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OCEAN OUTFALL OFF MANGALORE, WEST COAST OF INDIA

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SYNOPSIS : Various industries like refineries, petrochemicals, thermal power, iron & steel, copper smelter, nylon & resins, etc. are coming up along the coastal belt of India. They generally intend to discharge the effluent, brine and warm water from the plant into the adjoining coastal waters. In order to minimize the impact of the discharge in the marine environment, it has to be treated confined to Indian Standard and disposed in the sea at a suitable location with proper diffuser design. Such procedure would help in achieving maximum dilution and to maintain negligible impact to the marine eco-system. This paper presents the study related to the disposal of industrial effluent in the sea near Mangalore.

INTRODUCTION

Owing to the recent liberalized policies by the Government of India, many national and multi-national companies have been attracted to make investments on large industries in our country. The major industries like refineries, petrochemicals, thermal power, copper smelter, nylon & resins, iron & steel etc., are coming up largely along the coastal areas particularly in Gulf of Kuchchh, Hazira, Dahej, Ratnagiri, Mangalore, Cochin, Tuticorin, Cuddalore, Madras, Visakhapatnam, Gopalpur and Paradip. These industries generally discharge the treated effluent including the brine and warm water in the adjoining coastal waters. The volume of discharge ranges from 100 m^3/day to 9,00,000 m^3/day depending upon the type and size of the plant. The method of disposal of such effluent in the sea should carefully be studied, so that it would have the minimum impact on the biological and chemical characteristics of the marine eco-system. Such projects should integrate the multi-disciplinary investigations on biological, chemical, physical and engineering aspects of the effluent and marine environment (Reed, 1975). Based on the detailed investigations, proper mitigation measures should be evolved. This paper presents the details of field investigations for the disposal of the effluent from a shore based industry near Mangalore.

DESCRIPTION OF OUTFALL AREA

The study region is situated north of Mangalore as indicated in Fig.1. The coastline in this region consists of long open beaches with ample coconut fringes and casurina plantations.

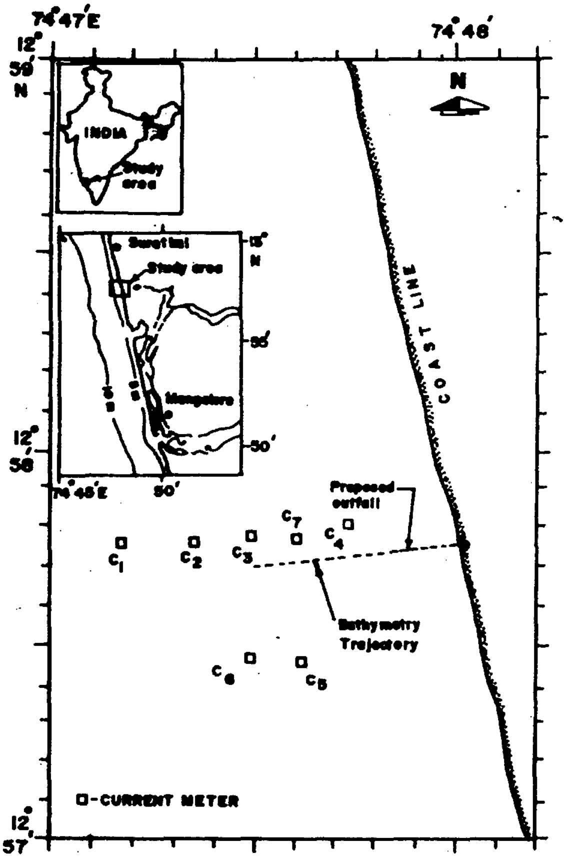

FIG. 1 MEASUREMENT LOCATIONS

New Mangalore Port is located close by at south. Mulki river joins the Arabian sea at north and Gurpur and Netravati rivers join at south near the study region. The beach predominantly consists of fine sand to medium sand. The continental shelf of this region extends upto 75 km from the coast. The seabed primarily consists of clayey silt till 50 m water depth and sand between 50 - 100 m water depth. The oceanographical 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).

