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Marine Pollution in the Coastal Waters of South India

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Some of the coastal and estuarine areas in South India are now under the direct threat from the increasing load of various types of pollution. Information on marine environmental damage from various sources of pollution and human interference becomes an obviously necessity to evaluate the present level of pollution as well as to understand the impact on living resources. In the Neendakara area near Quilon high oil content was observed due to the discharge of large quantities of oil and related waste into the coastal waters. Upto a depth of 20 meters, the Arabian sea waters contain 32.5 parts per billion of dissolved and dispersed petroleum residues derived from oilspills, refinery effluents and atmospheric fallout. For the Bay of Bengal, the average content was 24.1 ppb. Andhra coast is affected by high contents of heavy metals and other pollutants. Although diluted considerably by tidal mixing, concentrations of ammonia off Visakhapatnam due to sewage and industrial waste is likely to affect the coastal waters. Clams collected off Madras and Pondicherry coasts showed higher levels of DDT and reflected the current usage of DDT for vector control in urban localities. The level of HCH residues was slightly higher in clams collected off Portonovo, Pondicherry and Nagapatinam coast. The legal aspects of pollution control in the management of coastal waters need special mention. At the present context, the best environmental policy would be to prevent the creation of pollution problems at their source rather than trying to counter act their effects.

Introduction

Water quality is a vital aspect for the survival and well being of the living resources, especially in the coastal and estuarine areas. Some of these areas are now under the direct threat from the increasing load of various types of pollution. Any attempt to increase the productivity of the natural resources or by additional inputs like aquaculture is linked with the environmental problem. The environmental pressure due to pollution inputs and also due to human interference of the ecosystem are on the increase. Information on marine environmental damage from various sources of pollution and human interference becomes a obvious necessity to evaluate the present level of pollution as well as to understand the impact on living resources. Much of the current concern over pollution problems centers on the possible toxic effects of chemical pollutants on the human health and on organisms important to the stability and life supporting capacity of the biosphere.

Pollution of the aquatic environment and its effects on the living resources, especially the fishery resources, has assumed considerable interest as well as importance in the recent times. Most of the rivers which discharge large quantities of water into the coastal marine environment are polluted and these pollutants obviously end up in the inshore coastal waters. The vast marine environment has long been used as a site for the disposal of wastes. In some cases the polluted material is discharged directly into the sea and in other cases the pollutant reaches the rivers and estuaries and finally ends up in the sea.

When chemical pollutants are discharged into the sea they are not only diluted and dispersed by winds, tides, currents etc., but becomes intimately involved in the complexities of the biological food web of the sea. These toxic pollutants are not merely diluted, but may be re-concentrated by the marine biomass. When persistent toxic and carcinogenic pollutants enter the food web the pollution problem may become serious and lethal to plants, animals and man. Most of these toxic agents affect all living things and nutritional, communicative, reproductive, respiratory, genetic and a variety of metabolic activities of the organisms may be seriously altered or destroyed. This may result in the annihilation of some population of organisms and increase in noxious groups. This results in animal ace of the normal population pattern which can lead to serious problems in the ecosystems.

Present status of pollution in South Indian coastal waters

In the Neendakara area near Quilon high oil content was observed due to the discharge of large quantities of oil and related waste into the coastal waters. Upto a depth of 20 meters, the Arabian sea waters contain 32.5 parts per billion of dissolved and dispersed petroleum residues derived from oilspills, refinery effluents and atmospheric fallout. For the Bay of Bengal, the average content was 24.1 ppb. Andhra coast is affected by high contents of heavy metals and other pollutants. Although diluted considerably by tidal mixing, concentrations of ammonia off Visakhapatnam due to sewage and industrial waste is likely to affect the coastal waters. Clams collected off Madras and Pondicherry coasts showed higher levels of DDT and reflected the current usage of DDT for vector control in urban localities. The level of HCH residues was slightly higher in clams collected off Portonovo, Pondicherry and Nagapatinam coast-(Pillai,1996).

Physico chemical parameters

The impact of sewage pollution from the drains of surrounding area on the hydrological status of two ecologically different waterbodies at Dumka (South Bihar) from January to December 1996 (Kumar, 1997). The range of variation for some of the physico chemical parameters like dissolved oxygen, free CO_2, carbonate, bicarbonate alkalinity, calcium, phosphate, nitrate and BOD was 3.75 8.50 mg/l, 3.15 5.85 mg/l, 6.5 113. mg/l, 105 150 mg/l, 21.50 39.0 mg/l, 17.37 24.50 mg/l, 0.010 0.135 mg/l, 0.225 1.086 mg/l and 1.75 3.6 mg/l in pond I and 3.10 7.25 mg/l, 3.10 48.25 mg/l, 12.40 21.5 mg/l, 314 460 mg/l, 63.25 99.12 mg/l, 7050 110.25 mg/l, 0.195 0.845 mg/l, 0.225 1.660 mg/l and 5.20 9.45 mg/l in pond II respectively. These parameters exhibited a marked difference between two water bodies depending upon the quantity, quality and nature of sewage pollution.

