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Full Length Research Paper

Influence of pollutants on bottom sediment of sewage collecting Kalpi (Morar) River, Gwalior, Madhya Pradesh (M. P.)

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To investigate the nutrient value of bottom soil pH, conductivity, potassium, exchangeable potassium, total phosphorus, available phosphorus, organic carbon, total nitrogen, available nitrogen, calcium and magnesium were analyzed from monthly samples collected from six sampling stations during two year of study, that is, April 2002-March 2004 of study. Soil from station A was found unpolluted due to low level of pollution load and less human activities. While at other stations sewage and municipal wastes increased the amount of calcium, magnesium and other nutrient.

Key words: River, sediment pollution, nutrient level.

INTRODUCTION

The quality of soil of aquatic environment plays a major role in determining the fertility of water body. Soil acts as a reservoir of nutrients and several biogeo-cycling taken places at bottom and exchange of nutrients takes at bottom water interface. Nutrients are also derived from the drainage water and mineralization of organic matter. The influence of soil type and nutrients, on the benthos is well known. The role of sediment nutrients is very much useful in determining nutrients of the river ecosystem.

Nutrients are also derived from the drainage water and mineralization of organic matter. The bottom sediment also provides the shelter for various life forms including both micro and macrozoobenthic organisms. Sreenivasan (1976) reported that, the bottom sediment is the main source for different forms of nitrogen. Jhingran (1991) insisted that the organic carbon of sediment is a common constituent of all organic matter and this can also be a measure of bacterial activity. Kumar and Ramachandra (2003) have observed low values of conductivity in Sharavathi river Karnataka may result in least nutrient transfer, complexation and exchange of elements.

A survey repot on Mithi river (M.P.C.B., 2004) showed that the river had pH value between 6.5-8.5 and sulphate between 1500-1400 mgl^{-1} due to high load of municipal and domestic sewage. Due to sediment contamination, several changes take place in the sediment including that of degradation of bottom-feeding invertebrate communities, increased incidence of fish tumors and other abnormalities (Crane, 2005). Padmaja et al. (2008) studied the sediment quality of water tank in near Medak District A.P. and suggested its suitability in agriculture due to rich in nutrients.

MATERIALS AND METHODS

The sediment samples have been collected from different sampling stations by Ekman's dredge, scoop and direct by hand wherever possible and various physical, chemical parameters have analyzed after Trivedy and Goel (1986) and Chopra and Kanwar (1999).

The samples were kept in polythene bags and transported to laboratory as early as possible. Apparent density, pH and water holding capacity were analyzed immediately. For other parameters, soil sample were dried in air under the shadow in natural conditions. Soon after drying, stones and similar objects are picked up and the soil is grounded in a mortar to break up aggregates or lumps, taking care not to break actual soil particle. The soil was then passed with 2 mm sieve. The mesh size allows all the nutritionally important factors to pass through. Approximately, 4-5 gm of soil was grounded to get more fine particles which can pass through mesh size of 0.5 mm.

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Table 1. The mean values of Soil Characteristics in Kalpi (Morar) river during April 2002 - March 2004.

S/No.	Parameter	A	B	C	D	E	F
1	Apparent density ($g.cm^{-3}$)	1.93	1.34	1.85	1.76	1.59	1.65
2	Water holding capacity (%)	25.39	26.53	26.69	26.06	28.57	26.85
3	Soil pH	7.36	7.51	7.43	7.48	7.60	7.52
4	Conductivity ($mS.cm^{-1}$)	0.85	1.63	1.72	1.76	1.00	0.94
5	Total phosphorus (%)	0.067	0.069	0.071	0.079	0.069	0.068
6	Available phosphorus (%)	0.017	0.018	0.020	0.024	0.022	0.016
7	Total nitrogen (%)	0.034	0.052	0.053	0.054	0.036	0.035
8	Available nitrogen (mg..100 gm^{-1})	23.99	31.23	32.41	33.56	31.31	26.80
9	Organic carbon (%)	1.06	2.06	2.23	2.37	1.46	1.19
10	C and N ratio	30.94	41.53	40.68	45.37	45.21	35.20
11	K (mg.100 g^{1})	62.10	74.06	74.44	77.76	67.80	66.69
12	Exchangeable (K mg.100 g^{1})	33.12	40.10	42.77	43.40	36.46	33.29
13	Ca (m.e.100 g^{-1})	1.25	1.43	1.50	1.53	1.30	1.24
14	Mg (m.e. 100 g^{-1})	0.40	0.45	0.51	0.52	0.44	0.43

Physical characteristics

Apparent density, water holding capacity and specific conductivity.

Chemical characteristics

pH, total phosphorus, available phosphorus, total nitrogen, available nitrogen, organic carbon, carbon and nitrogen ratio, potassium, exchangeable potassium, calcium and magnesium.

RESULTS AND DISCUSSION

The physical and chemical properties of soil from all six stations are presented in the Table 1 and Figures 1 - 14. Soil of river were noticed with higher value of nutrients, this was occurred due to sedimentation through sewage and waste pouring.

Apparent density

Apparent density is a weight measurement in which the entire soil volume is taken in to consideration (Buckman and Brady, 1950) and which allows knowing the nature of bottom. In a study by Kumar and Ramchandra (2003) apparent density of Sharavathi river in Kerala was found between 0.783 and 1.475 g. cm^3 indicating rocky bottom condition. Physico-chemical analysis of bottom soil reveals minimum density of 0.923 and maximum of 1.092 $g.m^{-3}$ in Khandaleru reservoir, Tumayya (Asadi et al., 2008). In the present study Kalpi (Morar) river was having apparent density (1.34 to 1.93 $g.cm^{-3}$) similar to those of other workers (Figure 1).

Water holding capacity

The water holding capacity is determined to know the water content of soil. The moisture content of sediment samples was found up to 37.702% from Sharavathi river (Kumar and Ramchandra, 2003). In the present study, the water holding capacity was found 38.61% at station D during October, 2003 (post mansoon) the minimum of 25.39% value was evident at station A (Figure 2).

pH

The pH of soil is known to control both biogenic and abiogenic reactions and has a direct influence on the sediment nutrient status as well as the condition of the overlying water. The vertical concentration gradient of ions in the water, which controls the benthic communities, is closely related to pH (Banerjea, 1967). Hosetti et al. (1995) observed soil pH of 7.2 in Tunga river at Shimoga. Pathak et al. (2001) observed pH ranging from 6.7 to 7.2 of Mahanadi river from Durgapalli to Narsinghpur. Kumar and Ramchandra (2003) showed pH value varying between 6.37 and 7.39 in the sediment of Sharavathi river.

The pH values observed by above workers are least favorable for the bottom decomposition. pH of the sediments was to be found high in Mithi river of Mumbai due to domestic and municipal sewage pouring in to the river (MSPCB, 2004). The pH of sediment in Ase river, Nigeria was quite high during summer due to high concentration of heavy metals (Iwegbue et al., 2006) the similar trend of pH were noticed at Niger Delta by (Iwegbue et al., 2007). The pH of Kalpi river was noticed always moderately alkaline and varying from 7.1 – 8.14 during the study (Figure 3).