OCEANOGRAPHIC INVESTIGATIONS

Oceanographic investigations were conducted in the coastal waters in two seasons, i.e., i) November 1994 (postmonsoon) and ii)April 1995 (premonsoon). Variation of current speed and direction was measured by deploying self recording current meters manufactured by Aanderaa Instruments, Norway at 7 locations as indicated in Fig. 1 during November 1994 and April 1995. Surface drogues were released in the nearshore region and the path was tracked during flood and ebb tidal phases over the spring and neap tidal days. Dispersion studies were carried out in December and April using Rhodamine-B to estimate the dispersion coefficients of the nearshore water. Variation in beach levels was measured with reference to a bench mark, at every 5 m interval along a transect from backshore to seaward till 1 m water depth in November, 1994 and April, 1995. Bathymetry was carried out along the same transect for a distance of 1400 m into the sea using the echosounder.

RESULTS

Wind: Monthly average wind speed over a period of 60 years showed the highest wind speed of 9.6 km/hr during May and the lowest of 6.8 km/hr during September. For about 335 days in a year, the wind speed was less than 20 km/hr. Winds were dominantly from east during the morning hours and northwest during the evening hours. During the monsoon months, the wind direction showed mostly west and northwest.

Waves: Southwest monsoon waves are high showing the highest maximum wave height of 5.4 m (Dattatri, 1973). The maximum wave height varied between 1.2 and 3.6 m during the southwest monsoon period and between 0.8 and 1.6 m during the rest of the year. The zero crossing wave period varied between 8 and 11 s during monsoon period and persisted around 11 s over the rest of the year. Waves approach mostly from the sector between WSW and WNW during June to September and between NW and N sector during the rest of the year.

Currents:

November 1994: The measured current speed and direction at 1000m distance are shown in Fig.2. At all measured locations the average current speed was around 0.2 m/s. At 1500 m away from the coast, the current direction, both at surface and bottom was observed towards 165°. At 500m distance the current direction at the surface was 180° and at bottom, it was mostly offshore towards 270°. It has been observed that in November, the surface currents departing at 500 m and 1000 m are predominantly shore parallel towards south, and the bottom currents at these locations are predominantly towards offshore. The currents departing at 750 m and 1500 m away from the shore are predominantly shore parallel with a tendency towards south. At 1250 m distance, the current was towards offshore.

April 1995: The average current speed at all measured locations was around 0.2-0.3 m/s. At 1500 m distance, the average current direction was around 360° both at surface and bottom. At 1250 m away from the coast, the current direction was predominantly around 180° with the surface current almost parallel to the coast and the bottom current with a slight offshore component. At 1000 m, the current direction was predominantly south with the surface current showing strong offshore component and the bottom current flowing parallel to the coast. At 500 m away from the coast, the current direction was almost constant around 180° both at surface and bottom. The current study in April infers that offshore component of currents sets beyond 750 m distance from shore. The currents at 1500 m distance were northerly showing opposite to the currents observed between the coast and 1250 m distance. This reversal of current direction may help to carry the effluent in the opposite direction to that of any neighbouring effluent which would be carried southerly and thereby reduce meeting each other.

Float Study: Float studies conducted during the neap tide and spring tide in November and April showed that the ebb tidal current is directed onshore and the flood tidal current is directed offshore but both drifting towards south. Fig.3 shows the trajectory of surface current during the spring tide.

Dilution and Dispersion: Based on the dilution of the dye patch, it is estimated that the dispersion coefficients in longitudinal direction (K_x) was 7 and 0.3 m^2/s in December and April respectively, where as in the lateral direction (K_y) it was 1 and 0.03 m^2/s respectively. The dilution, dispersion and diffuser design were worked out based on above details using the NIO computer model SEAMIX.

