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Physico-chemical Analysis of Selected Surface Water Samples of Laxmi Tal (Pond) in Jhansi City, UP, Bundelkhand Region, Central India

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Abstract

Laxmi Tall situated in Jhansi city located in Bundelkhand region of Central India, receive rain water as well as waste water from various nallas. Some physico-chemical parameters like temperature, pH, DO, BOD, COD, alkalinity, total hardness, Ca hardness, Mg hardness, and chloride were analyzed. Sampling of water was done during January to June 2010 from five different sites around the Laxmi Tall. Analytical results of the water have been observed as pH ranging from (7- 9.4), temperature (10^0C -32^0C), DO (0.89 -2.96 mg/l) l, BOD (2.8 -9.8 mg/l), COD (6.01 -24 mg/l), alkalinity (155 -355 mg/l), total hardness (323 -142 mg/l), chloride (4 -24 mg/l). The water shows alkaline nature throughout the year indicating highly polluted characteristics. The values of DO and BOD fluctuate according to seasons but a very low value of BOD/COD ratio was found, which represents high chemical pollution. From the observations, chloride and total hardness were recorded under permissible limit.

Key Words: Surface water quality, Luxmi Tall, Jhansi

Introduction

Water is one of the most abundant compounds found in nature covering approximately three -fourths of surface of earth [1]. Water is the elixir of life, a precious gift of nature to the mankind and millions of other species living on the earth. it is fast becoming a scare commodity in most part of the world [2].Water is an essential requirement of human and industrial development and also it is one of the most delicate parts of the environment [3]. Availability of clean and potable water has become a key issue in several developing countries. Burgeoning population and water scarcity is affecting the quality of life significantly, India is no exception to this [4].From ancient times the rain water is being stored in small lakes in some area. These lakes work as reservoir throughout the year [5]. In Jhansi city, Laxmi Tall is a rain feed pond to store the rain water. Jhansi is located in Bundelkhand region of Central India. Jhansi region lies between 24^0 11' N to 25^0 57' N latitudes and 78^0 70' E to 79^0 23' E longitudes and situated in south western part of the U.P. The population of Jhansi city is found to be five lakh four thousand approximately [6].

The rain fall data show a maximum of 1194.5 mm in year 2003 and minimum of 486.1 mm in year 2004. The quality of water is defined in terms of its physical, chemical and biological parameters and ascertaining its water quality is crucial before use for various intended purpose such as potable water [7].

Physico chemical properties of water in any aquatic ecosystem are largely governed by the existing meteorological conditions and are essential for determining the structural and functional status of natural water [8].

The municipal waste water of Jhansi city is dumped into Laxmi Tal through various nalas namely Kuberau nala, Kasai mandi nala, laxmi gate nala, Jashiyana nala, Banglaghat nala, Budagaon nala. The waste water is dumped in Laxmi Tal combindely from these nalas flowing at the rate of 191.3 liter/second are recorded [9].

Hydrological condition of lake water affects the aquaculture activities, decreases in fish productivity, change in species composition of avifauna, eutrophication and overall loss of biodiversity that resulted in degradation of lake ecosystem [10].

The present study was under taken to define the various point sources of pollutants in Laxmi Tall and to assess the quality of water samples with special reference to physico-chemical properties in various months and stations.

Materials and Methods

Laxmi Tal is a part of historical, cultural and recreational life of Jhansi city. It is located between longitude of 78^0 37' E and 25^0 27' N of latitude. It is approximately 32.52 hectare in its full spread with an average depth of 2.5 m and has a catchment area of 2370 hectares having a storm water intensity of nearly 0.75 per hour/acre of flood rain. Water samples were taken from five sampling sites around Laxmi Tal namely Hazarat Khaki Shah masjid (S1), Atkhamba mandir (S2), Om shanki nagar (S3), Raja ki Samadhi (S4), and Radha

govind ki bagia (S5) on monthly basis from January 2010 to June 2010 (fig-1).

Physico-chemical analysis of water was carried out referring the 'standards methods' [11].The temperature, turbidity, pH and dissolved oxygen were determined in the field. The collected samples were brought to laboratory and analyzed within 24 hours, except the biological oxygen demand, which require a period of five days for incubation at a temperature of 20^{0}C using standard methods [11].

