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Assessment of Physico-Chemical Properties of Water and Sediments of Asan Lake Dehradun, India

Irfan Rashid Sofi[1], Pallavi P. Chuhan[2], Harendra K. Sharma[1] and Javid Manzoor[1]
[1]School of Studies in Environmental Science, Jiwaji University Gwalior (Madhya Pradesh), India
[2]Uttranchal College of Biomedical Science and Hospital Sewlakurd, Dehradun (Uttarakhand), India

(Corresponding author: Irfan Rashid Sofi)
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ABSTRACT: The objective of the present study was to investigate the water and sediment quality of Lake Asan in the Uttarakhand. The Physico-chemical parameters were Temperature, pH, TDS EC, Total Dissolved Solid (TDS), Conductivity, Salinity, Tota Hardness, Alkalinity Sodium, Potassium, Phosphate, Nitrate, Chloride were analyzed by following APHA, 2008. The results revealed that lake is polluted and is moving towards eutrophic stage. The deterioration in water quality is due to polluted influx into lake from different resources, like sewage pesticides, fertilizers and waste.

I. INTRODUCTION

Wetlands are unique areas with characteristics of land and water, hence are transitional areas between aquatic systems and upland terrestrial systems. They are sometimes submerged in water for longer periods of year and sometimes without water. These wetlands are being continuously polluted by undesirable pollutants, and industrial effluents. When dispersed into water bodies change the quality of water. The wetlands are polluted by domestic wastes from individual residence which enter the environment either in partially treated or untreated fashion. In urban areas, domestic wastes are collocated in sewage pipes and transmitted to control location either for treatment or discharge into a water bodies without any treatment [1]. Industrial waste generated contains huge amount of organic matter while some waste generated contains only small amount of organic matter but contains huge amount of toxic chemicals which are generated from chemical plants, mining facilities, and textile mills [2,3].

The industrial wastes often contain a wide range of contaminants such as petroleum hydrocarbons, chlorinated hydrocarbons and heavy metals, various acids, alkalis, dyes and other chemicals discharged into the water bodies greatly influence the different parameters of water. Therefore, it is important to better understand the Physico-chemical properties in the water bodies which is an important issue of present day research on pollution assessments. More ever the sediment testing also reflects the situation of the sediments [4]. The suspended and precipitated non-floating substances and organic substances in waters are capable of adhering pollutant particles by adsorption. The sediments, both suspended and precipitated substances stored on the water bottom, form a reservoir for many pollutants and trace substances of low solubility and low degree of degradability [5]. Since sediments act as a sinks and sources of contaminants in aquatic systems, chemical analysis for characterization of sediments also provides environmentally significant information about natural and anthropogenic influence on the water bodies [6].Changes in the amount and composition of sediment, carrying nutrients, industrial chemicals, and metals, can have an impact on the ecology of the aquatic ecosystem, increasing mortality and decreasing reproductive success [7, 8, 9].The present study was therefore carried out to understand the physico-chemical properties of the sediment samples collected from Asan Barrage Dehradun.

II. MATERIALS AND METHODS

A. Study Area

The Asan Barrage is situated at the confluence of the Eastern Yamuna Canal and the Asan River at Uttarakhand-Himachal Pradesh border region in Doon Valley, (near the village Dhalipur 38 km from Dehradun city). The lake is situated at Latitude 30° 26′ 9″ N, and longitude 77° 39′ 56″ E'. The barrage is 287.5 m long and the river bed is 389.4 m above the mean sea level. As the reservoir is fed by Asan and Yamuna rivers, the water level (controlled) attract a variety of marsh loving birds. In winter, it provides a good habitat for migratory water fowls who visit the area in large numbers.

Fig. 1. Map of Asan Barrage and nearby sites.

B. Water and Sediment sampling and sample preparation

The study of physiochemical parameters of water and sediments of Asan barrage was performed for the period of six months from December to May. Sampling was done along the different locations of the lake. Water sample were collected in BOD bottle and the sediment samples were kept in zip polythene bags which were free from heavy metals and organic impurities and were transported to the laboratory to avoid any contamination from the environment. The samples collected were air dried ground using agate mortar and sieved with a mesh size sieve to uniform particle size. The sediment samples were packed in polythene bags and kept in a dry place until analysis. The samples were analyzed every month for their physico-chemical parameters so as to get the seasonal variation in pollution level along the Asan Lake.

