

PHYSICO-CHEMICAL PARAMETER OF LAKE WATER FROM  
GAVILGHARH FORT CHIKHALADRA, AMRAVATI  
DISTRICT, MAHARASHTRA, INDIA.



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**ABSTRACT**

**W**ater is one of the five elements that are 'Akash, Vayu, Teja, Jala, & Pruthvi', by which body is constructed, according to vaidic thoughts. Scientifically water is gifted with unusual physico-chemical properties which are responsible for its specificity. Water is indeed a most essential commodity for human consumption of without it no life can exist. Water is the most widely distributed resource of the earth and unlike other mineral resources; it gets its annual replenishment from the meteoric precipitation. The world's total water resources are estimated at  $1.37 \times 10^8$  million M3 of this 97.2% is salt water mainly oceanic and only 2.8% is available fresh water at any time on the earth

planet. Out of this 20.8% about 2.25% is surface water and 0.6% ground water. Even out of this 2.2% of surface water 2.15% water is in form of glaciers and ice caps only of the order of 0.01% is available in lake and reservoirs and 0.001% water vapors in atmosphere and 0.002% as soil moisture in the top of 0.6% m store ground water. Only about 0.3% can be economically extracted with present drilling technology, the remaining being unavailable as it is situated below the depth of 800 meters.

In India, about 370 million hector of water is received as an annual rainfall over entire country. About 30% of it is vaporized immediately and about 22% seeps in to the soil and rest of the water flows into the large drainage and collect in lakes. A lake is a body of relatively still fresh or salt water of considerable size, localized in basin that is surrounded by land. Lakes are inland and not part of the ocean, and are larger and deeper than ponds. Lakes can be contrasted with rivers or streams, which are usually flowing. However most lakes are fed and drained by rivers and streams. Natural lakes are generally found in mountainous areas, rift zones, and areas with ongoing glaciations. Other lakes are found in endorheic basins or along the courses of mature rivers. In some parts of the world there are many lakes because of chaotic drainage patterns left over from the last Ice Age. All lakes are temporary over geologic time scales, as they will slowly fill in with sediments or spill out of the basin containing them. Many lakes are artificial and are constructed for industrial or agricultural use, for hydro-electric power generation or domestic water supply, or for aesthetic or recreational purposes.

In Maharashtra about 350 forts are present and maximum of them are provided with good water bodies to fulfill the need of water through the year. These lakes are made for both drinking and others use of water. In the course of time peoples lived in fort migrated to the other areas. Now days

most of the forts are located in the protected forests and only wild animals live inside. Today lakes constructed with aim to provide drinking water to human beings serves as water reservoirs for the wild creatures. So there is change in the water quality. Care taken for the human use is completely absent so there is change in physico-chemical parameters. Most of the lakes show increased population of algae, called Eutrophication, one of the best example for it is the Rankala Lake, Kolhapur. Important forts like Raigad, Torana, Panhala, Sinh-ghad (Sahyndri forts), Naranla which contains 22 lakes inside (in Vidarbha) and all sea forts shows lakes in them. All those lakes are now converting in the natural water bodies as there is no interface of human beings in with them. Most of the natural or man-made lakes can be used for the drinking purposes by human beings or animals. The water which organisms drink should have some physical and chemical properties. Water fulfilling the conditions can be called as potable water. For assessing this parameter physico-chemical analysis of the water is essential step. The results found should be compared with the standards suggest by different institutes like BIS, WHO etc.

**Keywords :** BIS, WHO

## 1. INTRODUCTION

Physico-chemical Parameters includes the, temperature, colour, odour, turbidity, conductivity, total solids, pH, DO, BOD, COD, alkalinity, acidity, total nitrogen, sulphate, phosphate, chlorides, free CO<sub>2</sub>, hardness etc.

