

## POLLUTION CHARACTERISTICS AND WATER QUALITY IN THE VISAKHAPATNAM HARBOUR

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### ABSTRACT

The impact of organic pollution on the quality of waters in the Visakhapatnam harbour has been studied over a year at 8 stations. The enrichment of nutrients in these waters enhances the eutrophication. The construction of outer harbour retards the tidal flushing resulting in a greater stagnation of these waters. The distribution pattern of phosphate and ammonia indicates the flow of pollutant rich waters at surface towards the sea during low tide.

*Key words:* Vishakhapatnam, hydrography, anoxic, eutrophication, pollution.

### INTRODUCTION

The combined domestic and industrial effluents discharged into Visakhapatnam harbour deteriorates the quality of water. Pollution studies in the Visakhapatnam harbour waters have been initiated recently. The topography of the harbour and the nature of the discharge of the effluents into these waters were earlier reported (Ganapathi and Raman, 1973). Large scale fish mortalities were reported in north western arm of harbour which receives the industrial effluents (Ganapathi and Raman, 1976). Impact of organic pollution on periodic outbursts of phytoplankton blooms was reported in these waters (Ganapathi and Raman, 1979; Premila and Umamahe-swara Rao, 1977). The abundance of oligochaeta worms as indicators of organic pollution was observed in south lighter channel (Subba Rao and Venkateswara Rao, 1980). However, it appears that no systematic survey has been carried out to assess the extent of pollution and quality of water in the harbour waters. The present study mainly deals with the impact of organic pollution on the hydrography of the harbour and nearshore waters based on the chemical data available from January 1980 to December 1980.

### MATERIAL AND METHODS

Monthly samples are collected at low tide from the stations indicated in Fig. 1. Surface samples are collected with a clean plastic bucket and subsurface samples with Nansen reversing bottles. Standard analytical methods are used for the determination of salinity, dissolved oxygen, nitrite, nitrate, ammonia, phosphate and silicon as described in Manual of Methods in Aquatic Environments Research, FAO, 1975. For the determination of nutrients the samples are diluted with deionised water. Dissolved oxygen is determined by the Winkler's modified method using sodium azide to eliminate the interference due to the presence of high concentrations of oxidising substances. BOD is deter-

mined by the direct method at all stations except for station 1 (South lighter channel) where it is determined by unseeded dilution method (Martin, 1970). pH is measured using an Elico pH meter with glass and calomel electrodes.

#### RESULTS AND DISCUSSION

Variations in different parameters during the study period at different stations, shown in Figs. 2 and 3, are discussed below :

##### Salinity

Annual variations in salinity in the harbour channels ranges from 15-34‰. The salinity values remained high from January to June with a maximum difference ( $<2\text{‰}$ ) from surface to bottom values. Low salinity values are persistent during the period of July to October with a maximum difference (2-10‰) from surface to bottom values which may be attributed to the influx of fresh water by monsoonal rains. The low salinities observed during September to October may be due to the combined effect of land drainage from the prevailing monsoonal rains and the southerly flowing northern diluted waters which is having its influence not only on the offshore waters but also in the coastal waters as reported earlier by La Fond (1957) and Varadarajulu and Tippu Abdul Khadar (1976).

##### pH

pH values are within the range of 7.5-8.2 at stns. 1 to 6 while at stns. 7 and 8 the values are in between 8.0-8.2. Occasionally low pH (6-7) values are noticed at stns. 1, 3 and 4, probably due to the increase of waste load.