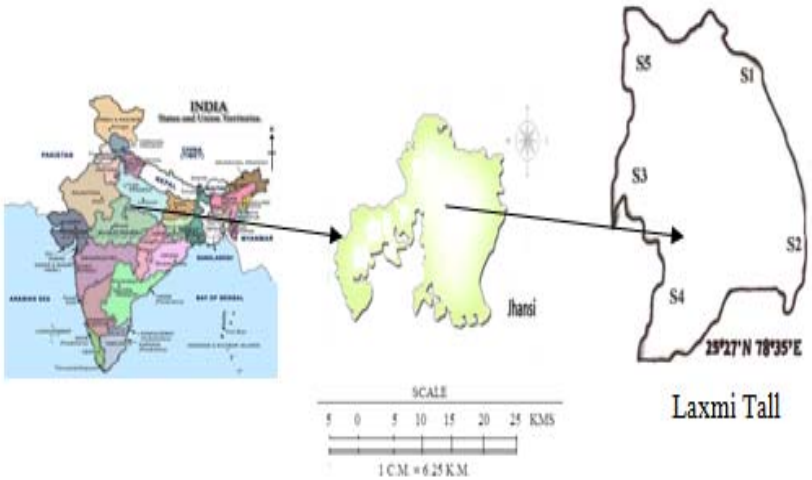

Fig:1 Map showing study area

Results and Discussion

With increase in anthropogenic meddling as a consequence of disregard to the socio-cultural values of water reservoir, there is increase in quality deterioration of their water. The quality of physical and chemical parameters serves as a good index in providing a complete and reliable picture of the conditions prevailing in a water body [12].

pH regulates most of the biological processes and biochemical reactions. In present study, Laxmi Tall is found to be slightly alkaline (7 to 9.4 pH). lake having such range of pH is defined as eutrophic lake [14]. The average pH observed at S1 is 7.5±0.4, S2 is 7.8±0.5, S3 is 8.5±0.8, S4 is 7.8±0.6 and S5 is 8.3±0.6.

Temperature is one of the most important factors in determining the physico- chemical property of water. Temperature is found negatively correlated with DO [13], pH, BOD and COD during January to May. The average temperature of various sites namely S1 is 16.6±4.97 ^{0}C, at S2 is 19.4±6.22 ^{0}C, at S3 is 26.2±5.93) ^{0}C, at S4 is 19.2±6.24 ^{0}C and at S5 is 23.6±5.94 ^{0}C respectively.

Dissolved Oxygen is negatively correlated with temperature. Low temperature in winter contributed rise in DO concentration while in summer season DO concentration decreases due to high temperature and more oxygen utilization. It has been reported that lower values of dissolved oxygen in summer months due to higher rate of decomposition of organic matter and limited flow of water in low oxygen holding environment due to high temperature [15]. There is an inverse relation between DO and oxygen utilization in terms of BOD and COD. The average DO is observed 1.46±0.68 mg/l (S1), 1.56±0.63 mg/l (S2), 1.54±0.72 mg/l (S3), 1.68±0.69 mg/l (S4) and 1.68±0.90 mg/ (S5).

Biochemical Oxygen Demand is positively correlated with temperature. On increasing the temperature biochemical oxygen demand also increases. This may be attributed to the photosynthetic activity and abundance of phytoplankton during hot period [16]. The average BOD recorded at S1 is 4.97±0.91 mg/l, at S2 is 6.22±2.87 mg/l, at S3 is 8.68±2.11 mg/l, at S4 is 3.84±0.70 mg/l and at S5 is 6.5±1.08 mg/l.

Chemical Oxygen Demand is the amount of oxygen required to oxidize the biodegradable organics as well as the non biodegradable organics both. COD represents a positive correlation with temperature and inverse relation with DO. 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 [17]. The average COD value at different sites observed are 1.34±3.59 mg/l (S1), 11.39±5.40 mg/l (S2), 15.90±5.6 mg/l (S3), 10.28±4.55 mg/l (S4) and 12.59±4.37 mg/l (S5).

