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MARINE OUTFALL LOCATION OFF SOUTH CHENNAI

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ABSTRACT

Disposal of industrial effluents into open sea envisages a thorough study of the marine environment in the vicinity of the outfall. Sufficient dilution and dispersion of the effluent has to take place before it reaches the shore. The required dilution and dispersion of the effluent can be achieved by locating the outfall appropriately. Study on the marine environmental parameters off south Chennai near Mahabalipuram has been made to understand the environment and to suggest a suitable outfall location for a chemical plant. Based on the studies conducted, a location 1000 m away from the shore at a water depth of 10 m has been recommended for the placement of effluent diffuser.

INTRODUCTION

Industrial growth along coastal regions has been on the rise due to the recent liberalization policies of the country. Most of these industries are large scaled like refineries, petrochemicals, thermal power, chemical & pharmaceutical, iron & steel, etc. These industries generally require large quantities of water for cooling and other purposes and therefore also discharge large quantities of effluent mostly into the sea. The volume of discharge ranges from 100 m^3/day to 900,000 m^3/day depending upon the type and size of the industry.

Discharging the effluent untreated will result in destruction of valuable marine plant and animal life. Also discharging the effluent at an improper location would result in the effluent washing back to the shore. Therefore, the method of disposal and the location of disposal in the sea should be thoroughly studied so as to minimize the detrimental effect of the effluent on the marine eco-system.

This paper deals with the marine environmental parameters like wave climate, current pattern, dilution and dispersion characteristics, which influence the behaviour of effluent after its release into the sea. Based on the studies conducted offshore of the proposed effluent landfall point, a suitable location for placing the diffuser for discharging the effluent of the order 100 m^3/day has been estimated.

DESCRIPTION OF STUDY AREA

The study area is located 33 km south of Chennai on the east coast of India as shown in Fig. 1. The oceanographic climate in this region can be classified into three seasons, viz., southwest monsoon (June to September), northeast monsoon (October to January) and fair weather period (February to May). The coast line in this region consists of long open beaches with casurina plantations. The shoreline from Ennur backwaters to Mahabalipuram is 75 km long and is oriented approximately north-south with a slight inclination to the east. The beaches in this region are appreciably straight, open and continous. These exposed beaches have large subaerial and subaqueous sand storage. The beach material predominantly consists of quartz sand having a median diameter of 0.2 to 0.35 mm (Raja Ganesh Ram and Subramanian, 1987).

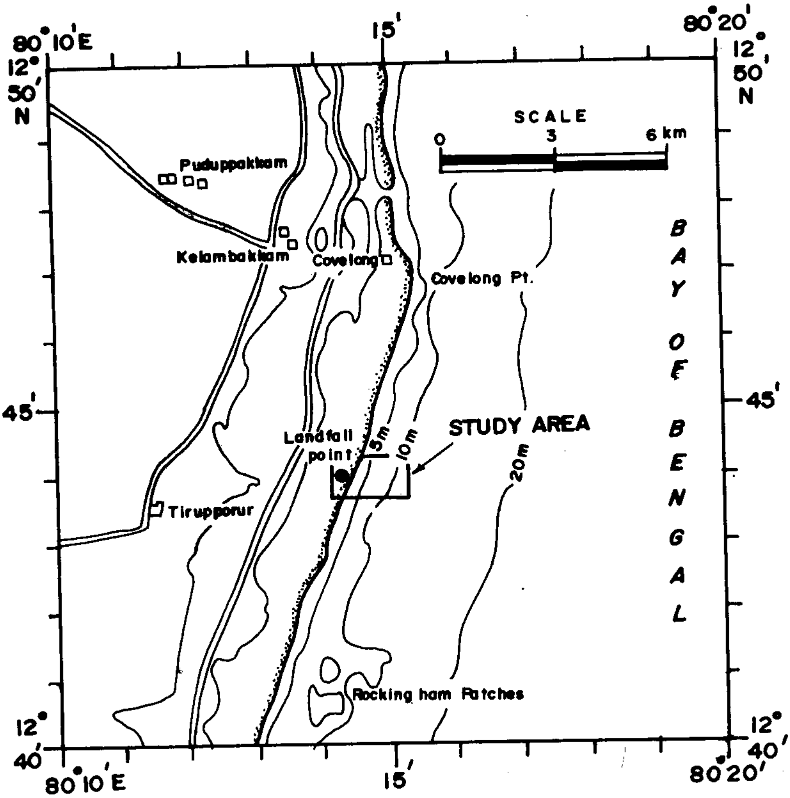

Fig.1 Location map

The beach between Covelong and Mahabalipuram has many beach resorts and is widely used for recreation. At and around Mahabalipuram, due to construction of semi-circular breakwater, the shoreline over a stretch of 3 km towards north experiences erosion. The nearshore in this region is found to be steep with 20 m water depth contour occurring at around 3 km from the shore near Covelong and at about 4.5 km near the landfall point. The beach at the land fall point is narrow and predominantly consists of fine sand to medium sand. The foreshore slope of the beach at the landfall point is steep. The oceanographic parameters suggest that the environment is clean and the nearshore waters is rich in biological resources.

