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The Study of Water Quality Assessment of Morvan Dam, Madhya Pradesh, India

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INTRODUCTION

The Morvan Dam is located in the Indian state of Madhya Pradesh, specifically in Morvan Village, which is part of Neemuch district in Jawad Tehsil. The dam is built on the Gambhiri River, which is a tributary of the Chambal River. It was mainly built to supply water for both irrigation and drinking purposes, and it provides water to 26 villages in the Neemach district. The dam is made of stone masonry and was constructed in 1960. Its coordinates are latitude 27° 37' 06" N and longitude 75° 03' 30" E. The length of the dam is 990 meters, and its width is 12 meters. The dam can hold a total of 16.46 million cubic meters of water. The maximum depth is 27.42 meters, while the average depth is 13 meters.

This dam is very important for the villagers because it supplies drinking water, helps with farming through irrigation, and supports fish farming.

It covers about 267,100 hectares of land that is used for irrigation. As development, industrialization, and population growth continue, the need for water is increasing significantly.

Dams like the Morvan Dam are used by people and animals for drinking and also for raising fish. Because of this, it is important to monitor the water continuously to ensure its long-term sustainability and proper management.

MATERIALS AND METHODS

Hydrogen ion Concentration (pH)

The HANNA-pHep is a digital pH meter that can be used to estimate the hydrogen ion concentration or pH of solution. This device is designed to be portable and easy to use, making it suitable for field work. It has a pH range from 0.0 to 14.0, a resolution of 0.1 pH and an accuracy of ± 0.1 pH. The digital pH meter HANNA-pHep was utilized for estimating hydrogen particle concentration (pH) by plunging the electrode into experimental water in clean beaker at the sampling station. This pH meter was previously calibrated in the laboratory utilizing various buffers.

Dissolved Oxygen

The determination of dissolved oxygen content of lake waters the unmodified Winkler's technique gave the most satisfactory result. Water was sampled in a 250 ml measuring flask with least disturbance of surface water and no air bubble. The stopper of the bottle was carefully removed. One ml of manganous sulphate ($MnSO_4$, 4 H_20) reagent and one ml of alkaline reagent (KOH and KI) was added by means of one ml pipette dipped to the bottom of the bottle and slowly drawing out as the reagents were added. The stopper was replaced and the bottle was inverted three or four times for a thorough mixing of the reagents, producing a flocculant precipitate of light brown colour. One ml of conc. Sulphuric acid was added to dissolve the precipitate, leaving a clear brown solution. To 50 ml of this solution .025 N sodium thiosulphate solutions was run drop by drop thereby changing the colour of the sample solution to pale yellow. One ml of starch solution (indicator) was added to it to give the solution a blue colour and the titration was completed by turning it colourless.

Number of ml of $Na_2S_2O_2$ solution X 4 = ppm of dissolved oxygen.

Free Carbon - di – oxide

50 ml of the water sample was taken and 2 drops of phenolphthalein indicator were added to it. It was titrated with N/ 44 sodium hydroxide solution which was standardised against sulphuric acid solution of equal strength with phenolphthalein as an indicator. The alkali was run slowly till the colour of the sample turned pink.

Number of ml of N/44 sodium hydroxide consumed X 2 was equal to parts per million of carbon – di – oxide present in the water sample.

Total alkalinity

100 ml of water sample was taken in a conical flask to which 0.1 ml of phenolphthalein was added to turn the colour to pink confirming the presence of phenolphthalein alkalinity. The sample was titrated with N/50 sulphuric acid till the pink colour just disappeared. The amount of sulphuric acid consumed was recorded as phenolphthalein alkalinity (P). To the same sample 0.1 ml of methyl orange indicator was added and titrated with N/50 sulphuric acid. The end point was the turning of the yellow colour into pinkish orange. The amount of sulphuric acid consumed was recorded as methyl orange alkalinity (T). The total alkalinity was obtained by adding these two values (P+T) and multiplying the same by 10 to express the term in parts per million.

Phosphate, Silicate, Organic matters, Nitrate, Nitrogen and Ammonia Nitrogen contents

There dissolved salts or chemicals in water was determined with the help of a Systronic's Digital Spectrophotometer 103. At first separate standard solutions for each of the abiotic factors (Table 1) were prepared.

Table-1

Sl. No.	Dissolved Nutrients	Standard Solution	Indicators
1.	Phosphate (inorganic)	Standard phosphate solution (.438% KH_2PO_4 solution)	1) Acid Molybdate reagent 2) Stannous Chloride solution
2.	Silicate	Standard Picric acid solution (.1088%) or Standard Potassium Chromate solution (.284%)	1) 10 % Ammonium molybdate solution 2) 25 % Sulphuric acid (by volume)
3.	Dissolved organic matters (sample fixed with 2 drops of toluene)	Standard KMnO4 Solution (.04%)	1) Standard Ammonium Oxalate Solution (.0888%) 2) Dilute Sulphuric acid (1:3)
4.	Ammonia Nitrogen (sample fixed with few drops of sulphuric acid)	Standard Ammonium Chloride solution (.3819%)	Nessler's solution
5.	Nitrate Nitrogen	Standard KNO_3 solution (.0722%)	1) Phenol disulphonic acid 2) Aluminium sulphate 10% 3) 12 N Sodium Hydroxide solution.

Table 1: Showing different standard solution and the indicators used for determination of dissolved salt in lake water.

For each standard solution a calibration curve of different concentration of standard solutions and the respective extinction measurement (with the help of spectrophotometer 103) was established using necessary indicators. (Table 1). The extinction of the sample solution was then determined using same indicators and from the calibration curve the dissolved salt content of the sample in respect to its extinction measurement was determined.

For different analysis, following standard solutions and indicators were used (Michael, 1984).

