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Water quality status of Kotwal reservoir Morena district, Madhya Pradesh

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Abstract
Due to rapid growth of population, industrialization and agricultural practices most of our natural water resources get polluted. Disposal of untreated or partially treated industrial effluents or sewage into surface waters is one of the major environmental problems.
The present study was undertaken to know the variation in physicochemical properties of kotwal reservoir situated at Morena in Madhya Pradesh. Water samples were analyzed for various physical parameters like pH, temperature, colour, depth, transparency, and chemical parameters like DO, BOD, COD, phosphates, sulphates, chlorides, hardness, alkalinity, nitrate, conductivity and total dissolved solids. The result revealed that the condition of this reservoir in different month showed fluctuations in physico-chemical parameters.

Keywords: physico-chemical parameters, Kotwal reservoir, Pollution, fluctuation

Introduction
Water is nature's most wonderful, abundant and most useful chemical compound gifted by nature with physico-chemical and biological properties and unique characteristics. It is absolutely essential for domestic purposes for cleaning, cooking, bathing, and carrying away wastes, and in agriculture for irrigation, power generation, industries, navigation, propagation of wild life, fisheries, recreation, aesthetics etc. (Simpi *et al.*, 2011) [23].
The healthy aquatic ecosystem is depended on the physico chemical and biological characteristics (Venkatesharaju *et al.*, 2010) [30]. Expanding human population brought about by the opportunities of good water supply, irrigation, fish production recreation and navigation offered by Dam has put enormous pressure and stress on the quality of water impounded by the dam. The impact of human activities in and around the dam is felt on the unique physical and chemical properties of water on which the sustenance of fish that inhabit the reservoir is built as well as to the functions of the reservoir. Water quality is important in drinking water supply, irrigation, fish production, recreation and other purposes to which the water must have been impounded (Sidnei *et al.*, 1992) [22].
Water quality deterioration in reservoirs usually comes from excessive nutrient inputs, eutrophication, acidification, heavy metal contamination, organic pollution and obnoxious fishing practices. The effects of these "imports" into the reservoir do not only affect the socio-economic functions of the reservoir negatively, but also bring loss of structural biodiversity of the reservoir (Mustapha, 2008) [15].
However, very little information is available in relation to physic-chemical characteristics of water. Hence, the present study was conducted to evaluate the properties of water in the Kotwal reservoir of Morena.

Materials and Method
Study area
Morena is one the districts that forms a part of the Chambal rivine system. The district is bordered by Rajasthan state on its north east. The rest of the sides are bordered by the districts of Madhya Pradesh. Geographically, it lies between 26°29'15" N latitude and 78°7'30"E longitude near the Kotwal village in district Morena. It is constructed on Aasan River with maximum depth 10.95 m and length of shoreline of dam is 294.13 m. The reservoir has been named on the name of village as Kotwal reservoir. Across Asan river which is a tributary of Kunwari River that empties into Chambal River. Reservoir is used for different purposes like drinking, irrigation and fisheries etc.

