

WATER QUALITY ASSESSMENT OF KANKE DAM IN RANCHI JHARKHAND INDIA

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ABSTRACT

Kanke Dam is a major water reservoir in Ranchi Jharkhand. Located in Kanke road and Kanke, this water reservoir on the River Potpoto which is a prime source of water for Kanke Dam. It was designed by the British in the year 1954. It is an earthen dam with boulder pitching and is built at the foot of Gonda hills. The dam is popular for picnic spot and has a scenic view, sunset point and Rock Garder on Gonda Hills. The dam extend between Latitude 23 °41° North and 23 °43 ° North and Longitude 85 °31° East and 85 °33 ° East, covering the areas of 182.10 Hectors of perennial water. Average Elevation is about 611m (2,004 ft).

This paper present the Water Quality Assessment of Kanke Dam. The analysis was carried out on the parameters such as Physical: Water Level, Temperature, and Transparency. Chemical: Hydrogen ion Concentration (pH), Dissolved Oxygen, Total Alkalinity, Chloride, Sulphate, Phosphate, Organic matter. Biological: Phytoplanktons. The range of various parameters of water of the water bodies are as Hydrogen ion Concentration (pH) (7.2),Dissolved Oxygen (10.9), Free Carbon-di-oxide (7.30),Total Alkalinity (96.8), Chloride (72.8), Sulphate (36.35), Phosphate (0.640), Organic matter (0.640). The duration of the study period is from Sept 2021 to Aug 2023.

Keywords – Water Quality Assessment, Kanke Dam, Hydrogen ion Concentration (pH), Dissolved Oxygen, Total Alkalinity, Chloride, Sulphate, Phosphate.

INTRODUCTION

In the present scenario the growing demand for water and its use in human activities, combined with the decline in natural water sources and environmental pollution, has made water quality

assessment a critical issue. Water is a vital natural resource essential for the survival of life and the environment. (Mishra and Bhatt, 2008; Dikio, 2010). Clean water is necessary for the healthy survival of all living organisms. Drinking water should be free from harmful pollutants to ensure a healthy and productive life. The quality of surface water provides important insights into the availability of resources that support life within an ecosystem (Manikannan et al., 2011).

The physical and chemical properties of water influence its quality. These properties include temperature, which is a critical factor in lakes, especially freshwater lakes. Temperature affects the life cycle of aquatic organisms. pH also plays a significant role in the health of a lake, as it indicates whether the water is acidic or basic and influences the survival of aquatic life. Dissolved oxygen is crucial for aquatic organisms, and its levels are affected by temperature and photosynthesis. As water temperature increases, oxygen levels decrease, making it harder for aquatic organisms to survive. On the other hand, photosynthesis by plants and algae increases oxygen levels, providing a safe environment for aquatic life.

Organisms that live on the surface of water are called plankton.

These include both plants and animals. The plant form is known as phytoplankton, and the animal form is called zooplankton. Phytoplankton are important primary producers in the aquatic ecosystem, forming the foundation of the autotrophic food web. The maximum production of phytoplankton occurs when the physico-chemical factors are at their optimal levels (Sinha and Srivastava, 1991; Muhammad et al., 2005). Zooplankton are tiny animals found in the water column of almost all water bodies, they can't swim against current so they float around in water bodies. They are the main primary consumers in the aquatic food chain and play a key role in the productivity of fish. Zooplankton are an important food source for omnivorous and carnivorous fish (Alam et al., 1987). They serve as a crucial link in the transfer of energy within the aquatic food web due to their drifting nature, high density, diverse species, and ability to withstand environmental stress (Bhat et al., 2014). The larvae of carp primarily feed on zooplankton (Bardach et al., 1972). The presence of zooplankton depends on water productivity, which is influenced by physico-chemical parameters and nutrient levels in the water (Sawane et al., 2009). The zooplankton community fluctuates with changes in the physico-chemical conditions of the environment, and their density in any water body is governed by various water quality parameters such as light penetration, temperature, nutrient levels, and microbial activity (Reynolds, 1987). They are included in bio-monitoring programs because their density and species composition can indicate changes in environmental conditions.

Materials and Methods

Kanke Dam

The Kanke Dam is the main water source for Ranchi city in Jharkhand. Located in Kanke road and Kanke, this water reservoir on the River Potpoto which is a prime source of water for Kanke Dam. The British engineers designed Kanke Dam during the colonial period to resolve Ranchi's drinking water problem. The construction of the dam wrapped up in the year 1954 and the Dam have been supplying water to the city ever since. It is an earthen dam mainly made of compacted soil and earth rather than concrete. The upstream slope is protected with boulder pitching, i.e., large stones packed together to stop the waves from eroding the dam and is built at the foot of Gonda hills. The dam is popular for picnic spot and has a scenic view, sunset point and Rock Garden on Gonda Hills. The dam extends between Latitude $23^{\circ}41'$ North and $23^{\circ}43'$ North and Longitude $85^{\circ}31'$ East and $85^{\circ}33'$ East, covering the areas of 182.10 Hectors of perennial water. Average Elevation is about 611m (2,004 ft).