METHODS

Various oceanographic investigations were undertaken in the nearshore close to the landfall point in February and March 1996 as indicated in Fig. 2. Wind information of the region has been compiled from the Bay of Bengal Pilot (Anonymous, 1978). The wave climate was extracted from the Wave Atlas published by NIO (Anonymous, 1990) based on the ship reported data. Current speed and direction were measured by deploying self recording Aanderaa current meters at four locations (Fig. 2). Tidal variation was measured for two days using a self recording Aanderaa water level recorder. Surface floats were released in the nearshore region of the study area and its Lagrangian path was tracked using a global positioning system, over a tidal cycle. Dye dispersion studies were carried out during a relatively calm period to estimate the dispersion characteristics of the nearshore waters. Seabed surface distribution sediments were collected using Van-veen grab for determining the sediment size. Beach level variation and bathymetry of the sea bed along a transect were taken using an echo sounder.

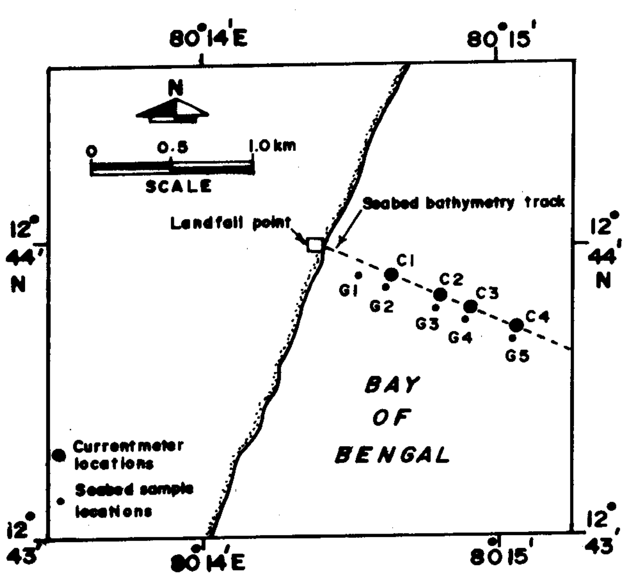

Fig.2 Measurement locations

RESULTS AND DISCUSSION

Wind

The wind climate off Chennai shows an average wind speed of 8 knots all-round the year. The wind direction varies depending on the season. During fair weather period (February to May) the morning wind direction is from south-southwest and the evening wind direction is from southeast. During southwest monsoon (June to September), the morning wind direction is from southwest-west and the evening wind is from southeast-south, whereas during northeast monsoon (October to January), the morning wind is from northwest and in the evening it is from north-southeast.

During the period 1891-1970, it is reported that 18 cyclones/depressions occurred in November, 5 each in May, September, October and December and one each in January, March, April and June. For the offshore conditions off Madras coast and a typical cyclonic wind speed of 80 km hr^{-1}, a storm surge of 2.1 m height is expected at this coast.

Waves

The deepwater wave characteristics are compiled based on ship reported wave data from 1968 to 1986 for the region 10° - 15° N latitude and 80° - 85° E longitude, covering Madras region. The deepwater wave characteristics off this region is presented in Table 1.

The deepwater significant wave height varies predominantly between 0.5 and 1 m during February to April, 1 and 2.5 m during May to September, and 1 and 2 m during October to January. The zero crossing wave period predominantly varies between 5 s and 6s over an year.

Table 1. Predominant significant wave height and zero crossing wave period off Chennai.

Month	Significant wave height (m)	Zero crossing wave period (s)
January	1.0-1.5	5-7
February	0.5-1.0	5-6
March	0.5-1.0	5-6
April	0.5-1.0	5-6
May	1.0-2.5	5-7
June	1.0-2.5	5-8
July	1.0-2.5	5-6
August	1.0-3.0	5-6
September	1.0-2.5	5-6
October	0.5-2.0	5-6
November	1.0-2.0	5-6
December	1.0-2.0	5-6

Tides

Tides in the region are characterized by a mixed type with predominantly semi-diurnal. The average spring tidal range is about 1 m and the average neap tidal range is about 0.41 m. The comparison of the measured tides at the site for two days with the predicted tides for Chennai Port shows no significant variation either in tidal amplitude or phase lag.