Temperature is one of the important parameter is basically important for its effect on the chemistry, and biological reactions in organisms in water. A rise in temperature of water leads to speeding up the chemical reactions in water reduces the solubility of gasses and amplifies the tastes and odors. At the elevated temperature metabolic rate of the organisms increases, requiring more oxygen at same time the solubility of the oxygen decreases, thus accentuating the stress. Temperature is also very important in the determination of various other parameter parameters such as pH, conductivity, saturation level of gases and various forms of alkalinity etc.

Water shows the different colours or shades; even pure water is not colourless. It has got a pale green-blue tint in large volumes. Colour in natural waters may occur due to the presence of humic acids, fulvic acids, metallic ions such as iron and manganese, suspended matter, phytoplankton, weeds and industrial wastes etc. colour due to organic acids may not be harmful as such, but highly coloured waters are objected on aesthetic grounds.

Conductivity is the measure of capacity of a substance or solution to conduct electrical current. Conductivity is reciprocal of the resistance. Conductivity if measured of a cube with each of 1cm at 25 °C is called specific conductance. The conductivity increases as the percent of the dissolved solid increases with increase in ions of dissolved solids. The conductivity is generally reported in mho or  $\mu$  mho. The present unit of conductivity has been named as Siemens (S) instead of mho.

Dissolved solids denote mainly the various kinds of minerals present in the water. However some organic substances are also present, as more often in polluted water, they may also contribute to the dissolved solids. Dissolved solid do not contain any gas and colloids. In natural water dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron and manganese etc. dissolved solid concentration is one of the most important parameter in drinking water and other water quality standards, in drinking water concentration of individual dissolved solid is more important than total dissolved solids.

pH is the measure of intensity of acidity or alkalinity and measure the concentration of the hydrogen ions in water. It does not measure the total acidity or alkalinity.

Alkalinity of the water is its capacity to neutralize a strong acid and is characterized by the presence of all hydroxyl ions capable of combining with the hydrogen ions. Alkalinity in natural water is due to free hydroxyl ions and hydrolysis of salt formed by weak acids and strong base. Alkalinity itself not harmful to human being still the water supplies with less than 100 mg/l is desirable for domestic use. The alkalinity value is also important in calculating the dose alum and biocides in water.

Acidity of the water is its capacity to neutralize a strong base and is mostly due to the presence of strong mineral acids, weak acids and the salt of strong acids and weak base. Determination of acidity is significant as it causes corrosion and influences the chemical and biochemical reactions.

Dissolve oxygen is one of the most important parameter in quality assessment and reflects the physical and biological processes prevailing in the water. Its presence is essential to maintain the higher forms of biological life in the water. Low oxygen in water can kill fish and other organisms present in water. Organisms have specific requirements of oxygen below which they fail to survive.

The concentration of DO also reflects on the processes in water whether they are aerobic or anaerobic. Low concentration of DO is the sign of contamination of water by heavy organic matter.

Biochemical oxygen demand is amount utilize by microorganisms in stabilizing the organic matter. BOD approximates the amount of oxidizable organic matter present in the water body. Type of microorganisms, pH, presence of toxins, some reduced mineral matter, and nitrification process are the important factors influencing the BOD of water body. Chemical oxygen demand is oxygen required by the organic substances in water to oxidize them by a strong chemical oxidant.

Phosphorus in natural fresh water is present mostly in inorganic forms such as  $\text{H}_2\text{PO}_4^{--}$ ,  $\text{HPO}_4^{-2}$  and  $\text{PO}_4^{-3}$ . Phosphorus being an important constituent of the biological system may also be present in the organic forms. The rocks in which most of the phosphorus is bound, are generally insoluble in water and hence the phosphorus content of natural water body is low and biological growth is limited due to this fact. The prime concern of phosphorus lies in the ability to increase the growth of algae and leads to eutrophication. It is naturally occurring anion in all kinds of natural water bodies. In arid and semi-arid region it found in high concentration. Sulphate is an important constituent of the hardness along with the calcium and magnesium.

