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**WATER CHEMISTRY WITH REFERENCE TO PHYSICO-CHEMICAL
PARAMETERS OF EUTROPHIC TANK IN BHADRAVATHI TOWN, KARNATAKA**

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ABSTRACT

Devarahalli tank is situated in Bhadravathi town of Karnataka. Water chemistry of Devarahalli tank is studied in the current article. Water samples were collected during January to December 2016 and analyzed for various physical and chemical parameters seasonally. It was observed that water quality of Devarahalli tank is polluted by sewage from the intensively surrounding catchments. Devarahalli tank is extensively used for washing, bathing, and for conducting religious rituals, idol immersion which showed eutrophication. Hence, the study was undertaken to find out the quality of tank water for various physico-chemical parameters. This water body is found to be organically polluted and greater degree of eutrophication was observed. The present article describes information of human activities on tank, and suggests some measures for restoration of this tank. The predicted water quality parameters were compared with the WHO and BIS standards.

Keywords: Agricultural runoff, Water quality, eutrophication, sewage, restoration

INTRODUCTION

The freshwater bodies are facing contamination problem all over the globe. Lentic water bodies like pond, lake, dams etc are the part of freshwater habitat and they are useful to mankind. The survival of life in the tank depends on the quantity and quality of water. Tank play a significant role in the ecological sustainability. Nevertheless, continuous inputs of various chemical pollutants from human activities has seriously deteriorated the quality of tank ecosystems in India. Water bodies are threatened due to point and nonpoint sources of pollution. Major factors for eutrophication include nutrients (Nitrate and phosphate) input and organic matter load, construction and logging activities [1].

Water is present in ponds, lakes, rivers, dams, etc., which is less than 1% used by man for industrial, domestic and agricultural usage. Ponds are useful in many ways and it is one of the methods of artificial permeation of underground water. In an aquatic bodies water quality is determined by physico-chemical and biological factors [2-3]. The term water quality was developed to give an indication of how suitable the water is for human consumption [4, 5].

Now a days, contamination of the water bodies augmented due to fast population, industrial revolution, urbanization, human activities. In India, the problem of water pollution started and water quality studies were given attention during last few decades [6]. Water pollution creates health problems. Even though ecological relationship, species variety and physico-chemical properties of lakes have received considerable attention [7-10]. Therefore, present study describes details of human impact on Devarahalli tank and suggests some measures for restoration of this important resource.

MATERIALS AND METHODS

Study Area

Devarahalli is a village in Bhadravati taluk of Shivamogga district in Karnataka of India. It belongs to Devarahalli Panchayath. It is located 24 Km away from head quarters Shivamogga. and 3 Km from Bhadravati town. Devarahalli is in the border of the Shivamogga District and Chikmagalur District. Tarikere is South towards this area. Devarahalli tank is situated 1 Km away from Kachagondanahalli village. The tank is surrounded by arecanut, coconut, sugar cane and paddy plantations (**Figure 1**).



Figure 1: Different views of Devarahalli tank showing aquatic vegetation

Method of water sampling

Water samples were collected during the year 2016 for Physico-chemical analysis from this tank at an interval of 30 days. Samples were collected in black plastic carbuoys of 2 litres capacity. Estimation of certain factors like dissolved oxygen, water was taken in 300 ml BOD bottle and fixed by using Winkler's reagent. Water temperature and p^H were recorded at the sampling spot. For the estimation of remaining parameters the samples were kept in air cooled chamber. In all cases the final results were calculated by following at least 3 consecutive readings. The methods employed for the estimation of the parameters are as follows:

The temperature of water at each station was recorded at a depth of 10-12 cm with the help of a mercury thermometer. p^H was determined at the place of collection with the help of p^H pen and was confirmed by using p^H meter at the laboratory. Turbidity was

measured by using digital turbidity meter.

Conductivity readings were taken in the laboratory using direct reading conductivity meter-304 (Systronics). Total solids, Total suspended solids as per standard method APHA [11]. Total dissolved solids readings were obtained by using water analysis kit (Elico). Chloride estimated by argentometric method [11]. Total hardness by EDTA titrimetric method, ISI. Total alkalinity by titrimetric method [11]. Nitrites determined by Standard methods, 1998. Ammonia estimated by Spectrophotometric method by using Nessler's reagent UV-VIS spectrophotometer-118(Systronics).

Dissolved oxygen was estimated as per Winkler's (1888) modified method was followed to estimate dissolved oxygen [11]. Biochemical oxygen demand and COD were determined by direct method. Phosphates by stannous chloride method [11]. While, Calcium and magnesium were determined by

EDTA titrimetric method, Free carbon dioxide was estimated by using titrimetric method [11].

One way ANOVA and Post Hoc Tukey HSD tests for physical and chemical parameters are calculated by using socscistatistics software.