Currents

Currents measured at 500 m (Stn. C1) away from the coast showed an average bottom current around 0.25 m/s The progressive vector plot of the measured current shows that the current direction at bottom was almost parallel to the shore towards north.

The variation in current speed at 750 m (Stn. C2) away from the coast shows an average surface and bottom current around 0.16 m/s. The progressive vector plot indicates that the surface and bottom currents were consistently towards north.

At 1000 m (Stn. C3) away from the coast, the average surface current was observed to be around 0.18 m/s. The progressive current vector indicate that at the surface the currents has the tendency to move almost parallel to the shore towards north with an offshore component.

At 1250 m (Stn. C4) away from the coast, the average surface and bottom currents were observed to be around 0.20 m/s. The progressive vector shows the bottom current tends to be offshore in the northerly direction.

The variation of current speed and direction at 1000 m away from the coast is shown in Fig. 3. The progressive current vector plot for the currents measured at 1000 m distance away from the coast is shown in Fig. 4.

Float study conducted during the neap tide day of 27.2.96 showed that the surface flood tidal current is directed onshore and the ebb tidal currents offshore.

Dispersion Study

Based on the dispersion study using the fluorescent tracer, it is observed that the dispersion coefficients in longitudinal direction was 0.15 m^2/s, whereas in the lateral direction it was 0.015 m^2/s. These coefficients were observed to be of low order which is due to the calm conditions prevailing during the study period.

Seabed Soil Characteristics

Seabed sediments collected at five locations shows that the sediments primarily consists of sand with 60-70%, followed by silt about 30-40%. Sediments at location G4 has been seen as consisting of fine silt with about 20 % clay. At location G5 the sediment consisted of 98% sand.

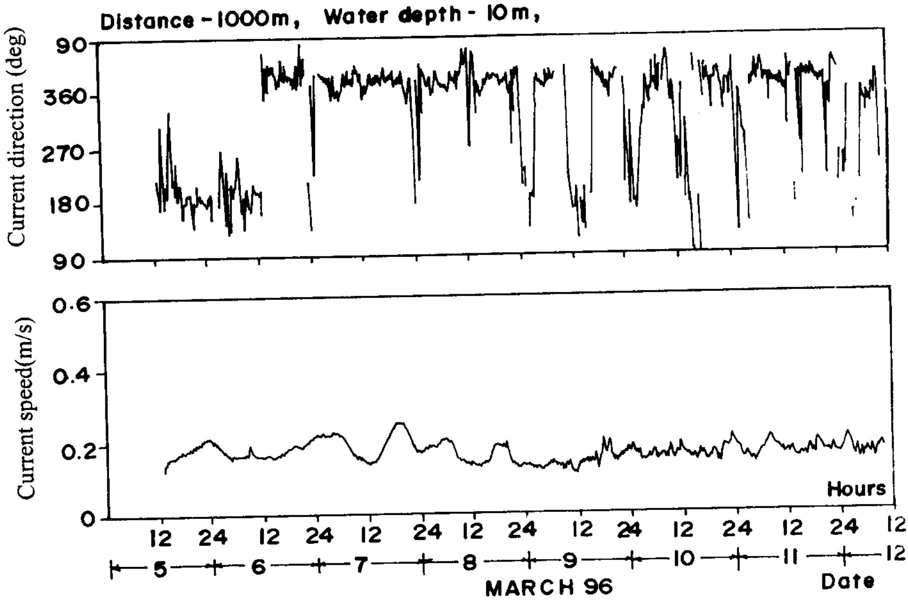

Fig.3 Variation of currents at station - C3

Beach and Nearshore Seabed Variation

Beach levels and cross-section of the nearshore were carried out along the proposed route of the effluent pipe line between the backshore and 1700 m distance into the sea. The variation with respect to lowest low tide level (LLTL) is shown in Fig. 5. The beach is about 110 m wide and the backshore is elevated about 3.8 m from the LLTL in February. The seabed falls steep to 8 m water depth within 450 m distance from the shore, and thereafter gently varies, with 13 m contour occurring at a distance of 1700 m from the shoreline.