Chloride occurs naturally in all kinds of natural water body, but their concentration remains quite low and is generally less than that of sulphate and bicarbonates. The most important source of the chloride is discharge of domestic sewage in water bodies. A chloride is highly soluble in most of the naturally occurring cations and does not precipitate, regimanted and cannot be removed biologically.

Hardness is the property of water which prevents the lather formation with soap and increase the boiling point of water. Principal cations imparting hardness are Calcium and Magnesium, while anions responsible for hardness are mainly bicarbonates, carbonates, sulphate, chloride, nitrite and silicates etc. hardness is called temporary if it is caused by bicarbonate and carbonate of the cations, since it can be removed simply by boiling the water. Permanent hardness is caused mainly by sulphate and chlorides of metals.

## II. Methodology:

The standard analytical techniques generally used for the water analysis are used to determine the parameters. Samples for DO can be fixed on the site and carried to the laboratory for further analysis. During taking sample for DO Precaution were taken to avoid external mixing of the oxygen in sample through atmosphere. Also the temperature can be taken at the spot

## III. Study Area:

The present work is done on the lakes present in the Gavilgharh fort, Chikhaldara in Amravati district, Maharashtra. It is present at distance of 3 km from Chikhaldara. It is one of the important fort in the Vidarbha region. The fort has long history which shows importance of this fort. The fort was constructed by Gavali kings in 12th century. The Gavali King may belong to the Yadava's ancesestery so the fort gets name as Gavilgharh. The renovation of fort was carried out in 1425 A.D. and it was made strong for both military and civilian purposes. It was a good fortress, as it is situated in hills and valise. It is present in the Gavilgharh Ranges of the Satpura hills.

Geographically it is situated in co-ordinates  $21^{\circ}22'56''\text{N}$   $77^{\circ}20'2''\text{E}$  And at elevation about 1,103 m (3,619 ft) MSL. About 10 lakes were constructed in fort which is also present today. Out of these ten lakes 7 lakes provides water up to 8 months of the year if there is average rainfall in year. And three lakes are perennial. Out of this 3 one get dried if there is below average rainfall. The construction of this lakes shows that they were constructed for the water shade management purpose. All this 3 lakes are constructed from the stones. And have high capacity to store the water.

The project work has been carried out on the 3 lakes i.e Kham Lake, Dev Lake and Dhobi Lake. The physico-chemical properties can be analyzed from the water sample of these lakes.

#### List of Lakes present in Gavilgharh Fort;

- ❖ Shakkar Lake,
- ❖ Dhobi Lake,
- ❖ Macchali Lake,
- ❖ Dariya Kund,
- ❖ Dev lake,
- ❖ Lendi lake,
- ❖ Sati lake,
- ❖ Bamji lake,
- ❖ Kham Lake,
- ❖ Shani lake.

