CHAPTER 5

WATER QUALITY

Introduction

Material and Methods

Result

5.1 Introduction:

Nearly 40% of the total open ocean area and 30% of the total area of the world's continental shelves lie within the tropics (Alongi, 1990). Pollution, urbanization and human population growth are increasing along tropical coastlines at an alarming rate. The hydrobiology of marine ecosystem plays an important role in predicting and tracking the changes happening in any coastal water body. Major water quality variables affecting the ecosystem include water temperature, salinity, nutrient and suspended sediment concentrations as well as toxicants including pesticides. Several recent studies have summarized the potential nature and consequences of global change on coastal areas and marine resources (Boesch *et al.,* 2000). Water quality of an area is affected by a wide range of natural and human influences. The most important of the natural influences are geological, hydrological and climatic, since these affect the quantity and the quality of water resource. In addition to these natural impacts, human activities on coastal water qualities have become widespread and varied in the degree, disrupting the coastal ecosystem. A single influence may give rise to a number of water quality problems. Pollution from diffuse and non-point sources, such as agricultural runoff, effluents from factories or from numerous small inputs over a wide area, such as faecal pollution is particularly difficult to control (Meybeck *et al.,* 1996). Physico-chemical properties of water play an important role in the diversity, distribution and relative abundance of different organisms in the marine and coastal environment. The boundaries of niche of any organism depend on the variation in physico-chemical parameters. Either individually or cumulatively they influence the biology of the organisms (Kinne, 1963). The life of benthic organisms in aquatic ecosystems also depends upon the interaction of

biotic and abiotic factors. Important abiotic factors such as temperature, salinity and dissolved oxygen play a key role in dispersal of organisms in this environment. The composition of benthic fauna in the aquatic environment is determined by the conditions of overlying water (Giere, 1993).

Coastal stretch of Kachchh, of late is witnessing a significant change in terms of increased human activities through faster industrial development. An assortment of industries like thermal power plants, ports and jetties, mining and Special Economic Zones (SEZs) have come up in this coastal belt in a short span of a decade. In the light of this development, it became imperative to document the present status of water quality which will both serve as a benchmark and a tool for coastal management. In view of this importance, the present study investigated nine crucial water quality parameters in the three study sites namely Mandvi, Mundra and Sanghi in Kachchh coast for 24 months.

5.2. Material and Methods:

5.2.1. Sampling and analysis of water:

Along with phytoplankton and zooplankton samples water samples were also sampled. Nine important parameters that overwhelmingly influence biotic components of coastal waters were studied in the present study. Water samples were collected during high tide and low tide both. Duplicate water samples were collected randomly from each station manually in pre-cleaned polyethylene bottles from June 2007 through May 2009. The collected samples were stored in an ice box and transferred immediately to laboratory and refrigerated at 4°C till further analysis. Analysis of the water quality parameters were carried out following standard methods (APHA, 2008; Stickland and Parsons, 1972). Temperature of the surface water was recorded with a Digital thermometer with

a accuracy of 0.1°C. Water salinity was measured using a refractometer (Aatago-Japan). pH was measured using a pH meter (Weathertronics, Type 705). Dissolved oxygen was estimated by Winkler's titrimetric method. Nitrite, nitrate and phosphate were estimated by standard method. The specific methods followed for each parameter are listed in the Table. 5.1

Table. 5.1 Methodology Followed for Analysis of Water Quality Parameters

Parameter	Methods	References	Instrument/Apparatus used
Temperature	Manual	----	Digital thermometer
pH	Potentiometry	APHA (1995), Strickland & Parsons (1972)	Digital pH/ Conductivity Meter (Lab India-Pico)
TSS	**Conductometry**		Digital EC-TDS meter - Model- (Systronics 308)
Turbidity (FTU)	Nephelometry		Microprocessor turbidity meter (Hanna HI 93703)
DO	Titrimetry (Winkler's Method)		----
Nitrate	Spectrophotometry (Brucine method)	Golterman *et al.* (1978)	UV-VIS Spectrophotometer (Shimadzu- UV 1601)
Phosphate	Spectrophotometry (Blue phosphomolybdate method)	Golterman *et al.* (1978)	UV-VIS Spectrophotometer (Shimadzu- UV 1601)
Nitrite	Spectrophotometry	Golterman *et al.* (1978)	UV-VIS Spectrophotometer (Shimadzu- UV 1601)

5.2.2. Statistical Analysis:

Statistical analyses were carried out using the statistical package SPSS (Version 17.0) and Primer 6 to elucidate the inter-annual variations among the physico-chemical parameters. Correlation coefficient between various physico-chemical

parameters, F-values (Two-way ANOVA) was calculated to determine the differences in the physico-chemical parameters between stations and years.