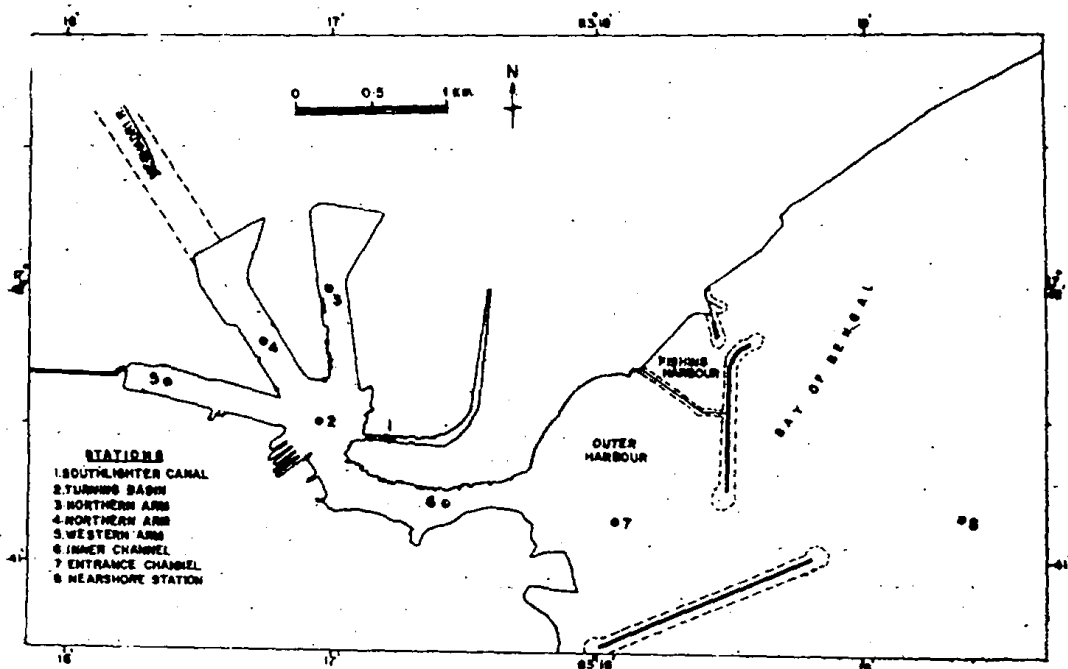


Fig. 1. Map showing the eight stations sampled.

*Dissolved Oxygen*

The variation in dissolved oxygen content at stns. 2 to 6 is more or less similar and the surface waters are supersaturated with dissolved oxygen because of several planktonic blooms as already reported in the area of study (Ganapathi and Raman, 1979). The concentration of dissolved oxygen in the premonsoon season lies between 6-8 ml/l. The existing meteorological conditions are favourable for the growth of plankton during this period and summer heating reduces the plankton growth and hence oxygen is being utilised by the organic matter in the period May-June. The concentration of dissolved oxygen in the monsoon