RESULTS AND DISCUSSION

Results are appended in **Figure 2-3** and **Tables 1-4** respectively. Drinking water quality standards as given by WHO and BIS standards is given in **Table 5**.

Physical parameters

The maximum water temperature of tank was recorded as 32°C in summer and minimum of 26°C in monsoon season. Temperature plays an important role, which governs the seasonal succession of the biota. Temperature was high in summer is associated with decreased solubility of gases in the tank. The minimum and maximum values of electrical conductivity of tank water fluctuated from 1450-2010µmhos/cm during pre-monsoon and monsoon months respectively. Electrical conductivity is good indicators of the water quality [12-13]. The elevated levels of EC are due to high concentration of ionic constituents in the water body and reflect the pollution by domestic wastes.

TDS of the tank water recorded the maximum value of 1450 mg/l in monsoon month respectively and minimum of 880 mg/l in pre-monsoon month respectively. The lowest total solids were recorded as 970mg/l during pre monsoon month and the highest of 1580 mg/l was noted during monsoon. Water body has high TDS which is caused by the adding of sewage. High solids in water cause inferior potable quality of water low values of transparency have been attributed to cloudy condition meager sunshine and surface runoff loaded with silt and organic wastes causing turbidity in water. The tank water showed the maximum turbidity of 29 NTU during monsoon month and minimum of 18 NTU in pre-monsoon month. The transparency value of tank water was the highest of 28 in monsoon month and lowest in the month of pre-monsoon month with 18 cm in summer month.

Chemical parameters

The highest pH value was recorded as 8.1 in pre-monsoon month and minimum of 7.5 in monsoon month in tank water. The lower pH during monsoon is due to high turbidity and in summers the temperature enhances microbial activity, causing excessive production of CO₂ and reduced pH. The higher alkalinity values may be due to the discharge of domestic sewage and urban

wash off into the water body. The maximum alkalinity was obtained in pre-monsoon season whereas minimum in post-monsoon season may be due to presence of HCO_3 and hydroxide of Ca, Mg, Na, K and protein in tank water. Higher values (550 mg/l) of total hardness during monsoon can be attributed to surface runoff and high rate of silt deposition. Total hardness was found to be much higher than said limit. Water of these sources is not suitable for drinking and washing with regard to it. Total hardness was high when compared to total alkalinity [13, 14]. Total hardness of water indicates water quality in terms of Ca^{2+} and Mg^{2+} contents. Total hardness higher than 200 mg/L is not suitable for domestic use as drinking and cleaning [15].

The highest total alkalinity was recorded with 220 mg/l during pre-monsoon month and lowest value was 150 mg/l in post-monsoon month. The critical parameters like BOD, COD, TDS, TS, total alkalinity and total hardness are above prescribed limits. The summer and winter seasons are more polluted than the other season. The analysis of physico-chemical parameters had indicated the wider human activity and influx of domestic waste in tank which caused eutrophication [13]. Total Alkalinity of 150 mg/L has been found conducive to

high productivity of water bodies [16]. The above results indicated that the Devarahalli tank was found to be more productive.

The high Dissolved Oxygen (DO) was recorded as 5.6 mg/l during monsoon month and low level was 3.2 mg/l in pre-monsoon month in tank water. DO is the regulator of metabolic activities of organisms and thus governs metabolism of the living organisms and also acts as an indicator of trophic status of the water body [17]. Low value of DO may be due to increase of phytoplankton and decrease of photosynthetic activity. BOD values of the tank water were ranged between 56-74 mg/l. The recorded values were maximum in monsoon and minimum in post-monsoon. The increased levels of BOD and COD indicated the nature of chemical pollution by the entry of surface run off and human activities. High BOD in rainy season was several microbes present in the water body accelerated their metabolic activities with concentrated amount of organic matter in the form of domestic wastes into the water body and hence, need more amount of oxygen [18].

The maximum COD value of 175 mg/l and the minimum value of 147mg/l obtained in the tank water. COD is a measure of oxygen required for complete oxidation of organic matter by a strong oxidant [13]. In this study, COD level in the tank water is higher than BOD. Maximum COD values indicated the

degree of non biodegradable oxygen demanding pollutants present in the tank.

Statistical Analysis

As in Table 1 and 3 the One way ANOVA “F” values for physical and chemical parameters are 294.1895 and 2812.8732 respectively. The p-values are < .00001. The result is significant at $p < .05$

Post Hoc Tukey HSD (beta)

The Tukey's HSD procedure facilitates pairwise comparisons within ANOVA data.

The F statistic (above) tells whether there is an overall difference between sample means.

Tukey's HSD test allows to determine between which of the various pairs of means - if any of them - there is a significant difference. In the below tables Q values in blue color indicates significant result.