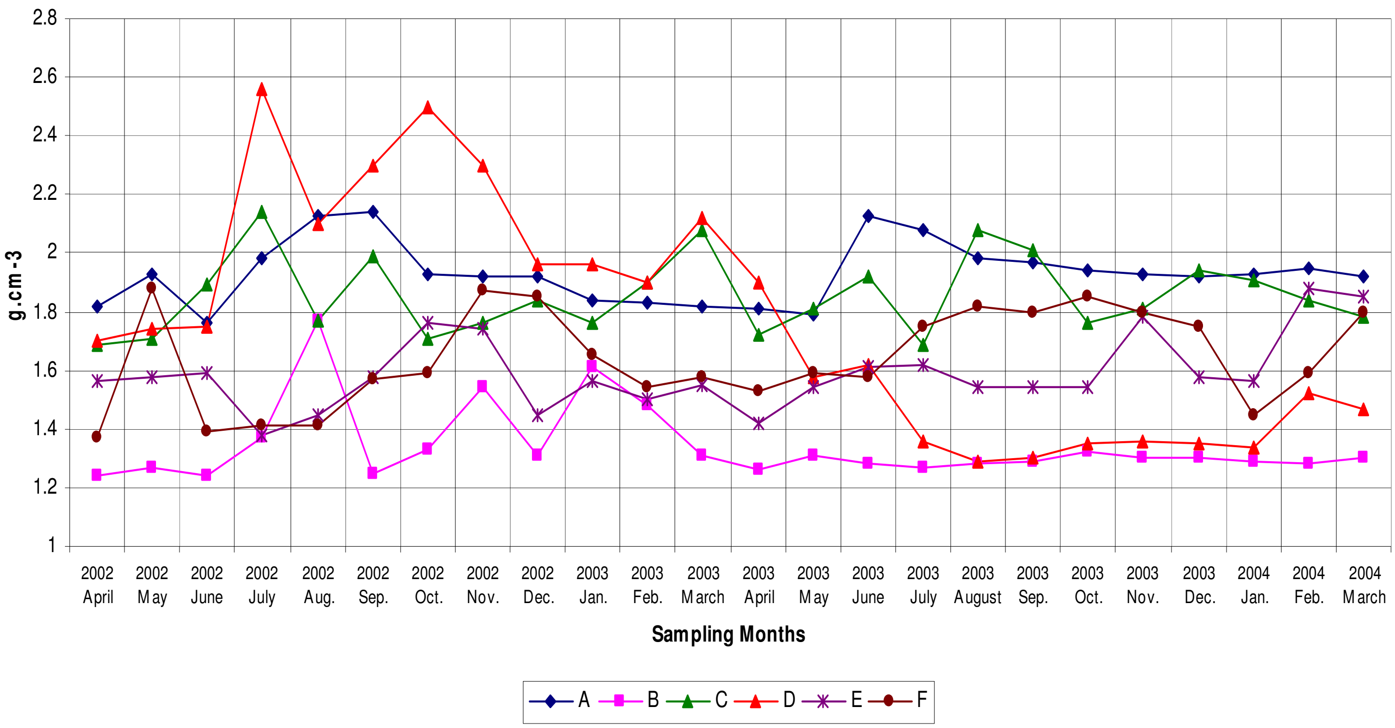

Figure 1. Showing sediment apparent density at various stations on Kalpi (Morar) river.

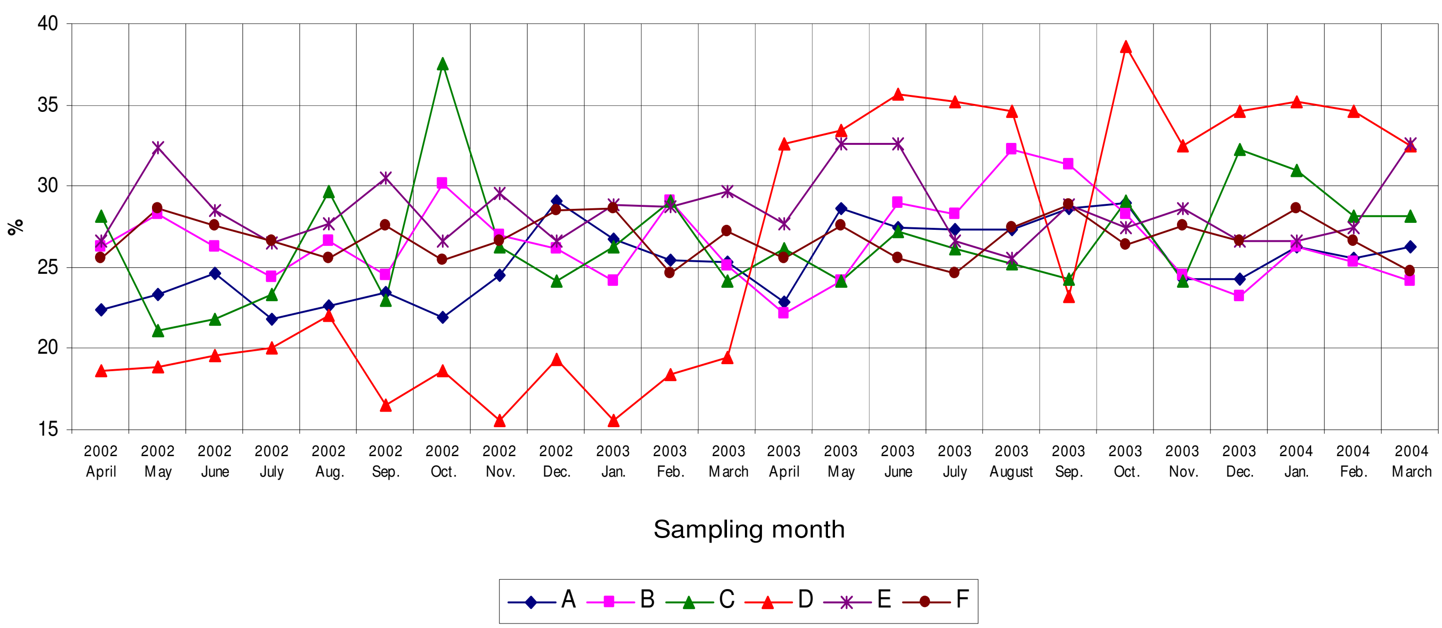

Figure 2. Showing water holding capacity at various stations on Kalpi (Morar) river.

Specific conductivity

Specific conductivity of sediment has an influence on the water medium. The fluctuations in conductivity of soil and that of water are quite proportional and ahs become a common trend. Ayyappan and Gupta (1985) have observed an increase in dissolved organic matter that affected the values of conductance. The specific conductivity values were lower in Sharavathi river, Kerala which resulted from least nutrient transfer, complexation and exchange