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Sulphates

Qualitative test showed that the water sample of Morvan Dam, Kanke Dam, Rukka Dam and Hatia Dam was richer in sulphate content. As such to 50 ml of the sample after necessary dilution was added 10 ml each of NaCl – HCl solution (250 gms NaCl and 20 ml of HCl to 900 ml of distilled water and diluted to 1 litre) and Glycerol – alcohol solution (1 Volume of Glycerol with 2 volumes of ethanol). The extinction was measured against a H_2O blank in the spectrocolorimeter at any wave length between 380 mμ and 420 mμ. 0.15gm of $BaCl_2$ was added to the sample and was stirred in an Electric stirrer for 30 minutes, shaken and the extinction was measured after 30 minutes. The extinction due to sulphate was obtained by the dfference. A calibration curve was prepared in the range of 0.02 – 0.2 m eq/l SO_4^{2-} using dilution of standard H_2SO_4.1 m eq. SO_4^{2-} = 48.05 mg SO_4^{2-} = 16.0 mg SO_4 – S

Chlorides

The chlorides were estimated chemically by titration with silver nitrate using potassium chromate as an indicator with greater accuracy. To a 100cc of water sample a few drops of potassium chromate solution was added. The sample was then titrated against N/100 silver nitrate solution stirring constantly. The end point was reached when a permanent faint red colour of silver chromate appeared 1cc of N/100 silver nitrate = 0.000355 gm of Chloride.

RESULTS

Hydrogen ion concentration

The pH of the lake water tended to remain neutral to slightly alkaline throughout the period of investigation barring a few months in the beginning of the study. In September 2021 the pH value recorded was 7.25 ppm which was subsequently found to be the neutral to slightly alkaline value during the entire course of the investigation. In the succeeding months of October and November the hydrogen ion concentration value remained slightly alkaline but December onwards the pH value shifted again to the slightly acidic range. A lower pH value in the cold season (December 2021, January and February 2022) was recorded in comparison to that of summer seasons. This was followed by a sharp decrease in the pH value during July 2022 that was 6.3 ppm. In August a marked increase of 6.8 ppm, in the pH value was recorded followed by a fall during the month of September 2022 were 6.5 ppm.

During the succeeding year of investigation the pH of the lake water remained slightly acidic and the fluctuation of its value showed a regular rise and fall, the trend of which was the same to that of the previous year.

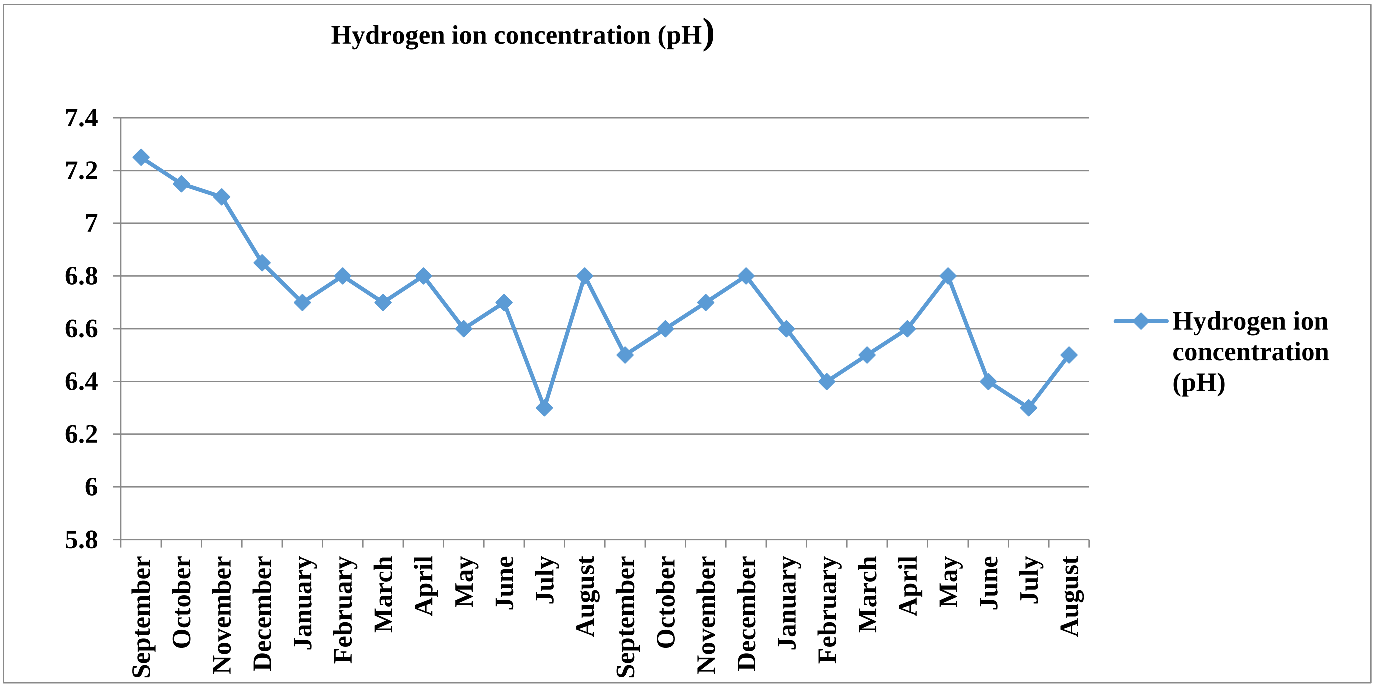

Fig (1) –Hydrogen ion Concentration of Morvan Dam

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Dissolved Oxygen Content

The dissolved content of lake water varied from 4.2 ppm to 11.6 ppm during the period of investigation. During September 2021 the dissolved Oxygen content of water was 7.1 ppm, then a gradual increase in the oxygen content of water was observed till January 2022 which was followed by a decline in the months of March and April. The dissolved Oxygen content of lake water showed an increased value during the monsoon months.

In the succeeding year, the trend followed more or less the same pattern but the highest values of 11.6 ppm were recorded in the month November 2022 and lowest value was recorded in the month of May 2023 that was 4.2 ppm.

The data also reveals that the dissolved oxygen was high during the winter months and low during the summer months. The periods of high dissolved oxygen content corresponded with the periods of low water temperature. It was further observed that the periods of high dissolved oxygen content of water corresponded with a decreased pH value.