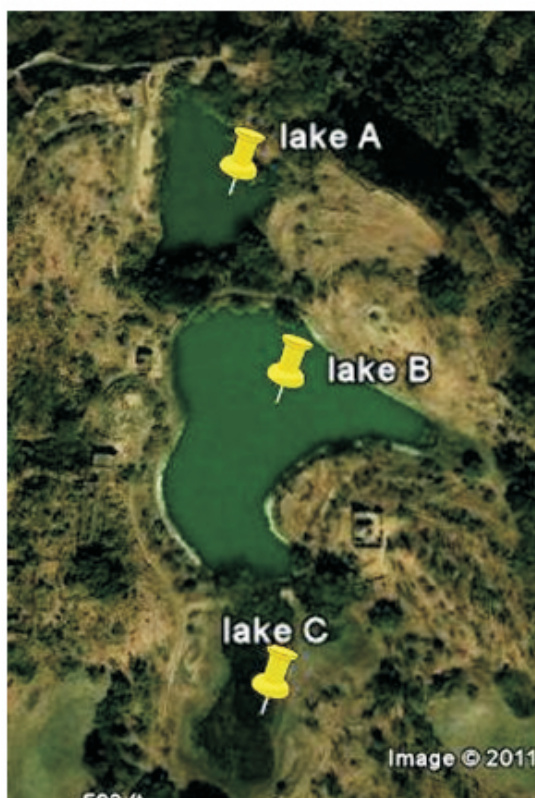
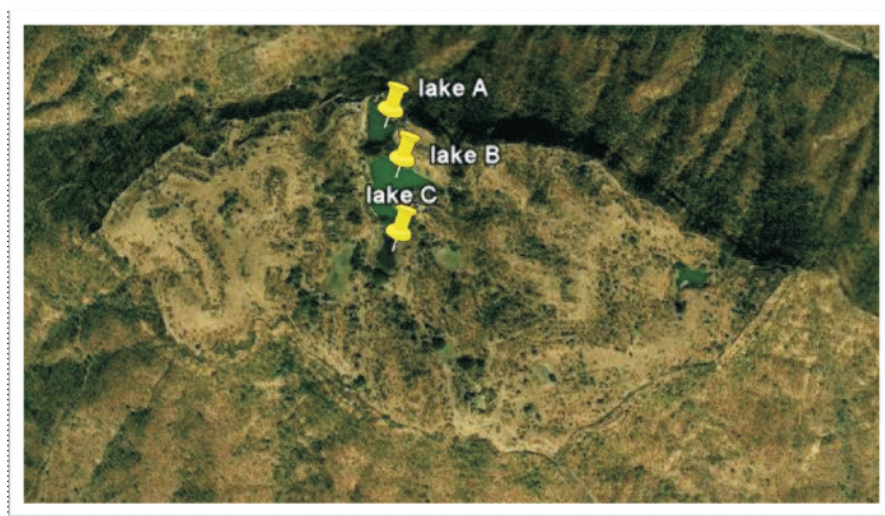
#### Geographical Position of Lakes studied in project are as follows

Table shows: Geographical Position of Lakes

Sr. No.	Name	Co-ordinates	Altitude
1	Kham Lake	$21^{\circ}22'41.28''\text{N}$ $77^{\circ}20'18.54''\text{E}$	3324 fts.
2	Dev lake	$21^{\circ}22'36.99''\text{N}$ $77^{\circ}20'20.14''\text{E}$	3370 fts
3	Dhobi Lake	$21^{\circ}22'31.18''\text{N}$ $77^{\circ}20'19.65''\text{E}$	3339 fts



**Plate – 1 Picture showing satellite view of Gavilghar Fort**



Lake A - Kham lake

Lake B- Dev lake

Lake C- Dhobi lake

#### **IV.Observation &Result:**

Observations can be taken in the February and March months. The physical and chemical parameters observed for 3 lakes are given in following tables.

#### **Observation table for February 2014.**

**Table shows: Physical Parameters**

Sr. No.	Parameter	Kham Lake	Dev Lake	Dhobi Lake
1.	Depth (cm)	170- 180	160-180	90-95
1.	Light penetration (cm)	62	54	Till depth
2.	Temperature	21 <sup>0</sup> C	22 <sup>0</sup> C	22 <sup>0</sup> C
3.	Conductivity (S cm <sup>2</sup> )	0.487	0.498	0.636
4.	TS (mg/L)	360	480	420
5.	TSS (mg/L)	80	100	60
6.	TDS (mg/L)	280	380	360

**Table shows : Chemical Parameters**

Sr. No.	Parameter	Kham Lake	Dev Lake	Dhobi Lake
1	pH	8.9	8.7	8.9
2	Total Alkalinity (mg/L)	360	280	365
3	Acidity(mg/L)	72.5	85	65
4	Chlorides(mg/L)	24.14	26.98	27.72
5	DO(mg/L)	10.59	9.38	9.78
6	BOD(mg/L)	11.12	9.41	7.35
7	COD(mg/L)	28.2	24.0	807
8	Nitrogen(mg/L)	523.25	569.62	430.5
9	Sulphate(mg/L)	9	10	11
10	Phosphate(mg/L)	0.67	0.43	0.74
11	Total Hardness(mg/L)	216	206	314
12	Calcium Hardness(mg/L)	73.74	75.35	85.71
13	Magnesium hardness(mg/L)	34.71	31.87	55.70