5.3. Results:

5.3.1. Dissolved Oxygen (DO):

DO levels are used as an indicator of water quality. In the three study areas, the DO content varied between 3.03 mg/L and 7.651 mg/L with an average of 4.78 mg/L during the study period. Higher values were recorded during December and May 2009 and lower values during June 2007, though relatively an open coast with much turbulence and wind force, mean DO value was lowest at Mandvi (4.65 mg/L) than Mundra (4.9 mg/L) and Sanghi (4.75 mg/L) (Fig. 5.1). Values were generally higher during the month of May and June due to prevailing high wind force and lower during the monsoon months of August, September and October.

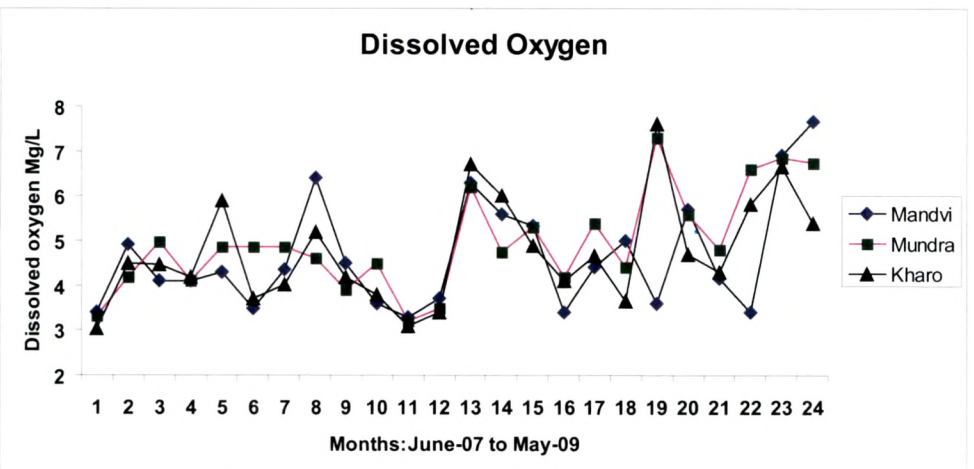

Fig: 5.1 Dissolved oxygen among stations

5.3.2 Temperature:

Water temperature is a fundamental factor for water quality, exerting great influence over the aquatic system. As water temperature rises, biological and chemical activity also increases while the capacity of water to hold dissolved oxygen decreases. Water temperature is dependent upon many factors including depth, season, amount of mixing from tides, wind, storms, amount of freshwater input and degree of stratification. The surface water temperature in all the three stations ranged between 17°C to 33°C during the study period. The lowest temperature (17°C) was recorded at Sanghi during December 2008 and highest temperature (33°C) was at Mundra during August 2007 with an all station mean of 27.45°C (Fig. 5.2). As a normal rule temperature was lower during winter months (November to February) higher during summer months (March to June). Mean values of three stations for the study period varied only marginally and ranged from 26.9 to 27.7°C. Temperature is significantly negatively correlated with pH.

