Observations

Observations

3.1 Physico-chemical Analysis:

Physico-chemical analysis of the parameters like Temperature, pH, Salinity, Dissolved oxygen, Biochemical oxygen demand, Chemical oxygen demand, Total dissolved solid, Total suspended solid, Chloride, Nitrate and Oil and Grease were studied from the estuaries, Achara, Kolam and Tarkarli at upstream and downstream stations. Heavy metal study was also carried out on seasonally. The water sample collection was done monthly from Nov 06 to Oct 07. The results are as follows.

3.1.1 Temperature (Table 1, Graph1)

Monthly variations in Temperature at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

Temperature was significantly increased at downstream site as compared to upstream during Dec 06, Feb 07, Mar 07, Apr 07 and Oct 07, whereas significantly decreased at downstream site in Jul 07 and Aug 07. Temperature increase was found insignificant as compared to upstream site in Nov 06, May 07, Jun 07 and Sept 07. Maximum temperature increase was observed in the month of Mar 07 and minimum in Jun 07. Temperature was found lowest at both sites in the month of Jun 07.

Kolam estuary:

Temperature was found significantly increased at downstream site as compared to upstream site during Dec 06, Mar 06, Apr 06, May 06, Jun 06, Sept 06 and Oct 06, whereas significantly decreased at downstream site in Jul 07 and Aug 07. Temperature was found insignificantly increased as compared to upstream site in Nov 06, Jan 06 and Feb 07. Temperature was decreased in the month of Jun 07 and Jul 07. High temperatures were found in the month of May 07 and low in Jun 07. Temperature was somewhat increased in Mar 07.

Tarkarli estuary:

Temperature was significantly increased at downstream site as compared to upstream during Jan 07 and Mar 07, whereas significantly decreased at downstream site in Nov 06, Apr 07 and Aug 07. Temperature showed insignificant increase as compared to upstream site in Dec 06, Feb 07, May 07, Jul 07, Sept 07 and Oct 07. Temperature was lowered in Jun 07 and Jul 07. High temperatures were found in Apr 07, May 07 and low in Jun07. Temperature was somewhat increased in Feb 07. Maximum deviation in temperature was found in the month of Jan 07. Temperature was found significantly increased in winter and summer season as compared to rainy season.

3.1. 2 pH (Table 2, Graph 2)

Monthly variations of pH at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

pH was found significantly increased at downstream site as compared to upstream site during Jan 07, Feb 07, Mar 07, Apr 07 and May 07. pH showed insignificant increase as compared to upstream site in Nov 06, Dec 07, Jun 07, Jul 07 Aug 07, Sep 07 and Oct 07. pH observed maximum during Apr 07 to May 07 and minimum during Jun 07. pH was found decreased at both the sites in Jun 07 and Jul 07 respectively.

Kolam estuary:

pH was significantly increased at downstream site as compared to upstream site during Nov 06, Mar 07 and Sept 07. pH showed insignificant increase as compared to upstream site in Dec 07, Jan 07, Feb 07, Apr 07, Mar 07, Aug 07 and Oct 07. pH was significantly increased at downstream site in Jun 07 and Jul 07. High pH values were observed in Apr 07 and May 07, whereas decreased in Jun 07 to Aug 07.

Tarkarli estuary:

pH was significantly increased at downstream site as compared to upstream site during Jan 07, Feb 07, Mar 07, whereas significantly decreased at downstream site in Nov 06 and Jul 07. pH was found insignificantly increased as compared to upstream site in Dec 07, Apr 07, May 07, Jun 07, Aug 07, Sept 07 and Oct 07. High pH values were recorded in Mar 07 to May 07, whereas lowest in Jun 07 to Sept 07. pH was significantly increased in winter and summer season as compared to rainy season.

3.1.3 Salinity (Table 3, Graph 3)

Monthly variations in Salinity at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

Salinity was significantly increased at downstream site during the month of Nov 06 to Oct 07, whereas it is insignificantly increased as compared to upstream site in Sept 07. Salinity was somewhat decreased in Jan 07, whereas increased in Aug 07. High salinity found in month of May 07, whereas found it's lowest in Jun 07.

Kolam estuary:

Salinity was found significantly increased at downstream site in the month of Nov 06, Dec 06, Feb 07, Aug 07, Sept 07, and Oct 07, whereas significantly decreased at downstream site during Apr 07. Salinity was insignificant in Mar 07 as compared to upstream. Salinity somewhat lowered in Jan 07 and Jun 07, whereas increased in Sept 07. High salinity was found in Mar 07, while low in Aug 07.

Tarkarli estuary:

Salinity was significantly increased at downstream site during the month of Nov 06, Jan 07, Feb 07, Mar 07, Jun 07, Jul 07, Aug 07, Sept 07 and Oct 07, whereas it was insignificantly increased as compared to upstream site in Dec 06. Salinity was somewhat increased Mar 07 and Oct 07. High salinity found in month of May 07, whereas lowest in Jun 07. Salinity was

significantly found increased in winter and summer season as compared to rainy season.

3.1.4 Dissolved Oxygen (Table 4, Graph 4)

Monthly variations in dissolved oxygen at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

In the month of Nov 06, Dec 06, Jun 07 and Oct 07 dissolved oxygen was found significantly increased at downstream site, whereas insignificantly increased found at upstream and downstream during the month of Jan 07, Feb 07, Mar 07, Apr 07, May 07, Jul 07, Aug 07 and Sept 07.

Kolam estuary:

Dissolved oxygen was significantly increased at downstream site during the month of Mar 07, Apr 07, Sept 07 and Oct 07, whereas it is significantly decreased at downstream site during Nov 06, Dec 06, May 07, Jun 07 and Aug 07. Dissolved oxygen was found insignificantly increased at upstream and downstream during the month of Jan 07, Feb 07 and Jul 07.

Tarkarli estuary:

Dissolved oxygen was significantly increased at downstream site during the month of Dec 06, Jan 07, Mar 07, May 07 and Jun 07, whereas it is significantly decreased at downstream site during the month of Nov 06. Dissolved oxygen was found insignificantly increased as compared to upstream during the month of Feb 07, Jul 07, Aug 07 and Oct 07.

Lower values of DO were recorded at Tarkarli upstream site, whereas high were observed at Achara downstream site. Dissolved oxygen was significantly decreased in winter and summer season as compared to rainy season.

3.1. 5 Biochemical Oxygen Demand (Table 5, Graph 5)

Monthly variations in Biochemical Oxygen Demand at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

Biochemical oxygen demand was significantly decreased at downstream site. In the month of Nov 06, Dec 06, Jan 07, Apr 07, May 07, Jul 07, Aug 07, and Oct 07, whereas, significantly increased at downstream site as compared to upstream site in Mar 07. BOD was insignificantly increased in Feb 07, Jun 07 and Sept 07 as compared to upstream. BOD was somewhat increased in Apr and May 07, whereas decreased in Dec 06 and Jan 07.

Kolam estuary:

Biochemical oxygen demand was significantly decreased at downstream site during the month of Nov 06, Dec 06, Jan 07, Feb 07, Mar 07, Apr 07 and Sept 07, whereas significantly increased at downstream site as compared to upstream site in Aug 07. BOD was insignificantly increased in the month of May 07, Jun 07 and Oct 07 as compared to upstream. BOD was somewhat increased in May 07, whereas decreased in Feb 07.

Tarkarli estuary:

Biochemical oxygen demand was significantly decreased at downstream site during the month of Nov 06, Dec 06, Jan 07, to Jul 07 and Oct 07, whereas significantly increased at downstream site as compared to upstream site in Aug 07 and Sept 07. High BOD was recorded in month of Mar 07 and Apr 07 at upstream site and decreased in Aug 07 and Sept 07. A marginal increase was found in May 07, whereas decrease in Feb 07.

Biochemical oxygen demand was significantly decreased during winter and rainy season. High BOD found at Tarkarli upstream site during Nov 06 to Feb 07.

3.1.6 Chemical Oxygen Demand (Table 6, Graph 6)

Monthly variations in Chemical oxygen demand at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

Chemical oxygen demand was significantly increased at downstream site during the period of Nov 06 to May 07, whereas found insignificant as compared to upstream site during Jun 07 to Aug 07. Lower values were observed in Jun 07 and Jul 07. High COD was found in Jan 07 and Feb 07 respectively.

Kolam estuary:

Chemical oxygen demand was significantly increased at downstream site during the period of Nov 06 to Jun 07, whereas found insignificant as compared to upstream site during Jul 07. Lower values were observed in Jul 07. High COD was found in Apr 07 and May 07 respectively.

Tarkarli estuary:

Chemical oxygen demand showed significantly increased values at downstream site during the period of Nov 06 to May 07, whereas found insignificant as compared to upstream site during Jun 07, Jul 07, Aug 07. Lower values were recorded in Jun 07 and Jul 07. High COD found in Jan 07.

Chemical oxygen demand was significantly decreased during rainy season and increased in winter and summer season.

3.1. 7 Total dissolved solid (Table 7, Graph 7)

Monthly variations in Total dissolved solids at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

Total dissolved solids were significantly increased at downstream site as compared to upstream site during Nov 06, Dec 06, Jan 07, Feb 07, Mar 07, Apr 07 May 07, Jul 07, Aug 07, Sept 07 and Oct 07, whereas insignificant as

compared to upstream in Jun 07. TDS was sequentially decreased from Jun 07 to Aug 07. High TDS was found in the month of Mar 07.

Kolam estuary:

Total dissolved solids were significantly increased at downstream site as compared to upstream site during Nov 06 to Oct 07 throughout the year. TDS was somewhat decreased in Jun 07 to Aug 07 and high TDS was recorded in the month of Mar 07 to Apr 07. TDS was somewhat reduced in Jan 07.

Tarkarli estuary:

Total dissolved solids were significantly increased at downstream site as compared to upstream site during Nov 06 to Oct 07 throughout the year. TDS was decreased in Jun 07 to Sept 07 and high TDS observed during Apr 07 and TDS was somewhat lowered in Jan 07 and Feb 07.

Total dissolved solids were significantly decreased during rainy season as compared to summer and winter. In Kolam site TDS was found in high range as compared to other site.

3.1.8 Total suspended solid (Table 8, Graph 8)

Monthly variations in Total dissolved solids at three locations in the estuaries and around Malvan are as follows.

Achara estuary:

Total suspended solids were significantly increased at downstream site during Nov 06, Dec 06 and Jan 07, whereas significantly decreased at downstream site during Feb 07, Mar 07, Apr 07, May 07, Jul 07, Aug 07 and Sept 07. It was found insignificantly increased as compared to upstream site in Jun 07. High TSS was observed in Jun 07 at upstream site. Lower values were found in Jan 07 and Apr 07. TSS was somewhat increased in Oct 07.