**Observation table for March 2014.****Table shows: Physical Parameters**

Sr. No.	Parameter	Kham Lake	Dev Lake	Dhobi Lake
1.	Depth (cm)	155-165	145-155	-
1.	Light penetration(cm)	59	47	-
2.	Temperature	23 <sup>0</sup> C	25 <sup>0</sup> C	-
3.	Conductivity (S cm <sup>2</sup> )	0.56	0.519	-
4.	TS (mg/L)	420	520	-
5.	TSS (mg/L)	120	140	-
6.	TDS (mg/L)	300	380	-

Tableshows : Chemical Parameters

Sr. No.	Parameter	Kham Lake	Dev Lake	Dhobi Lake
1	pH	8.4	8.1	-
2	Alkalinity(mg/L)	210	175	-
3	Acidity(mg/L)	47.5	67.5	-
4	Chlorides(mg/L)	26.98	29.82	-
5	DO(mg/L)	8.57	7.75	-
6	BOD(mg/L)	10.61	10.59	-
7	COD(mg/L)	36.1	56.3	-
8	Nitrogen(mg/L)	533.0	557.37	-
9	Sulphate(mg/L)	10	10.5	-
10	Phosphate(mg/L)	0.69	0.51	-
11	Total Hardness(mg/L)	252	218	-
12	Calcium Hardness(mg/L)	62.52	77.95	-
13	Magnesium hardness(mg/L)	46.23	57.58	-

### Results for Physical parameters are as follows

The depth of the Kham lake was averagely 170-180 cm in fem. while it decreases by the March up to 155-165 cm. Same of the Dev lake was 160-180 cm and reduced up to 145-155. Dhobi lake was very shallow ad its depth was just near to 90-95 cm and it dried by start of the March.

Result shows that the depth of every lake decreases from February to march. It may happens due to the increase in evaporation rate and due to the seepage of water from rock.

Light penetration in Kham lake, Dev lake found 62 and 54 while in Dhobi lake it was till depth in February. The light penetration decrease in March and comes down to 59 and 47 cm for Kham lake and Dev lake respectively. Dhobi lake were dried in March. Temperature is one of the important physical factor, which shows effects on other parameters like dissolved gases like Carbon dioxide, oxygen etc. also growth of living organisms like zooplanktons and phytoplankton is influenced by the temperature factor. Temperature of the all lakes found nearer to each other i-e in sequentially for Kham, Dev and Dhobi lake temperatures were 21°C, 22°C, 22°C for month of February and for March kham lake 23°C, Dev lake 25°C while Dhobi lake was dried out. Total solids in February found 360, 480 and 420 mg/l for Kham, Dev and Dhobi lake respectively. It increases in March up to 420 and 520 mg/l for Kham and Dev lake in March. Total suspended solid contains in TS was 80, 100 and 60 mg/l in February and 120, 140 and nil in March for Kham, Dev and Dhobi lake respectively. Total dissolve contains found 280, 380 and 360 mg/l for Kham, Dev and Dhobi lake in February and 300 and 380 for Kham and Dhobi lake in March.

### Results For Chemical Parameters

pH is the hydrogen potential of the water. pH of the all lakes found in the range of 8.9 to 8.4 in February which decreases slightly in March to 8.4 to 8.1. This high pH value indicates the basic nature of the water body. Alkalinity of the lake found to be 360, 280, 365 mg/L for Kham, Dev and Dhobi lake

respectively in February and that's in March found 210 and 175mg/L for Kham and Dev Lake respectively.