Seabed Bathymetry: The variation of seabed bathymetry with respect to lowest low tide level is shown in Fig.4. It shows that the beach is about 85 m wide in November with a steep foreshore. The backshore is elevated about 3.8 m above LLTL. The seabed falls steep to 6 m water depth within 275 m

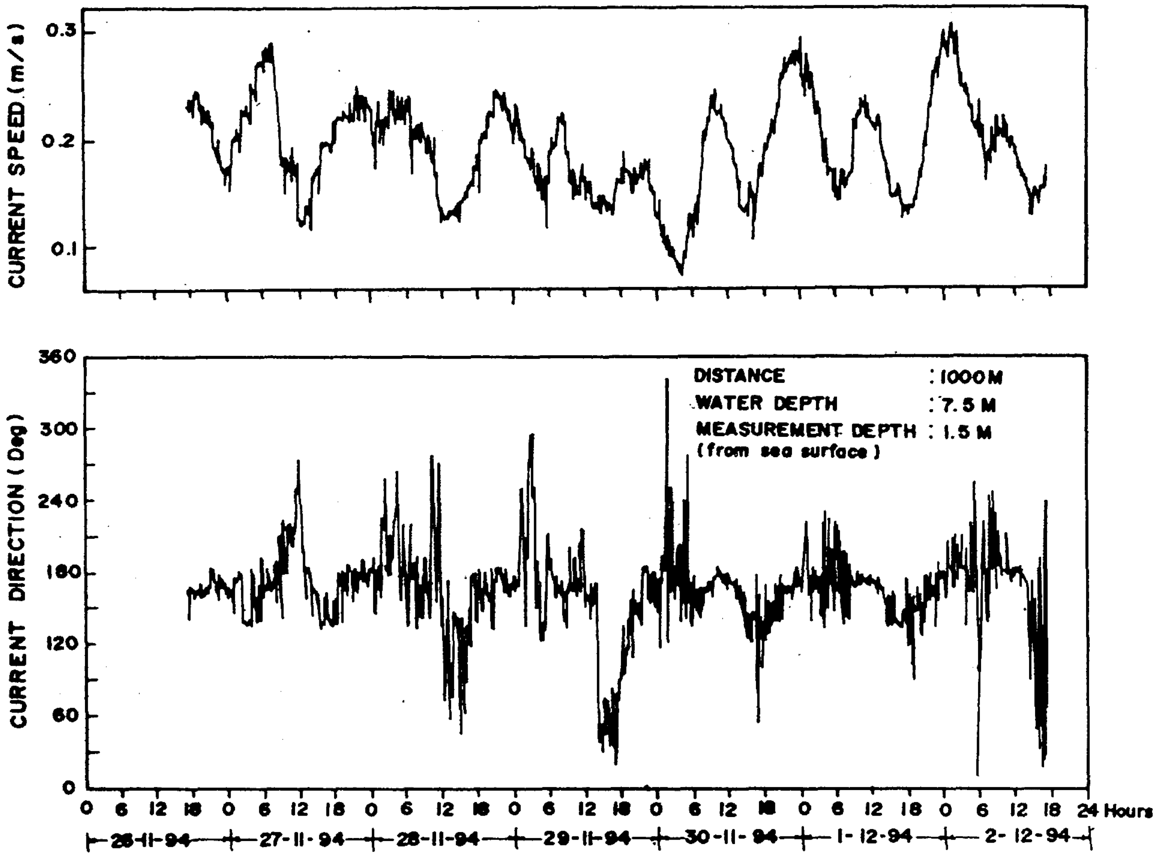

FIG. 2 VARIATION OF CURRENT SPEED AND DIRECTION AT 1000 M DISTANCE

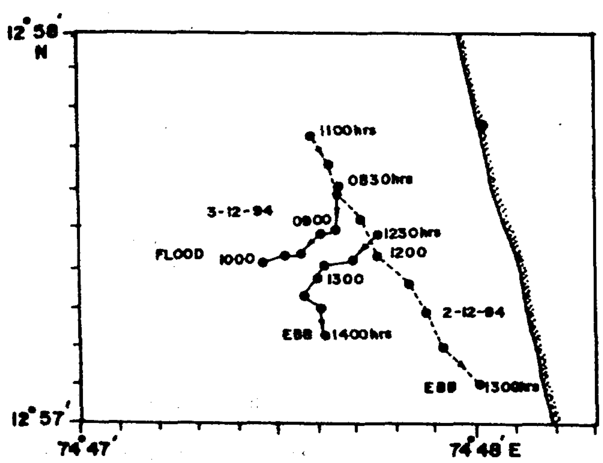

FIG. 3 TRAJECTORY OF SURFACE FLOATS

distance from the shore, and thereafter varies very gently, with 7.5 m water depth occurring at a distance of 1400 m from the shore.