Kolam estuary:

Total suspended solids were significantly increased at downstream during Nov 06, Dec 06, Jan 07, Feb 07 whereas significantly decreased at downstream site during Mar 07 to Aug 07. A insignificant increase as compared to upstream was observed in Jun 07 to Sept 07. High TSS were observed in Jun 07 and Jul 07 at upstream site and lower values were found in Jan 07 and Feb 07.

Tarkarli estuary:

Total suspended solids were significantly increased at downstream site during Nov 06, Dec 06, Jan 07, Feb 07 and Apr 07 whereas significantly decreased at downstream site during Mar 07, Jun 07, Sept 07 and Oct 07. TSS was found insignificant during Jun 07 to Aug 07. High TSS observed in Jun 07 at upstream site. Lower values were observed in Feb 07 at both the sites.

Total Suspended solids were significantly decreased during rainy season as compared to summer and winter. In Kolam site TDS was found in very high range as compared to other sites.

3.1.9 Chlorides (Table 9, Graph 9)

Monthly variations in Chlorides at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

Chlorides were significantly increased at downstream site during the period of Nov 06 to May 07, whereas found insignificantly increased as compared to upstream site during Jul 07 to Sept 07. Lower values were observed in Jun 07 and Jul 07. High Chlorides found in Mar 07 and Apr 07 respectively.

Kolam estuary:

Chlorides were significantly increased at downstream site during the period of Nov 06 to Oct 07, whereas found insignificant as compared to

upstream site during Jun 07. Lower values were observed in Jun and Jul 07. High Chlorides were found in Mar 07, Apr 07 and May 07 respectively.

Tarkarli estuary:

Chlorides were increased significantly at downstream site during the period of Nov 06 to May 07, whereas found insignificantly increased during Jun 07, Jul 07, Aug 07 as compared to upstream site. Lower values were observed in Jun 07 and Jul 07. High Chlorides were found in Feb 07, Mar 07 and Apr 07 respectively.

Chlorides were significantly decreased during rainy season whereas increased in winter and summer season. Lower Chlorides were observed at Tarkarli upstream site. High values were found in rainy season at Kolam estuary and downstream site of Tarkarli estuary.

3.1. 10 Nitrate (Table 10, Graph 10)

Monthly variations in Nitrate at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

Nitrates were significantly increased at downstream site during the period of Nov 06 to May 07, whereas found insignificant as compared to upstream site during Feb 07. Nitrates were significantly decreased at downstream site in Jun 07. Higher Nitrate concentration was observed during Jun 07 to Sept 07. Lower values were observed in Jan 07 and Feb 07.

Kolam estuary:

Nitrates were significantly increased at downstream site during the period of Nov 06 to Oct 07, whereas found insignificant as compared to upstream site in Feb 07. Higher Nitrate concentration was observed during Jun 07 and Jul 07. Lower values were observed in Nov 06 to Feb 07.

Tarkarli estuary:

Nitrates were found significantly increased at downstream site during the period Nov 06 to May 07, whereas found insignificantly increased as compared to upstream site during Jun 07 and Jul 07. Nitrates were significantly decreased at downstream site during Aug 07 and Sept 07. Lower values were observed in Jun 07 and Jul 07. High Nitrates were found in Jun 07, Jul 07 and lowered in Nov 06 and Oct 07.

Nitrates were significantly increased during rainy season and decreased in winter and summer season. Higher nitrate contents were observed at Tarkarli upstream site during the period of Nov 06 to Mar 07. High values were found in rainy season at all sites due to higher organic load from river.

3.1. 11 Oil and Grease (Table 11, Graph 11)

Monthly variations in Oil and Grease at three locations in the estuaries in and around Malvan are as follows.

Achara estuary:

Oil and Grease was found insignificantly increased as compared to upstream site during the period of Oct 06 to Feb 07, whereas significantly decreased at downstream site in Mar 07 to Apr 07. Oil and grease was not detected during Jun 07 to Sept 07.

Kolam estuary:

Oil and Grease was found insignificantly increased as compared to upstream site in the period of Nov 06 to Mar 07, whereas significantly decreased at downstream site in Mar 07 to May 07. Oil and grease was not detected during Jun 07 to Sept 07. Oil and grease was found insignificantly increased at upstream in Oct 07.

Tarkarli estuary:

Oil and Grease was found insignificantly increased as compared to upstream site in the period of Nov 06, Feb 07, and May 07, whereas significantly decreased at downstream site in Dec 06, Jan 07, Mar 07, Apr 07,

Sept 07 and Oct 07. Oil and grease was not detected in the month of Jun 07 to Aug 07.

Oil and grease was not detectable during rainy season at all sites. High values were recorded at Tarkarli upstream site, whereas found low in Aachra upstream site.

3.2 Heavy Metal:

Seasonal variations in heavy metal at three locations in the estuaries in and around Malvan are as follows.

3.2.1 Winter season (Table 12, Graph, 12)

Achara estuary:

Copper, Iron, Nickel and Lead were insignificantly increased as compared to upstream site. Zinc, Sodium, Potassium and Calcium were significantly increased at downstream site, while Magnesium was significantly decreased at downstream site. Manganese was not detected at both sites.

Kolam estuary:

Copper, Iron, Lead and Zinc were insignificant as compared to upstream site, while Magnesium, Manganese, Nickel and Sodium were significantly increased at downstream site. Potassium and Calcium were significantly decreased at downstream site.

Tarkarli estuary:

Copper, Iron, Manganese, Nickel and Sodium were found significantly increased at downstream site, while Magnesium, Lead, Potassium and Calcium were significantly decreased at downstream site. Zinc was found insignificant as compared to upstream site. Sodium, Magnesium and Potassium were found in higher range at upstream and downstream sites respectively, while Nickel, Zinc and Manganese showed low range. Lead was found in higher range at upstream site.

3.2.2 Summer season (Table 13, Graph, 13)

Achara estuary:

Copper, Magnesium and Nickel were found insignificantly increased at upstream, whereas Iron, Zinc and Sodium were found insignificant as compared to upstream site. Manganese, Lead and Sodium were significantly increased at downstream site. Nickel was not detected in the downstream site.

Kolam estuary:

Copper and Iron were found insignificantly increased as compared to upstream site. Magnesium, Nickel, Sodium and Calcium were significantly increased at downstream site. Manganese, Lead, Zinc and Potassium were found insignificant as compared to upstream site.

Tarkarli estuary:

Sodium and Calcium were significantly increased at downstream site. Manganese and Lead were not detected. Potassium was significantly decreased at downstream site. Copper, Iron, Nickel and Zinc were insignificant as compared to upstream site. Sodium and Magnesium were found in higher range at upstream and downstream sites respectively, while Nickel, Zinc and Manganese showed lower range.

3.2.3 Rainy Season (Table 14, Graph, 14)

Achara estuary:

Copper, Magnesium, Nickel, Sodium, Potassium and Calcium were significantly increased at downstream site, while Zinc was found significantly decreased at downstream site. Manganese and Lead were not detected at upstream and downstream respectively.

Kolam estuary:

Iron, Magnesium, Potassium and Calcium were significantly decreased at upstream site. Copper and Nickel were insignificant as compared to upstream site. Sodium was found significantly increased at downstream site.

Zinc, Lead and Manganese were not detected at upstream and downstream sites respectively.

Tarkarli estuary:

Sodium, Potassium and Calcium were found significantly increased at downstream site. Manganese and Lead were not detected at upstream and downstream sites respectively. Copper, Iron, Magnesium, Nickel and Zinc were found insignificant as compared to upstream site. In rainy season Iron and Magnesium found in higher range while other elements were decreased in rainy season.

From this observation it is seen that the physico-chemical parameters like, Temperature, salinity and pH have positive correlation with each other. pH and temperature were having positive correlation. Seasonal variation was found in pH. Dissolved oxygen and temperature showed negative correlation with each other. Dissolved oxygen was found significantly decreased at upstream site of Tarkarli, showed impact of organic load from surrounding area.

High BOD was found at Tarkarli upstream site showed organic load from surrounding area. BOD and DO were having negative correlation. COD parameter shows negative correlation with temperature and dissolved oxygen. TDS and TSS showed a positive correlation with temperature. Chlorides showed positive correlation with Chemical Oxygen Demand.

3.3 Social Survey (Table 15, 16 Graph, 15,16)

Social survey was carried out to know the disposal pattern of solid and liquid waste in the estuaries. Three villages around the estuaries were selected for the study. The villagers at each site selected respondent (twenty-five) were randomly selected includes the hotel owners, residential people and fisherman.

2. Age group :

Achara Site:

All the respondents were interviewed, out of them 13% each belongs to age group in between 20 to 25 years, 27% were 25 to 30 years, 47% were 30 to 35 years and 13% were above 35 years. Gender bias was observed as 66 % male and 34 % female.

Kolam Site :

All the respondents interviewed for feed back. Out of these 10% belongs to age group in between 20 to 25 years, 30% were 25 to 30 years, 45% were 30 to 35 years and 15% were above 35 years. Gender bias was observed as 74 % male and 26 % female

Tarkarli Site:

All the respondents interviewed for feedback. Out of them 15% each belongs to age group in between 20 to 25 years, 25% were 25 to 30 years, 35% were 30 to 35 years and 25% were above 35 years. Gender bias was observed as 64 % male and 36 % female

2. Literacy Rate:

Achara Site :

Among the respondents interviewed from selected site, Most of them were 70.66% were literate and 29.34% were found illiterate. 37 % were educated graduates, 4 % were postgraduates while 59 % were studied up to higher secondary level.

Kolam Site :

Among the respondents interviewed from selected site, Most of them were 66.33% were literate and 33.66% were found illiterate. 19 % were educated up to graduates, 1% were postgraduates while 80 % were studied up to higher secondary level.

Tarkarli Site :

Among the respondents interviewed from selected site, 74% were literate and 26% were found illiterate. Among them 27% were educated up to graduation, 3 % were post graduate while 70 % were educated up to higher secondary level.

3. Waste disposal pattern :

The respondents interviewed to know the disposal pattern of solid and wastewater from household activity and waste form hotels.

Achara site:

Achara site 25 % people were disposing their solid waste directly in to the seas from this 5% hotel owners, 15% residential and 5% fisherman. 33.33% were selected estuary for disposal. From this people 8% hotel owners, 15% residential and 10.33% fisherman. 26.66 % people directly release their waste on open. From these 6% hotel owners, 12% residential people and 8% were fisherman. 10% of solid waste was burned by 8% residential people and 2% by fisherman. Local facility like dust bins used by 5% people from which 3% are hotel owners and remaining 1% were fisherman and residential people.