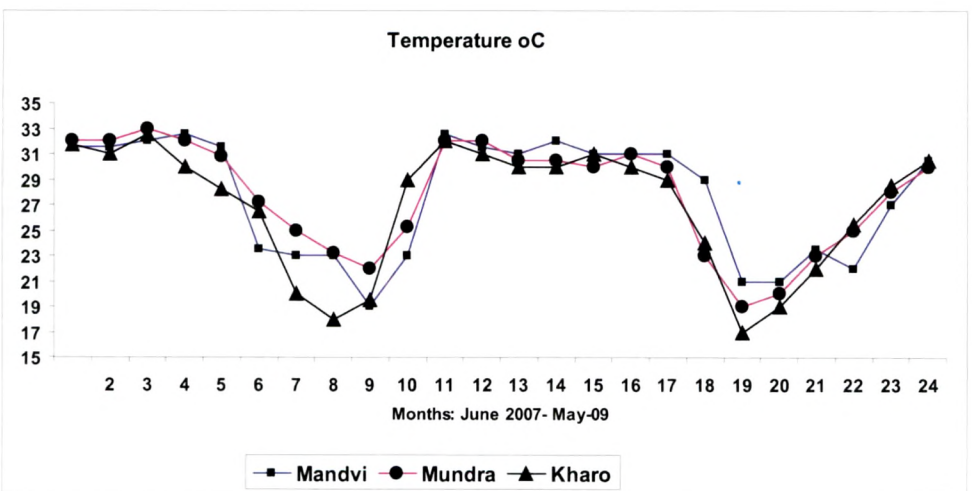

Fig: 5.2 Temperature variations in the study stations

5.3.3. Hydrogen Ion Concentration (pH):

The water in all the three stations was slightly alkaline in nature and ranged from 7.3 to 8.35 with a mean value of 7.95 (Fig. 5.3.). Maximum pH of 8.35 was recorded at Sanghi during March 2008 whereas minimum of 7.3 was recorded during June 2007 at Mundra.

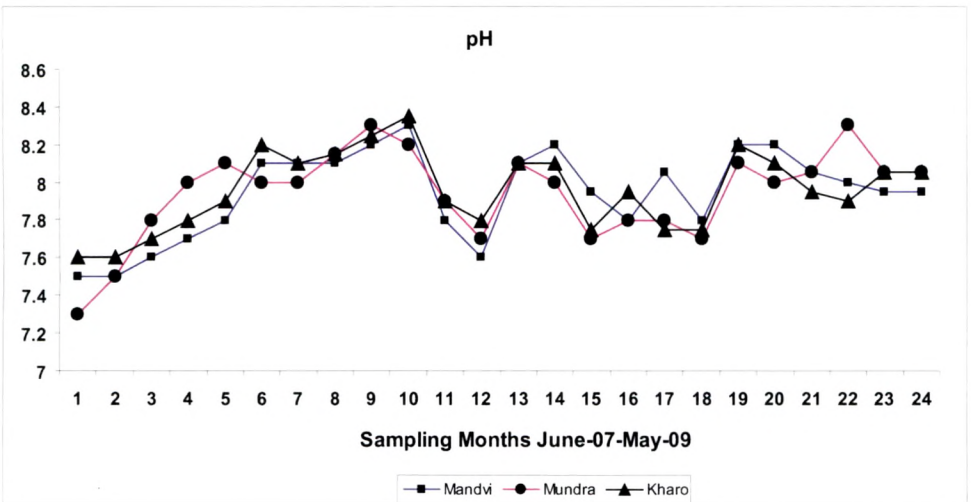

Fig.5.3. pH variations in the study stations

5.3.4. Salinity:

Salinity values for the entire study for the three stations are shown in Fig.5.4. Surface water salinity in the study stations during this two year study period ranged from 34 to 42‰ with mean value of 37.18‰. Highest (42‰) salinity was recorded at Sanghi and Mundra during April and May 2008 whereas lowest (34 ‰) salinity was recorded during July 2007 and September 2008 at Mundra and Mandvi. Overall mean salinity values were marginally lesser at Mundra (36.7‰) than the other two stations which recorded mean values of 37.06‰ at Mandvi and 37.77‰ at Sanghi. Monsoon months (June-Sep 2007) recorded lesser

values in all the three stations while values were higher during summer months of March to June. Salinity is significantly correlated with pH and nitrite and negatively correlated with TSS and nitrate (Table 5.2). Salinity is correlated with the DO. (Table:5.1)