FIG – 1 GPS PHOTO (taken from Net)



FIG – 2 TOPOGRAPHIC MAP OF KANKE DAM
(taken from Net)



FIG -3 KANKE DAM

Water Sample

The water sample was collected once in a week at 8 A.M from Kanke Dam in Ranchi Jharkhand. The water sample was collected at the same time of day for the entire study. Water was collected in black-painted Winchester bottle of two liter capacity, adding few drops of chloroform or toluene. Here the determination of the temperature, the turbidity and the pH were done on the spot. For the methods employed for the chemical analysis of water Welch (1948), Dowdeswell (1959), APHA (1965), Jhingran *et.al.*(1969) and Michael (1984) were followed.

The methodology that is adopted for the analysis of water quality parameters as under:-

Physical Parameters

Temperature

The temperature of the surface water was recorded weekly at the time of sampling with the help of a mercury bulb thermometer while avoiding its direct exposure to the sunlight (Welch 1952).

Transparency

The transparency of the water was determined by Secchi disc of 20 cm in diameter (painted black and white on the upper surface) and determined by the formula:

The reading

$$\frac{d_1 + d_2}{2}$$

in cm

this gave a measure of light penetration and it is known as Secchi Disc transparency.

Where,

d1 = Depth of disappearance in cm.

d2 = Depth of reappearance in cm.

Chemical Parameters

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. It was utilized for estimating hydrogen particle concentration (pH) by plunging the electrode into the experimental water in a clean beaker at the sampling station. The pH meter was calibrated in the laboratory by utilizing various buffers.

Dissolved Oxygen (OD)

The determination of dissolved oxygen content of lake waters the unmodified Winkler's technique gave the most satisfactory result.

Free Carbon - di – oxide (FCO₂)

The water sample 50 ml was taken and 2 drops of phenolphthalein indicator were added to it then it was titrated with N/ 44 sodium hydroxide solution. This solution was standardised against sulphuric acid solution of equal strength with phenolphthalein and it is used as an indicator. The alkali was run slowly and the colour of the sample turned pink, this showed the result.

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

These dissolved salts in water was determined with the help of a Systronic's Digital Spectrophotometer 103.

Plankton Sample

The plankton sample were collected from the surface by filtering 100 litres of water through a plankton net made of Nylon bolt No.25. The net plankton was carefully washed and transferred in a specimen tube. The samples were fixed by adding 4% formalin solution.

Zooplankton Sample

Planktonic invertebrates or zooplankton were collected by filtering 100 liters of water sample through the plankton net of standard bolting silk cloth no.25 (mesh size 0.003 – 0.004 microns). The volume of zooplankton samples was adjusted to about 20 ml and was preserved by adding 5% of formalin. The preserved zooplankton sample were then brought to the laboratory and analyzed both qualitatively and quantitatively. The identification was done using the Ward and Whipple (1959), Pennak (1978), and Adoni (1985).

Data Analysis

Various diversity indices – Shannon – Wiener diversity index, Simpson's Index, Margalef's Index were applied to the resultant data.

Result and Discussion

Physical factors

Water Level

During September in the post-monsoon period of the year. The water level of Kanke Dam was 4.3 m, subsequently there occurred a gradual decrease in the level due to the onset of winter and followed by the summer causing ample evaporation of water. These months were also associated with a gradual increase in the exposure of the surface water to the bright sunshine. The decrease continued till the month of June when the minimum level was observed to be 8.8 m in Kanke Dam. From July onwards it showed an increasing tendency due to the heavy rain of monsoon and continued till the month of September 2022 (10 m in Kanke Dam), which was the highest water level of the year. There was no marked change in the level of water till the month of February but it started decreasing from March onwards. Then the same trend followed. It reveals that the water level always tends to remain near the overflow level and is only distributed by the onset of hot weather or monsoon seasons, there was no other source of incoming of water in the lake except through rains.