C. Physico-chemical analysis

The samples collected were preserved and the analysis of various physico-chemical parameters was performed in the laboratory. Temperature, pH, total dissolved solid (TDS), conductivity, salinity, total hardness, Alkalinity sodium, potassium, phosphate, nitrate, chloride of surface water and sediments were determined following standard methods [10]. Total organic matter (TOM) in sediment was determined by measuring weight loss after burning in a preheated muffle furnace at 450°C for 4 h [11]. Sediment pH was measured in a suspension of 10 g of sediment in 25 mL deionized water after shaking for 2 h using a digital pH meter.

III. RESULTS AND DISCUSSION

The physico-chemical parameters of water and sediments such as pH, electric conductivity, alkalinity, dissolved oxygen, total dissolve solid, calcium, magnesium, chloride, nitrate and phosphate, sodium, potassium, and organic matter, were analyzed for the water and sediments samples collected from the Asan Lake. The samples were taken from four different sites during different months of the year. All parameters with the mean value of the data with standard error were calculated as shown in the Table 1 and 2.

Table 1: Physico-chemical characteristics of lake Sediments.

Parameters	Site 1	Site 2	Site 3	Site 4	SE
Salinity (mg/l)	298.8	307.8	290.6	324	305.3± 6.1
Conductivity (ds/m)	1.061	0.830	0.925	1.014	0.96±1.13
pH	6.83	6.96	7.42	6.84	7.01±1.21
Alkalinity (mg/l)	182	186.16	182.3	197	186.86 ±2.37
Calcium(Ca^{2+})(mg/l)	72.59	72.77	70.57	80.25	74.04± 1.07
Magnesium(Mg^{2+}) (mg/l)	33.812	37. 14	38.99	39.10	37.26± 1.12
Sodium(Na^{+}) (mg/l)	19.16	19.83	22.16	21.5	20.66± 1.1
Potassium (K^{+}) (mg/l)	16.5	15.16	20	19.5	17.79± 1.32
Phosphate(PO_4^{2-}) (mg/l)	0.528	0.359	0.249	0.369	0.37±1.15
Nitrate (NO^{3}) (mg/l)	0.333	0.375	0.287	0.293	0.32±1.15
Chloride (Cl^{-}) (mg/l)	6.68	6.46	7.28	6.80	6.81±1.18
Organic matter (mg/l)	2.308	2.708	3.09	3.315	2.85±1

Table 2: Physico-chemical characteristics of water.

Parameters	Site 1	Site 2	Site 3	Site 4	SE
Temperature(°C)	20.66	20.66	25.14	20.9	21.84± 1.1
Turbidity (mg/l)	5.67	6.6	6.83	6.67	6.44± 0.26
Total dissolved salts mg/l)	639	624.12	565.84	722.4	637.84± 32.31
Conductivity (ds/m)	0.39	0.435	0.466	0.476	0.44±0.02
pH	7.6	7.63	7.58	7.22	7.51±0.1
Calcium (mg/l)	55.87	53.4	50.1	58.08	54.36±1.71
Magnesium (mg/l)	18.98	22.37	23.62	24.94	22.48± 1.28
Dissolved oxygen (mg/l)	4.08	4.22	4.22	4.85	4.34±0.17
Total Alkalinity (mg/l)	133.83	142.67	149.34	164.83	147.67 ±6.54
Sodium (mg/l)	7.5	7.8	6.84	8.5	7.66±0.34
Potassium (mg/l)	4.83	5.5	6.17	6.84	5.84± 0.43
Nitrate (mg/l)	0.062	0.063	0.612	0.06	0.2±0.14
Phosphate (mg/l)	0.34	0.388	0.394	0.412	0.38±0.02
Chloride (mg/l)	21.16	18.84	19.33	19.62	19.74± 0.5

A. Temperature

Water temperature can fluctuate diurnally and seasonally. Water temperature is also influenced by altitude and latitude Water temperature varied from 20.66 °C to 25.14 °C. The exact temperature depends on the time of day and of the sunlight absorbed by the water.