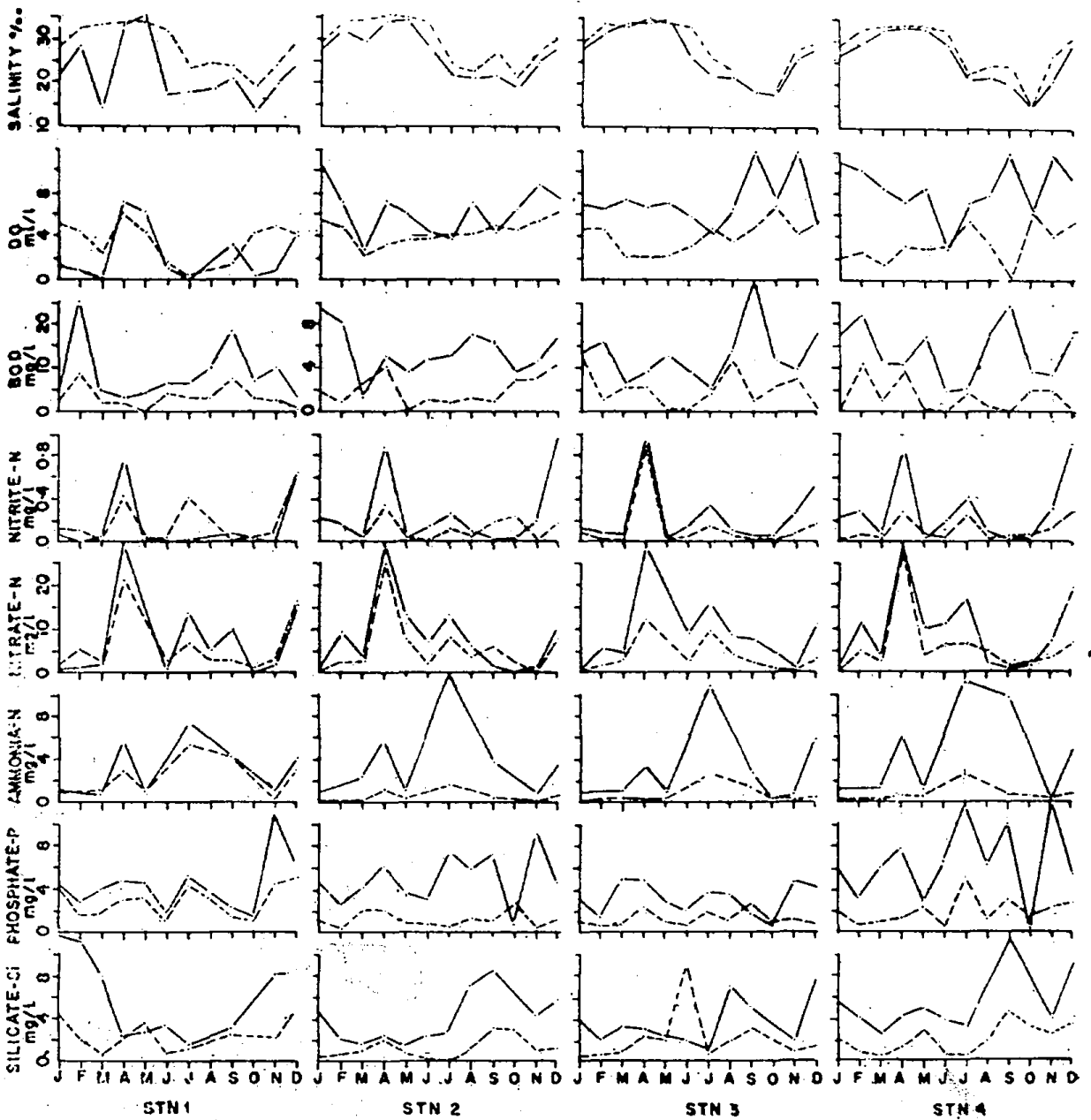


Fig. 2. Seasonal variations in different parameters at stations 1-4 (— Surface, .... bottom).

season lies only between 3-6 ml/l which may be due to the adverse conditions for the bloom formation and the monsoonal runoff which carries the organic wastes into the harbour waters. During the study, totally anoxic conditions are also observed in the bottom waters at stns. 1 and 4 (South lighter channel and northwestern arm) which are attributed to the biochemical oxidation of organic wastes emerging from the city into these channels through monsoonal runoff. The oxygen supersaturated surface waters (6-12 ml/l) in the post-monsoon season indicate the prominence of plankton production peak during September to December (Premila and Umamaheswara Rao, 1977) over the first peak in January to April.

