

WATER QUALITY ASSESSMENT OF KOTITHIRTA –A HOLY TEMPLE LAKE OF GOKARNA, KARNATAKA

H.S.Anantnarayan¹, Tina Beretto², Anupama Desai³ and Gajanan Hegde^{4*}

^{1,2,3} Department of Chemistry, Gokhale Centenary College, Ankola, Karnataka, India-581314

⁴ Assistant Professor, Department of Chemistry, Gokhale Centenary College, Ankola, Karnataka, India-581314.

ABSTRACT: A lake is an area which is filled with water localized in a basin that is surrounded by land other outlet that serves to feed as drain the lake. Lakes are not part of the ocean but it lie on land and therefore they are distinct from lagoons. Lakes are an important water resource found on this planet. Lake water is source for drinking and many of the domestic use in rural and urban population of India. The main aim of current study was to assess water quality of kotiteertha lake, Gokarna a holy place situated in Karnataka. Water samples were collected in winter season of Costal Karnataka. Due to increased population and manmade activities and performing rituals, water is being highly polluted with different types of contaminates¹. The water samples were collected at five different selected sampling sites. The assessment of physico chemical parameters of Kotiteertha lake water was done during January 2018. It is very necessary to know details about different parameters like pH, temperature, turbidity, alkalinity, hardness, conductivity, sulphate, TS, TDS, TSS, DO, BOD etc. At the end of the results obtained from different physic-chemical parameters we came to know that Kotithirta lake has been declared as class E types of lake according to classification laid by CPCB. The lake water is not suitable for drinking purpose as per criteria laid down by the IS 10500:2012 without filtration or necessary pre treatments.

Keywords: Kotithirta lake, Gokarna, Biochemical Oxygen Demand, Physico- Chemical analysis.

INTRODUCTION:-

Globally, the pressure on the water resource and particular on ground water resources is mainly increased due to the growing demands and degradation of water quality. Water is most essential source in day today life for human survival. Water is not only important for human consumption but also for plants, animals and other living organism which is necessary for their survival purposes and for the development of their natural resources. Due o the increasing in pollution and growth of urbanisation water gets contaminates and hence man made water is polluted a great problem and there is sharply decrease in availability of drinking water². Due to its economic potential many of the lakes have become popular tourism and based on water recreational sites and commercial activities. Therefore it is very necessary to check out the water quality and maintain of quality of ground water, the continuous monitoring of physio- chemical should be carried out.

Gokarna is one of the small temple town on the western coast of India which lies Kumta thaluka of Uttar Kannada district of Karnataka state. Gokarna means cowsear. It is still believed that Lord Shiva emerged from ear of the cow. Gokarna is at the ear shape of the two river of Gangavali and Aghanashini. Gokarna is about 59Km from Karwar and 26km from Ankola and 238 km from North of Manglore, 483km from Bengaluru³.

Kotithirta lake is a natural fresh water body situated in the township of Gokarna in Uttar kannada district Karnataka state of India. Kotithirta the name literally means a thousand springs and it is still believed that to be one of the most sacred water sources in the Gokarna⁴.

Kotithirta lake is surrounded by priest houses and It is a famous lake in the Gokerna which is located at the center of the town and several other houses of nearby areas and this temple lake also referred as tirtha are created in enclosures of the temple premises to meet the water requirement for rituals purpose. The temple lake is highlight as the historical design. This lake is well constructed by the man to store the rain water for meeting water demands throughout the year. The Kotithirta Lake (170m x90m) has an area of ~1.53 hectares. The depth of the pond varies from ~5m (at west) to 1.5cm (on eastern side). The estimated volume of the temple lake is >50,000m³.

The reason for the contamination of kotithirta lake water may be by the human activities like bathing of large number of devotees, washing of cloths, washing of utensils; disposal of organic materials like flower, ghee, curd, banana, rice balls, and disposal of solid waste etc. The pictures of lake view is shown in Fig 1 and contamination sources are shown in Fig.2.

Fig 1: Pictures showing view of Kotithirtha Lake.



