

MEASURES OF THE COASTAL ZONE AND MARINE ENVIRONMENT ALONG
THE WEST COAST OF INDIA

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INTRODUCTION

Along the west coast of India important measures are being taken by the Central and the State government organizations for the development of marine fisheries and other industries in the coastal areas. New industries are being started to manufacture chemicals, paper, caustic soda, fertilizers, coal products and deal with fish processing. The effluents and wastes from these factories are either discharged directly into the sea or into the backwaters and estuaries. In addition to the industrial effluent, the coastal cities and harbours also dispose sewage and other wastes. The atomic power industry is a recent development - the plants in coastal waters discharge low level radioactive wastes and water from cooling plants.

On the other hand, there is a great necessity to use the coastline for holiday and pleasure. With the increasing population the pressure has increased for use of beaches and coastal zone for recreation and development of tourism. (Fig. 1)

In the past, disposal of wastes have led to pollution of the marine environment. The examples are coastal waters

near Bombay city, backwaters of Kerala and beaches in many other states. The problem is aggravated during monsoon season, when the discharges from estuaries and the nearshore areas are washed ashore and present a serious threat for the coastal environment, particularly beaches. Thus, the multi-use of the coastal zone requires a scientifically well-planned effort, for better use of resources and preservation of the environment. In this communication the multiuse of coastal zone is being discussed with special reference to food resources and disposal of sewage, industrial and other wastes.

India needs marine food and industries, and the coastal zone should be judiciously used for both. Therefore, research is directed to evolve standards for the quantity and quality of effluents which can be discharged into the sea without any adverse effects on the marine environment. Along the Indian coast major hazards come from sewage, industrial waste, harbours, shipping and disposal of wastes and hot water from atomic power plants. Some of these aspects are discussed here:

1. Use of coastal zone for food
2. Sewage and industrial effluent of a metropolitan city - Bombay.
3. Problems of effluent disposal of a developing city - Bereds.
4. Problems posed by discharge of effluents from fertilizer factories.
 - (a) Zuari Agro-chemicals Limited, Sencels, Goa
 - (b) Mangalore Chemicals and Fertilizers, Limited, Mangalore
4. Effluents from a pesticide factory - Libe-Saigy, of India, Cozlim, Goa

6. Public health hazards from atomic power plants
7. Estuaries and beaches
 - (a) Oil pollution and tar balls
 - (b) Pollution due to human activities

USE OF COASTAL ZONE FOR FOOD

Along the Indian coast the nearshore area is extensively fished by indigenous non-mechanised boats following traditional fishing methods. There are about 1.06 million fishermen (Anon, 1973) who use indigenous fishing vessels and small nets and their area of fishing generally does not extend more than 8 to 10 km from the coast (Rao, 1968). Though, these are gradually being replaced by medium sized mechanised boats, the major part of their catches are still from nearshore areas. The major fisheries in the coastal areas are prawns and shrimps, the oil sardine and the mackerel. It is estimated that almost the entire catch of the oil sardine and about 90% of the mackerel catch are landed by shore-seines and other types of nets operating along the west coast. In future years, their catches are likely to increase (Dwivedi & Dubey, 1973). The coastal inshore regions offer immense scope for aquaculture (Alagiriwami & Qasim, 1974) particularly in regard to shell fish and seaweeds. Thus at present India's fishing industry being heavily dependant on coastal areas, any changes in the marine environment can seriously effect fish production. Recent investigations (Halder & Tejam, 1974) have shown that in some fishes, caught from polluted areas around Bombay harbour, the mercury content was above the permissible limit (Table 1) and that they were not suitable for human consumption. Therefore, preservation of food resources requires very careful management of the coastal zone.

Table - 1
MERCURY IN FISH*
 (Nanogram per gram fresh weight basis)

Source	Bhekkai (Labea sp.)		Khalisa (Squalus sp.)		Boi. Boiti (Mugil sp.)		Bhingri, Indira sard (Hansa sp.)		
	Muscle	Bone	Bone	Brain	Muscle	Bone	Muscle	Bone	Brain
Murdeshwar Lake	374	412	97	-	79	177	36	-	-
Sidheshwar Lake	462	610	101	-	376	570	105	-	-
Thana Market	279	382	-	-	57	143	-	493	-
Mumbro Creek	390	414	98	-	363	505	100	-	-
Besabey Market	-	-	-	-	-	-	-	-	-
Thana Creek	-	-	-	-	-	-	-	-	-
								510	78

*Reference: Halder and Tejen, 1974.

