washed back again on the beach, which again re-enter the sea with subsequent retreating waves.

Silas *et al.* (1984 & 1985) found that 72,200 hatchlings emerged from the nest in Gahirmatha coast. The number of emerged hatchlings per clutch, randomly selected is given in table-6.

Table 6 - No of hatchlings observed per clutch in 1984-85 studies in Gahirmatha

April 1984		March 1985	
Clutch size	**Live hatchlings emerged**	**Clutch size**	**Live hatchlings emerged**
110	94	166	157
99	86	133	117
114	81	83	71
76	48	114	105
149	105	133	119
94	84	96	69
105	79	125	115
133	69	142	116
86	59	117	105
130	109	108	92
133	120	73	68
149	128	118	98
139	122	121	109
127	87	155	145
101	53	122	117
104	99	161	159
105	54	151	139
147	114	165	159
112	73	108	93
107	62	127	120

12. Marine Flora and Fauna of Gahirmatha Sanctuary

(a) Phytoplankton

In the present study (1998-99), 116 species of phytoplankton were recorded (95 species of Bacillariophyceae, 10 species of Dinophyceae, 4 species each Chlorophyceae, Cyanophyceae and one species each of euglenozoa, prymneziophyceae and xanthophyceae). The sampling location and distribution of phytoplankton station-wise are indicated in figure 17. The maximum diversity of phytoplankton was recorded during December 1998. The maximum density of phytoplankton was recorded as 75.000/m^3 in Wheeler Island and 71,600/m^3 in Maipura River. The density of phytoplankton was found to be higher in the estuarine zone than in the neritic zone.

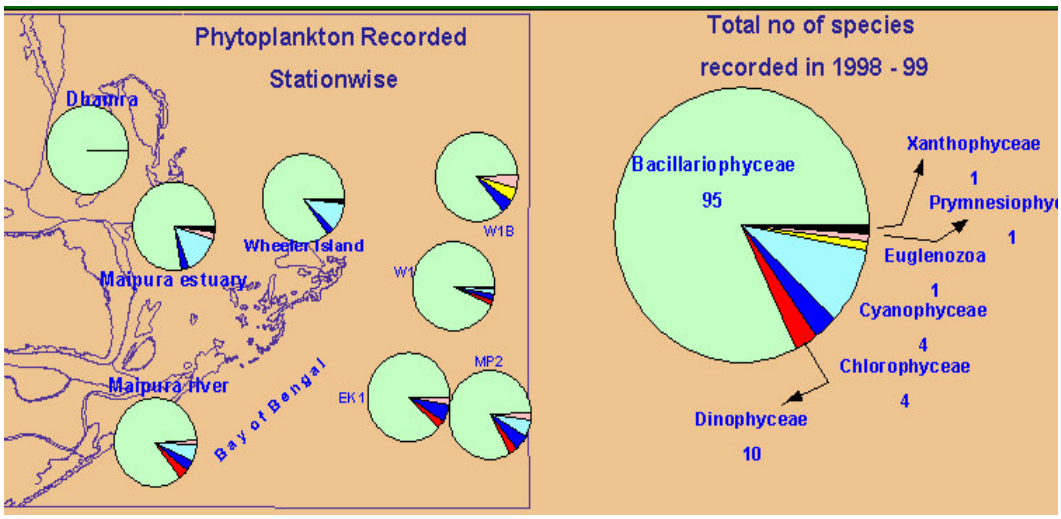


Fig. 17 - Distribution of phytoplankton in Gahirmatha coastal waters

(b) Zooplankton

In the present study (1998-99), 18 zooplankton groups were identified in Gahirmatha coast. Totally 32 species of zooplankton were recorded. They are 19 species of crustaceans, 3 species of sagittoidea, two species each of polyhymenophora, polychaeta, hydrozoans, and one species each of appendicularia, thaliacea and tentaculata. The sampling location and distribution of zooplankton station-wise are indicated in figure 18. The zooplankton density was found to be higher in the estuarine zone compared to neritic zone. The maximum no. of species was observed in the post monsoon. The density of zooplankton ranged from 49 to 2904 numbers/m^3.