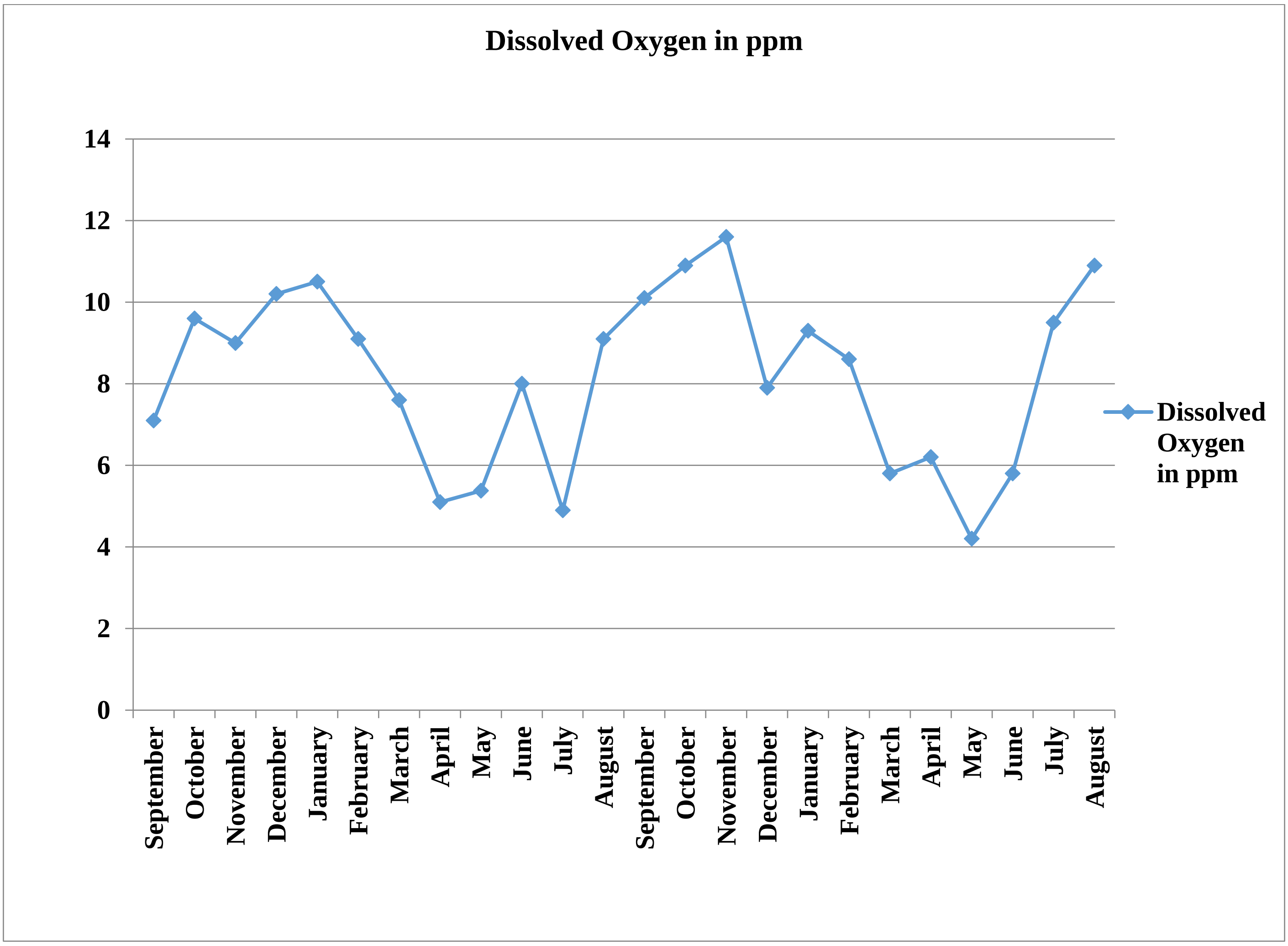


Fig (2)- Showing Dissolved Oxygen (O_2) in ppm in Morvan Dam

Free Carbon-di-oxide

The amount of free carbon-di-oxide recorded throughout the period of investigation was not very high, the maximum of 7.35 ppm, bring in the month of January 2023. No free carbon-di-oxide was recorded during the month of October 2021, April 2022, June 2022 and June 2023. Expectedly enough free carbon-di-oxide was observed to be absent when the dam water was slightly alkaline. A linear relationship was established between free carbon-di-oxide content and turbidity of water ($r = 0.85$, $p > .0001$).