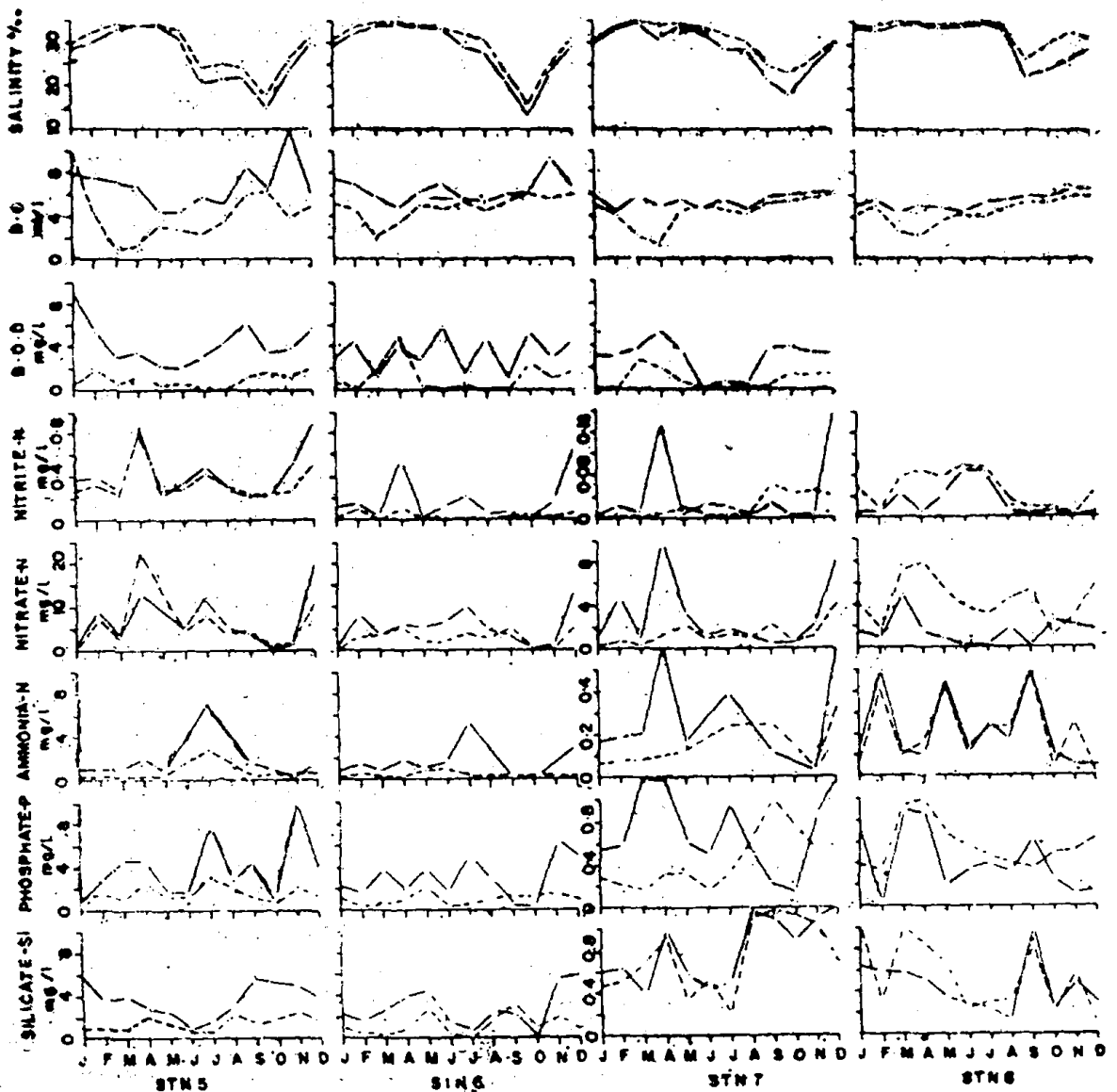


Fig. 3. Seasonal variations in different parameters at stations 5-8 (— Surface, ...bottom).

Although the general trend of oxygen decreasing with depth is observed at all stations, the stn. 1 showed bottom waters rich in oxygen (4-5 ml/l) when the surface waters were anoxic during February - March and October-November. This observation along with high BOD at surface indicates the accumulation of less dense organic wastes flowing at the surface. At stn. 8 a rise in the levels of nutrients in bottom waters concurrent with low dissolved oxygen concentration in the premonsoon season is attributed to the mixing of low temperature upwelled water along this coast. However the low dissolved oxygen concentration observed during this season at the other stations may be probably due to the degradation of organic matter.

#### *Biochemical Oxygen Demand*

The seasonal variation in BOD at stns. 2 to 5 shows its direct relationship with dissolved oxygen whereas inverse relationship is encountered at stn. 1 which is highly polluted with domestic wastes. High values of BOD and dissolved oxygen at stns. 2 to 5 indicate the eutrophication wherein high concentration of industrial and domestic wastes are associated with high plankton growth. Two major peaks for BOD in the harbour channels are observed during January-February and August-September. No definite pattern in the variation of BOD at stn. 6 was noticed but stn. 7 too indicated two peaks, major during February-April and minor during October-December which can be correlated with maximum production at these stations.

#### *Nitrogen compounds*

Abnormally high concentrations of nitrite, nitrate, ammonia are found in the harbour channels. The maximum concentration of these nutrients at stns. 1 and 4 are of the order of 1, 30 and 12 mg/l respectively. Nutrient enrichment through pollution were reported from other marine areas (Verlencar and D'silva, 1977, Unnithan, Vijayan, Radha Krishnan and Ramani, 1977). The enrichment of nutrients enhances the eutrophication and stimulates the algal growth. The seasonal variation in all the nitrogen constituents show similar trend at all the stations. High concentration of nitrogen compounds in surface water during April and November-December may be the reason for the plankton peaks as reported earlier. Although the peak in the monsoon season is lesser than the other two, it shows the drainage and land runoff which brings nutrient rich wastes to the harbour. The values reported here for nitrate concentrations are 10-20 times higher than the nitrite values. This observation which prevails in the oxygen supersaturated environment deviates from the earlier observations reported by Ganapathi and Raman (1979). The high concentrations of nitrate in the sewage effluents was found to be responsible for the prolific growth of marine algae (Wilkinson, 1963; Subba Ramaiah and Parekh, 1966). The variations observed in the growth and survival of *Ulva fasciata* in the polluted waters of Visakhapatnam harbour indicates a change in water quality in different channels (Sreeramulu, Umamaheswara Rao and Premila, 1977).

Ammonia is found to be at an intolerable levels at stns. 1, 2, 3 and 4. Eventhough the concentration of ammonia is minimum at stns. 7 and 8 at stns.

1 to 6 the concentrations exceeded the limits as reported elsewhere by others (Zingde, Singbal and Reddy, 1979). The major peaks in the months of July to August in the distribution pattern clearly indicates that the industrial effluents are discharged into the harbour waters only through monsoonal runoff.