B. Turbidity

Turbidity in water is caused by suspended material such as clay, silt, finely divided organic and inorganic matter, soluble coloured compounds and plankton and microscopic organisms. The turbidity of the water was found maximum (6.83 mg/l) at site III and the minimum (5.67mg/l) value was found at site I. The average value of turbidity was 6.44mg/l. The turbidity of the water samples can be attributed due to different waste dumped in the lake by the tourists as Asan lake is main tourist attraction in the city.

C. Total dissolved solids

Solids refer to the suspended and dissolved matter in water. They are very useful parameters describing the chemical constituents of the water and can be considered as edaphically relation that contributes to productivity within the water body [12]. The total dissolved solids in the sampled water ranged from the 565.82 to 722.4 mg/L. The highest TDS (722.4 mg/L) was reported at site III and lowest TDS 565.82mg/L reported was at site I due to the addition of organic matter and solid waste into the lake. The average value of TDS found in the lake was 634.84 mg/l [13]. The application of different fertilizers and pesticides to nearby agriculture fields might have increased the TDS of the sample.

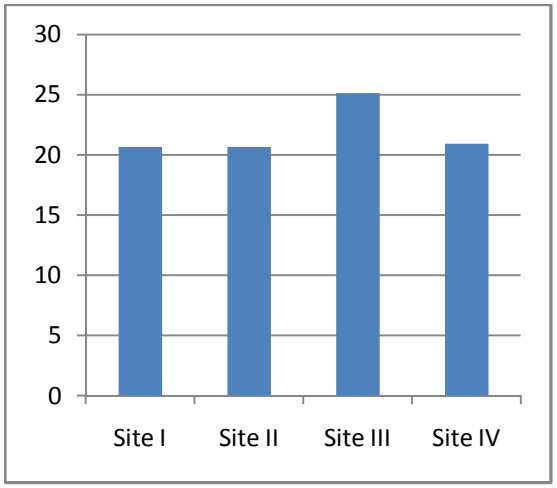


Fig. 1. Variation of Temperature (°C) at different sites.

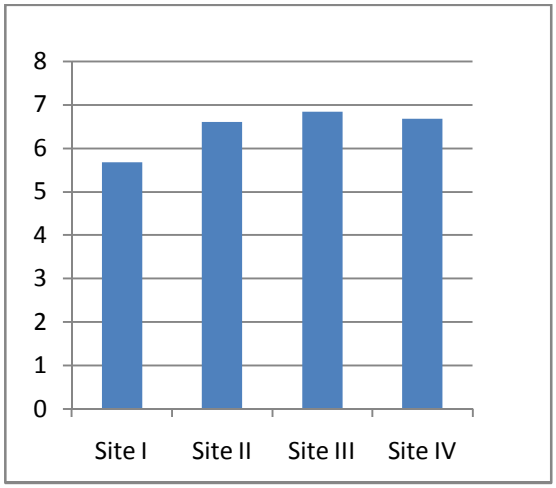


Fig. 2. Variation of Turbidity (mg/l) at different sites.

D. Salinity

Soil salinity is the salt content in the soil and the process of increasing the salt content is called salinization. The ions responsible for the salinization are Na, K, Mg, and Cl. When the level of these water soluble salts exceeds a certain limit, the high salinity of the sediment may result in increase in salinity water which is considered as a major stress factor for most fresh water organisms. In the present study it is revealed that the lowest salinity of 290.6 mg/l was found at the site III and the highest salinity (324 mg/l was found at site IV. The average salinity found in the sediment of Asan lake were 305 mg/l. The different salts might have increased due to leaching of different salts from rocks in the nearby area.