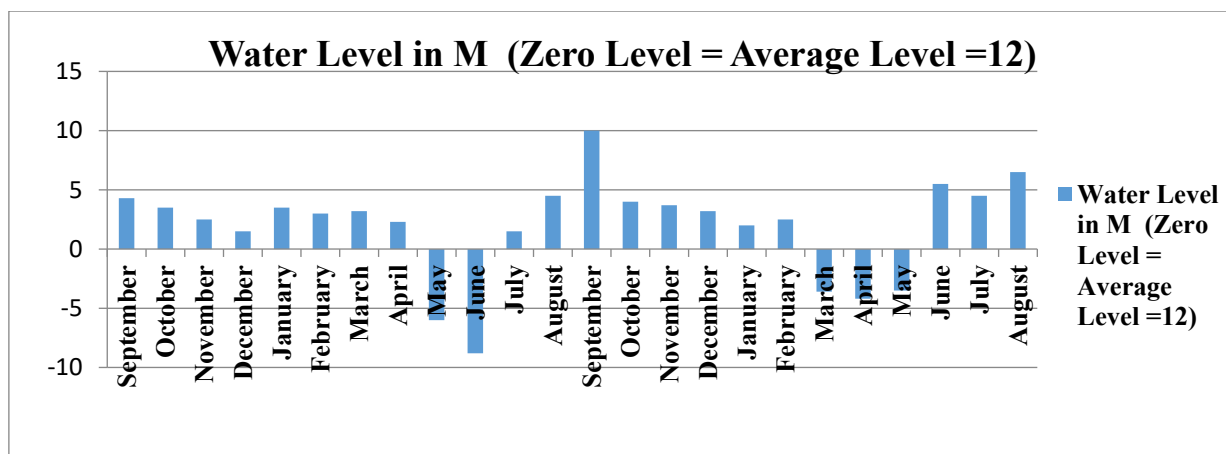


Fig 4– Showing Water Level in Meter in Kanke Dam

Temperature

The seasonal fluctuation of surface water temperature of the lake showed that it was 25°C in the month of September. It tended to decrease gradually in succeeding months and reached the minimum 13°C in the month of December. From January onwards, the water temperature gradually increased with the approach of summer and was maximum 31°C in the month of May. Due to the onset of monsoon the water temperature then steadily went down. During the succeeding year, the maximum temperature was 31°C was recorded in May. For the rest of the months the fluctuation of the water temperature followed the same pattern. An obvious linear relationship between the surface water and air temperature was observed in Figure 5. A gradual downfall of temperature with the increase of rainfall was also recorded.

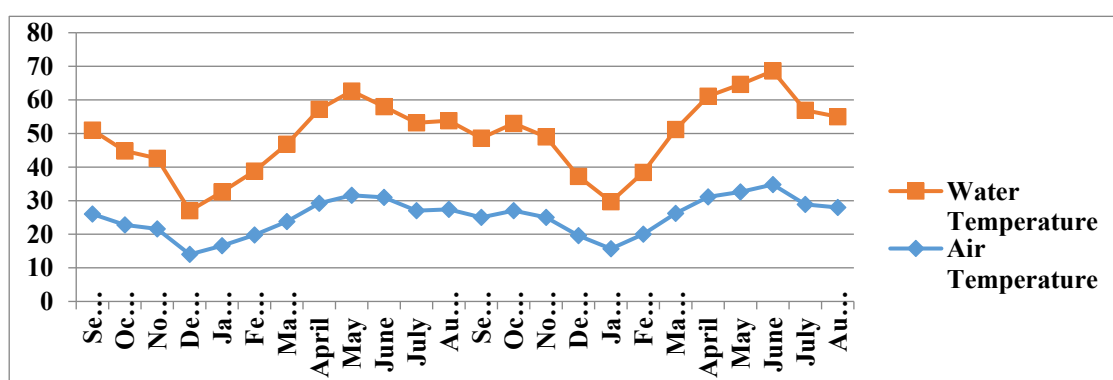


Fig 5–Air Temperature and Water Temperature showing Temperature in 0°C of Kanke Dam

Transparency

During September, the transparency of water was recorded to be 80.0 cm. There occurred a steady increase in the transparency of water in November with a slight fall in December and increase in January and again fall in February, until the highest value was observed in April 198.0 cm. The minimum value was recorded in the month of August 88.0 cm. After two months of heavy rain. The shorter light penetration during the month of August and September can be well attributed to the steady inflow of turbid water from the surrounding during the monsoon. In the succeeding year, the fluctuation followed the same pattern through the highest value were recorded in March, 172.0 cm with subsequent steady reduction of transparency values caused by the onset of showers.