For liquid waste 30 % people were disposing directly in to the seas, in which 5% were hotel owners, 8% residential and 17% fishermans. 37% release waste in estuary from which 2% are hotel owners, 18% residential people and 17% are fisherman. 25% liquid waste is disposed on open land, from which 3% are hotel owners, 12% residential and 10% fisherman. Local facility like availability of drainage system is used 8% from which 2% by hotel owners, 3% by residential and 3% by fisherman.

Kolam site:

In Kolam site 20% people were disposing their solid waste directly in to the seas from this 5% hotel owners, 7% residential people and 8% fisherman. 26.33% were selected estuary for disposal from these 5% hotel owners, 16.33% residential and 5% fisherman. 13% people directly release their waste on open. From these 2% hotel owners, 8% residential people and 5% was fisherman. 31% of solid waste was burned by 8% hotel owners, 15% residential and 8% by fisherman. Local facility like dust bins used by 9% people from which 3% were hotel owners and remaining 6% were fisherman and residential people.

For liquid waste 20% people were disposing directly in to the seas, in which 2% hotel owner, 8% residential people and 10 % were fisherman. 34.34% release waste in estuary from which 9.34% are hotel owners, 15% residential people and 10 % by fisherman. 42.66 % liquid waste is released on open land, from which 12 % are hotel owner, 18% residential and 10.66% were fisherman. Local facility like availability of drainage system is 5 % from which 2% is used by hotel owners, 1% by residential and 2 % by fisherman.

Tarkarli site:

Tarkarli site, 18% people were disposing their solid waste directly in to the seas, from this 8% were hotel owners, 7% residential people and 3% fisherman. 46% were selected estuary for disposal. From this 10% were hotel owners, 2% residential people and 10% fisherman. 10% people directly release their waste on open. From this 3% were hotel owners, 4% residential people and 3% were fisherman. 16% solid waste was burned by 5% Hotel owners, 12% residential people and 6% by fisherman. Local facility like dust bins was used by 10% people from which 6% were hotel owners and remaining 1% were fisherman and 3% residential people.

For liquid waste 13 % people were disposing directly in to the seas, in which 3% were hotel owners, 6% residential people and 4% were fisherman. 49.33% release waste in estuary from which 10% were hotel owners, 22% residential people and 17.33% are fisherman. 22% liquid waste is released on open land, from which 5% were hotel owners, 7% residential people and 10% fisherman. Local facility like availability of drainage system is used by 16% from which 7% was hotel owners, 7% residential people and 2 % by fisherman. Achara site 40 %, Kolam 35 % and 25 % of Tarkarli site, people were aware about disposal facility and its effect on surrounding environment.

From social study it is observed that the people residing in and around Tarkarli site are more literate, whereas illiterate people are more at Kolam and Achara. A very large quantity of solid and liquid waste dumped is in estuary and seas at Tarkarli site, whereas maximum local facility was used at Tarkarli

site. Fishermen in and around estuary are unaware about disposal and the available only 1 to 2% local facility. Hotel owners at Achara are releasing very small quantity of waste in to the estuary whereas hotel owners at Kolam are releasing maximum liquid waste in the estuary.

Table 1: Monthly variation in Temperature at three locations in the estuaries in and around Malvan.

Months	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	27.0 ± 0.22	26.5 ± 0.11	27.8 ± 0.12	27.5* ± 0.15	28.03 ± 0.12	27.9** ± 0.11
Dec-06	28.5 ± 0.24	28.6* ± 0.1	28.3 ± 0.45	29.0 ± 0.45	28.24 ± 0.05	28.5 ± 0.22
Jan-07	28.6 ± 0.99	28.0 ± 0.045	28.6 ± 0.66	28.0 ± 0.05	28.9 ± 0.99	28.9* ± 0.55
Feb-07	29.0 ± 0.04	29.8* ± 0.99	28.21 ± 0.01	28.6 ± 0.15	29.0 ± 0.99	29.2 ± 0.55
Mar-07	29.1 ± 0.21	29.54* ± 0.33	29.0 ± 05	29.54* ± 0.12	30.5 ± 0.16	30.22 ± 1.1
Apr-07	29.12 ± 0.12	30.5* ± 0.12	29.0 ± 0.55	30.0* ± 0.23	30.5 ± 0.12	29.41** ± 0.41
May-07	33.0 ± 0.2	33.0 ± 0.15	32.4 ± 0.06	33.5* ± 0.12	31.3 ± 0.66	32.1 ± 0.48
Jun-07	25.33 ± 0 .55	25.02 ± 0.11	24.95 ± 0.11	25.6* ± 0.12	25.4 ± 0.23	25.9 ± 0.66
Jul-07	24.9 ± 0.12	25.0** ± 0.99	25.5 ± 0.25	25** ± 0.13	25.6 ± 0.22	25.12 ± 0.66
Aug-07	25.6 ± 0.44	24.66** ± 0.66	25.66 ± 0.45	24.89** ± 0.12	26.0 ± 1.2	25.6** ± 0.88
Sep-07	25.9 ± 0.12	25.6 ± 0.02	24.9 ± 0.88	24.83* ± 0.11	25.0 ± 0.22	26.3 ± 0.22
Oct-07	26.9 ± 0.01	27.55* ± 0.12	27.3 ± 0.01	27.85* ± 0.12	27.33 ± 0.11	27.21 ± 0.33

Values are expressed in °C Mean ± SD *significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test.

Graph No : 1 Monthly variation in Temperature at three locations in the estuaries in and around Malvan.

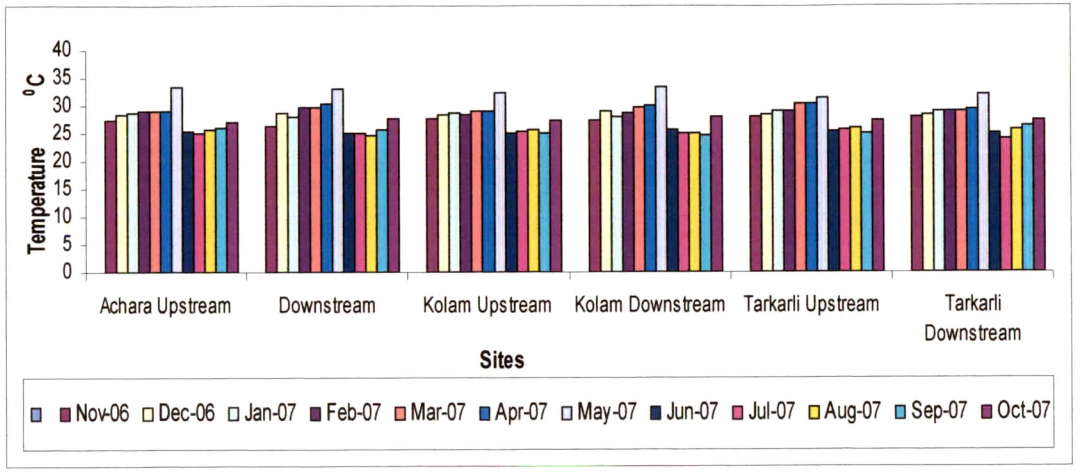


Table 2 : Monthly variation of pH at three locations in the estuaries in and around Malvan.

Months	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	8.2 ± 0.88	8.9 ± 0.99	8.6 ± 0.12	9.2* ± 1.1	8.0 ± 0.23	7.9** ± 0.66
Dec-06	8.8 ± 1.2	9.1 ± 0.78	8.5 ± 1.1	8.2 ± 0.88	8.3 ± 0.88	8.1 ± 0.12
Jan-07	± 1.5	8.5 ± 0.23	8.77 ± 0.88	8.21 ± 1.14	8.71 ± 0.99	9.99* ± 1.23
Feb-07	8.85 ± 0.99	8.91* ± 0.11	7.99 ± 0.12	8.62 ± 0.56	8.25 ± 0.57	9.5* ± 1.20
Mar-07	7.96 ± 1.1	8.12* ± 0.55	8.0* ± 0.23	8.6* ± 0.45	8.1 ± 0.55	8.29* ± 1.10
Apr-07	8.9 ± 0.88	9.3* ± 0.99	8.39 ± 0.55	8.56 ± 0.75	8.33 ± 0.23	8.21 ± 0.99
May-07	8.5 ± 0.84	9.12* ± 1.12	8.1 ± 0.01	8.2 ± 0.72	8.5 ± 0.66	8.3 ± 0.25
Jun-07	7.22 ± 0.99	7.1 ± 0.05	7.54 ± 0.54	7.15** ± 0.66	7.1 ± 0.44	7.11 ± 0.11
Jul-07	7.9 ± 1.10	7.55 ± 0.23	8.0 ± 0.12	7.45** ± 0.45	7.6 ± 0.12	7.55** ± 0.12
Aug-07	7.5 ± 1.1	7.15 ± 0.05	7.9 ± 0.23	7.1 ± 0.45	7.77 ± 0.55	7.25 ± 0.14
Sep-07	7.89 ± 2.2	7.21 ± 0.25	7.9 ± 0.55	8.12* ± 0.87	7.75 ± 0.12	7.7 ± 0.55
Oct-07	8.88 ± 2.33	8.56 ± 0.58	8.21 ± 0.45	8.52 ± 0.55	8.54 ± 0.12	8.11 ± 0.11

Mean ± SD

* significantly increased P< 0.05 by t-test

** significantly decreased P>0.05 by t-test.

Graph No: 2 Monthly variation of pH at three locations in the estuaries in and around Malvan.

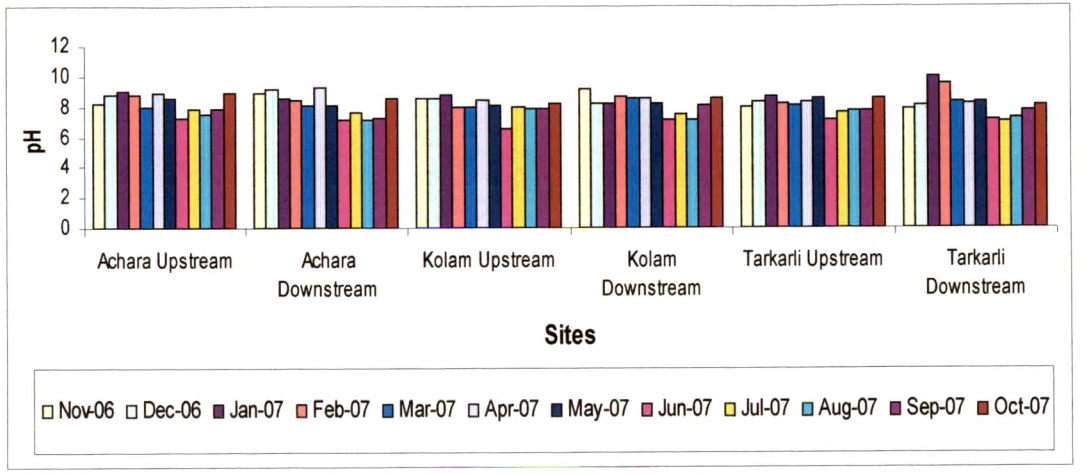


Table 3: Monthly variation in Salinity at three locations in the estuaries in and around Malvan.