Primary production

Spatial and temporal variations and the factors influencing primary production have been studied by Purvaja and Ramesh (2000) in three different mangrove waters (Pichavaram, Ennore Creek and Adyar Estuary) of South India characterised by different anthropogenic impacts (Ref). The gross primary productivity in the unpolluted Pichavaram mangrove was 113 g C m^2 yr exhibiting natural variability with the environmental forcing factors. Human activities have elevated primary productivity in the Ennore Creek mangrove (157 g C m^2 yr primarily through the direct discharge of fertilizer effluents. By contrast, a combination of domestic and industrial effluent discharges into the Adyar estuary mangrove has considerably reduced phytoplankton primary productivity (83 g C m^2 yr). The Redfield N:P ratio varies from 0.96 N:1P at Ennore Creek, 1.75N:1P at Adyar estuary to 15.2N:1P at Pichavaram mangroves. This suggests that the Pichavaram mangroves represent a well equilibrated ecosystem with N:P ratio close to steady state values in contrast to the anthropogenically altered mangrove ecosystems studied elsewhere. Results show a significant temporal variability in nutrient concentration in the three mangrove areas. Distinct differences in nutrient concentrations between the dry and the wet seasons have been observed.

Phytoplankton

An annual survey of phytoplankton indicator species was carried out by Vareethiah and Haniffa (1998) in Anadan Victoria Martandavarman Canal (A.V.M. Canal) (8°15' and 8°18' N: 77°3' and 77°8' E) south west coast of India, where pollution due to coir retting was prevalent. Hydrogen sulphide concentration varied between 0.91 and 51.2 mg/l at the surface water and BOD_5 between 4.43 and 23.4 mg/l. Hypoxic/anoxic conditions prevailed during most part of the year. Fortnightly collections of phytoplankton revealed that the year round dominance of three freshwater phytoplankton *viz. Anabaena* sp. *Oscillatoria* sp. and *Spirogyra* sp. and an estuarine species, *Skeletonema costatum*.

Dipteran bioindicator

Biomass of a dipteran bioindicator, *Chironomus* larvae was studied by Krishnan *et al.* (1997) in Vaigai river, Madurai in relation to urban pollution. Three stations viz., Sholavanthan (unpolluted), Kailasapuram and Kurivikkaran salai (both highly polluted) were selected for sampling the population of *Chironomus* larvae. Wet weights of midges per sample were ranged from 258 mg at unpolluted station (Sholavanthan) to 522 mg at polluted stations (Kailasapuram and Kuruvikkaran salai). Values of dry weights ranged from 45 mg to 72 mg at unpolluted and polluted stations respectively. Maximum relative dry weight (17.679) was estimated at unpolluted station and the minimum ranged from 12.819 to 13.861 at polluted stations. Statistical comparisons yielded significant differences for estimates between selected stations. The concept of using *Chironomus* larvae as bioindicator of aquatic pollution is favoured.

Plankton, weed, snail, bivalve, prawn and fish

Data on the concentrations of ^{210}Pb in water, sediment and biota (plankton, weed, snail, bivalve, prawn and fish) of the Kaveri River ecosystem at Tiruchirappalli in South India are presented. The highest level of ^{210}Pb activity was observed in the sediment (15.5 Bq/kg dry) and the lowest activity in water (2.7 mBq/l). The root of the aquatic weed, *Eichhornia crassipes* showed a higher activity (1.17 Bq/kg wet) than its shoot (0.22 Bq/ kg wet). Among the biotic components, the shells and bones of animals accumulated higher ^{210}Pb than their tissues and muscle. Among animals, the freshwater mussel, *Lamellidens marginalis* was identified to accumulate more ^{210}Pb in its soft tissues (0.79 Bq/kg wet) and shell (6.55 Bq/kg wet) than prawns (muscle: 0.65 Bq/kg wet; exoskeleton: 1.06 Bq/kg wet) and fish (muscle: 0.24 Bq/kg wet; bone: 1.37 Bq/kg wet). The concentration factors (CFs) of ^{210}Pb in biotic components ranged from similar to 10 to similar to 10^3 with higher CFs observed for shells and bones. It is shown that ^{210}Pb undergoes a seasonal variation in surface deposition with minimum values in summer and maximum values in winter.

Macro invertebrates and fish

Martin *et al.* (2000) studied occurrence of macro invertebrates and fish at 11 stations along the course of Tamiraparani River, South India. Monthly variations in macro invertebrate density were studied during 1991. Among macro invertebrates, hemipterans were the dominant group at all sites, except site 2 (Fig. 1). Using an ordination technique, density and occurrence of macro invertebrates were correlated with dissolved oxygen, biological oxygen demand (BOD) and chemical oxygen demand (COD). A total of 36 species of fish was recorded and their diversity in undisturbed and disturbed regions of the river was compared on a spatial scale. Different diversity indices were calculated to assess response of fishes to pollution and to determine species richness and composition.