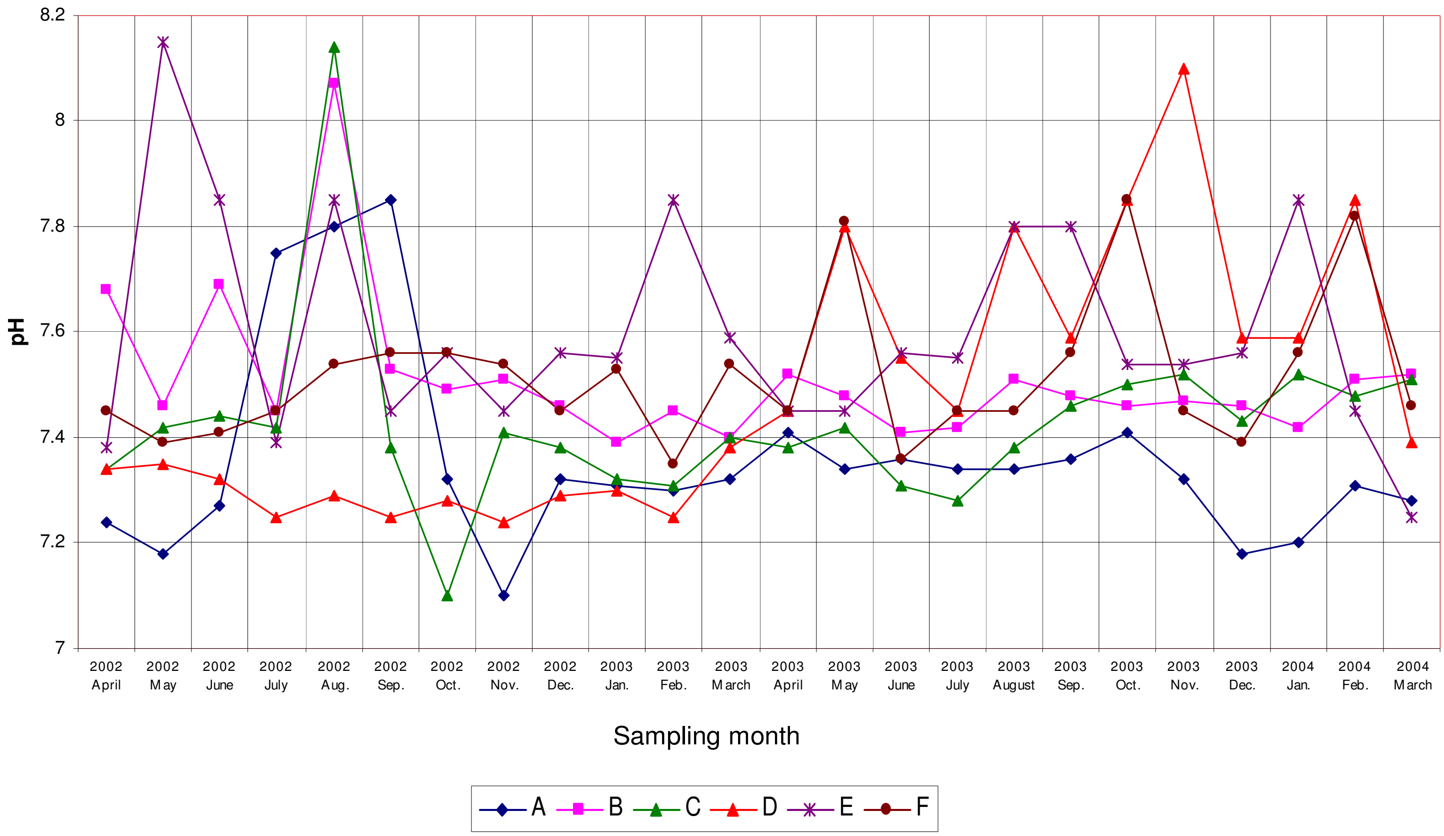

Figure 3. Showing soil pH at various stations on Kalpi (Morar) river.

of elements (Kumar and Ramchandra, 2003).

According Assadi et al. (2008), the specific conductivity values of the soil were within permissible limit and do not indicative of contamination. In the Kalpi (Morar) river, conductivity was minimum (0.81 $m.Scm^{-1}$) at station A in the month of February, 2003, where the sediment was almost without contamination, while higher of value of specific conductivity were noted at station D (2.51 $m.Scm^{-1}$) followed by station C (2.14 $m.Scm^{-1}$), and station B (2.01 $m.Scm^{-1}$). It was because of the fact that the municipal sewage started pouring at these points (Figure 4).

Phosphorus

The high phosphorus content in all the soil profiles may be attributed to continuous addition of fertilizers, manures and sewage sedimentation. Plants in the sediments of river continuously absorb available phosphorus. Analysis of phosphorus revealed a maximum value at Ramapuram area due to surrounding agricultural lands in the downstream of Khandaleru reservoir at reservoir (Assadi et al., 2008). In the present study, the phosphorus was minimum in the sediment at station A while maximum amount was observed at station D (Figure 5).

Available phosphorus

Ghosh (1989) observed higher amount of available phosphorus in Hoogly estuary near haldia port due to seepage of municipal sewage and industrial effluents. In Kalpi (Morar) river also, the sediments were having good amounts of available phosphorus in the areas of the river with appreciale organic matter load (Figure 6).

Nitrogen

Nitrogen being a major nutrient plays an important role in determining the fertility. The carbon and nitrogen (C: N) ratio is also an important factor in soil fertility because it is an indicator of decomposition of organic matter. Sreenivasan (1976) reported that the bottom sediment is the main source for different forms of nitrogen. Ayyappan and Gupta (1985) observed a negative correlation between the nitrate–nitrogen content and available nitrogen content of water and the available nitrogen content sediment. Purusothama (1985) stated that increased water level cause enhancement in nitrogen content of the sediment during rainy season. In Kalpi (Morar) river, the total Nitrogen was high at places where organic pollution was higher. The high value of Nitrogen content was at

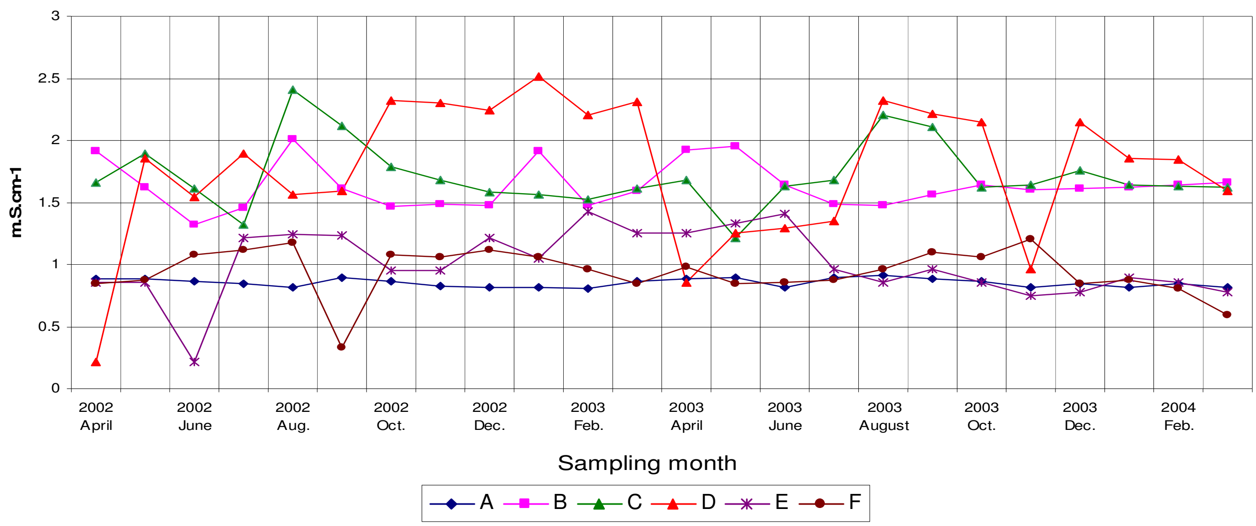

Figure 4. Showing specific conductivity m.S/cm at various station on Kalpi (Morar) river.