Month	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-6	23.99 ± 0.57	28.21* ± 0.21	20.45 ± 0.1	25.4* ± 0.07	25.1 ± 0.2	25.36* ± 0.09
Dec-6	20.2 ± 0.2	24.66* ± 0.33	23.85 ± 0.01	25.66 ± 3.07	24.6 ± 1.78	24.5* ± 2.91
Jan-07	18.2 ± 0.21	19.5* ± 0.4	21.4 ± 0.068	25.0 ± 2.28	22.3 ± 0.49	26.5* ± 2.65
Feb-07	21.1 ± 0.12	23.5* ± 0.98	26.5 ± 2.56	27.14* ± 0.24	23.6 ± 1.38	27.4* ± 0.27
Mar-07	24.8 ± 0.42	27.4* ± 0.4	27.4 ± 0.41	27** ± 0.12	26.9* ± 0.47	27.9 ± 3.8
Apr-07	25.8 ± 0.13	27.89* ± 0.01	25.8 ± 0.13	27.5* ± 0.08	27.4 ± 0.4	28.5 ± 0.09
May-7	24.66 ± 0.38	26.3* ± 2.30	22.45 ± 0.45	27.12 ± 0.20	26.3 ± 2.60	26.3 ± 3.17
Jun-07	16.50 ± 058	18.8* ± 0.13	14.5 ± 0.5	13.2 ± 0.68	12.5 ± 0.07	9.5* ± 0.5
Jul-07	11.2 ± 4.80	13.2* ± 3.48	13.0 ± 3.076	19.3 ± 2.60	14.5 ± 1.85	15.6* ± 1.92
Aug-7	14.6 ± 0.345	15.4* ± 3.49	8.5 ± 3.06	14.8* ± 1.80	9.5 ± 0.28	14.5* ± 3.50
Sep-7	21.2 ± 1.5	21.66* ± 3.94	14.3 ± 0.51	15.6* ± 3.71	15.6 ± 3.23	16.2* ± 2.97
Oct-07	23.5 ± 0.5	26.2* ± 2.45	20.12 ± 1.22	24.5* ± 0.26	23.1 ± 0.20	25.4 ± 0.40

Values are expressed in gm/kg (‰) Mean ± SD *significantly increased P< 0.05 by t-test ** significantly decreased P>0.05 by t-test.

Graph NO: 3 Monthly variation in Salinity at three locations in three locations in the estuaries in and around Malvan.

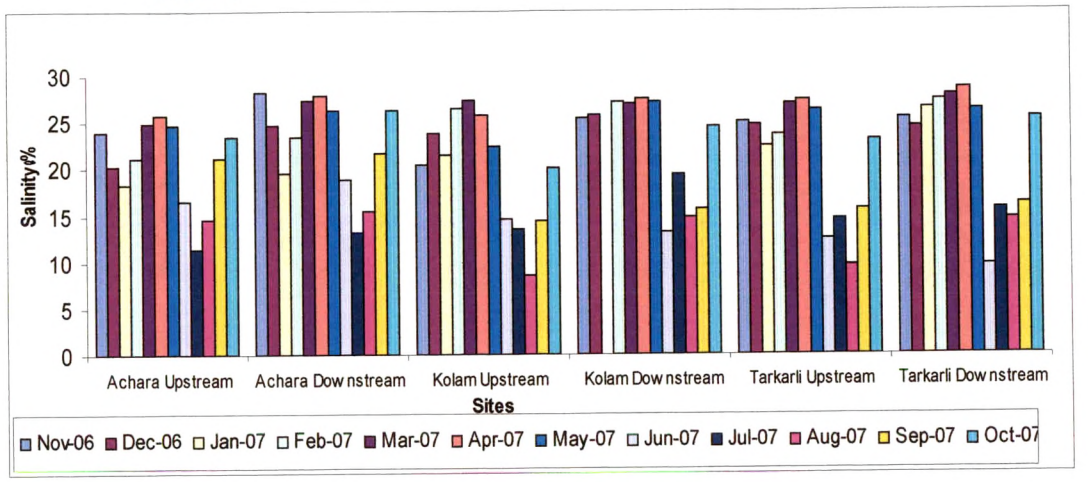


Table 4: Monthly variation in Dissolved Oxygen at three locations in the estuaries in and around Malvan.

Month	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	5.65 ± 0.05	6.49* ± 0.01	6.86 ± 0.12	6.2** ± 0.31	5.59 ± 0.01	4.9** ± 0.39
Dec-06	4.2 ± 0.34	6.9* ± 0.34	6.78 ± 0.08	5.52** ± 0.02	4.2 ± 0.61	6.33* ± 0.1
Jan-07	6.9 ± 0.2	7.1 ± 0.15	7.50 ± 028	7.2 ± 0.3	4.15 ± 0.69	6.9* ± 0.47
Feb-07	4.98 ± 0.57	4.62 ± 0.5	4.41 ± 0.71	5.62 ± 0.99	4.16 ± 0.81	4.33 ± 0.66
Mar-07	5.12 ± 1.62	5.43 ± 0.57	5.23 ± 0.15	6.44* ± 0.4	4.98 ± 1.54	5.45* ± 0.57
Apr-07	4.1 ± 0.60	4.22 ± 0.62	4.1 ± 0.58	4.58* ± 0.95	4.33 ± 0.76	5.59 ± 0.01
May-07	4.65 ± 1.39	4.40 ± 0.1	5.62 ± 1.19	4.1** ± 0.58	4.88 ± 1.81	5.43* ± 1.69
Jun-07	8.01 ± 1.459	8.54* ± 0.02	8.05 ± 0.09	6.66** ± 0.38	6.13 ± 0.25	8.57* ± 0.04
Jul-07	6.54 ± 1.87	6.66 ± 1.04	6.66 ± 0.93	7.01 ± 1.56	7.55 ± 0.05	7.66 ± 0.02
Aug-07	6.12 ± 1.84	6.14 ± 1.69	7.45 ± 1.70	6.87** ± 1.65	6.99 ± 0.07	6.9 ± 0.09
Sep-07	5.59 ± 0.011	5.34 ± 0.29	4.66 ± 0.06	6.32* ± 0.32	5.22 ± 1.54	6.32 ± 0.55
Oct-07	4.55 ± 0.05	8.99* ± 1.70	4.21 ± 0.16	5.21* ± 0.36	4.33 ± 0.57	5.58 ± 0.02

Values are expressed in mg/l Mean ± SD * significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test.

Graph NO: 4 Monthly variation in Dissolved Oxygen at three locations in the estuaries in and around Malvan.

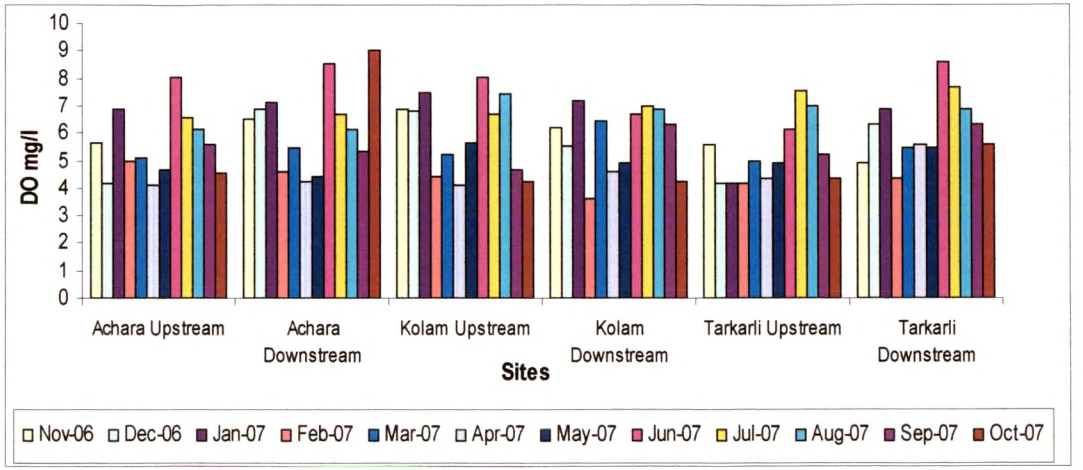


Table 5: Monthly variation in Biochemical Oxygen Demand at three locations in the estuaries in and around Malvan.

Month	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	36.21 ± 9.80	33.0** ± 8.5	31.2 ± 1.12	21.9** ± 0.68	56.2 ± 0.1	55.2** ± 5.5
Dec-06	41.2 ± 19.10	25.66** ± 5.0	27.0 ± 1.52	24.5** ± 0.1	68.7 ± 2.2	35.6** ± 5.06
Jan-07	26.3 ± 3.51	18.9** ± 2.14	26.5 ± 0.55	22.56** ± 2.2	37.12 ± 3.1	39.6** ± 1.10
Feb-07	40.21 ± 20.0	16.15 ± 4.15	29.9 ± 0.76	14.32** ± 4.0	41.54 ± 1.11	46.21** ± 4.33
Mar-07	37.5 ± 3.3	32.3** ± 2.2	41.6 ± 3.28	25.6** ± 5.0	32.3.3 ± 1.57	30.12** ± 0.22
Apr-07	44.2 ± 1.2	19.8** ± 0.73	41..23 ± 1.22	26.9** ± 4.4	44. 5 ± 3.12	39.31** ± 4.0
May-07	25.6 ± 5.5	15.6** ± 5.5	37.3 ± 2.23	33.5 ± 5.0	29.87 ± 0 .60	26.54** ± 4.27
Jun-07	9.99 ± 2.0	10.11 ± 3.2	22.3 ± 1.22	23.1 ± 3.6	15.4 ± 0.90	3.21** ± 0.61
Jul-07	16.2 ± 3.2	18.9** ± 0.16	34.21 ± 10.2	19.5 ± 0.22	11.23 ± 1.5	9.88** ± 2.1
Aug-07	19.25 ± 0.25	21.3** ± 2.0	24.6 ± 1.53	31.25* ± 1.27	19.8 ± 1.52	40.0 * ± 2.2
Sep-07	45.66 ± 5.34	42.3 ± 10.2	49.6 ± 3.05	27.41** ± 3.3	18.7 ± 2.90	18.41* ± 3.90
Oct-07	31.23 ± 1.11	21.45** ± 0.99	38.3 ± 1.2	35.36 ± 9.65	33.33 ± 1.66	29.87** ± 1.1

Values are expressed in mg/l Mean ± SD *significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test.