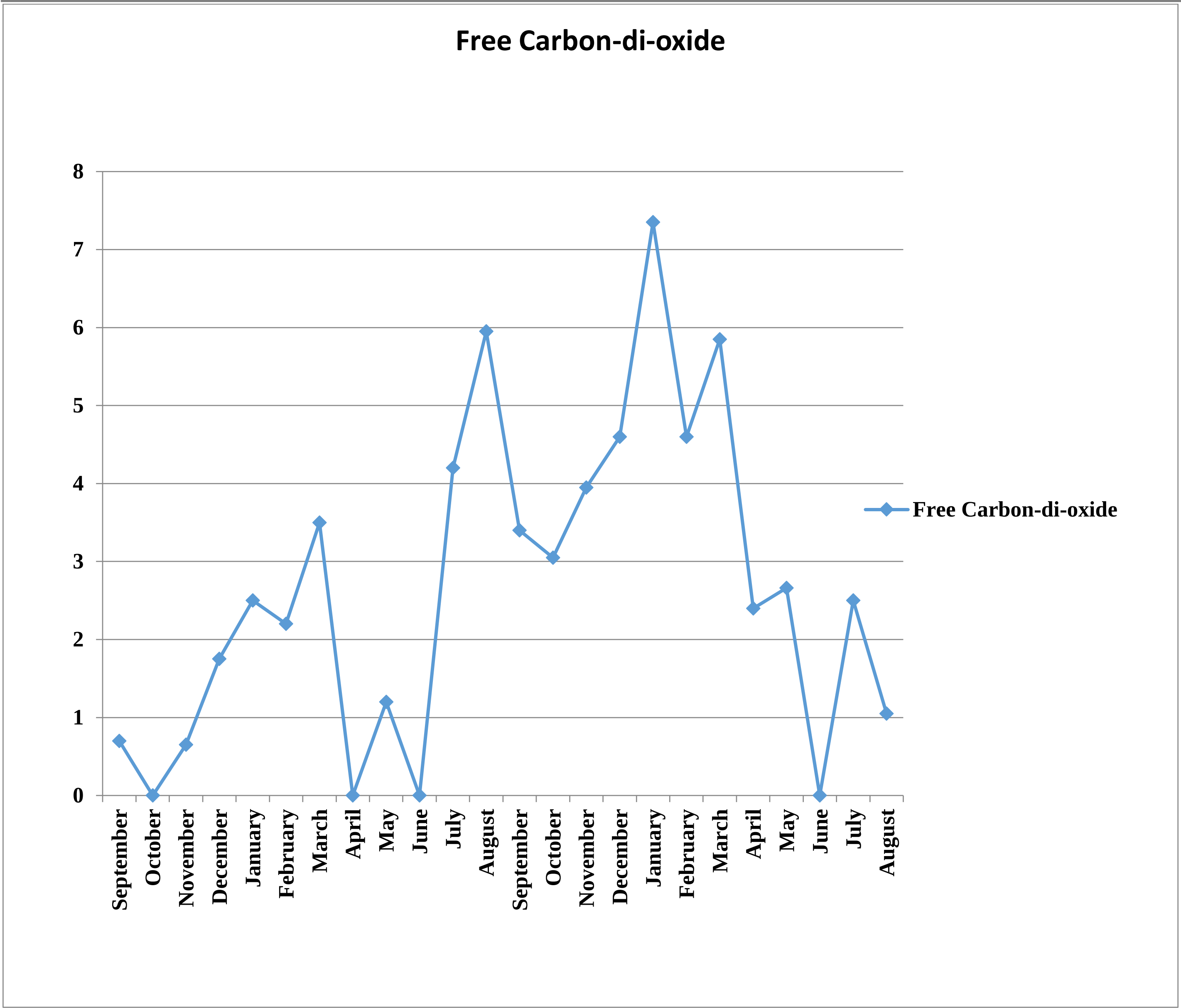


Fig (3) – Showing Free Carbon-di-oxide of Morvan Dam

Total Alkalinity

Alkalinity value of lake water was primarily due to the presence of bicarbonates and the surface bicarbonate alkalinity value ranged from 25.0 ppm (November 2022) to 98.9 ppm (October 2021). The carbonate alkalinity was recorded in small amount only during the month of November 2022 was 25.0 ppm, June 2022 was 48.8 ppm for the dam and no free carbon-di-oxide was detected during the period as the pH of lake water was more than the neutral value. The seasonal curve of total alkalinity value distinct fluctuations throughout the period of investigation. In September 2021, the total alkalinity value was found to be 30.0 ppm. After a sudden rise in October 2021 and fall in November 2021, the alkalinity value tended to increase steadily from the month of February 2022 and reached the peak in April 2022 which was 60.0 ppm. The bicarbonate contents of lake water then tended to go down and reached the minimum in August 2022 was 29.2 ppm for the dam ppm. The second year of observation also confirmed the earlier data with slight deviations. The highest value was recorded in the month of April 2023 and July 2023 which was 87.6 ppm and 82.9 ppm and the minimum value was recorded in the month of November 2022 which was 25.0 ppm.

An inverse relationship with the free carbon-di-oxide with bicarbonate alkalinity was established (r = -0.94, P.0.001). The increase of free carbon-di-oxide value corresponded with the decreased value of bicarbonate alkalinity and the reverse was also observed to be true. The absence of free carbon-di-oxide showed the presence of carbonate content of lake water thereby implying an inverse relationship between them.