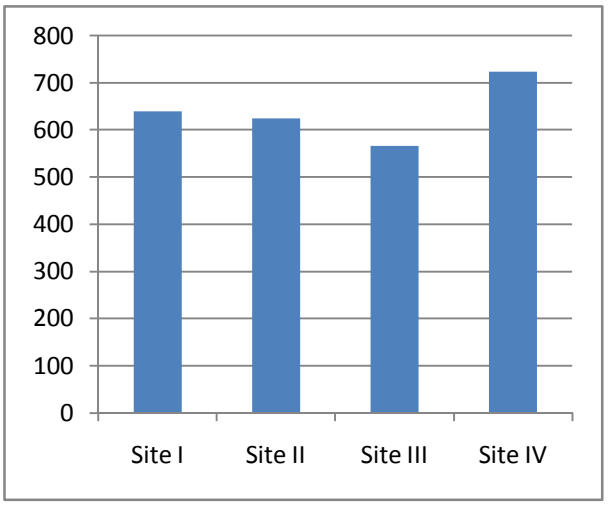


Fig. 3. Variation of Total dissolved solids (mg/l) at different sites.

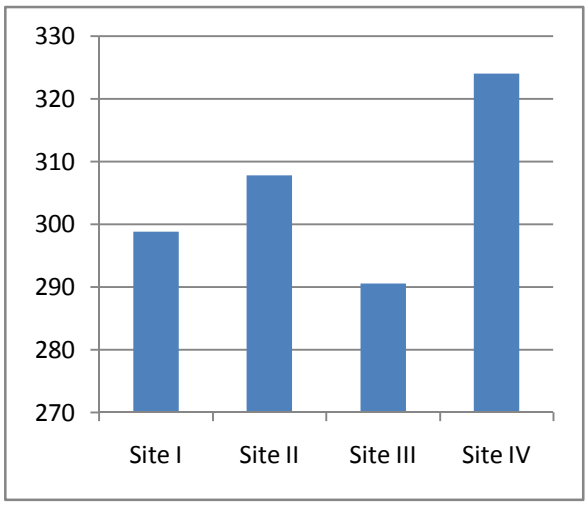


Fig. 4. Variation of Salinity (mg/l) at different sites.

E. Conductivity

Conductivity is the measure of capacity of substance or solution to conduct electric current. Conductivity is the opposite of resistance. Presence of salts and the contamination with waste water increases the conductivity of sediments. In the present study the conductivity of water were observed minimum at site I with the value of were 0.39 ds/m and the maximum conductivity of 0.47 ds/m was observed at site IV, while as the conductivity of sediments observed were minimum at the site III with the conductivity value of 0.830 ds/m and the maximum conductivity 1.061ds/m were found at site IV. The average conductivity of lake were found 0.44 and 0.96 ds/m for water and sediments, respectively.

F. pH

pH is one of the important parameter in sediment quality monitoring as it governs most of the chemical reactions that take place in soil and water. At high or low pH values many plants and other living biota may die and may pose hazardous impacts on human and animal health. The pH value measures the ratio of H^+ ions and OH^- ions in water or soil. pH of the investigated water revealed slightly alkaline pH at some of the site with minimum pH of 7.6 at site I and the maximum pH (7.58) was found at the site IV. Similarly, the pH of sediments were found acidic at some site with minimum pH value of 6.83 at site I and the maximum value of 7.84 was found at site III. The average pH of the lake was found to be alkaline with mean pH value of 7.51 and 7.01 for water and sediments respectively. The decrease in pH value can be linked to the pollution of the lake Asan in Uttarakhand.

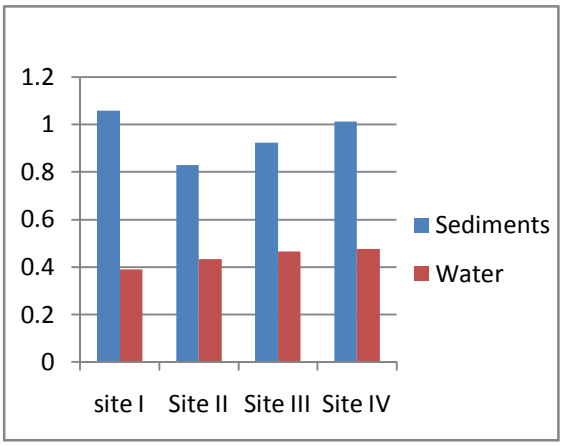


Fig. 5. Variation of Conductivity (mg/l) at different sites.