Graph No : 5 Monthly variation in Biochemical Oxygen Demand at three locations in the estuaries in and around Malvan

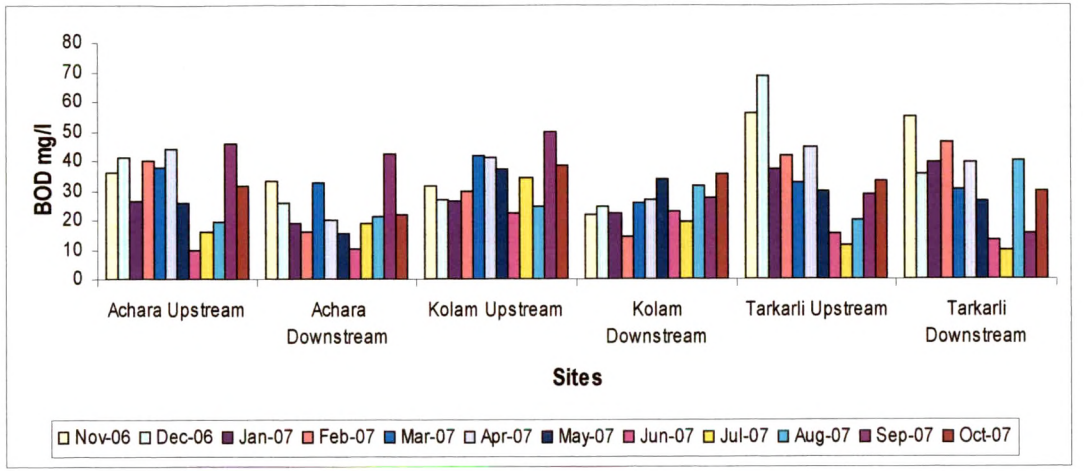


Table No:6 Monthly variation in Chemical Oxygen Demand three locations in the estuaries in and around Malvan.

Months	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	452 ± 28.5	641* ± 11.1	208 ± 17.8	470* ± 23.6	380.1 ± 13.2	660* ± 66.1
Dec-06	288 ± 88.0	372* ± 285.3	666.3 ± 23.31	1205* ± 10.0	556 ± 33.21	780* ± 80.4
Jan-07	580 ± 15.2	602* ± 38.2	510 ± 19.0	677* ± 19.8	440 ± 22	952* ± 49.2
Feb-07	354.2 ± 14.2	451* ± 25.0	340 ± 25.5	460* ± 10.40	410 ± 17	665.4* ± 50
Mar-07	266.5 ± 12..3	333* ± 33.2	540 ± 29.0	660* ± 10	398.3 ± 5.5	542* ± 29.51
Apr-07	520 ± 11.2	472* ± 49.5	510 ± 22.3	980* ± 19.5	522.4 ± 38	712.5* ± 102
May-07	345.6 ± 7.6	611.2* ± 11.5	768.3 ± 11.2	946.3* ± 46.5	260.3 ± 14.5	666.3* ± 0.66
Jun-07	198.5 ± 12.3	211. ± 22.3	233.3 ± 21.3	545.6* ± 33	194.3 ± 2.42	210 ± 18.7
Jul-07	166.2 ± 19.6	199.6 ± 12.5	441.3 ± 15.2	530 ± 12.3	155.7 ± 12.2	158 ± 11.8
Aug-07	107.6 ± 55.6	150.2 ± 20.2	387. ± 22.1	698.3 ± 1.35	148.7 ± 15.2	154.6 ± 13.2
Sep-07	222.2 ± 22.3	298.3 ± 7.1	412.2 ± 12	512 ± 20.44	112 ± 9.5	321.3 ± 20.1
Oct-07	459.3 ± 11.2	670.2 ± 30.2	320.3 ± 33.2	577.7 ± 34.25	321 ± 1.3	478.2 ± 22.2

Values are expressed in mgl Mean ± SD * significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test.

Graph No : 6 Monthly variation in Chemical Oxygen Demand at three locations in the estuaries in and around Malvan

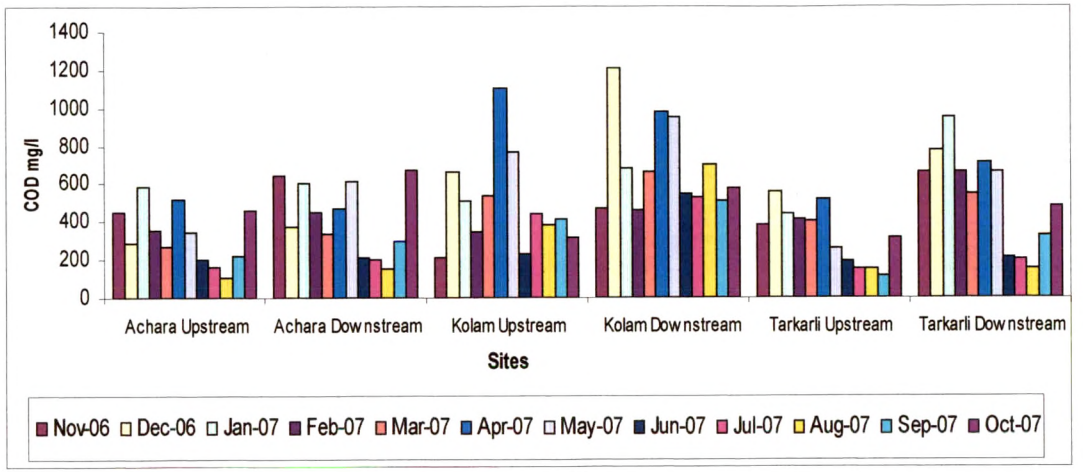


Table 7: Monthly variations in Total Dissolved Solid at three locations in the estuaries in and around Malvan.

Months	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	22410 ± 80.0	27710* ± 190.2	19410 ± 66.3	26574* ± 46.5	22841 ± 133.2	26874* ± 136.3
Dec-06	21510 ± 55.0	25920* ± 82.0	23456 ± 33.54	25000* ± 80.1	24700 ± 112.3	23451* ± 49.2
Jan-07	19700 ± 19	26150* ± 150.3	20410 ± 88.2	22050 ± 55.6	21820 ± 44.6	25830* ± 99.2
Feb-07	18755 ± 12.2	22511 ± 98.0	21720 ± 220.2	26980* ± 56.8	22950 ± 66	26850* ± 111.3
Mar-07	23410 ± 30.2	27100* ± 200	26400 ± 101.2	24781* ± 122.2	24700 ± 55.6	26700* ± 225.3
Apr-07	22100 ± 02.3	26450* ± 175.6	24755 ± 33.29	25780* ± 102.3	26410 ± 205	27710* ± 190.2
May-07	23980 ± 22.0	25740* ± 110.3	21820 ± 5.77	26987* ± 64.1	21320 ± 110.2	25980* ± 112
Jun-07	256 ± 10.1	330.33 ± 30.39	1002 ± 52	6345* ± 34.5	198.7 ± 232.3	199.55* ± 55.2
Jul-07	601 ± 2.25	713* ± 3.3	1950 ± 50	3100* ± 20.2	220.3 ± 30.3	289* ± 16.0
Aug-07	595 ± 7.99	810* ± 36.2	1420 ± 38.5	2900* ±200	160.4 ± 41.2	220* ± 15.6
Sep-07	712.3 ± 11.22	966.3* ± 8.55	7900 ± 45.0	13900* ± 113.2	325.6 ± 74.5	326.3* ± 26.3
Oct-07	22890 ± 44.1	24510* ± 101	19500 ± 40.1	25741* ± 21.2	22111 ± 110.2	26050* ± 264.3

Values are expressed in mg/l Mean ± SD * significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test.

Graph No : 7 Monthly variation in Total Dissolved Solid at three locations in the estuaries in and around Malvan.

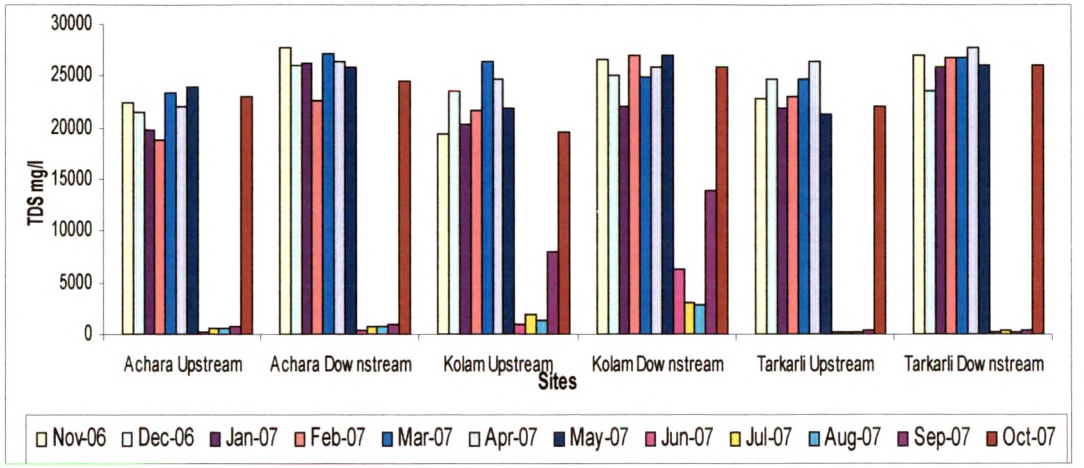


Table 8: Monthly variation in Total Suspended Solid at three locations in the estuaries in and around Malvan.