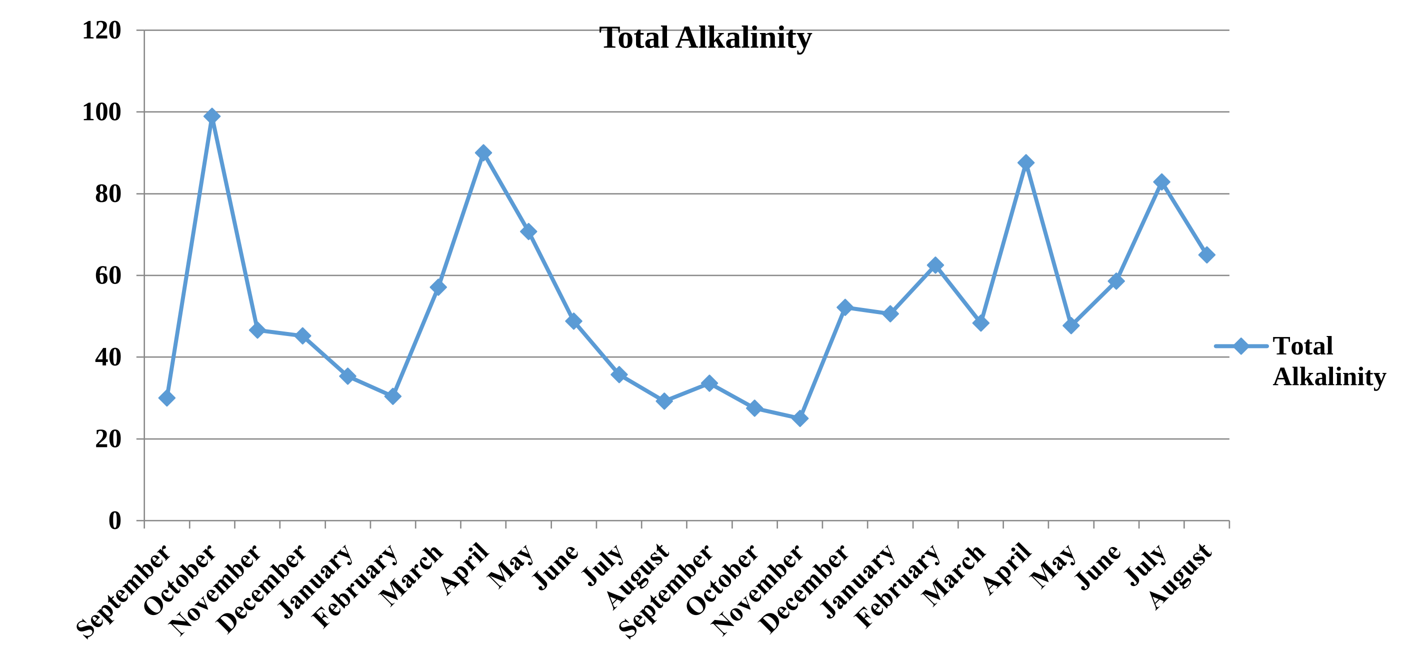


Fig (4) – Showing Total Alkalinity of Morvan Dam

Chloride contents

The Chloride content was found to vary from a minimum of 9.8 ppm in September 2021 to a maximum of 72.8 ppm in July 2023.The chloride content was found to be very high during the early monsoon and rainy seasons (June, July and August) which was mainly due to washing down of organic matter from the surrounding catchment area. Afterwards there was a sharp downward trend to chloride content of the lake water up to October. From May onwards there was a steady increase of chlorides in water which may be attributed to the low water level caused by surface water evaporation due to summer beat. During the second year more or less similar trend was observed. A direct correlation was observed between the chloride content and bicarbonate alkalinity($r=0.98$, $P>0.001$) and also between the chloride content and pH ($r=0.75$, $P>0.001$).

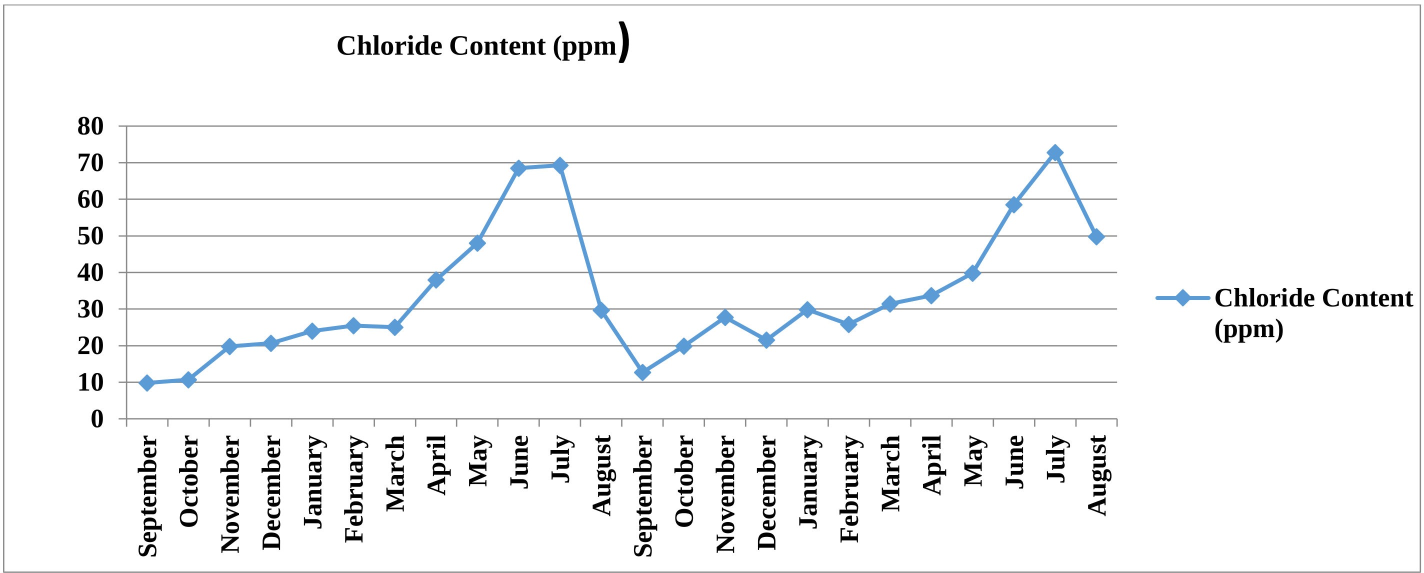


Fig (5)–Chloride Content of Morgan Dam

Sulphate contents

Sulphate was chiefly contributed from biotic sources and its concentration varied between a minimum of 17.50 ppm, to a maximum of 36.35 ppm. The fluctuation of sulphate content of the lake water showed a high value in the rainy as well as colder months throughout the period of observation. In warmer months, the sulphate content value was observed to decline to the lowest in the month of April during all the years of investigation (20.60 ppm ,18.60 ppm) respectively. The decrease and increase of the sulphate content of lake water was not observed to be in any relation with the other abiotic components of the lake.