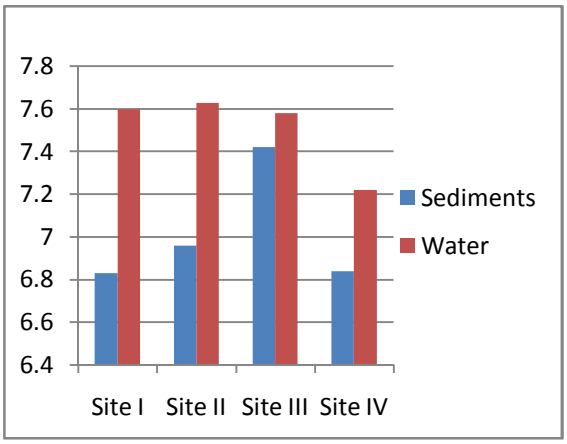


Fig. 6. Variation of pH at different sites.

G. Total alkalinity

The presence of high amount of free carbonates indicates alkalinity of water and soil. They form under dry climatic conditions. The total alkalinity of water at different sites varies showing the minimum value of 133.83 mg/l at site I and the maximum value of 164.83 (mg/l), while in case of sediments the total alkalinity were found minimum (182 mg/l) at site I and the maximum value (197 mg/l) was found at the site IV. The mean alkalinity of the lake water and sediments were found 147.67 mg/land 186.86mg/l respectively.

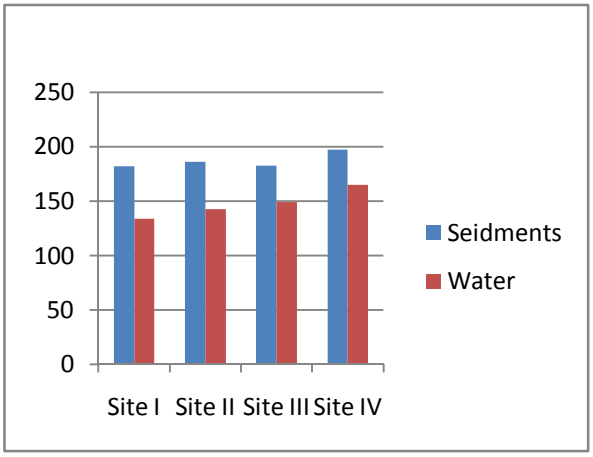


Fig. 7. Variation of Alkalinity (mg/l) at different sites.

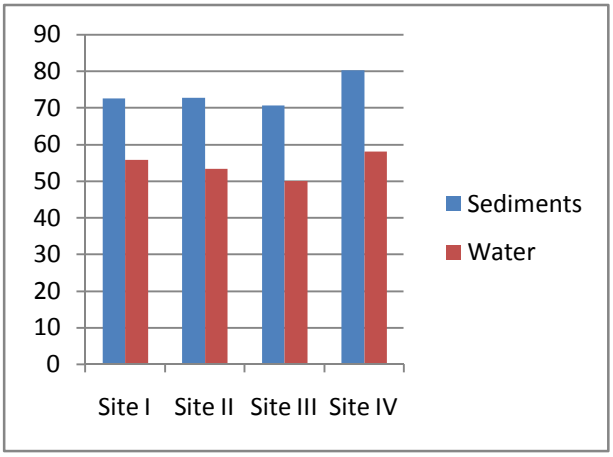


Fig. 8. Variation of Calcium (mg/l) at different sites.

H. Calcium and Magnesium

The hardness of the water and sediments is not pollution indicator but indicates the quality of water and sediments in terms of calcium and magnesium. The hardness is governed by the carbonates and bicarbonates and bicarbonates of calcium and magnesium and other ions. Calcium and magnesium accounted for the most of the hardness in the lake. The maximum calcium content (58.08 mg/l) in water was observed at the site IV and the minimum calcium content (50.01mg/l) was observed at site III. Similarly the calcium content in the sediment was observed maximum (80.25 mg/l) at site IV and the minimum at Site III (70.57 mg/l). Moreover the magnesium concentration found in the lake water was maximum at site IV (24.4 mg/l) and the minimum concentration was observed at site I (18.98 mg/l). Similarly in case of sediments the maximum concentration of magnesium was observed at the site IV (39.10 mg/l) and the minimum concentration was observed at site I (33.81 mg/l).