This high alkalinity may due high carbonate and bicarbonate content in the basaltic rock strata, which mainly contents  $\text{CaCO}_3$ . Acidity is the capacity of any solution to neutralize the strong base. The Acidity of the lakes found 72.5, 85 and 65 mg/l for Kham, Dev and Dhobi lake respectively in February. While in March it decrease to 47.5 and 67.5 mg/l for Kham and Dev lake. Chlorides in the water found 20 to 30 mg/L concentration. There is no significant change in the chloride concentration. The way for chloride entry is the fecal matter of the wild animals only so the concentration of the Chlorides found very low in all the lakes. Dissolve oxygen is the amount of oxygen dissolve in the water body. It also depends upon the temperature factor and the growth rate of phytoplankton in the natural water body. The DO found more in hot days than Rainy season. The dissolve oxygen in stagnant water is mainly temperature dependent. As it is required to all the plants and animals for respiration, then high temperature and low dissolve oxygen during summer create favorable condition for the development of green algae (Prakash 1982). The maximum DO in present work was estimated in Kham lake i-e 10.59 mg/L while Dev lake shows DO value 9.38 mg/L and Dhobi lake 9.78 mg/L. there is average decrease of the 2 mg/L in the March month. And value comes down to 8.57 and 7.75 for Kham and Dev Lake respectively. The COD values increased during hot period and ranged from 10.00 – 18.00 mg/l. The decreases in COD values were recorded during cold period (4.40 – 9.20 mg/l). However, the increase in COD during hot period is mainly attributed to the increase in the air and water temperatures, facilitating the decomposition and oxidation of organic matter, in present work the COD values ranges in between 28.2 (Kham lake) and 24.0 (Dev lake) while Bhobi lake shows very high COD value i-e 80.7 it may be due to presence of high organic matter comparing with the volume of water in lake and low DO.

COD shows increased values in March as there is slight rise in temperature. The values increases up to 36.1 (Kham lake) and 56.3 (Dev lake)

Nitrogen contents in the natural water body enter through the fecal matter of Birds, reptiles and urine of the mammals. Also nitrogen concentration in the water body depends upon the micro-organisms responsible for the nitrogen fixation, example nitrogen fixing Bacteria's, and Blue green algae.

Nitrogen in Kham, Dev and Dhobi lake was found 523.25, 569.62 and 430.5 mg/l in February while it found 533 and 557.37 mg/l in Kham and Dev lake. Sulphate contains found in lakes shows values 9, 10 and 11 mg/l In Kham, Dev and Dhobi lake respectively in February and 10 and 10.5 mg/l in Kham and Dev lake in March. Inorganic Phosphate found in all lake below 1.0 mg/l. for Kham lake it is 0.67 mg/l, Dev lake 0.43 mg/l and for Dhobi lake it found 0.74 mg/l in February, while it found 0.69 mg/l and 0.51 mg/l for Kham and Dev lake in March. Total hardness of Kham, Dev and Dhobi lake was 216, 206 and 314 mg/l in February which increases to 252 and 218 mg/l in March for Kham and Dev lake.

Calcium is more in water than magnesium. Calcium contains in February estimated about 73.74, 75.35 and 85.071 mg/l, while magnesium estimated about 34.71, 31.87 and 55.70 mg/l for Kham, Dev and Dhobi lake respectively. Values increases in March and Calcium reach up to 62.52 and 77.95 mg/l and Magnesium increased to 46.23 and 57.58 mg/l in Kham and Dev lake.



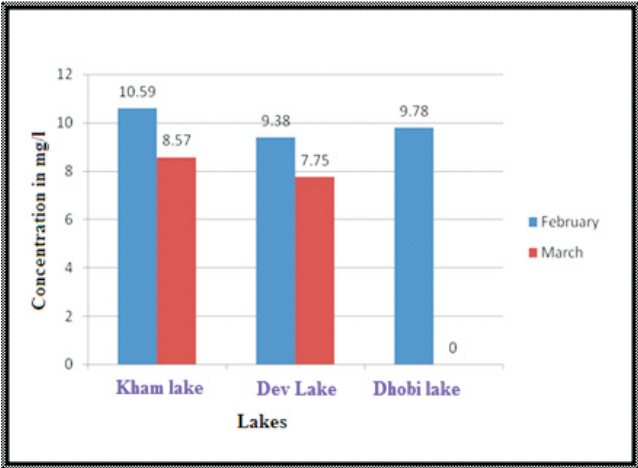


Fig1: Monthwise distribution of DO in lakes of Gavilgarh.