SEWAGE AND INDUSTRIAL EFFLUENT OF A METROPOLITAN CITY - BOMBAY

Bombay has a large number of industries and the population is around 7 millions. It is the biggest harbour on the west coast and there is a heavy traffic of crude and other oil products. All these factors have created a massive problem for the disposal of industrial effluents, sewage and oil wastes. As a result around Bombay city (Desai & Wagh, 1971), Mahim and Worli bays are polluted due to domestic sewage and Thana Creek due to the industrial waste (Fig. 2, Desai, 1971) and areas near Sesson Dock and Lions Gate due to oil. Various problems relating to the discharge of different kinds of waste and evolving a disposal system have been studied (Murthy, 1972; Sastri and D'Souza 1972).

The seriousness of the problems was recognised by Bombay Municipal Corporation and extensive studies have been conducted (Desai and Wagh, 1971). The biological oxygen demand in the area is very high and the availability of dissolved oxygen is very low (Fig. 3). The hydrographic studies in the area (Varadachari *et al.*, 1971), suggest that by discharging the sewage about 7 to 8 km away from the coast, where offshore component of the current is less intense, the sewage pollution can be reduced. This will ensure very large dilution and at no time during the year sewage and industrial effluents will be washed towards the coast. However, laying a pipeline along the sea floor and its maintenance requires large financial provision and engineering knowhow for submarine work. Alternative measures are also being examined to control the increasing pollution.

Around the harbour area, oil film is present almost throughout the year. With the approach of monsoon months the tar-balls which are derived from crude oil and other oil wastes, start depositing along the coast and affect the beaches around Bombay city (Dwivedi & Parulekar, 1974). Heavy deposition of the balls has been noted at Versova beach.

PROBLEMS OF EFFLUENT DISPOSAL OF A DEVELOPING CITY - BARODA

Many cities like Baroda, are situated away from the sea coast. Baroda, for example, is about 50 km away from the sea and is developing a large industrial complex. The problem of industrial effluent and sewage disposal is serious.

It was proposed to discharge the effluent into an estuary, through a 50 km long canal (Fig. 4). This canal will connect Kavi estuary from where the effluent will be carried to the sea. However, it must be ensured that even a part of the effluent is not carried towards the shore at any time during the year because this area has large number of salt pans. Even partial washing of effluent towards the coast can contaminate salt and endanger public health. The studies in Kavi estuary suggested that the proposed discharge system was not suitable. Introduction of container system was suggested in which entire effluent may be discharged within first two or three hours of the ebb tide. This system also presents technological problems. Therefore, methods for treatment of sewage, toxic components like organochemicals and heavy metals and removal of suspended matter are being considered.

PROBLEMS POSED BY DISCHARGE OF EFFLUENTS FROM FERTILIZER FACTORIES:

India has a large demand of fertilizers for agriculturists. New fertilizer factories are being set up along the coast. They discharge their effluents into the sea and two specific cases are discussed here.

(a) Zuari Agro-chemicals Limited, Sancoale, Goa:- In Goa, Zuari Agro-chemicals Limited, Sancoale, is producing urea and superphosphate (Plate 1). They discharge the treated effluent into the sea. The effluent contains arsenic and ammonia, has a higher temperature and pH varies considerably. Specifications have been evolved that the concentration of various components of the treated effluent should not exceed certain levels (Table 2).

Table - 2

Composition of untreated effluents from Zuari Agro-chemicals Limited, Goa, India.

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Total volume of liquid waste	10,201 tons/day
pH	5.5-9.0
Dissolved solids	800 ppm
Suspended solids	30 ppm
B.O.D.	2.6 ppm
C.O.D.	1.0 ppm
Sulphides	1.7 ppm
Hydrocarbons	Nil
Chlorinated hydrocarbons	1.0 ppm
Phenols	Nil
Heavy metals	1.0 ppm
Free NaOH(Na) or free NH ₃	1.2
Urea	76 ppm
Free H ₂ SO ₄	0.05
Arsenic	0.0075 ppm
Oil	1.7 ppm.

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The effluent creates certain problems like cumulative effect of arsenic on marine animals in the area and adverse effect of ammonia. The effluents containing urea at present are stored in Bisco reservoir. Seepage from the reservoir affects the rice fields and wells used for drinking water. The rest of the effluent is discharged through a pipeline at the depth of 5 m below the sea surface. There is also an adjoining creek which is estuarine in character. From this inland creek fish mortality was reported during 1973 and 1974. The ammonia content in the creek had increased. Semisolid or oil wastes discharged through the pipeline are also washed ashore. Changes in the environment including the intertidal area are also being monitored. Even the vegetation on the beach as well as creek was effected (Untawale & Nair - in press). Intertidal area developed rich algal growth. The vegetation in supratidal area which normally has Ipomea pes-caprae, Spartina acuminata, Cyperus arenarius, Lumnitzera racemosa, Eragrostis sp., was replaced by a single species Ipomea biloba (Plate 2) This study demonstrates clearly that effluent discharge from Zuari Agro Chemicals should be dealt with more carefully. It is also necessary to develop a new technology for the management of the coastal zone including land intertidal and subtidal areas. Corrective measures have been taken, these include addition of two settling tanks, temperature and pH control and discharge of arsenic into the sea has been stopped.