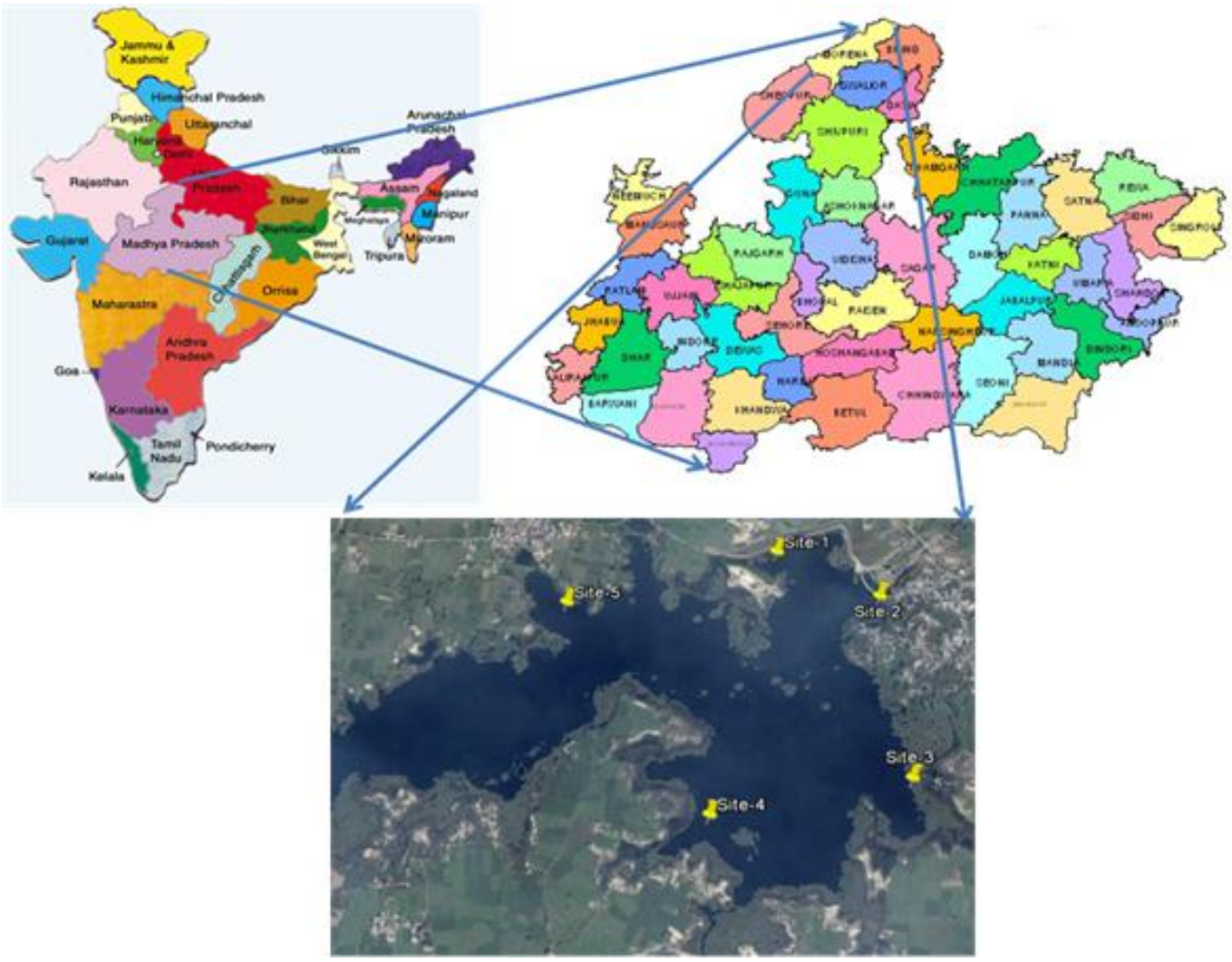

Fig 1: shows the location of the present study area

Collection of sample

Monthly analysis of various physico-chemical parameters was undertaken for a period of one year from June 2016 to May 2017. The Water Samples were collected from various sites in the morning hours between 9 to 11am during first week of each month. Samples water was collected from all site of study area in polythene coated bottles. Water sampling station was selected to keep in mind covering the whole area of reservoir. Five sampling stations were selected for the collection of water sample depicted as Site-1, Site-2, Site-3, Site-4 and Site-5. Some of the physic-chemical parameters were estimated like water temperature, air temperature, transparency, color, depth, odour, pH, turbidity, total dissolved solid were estimated at the spot whereas the other was estimated in the laboratory by using the standard methods APHA (2005) [1]. Almost care was taken, so that no bubbling should observe during sampling, which avoids influence of the dissolved oxygen. The water of this Reservoir is used for drinking, agriculture and supports fish culture. The surrounding area of dam is rural and agricultural. The need to define quality of water has development with the increasing demand of water, which is suitable for specific uses and confirms to desired quality.

Result and Discussion

The main purpose of analyzing physical and chemical characteristics of water is determine its ecological status. The physico- chemical characteristics of water quality may be affected by rainfall, temperature, availability of light. The monthly variation in physico-chemical parameters was presented in table -1. In the present study the data revealed that there were considerable variations in the quality with respect to their physico-chemical characteristics. Minimum, maximum, Standard Deviation and Standard Error were calculated with by using the software sigma state 3.5 given in table-2.

Table 1: Showing mean and statistical characteristics of water from Kotwal Reservoir during June-2006 to May- 2017

S. No	Parameters	Minmum	Maximum	Mean	S.Dav	S. Error
1	Depth	13.18	17.04	15.143	1.115	0.322
2	Water temp	16.56	30.6	26.283	4.779	1.38
3	Air temp	14.86	34.1	28.092	6.584	1.901
4	Transparency	41.04	101.04	83.695	17.258	4.982
5	Conductivity	1372.52	1751.8	1554.26	128.73	37.161
6	pH.	6.96	7.46	7.273	0.129	0.0374
7	T.D.s	659.4	1009.6	861.547	105.646	30.497
8	T.S.s	59	223.2	101.533	40.838	11.789
9	Total alkanity	237.2	328	288.3	30.775	8.884
10	Total hardness	339.36	1111.06	462.707	208.1	60.073
11	Calcium hardness	253.64	312.92	275.59	16.154	4.663
12	Mg Hardness	76.38	376.48	143.037	77.569	22.392
13	Chloride	99.86	154.28	131.286	15.636	4.514
14	Nitrate	0.296	1.833	0.584	0.414	0.12
15	Phosphate	0.0297	0.367	0.101	0.108	0.0312
16	Do	2.384	57.584	9.845	15.093	4.357
17	BOD	0.0304	1.922	1.008	0.464	0.134
18	COD	33.22	9.8	34.299	17.632	5.09