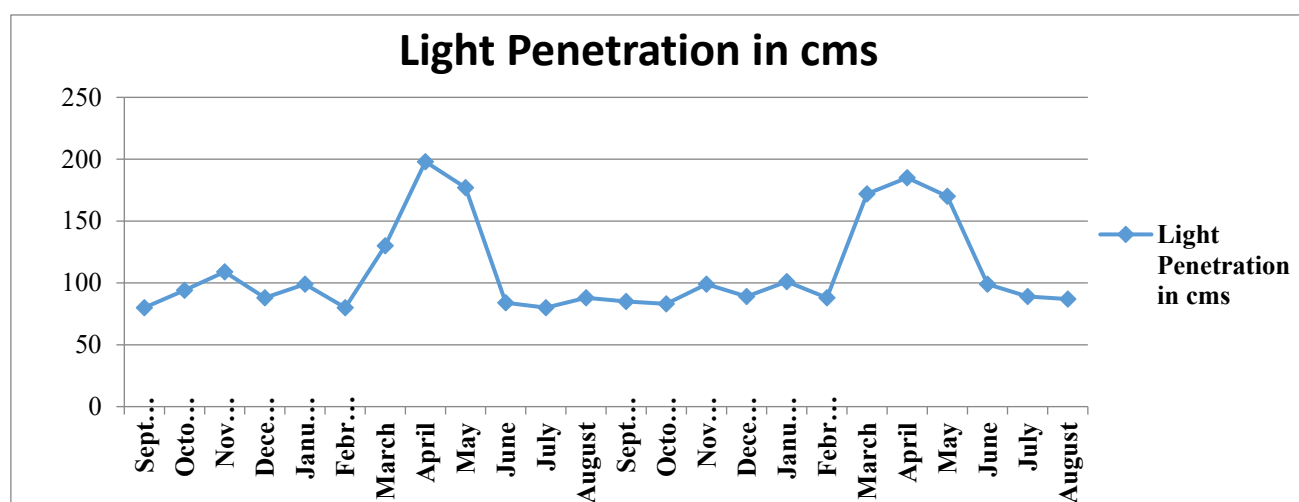


Fig 6–Light Penetration in cms of Kanke Dam

Chemical Factors

Hydrogen-ion concentration

The pH of the lake water tended to remain slightly acidic throughout the period of investigation barring a few months in the beginning of the study. In September the pH value recorded was 6.4, which was subsequently found to be the minimum value during the entire course of the investigation.

In the succeeding months of October the hydrogen ion concentration value remained slightly acidic and in November the hydrogen ion concentration value remained Alkaline

but December onwards the pH value shifted again to slightly acidic range. The pH value in the cold season (December, January and February) was recorded to be slightly acidic. This was followed by a sharp decrease in the pH value during July that was 6.4, due to the onset of first heavy showers later on. In August a marked decrease of 6.1 in the pH value was recorded followed by an increase in the month of September were 6.9.

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. The level of pH support many aquatic invertebrates and fishes in aquatic ecosystem.

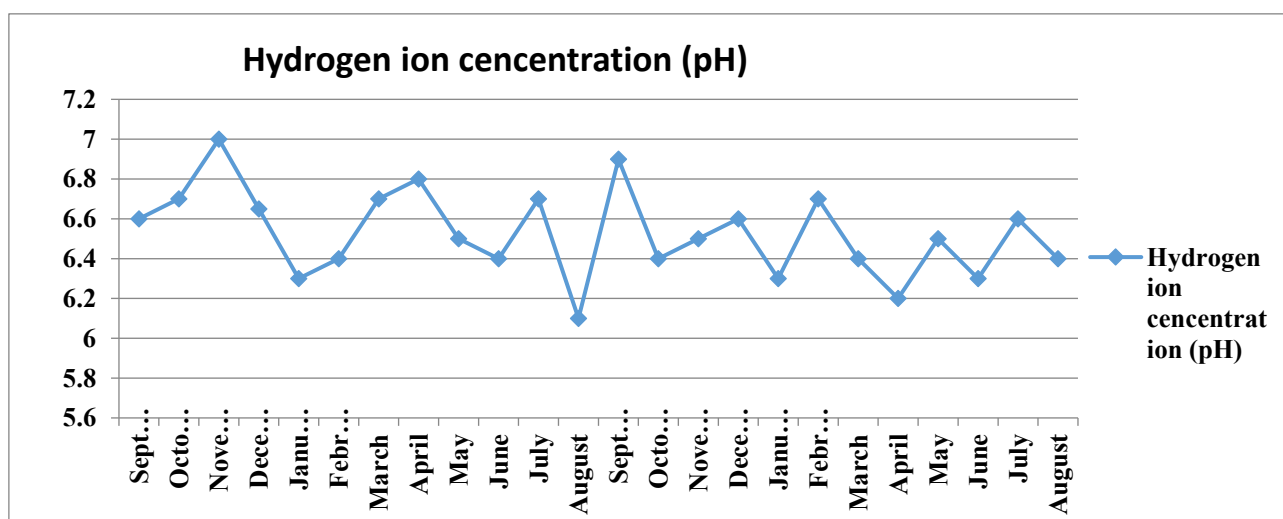


Fig 7– Hydrogen ion Concentration of Kanke Dam

Dissolved Oxygen (O₂) in ppm

The dissolved content of lake water varied from 4.3 ppm to 10.8 ppm during the period of investigation. During September the dissolved Oxygen content of water was 7.5 ppm, then a gradual increase in the oxygen content of water was observed till January 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 10.9 ppm were recorded in the month November and lowest value was recorded in the month of May.

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.