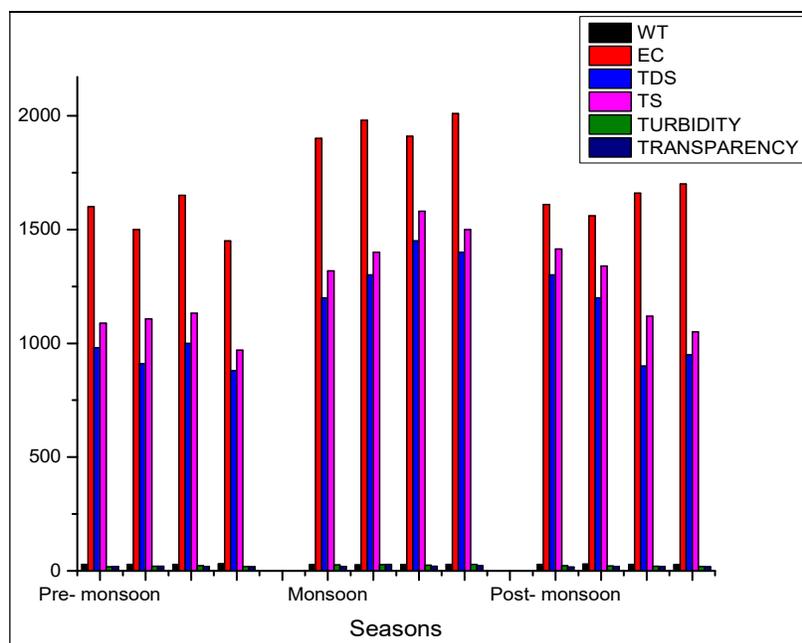


Figure 2: Seasonal variations of Physical Parameters of Devarahalli tank at Bhadravathi town (Water temperature expressed in °C, EC (µmhos /cm), Turbidity (NTU), Transparency (Cm), TDS & TS in mg/l)

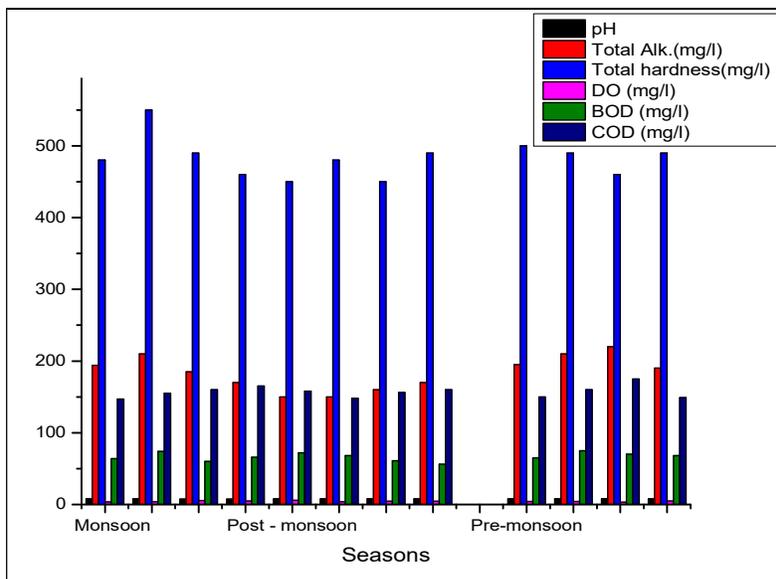


Figure 3: Seasonal variations of Chemical Parameters of Devarahalli tank in Bhadravathi town

Table 1: One-Way ANOVA data for physical parameters

	Physical parameters					Total
	WT (T1)	EC (T2)	TDS(T3)	TS (T4)	Tur (T5)	
N	12	12	12	12	12	60
$\sum X$	339	20530	13470	15018	268	49625
Mean	28.25	1710.8333	1122.5	1251.5	22.3333	827.083
$\sum X^2$	9599	35524900	15597900	19224698	6126	70363223
Std.Dev.	1.4222	191.0477	208.4194	197.6386	3.576	704.9367
Source		SS		df	MS	
Between-parameters		28010062		4	7002515.5	$F = 294.1895$
Within-parameters		1309150.5833		55	23802.7379	
Total		29319212.5833		59		The p-value is < .00001. The result is significant at $p < .05$