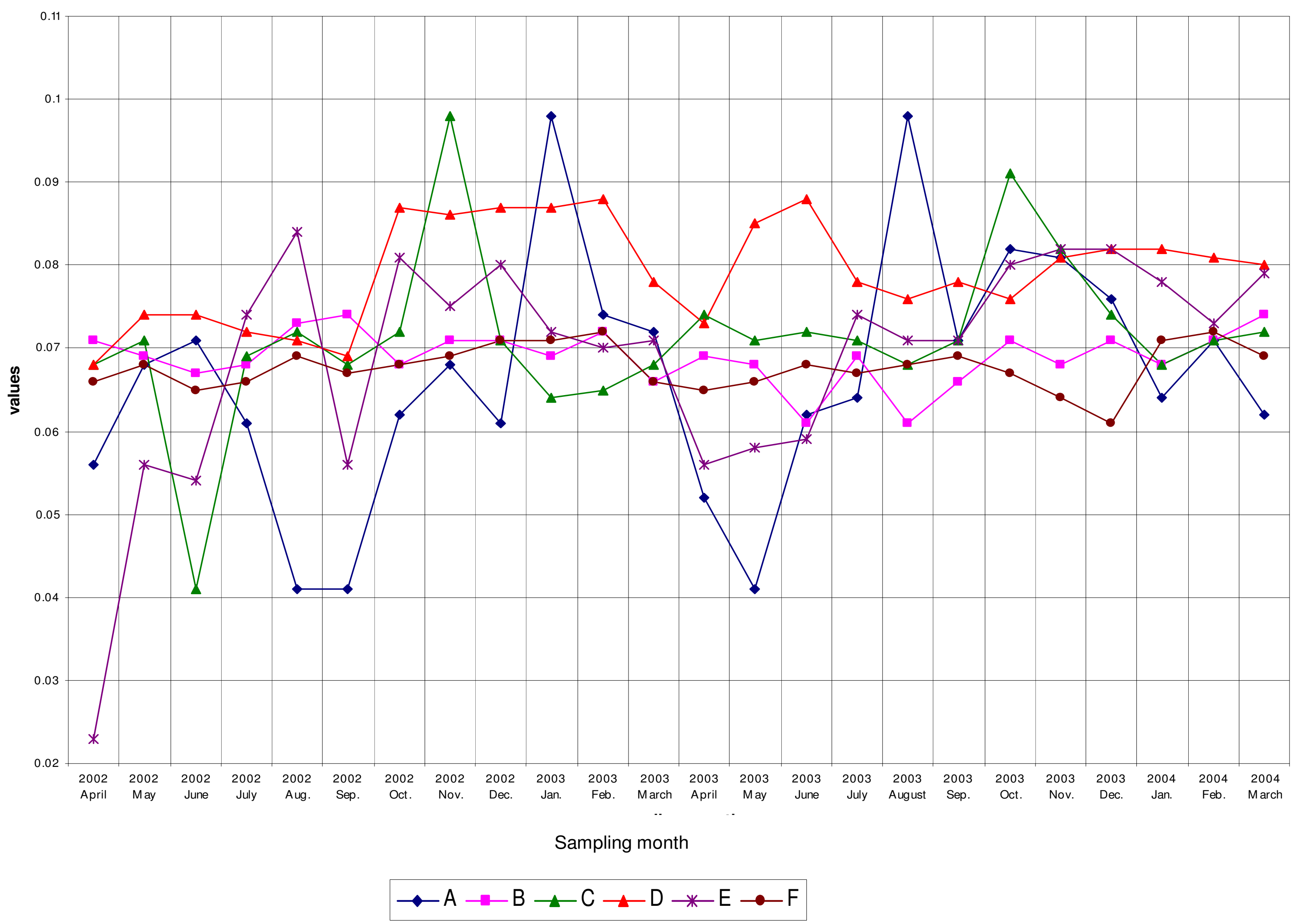

Figure 5. Showing total phosphorus at various stations on Kalpi (Morar) river.

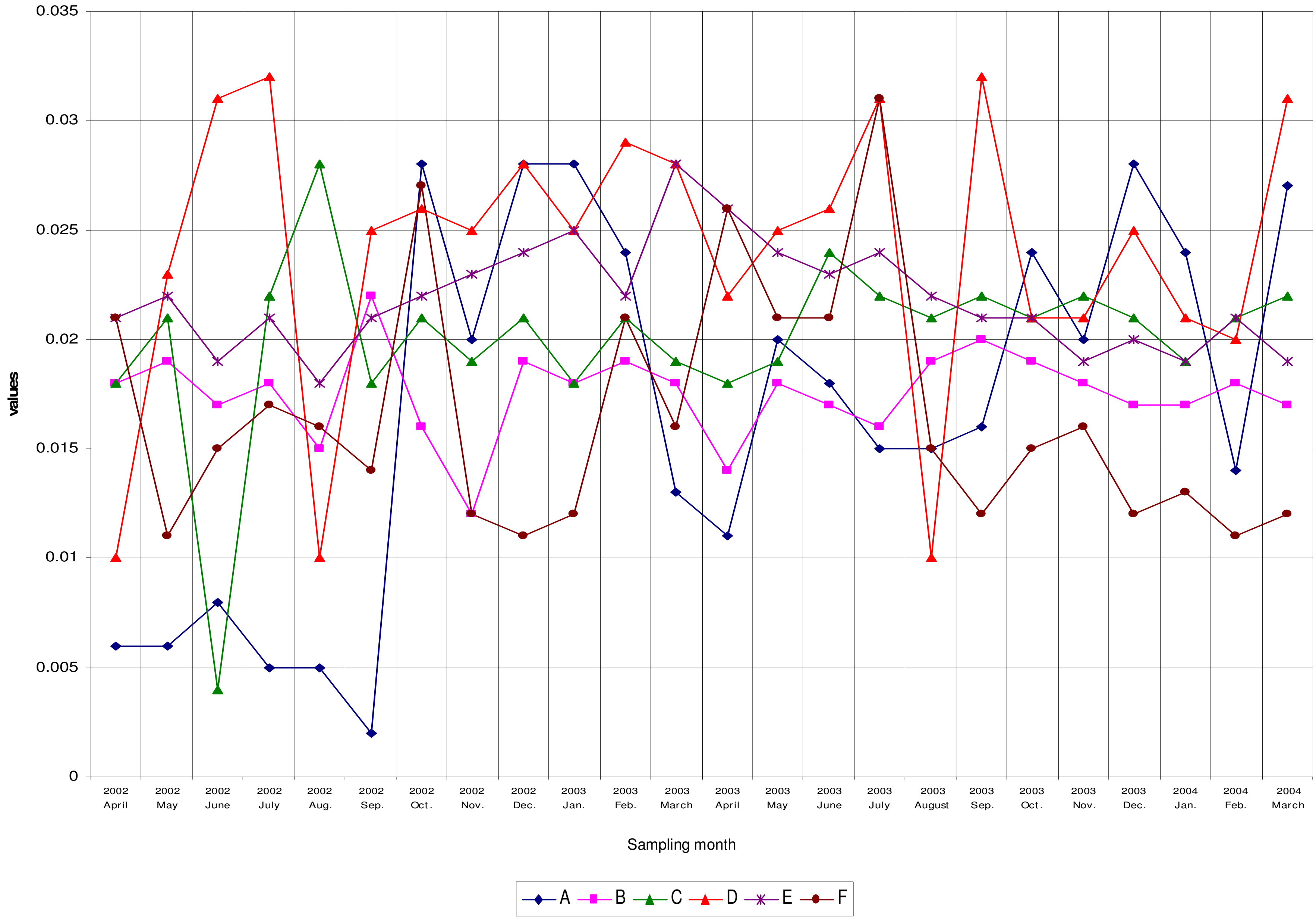

Figure 6. Showing available phoshphorus at various stations on Kalpi (Morar) river.