Months	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	22.69 ± 1.52	32* ± 5.5	11.2 ± 1.52	85.2* ± 5.6	30.0 ± 2.20	32.9* ± 10.2
Dec-06	62.1 ± 5.52	73.2* ± 4.25	41 ± 5.6	55* ± 4.99	33.0 ± 1.56	25.0* ± 2.23
Jan-07	15.01 ± 3.6	19.14* ± 2.50	18.21 ± 3.3	16.5* ± 4.4	10.01 ± 1.85	11.1* ± 1.56
Feb-07	27.12 ± 2.2	30.0** ± 3.9	20.0 ± 2.50	41.4* ± 2.2	25.21 ± 1.66	55.21* ± 2.2
Mar-07	69.21 ± 11.2	48.55** ± 3.95	29.3 ± 2.2	25.11** ± 0.58	75.52 ± 3.33	62.32** ± 5.5
Apr-07	17.07 ± 3.3	10.1** ± 1.1	22.0 ± 0.55	20.0** ± 1.0	54.12 ± 2.2	55.0* ± 10.2
May-07	46.01 ± 6.8	28.12** ± 6.8	26.14 ± 1.80	25.0** ± 2.1	65.0 ± 5.5	60.23 ± 12.3
Jun-07	459 ± 68.2	394.2 ± 35.6	103.2 ± 3.35	98.5** ± 29.57	660.12* ± 55.4	620** ±140.3
Jul-07	219.3 ± 55.6	222** ± 70.2	56.3 ± 10.72	101.2** ± 9.54	784 ± 48.5	445.3 ± 42.3
Aug-07	290 ± 45.2	220** ± 6.8	74.3 ± 10.84	97.2** ± 21.3	975.5* ± 66.3	952.2 ± 65.5
Sep-07	112 ± 26.2	56** ± 9.9	42.1 ± 11.32	75.11 ± 15.2	252.3 ±0. 23	212** ± 5.13
Oct-07	21.33 ± 3.3	21.66 ± 3.3	32.2 ± 1.56	33.21 ± 1.52	58 .2 ± 14.7	52.33** ± 8

Values are expressed in mg/l Mean ± SD * significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test.

Graph No : 8 Monthly variation in Total Suspended Solid at three locations in the estuaries in and around Malvan.

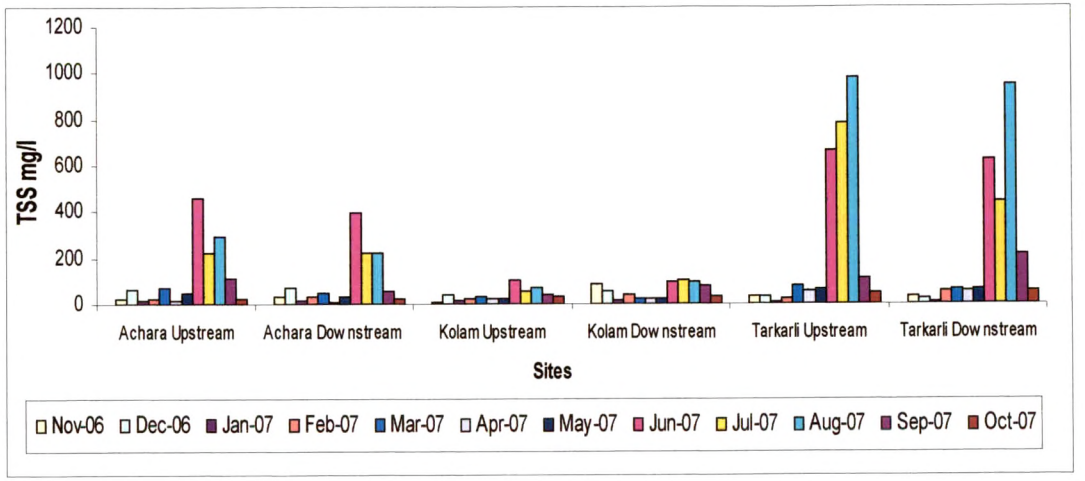


Table 9: Monthly variation in Chlorides at three locations in the estuaries in and around Malvan.

Month	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	21980 ± 80	26910* ± 250	18742 ± 41.2	22580* ± 90.30	21400 ± 100	25410* ± 120.3
Dec-06	19455 ± 27.54	22300* ± 301	21540 ± 101	21600* ± 122.3	22710 ± 15.2	22100* ± 160.55
Jan-07	16740 ± 166	23850* ± 211	17999 ± 240.6	19745* ± 36	18710 ± 114.3	23600* ± 101
Feb-07	16454 ± 160.3	19703* ± 30	18400 ± 100	25436* ± 27.54	19790 ± 205.2	25740* ± 85
Mar-07	22580 ± 55.6	26870* ± 10	23875 ± 224.2	24875* ± 101.3	22410 ± 155.3	25710* ± 475.6
Apr-07	21000 ± 41.3	24920* ± 250	22450 ± 160	24710* ± 122.1	25450 ± 55	26980* ± 112.3
May-07	22541 ± 170.2	23750* ± 11.25	19300 ± 48.5	25450* ± 25.6	18645 ± 1.56	22450* ± 45.2
Jun-07	133.2 ± 20.5	102.3 ± 60.2	755 ± 181.2	770.2* ± 55.67	99.2 ± 58.2	102.3 ± 55
Jul-07	280 ± 33.6	281.66 ± 17.66	810 ± 16.9	1780* ± 40.86	77.2 ± 11.5	88.1 ± 29.68
Aug-07	220 ± 15.3	252.3 ± 66	1190 ± 90	1540* ± 233	65.2 ± 42.3	70.2 ± 45
Sep-07	557.2 ± 220.3	554.2 ± 201.0	5690 ± 90	11620* ± 103.2	198.2 ± 70.0	610 ± 45.2
Oct-07	19420 ± 120.3	22540 ± 150	17420 ± 170.3	24580* ± 45	17850 ± 55	22100 ± 198

Values are expressed in mg/l Mean ± SD * significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test.

Graph No :9 Monthly variation in Chlorides at three locations in the estuaries in and around Malvan

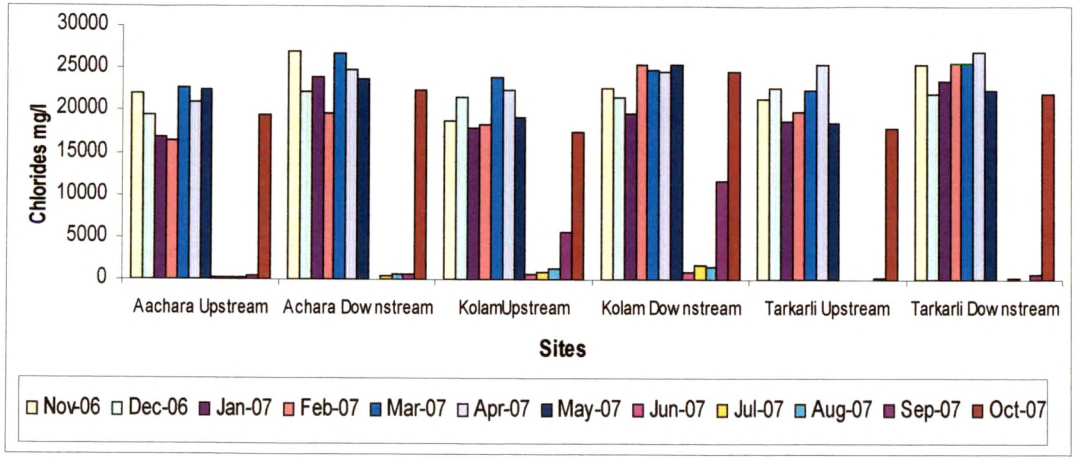


Table No: 10 Monthly variation in Nitrates at three locations in the estuaries in and around Malvan

Month	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	0.31 ± 0.59	1.22* ± 0.11	1.14 ± 0.02	1.4* ± 0.02	1.21 ± 0.02	2.2* ± 0.88
Dec-06	0.11 ± 0.74	2.9* ± 0.1	1.23 ± 0.02	2.19* ± 0.23	2.38 ± 0.01	2.22* ± 0.1
Jan-07	0.41 ± 0.15	0.41.2* ± 0.11	1.9 ± 0.41	1.45* ± 0.1	2.11 ± 0.45	2.15* ± 0.88
Feb-07	1.4* ± 0.015	1.12* ± 0.1	2.21 ± 0.041	2.24* ± 0.025	2.19 ± 0.02	3.66* ± 0.25
Mar-07	1.2 ± 0.11	2.23* ± 0.1	1.21 ± 0.05	2.19* ± 1.1	2.28 ± 0.11	3.23* ± 0.45
Apr-07	0.4 ± 0.14	0.14* ± 0.022	1.45 ± 0.12	3.41* ± 2.2	2.44 ± 0.21	4.39* ± 1.66
May-07	1.27 ± 0.9	0.9* ± 0.04	1.14 ± 0.05	0.17* ± 0.11	2.41 ± 0.11	2.90* ± 0.012
Jun-07	2.56 ± 0.44	2.41** ± 0.88	3.69 ± 1.1	4.66* ± 1.1	2.78 ± 1.1	3.98 ± 0.78
Jul-07	1.55 ± 0.21	5.25 ± 1.55	1.11 ± 0.23	3.25* ± 0.99	2.66 ± 1.1	5.12 ± 1.12
Aug-07	2.14 ± 0.99	3.22 ± 1.22	1.87 ± 0.99	2.56* ± 0.11	3.33 ± 1.2	1.66** ± 1.13
Sep-07	1.66 ± 1.1	1.99 ± 0.99	1.64 ± 0.88	2.45* ± 0.88	3.25 ± 0.44	2.66** ± 0.98
Oct-07	0.45 ± 0.02	2.66 ± 0.22	0.55 ± 0.25	1.89* ± 0.88	1.44 ± 0.012	2.52 ± 0.12

Values are expressed in mg/l Mean ± SD * significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test

Graph No : 10 Monthly variation in Nitrates at three locations in the estuaries in and around Malvan.

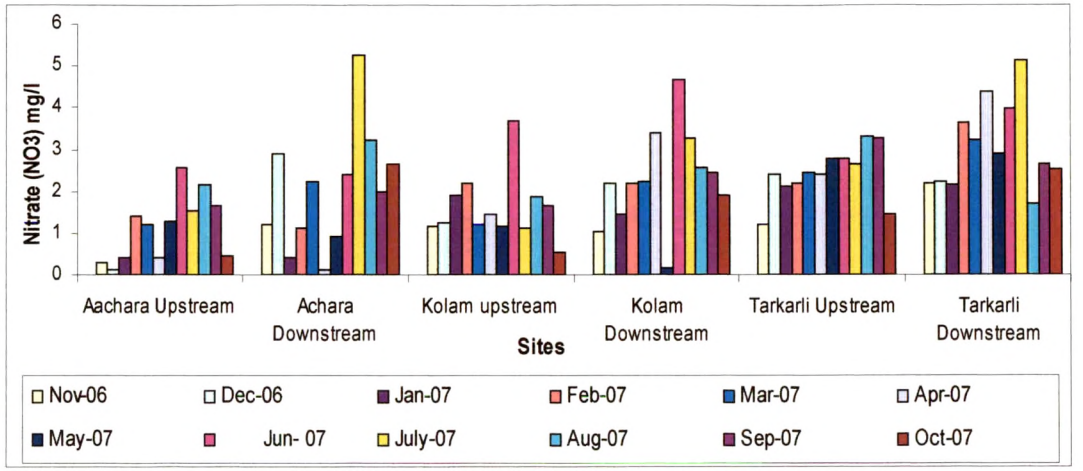


Table No: 11 Monthly variations in Oil and Grease at three locations in the estuaries in and around Malvan.