(b) Mangalore Chemicals and Fertilizers Limited, Mangalore:-
A new fertilizer factory is being started at Mangalore. The composition of untreated effluent is given in Table 3.

Table - 1

Composition of untreated effluents from Mangalore
Chemicals and Fertilizers Limited, Mangalore, INDIA

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Total liquid waste	100 cu.m/hr
pH	11
Temperature	60°C
Ammonia	300 mg/l
Urea	3000 mg/l
Average flow	23 cu.m/hr.

Amongst effluents, ammonia can be toxic and affect marine life. Therefore ammonia stripping should be adopted as a permanent measure. However, the supply of equipment for ammonia stripping has a time lag of more than one year, therefore, to meet the production deadline alternative adhoc measures are being recommended. In the same area, Mangalore harbour is being constructed. Studies are in progress to determine the effect of ammonia on the metal structure and other coastal installations. Detailed studies by fluorescent tracer have also been conducted for sediment movement in harbour area (Siddiqui and Shrivastava, 1970). Current pattern has also been studied. In this area, there are two alternatives. The effluent can be disposed either into the Gurupur estuary or directly into the sea. The estuary is important for prawn fisheries and therefore, the only alternative left is to discharge the effluent into the sea. The factory is going into production in early 1975 and as an adhoc measure it is being considered to discharge the effluent beyond the surf zone.

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This clearly illustrates that it is essential to start environmental studies well in advance of the commencement of any factory to enable to provide sufficient data for decision-making regarding disposal of effluent in the marine environment.

EFFLUENTS FROM A PESTICIDE FACTORY - CIBA-GEIGY OF INDIA, CORKIM, GOA.

CIBA-GEIGY of India Limited is located in Goa and manufactures pesticides. The products are (a) Phosphamidon - dimethyl-(2-chloro-2-diethyl-carbamoyl-1-methyl-vinyl)- phosphate, (b) D.D.V.P. - O, O-Dimethyl-2, 2-dichlorovinyl phosphate and (c) Cuman - Zinc-N-N-dimethyldithiocarbamate. The effluent from this factory is discharged in Cumbarjue canal which is a part of the Mandovi-Zuari estuarine complex of Goa. The composition of the untreated effluent is given in Table-4.

Table - 4

Composition of untreated effluents from
CIBA-GEIGY Pesticide, Corlim(Goa) INDIA

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Total volume of liquid waste	380m ³ /day
pH	wide variation
Dissolved solids	2220 ppm (approx.)
B.O.D.	-
C.O.D.	-
Sulphides	Negligible
Hydrocarbons	-
Chlorinated hydrocarbons	-
Phenols	Nil
Heavy metals	Nil

The effluent is treated in the factory (Fig. 3.5.7.) , and are equalised and then neutralised by hydrochloric acid or lime.

The biological oxygen demand is also regulated. To ensure thorough mechanical agitation aeration grid at the bottom and a recirculation pump is used, and during the process pH is monitored and adjusted to remain between 6 and 9 (Anon, 1973). The sludge and suspended solids are also separated. The neutralized effluent is pumped into clarifiers and allowed to settle for 12 to 24 hours. The sludge settled in the bottom is continuously scraped from the bottom before the effluent is discharged. In the final effluent, suspended solids do not exceed 10-16 ppm.

The effluent is discharged into the canal through a submarine diffuser. It is ensured that discharged effluents move laterally and then rise towards the surface to provide maximum dilution. Earlier studies (Das, et al, 1972) in the canal for water movement have been taken note of and these effluents are discharged with the rising tide which ensures that diluted effluents move towards the sea.

In addition as a precautional measure, an aquarium is maintained which is fed with running water of the canal. The fishes from Gumberjua canal are maintained in this aquarium to study toxic effects, if any. The measures adopted in this factory to treat effluent had been successful and so far no adverse effects have been seen.

Extensive environmental monitoring studies have also been undertaken (Parulsker and Dwivedi, 1973) and environmental parameters (Fig. 8), phytoplankton, zooplankton and benthic parameters have been studied. This data provides baseline information to monitor further changes, if any. A detailed study is being published separately.

PUBLIC HEALTH HAZARDS FROM ATOMIC POWER PLANTS

In India, atomic power plants are being started for production of energy. These plants usually discharge extremely mild radioactive wastes (Kamath and Ganguly, 1972) and water used for cooling. At Tarapore atomic power station approximately 650 million gallon of sea water is used per day for cooling purposes. The water is directly drawn from the sea and discharged again near the same point. The temperature difference between incoming and outgoing water is of the order of 2°C. Large quantity of water is being used in cooling plants to reduce temperature and avoid thermal pollution. In this area, studies have been conducted to monitor the marine life with special reference to zooplankton. The study for one full year has shown that by careful planning thermal pollution can be avoided. Typical zooplankton composition from the month of December is shown in Fig. 9 (Sarcoma Bose, personal communication).