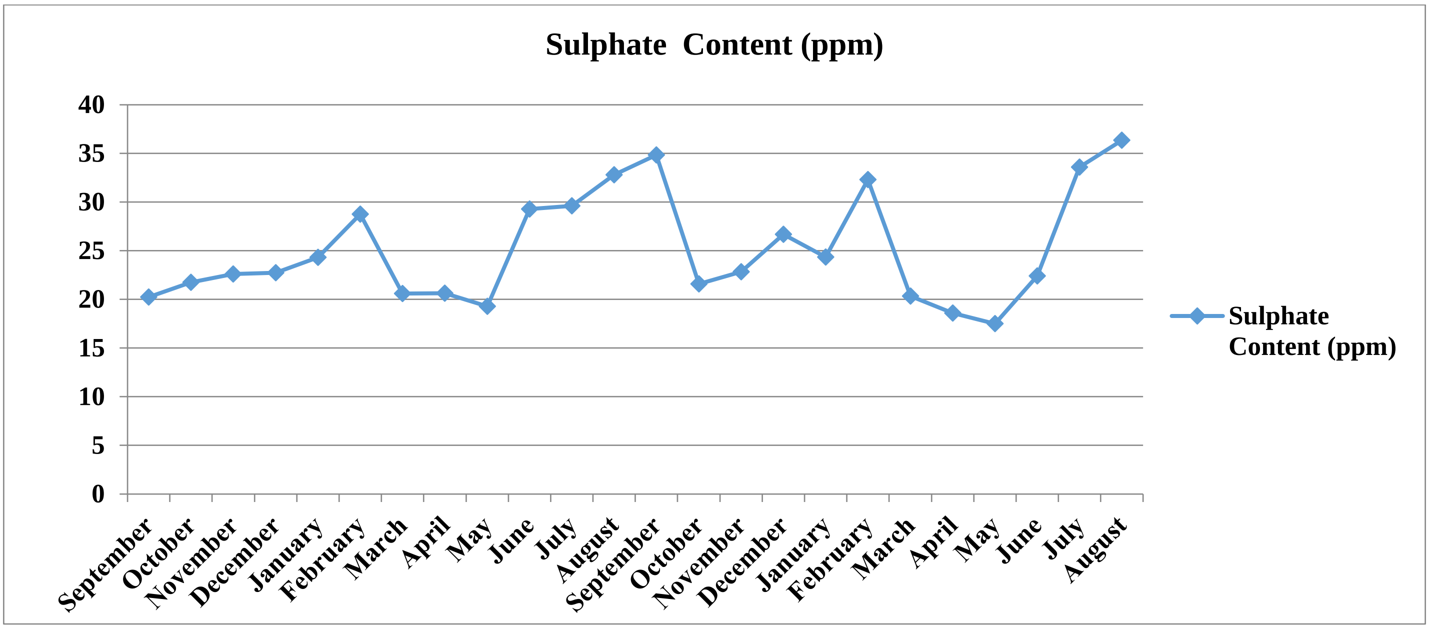


Fig (6)– Sulphate Content of Morvan Dam

Inorganic Phosphate contents

The present study revealed a distinct seasonal, unimodal fluctuation of phosphate content in the lakes water. In September 2021 the phosphate content value was 0.640 ppm. In the following month it decreased to 0.486 ppm, in September 2021 which was subsequenttly observed to be the peak for the phosphate values of the first year of investigation. From September onwards, a gradual decrease of phosphate value was observed till it reached the minimum during the month of August 2022 (0.109 ppm). In the succeeding year, the value fluctuated in the same way, but the peak was observed during the month of December, which was incidentally the highest value observed ever (0.523 ppm). The minimum value for the second year was observed to be during the month of August, 2023(0.164 ppm) which was again the lowest of all.

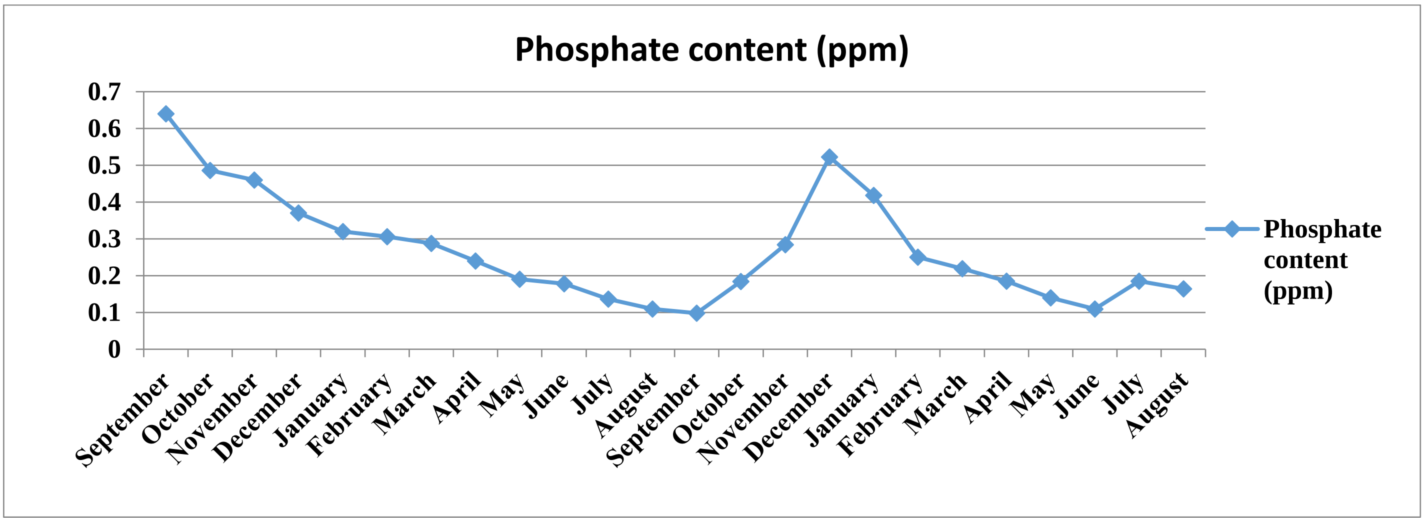
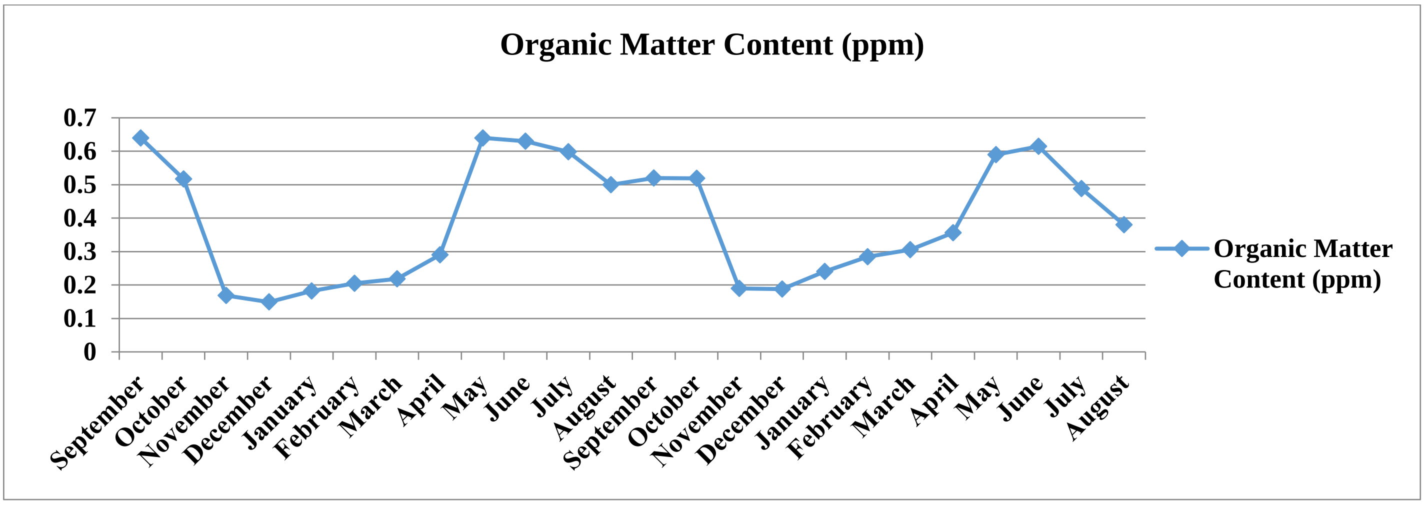