Table 2: Montly variation of physico-chemical parameters of water of kotwal reservoir

S. No	Parameters	Unit	June	July	August	September	October	November	December	January	February	March	April	May
1	Colour	Nm	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
2	Depth	Ft	14.76	14.80	15.60	16.72	17.04	15.95	15.52	15.12	14.86	14.34	13.82	13.18
3	Water temp	C	30.16	28.90	29.14	28.40	28.00	26.92	18.32	16.56	21.32	27.56	29.52	30.60
4	Air temp	C	33.86	32.34	34.10	31.22	31.00	25.16	15.98	14.86	25.22	29.40	31.40	32.56
5	Transparency	Cm	101.04	92.30	41.04	87.68	90.98	75.44	96.20	99.56	97.12	67.18	75.02	80.78
6	Conductivity	µ	1751.80	1715.00	1592.00	1700.40	1642.00	1515.60	1504.60	1513.00	1385.80	1413.60	1544.80	1372.52
7	pH.		7.18	7.24	7.36	7.38	7.38	6.96	7.46	7.30	7.20	7.32	7.22	7.28
8	T.D.S	mg/L	1009.60	990.00	960.20	958.80	890.40	659.40	861.00	802.40	756.20	779.60	855.40	815.56
9	T.S.S	mg/L	101.60	223.20	101.40	92.20	71.00	59.00	102.00	105.20	81.40	86.40	93.40	101.60
10	Total alkanity	mg/L	328.00	321.60	289.20	321.80	292.00	263.80	259.80	284.00	237.20	260.80	273.40	328.00
11	Total hardness	mg/L	466.06	446.86	380.00	453.80	425.70	405.96	386.70	404.88	341.48	339.36	390.62	1111.06
12	Calcium hardness	mg/L	276.52	275.74	263.02	312.92	296.00	268.22	272.94	283.92	266.16	253.64	261.48	276.52
13	Mg Hardness	mg/L	155.70	146.64	376.48	141.36	126.40	116.54	95.70	115.02	100.18	76.38	110.34	155.70
14	Chloride	mg/L	141.36	154.28	146.52	151.43	132.30	119.16	122.46	136.66	124.10	99.86	125.94	121.36
15	Nitrate	mg/L	0.55	0.53	0.52	0.61	0.37	0.30	0.35	0.72	0.36	1.83	0.33	0.54
16	Phosphate	mg/L	0.18	0.05	0.25	0.06	0.04	0.03	0.05	0.37	0.04	0.03	0.04	0.06
17	DO	mg/L	5.89	6.68	6.41	6.56	4.13	2.38	5.15	6.75	5.12	57.58	4.57	6.89
18	BOD	mg/L	1.18	1.12	1.03	1.33	0.47	0.03	1.16	1.92	1.07	0.74	0.87	1.18
19	COD	Mg/l	34.88	32.33	35.44	28.10	13.96	9.80	33.22	44.16	29.58	81.62	33.22	35.28

Colour and depth

Muddy water was observed in the month of July while no colour observed in any month during the study period. Water colour of reservoir because of rainfall water reaches into the reservoir. Depth of Reservoir water ranged from 13.18 cm to 17.04 cm (fig. 2), minimum depth were recorded in April while maximum depth were found in the month of October with mean and slandered deviation 15.14±1.12 in different month. Reservoir water fluctuated due to extraction, for irrigating by canal and motor pump and industrial uses by motor pump.

Water temperature

In an established system the water temperature controls the rate of all chemical reactions, and affects fish growth, reproduction and immunity. Temperature of Reservoir water ranged from 16.56°C to 30.16°C in different month (fig. 3). The average value of minimum temperature was recorded 16.56°C in January and average value of maximum temperature was 30.6°C in June with mean value and standard deviation 26.28±4.78. Respectively Shyamala *et al.*, (2008) [21] also reported the range of temperature in between 24.75 to 28.5°C and 26.3 to 27.2°C. Sharma *et al.*, (2000) [20] observed that water temperature fluctuate between 21°C to 29°C during limnological studies of Udaipur lakes.

Air temperature

The abiotic factor, temperature have several biological and

physical impacts on organisms. Minimum air temperature with average value were recorded 25.0 °C in winter month and maximum 36.83 °C in summer month with mean value and standard devation 28.09±6.58 (fig. 4). Yadav *et al.,* (2013) [32] reported air temperature of reservoir water ranged from 14.86°C to 34.1°C in different seasons.