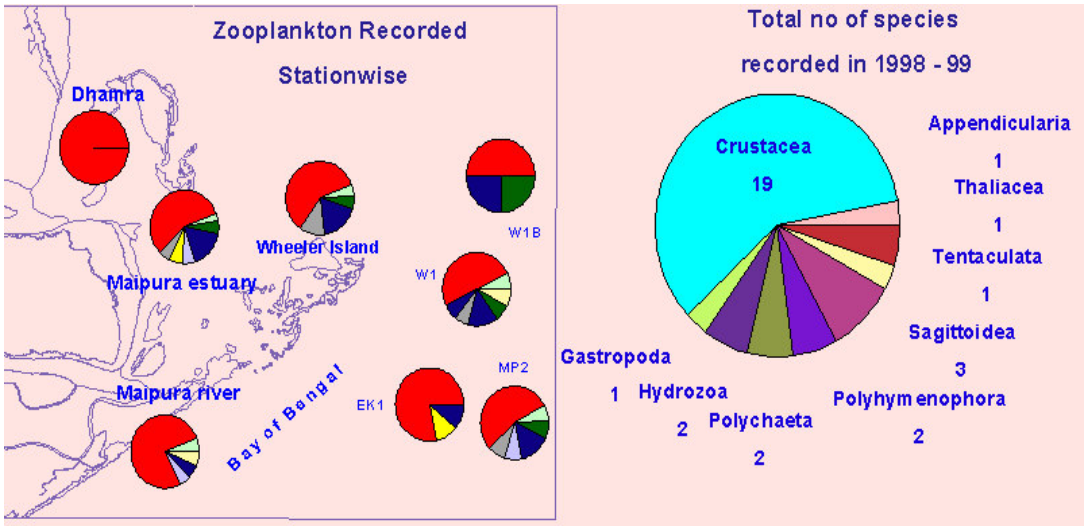


Fig. 18 - Distribution of zooplankton in Gahirmatha coastal waters

(c) Benthos

In the present study (1998-99) totally 29 species of benthic organisms were recorded (15 species of annelida, 5 species of arthropoda, 8 species of mollusca and one species of chordata). The sampling location and distribution of benthic organisms station-wise are indicated in figure 19.The maximum number of benthic organisms was recorded during post-monsoon period.