Fig (7)– Phosphate Content of Morvan Dam

Organic matter content

The organic matter content of the lake was found to be 0.640 ppm in the month of September, 2021 which gradually decreased then onwards and the minimum value of 0.149 ppm was reached in December 2021. This abiotic component gradually increased as the monsoon approached and the highest value of 0.630 ppm was obtained during the month of heavy shower (June 2022). The post monsoon period also showed the increased value. The amount of organic matter content decreased in the lake water in early winter months. The second year of study also revealed the same pattern, where the highest value was in the month of June 2023, 0.615 ppm and lowest value was during the month of January 2022, 0.182 ppm. A pronounced increase in the organic matter content of the lake water was observed in the rainy months. This may be due to the influx of organic matter from the surrounding catchment area along with rain waters into the lake. The decay of diatoms and phytoplankton also contribute to the increase of organic matter content in water.



Nitrate contents

The chemical analysis of water samples of the lake revealed the presence of both Nitrate Nitrogen (NO_3-N) and Ammonia Nitrogen (NH_3-N); though the latter was found only in traces.

Nitrate Nitrogen (NO_3-N)

A distinct seasonal fluctuation of Nitrate Nitrogen content of the lakes. During the first year of investigation the minimum value was recorded to be 0.110 ppm in the month of April 2022 and the maximum value was observed to be 0.364 ppm in the month of August 2022. A steady decrease in the Nitrate Nitrogen content of water was observed during the month of summer, followed by a steady increase of the values in the monsoon i.e., June, July, August and September and post –monsoon periods i.e., October, November and December. .

In the succeeding year (2021-2022) the minimum value was observed to be nil in the month of April 2023 and maximum value was recorded in the month of September 2021 (0.447 ppm). The supply of the Nitrate to the lakes appeared to be regulated by the drainage and surface run-off of water during the monsoon months.

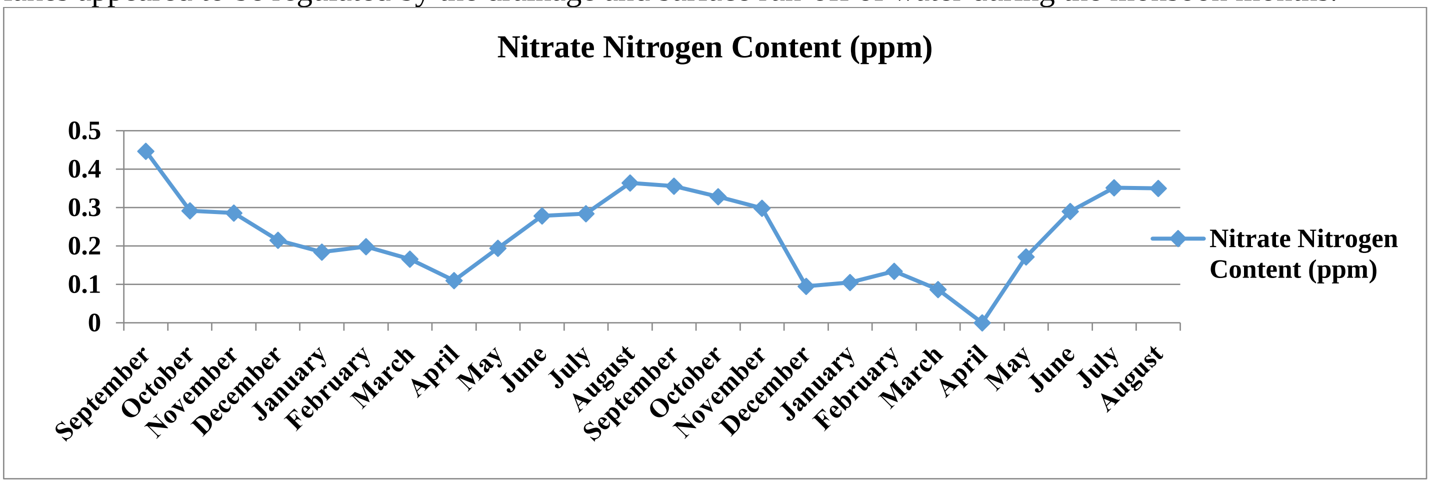


Fig (9)– Nitrate Nitrogen Content of Morvan Dam

Ammonia Nitrogen (NH_3-N)

During the present investigation, the minimum value recorded for the Ammonia Nitrogen of the lakes was 0.012 ppm dam. Throughout the period of observation the seasonal fluctuation followed more or less the same pattern, which was evidenced by lower value in the colder and warmer months. During the first year of investigation, higher value was obtained in the post monsoon months, whereas in the second year of investigation, the higher values were obtained during the monsoon months. The results of the first year's observation may well be caused by the abundance of decaying organic matter in the lakes.