Month	Achara		Kolam		Tarkarli	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Nov-06	0.98 ± 0.01	0.66 ± 0.012	0.78 ± 0.2	0.19 ± 0.1	0.95 ± 0.12	0.88** ± 0.1
Dec-06	0.25 ± 0.14	0.55 ± 0.044	0.3 ± 0.11	0.17 ± 0.04	1.68 ± 0.06	1.1** ± 0.22
Jan-07	0.55 ± 0.04	0.4 ± 0.01	0.45 ± 0.11	0.31 ± 0.15	1.3 ± 0.55	0.9 ± 0.44
Feb-07	0.52 0.50	± 0.5 ± 0.1	0.25 ± 0.11	0.56 ± 0.05	1.9 ± 0.28	0.40 ± 0.012
Mar-07	0.33 ± 0.11	0** 0	0.96 ± 0.11	0.6** ± 0.25	0.87 ± 0.45	0.40** ± 0.012
Apr-07	1.41 ± 0.13	0** 0	0 0	0 0	1.9 ± 0.33	0.71** ± 0.22
May-07	0 0	0.33 ± 0.1	0.9 ± 0.1	0.19** ± 0.012	1.2* ± 0.31	0.99 ± 0.1
Jun-07	0 0	0 0	0 0	0 0	0 0	0 0
Jul-07	0 0	0 0	0 0	0 0	0 0	0 0
Aug-07	0 0	0 0	0 0	0 0	0 0	0 0
Sep-07	0 0	0 0	0 0	0 0	0.81 ± 0.55	0** 0
Oct-07	0.88 ± 0.23	0.56 ± 0.12	0.65 ± 0.41	0.45 ± 0.12	1.55 ± 0.54	0.21** ± 0.1

Values are expressed in mg/l Mean ± SD * significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test

Graph No: 11 Monthly variation in Oil and Grease at three locations in the estuaries in and around Malvan.

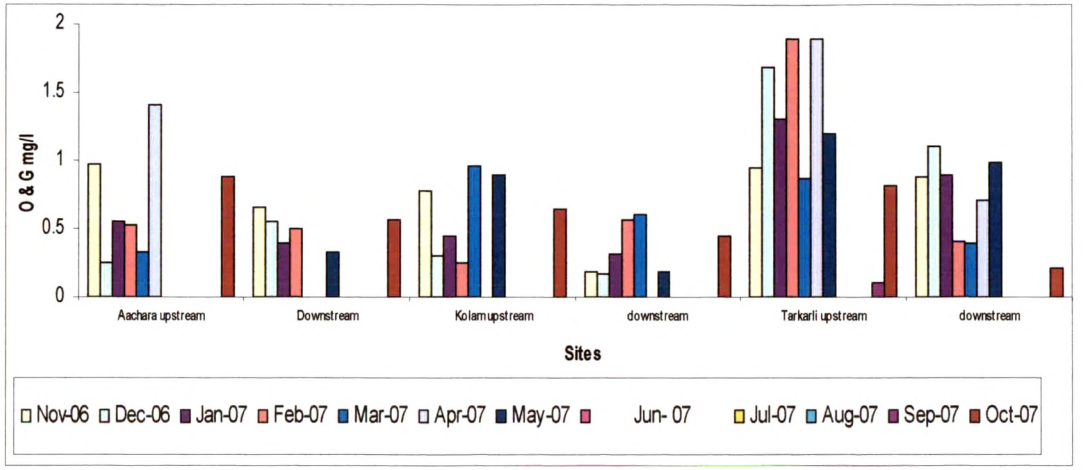
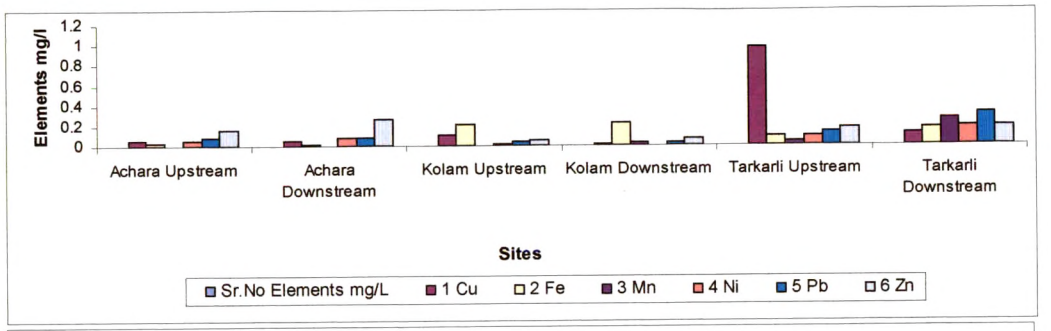


Table No: 12 Seasonal variations in Heavy metal during winter season at three locations in the estuaries.

Sr. No	Elements mg/L	Achara		Kolam		Tarkarli	
		Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
1	Cu	0.047 ± 0.07	0.059 ± 0.0021	0.099 ± 0.011	0.0111 ± 0.03	0.98 ± 0.22	0.114* ± 0.015
2	Fe	0.022 ±0.02	0.012 ± .0011	0.21 ± .001	0.23 ± 0.11	0.087 ± 0.045	0.168* ± 0.12
3	Mg	430 ± 1.2	390** ± 12.3	544.36 ± 24.2	619.3* ± 42.3	524 ± 12.2	416 ± 65.2
4	Mn	0	0	0.04 ± 0.03	0.021* ± 0.0012	0.0444 ± 0.02	0.26* ± 0.012
5	Ni	0.05 ±. 0.02	0.08 ± 0.02	0.012 ± 0.0015	0.69.8* ± 0.045	0.091 ± 0.004	0.183* ± 0.012
6	Pb	0.074 ± 0.011	0.08 ± 0.004	0.044 ± 0.011	0.021 ± 0.02	0.136 ± 0.011	0.32** ± 0.11
7	Zn	0.164 ± 0.022	0.259* ± 0.11	0.055 ± 0.0015	0.066 ± 0.0012	0.174 ± 0.089	0.181 ± 0.99
8	Na	1290 ± 22.3	3987* ± 55.4	1560 ± 12.3	2789* ± 111.2	1980 ± 22.3	3780.3* ± 113.5
9	K	231.3 ± 1.5	560.6* ± 22.1	650 ± 56.3	333** ± 12.3	754 ± 12.2	218** ± 23.
10	Ca	238.8 ± 41.2	430* ± 11	360.12 ± 22.3	122.3** ± 44	506.7 ± 9.8	231.7** ± 8.2

Values are expressed in mg/l Mean ± SD * significantly increased P< 0.05 by t-test ** significantly decreased P>0.05 by t-test

Graph No : 12 Seasonal variation in heavy metal during winter season at three location in the estuaries in and around Malvan.



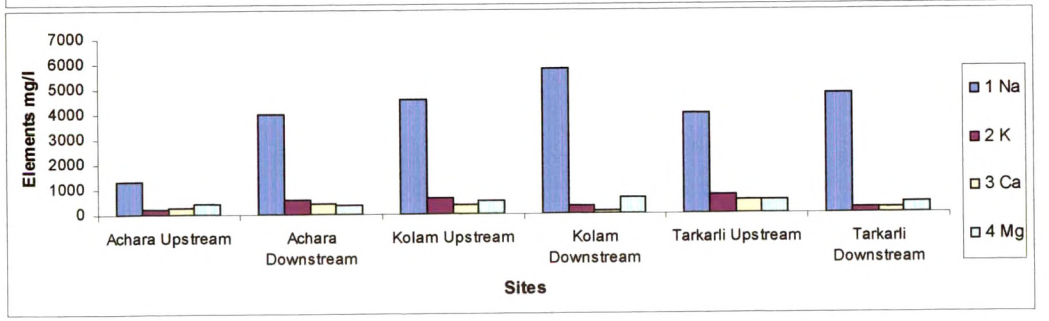


Table No: 13 Seasonal variations in Heavy metal during summer season at three locations in the estuaries.

Sr.NO	Element mg/L	Achara		Kolam		Tarkarli	
		Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
1	Cu	0.22 ± 0.11	0.032** ± 0.02	0.078 ± 0.22	0.088 ± 0.03	0.024 ± 0.01	0.051 ± 0.22
2	Fe	0.055 ± 0.15	0.025 ± 0.01	0.161 ± 0.12	0.164 ± 0.12	2.876 ± 0.88	2.376 ± 1.1
3	Mg	974 ± 112	382.4** ± 45.2	612.8 ± 32.3	928* ± 45.3	0.269 ± 0.11	0.221 ± 0.055
4	Mn	0.00716 ± 0.15	0.0395* ± 0.025	0.0418 ± 0.032	0.0538 ± 0.022	0 0	0 0
5	Ni	0.06 ± 0.04	0 0	0.55 ± 0.14	0.86* ± 0.112	0.074 ± 0.004	0.067 ± 0.04
6	Pb	0.225 ± 0.112	0.452* ± 0.23	0.395 ± 0.22	0.376 ± 0.11	0 0	0 0
7	Zn	0.074 ± 0.014	0.055 ± 0.01	0.08 ± 0.07	0.074 ± 0.045	0.02 ± 0.01	0.029 ± 0 .010
8	Na	2497.9 ± 321.2	3973.8* ± 12.3	1459 ± 62.3	2090* ± 12.5	2690.5 ± 2.0	3810.1* ± 2.1
9	K	425.1 ± 82.2	307.1 ± 3.3	225.3 ± 33.3	205.9 ± 35.4	285.1 ± 14.2	208.5** ± 12.3
10	Ca	315.2 ± 66.2	307.6 ± 45.6	70.4 ± 12.3	188.5* ± 15.6	221.9 ± 61.2	252.3* ± 32.5

Values are expressed in mg/l Mean ± SD * significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test

Graph No : 13 Seasonal variation in heavy metal during summer season at three location in three estuaries in and around Malvan.