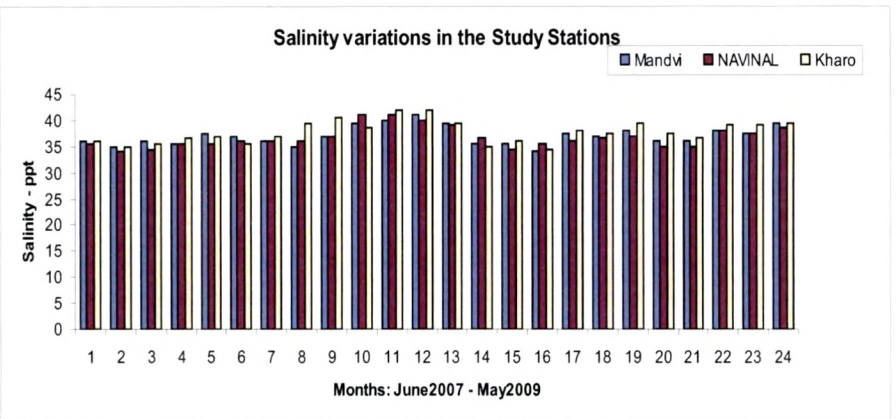

Fig.5.4. Salinity variations in the study stations

5.3.5. Turbidity:

Turbidity is considered as a good measure of the quality of water since it controls photosynthesis in the water column. The turbidity (NTU) in the surface water during the entire study in all the three stations was in the range of 10.2 to 75 NTU with an average value of 24.76 NTU. Maximum (75 NTU) turbidity was recorded during April 2009 at Mandvi and minimum (10.2 NTU) during January 2008 at Mundra (Fig. 5.5). Levels of turbidity were generally lower during winter and pre-monsoon and higher during monsoon months. Mean values were highest (28.47 NTU) at Mandvi followed by Sanghi (22.70 NTU) and Mundra (23.11 NTU) stations. Higher turbidity is seen at Mandvi might be due to its open coast and wave action. Turbidity is significantly correlated with nitrite (Table 5.1)

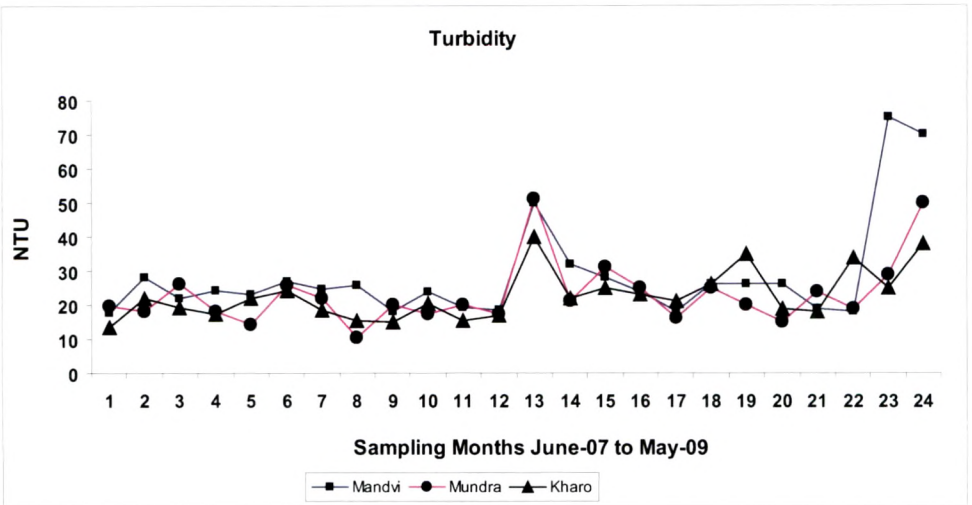

Fig.5.5. Turbidity values in the study stations

5.3.6. Total Suspended Solids(TSS):

Total Suspended solids in seawater originate either from autochthonous (biological) or allochthonus (derived from terrestrial matter) sources. Similar to turbidity, TSS levels in water column also determines photosynthesis and in turn productivity of the water body. Maximum total suspended solid level of 2345 mg/L was recorded at Mandvi during July 2007. Minimum level recorded was 685 mg/L at Mundra during October 2008 (Fig.5.6). Two yearly average of TSS was lowest (1258 mg/L) at Sanghi and highest (1511 mg/L) at Mandvi. Monsoon months (May to October) recorded higher values than other seasons. TSS is positively correlated with temperature (Table 5.1)