Transparency

In the present study water transparency values ranged from 41.04 to 101.04 cm with mean and standard deviation 83.69±17.26 cm. The minimum transparency were recorded 41.04 cm in August and maximum 101.04 cm in the month June (fig. 5). The transparency of water is affected in various seasons due to algal blooms and suspended sediments (Horn and Goldman, 1994) [9].

Conductivity

Water conductivity varied from 1372.52 to 1751.8 mg/l. The minimum were recorded 1372.52 in May and maximum 1751.8 in the month of June with mean value and standard deviation 83.695± (fig. 6). The fluctuations in electric conductivity are due to fluctuation in total dissolved solids and salinity (Boyd, 1981) [3].

pH

pH is most important in determining the corrosive nature of water. Lower the pH value higher is the corrosive nature of water. pH was positively correlated with electrical conductance and total alkalinity (Gupta 2009) [8]. The pH of a solution refers to its hydrogen ion activity and is expressed as the logarithm of the reciprocal of the hydrogen ion activity at a given temperature. In the present study pH values ranged 6.96 to 7.46 (fig. 7). The minimum pH was recorded 6.96 and maximum 7.46 with mean value and standard deviation 7.273± 0.129.

Total dissolved solid

During the present study water T.D.S values ranged from 659.4 to 1009.6 mg/L. The minimum 659.4 mg/L. were recorded in the month of November while maximum 1009.6 mg/L. in the month of June with mean value and standard deviation 861.547± 105.65 (fig. 8). Similar findings have been reported by Rao *et al.,* (2003) [19], Kirubavathy *et al.,* (2005) [12], Garg *et al.,* (2006b) [6]. TDS analysis has great implications in the control of biological and physical waste water treatment processes.

Total suspended solid

The value of T.S.S varied from 59 mg/l to 223.2 mg/l. the maximum value was 223.2 mg/l recorded in the month of July and minimum value 59 mg/l in the month of March. Mean value and standard deviation 101.533± 40.834 (fig. 9). Similar seasonal peak was recorded by Manimegalai *et al.,* (2010) [14] in Walayar reservoir, Pelghat, Kerala. Total solids peak in summer may be due to low water flow into water body and higher evaporation rate (Karne and Kulkarni, 2009) [11].

Total Alkalinity

The value of alkalinity varies from 237.2 mg/l to 328 mg/l. the maximum value was 328 mg/l recorded in the month of June and minimum value 237.2 mg/l in month of February with mean value and standard deviation 288.3±30.77 n (fig. 10). Hujare (2008) also reported similar results that it was maximum in summer and minimum in winter due to high photosynthetic rate.

Total hardness

The value of hardness varies from 339.36 mg/l to 1111.06 mg/l, the maximum value was recorded in the month of May and minimum value were in the month of March while mean value and standard deviation 462.707±208.1 (fig. 11). Hujare (2008) reported total hardness was high during summer than rainy season and winter season.

Calcium Hardness

Sirsath *et al.,* (2006) [24] affirmed that cations of calcium and magnesium are foremost components that determine the amount of total hardness. According to Ohle (1956) [16] on the basis of calcium content, water resources can be categorized in to: (i) poor, (ii) medium and (iii) rich water body. During the present study, calcium hardness range from 253.64 mg/l minimum in the month of March to 312.92 mg/l. maximum in the month of September with mean value and standard deviation 275.59± 16.154 (fig. 12). Similar results were reported by Verma *et al., (*2011) [31] while analyzing Kankaria Lake, Ahmedabad.

Mg hardness

According to Venkatasubramani and Meenambal, (2007) [29] magnesium is often associated with calcium in all kinds of waters but its concentration remains generally lower than the calcium. The value of Mg hardness fluctuates from 76.38 mg/l to 376.48 mg/l. the maximum value was 376.48 mg/l recorded in the month of August and minimum value 76.38 mg/l in the month of March with mean value and standard deviation 143.037± 77.569 (fig. 13). According to Wetzel (2001) low magnesium content is possibly due to its uptake by the plants in the formation of chlorophyll – porphyrin metal complexes and in enzymatic transformation.

Chloride

The value of phosphate fluctuates from 99.86 mg/l to 154.28 mg/l. the maximum value was154.28 mg/l recorded in the month of July and minimum value 99.86 mg/l in the month of March with mean value and standard deviation 131.286 ±15.636 (fig. 14). Similar results were reported by Swarnalatha and Nasingrao (1998) and Umavathi *et al.,* (2007) [28] showed that higher concentration of chloride is association with increased level of pollution.

Nitrate

The nitrate is one of the most oxidized forms of nitrogen and is an essential plant nutrient Nitrate concentration is associated with rain water runoff, sewage, and sludge discharge Jha & Barat, (2003) [10]. The values of nitrate ranges from 0.296 mg/l to1.833 mg/l. the maximum value was 1.833 mg/l and minimum value was 0.296 mg/l with mean value and standard deviation 0.584 ±0.414 (fig. 15). Similar seasonal

peak was also recorded by Bhongade and Patil (2012) [2].