Fig 2: Picture showing sources of contamination in Kotithirtha Lake.





Water Quality:

Water quality refers to the chemical, physical, biological, and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. Water pollution may be defined as the presence of impurities in such quantity and of such nature as to impair the use of water for a stated purpose. Thus, the definition of water quality is predicted on the intended use of the water. Many parameters have evolved that qualitatively reflect the impact that various impurities have on selected water uses. Many methods and criteria are available to assess aquatic ecosystems. A physico-chemical approach to monitor water pollution is most common and plenty of information is available on these aspects. Such data is valuable and necessary in the assessment of water quality of the water body.

A lake is an open system which is connected to its surrounding by the streams (inlets and outlets) and its watersheds. Therefore, the use of the lake associated with population growth and technology development become a threat if the lake utilization and its water body are not well managed. Water body management can be a very complex task and in order to design and put into preventative practice or curative water quality management programs, it is essential to have a firm understanding of the causes of water quality problems⁵.

Sampling Methodology

Sampling Point:

Sampling point was not uniform within the water body. It varied with area, size, and also the morphometric of water body. The sampling point was fixed in dead storage region of water body by the help of GPS reading, because in order to maintain the reliability. In several places, the water samples from water body were collected in a place where water was present, even if the dead storage was not available.

Sample Collection:

Samples were collected in clean 1L plastic bottles. The samples were collected from 30cm below the water surface and brought to the laboratory for physico-chemical analysis. The D.O was fixed in the field by collecting water sample in 300 ml BOD bottle and brought to laboratory for analysis.

Temperature of the water was measured in the field itself by using a digital thermometer by dipping into freshly collected water sample.

Sampling Sites: There are mainly five sampling sites are chosen at the different corners of lake as shown in fig 2, where the comparatively high organic matters are thrown after the performance of rituals activities.

Fig 2: Picture showing the Sampling sites



Physico-chemical analysis of water

Monitoring lakes requires many different parameters to be sampled and analysed in the laboratory using standard methods ⁶⁻⁸. The parameters analyzed in this assessment include:

p^H

Measurement of p^H is one of the most important test used in water chemistry. In the practically every phase of waste water and water supply treatment such as acid base neutralization, in water softening, precipitation, coagulation, disinfection and corrosion control these all depend on p^H. At ascertain given temperature the intensity of the acidic or basic character of a solution is indicated by p^H or hydrogen ion activity.

p^H is defined by the Sorenson as $-\log [H^+]$ it is the intensity factor of acidity.

The p^H scale is usually represented as ranging from 0 to 14, with p^H 7 at 25 °C representing neutrality. Acid conditions increase as p^H values decrease and alkaline conditions increase as p^H values increase. The p^H values of samples were between 5.8-7.5 .

Electrical Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electric current. It is used to estimate the ionic or soluble salt concentration in soils, fertilizer solution, chemical solution and in water supplies. EC meter helps to measures the resistance offered by water between two platinised electrodes Instrument is standardized with known values of conductance observed with standard KCl solution. The ability measuring electric current depends on the presence of ions on their total concentration, mobility and valence and on the temperature of measurement solution of most inorganic compounds are relatively good conductors. Organic compounds that do not dissociate in aqueous solution conduct current is very poor.

Conductivity is measured in laboratory by using Electrometric method as described in, IS 3025 part 14 and by using instrument Systronics MK-509 conductivity meter.

Turbidity

Suspension of particles in water interfering the passage of light is called Turbidity. Turbidity is caused by wide variety of suspended matter which range in size from colloidal to coarse dispersion depending upon the degree of turbulence. It also ranges from inorganic substance to those that are organic in nature. Turbidity is measured to evaluate the performance of water treatment plant.

Turbidity is measured in laboratory by using Nephelometric method as described in CPCB guide manual for water and waste water analysis and IS 3025 part 10 and by using instrument Systronics-135 Turbidity meter.

High levels of turbidity increase the total available surface area of solids in suspension upon which bacteria can grow. High turbidity reduces light penetration; therefore, it impairs photosynthesis of submerged vegetation and algae. In turn, the reduced plant growth may suppress fish productivity. Turbidity interferes with the disinfection of drinking water and is aesthetically unpleasant.