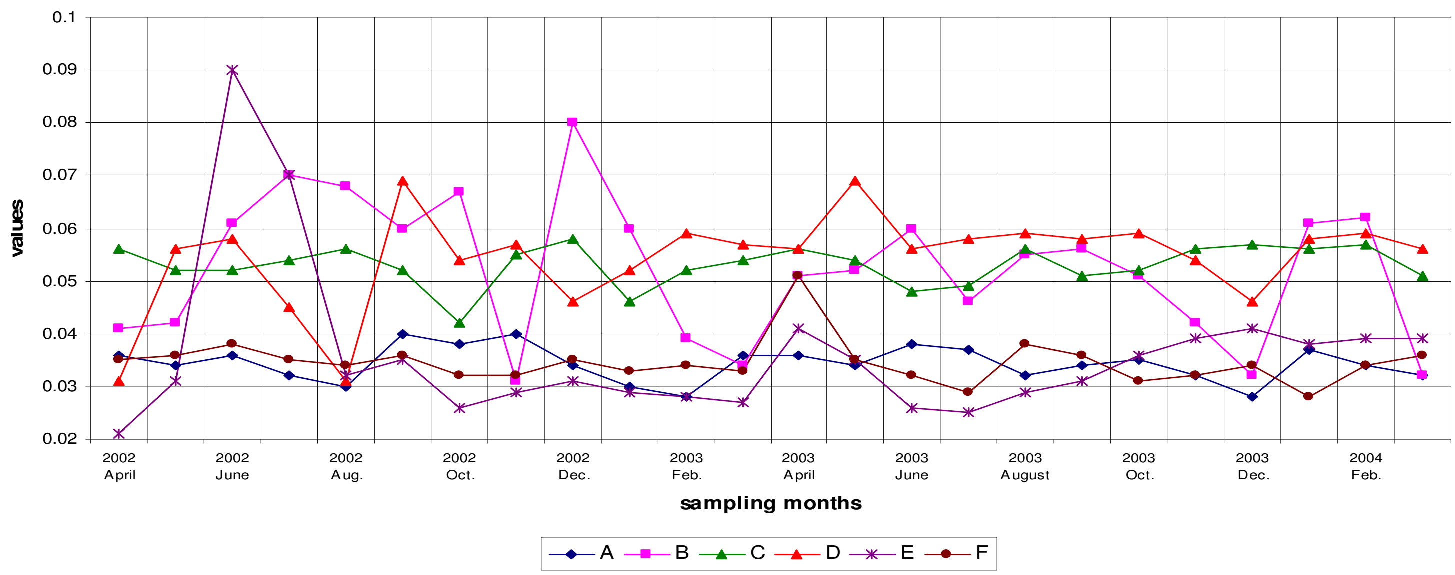

Figure 7. Showing total nitrogen at various stations on Kalpi (Morar) river.

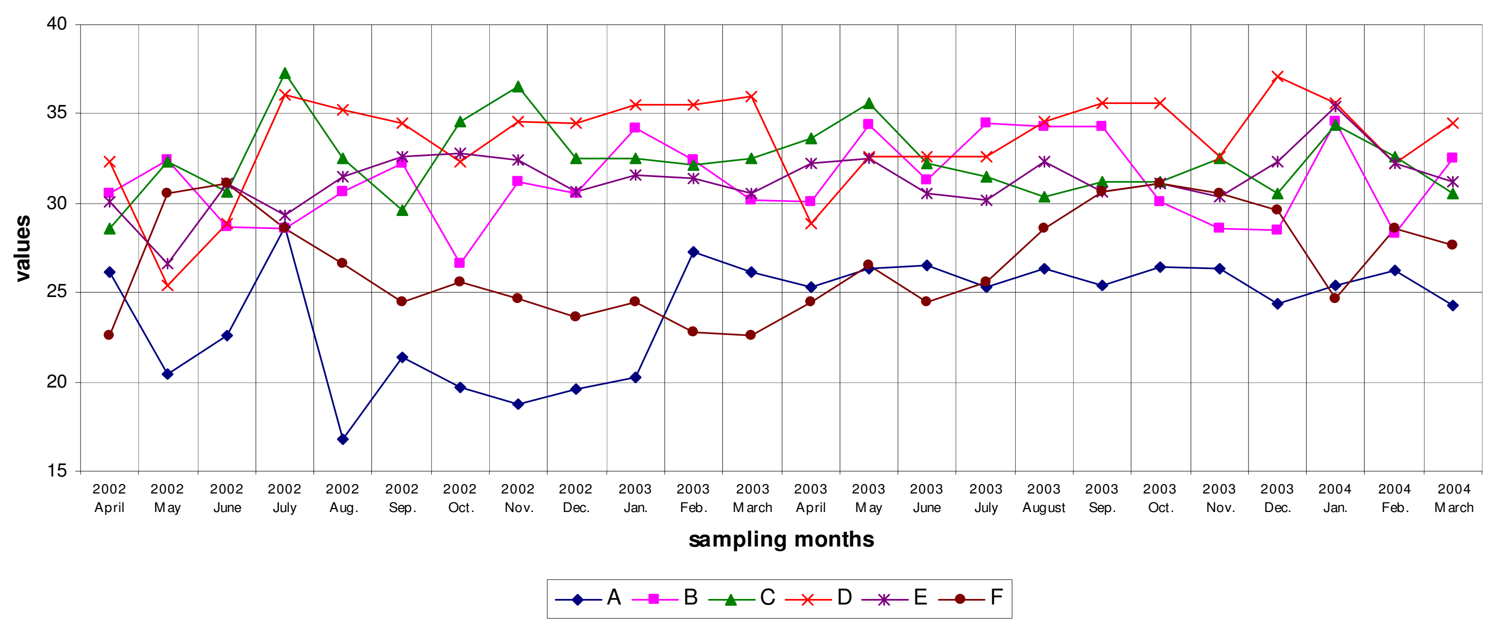

Figure 8. Showing available nitrogen at various stations on Kalpi (Morar) river.

station B, C and D probably due to addition organic matter in the form of sewage and a low value was obtained at station A where no organic pollution was observed (Figure 7).

Available nitrogen

Banerjee and Pakrasi (1986) have shown a low concentration of available nitrogen in newly constructed impoundments at Sunderban. Ghosh and Chaudhary (1989) found high values of available nitrogen in Haldia port at Hoogly estuary were due to dumping of organic wastes. Low level of available nitrogen in ponds along chilka lake may be due to the least human activity in that region (Gupta et al., 1999). Nasnolkar et al. (1996) reported higher sediment nitrogen content in Mandovi estuary.

In the present study also, the available nitrogen was obtained with its lower value at station A 16.8 mg.100 g^{-1} with less organic material input and higher value of 37.10 mg.100g^{-1} was obtained at station D with greater influx or sewage (Figure 8).