The inflow of organic matter through the drainage and surface run-off of water was also observed to influence the Ammonical Nitrogen concentration.

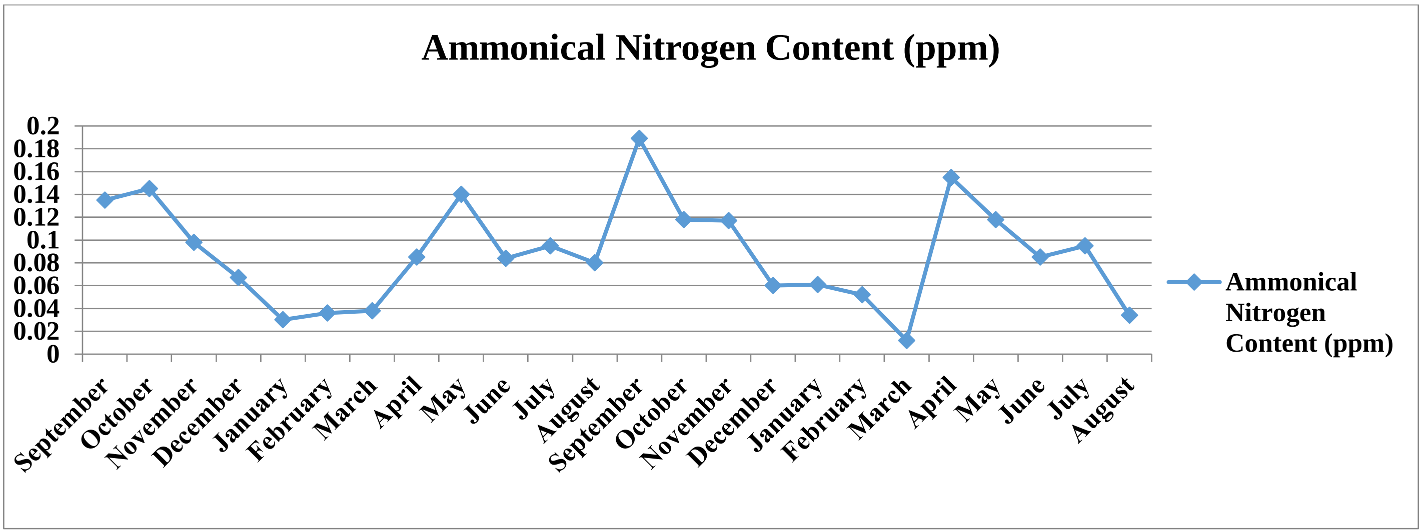


Fig (10)– Ammonical Nitrogen Content of Morvan Dam

Silicate contents

During the first year of study, the silicate value of 0.13 ppm was found to be the minimum whereas the maximum value was 0.99 ppm. The silicate value showed distinct seasonal fluctuation. It was evident, that silicate value of lake water was minimal in cold weather and post monsoon seasons, whereas it increased during the hot weather and pre-monsoons. During the second year of study, more or less a similar trend was found, whereas the minimum value was obtained to be 0.13 ppm (January 2023) and the maximum value was found in the month of April 2023 (0.98 ppm).

A positive significant correlation between the pH value and the silicate value was observed as when pH tended to be alkaline, the silicate value also increased and vice-versa ($r = 0.84$, $p > 0.001$).

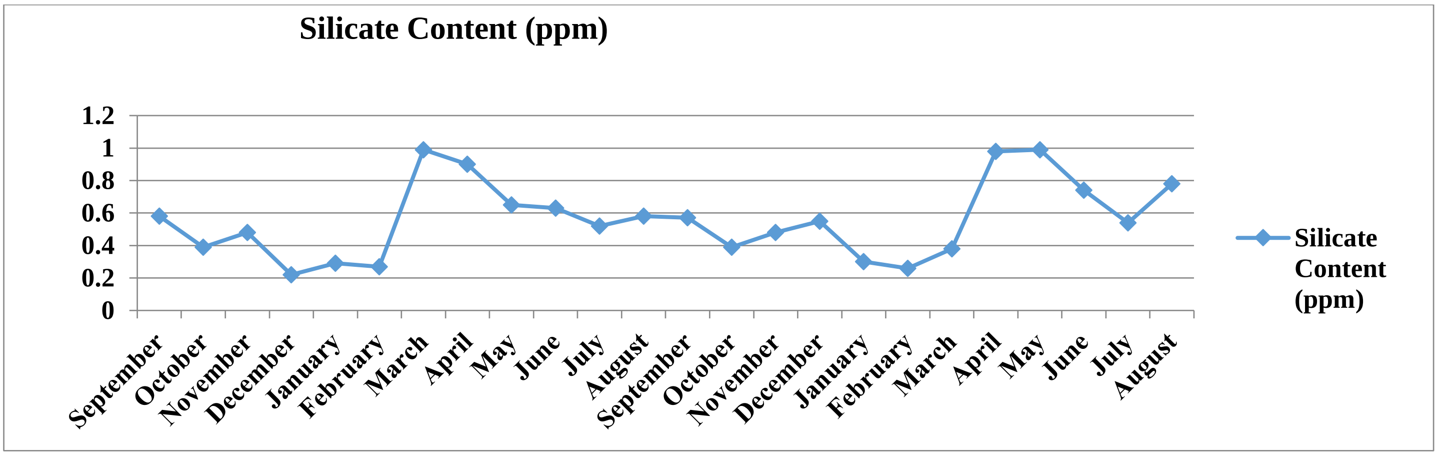


Fig (11)– Silicate Content of Morvan Dam

SUMMARY

The study suggests that the water body is in good condition and good for drinking and Irrigation and also has a positive trend during several months and seasons as far as the parameters studied in the research work is considered with significance correlation between the water level and monsoon rainfall.. The outer skirt of the dam is shunk considerably due to the aggressive and rapid urbanization process and uncontrolled encroachment, we need to spread awareness among people in order to maintain pollution. Hence the finding are crucial for water resource management and planning in this region.

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