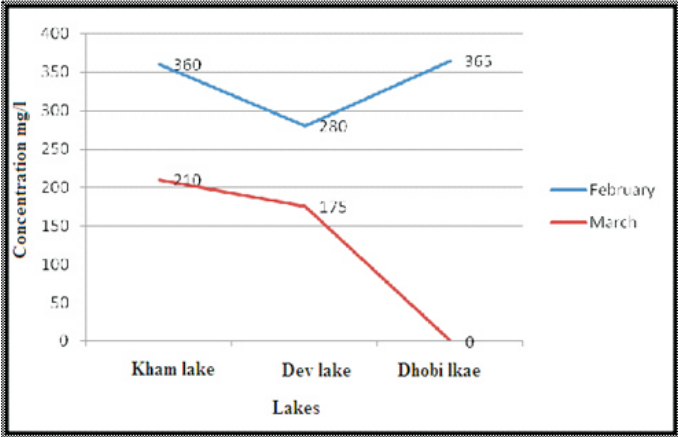


Fig2: Monthwise variation in Alkalinity in lakes of Gavilgarh.

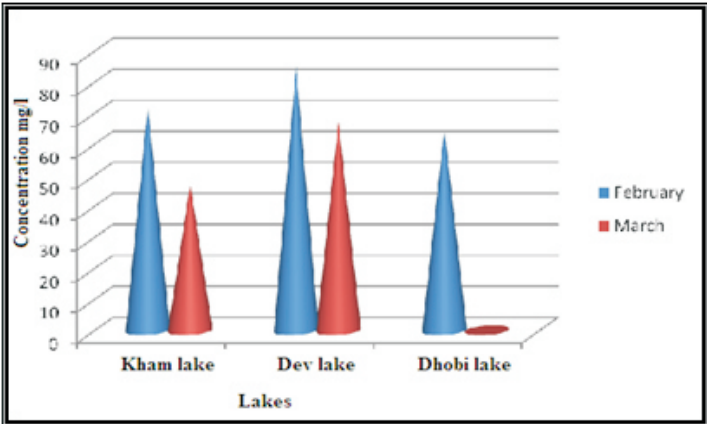


Fig3: Variation in acidity values in lakes of Gavilgarh.

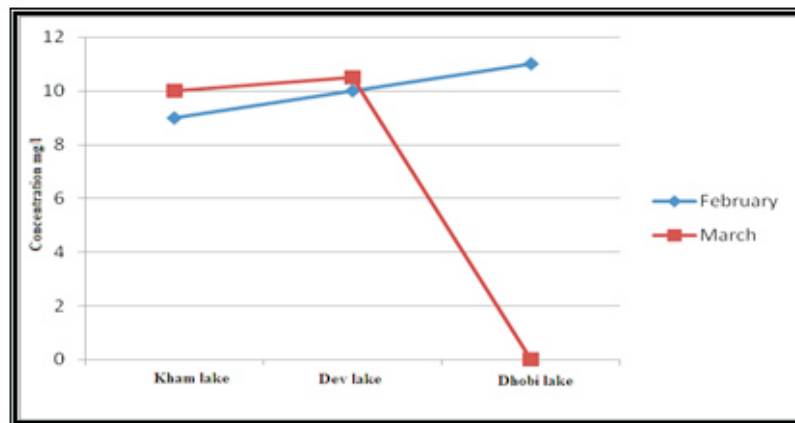


Fig4: Distribution of Sulphate in Lakes of Gavilgarh.