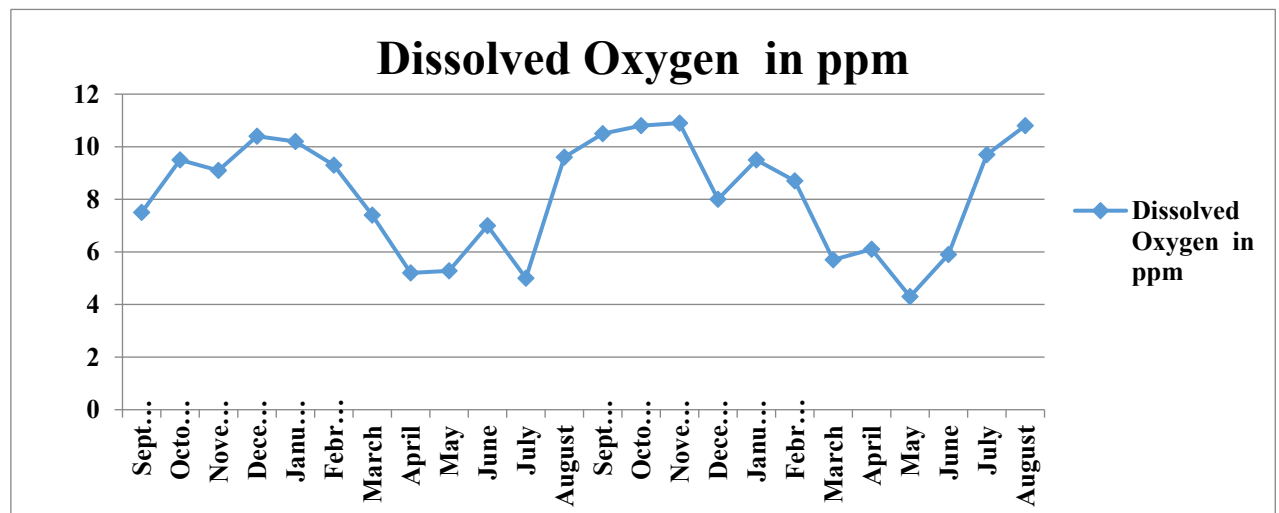


Fig 8 - Showing Dissolved Oxygen (O_2) in ppm in Kanke Dam

Chloride

The Chloride content was found to vary from a minimum of 9.7 ppm in September to a maximum of 78.9 ppm in July. 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 heat.

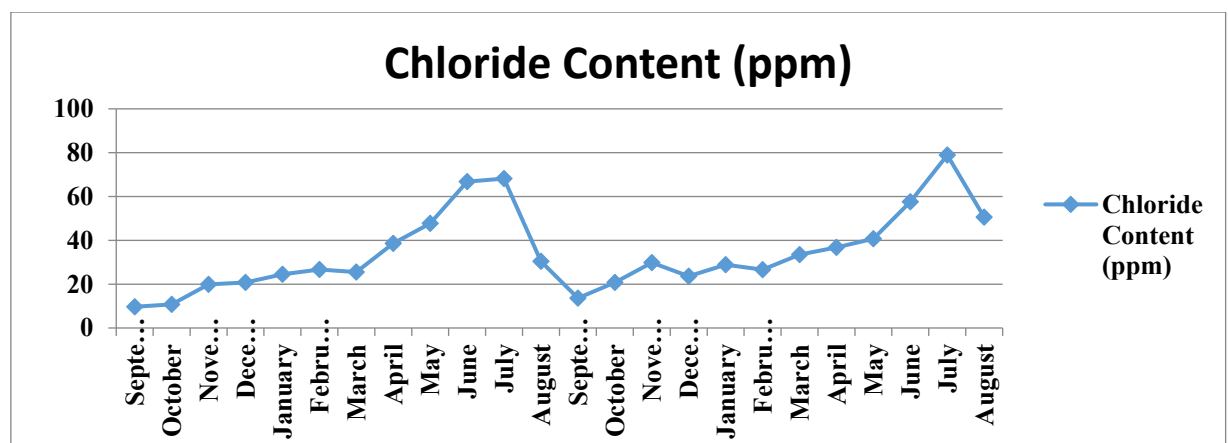
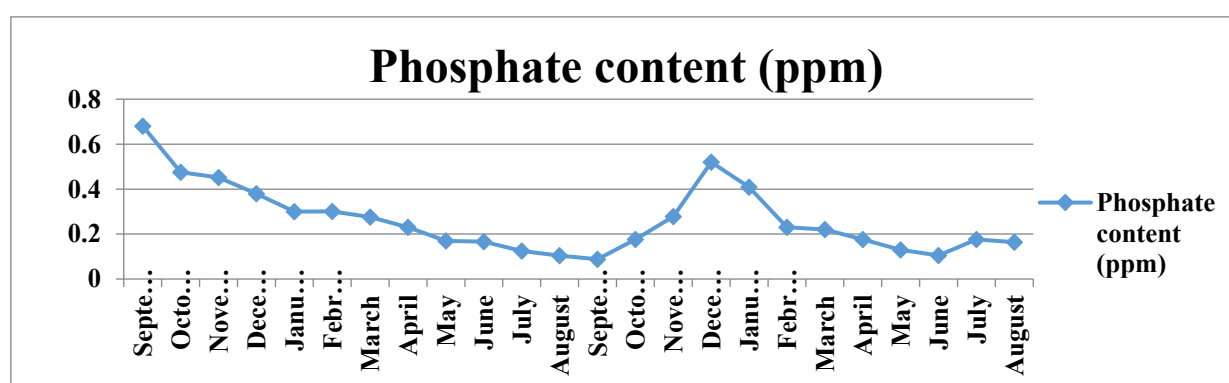


Fig 9 - Chloride Content of Kanke Dam**Phosphate**

The present study revealed a distinct seasonal, unimodal fluctuation of phosphate content in the lakes water. In September the phosphate content value was 0.680 ppm. In the following month it dropped to 0.475 ppm. From September onwards, a gradual decrease of phosphate value was observed till it reached the minimum during the month of August (0.140 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 (0.520 ppm). The minimum value for the second year was observed to be during the month of July, 2023 (0.176 ppm).