Total suspended solids

The solids refer to matter suspended or dissolved in water and waste water. Solids may affect water or waste water quality adversely in a number of ways. Water high in suspended solids may be aesthetically unsatisfactory for such purposes as bathing. Suspended Solid analysis is important in the control of biological and physical waste water treatment processes and for assessing compliance with regulatory agency's effluent limitations. The total suspended solids are the portion of total solids retained by a filter of 2.0 μm (or smaller) nominal pore size under specified conditions.

Total suspended is analysed in laboratory by using gravimetric method as described in CPCB guide manual for water and waste water analysis and IS 3025 part 17.A well mixed sample is filtered through a weighed standard whatman filter, dried to a constant weight at 103 to 105°C The increase in weight of the filter paper represents suspended solids. High concentrations of non-filterable residue (Suspended solids) increases turbidity, thereby restricting light penetration (hindering photosynthetic activity). Suspended material can result in damage to fish gills. Settling suspended solids can cause impairment to spawning habitat by smothering fish eggs. Suspended solids interfere with water treatment processes.

Total dissolved solids

The solids refer to matter suspended or dissolved in water or wastewater. Solids may affect waste or effluent quality adversely in a number of ways. Water with high dissolved solids generally is non-palatable and may induce an unfavourable physiological reaction in the transient consumer. For these reasons a limit of 500mg DS/l is desirable for drinking water. Dissolved solids is the portion of solids that passes through a filter of 2.0 μm (or smaller) nominal pore size under specified conditions.

Total suspended is analysed in laboratory by using gravimetric method as described in CPCB guide manual for water and waste water analysis and IS 3025 part 18.

A well mixed sample is filtered through a standard whatman filter and the filtrate is evaporated to dryness in a pre-weighed dish & dried at 180°C. The increase in dish weight represents the total dissolved solids.

High concentrations of TDS limit the suitability of water as a drinking source and irrigation supply. High TDS waters may interfere with the clarity, colour and taste of manufactured products.

Dissolved Oxygen (D.O)

All living organisms are dependent upon oxygen in one form or the other to maintain the metabolic processes that produce energy for growth and reproduction. Aerobic processes are of great interest, which need free oxygen for wastewater treatment. Dissolved Oxygen (DO) is also important in precipitation and dissolution of inorganic substances in water. DO levels in natural waters and wastewaters depend on physical, chemical and biological activities in water body. The solubility of atmospheric oxygen in fresh water ranges from 14.6mg/L at 0°C to about 7.0mg/L at 35°C under normal atmospheric pressure. Since it is poorly soluble gas, its solubility directly varies with the atmospheric pressure at any given temperature. Analysis of DO is a key test in water pollution control and wastewater treatment processes.

Method used for analysis of D.O is Modified Winkler's method (Azide Modification) as described in CPCB guide manual for water and waste water analysis and IS 3025 part 38. The basic principle of Winkler's method is estimation of dissolved oxygen uptake at 27°C temperature. It has been modified to remove Nitrate interference by adding sodium azide along with Alkali-Iodide.

This is a measure of the amount of oxygen dissolved in water. Typically the concentration of dissolved oxygen in surface water is less than 10 mg/L. The DO concentration is subject to diurnal and seasonal fluctuations that are due, in part, to variations in temperature, photosynthetic activity and river discharge.

Dissolved oxygen is essential to the respiratory metabolism of most aquatic organisms. It affects the solubility and availability of nutrients, and therefore the productivity of aquatic ecosystems. Low levels of dissolved oxygen facilitate the release of nutrients from the sediments.

Biological Oxygen demand:

The Biological Oxygen Demand (BOD) is an empirical test in which standardized laboratory procedures are used to determine the relative oxygen requirements of water and waste water. A number of factors may affect the accuracy and precision of BOD measurements. For instance soluble and floatable solids, oxidation of reduced ions and sulphur compounds, lack of mixing etc. the BOD test is dependent of dissolved oxygen (DO) available in the incubated sample. Therefore it is necessary to dilute the sample before incubation, to bring the oxygen demand and supply in to appropriate balance.