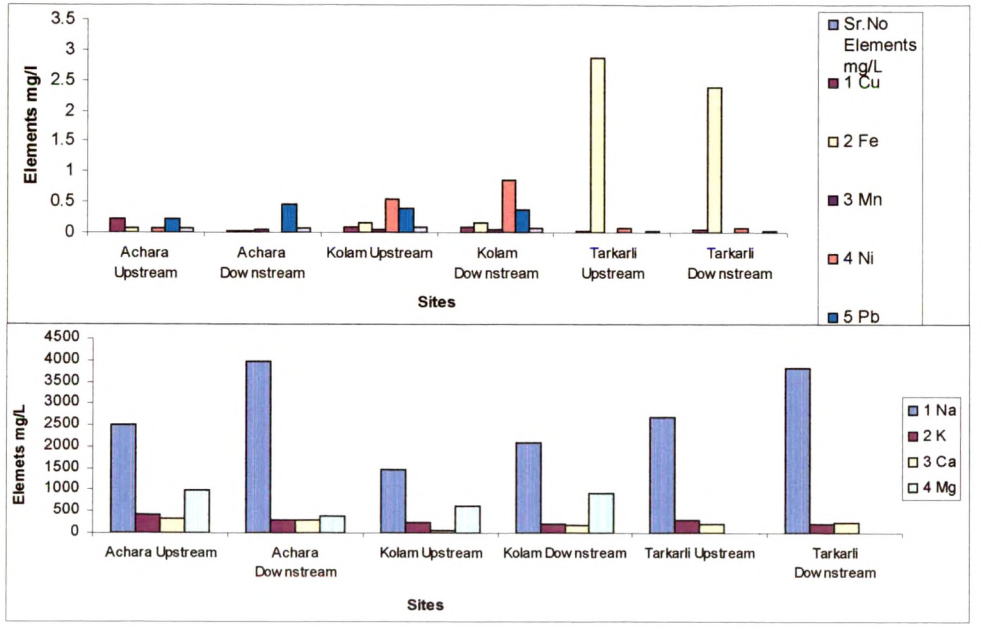


Table No: 14 Seasonal variations in Heavy metals during rainy season at three locations in the estuaries.

Sr. No	Elements mg/L	Achara		Kolam		Tarkarli	
		Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
1	Cu	0.02 ± 0.001	0.052* ± 0.044	0.027 ± 0.011	0.02 ± 0.001	0.024 ± 0.004	0.051 ± 0.011
2	Fe	2.1 ± 0.99	3.074 ± 0.88	3.035 ± 1.1	1.172** ± 0.12	2.876 ± 0.0045	2.376 ± 1.1
3	Mg	0.329 ± 0.12	0.23* ± 0.088	0.251 ± 0.25	0.30** ± 0.11	0.269* ± 0.025	0.221 ± 0.01
4	Mn	0 0	0 0	0 0	0 0	0 0	0 0
5	Ni	0 0	0.092* ± 0.055	0.053 ± 0.011	0.041 ± 0.001	0.074 ± 0.0045	0.067 0
6	Pb	0 0	0 0	0 0	0 0	0 0	0 0
7	Zn	0.011 ± 0.55	0 0	0.014 ± 0.07	0 0	0.021 ± 0.0012	0.029 ± 0.0014
8	Na	419.3 ± 56	610.3* ± 21.3	919 ± 65.2	1912* ± 22.3	210 ± 12.3	523.2* ± 22.3
9	K	101 ± 23.1	193.2* ± 100	158.9 ± 25.6	102.3** ± 21.2	89 ± 8.8	199* ± 15.8
10	Ca	251 ± 45.2	320.3* ± 10	122.3 ± 9.5	104.3** ± 9.8	155.6 ± 14.3	1 74.4* ± 16.3

Values are expressed in mg/l Mean ± SD * significantly increased P< 0.05 by t-test. ** significantly decreased P>0.05 by t-test

Graph No : 14 Seasonal variation in heavy metal during rainy season at three location in three estuaries in and around Malvan.

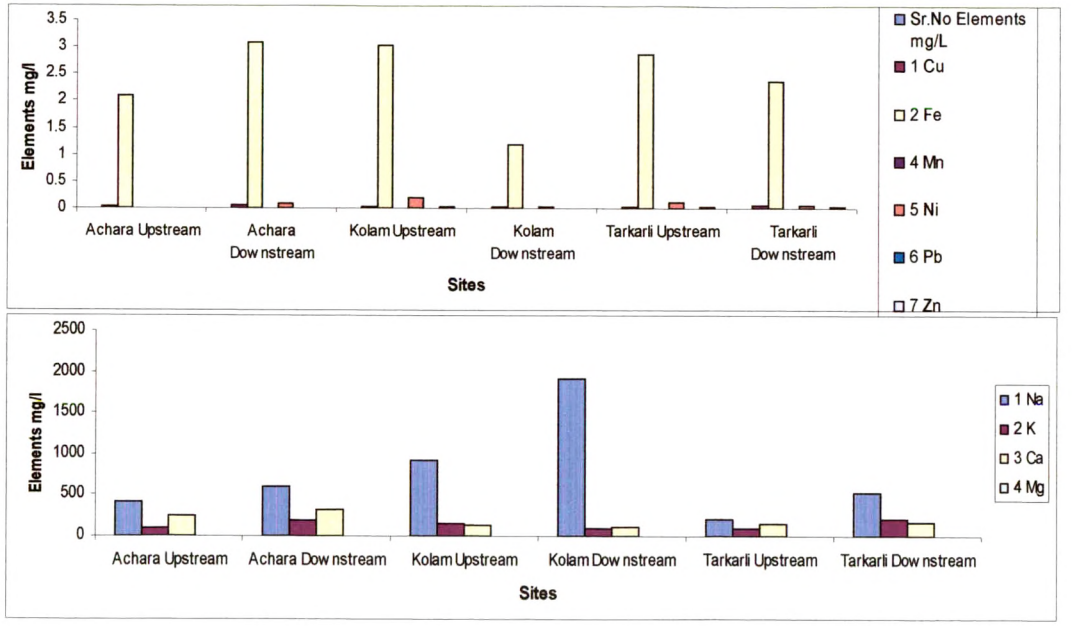


Table No: 15 Disposal pattern of waste water at three locations in and around Malvan.

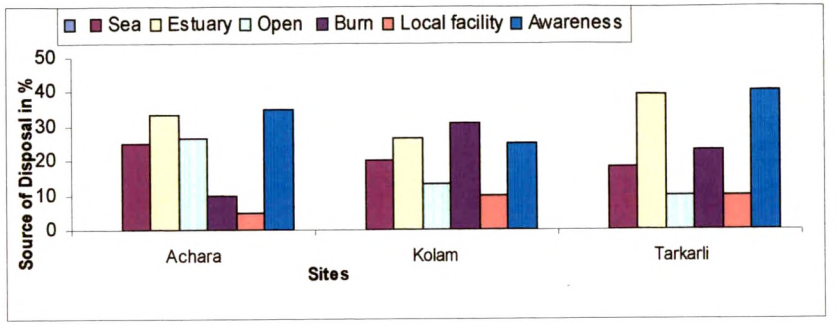
Source of Disposal	Achara			Kolam			Tarkarli		
	Hotel owners	Residential	Fisherman	Hotel Owners	Residential People	Fisherman	Hotel owners	Residential People	Fisherman
Sea	5	8	22	2	8	10	3	6	4
Estuary	2	18	17	9.34	15	10	10	22	17
Open	3	12	10	10	20	10.66	5	7	10
Local facility	2	3	3	2	1	0	7	7	2

Table No: 16 Disposal pattern of Solid waste at three locations in and around Malvan.

Source of Disposal	Achara			Kolam			Tarkarli		
	Hotel owners	Residential	Fisherman	Hotel Owners	Residential People	Fisherman	Hotel owners	Residential People	Fisherman
Sea	5	15	5	5	7	8	8	7	3
Estuary	8	15	10.33	5	16.33	5	10	19	17
Open	6.66	12	8	0	8	5	3	4	3
Burn	0	8	2	8	15	8	5	5	6
Local facility	3	1	1	3	5	1	6	3	1

Value expressed in percentage (%)

Graph No : 15 Disposal of Solid waste at different location in and around Malvan



Graph No : 16 Disposal of waste water at different location in and around Malvan

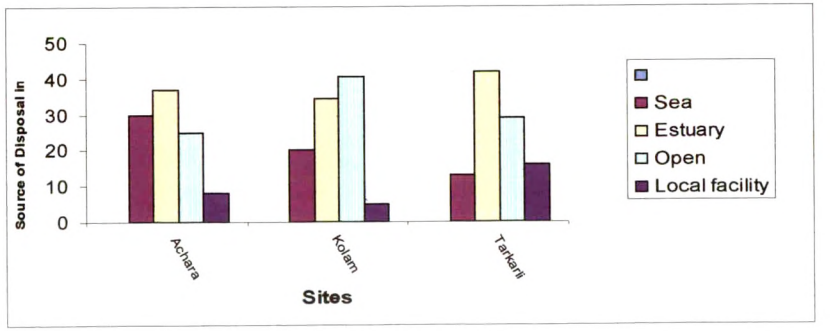


Plate - III

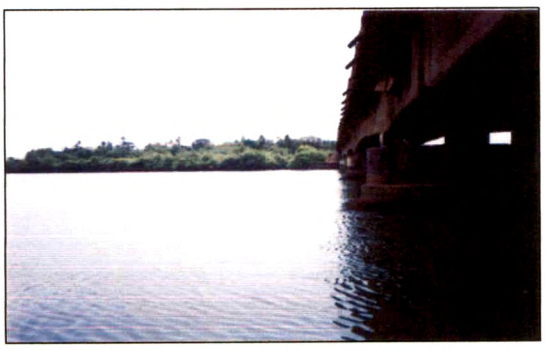
Upstream location of Achara estuary

Downstream location of Achara estuary

Fishing Trollers at Achara estuary

Plate - IV

Upstream location of Kolam estuary

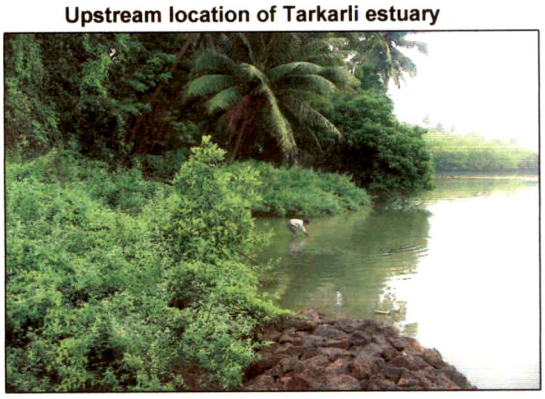


Downstream location of Kolam estuary

Disposal of garbage in Kolam estuary

Plate - V

Upstream location of Tarkarli estuary



Downstream location of Tarkarli estuary

Solid waste disposal on the bank of Tarkarli estuary

Plate- VI

Improper disposal of waste at Tarkarli estuary

Direct release of sewage in Kolam estuary

Blockage of estuary for Tourism development at Achara estuary

Tourism business Tarkarli at estuary