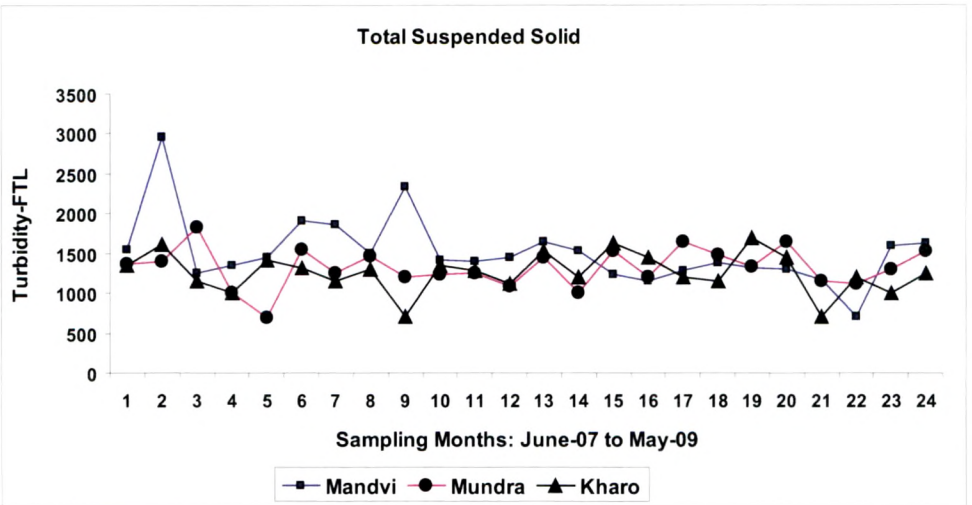

Fig: 5.6 Total suspended solid in the Study Stations

5.3.7. Nutrients-Nitrite- N-NO_2:

Levels of nitrite during the study period fluctuated widely. Minimum (0.03 µg/L) and maximum values (2.497 µg/L) of nitrite (NO_2-N) were recorded at Mandvi and Mundra, during August 07 and May 2009, respectively (Fig. 5.7). Mean values for 24 months was higher (0.67 µg/L) at Mundra whereas it was lowest (0.48 µg/L) at Mandvi. Sanghi recorded an overall mean value of 0.61 µg/L. Nitrite values were generally higher during monsoon and summer months of June July, April and May in all stations whereas post-monsoon and winter months of September-November recorded lower values. Nitrite is significantly correlated with TSS and phosphate (Table:5.1)

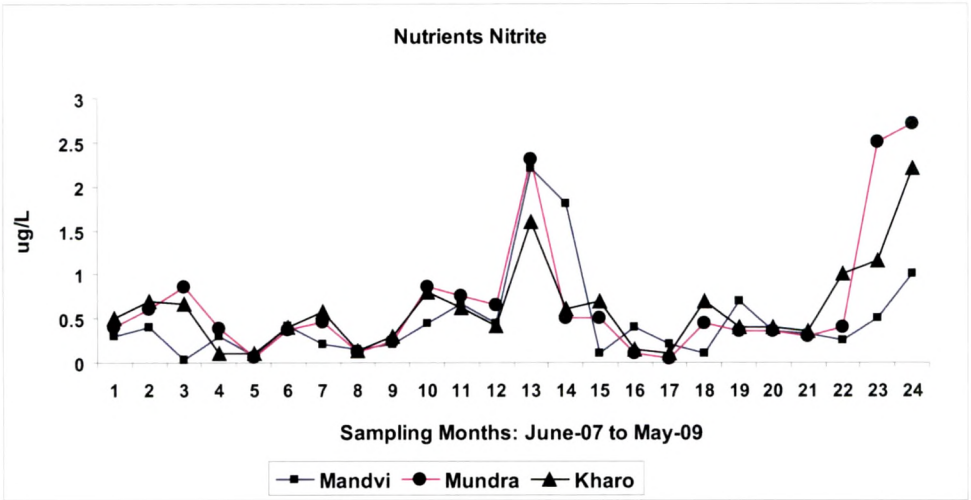

Fig. 5.7 Nitrite levels in the study stations

5.3.8. Nutrients- Nitrate- $N\text{-}NO_3$

Nitrate values are in general higher as compared to nitrite values. Nitrate is the final oxidation product of nitrogen compounds in seawater and is considered to be the only thermodynamically stable oxidation levels of nitrogen in seawater. Nitrate, as a micronutrient controls primary production in the euphotic surface waters. Concentration of nitrate is governed by several factors of which microbial oxidation of NH_3 and uptake by primary producers are important. Lowest (0.2 µg/L) and highest (22.5 µg/L) levels of nitrate contents were recorded during January 2008 and November 2008 at Sanghi creek (Fig.5.8). Average value of nitrate recorded was marginally higher (6.6 µg/L) at Mundra whereas Mandvi and Sanghi recorded a two year mean of 5.49 µg/L and 5.35 µg/L, respectively. Monsoon and summer months recorded higher nitrate values whereas it was lower during winter months. Nitrate is positively correlated with Dissolved Oxygen, Turbidity, TSS, Nitrite (Table 5.1)