The Method used for analysis of BOD is Modified Winkler's method (Azide Modification) as described in CPCB guide manual for water and waste water analysis and IS 3025 part 44. The basic principle of Winkler's method is estimation of dissolved oxygen uptake at 27°C temperature under incubation for 3 days. It has been modified to remove Nitrate interference by adding sodium azide along with Alkali-Iodide.

Biochemical Oxygen Demand is an important water quality parameter because it provides an index to assess the effect discharged wastewater will have on the receiving environment. The higher the BOD value, the greater the amount of organic matter or "food" available for oxygen consuming bacteria. If the rate of DO consumption by bacteria exceeds the supply of DO from aquatic plants, algae photosynthesis or diffusing from air, unfavourable conditions occur. Depletion of DO causes stress on aquatic organisms, making the environment unsuitable for life. Further, dramatic depletion can lead to hypoxia or anoxic environments. BOD is also used extensively for wastewater treatment, as decomposition of organic waste by microorganisms is commonly used for treatment. Regulations for BOD will vary by country and region. In general, maximum allowable concentration for direct environmental wastewater discharge fall around 10 mg/L BOD and maximum allowable concentrations for discharge to sewer systems around 300 mg/L BOD.

Total Hardness

Total and Calcium Hardness of the water sample were measured by using EDTA titration method (APHA, 1995). For determination of total hardness, about 1ml of ammonia buffer solution was added to 10ml of sample and titrated against 0.2 N EDTA solution using Erichrome Black T indicator. For determination of Calcium hardness, 1ml of 1N NaOH solution was added to 10ml of sample and titrated against 0.02 N EDTA solution using Muroxide indicator (Ammonium purpurate).

Carbonate Alkalinity

Alkalinity as CaCO₃ (mg/L):

Alkalinity of water is a quantitative measure of the basic constituents of water and is defined as the capacity of the water to neutralise a strong acid at a designated pH. The alkalinity of natural water is mainly due to the presence of salts like carbonates, bicarbonates and hydroxide of calcium, magnesium, sodium and potassium. The borates, silicates and phosphates also contribute to some extent. Alkalinity value helps in deciding chemical doses in water and wastewater treatment processes particularly in coagulation, softening and operational control of anaerobic digestion and suitability of water for irrigation purposes (CPCB, 2008). As per IS: 10500-1992 desirable limit of total alkalinity for inland surface water is 200 to 600mg/L in absence of alternate source. Average total alkalinity of all the water bodies in all the seasons has recorded between 8mg/L and 292mg/L.

Sulphate

Sulphate (SO₄) was determined by following the turbidometric method, where 5ml of conditioning reagent (NaCl: HCl: 95% Ethanol: Glycerol: distilled water in the ratio of 6:0.8:2:1:0.2) and pinch of Barium Chloride (BaCl₂) were added to 50ml of water sample and measured at 420nm using Jenway 6400 spectrophotometer.

$$\text{Sulphate (mg/L)} = \text{Sample Optical Density} \times \text{Concentration Factor} \times \text{Dilution factor}$$

Classification of lakes by CPCB guidelines:

CPCB has specified water quality criteria depending on the designated best use and activities in the river⁹. The classifications are:

Class “A” – Drinking water source without conventional treatment but after disinfection.

Class “B” – Out door bathing (organized).

Class “C” – Drinking water source with conventional treatment followed by disinfection.

Class “D” – Propagation of wild life, fisheries.

Class “E” – Irrigation, Industrial Cooling, Controlled Waste disposal.