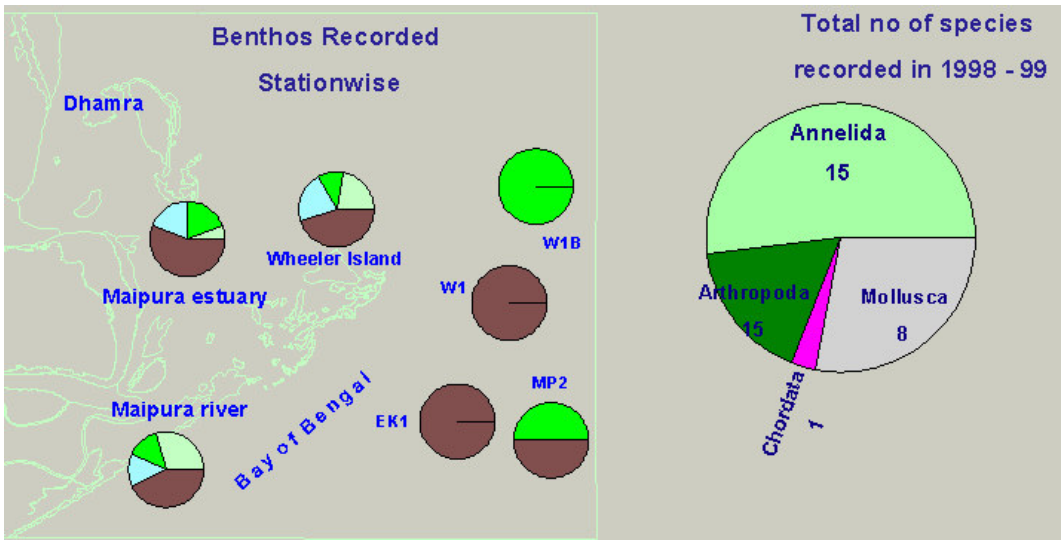


Fig. 19 - Benthic organisms recorded in Gahirmatha coastal waters

(d) Mangrove

In Orissa, the mangroves extend from Balasore coast to Puri coast covering an area of 211 sq. km., of which 161 sq. km. is in and around the Gahirmatha coastal region (Fig – 20). Around Dhamra mouth, the mangroves exist in very dense patches. To ensure protection of mangrove habitat, the Government of Orissa has declared the Bhitarkanika area as a sanctuary in 1975.

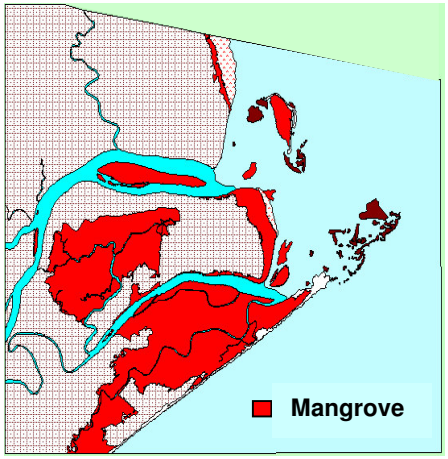


Fig. 20 - Mangrove distribution in and around Gahirmatha

The sanctuary is located between 20° 4' N – 20° 8' N latitude and 86 ° 45' E – 87 ° 50' E longitude covering an area of about 672 sq. km. The following species are found in the Gahirmatha coastal region; *Avicennia alba, Avicennia officinalis, Avicennia marina, Lumnitzera racemosa, Exoecaria agallocha, Xylocarpus granatum, Xylocarpus mokongensi, Derris scandens, Bruguiera gymnorrhiza, Bruguiera sexangula, Bruguiera parviflora, Bruguiera cylindrica, Ceriops decendra,* and *Ceriops tagal*.

13. Shifting of the Gahirmatha mass nesting site

It has been observed that the mass nesting site of Gahirmatha coast has been gradually shifting during the last 20 years, from Gahirmatha northward. In early 1970's according to local villagers, mass nesting was near Satabhaya up to Ekakula. In 1974-75, the mass nesting site was observed along a 10 km stretch of the coastline from Gahirmatha to Ekakula. In the early 1980's the turtles devastated the stretch from Satabhaya up to Habalikhati and nesting was observed near Ekakulanasi. The shifting of mass nesting site of olive ridley turtles in Gahirmatha coast is shown in Figure – 21. Kar and Dash (1984) and Silas *et. al* (1984) based on visual observations reported severe beach erosion in Gahirmatha every year. In 1984, beach erosion was noticed near Gahirmatha, immediately after the first nesting was completed.