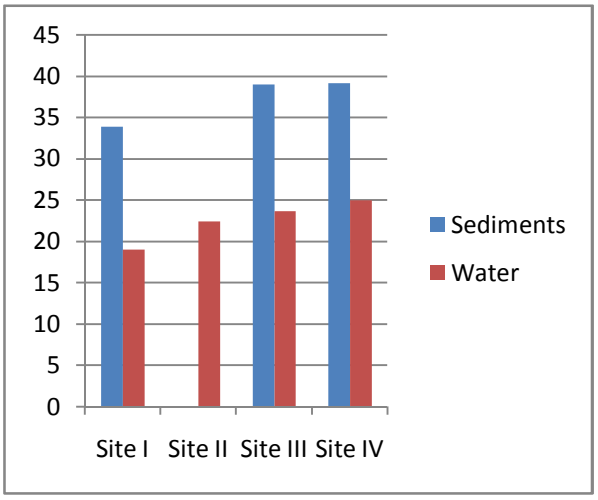


Fig. 9. Variation of Magnesium (mg/l) at different sites.

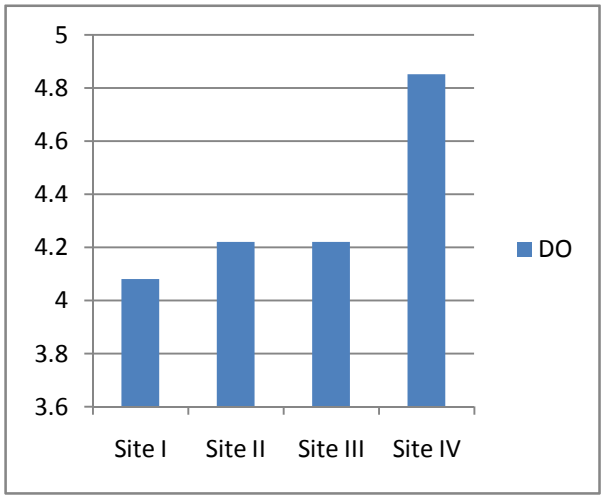


Fig. 10. Variation of DO (mg/l) at different sites.

I. Dissolved oxygen

DO is one of the most important parameter. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc. [14]. During summer the long days and intense sunlight seem to accelerate photosynthesis by phytoplankton, utilizing CO_2 and giving off oxygen. This possibly accounts for the greater qualities of O_2 recorded during summer [15]. DO in sample is measured titrimetrically by Winkler's method after 5 days incubation at 293 K. The maximum DO mg/l observed 4.85 mg/l at site IV and minimum (4.08 mg/l) value was observed at site I. The average dissolved oxygen in the lake water was found 4.34mg/l. The highest amount of DO is due to the turbulence of water facilitating the diffusion of atmospheric oxygen and the increased solubility of oxygen at lower temperature [16]. The lowest dissolved oxygen recorded during summer season is due to the high temperature and addition of sewage and other waste which can be responsible for low value of dissolved oxygen [17].

J. Available Sodium

Soil with high sodium content tends to be very dense and the root penetration of the plant is extremely difficult. This is caused from the sodium ions forming the soil platelets into compact structure. Soil improvement involves the replacing the positive sodium ions with positive calcium ions. The present study indicates fluctuation in the concentration of sodium in the water with maximum sodium content at site IV (8.5 mg/l) and the minimum concentration at site III (6.84 mg/l). Similarly in case of sediments the maximum value was observed at site-III (22.16mg/l) and the minimum concentration were observed at site I (19.16 mg/l).

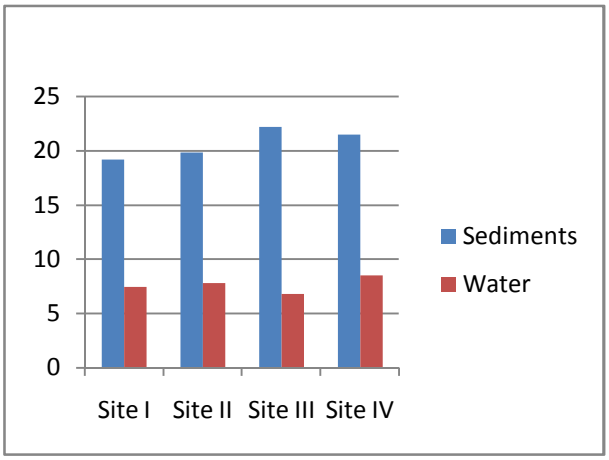
K. Potassium

Potassium occurs naturally in the in ground water by weathering of rocks and is very essential mineral for the plants and human health. The maximum potassium content in water was observed at site IV (6.84 mg/l) and the minimum value was observed at site I (4.833 mg/l).