Balasubramanian *et al.*(1999) have reported the pollution of Cauvery River in South India from industrial effluent, agricultural run off and urban wastes. The use of agrochemicals in the field has the potential to change the aquatic medium, affecting the tolerance limit of aquatic fauna and flora, as well as endangering the ecosystem. These agrochemicals adversely affect the non target organisms, especially plankton and fish. Proteins, carbohydrates and lipids in gill, muscle, liver, intestine and kidneys of *Oreochromis mossambicus* decreased with increased cadmium (Cd) intake. *Oreochromis mossambicus* exposed to sub lethal concentrations of the organochlorine insecticide endosulfan, showed decreased levels of protein, carbohydrate and lipid in their liver. Urea is highly soluble in water, penetrates into the tissues of fishes and induced alterations in the skin and gastric lining of the fish *Channa punctatus*. An attempt has been made in Balasubramanian *et al.*(1999) study to determine the urea induced alterations in certain tissues of the fresh water fish *Oreochromis mossambicus* (Peters).

Pesticides

Rajendran and Suramaniam (1997) reported that the residue levels of persistent chlorinated pesticides such as HCH (hexachlorocyclohexane) isomers and DDT (dichlorodiphenyl trichloroethane) compounds were quantified in water samples collected from the River Kaveri and its distributor River Coleroon in Tamil Nadu, South India. HCH showed higher levels in River Kaveri during premonsoon (July to September) and monsoon (October to December) months, reflecting the HCH usage during that season for paddy crops. But in the case of DDT no clear trend in residue level was observed. The alpha HCH was detected as the dominant isomer in all the three sampling sites. Among DDT compounds, p,p' DDT and p,p' DDE showed higher percentage of the total. International comparison of residue levels revealed that the values are comparable to the waters from Asian and South East Asian nations, but lower than some samples from other parts of India. The value of DDT is well below the EEC's maximum acceptable concentration for surface waters and lower than the recommended limit of 2000 ng/l in USA water for protection of aquatic life.

Methane

The methane emissions from diverse coastal wetlands of South India have been measured by Purvaja and Ramesh (2001) for the first time. Annual emission rates varied widely, ranging from 3.10 $mg/m^2/hr$ (Bay of Bengal) to 21.56 $mg/m^2/hr$ (Adyar River), based on nature of the perturbance to each of the ecosystems studied. Distinct seasonality in methane emission was noticed in an unpolluted ecosystem (mangrove: 7.38 $mg/m^2/hr$) and over a twofold increase was evident in the ecosystem that was disturbed by anthropogenic activities (21.56 $mg/m^2/hr$). The wide ranges in estimate suggest that methanogenesis occurs by both natural and anthropogenic activities in these coastal wetlands. Several physical and chemical factors such as salinity, sulfate, oxygen, and organic matter content influenced methanogenesis to a large extnet in each of these ecosystems in addition to individual responses by the human induced stresses. For eg., there was a clear negative correlation between oxygen availability (0.99), sulfate (0.98), and salinity (0.98) with CH_4 emission in the Adyar River ecosystem. Although similar results were obtained for the other wetland ecosystems, CH_4, emission was largely influenced by tidal fluctuations, resulting in a concomitant increase in methanogenesis with high sulfate concentrations. This study demonstrates that coastal wetlands are potentially significant sources of atmospheric methane and could be a greater source if anthropogenic perturbations continue at the current rate.

Trace metals in South Indian coastal waters

Coastal Region	Location	Conc.(μg/l)
Kerala	Canannore	Zn-40
	Calicut	Hg-0.4
	Cochin	Cu-10
		Pb-8
		Cd-0.8
	Veli	Hg-0.5
Tamil Nadu	Cuddalore	Cu-15

(C. S. P. Iyer, 1994)

Comparative account of mercury levels in the south Indian coastal and estuarine waters (Hg/µg/l)

Area	Level of Mercury	Source
Inge bay, Karwar	0.146-26.68	Kureishy *et al.*,1986
	0.91-2.62	Krishnakumar and Pillai, 1990
Cochin backwaters	1.2-50.0	Balchand and Nambisan,1986
Cochin inshore waters	1.02	Alavandi *et al.*,1988

Conclusion

The legal aspects of pollution control in the management of coastal waters need special mention. At the present context, the best environmental policy would be to prevent the creation of pollution problems at their source rather than trying to counter act their effects. Government should use the best practical means available to minimize the release to the environment of toxic or dangerous substances, especially if they are persistent substances such as heavy metals and organo-chlorine compounds, utility has been demonstrated that their release will not give rise to unacceptable risks or unless their use in essential to human health or food production, in which case appropriate control measures should be applied. It is necessary to identify certain critical areas ad critical parameters ad monitor a series of small changes as a guide to surveillance for developing criteria ad standards and fashioning of appropriate controls and monitoring mechanisms.

Sediment quality of South Indian coastal waters with respect to Heavy metals (µg/g)

Trace metal	Tamil Nadu	Kerala	Andhra
Cu	28.3-158		
Zn	8.7-150		
Cd	0.5-49	1-6.7	1.0-3
Pb	4.7-57.4	0-90.9	18-40
Hg	0.1-2.9	0.04-0.52	

(C.S.P.Iyer, 1994)

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