LOCATION OF OUTFALL

The currents observed at various locations in the region indicates that at and beyond 1000 m distance away from the shore, considerable offshore component in the current direction is noticed. Further due to differential current between 500 m and 1000 m, good mixing of the effluent is expected if any effluent departs from 1000 m towards the shore. The deeper the depth at the effluent release point, the more the initial dilution of the effluent. The rising effluent jet plume from the outfall diffuser ports tend to travel more distance and thereby undergo mixing thoroughly. The nearshore bathymetry along the proposed pipeline route shows that from 8 m water depth till 13 m water depth the seabed is relatively flat.

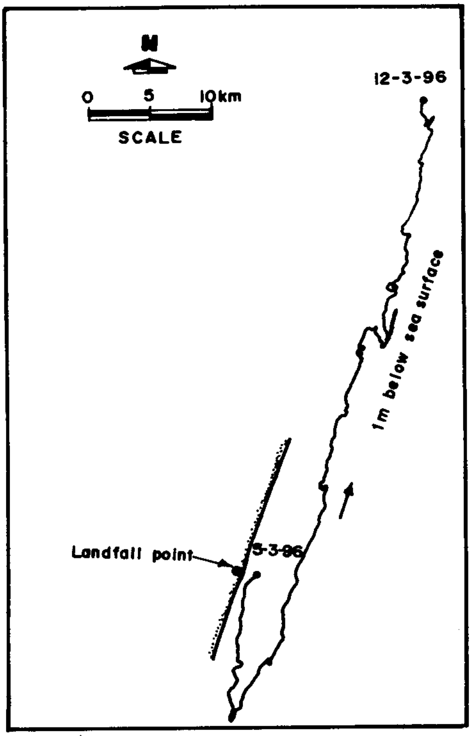

Fig.4 Progressive current vector at 1000m distance.

The seabed sediments along the proposed pipeline route are sandy in nature which is suitable for the laying and placement of diffuser. Considering the current pattern, dispersion observation, the required depth to obtain maximum initial dilution, and depth variation it indicates that the location at 1000 m distance from the coast, at 10 m water depth would be suitable for discharging the pretreated efluent of the order of 100 m^3/ day.

It is essential that the effluent should be suiably treated conforming to the standards laid down by State and Central Pollution Control Boards before discharging into the sea. Adequate measures should be taken to control marine fouling inside the pipeline in order to maintain the design velocity of the effluent. Post project monitoring has to be carried out periodically to verify the quality of the marine environment.

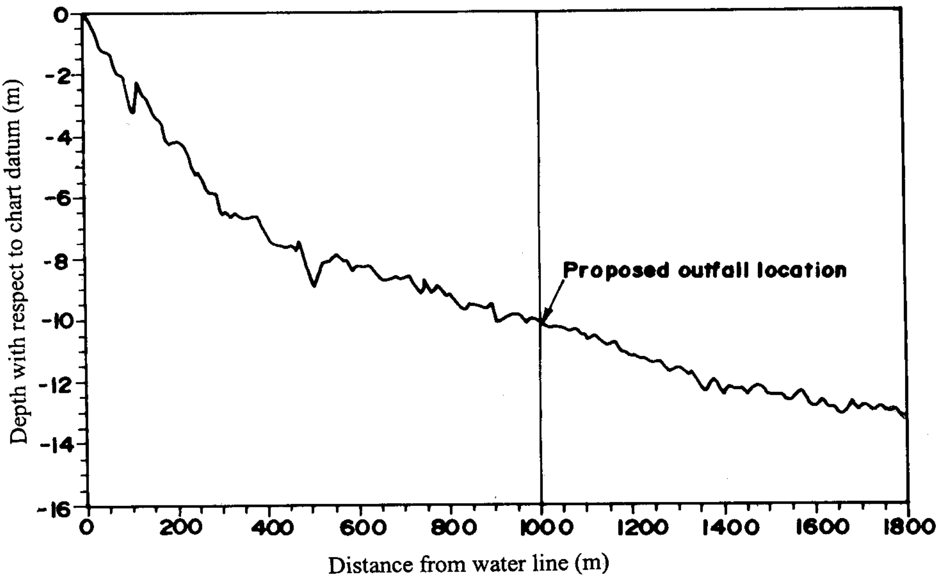

Fig.5 Variation of sea bed bathymetry

Acknowledgements

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References

Anonymous, 1978. Bay of Bengal Pilot, Hydrographer of the Indian Navy, Ministry of Defence, 187p

Anonymous, 1990. Wave Atlas for the Indian Coast, National Institute of Oceanography, Goa, 312. p.

Raja Ganesh Ram, S. and Subramanian, S.P.,1987. Morphodynamics and coastal processes for beaches of Madras, Second National Conference on Dock and Harbour Engineering, Indian Institute of Technology, Madras, pp. 299-308.