The classification of designated best use of inland surface water as stipulated by CPCB is given in the table:

Table 1: PRIMARY WATER QUALITY CRITERIA AS PER CBCB

Designed Best Use	Class of Water	Criteria
Drinking Water Source without Conventional treatment but after disinfections	A	1. Total Coliforms Organized MPN/100 ml shall be 50 or less 2. pH between 6.5 to 8.5 3. Dissolved Oxygen 6 mg/l or more 4. Bio-Chemical Oxygen Demand 5 days at 20 ° C 2 mg/l or less
Outdoor bathing (Organized)	B	1. Total Coliforms Organized MPN/100 ml shall be 500 or less 2. pH between 6.5 to 8.5 3. Dissolved Oxygen 5 mg/l or more 4. Bio-Chemical Oxygen Demand 5 days at 20 ° C 3 mg/l or less
Drinking Water Source with conventional treatment followed by disinfection	C	1. Total Coliforms Organized MPN/100 ml shall be 5000 or less 2. pH between 6.0 to 9.0 3. Dissolved Oxygen 4 mg/l or more 4. Bio-Chemical Oxygen Demand 5 days at 20 ° C 3 mg/l or less
Propagation of Wild Life, Fisheries	D	1. pH between 6.5 to 8.5 2. Dissolved Oxygen 4 mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial cooling, Controlled Waste disposal	E	1. pH between 6.0 to 8.5 2. Electro Conductivity at 25 ° C micro Mhos/cm Max. 2250 3. Sodium Absorption Ratio Max. 26 4. Boron, Max. 2mg/l.
	Below E	Not meeting A,B,C,D & E criteria

Table 2: Drinking water quality as per IS 10500:2012 ¹⁰.

Sl.No	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate source
1	Colour,Hazen units, Max	5	15
2	Odour	Agreeable	Agreeable
3	pHvalue	6.5-8.5	No relaxation
4	Taste	Agreeable	Agreeable
5	Turbidity, NTU, Max	1	5
6	Total dissolved solids, mg/l, Max	500	2000
7	Total alkalinity as calcium carbonate, mg/l, Max	200	600
8	Total hardness (as CaCO ₃), mg/l, Max	200	600
9	Sulphate(as SO ₄) mg/l, Max	200	400

Results and Discussion:

In the present study the physio chemical examination of the Kotithirta lake water at all the five sampling sites are carried out to normal atmospheric conditions. Samples are collected in the morning time before 10 a.m and brought to laboratory for the analysis of various water quality parameters and the results obtained are tabulated in table no.3.

Table No.3: Water Quality Analysis results

Parameters	Sample site 1	Sample site 2	Sample site 3	Sample site 4	Sample site 5
Latitude	14°32'32.2692	14°32'32.0424	14°32'30.4764	14°32'27.7368	14°32'27.5352
Longitude	74°19'11.7372	74°19'11.9316	74°19'17.1912	74°19'16.4172	74°19'15.6936
Temperature °C	27.6	27.5	26.9	27.2	28.5
p ^H	6.5	7.3	5.8	6.0	7.5
Conductivity mS	0.10	0.08	0.09	0.08	0.21
Alkalinity mg/l	48	48	36	32	44
Turbidity NTU	7.0	6.2	4.4	3.2	3.6
Hardness mg/l	8.2	6.0	3.0	3.2	3.5
TDS Mg/l	20	20	58	18	50
TSS Mg/l	680	480	18	20	82
TS Mg/l	700	500	76	38	132
DO Mg/l	3.2	2.3	2.1	1.4	2.5
BOD mg/l	4.1	5.8	6.4	8.2	4.9
Sulphate ppm	21	<5	<5	<5	<5

Temperature:

In the present study the temperature of water noted at the time of sampling .It is basically important parameter because its affects the conductivity and solubility. If increase in temperature it effects water so and hence leads to the leading to the chemical reaction. The temperature of kotithirta lake water is found to be in the range of 27.6 to 28.5°C at the sampling time.

pH:

It is suggested that p^H serve as an important factor for measure a alkalinity or acidity of a soil pollution. So in this case study average pH values found of Kotithirta lake was ranged from 6 to 7.5 as shown in table no. 4.The ideal pH for portable water quality is described in the range of 6.5- 8.5 by ISI Standards.