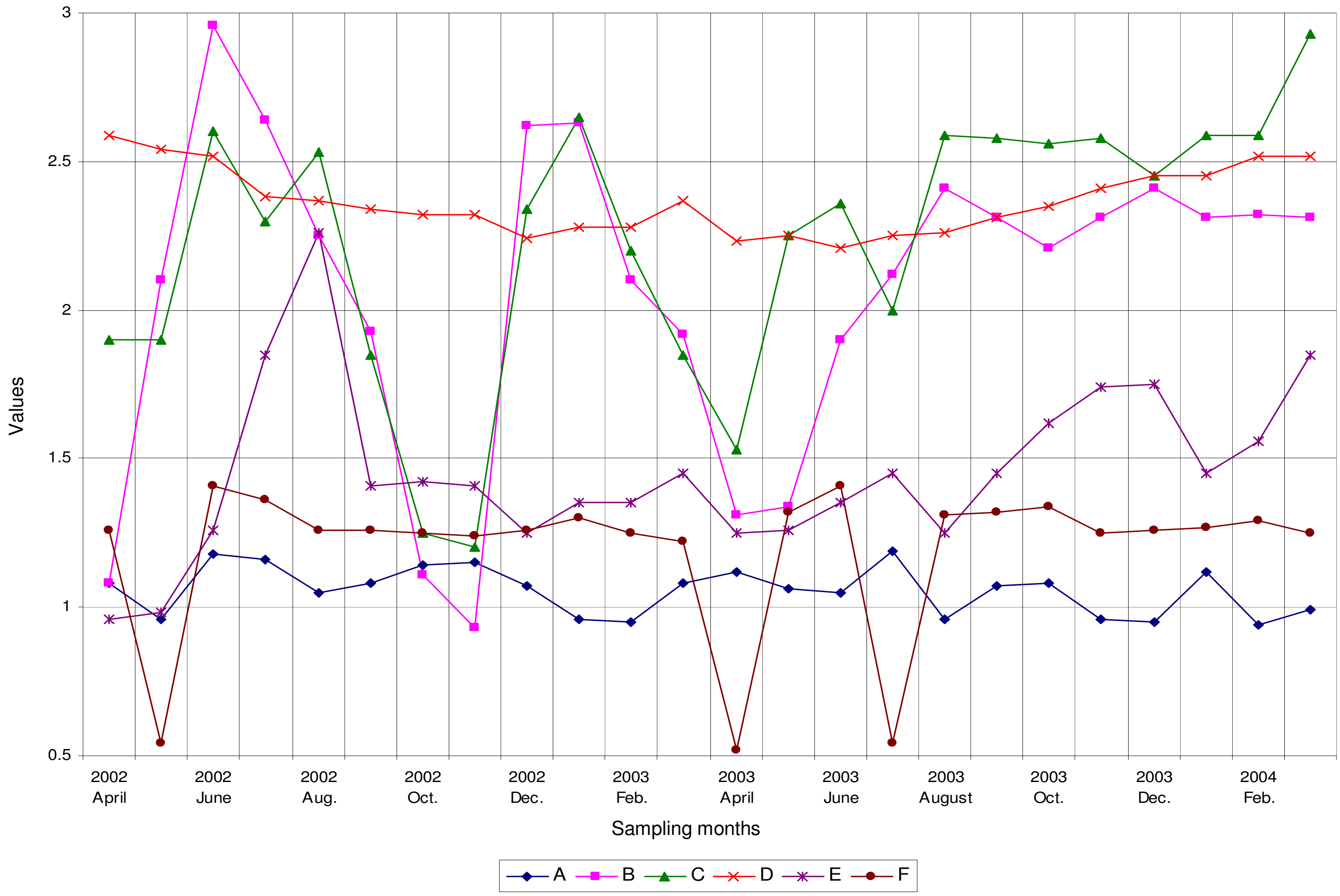

Figure 9. Showing organic carbon at various stations on Kalpi (Morar) river.

Organic carbon

The organic carbon represents the organic matter in the sediment. The dead organic matter gets deposited in the bottom and undergoes chemical and bacterial decomposition. Estimation of organic carbon can serve as an important tool in determining the status of food available to the benthic fauna and also indicates the extent to which the bottom soil is fertile for the subsistence of benthic fauna. The organic carbon also exerts an influence on the available phosphorus level in the soil. Jhingran (1991) described that, the carbon is the common constituent of all organic matter and is a measure of bacterial activity. Kumar and Ramchandra (2003) observed the organic carbon is rich condition in Sharavathi river due to large amount of organic matter. The organic matter content of Ase river sediments are generally low (Iwegbue et al., 2007).

Similar low organic matter content has been reported for some river system in the Niger Delta (Horsfall et al., 1999) due to less anthropogenic activities on both the side. Higher organic matter was observed in the soil of Khandaleru reservoir due to unplanned irrigation practices which contributed input of fertilizer into the reservoir (Assadi et al., 2008). The organic carbon content is generally high in the sediment of river Kalpi (Morar) ranging 0.93 - 2.59%, showing higher contamination. The highest values were obtained from station D (April, 2002), while the minimum values were evident 1.06% at station A, where least human activities were observed. Station D is the highly polluted point of the river (Figure 9).

Carbon and nitrogen ratio

The carbon to nitrogen (C:N) ratio is also an important factor in soil fertility because it is indicative of the rate of decomposition of organic matter. The application of nitrogenous fertilizers cause reduction in the population of both nitrogen fixing and denitrifying bacteria and

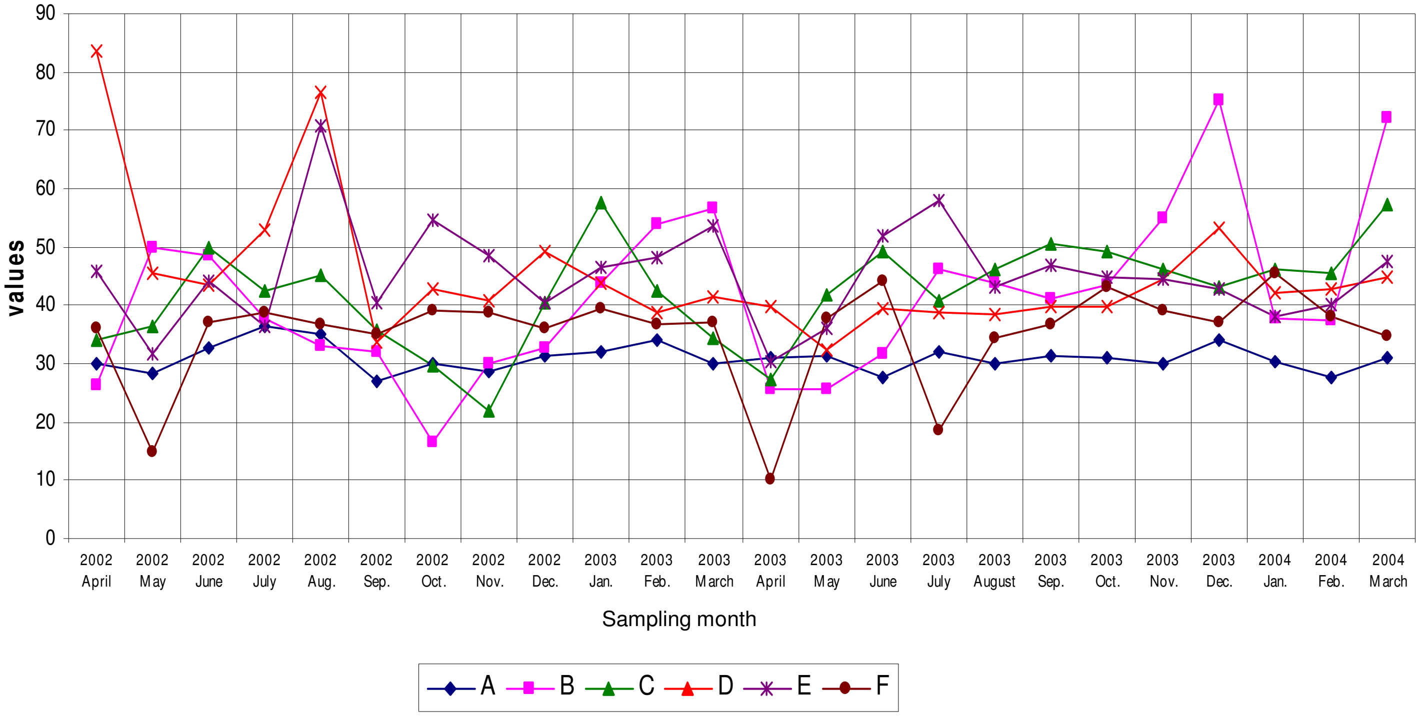

Figure 10. Showing carbon and nitrogen ratio at various stations on Kalpi (Morar) river.

further influenced by various factors (Hepher, 1952). In the present study the carbon and nitrogen ratio were fluctuated with the range of 30.94 to 45.37 (Figure 10).

Potassium

The values of potassium in sediment were found ranging from 0.013 to 0.89 mg.gm^{-1} in Sharavathi river which considered as low because of least pollution and human activities (Kumar and Ramchandra, 2003). In the present study, the potassium was found in good amount with 42 showing higher concentration at station D which is highly polluted (Figure 11).

Exchangeable potassium

The mean exchangeable potassium was observed to be at station A and it was found in increasing order from B to D. Again, the exchangeable potassium was reduced at station E and F as these stations are pollution free areas (Figure 12).

Calcium

Calcium promotes the activity of soil bacteria concerned with the fixation of the free nitrogen or the formation of nitrates from organic forms of nitrogen. Calcium deficiency is commonly associated with the acidity, which will lead to the accumulation of toxic salts of iron, aluminium and manganese in the sediments. In the present study, the amount of calcium in soil was higher in contaminated soils in comparison to uncontaminated soil, probably due to the sedimentation of water pollutants. The higher amount of calcium in the water itself reflects the high calcium content in the bottom soil. The highest mean value of calcium was in soil 1.53 m.e.100 g^{-1} at station D while lowest mean was 1.25 m.e.100 g^{-1} at station A in Kalpi (Morar) river (Figure 13) mg.100 g^{-1} at station A to 85.3 mg.100 g^{-1} at station D.

Magnesium

In Sharavati river in Kerala was highly dependent on the parent materials or rock (Kumar and Ramchandra, 2003). Usually, amount of magnesium is higher in organic matter rich soils than in other soils. At station D the highest value of magnesium was obtained due to high sewage load at this point the lowest value of this element was evident as this point is pollution free (Figure 14).