In case of sediments the maximum potassium content was observed at site III (20 mg/l) and the minimum value was observed at site II (15.16 mg/l). The average content of potassium in lake water and sediments observed was 5.84 mg/land17.49 mg/l respectively**.**

L. Nitrate

Nitrate is one of the most popular diseases causing parameter of water quality particularly blue baby syndrome in infants. The source of nitrate is nitrogen cycle, industrial waste, nitrogenous fertilizers etc. The permissible limit of nitrate in drinking water as per the WHO is 10mg/l. In this study the amount of nitrate was found maximum at site III (0.612 mg/l) and minimum at site IV (0.06 mg/l).Similarly the nitrate content in sediment was found maximum at site II (0.375 mg/l) and minimum at site II (0.287 mg/l). The mean value of nitrate in water and sediments were 0.2 mg/l and 0.32 mg/l, respectively.



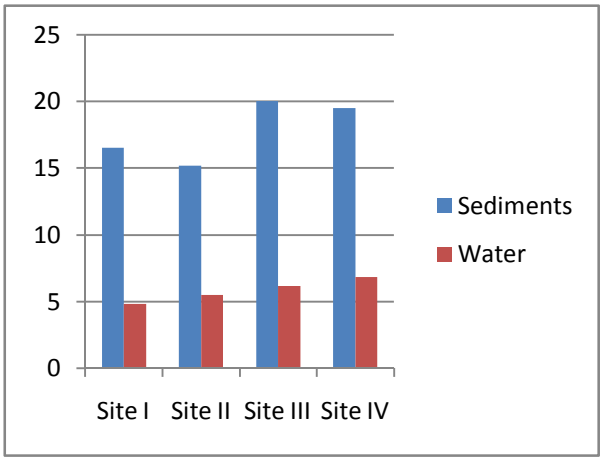
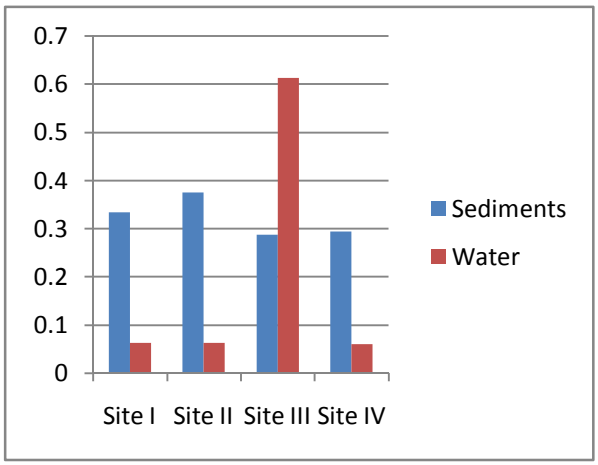


Fig. 11. Variation of Sodium(mg/l) at different sites. **Fig 12.** Variation of Potassium (mg/l) at different sites.

M. Phosphate

Phosphates are present in all nutrient material (plant tissue excreta, bones etc) as they are released by organic decomposition processes, they tend to form insoluble compounds and thus become fixed with minerals of soil. In the present study the phosphate in water recorded the highest value of 0.412mg/l at site IV and lowest value of 0.34mg/l at site I and in case of sediments the highest content of phosphate was found at site I (0.528 mg/l) and lowest content at site II 0.249 (mg/l). The mean value of phosphate in water and sediments were 0.38mg/l and 0.37 mg/l, respectively.