Phosphate

The values of phosphate varied from 0.0297 mg/l to 0.367 mg/l. the maximum value was 0.367 mg/l in month January and minimum value was 0.0297 mg/l in month of November with mean value and standard deviation 0.101± 0.108 (fig. 16). This finding is agreement with that of Udaipur lakes (Ranu, 2001 and Chisty, 2002) [18, 4].

Dissolve oxygen

The DO observation was recorded ranges from 2.384 mg/l to 57.584 mg/l. the maximum value was 57.584 mg/l in month March and minimum value was 2.384 mg/l in month of November with mean value and standard deviation 9.845 ±15.093 (fig. 17). Dissolved Oxygen value is remarkable in determining the water quality criteria of an aquatic system. Torzwall (1957) had reported that if the concentration of DO is about 5mg/l, throughout. Rani *et al.,* (2004) [17] also reported lower values of Dissolved oxygen in summer season due to higher rate of decomposition of organic matter and limited flow of water in low holding environment due to high temperature. The long days and intense sunlight during summer seem to accelerate photosynthesis by phytoplankton, utilizing CO2 and giving off oxygen. This possibly accounts for the greater qualities of O2 recorded during summer. (Krishnamurthy, R. 1990) [13].

Biochemical Oxygen Demand

The value of BOD fluctuates from 0.0304 mg/l to 1.922 mg/l. The maximum value was 1.922 mg/l recorded in the month of July and minimum value 0.0304 mg/l in the month of March with mean value and standard deviation 1.008± 0.464 (fig. 18). Devaraju *et al.,* (2005) [5] has made similar observations in Maddur Lake and Garg *et al.,* 2009 [7] has also made similar observations in Ramsagar reservoir.

Chemical Oxygen Demand

The value of COD fluctuates from 33.22 mg/l to 9.8 mg/l. where maximum value was 9.8 mg/l analyzed in the month of November and minimum value 33.22 mg/l in the month of December with mean value and standard deviation 34.299 ±17.632 (fig. 19). Tepe *et al.,* (2005) [27] observed that high chemical oxygen demand has been linked with pollution.