Conclusion

Apparent density and water holding capacity of river

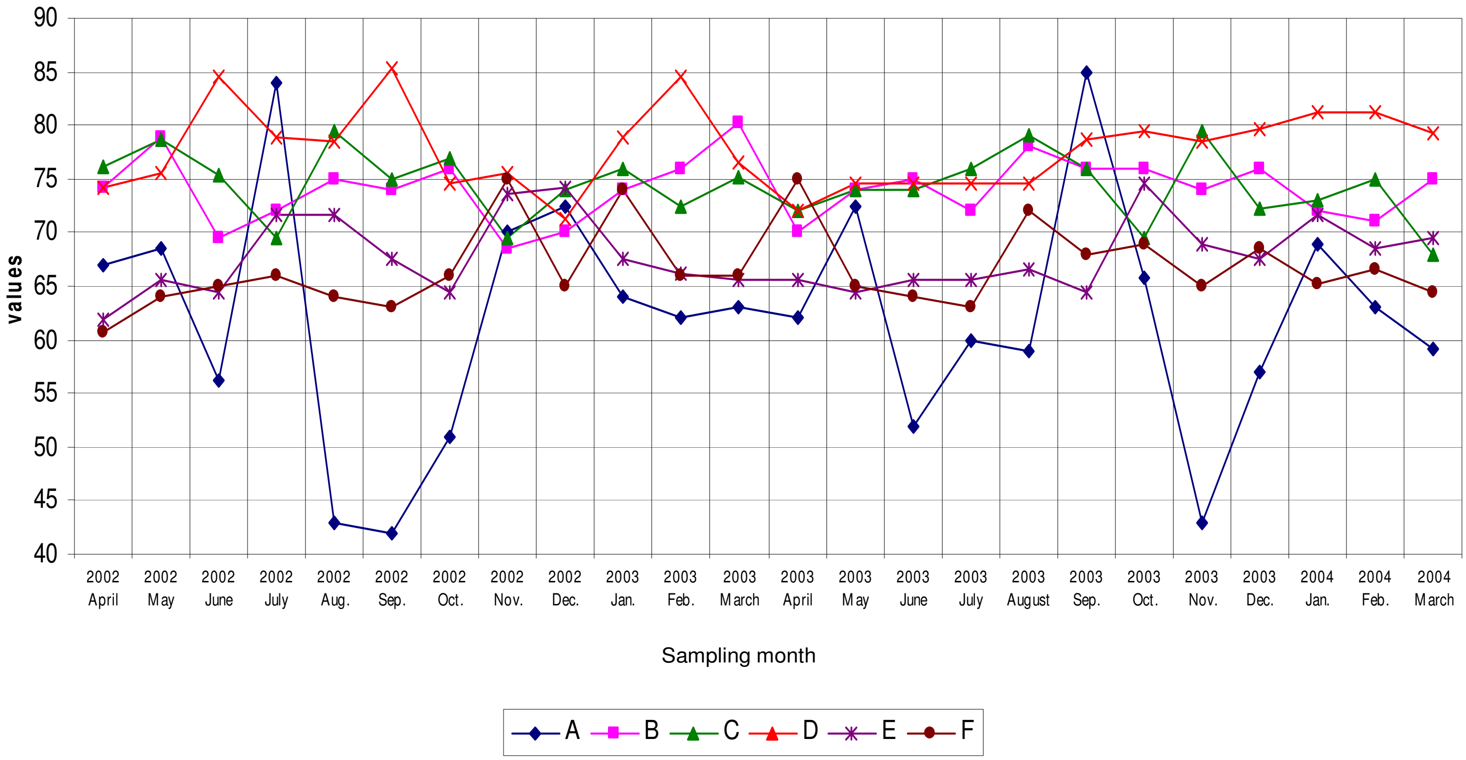

Figure 11. Showing potassium (mg/100 g) in sediment at various stations on Kalpi (Morar) river.

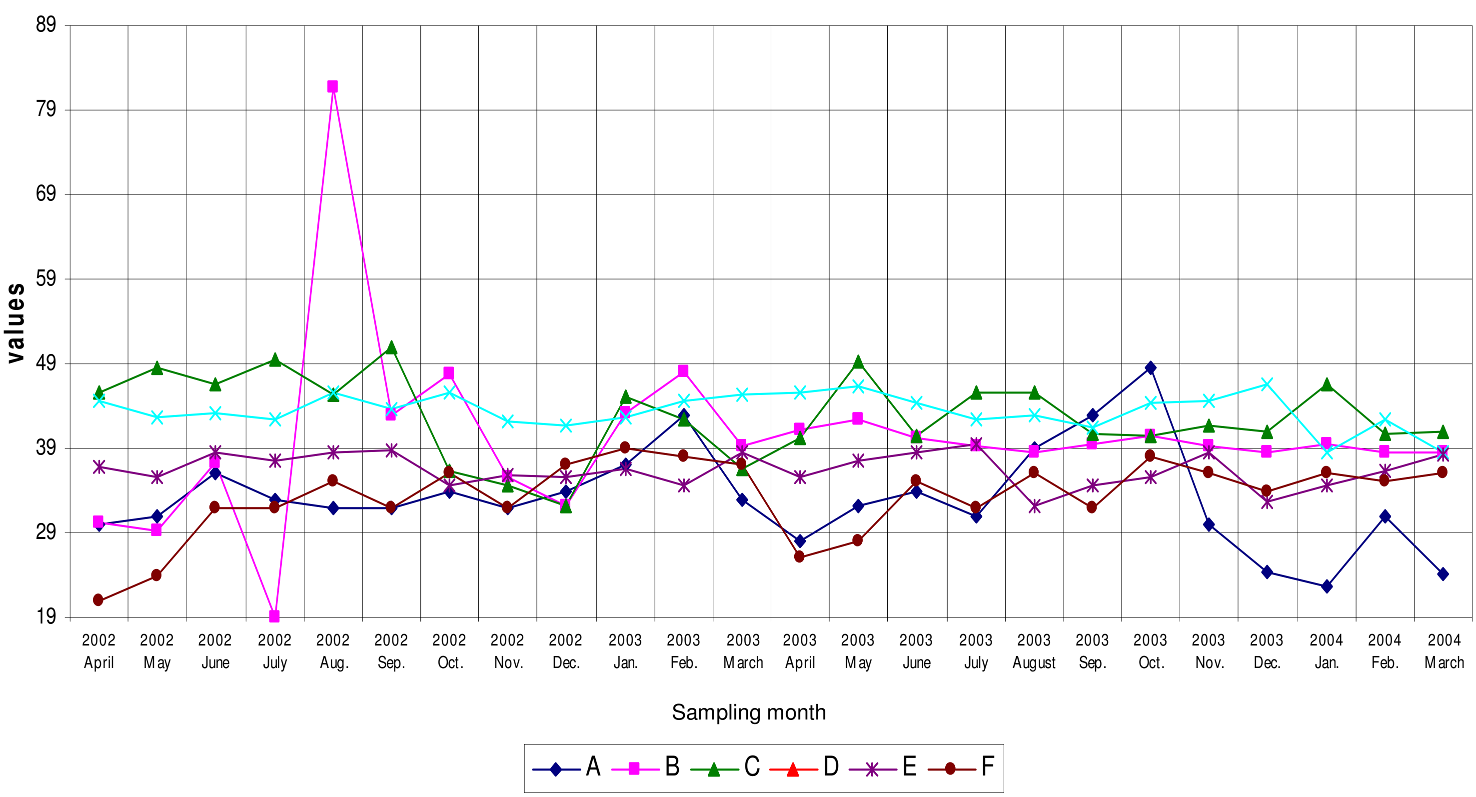

Figure 12. Showing exchangeable potassium at various stations on Kalpi (Morar) river.