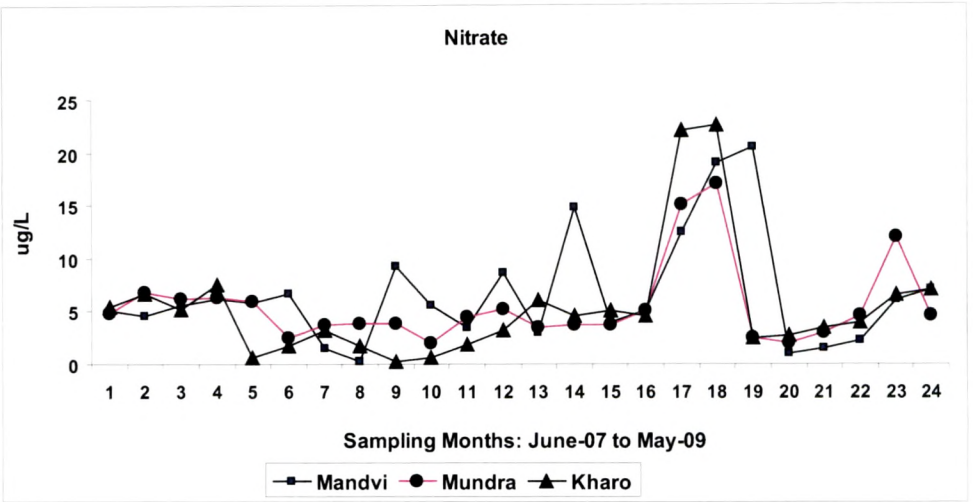

Fig.5.8. Nitrate distributions in the study stations

5.3.9. Phosphate

Inorganic phosphate is also an important nutrient like nitrogen compounds in the primary production of the sea. Concentration of phosphate in the coastal waters is influenced by the land run off and domestic sewage. Phosphate level in the surface water of all the three stations showed wide variation with the minimum of 0.4 µg/L at Mandvi during December 2008 and a maximum of 7.5 µg/L at Sanghi during April 2009 with an all season and station average of 1.96 µg/L (Fig. 5.9). Of all the three study stations Mundra recorded highest average phosphate level of 2.20 µg/L whereas at Mandvi and Sanghi, levels were lowers (1.77 µg/L and 1.91 µg/L). Phosphate levels were generally higher during monsoon months of 2008 and summer months of 2009. Phosphate showed significant correlation with salinity.(Table 5.1)

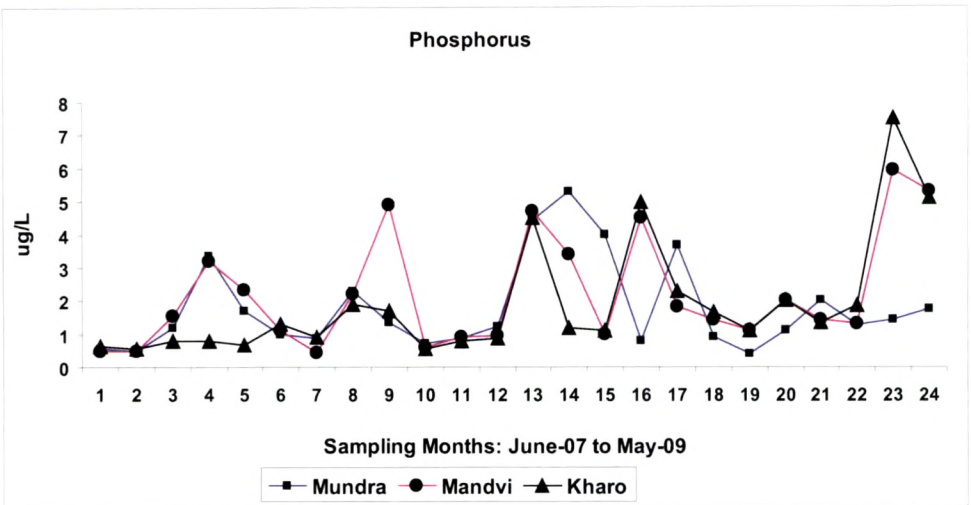

Fig. 5.9. Phosphate distributions in the study stations

Table: 5.1 Correlation Matrix among Parameters

	DO	Temp	pH	Salinity	Turbidity	TSS	Nitrite	Nitrate	Phosphate
DO		0.18	0.01	0.33	0.00	0.11	0.00	0.60	0.00
Temp	-0.16		0.00	0.02	0.28	0.82	0.05	0.28	0.19
pH	0.33	-0.58		0.08	0.40	0.19	0.15	0.06	0.02
Salinity	0.12	-0.27	0.21		0.05	0.89	0.01	0.40	0.92
Turbidity	0.60	0.13	0.10	0.23		0.02	0.00	0.66	0.01
TSS	0.19	0.03	-0.16	-0.02	0.28		0.49	0.69	0.31
Nitrite	0.41	0.23	0.17	0.29	0.55	0.08		0.59	0.00
Nitrate	-0.06	0.13	-0.22	0.10	0.05	0.05	0.06		0.39
Phosphate	0.40	0.16	0.28	0.01	0.30	-0.12	0.54	0.10	