The mild radioactive wastes are discharged very carefully and do not create any hazard. However, very high importance has been given to this problem. Extensive studies have been undertaken by Gastril and D'Souza (1971, 1972), Kamath and Ganguly (1972) and others, to study the various aspects of this problem.

Similar detailed environmental studies are being conducted in Goa by the National Institute of Oceanography where location of another atomic power plant is under consideration.

ESTUARIES AND BEACHES

Estuaries along the west coast of India have an area of 31 lac acres (Dwivedi, 1973) and some of them like Sharavati

(Plate). Galgibag, Mandovi and Zuari are very rich in mangrove (Untawale *et al.*, 1973). The productivity of these areas is high and large quantities of leaves and other foliage fall into the estuary. The leaves deposit at the bottom and change the benthic ecology. At Borim, in Zuari estuary bottom remains covered with dead leaves for a major portion of the year and polychaetes are the most dominant benthic group. The leaves and other foliage get degraded as organic detritus and are washed ashore (Dwivedi, *et al.*, 1972) and deposited near the mouth of the estuary then pollute the beaches. Similar phenomenon has been observed at Karwar and Ceranzalem from 1972 to 1974 (Dwivedi *et al.*, unpublished). The estuaries also receive domestic wastes, from the villages and cities situated along the banks. The inhabitants of the area use estuarine beaches as open air lavatories and the beaches become contaminated due to bacteria (Gore & Singhal, 1973).

Along Indian beaches, large complexes are also being developed for beach resorts and recreation. The example is Fort Aguada Beach Resort, Sinquerim, Goa which is being developed at a cost of Rs.20 million, approximately. The other beaches, in the same area are also being used for tourist activities. Therefore, the environmental monitoring (Dwivedi *et al.*, 1974) is being undertaken along some of these beaches (Fig. 10).

Along the beaches apart from washing ashore of debris as discussed earlier, the two other important pollutants are, (i) accumulation of tar balls due to oil pollution and (ii) human activities.

(a) Oil pollution and tar balls: Oil pollution studies conducted along the Indian coast (Nair et al, 1972; Dabbedi & Perulekar, 1974) indicated that the deposition of tar balls is an extensive phenomenon and occurs from Saurashtra to Kerala coast (plate 3). It starts every year in April, May, with the approach of monsoon and continues till September.

Oil pollution has also been found along the coastal islands. The Konkan group of islands have been extensively affected by oil pollution. Around Laccadive group of islands also deposition of tar balls was noticed from 1969 to 1972 (Siddiquie - personal communication).

The oil pollution is directly related to shipping activities and is likely to increase with the increase in coastal shipping and movement of crude oil along the coast. India's present shipping tonnage shared by foreign shipyards is 3.45 million GRT, which is likely to reach 8.6 million GRT by the end of the fifth five year plan. At present, India is acquiring 40 ships and action is under way to obtain more ships. Thus shipping activities are likely to be doubled in next few years and an intensive effort to control oil pollution due to the discharge of bilch is essential.

(b) Pollution due to human activities: Extensive study of the intertidal areas have been conducted along the west coast. The areas near outskirts of the cities are polluted (Gore & Singhal, 1973) and emit foul smell. The pollution deteriorates with the increasing population. The pollution due to human faecal matter was extreme at Kozhikode and Calicut in Kerala. Organic content in intertidal sand and total bacterial counts were higher. Further studies are in progress. However, the concerned government

has taken notice of the problem and corrective measures are being taken to improve this position. Similar studies were conducted along the east coast of India from Rameshwaram in Tamil Nadu to Ongole in Andhra Pradesh (Dwivedi et al, in press) which also indicate higher pollution along sheltered beaches in Palk bay and pollution due to faecal matter near bigger townships like Nagapattinam.

There are other problems also. The coir industry uses coconut shells in large quantities. These are kept immersed in backwaters for taking out fibres and emit hydrogen sulphide. Some other minor industries in the area also affect the environment. A caustic soda plant is being put up at Binga, known as Ballarpur Paper Mills. The treated effluent will be discharged through a small rivulet into the sea. These and a few other problems have not been discussed here but in these areas suitable precautions are being envisaged to protect the marine environment.

CONCLUSION

It is thus seen that for the last two decades the coastal zone of India is changing - the rate of change is going to be much faster in next decade. Therefore, extremely careful planning is necessary for the multiuse of the coastal zone and protection of the environment. India is extremely conscious of the problem and an Environmental Monitoring Programme (Fig. 11) along the Indian coast has been envisaged with the assistance of United Nations Environmental Programme and suitable antipollution legal measures are also being promulgated.

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