LOCATION FOR EFFLUENT DISPOSAL

The design discharge of the effluent is 300 m^3/hour. The internal diameter of the effluent pipeline is proposed as 400 mm. More initial dilution is needed due to the presence of harbour breakwaters, neighbouring industry effluent disposal point and the large fishing grounds in this region.

The current measurements and float study suggest that the offshore component existing both at surface and bottom after 1250 m would be ideal for the effluent disposal. The rising effluent jet plume from the ports can travel more distance and can undergo more turbulent mixing. The nearshore is relatively

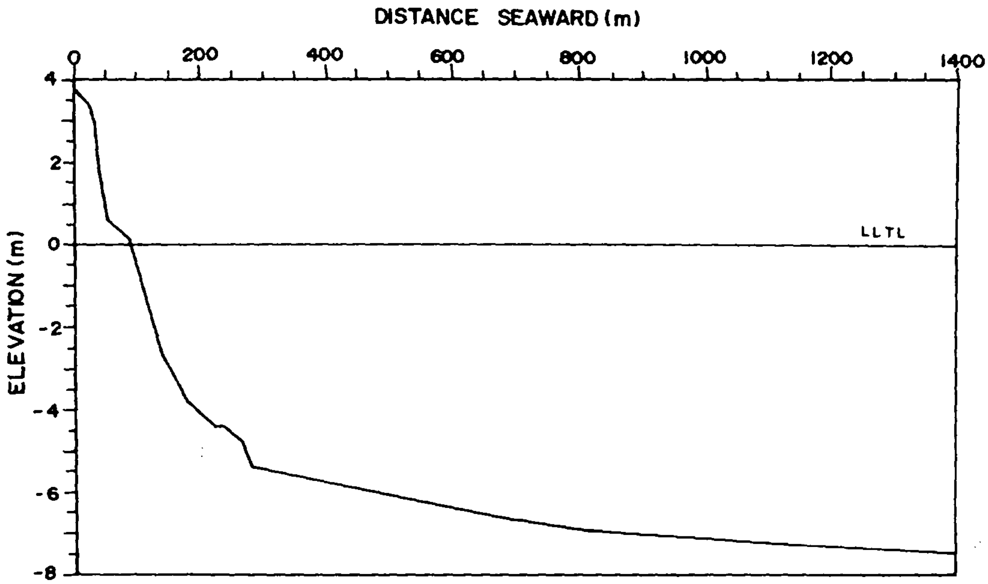

FIG. 4 VARIATION OF SEABED BATHYMETRY

flat changing from 6 m water depth at 275 m from shore to 7.5 m water depth at 1400 m from the shore. This shows the limitation of depth available by going far into the sea.

The NIO computer model shows that for the region under consideration, the effluent plume raised to the sea surface is stipulated to undergo further dilution to the order of 7.5 in 3 hours, before reaching the shore. Various measurements suggested that atleast a minimum distance of 1 km away from the coast is necessary to locate the disposal point to achieve the required dilution. The proposed location is indicated in Fig.1.

IMPACT

The input or removal of energy in any ecosystem induces changes in the energy levels, population dynamics, structure and diversity. Hence the ecosystem, community structure and species diversity form the important part of environmental impact assessment study. In order to understand any ecosystem, a detailed estimate of the organism in different tropic levels and the overall production potential of the area is very important. The predicted treated waste water from the industry contains mainly inorganic salts (0.5% NaCl), suspended solids (80 mg/l), BOD (30 mg/l) and some of the heavy metal ions like Copper, Zinc, Nickel and Chromium in traces. Living organisms can accumulate metals in their tissues to concentrations much greater than what is found in the water or sediments. Hence proper care should always be taken to keep all these metal fractions well under permissible limit in marine environment.

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