Alkalinity:

The total alkalinity is not harmful to Human beings. The alkalinity termed as capability water to neutralize acid. The presence of hydroxides and carbonates makes water alkaline. The Alkalinity exceeds the desirable limit ,can cause taste become unpleasant .The total alkalinity observed for five sampling site are found to be between 48 to 44 mg/l.

Conductivity:

The conductivity is used to measure the conductance generated by various ions in the water and also amount water dissolved in aqueous solution. The electrical conductivity values of samples were between 0.10 to 0.21 micro simens/cm.

Hardness:

Calcium Hardness is determined by EDTA method in alkaline condition. The degree of hardness water has been classified in terms of the equivalent CaCO₃ concentration as following.

Soft 0-60mg/l

Medium 60-120mg/l

Hard 120-80mg/l

Very hard >180mg/l

The values of hardness are found to be little high in the sample sites 1 and 2 may be due to use of soaps and detergents for washing of holy cloths after performing rituals in the lake water.

TSS:

TSS is a most accurate method which is used to determine by dry weight of particles in water in which particles can be trapped by filter. Hence it is water quality parameter used for identify the wide variety of materials' such as sewage and decaying plant. The Total Suspended Solids values of samples of Kotithirta lake were in the range of 20 to 680 Mg/l.

TDS:

The TDS are the solids present in the filtrate from the TSS separated sample. The liquid which is passed through the TSS filtrate is collected in a previously weighed dish and evaporated for an hour 180° C. The parameter TDS affects the water quality in various way like drinking, cleaning, bathing, disposal waste materials. TDS values in the samples observed in the range of 20 to 58 ppm across all location. The value of TDS at sample site 3 and 5 are found to be much higher comparing with other sampling sites due to the high disposal of organic materials and waste materials.

Turbidity:

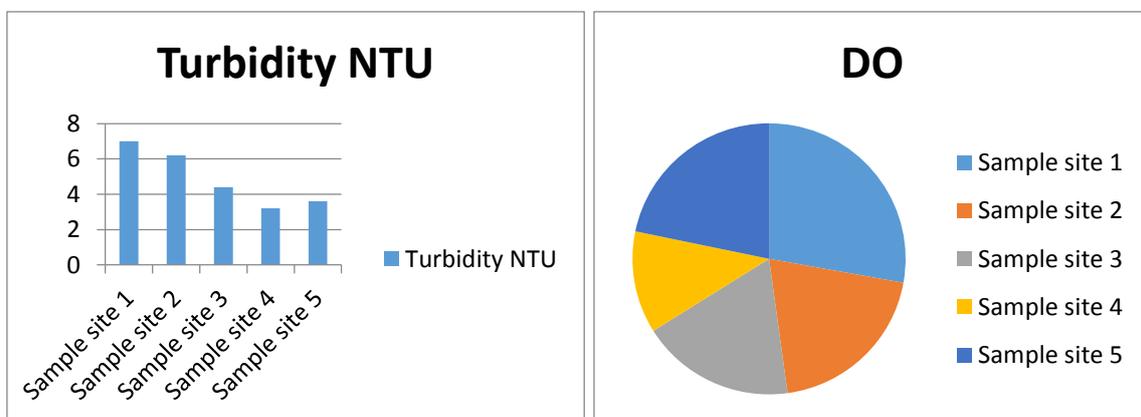
Turbidity is the most generally measure clarity of a liquid because of the presence of suspended matter. Thus turbidity shows the suspended sediments, presence of solid matter as suspension in the water. Turbidity values of samples are found to be in sampling site 1 and 2 are crosses the permissible limit given by IS 10500 for drinking water quality. The variation of turbidity in different sampling sites is shown in fig 4.

Dissolved Oxygen:

Occurrence of Dissolved Oxygen (DO) in natural and wastewater depends on the physical, chemical and biological activity in a water body. The analysis for DO is important in water pollution control and waste treatment process. DO parameter used to assess quality of surface water and to keep a check on stream pollution. It is the basis for BOD, which is an important parameter to evaluate pollution potential of wastes, it is responsible for corrosively, photosynthetic activity and septicity and is necessary for all aerobic biological wastewater treatment processes.