**Fig 10 - Phosphate Content of Kanke Dam****Organic matter content**

The organic matter content of the lake was found to be 0.680 ppm in the month of September, which gradually decreased then onwards and the minimum value of 0.150 ppm was reached in December. This abiotic component gradually increased as the monsoon approached and the highest value of 0.590 ppm was obtained during the month of heavy shower in July. 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 (0.610 ppm) and lowest value was during the month of January (0.250 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.

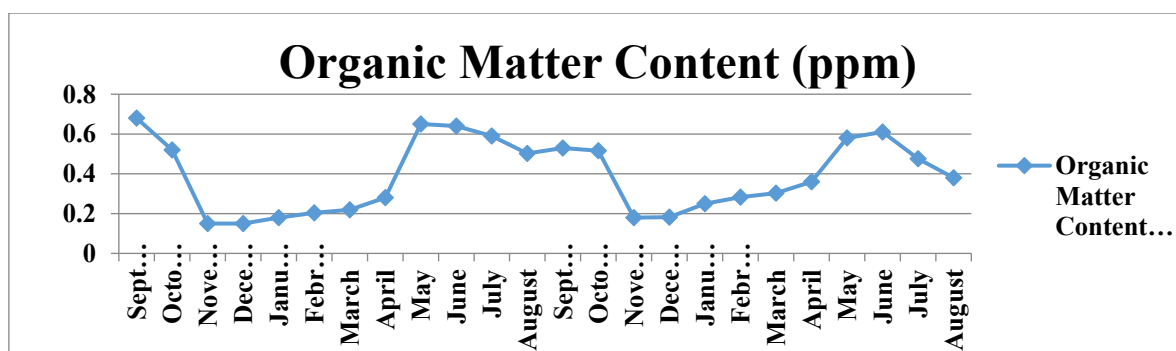


Fig 11– Organic Matter Content of Kanke Dam

Sulphate

Sulphate was chiefly contributed from biotic sources and its concentration varied between a minimum of 18.60 ppm to a maximum of 36.0 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 (in April 2022 it was 19.80, and in 2023 it was 19.55 ppm). 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.

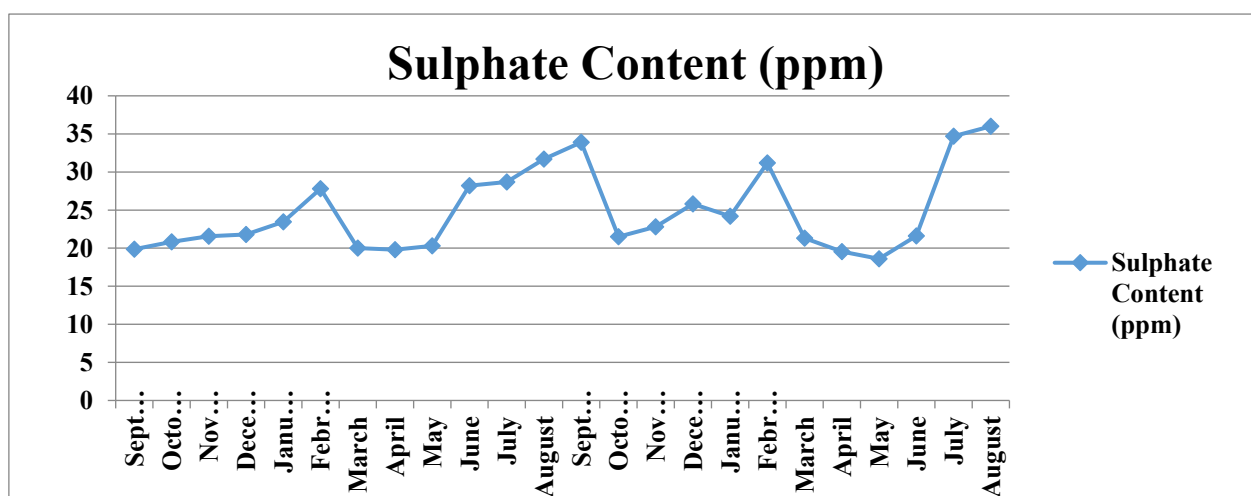


Fig 12– Sulphate Content of of Kanke Dam

Nitrate contents

The chemical analysis of water samples of the lake revealed the presence of both Nitrate Nitrogen ($\text{NO}_3\text{-N}$) and Ammonia Nitrogen ($\text{NH}_3\text{-N}$); though the latter was found only in traces.