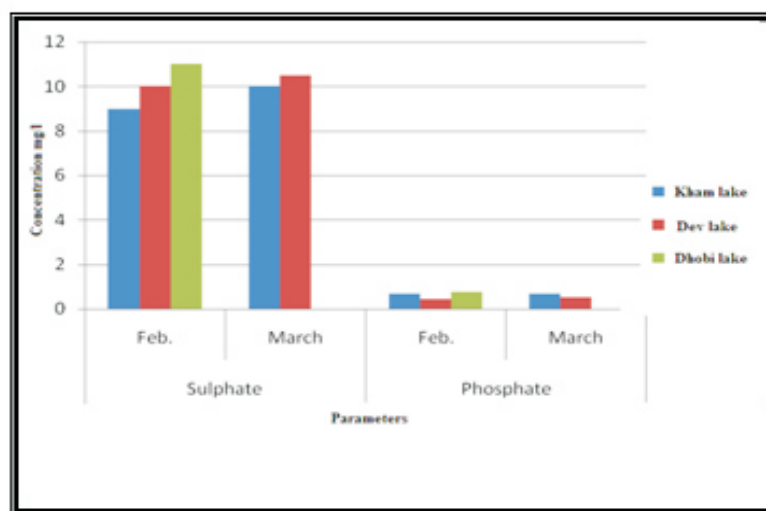


Fig5: Comparision between Sulphate & Phosphate in lakea of Gavilgarh.

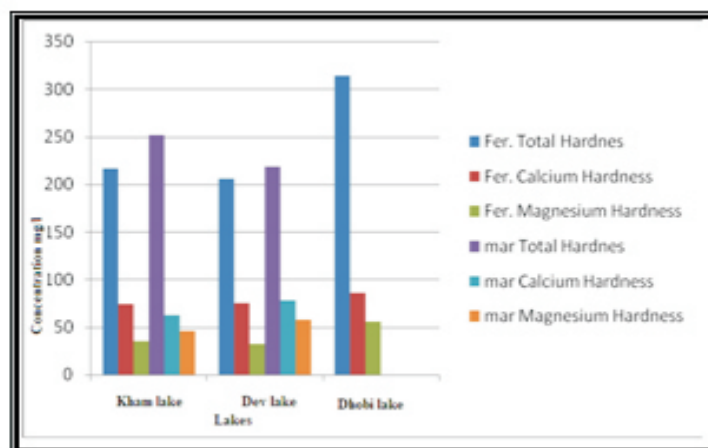


Fig6: Monthwise distribution of Calcium, Magnesium & Total Hardness in lakes of Gavilgarh.

## V.Conclusion

:From the present observations and results obtained from the analysis of water samples from

Kham, Dev and Dhobi lakes of Gavilgarh fort, it was conclude that, The decrease in depth of water may attribute to evaporation of water due to increase in atmospheric temperature, but about Kham lake and Dev lake decline of water level is very little. It indicates that Kham and Dev lake has underground water source. The decrease in light penetration in lakes attributed to increase concentration of TSS and TSS is due favorable temperature to phytoplankton and zooplanktons. The slight depletion of pH due to generation of acids in water by decomposition, because level of DO also decreased and all become attributed to shifting water temperature. Presence of Chlorides in the lakes is the result of excreta of wild and domestic animals coming there for drinking water. No other source for chloride is present. Water bodies' shows higher amount of DO, it is due to more algal population. They produce the oxygen during the photosynthesis process. Increase in algae shows increase in TSS value, as found in the present work. Nitrogen in any water body comes through the organic matter from living being and decomposition of organic matter. From observations we may conclude the high percentage of nitrogen in lakes is due to the urinary matter of wild animals coming there for drinking water. It also concludes that the high algal population increase decomposition load of lakes and decomposition of this organic matter again adds the nitrogenous compound to lake.

Hardness is more due to high calcium contains. From this it is concluded that the rocks contains more  $\text{CaCO}_3$ , which is responsible for increase in hardness due to more dissolution of  $\text{CaCO}_3$  in water from parent rock i.e. basalt. Finally, the physic-chemical characteristics of water, all lakes not support to utilize the water for drinking purpose, for human being, and on account of parameters there may, lead to minimization oh depth of lake in future periods.

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