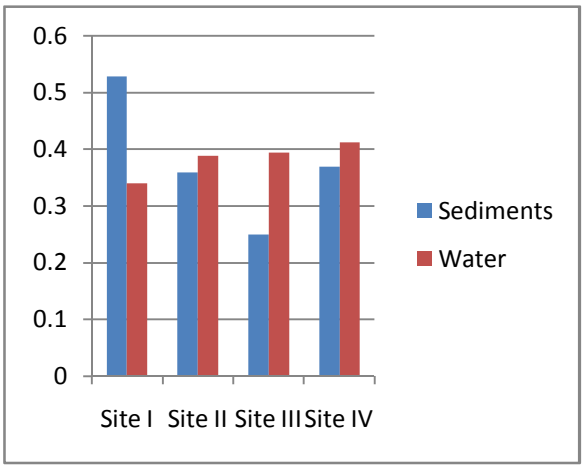


Fig. 13. Variation of Sodium (mg/l) at different sites. **Fig. 14.** Variation of Sodium(mg/l) at different sites.

N. Chloride

The chloride ion is not adsorbed on soil particles at neutral and alkaline pH values and therefore is easily leached. The higher or lower concentration of chloride might be contributed to its geological origin. The chloride content of lake water and sediments displayed wider spatial fluctuation ranging from 18.84 mg/l at site II and maximum content at site I (21.16 mg/l) for water and incase of sediments the maximum chloride content was found at site III (7.28 mg/l) and the minimum content at site II (6.46 mg/l). The average content of chloride found in water and sediments were 19.74 mg/l and 6.81 mg/l, respectively.

O. Organic matter

Organic matter influences physical, chemical and biological activities in the soil. Organic matter serves as the reserve for many essential nutrients, especially nitrogen. Determination of organic matter helps to estimate the nitrogen which will be released by bacterial activity. Organic matter exerts positive influence on wetland soils to transform chemicals. In the present study the highest value was observed at site IV (3.315 mg/l) and the lowest value at site I (2.308 mg/l). The average value of organic matter in the sediments of lake was 2.85 mg/l.

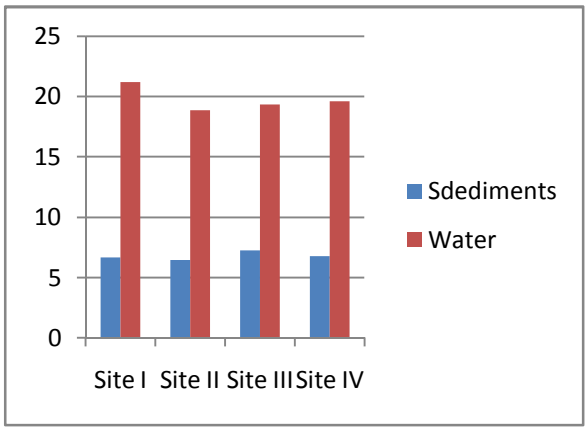


Fig. 15. Variation of Chloride (mg/l) at different sites.

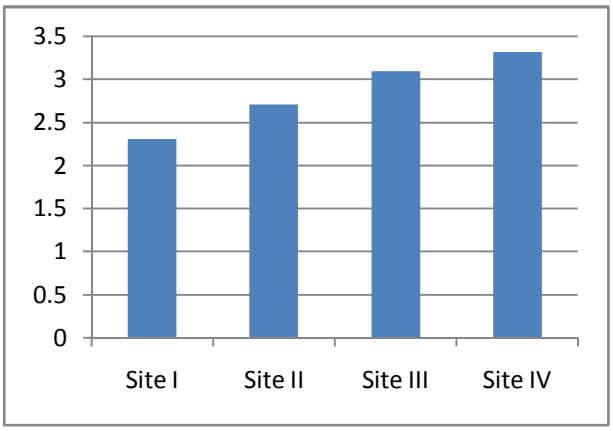


Fig. 16. Variation of Organic matter (mg/l) in sediments at different sites.

IV. CONCLUSION

The study observed that the water quality of lake is deteriorated and all the water quality parameters werefound very high, this is attributed to influx of different of different pollutants into water body. Further the application of different pesticides and fertilizers are increasing the TDS, nitrates, phosphate and other salts in the lake ecosystem. The organic matter accumulation may due to decomposition of phytoplankton and zooplankton at the bottom.

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