Quantitative analytical results of alkalinity, total hardness, calcium and magnesium, shows higher concentration at extreme temperature. Laxmi Tall water exhibit slightly alkaline character due to continuous sewage disposal and improper decomposition of organic waste. Notable increasing trend is observed in calcium and magnesium in summer season due to increase in ionic concentration and movement [18]. The average value of alkalinity observed at S1 is 284.4±16.10 mg/l, at S2 is 257±18.23 mg/l, at S3 is 319.4±39.23 mg/l, S4 is 176±14.12 mg/l and at S5 is 284.6±15.43 mg/l. Average value of total hardness detected at different sites are 179±10.93 mg/l (S1), 156.2±11.23 mg/l (S2), 310±12.22 mg/l (S3), 183.4±11.53 mg/l (S4) and 264.8±13.40 mg/l (S5). It was reported that total hardness was high during summer than monsoon and winter. High value of hardness during summer can be attributed to decrease in water volume and increase of rate of evaporation of water [19]. Calcium hardness in its average value is observed 217.61±109.22 mg/l (S1), 1.72±3.30 mg/l (S2), 61.01±2.48 mg/l (S3), 30.08±1.59

mg/l (S4) and 27.15±1.46 mg/l (S5). Average value of magnesium is found 22.72±2.19 mg/l (S1), 100.35±3.97 mg/l (S2), 294.4±4.16 mg/l (S3), 151.32±1.81 mg/l (S4) and 235.2±2.70 mg/l (S5) at various sites. Generally, the calcium content in the water is affected by the adsorption of the calcium ion on the metallic oxides [20].

Chlorides can be considered as one of the basic parameters of classifying lakes polluted by sewage into different categories [21].The chloride content of Tall water refers to positive correlation with temperature. The average value of chloride throughout the study period is observed as at S1 is 13.4±5.59 mg/l, at S2 is 13.4±7.50 mg/l, at S3 is 16.4±4.62 mg/l, at S4 9.0±4.92 mg/l and at S5 is 15.6±6.69 mg/l.

The physico- chemical properties of tall water from site 1, site 2, site 3, site 4 and site 5 have been represented in tables 1, 2, 3, 4, 5, and their correlation are given in tables 6, 7, 8, 9 and 10 respectively.

Table 1: Monthly variation in Physico-chemical characteristics of Laxmi Tall water at S1

Parameters	Jan	Feb	March	April	May	max	min	Average
pH	8.2	7.9	7.6	7.2	7	8.2	7	7.58±0.49
Temp.^{0}C	10	13	18	20	22	22	10	16.6±4.98
DO(mg/l)	2.63	1.50	1.14	1.12	0.94	2.63	0.94	1.46±0.68
BOD (mg/l)	3.50	5.00	5.13	5.24	6.00	6.00	3.50	4.97±0.91
COD (mg/l)	7.16	9.20	10.37	14.00	16.00	16.00	7.16	11.34±3.60
Alkalinity (mg/l)	285	260	280	295	302	302	260	284.4±16.10
T H (mg/l)	165	172	180	185	193	193	165	179±10.93
Ca (mg/l)	251.31	25.80	250.90	258.90	301.17	301.17	25.80	217.61±109.23
Mg (mg/l)	23.94	20.01	21.09	23.12	25.47	25.47	20.01	22.72±2.19
Cl (mg/l)	7.00	9.00	14.00	16.00	21.00	21.00	7.00	13.4±5.59

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium and Cl=Chloride.

Table 2: Monthly variation in Physico-chemical characteristics of Laxmi Tall water at S2

Parameter	Jan	Feb	March	April	May	max	min	Average
pH	8.5	8.2	7.8	7.6	7.1	8.5	7.1	7.84±0.54
Temp	12	15	20	22	28	28	12	19.4±6.23
DO(mg/l)	2.51	1.9	1.3	1.2	0.93	2.51	0.93	1.56±0.63
BOD (mg/l)	3.3	4.13	8.71	5.19	9.8	9.8	3.3	6.22±2.87
COD (mg/l)	6.01	8.27	8.71	15	19	19	6.01	11.39±5.40
Alkalinity (mg/l)	255	235	250	260	285	285	235	257±18.23
T H (mg/l)	157	142	150	160	172	172	142	156.2±11.23
Ca (mg/l)	53.51	46.49	50.5	53.5	54.61	54.61	46.49	51.72±3.30
Mg (mg/l)	101.24	94.31	99.49	101.49	105.23	105.23	94.31	100.35±3.97
Cl (mg/l)	5	8	13	17	24	24	5	13.4±7.50

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium and Cl=Chloride.