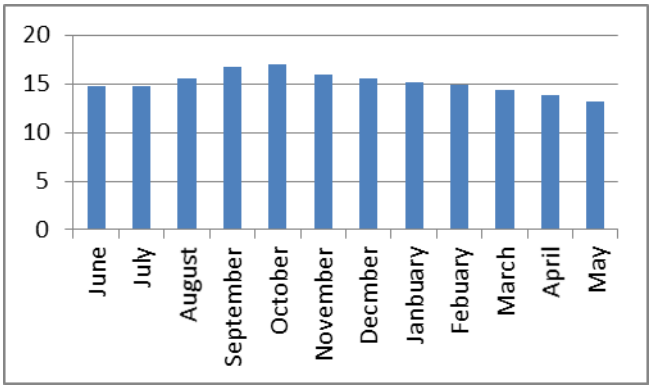

Fig 2: Monthly variations in Depth

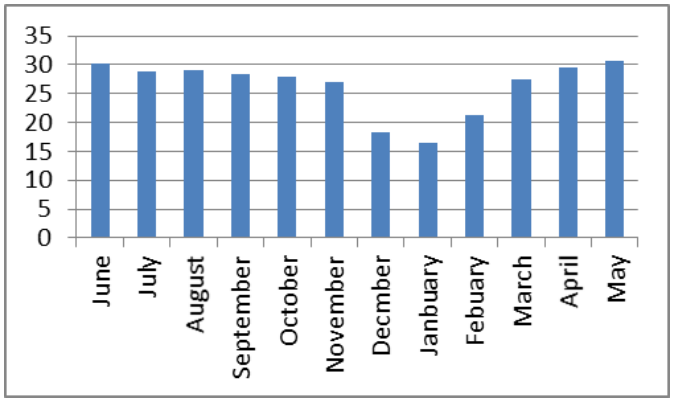

Fig 3: Monthly variations in water temperature

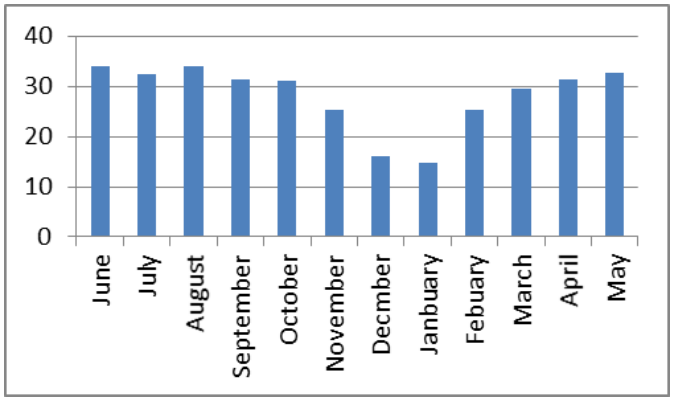

Fig 4: Monthly variations in Air temp

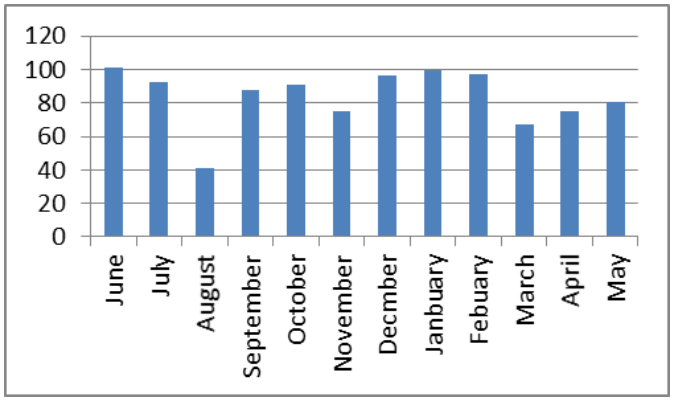

Fig 5: Monthly variations in Transparency

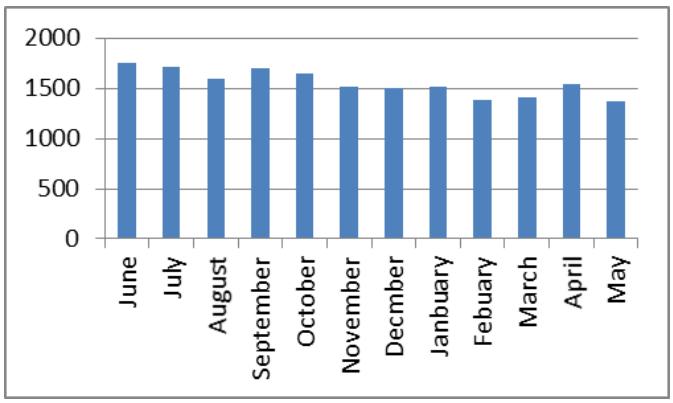

Fig 6: Monthly variations in Conductivity

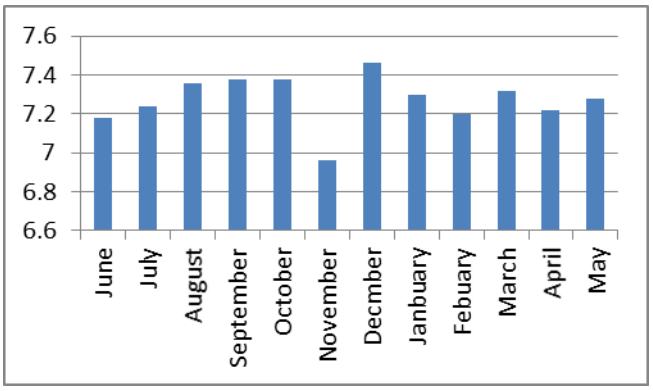

Fig 7: Monthly variations in pH

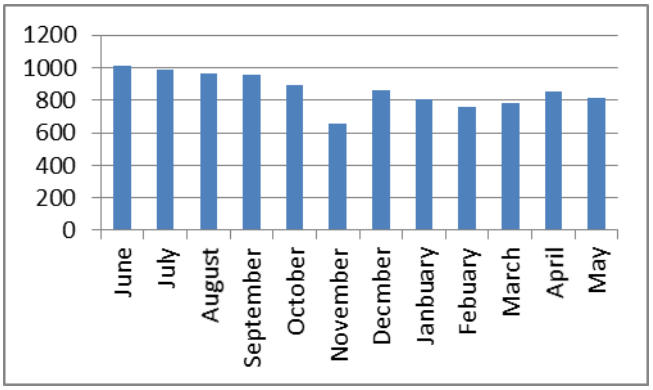

Fig 8: Monthly variations in T.D.S

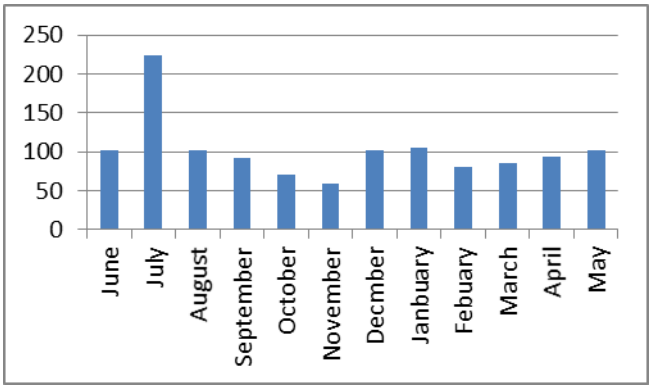

Fig 9: Monthly variations in T.S. S