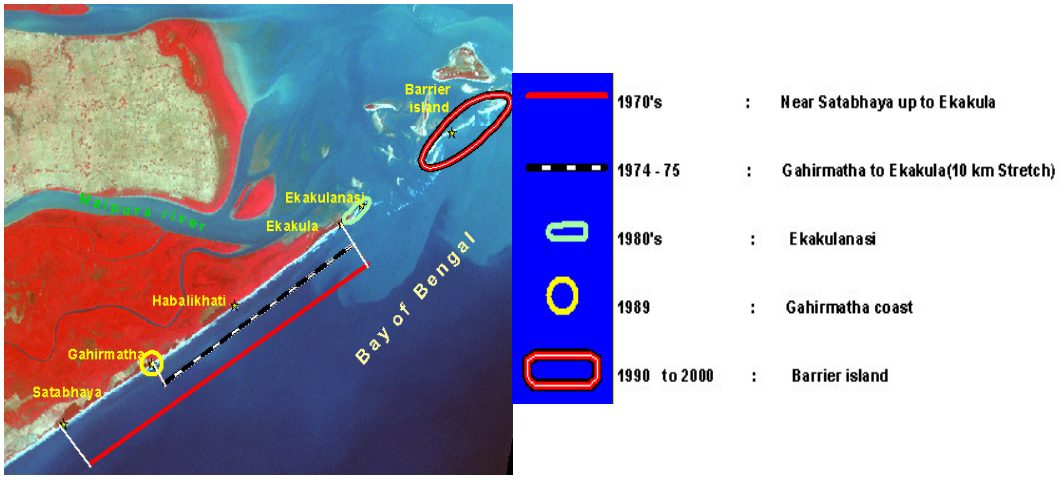


Fig. 21- Shifting of mass nesting site in Gahirmatha coast

The beach erosion and accretion are regular phenomenon every year (Silas et al., 1985). In May 1989, a cyclonic storm swept across the Gahirmatha coast and fragmented the mass nesting beach. However, currently due to the heavy erosion of this region, the width of the beach is reduced. The comparative data of beach width in Gahirmatha coast (1972 and 1998) are given in table-7.

Table 7 - Comparative data of beach width in Gahirmatha coast

Name of the place	1972	1998
Satabhaya	375 m	198 m
Gahirmatha	405 m	101 m
Habalikhati	756 m	159 m
Ekakula	70 m	123 m
Barrier island (Nasi island)	4 sq. km	5 sq. km

The mass nesting site which was originally located at Satabhaya to Ekakula (up to 1990) disturbed by the opening of Maipura river opened into the Bay of Bengal cutting through the mass nesting beach. As a result, northern most tip got separated from the mainland forming a barrier island covering an area of about 4.94 sq. km. during 1998. This island is bound by Maipura river mouth in the west and by the Bay of Bengal on the east. The newly formed island has become known as the “Nasi Island” where mass nesting continued from 1990 onwards. The shoreline changes in Gahirmatha coast are given in figure-22.