Nitrate Nitrogen ($\text{NO}_3\text{-N}$)

A distinct seasonal fluctuation of Nitrate Nitrogen content of the lakes shows the minimum value which was recorded to be 0.116 ppm in the month of April and the maximum value was observed to be 0.366 ppm in the month of August. 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 and post –monsoon periods.

In the succeeding year the minimum value was observed to be nil in the month of April and maximum value was recorded in the month of September (0.358 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.

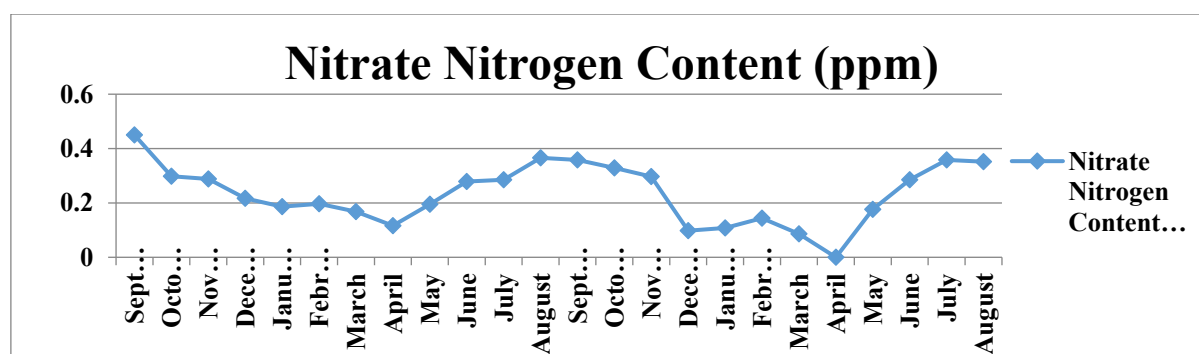


Fig 13– Nitrate Nitrogen Content of Kanke Dam

Ammonia Nitrogen ($\text{NH}_3\text{-N}$)

During the present investigation, the minimum value recorded for the Ammonia Nitrogen of the lakes was 0.013 ppm. 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 investigation, higher value was obtained in the post monsoon months, whereas in the second 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.

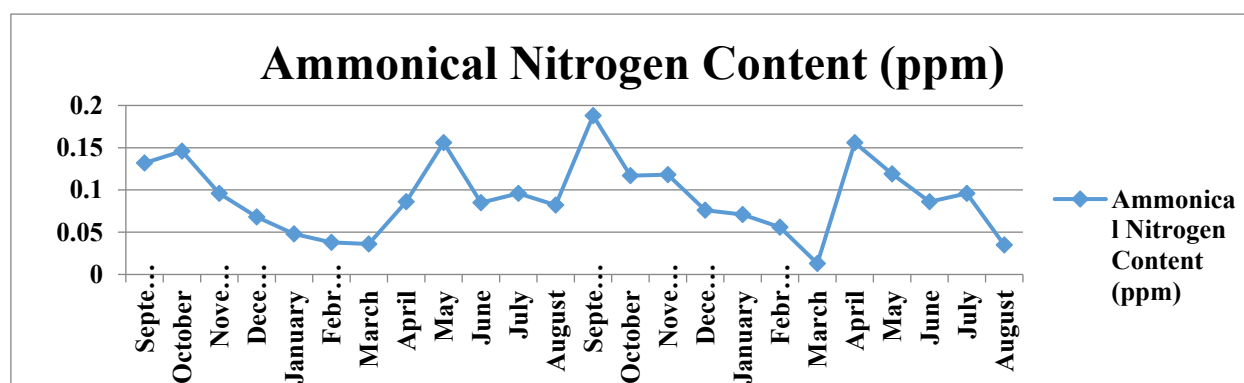
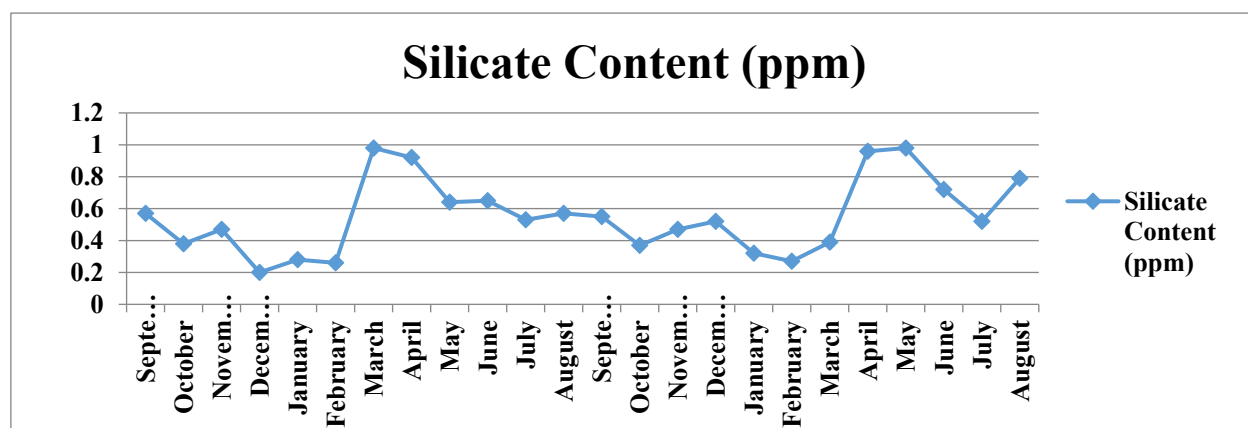


Fig 14- Ammonical Nitrogen Content of Kanke Dam**Silicate contents**

During the study, the silicate value of 0.12 ppm was found to be the minimum whereas the maximum value was 0.98 ppm. 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 0.16 ppm (January) and the maximum value was found in the month of May (0.98 ppm).