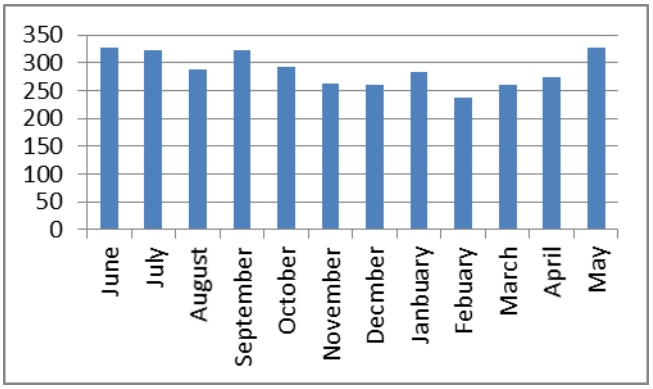

Fig 10: Monthly variations in Total alkalinity

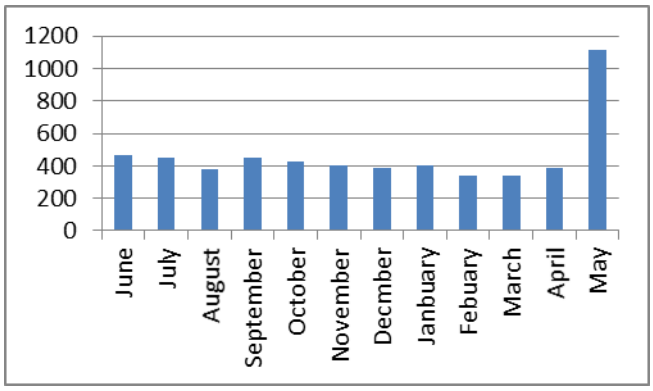

Fig 11: Monthly variations in Total hardness

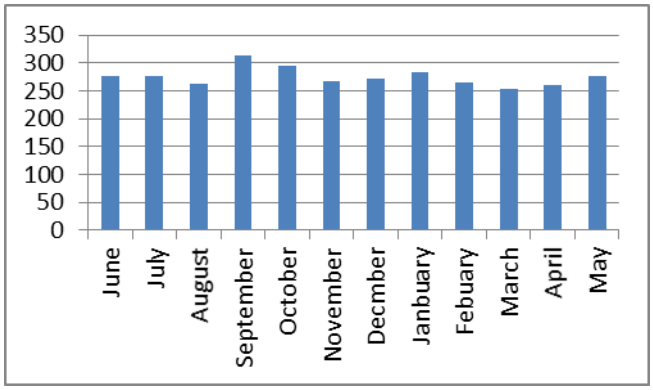

Fig 12: Monthly variations in Ca hardness

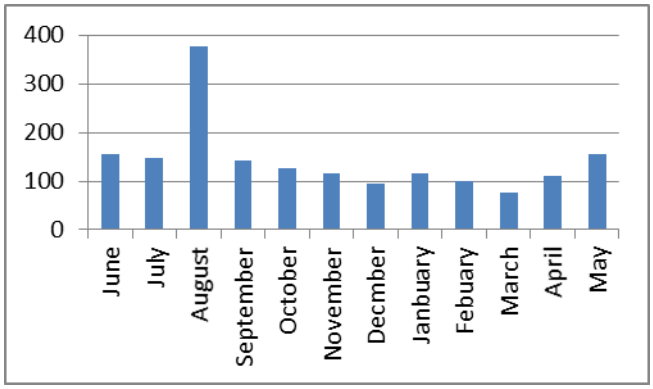

Fig 13: Monthly variations in Mg hardness

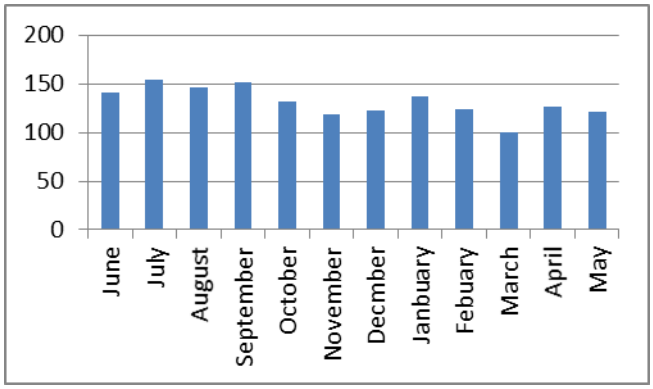

Fig 14: Monthly variations in Chloride

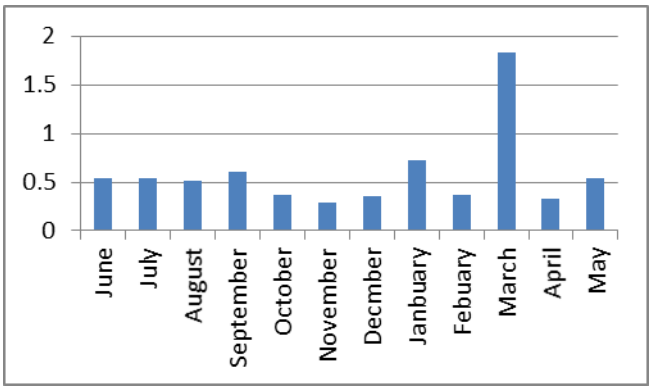

Fig 15: Monthly variations in Nitrate

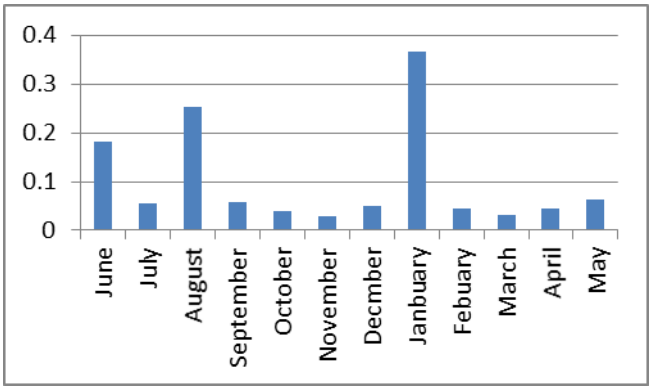

Fig 16: Monthly variations in Phosphate

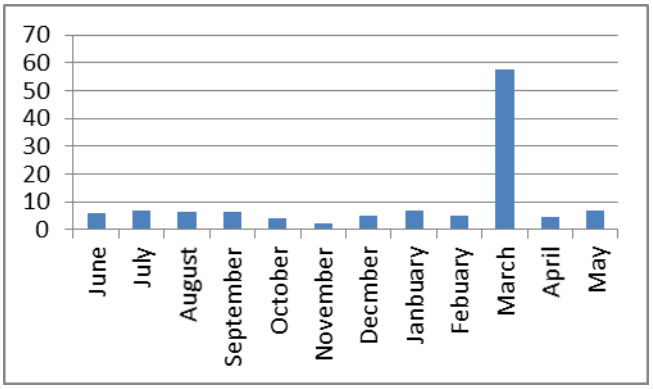

Fig 17: Monthly variations in Do