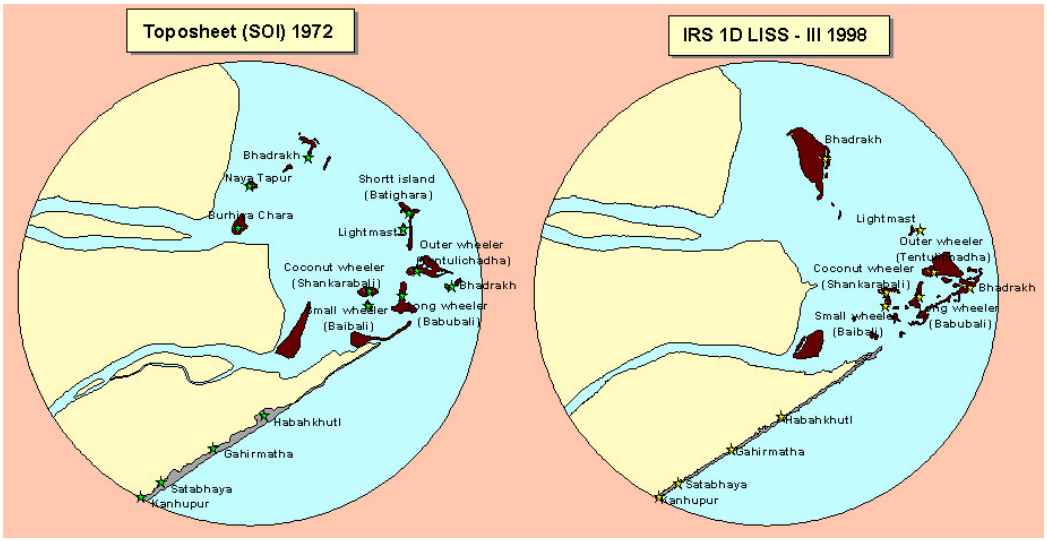


Fig. 22 - Shoreline changes in Gahirmatha coast

14. Threats

Decayed specimen of adults and various stages of hatchlings were found along the Gahirmatha beach during the nesting seasons. This was undoubtedly the result of incidental catch from fishing gears operated from mechanised and non-mechanised fishing crafts. The uncontrolled mechanised fishing in areas of dense sea turtle population has resulted in large-scale mortality of adult sea turtles, during the last two decades in Orissa (James et al. 1989; Dash and Kar 1990; Pandav et. al 1994; Pandav et. al 1997) (Fig – 23 a & b). Mortality due to such illegal trawling has been increasing every year and reached 13,575 ridley in 1997-98 (Pandav & Choudhury 1999). Dash and Kar (1990) reported stranding of 4,682 adult olive ridley turtles at Gahirmatha rookery between September 1978 and May 1985. James et. al., (1989) documented the stranding of more than 8,000 numbers between 1983 and 1987. In the 1993-94 season, 5282 dead olive ridley turtles were recorded (Pandav et. al 1994, 1997). During 1998-99, the stranding of more than 30,000 olive ridley turtles recorded in Orissa (Pandav and B. C. Choudhury 1999).

Das (2001) reported that more than 20,000 of these turtles died last year alone due to mechanised trawling in prohibited areas and non-use of the Turtle Excluder Device (TEDs) by the trawlers. The incidental catch of olive ridley turtles is given in table- 8.

Fig. 23 a & b - Dead turtles observed in Gahirmatha coast due to incidental catches

Table 8 - Incidental catch of olive ridley turtles (in numbers)

Year	No. of dead turtles recorded
1990-91	2,810
1991-92	2,315
1993-94	5,282
1994-95	3,250
1997-98	13,575
1998-99	30,000
1999-2000	20,000

(Source: Kar and Dash 1990, Silas et. al 1984-85, Pandav et. al 1994, Pandav and Choudhury 1999 and Das 2001.)

Another major problem encountered in nesting site of Orissa Coast, is that after the first arribada (January) of olive ridley turtles, the second mass arribada commenced last week of March. There was severe damage to the earlier nests (Fig-24) as females of the second arribada devastatingly dug up pits in the same stretches of the beach especially in the "core" area of overlap with the first mass nesting (Fig - 24) leading to mortality of hatchings.

Fig. 24 - Females of second mass nesting in the same stretches damaged by the first mass nesting

15. Suggestion for turtle conservation

- For reducing the mortality of sea turtles, strict enforcement of Orissa Marine Fishing Regulation Act 1982 and Rules 1983, which prohibits any kind of mechanised fishing within 5 km of the shore along the Orissa is needed. Currently none of the 3000 trawlers operating off the Orissa coast use Turtle Excluder Devices (TED) to minimize the turtle mortality.

- Protection of nesting ground and aquatic habitats, minimising human intervention/interference in the nesting area.

- Creation of facilities for nesting, incubation, hatching and protection of the hatchlings along the beach.

- National and international coordination of conservation strategies.

- To create awareness among local people on conservation of turtle and its nesting grounds, through informal education, training, extension and media.

- To conduct studies on the causative factors responsible for change in beach profile, which lead to shifting of nesting grounds and for planning corrective measures.

16. Conclusion

The Information System developed by ICMAM-PD on Gahirmatha using GIS especially mapping of Land use /land cover, geomorphology, mangroves, boundary of marine sanctuary and causes for shifting of nesting site of turtles using remote sensing and GIS has demonstrated that these tools can be effectively used for monitoring and managing the breeding and nesting grounds of olive ridley turtles in Gahirmatha coast, especially shifting of the nesting grounds.

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