A salient feature of the present study is that the concentration of these constituents at the surface waters are much more compared to the bottom waters. The distribution pattern of ammonia (Fig. 4) during peak season shows that there is a layer of water which is rich in nutrients flowing to the sea during the low tide period. The flow of pollutant rich waters from the harbour is extended upto stn. 7. The severe mixing at stn. 7 increases the concentration of constituents in the inflowing water and this may be the reason for the relatively high concentrations in bottom waters when compared to the nearshore waters. The isolines in Fig. 4 indicate the existence of high concentration of ammonia and phosphate at the surface and the sudden

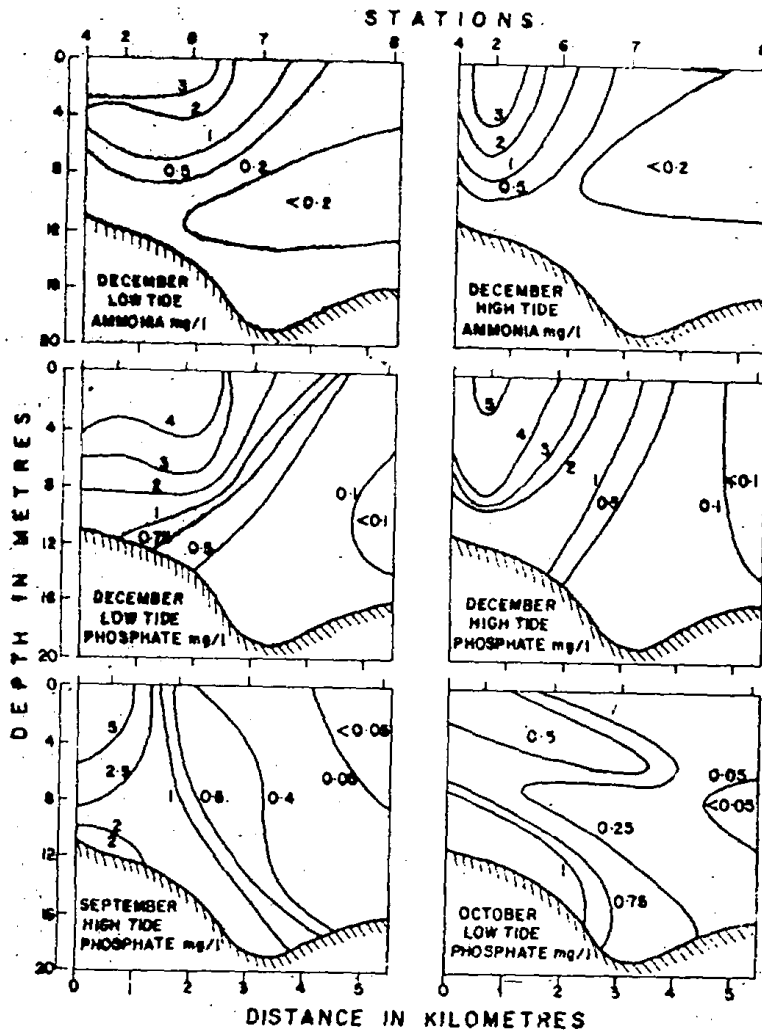


Fig. 4. Microdistribution of ammonia and phosphate during low and high tides.

lowering in the levels of these constituents at stn. 8 is noticed which is because of the retardation of tidal flushing by the outer harbour.

#### *Phosphorus compounds*

The distribution pattern of phosphate also shows similar major peaks in April, November and December and a minor peak during July and August which can be attributed to the above mentioned reasons. The high phosphate concentration at stn. 1 is due to the municipal wastes.

The distribution pattern of phosphate during low and high tide clearly indicates that the pollutant rich surface waters of the harbour are flowing at the surface. No appreciable variation in the concentration of phosphate is observed in the surface layer (<6 m) whereas in the subsurface waters (6 m to bottom) the presence of high saline water with low concentrations of nutrients is noticed. The low surface concentrations observed during October is due to the maximum rain fall recorded (235 mm). Even the detailed distribution pattern of phosphate in September-October (Fig. 4) indicates the pollutant rich water flowing in the surface layer (2-6 m) with less concentrations of phosphate in subsurface waters (6 m to bottom), and the near bottom waters (< 2 m from bottom) shows slightly high concentration of phosphate.

#### *Silicon*

The distribution of silicon at all stations shows a similar pattern as those of other nutrients. The presence of high concentrations of silicon along with the other nutrients in these harbour waters are responsible for the growth of diatoms like *Skeletonema* and *Oscillatoria*. Major peak of the diatom production during October-December can be correlated with the maximum concentrations of silicon observed during this season.

The eutrophication in harbour waters is due to contamination with organic wastes with the result that quite large concentrations of nutrients may remain unused. Further the construction of outer harbour retards the tidal flushing, resulting in a greater stagnation of harbour waters.

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