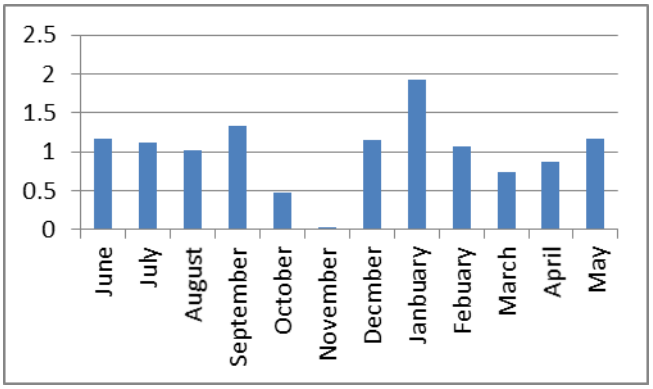

Fig 18: Monthly variations in BOD

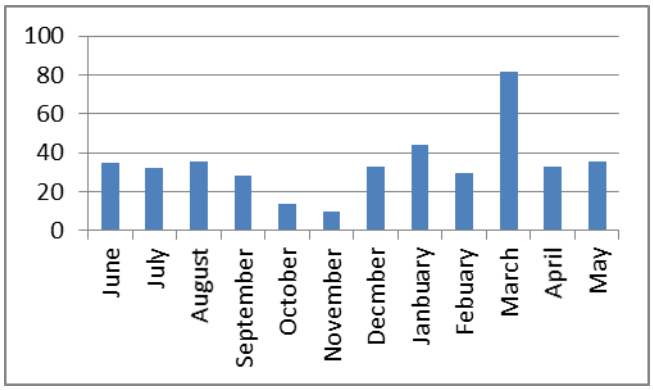

Fig 19: Monthly variations in COD

Conclusion

It is very essential and important to test the water before it is used for drinking, domestic, agricultural or industrial purpose. Observation of the study indicates that higher values of some parameters of the reservoir water. Electrical Conductivity exceeds the permissible limit as recommended by WHO Total dissolved solids found above the permissible limit. They minimize the suitability of the water for drinking purpose without prior treatment.

Acknowledgement

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