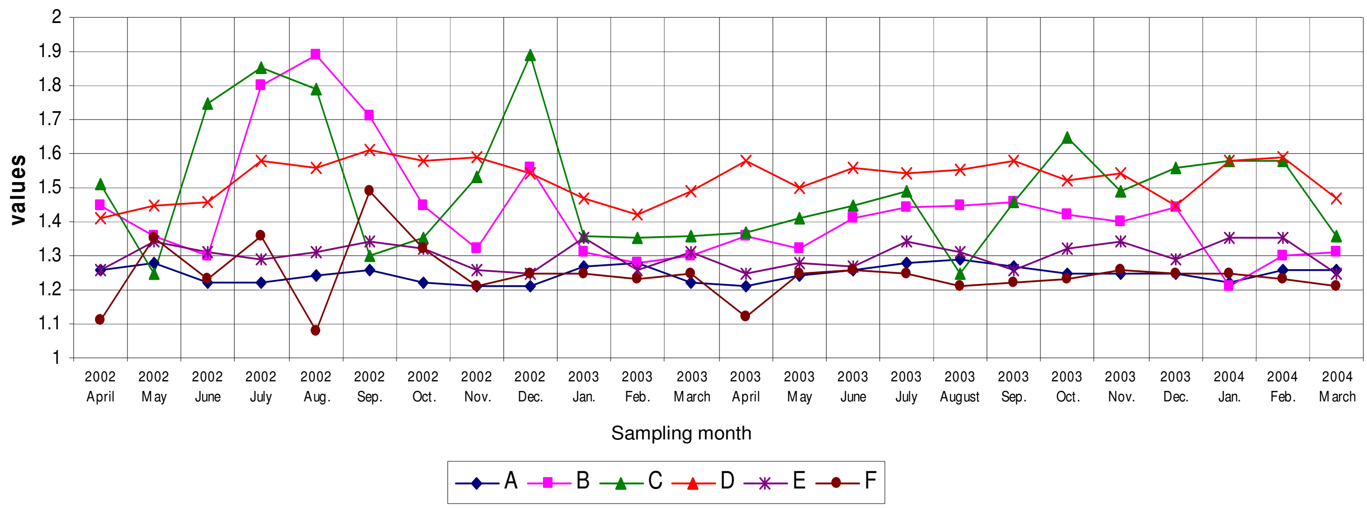

Figure 13. Showing calcium at various stations on Kalpi (Morar) river.

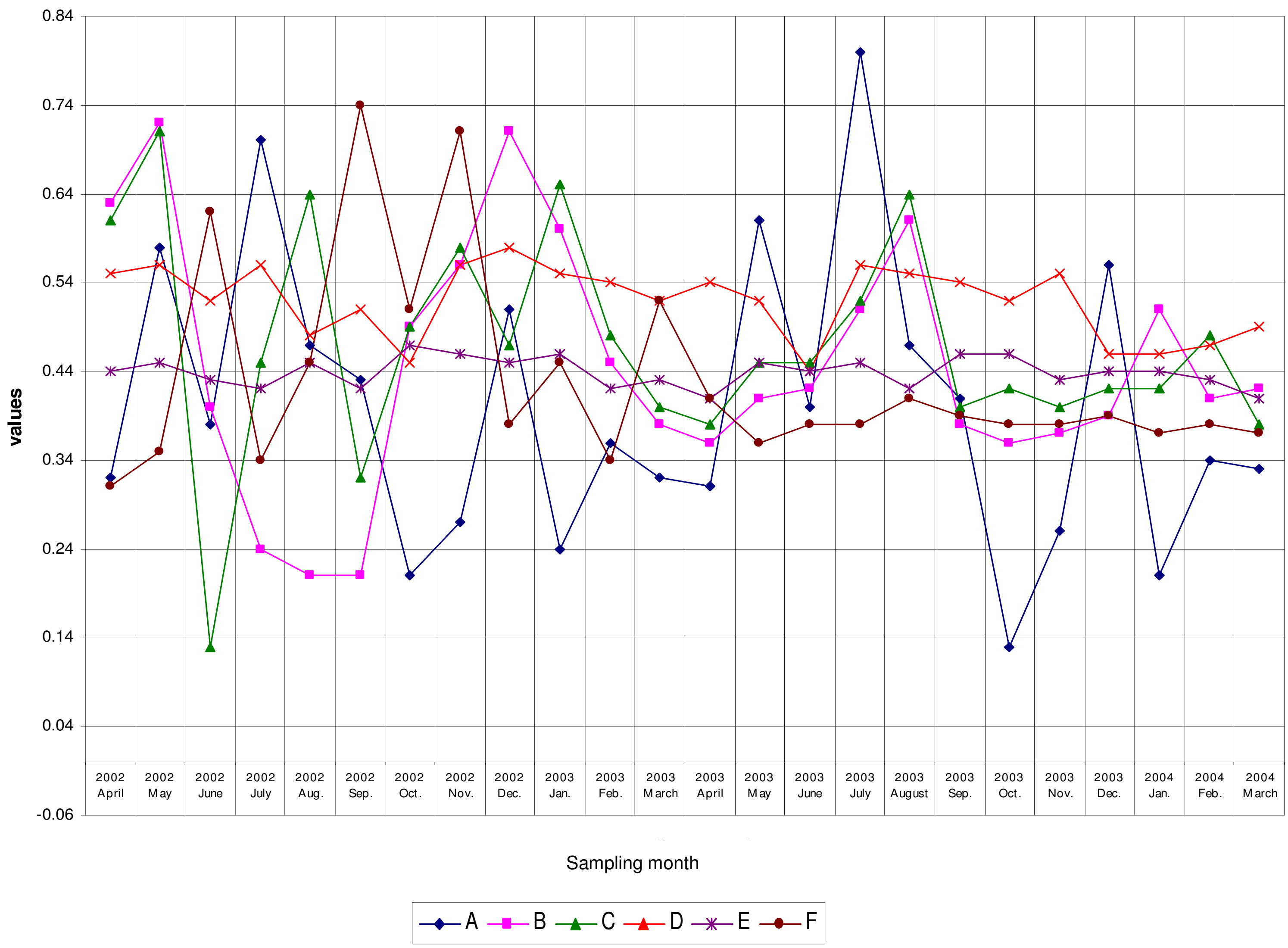

Figure 14. Showing magnesium at various stations on Kalpi (Morar) river.

sediment ranged between 1.24 to 2.56 and 15.16 to 38.61%, respectively. The pH of Kalpi (Morar) river was noticed always moderately alkaline varying from 7.1 – 8.14 during the study that has direct bearing on biogenic and abiogenic reactions and vice versa. The specific conductivity of sediment ranged form 2.51 $mScm^{-1}$ at station D during, 2.14 $mScm^{-1}$ at station C during and 2.01 $mScm^{-1}$ at station B which are indicative of high organic load at station B, C and D. It also showed that station A, E and F lower values of specific conductivity. The organic carbon content is generally high in the sediment of river ranging high in the sediment of river ranging from 0.93% at station A to 2.52%n at station D, showing high contamination. Higher organic carbon at polluted sites is due to chemical and bacterial decomposition and sewage contamination. Nitrogen and available nitrogen were also high at contaminated sites while less at less contaminated sites, other nutrients like phosphorus and available phosphorus were also evident high at polluted sites were in increase order from station A to station D.

Carbon and nitrogen ratio were range from 31.28 to 49.36, higher at station D indicating higher contamination at this point. Potassium, exchangeable potassium, magnesium and calcium were found high at station B, C and D and low at station A, while moderate values at station E and F. Higher contents of these nutrients shows higher organic level at the river sediment. The high input of sewage has increase the amount of Ca, Mg and other nutrients at B, C and D stations. Station A, E and F are having less concentration of these cations. The soil parameters are also indicating the increasing pollution in stations B, C and D in Kalpi (Morar) river.

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