The result of DO ranges from 1.4 mg/L to 3.2 mg/L. The minimum level of DO is in sample site 4 due to excess through of organic matters from the surrounding area. As per ISI-IS: 2296-1982, DO in inland surface water tolerance limit should be minimum of 4mg/L. The sample sites have shown low DO value were the aquatic living organisms may have threat to their life. The change of DO in different sampling sites is shown in fig.4.

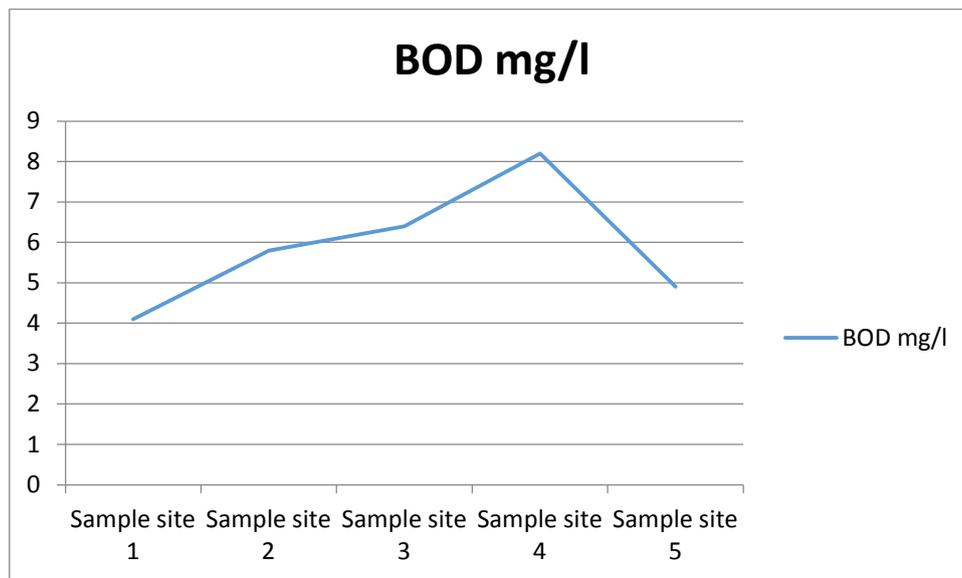
Fig 4: Plot showing variation of Turbidity and Dissolved Oxygen in different sampling sites.



BOD:

Biochemical Oxygen Demand (BOD) determines the strength of organic waste (sewage, effluents and other pollutants) in water and provides data on the pollution load in all natural water. Average BOD in the sampling seasons ranges between 4.1 mg/L and 8.2 mg/L. The highest BOD is in Sample site 4 and it is low in sample site 1. Reason for high values of BOD may be due to trough of rice ball and organic matters like flowers, plant leaves, wood materials etc. BOD tolerance limit of ISI-IS: 2296-1982 for inland surface water is 3mg/L. Variation of BOD in different sampling site are shown in the fig no. 5.

Fig 5: Plot showing variation of Biological oxygen demand within the sampling sites.



Conclusion:

The present study was appraises some of the past year studies (upto 2015) that have been carried out in the Kotithirtha lake. The analytical results of various samples of Kotithirtha Lake have been shown in table No 3 above. In the present case study the data have been revealed in 2018 and found that considerable variation in the physio – chemical characteristics. In the present study it is found that kotithirtha lake water comes under the category of “Class E”, as per the guidelines given by the central pollution control board (CPCB).

The above analysis results of Physico chemical parameters reveals that majority of lake water is contaminated due to several man made activities and performing rituals in the lake water. The high value of turbidity and Total solids confirms that the lake water is unsafe for drinking purpose as per the guidelines given by IS 10500:2012. However, after filtration or necessary treatment like Ultra filtration, Reverse osmosis, etc the water can be used for drinking purpose. The low value of D.O and high value of BOD at some sampling points concludes that the water is going to be dangerous for aquatic life. Further studies are required to estimate the Heavy metals and microbial analysis for reporting the complete assessment of water quality.

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