**Fig 15– Silicate Content of Kanke Dam****Phytoplanktons**

Among the phytoplankton member of blue-green algae (myxophyceae) green algae (chlorophyceae) are diatoms (bacillariophyceae) are most common in the lake. Among the three groups, myxophyceae is the most dominant followed by baccillariophyceae and chlorophyceae. Odum (1971) stated that blue green algae is of considerable biological importance because of its enormous production in most polluted waters. Members of myxophyceae especially *Microcystis* sp. are present in considerable number in the lake throughout the study period. During the present investigation the dominance of the species of myxophyceae especially *Microcystis* sp. and *Spirulina* sp. have been observed in the lake. The abundance of these algae can be seen throughout the year on the surface water. The abundant production of myxophyceae in tropical lakes could be attributed to the moderate temperature, long hours of sun shine and fair degree of concentration of nutrients.

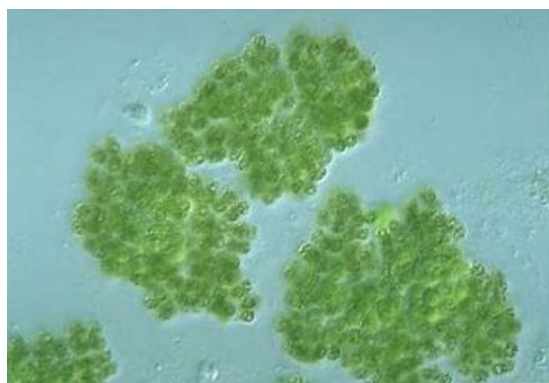


Fig -16 *Microcystis* sp.



Fig -17 *Spirulina* sp

ZOOPLANKTONS

The lake's Zooplankton mainly consist of rotifers, cladocerans and copepods. The protozoans were also present but in much smaller numbers. The seasonal variations of volumetric and numerical abundance of the total zooplankton and the important forms of the different zones of the lake. The various zooplankton encountered during the investigation period were *Brachionus* sp., *Keratella* sp., and *Esplanchna* sp., among rotifers, *Diaphanosoma* sp., *Daphnia* sp., *Simocephalus* sp., and *Chydorus* sp., among the Cladocerans, *Cyclops* sp., and *Diaptomus* sp. among the cepepods and *Diffugia* sp., *Paramecium* sp., among the protozoans. Cladocerans were next to copepods while rotifers showed minimum abundance.



Fig -18 *Brachionus sp*



Fig -19 *Keratella sp*



Fig -20 *Esplanchna sp*



Fig - 21 *Diaphanosoma sp*



Fig -22 *Daphnia sp*



Fig - 23 *Simocephalus sp*

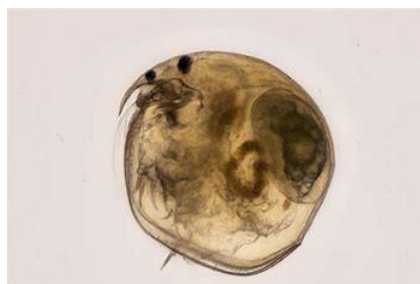


Fig-24 *Chydorus sp*



Fig – 25 *Diaptomus sp*



Fig -26 *Diffugia sp*

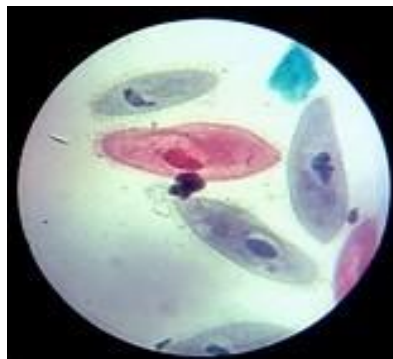


Fig - 27 *Paramecium sp*

SUMMARY

The study suggests that the characteristics of Kanke Dam is maintained with the respect to the water quality assessment parameters and the water body is in good condition and a good drinking water source (after disinfection) and has a positive trend during several months and seasons as far as the parameters studied in the research work is considered with the water level.

CONCLUSION

The water quality assessment of Kanke Dam reveals that while the reservoir maintains acceptable levels for most parameters, seasonal variations and anthropogenic activities pose ongoing challenges. The study indicates that continuous monitoring and protective measures are essential to maintain water quality standards for drinking and agricultural purposes.

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