Table 2: Post Hoc Tukey HSD values for physical parameters

Pair wise Comparisons		HSD _{.05} = 177.6366 HSD _{.01} = 215.4709	Q _{.05} = 3.9885 Q _{.01} = 4.8380
T ₁ :T ₂	M ₁ = 28.25 M ₂ = 1710.83	1682.58	Q = 37.78 (p = .00000)
T ₁ :T ₃	M ₁ = 28.25 M ₃ = 1122.50	1094.25	Q = 24.57 (p = .00000)
T ₁ :T ₄	M ₁ = 28.25 M ₄ = 1251.50	1223.25	Q = 27.47 (p = .00000)
T ₁ :T ₅	M ₁ = 28.25 M ₅ = 22.33	5.92	Q = 0.13 (p = .99998)
T ₂ :T ₃	M ₂ = 1710.83 M ₃ = 1122.50	588.33	Q = 13.21 (p = .00000)
T ₂ :T ₄	M ₂ = 1710.83 M ₄ = 1251.50	459.33	Q = 10.31 (p = .00000)
T ₂ :T ₅	M ₂ = 1710.83 M ₅ = 22.33	1688.50	Q = 37.91 (p = .00000)
T ₃ :T ₄	M ₃ = 1122.50 M ₄ = 1251.50	129.00	Q = 2.90 (p = .25744)
T ₃ :T ₅	M ₃ = 1122.50 M ₅ = 22.33	1100.17	Q = 24.70 (p = .00000)
T ₄ :T ₅	M ₄ = 1251.50 M ₅ = 22.33	1229.17	Q = 27.60 (p = .00000)

Table 3: One-Way ANOVA data for Chemical parameters

Chemical parameters						
	pH (T1)	TH (T2)	DO (T3)	BOD (T4)	COD (T5)	Total
N	12	12	12	12	12	60
ΣX	93.2	5790	53.2	799	1883	8618.4
Mean	7.7667	482.5	4.4333	66.5833	156.9167	143.64
ΣX ²	724.06	2801900	242.68	53567	296189	3152622.74
Std.Dev.	0.1371	27.3446	0.7878	5.7755	8.0618	180.1448
Source		SS	df	MS		
Between-parameters		1905361.8973	4	476340.4743	<i>F</i> = 2812.87322	
Within-parameters		9313.8667	55	169.343		
Total		1914675.764	59		The p-value is < .00001. The result is significant at p < .05	

Table 4: Post Hoc Tukey HSD (beta) values for chemical parameters

Pair wise Comparisons		HSD _{.05} = 14.9831 HSD _{.01} = 18.1744	Q _{.05} = 3.9885 Q _{.01} = 4.8380
T ₁ :T ₂	M ₁ = 7.77 M ₂ = 482.50	474.73	Q = 126.37 (p = .00000)
T ₁ :T ₃	M ₁ = 7.77 M ₃ = 4.43	3.33	Q = 0.89 (p = .97000)
T ₁ :T ₄	M ₁ = 7.77 M ₄ = 66.58	58.82	Q = 15.66 (p = .00000)
T ₁ :T ₅	M ₁ = 7.77 M ₅ = 156.92	149.15	Q = 39.70 (p = .00000)
T ₂ :T ₃	M ₂ = 482.50 M ₃ = 4.43	478.07	Q = 127.26 (p = .00000)
T ₂ :T ₄	M ₂ = 482.50 M ₄ = 66.58	415.92	Q = 110.72 (p = .00000)
T ₂ :T ₅	M ₂ = 482.50 M ₅ = 156.92	325.58	Q = 86.67 (p = .00000)
T ₃ :T ₄	M ₃ = 4.43 M ₄ = 66.58	62.15	Q = 16.54 (p = .00000)
T ₃ :T ₅	M ₃ = 4.43 M ₅ = 156.92	152.48	Q = 40.59 (p = .00000)
T ₄ :T ₅	M ₄ = 66.58 M ₅ = 156.92	90.33	Q = 24.05 (p = .00000)

Table 5: Drinking water standards of WHO & BIS limits

Parameters	Permissible limit	
	WHO	BIS
Turbidity, NTU	5.0	5.0
Dissolved solids	500	500
Total hardness	100	300
Calcium hardness	75	75
Magnesium hardness	30	30
Alkalinity	200	200
Dissolved oxygen	4-6	4-6
Chloride	250	250
Nitrate	45	45
Iron	0.3	0.3
pH	6.5-8.5	-
BOD	5	-
Potassium	12	-

CONCLUSION

Devarahalli tank water quality parameters undergo seasonal changes and values are generally higher during summer season. Tank water is polluted in terms of physico-chemical parameters. It was found that water quality problems associated with Devarahalli tank includes depletion of dissolved oxygen, less water clearness and high algal growth, blooms. Tank is declined in aesthetic quality. The surface run off directly from the surrounding tank area, dumping of garbage, rituals and idol immersion during festival, have contributed considerable contamination in tank area. The results of physico-chemical study have revealed that the this tank is contaminated by nutrients. In the light of standard water quality recommended by WHO [19] and BIS [20], the tank water should be used by human beings especially for drinking and cooking after proper treatment. Nevertheless, government authorities should take essential steps to beautify the tank to control eutrophic To improve the quality of tank water, there should be continuous monitoring of water in Devarahalli tank of Bhadravathi, Karnataka. Further, suggests that the tank which is present in Bhadravathi taluk have to be well maintained by the respective authorities.

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