Table 3: Monthly variation in Physico-chemical characteristics of Laxmi Tall water at S3

Parameters	Jan	Feb	March	April	May	max	min	Average
pH	9.4	9.2	8.5	7.9	7.5	9.4	7.5	8.5±0.82
Temp	18	22	29	30	32	32	18	26.2±5.93
DO(mg/l)	2.66	1.85	1.33	1.04	0.86	2.66	0.86	1.54±0.73
BOD (mg/l)	4.9	9.5	9.6	9.6	9.8	9.8	4.9	8.68±2.12
COD (mg/l)	8.47	14.02	15.03	18	24	24	8.47	15.9±5.69
Alkalinity (mg/l)	292	265	335	350	355	355	265	319.4±39.23
T H (mg/l)	290	312	310	315	323	323	290	310±12.23
Ca (mg/l)	57.12	60.12	62.12	62.19	63.5	63.5	57.12	61.01±2.49
Mg (mg/l)	242.1	249.88	251.22	251.64	252.17	252.17	242.11	249.4±4.16
Cl (mg/l)	10	14	17	19	22	22	10	16.4±4.62

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium and Cl=Chloride.

Table 4: Monthly variation in Physico-chemical characteristics of Laxmi Tall water at S4

Parameters	Jan	Feb	March	April	May	max	min	Average
pH	8.7	8.4	7.6	7.3	7.1	8.7	7.1	7.82±0.62
Temp	11	14	19	24	28	28	11	19.2±6.24
DO(mg/l)	2.81	2.1	1.54	1.09	0.89	2.81	0.89	1.68±0.70
BOD (mg/l)	2.8	3.5	3.98	4.2	4.9	4.9	2.8	3.87±0.70
COD (mg/l)	6.29	6.94	7.19	13	18	18	6.29	10.28±4.55
Alkalinity (mg/l)	175	155	170	182	198	198	155	176±14.13
T H (mg/l)	189	163	180	188	197	197	163	183.4±11.53
Ca (mg/l)	30	27.43	29.65	31.2	32.14	32.14	27.43	30.08±1.59
Mg (mg/l)	152.49	148.24	150.34	152.37	153.19	153.19	148.24	151.32±1.81
Cl (mg/l)	4	6	9	12	18	18	4	9.8±4.92

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium and Cl=Chloride.

Table 5: Monthly variation Physico-chemical characteristics of Laxmi Tall water at S5

Parameters	Jan	Feb	March	April	May	max	min	Average
pH	9.1	8.8	8.3	7.8	7.7	9.1	7.7	8.34±0.61
Temp	16	19	25	28	30	30	16	23.6±5.94
DO(mg/l)	2.96	2.3	1.33	0.99	0.85	2.96	0.85	1.68±0.91
BOD (mg/l)	4.6	6.8	7.14	6.8	7.2	7.2	4.6	6.5±1.08
COD (mg/l)	7.31	10.24	12.42	14	19	19	7.31	12.59±4.37
Alkalinity (mg/l)	280	265	285	285	308	308	265	284.6±15.44
T H (mg/l)	267	248	260	264	285	285	248	264.8±13.41
Ca (mg/l)	27.22	25.13	26.45	28.01	28.97	28.97	25.13	27.15±1.47
Mg (mg/l)	235.64	231.49	233.54	237.26	238.1	238.1	231.49	235.2±2.71
Cl (mg/l)	8	11	15	19	25	25	8	15.6±6.69

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium and Cl=Chloride.

Table 6: Correlation matrix for various physicochemical parameters at S1

	pH	Temp	DO	BOD	COD	Alkalinity	TH	Ca	Mg	Cl
pH	1.000									
Temp	-0.984	1.000								
DO	0.867	-0.904	1.000							
BOD	-1.783	0.898	-0.815	1.000						
COD	-1.980	0.951	-0.815	0.873	1.000					
Alkalinity	-0.687	0.651	-0.265	0.318	0.708	1.000				
TH	-0.990	0.987	-0.882	0.918	0.977	0.665	1.000			
Ca	-0.484	0.508	-0.122	0.119	0.469	0.919	0.045	1.000		
Mg	-0.438	0.358	0.046	0.101	0.512	0.897	0.430	0.786	1.000	
Cl	-0.977	0.976	-0.832	0.878	0.968	0.728	0.993	0.569	0.511	1.000

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium and Cl=Chloride.

Table 7: Correlation matrix for various physicochemical parameters at S2

	pH	temp	DO	BOD	COD	Alkalinity	TH	Ca	Mg	Cl
pH	1.000									
Temp	-0.999	1.000								
DO	0.955	-0.951	1.000							
BOD	-0.833	0.844	-0.825	1.000						
COD	-0.946	0.941	-0.843	0.630	1.000					
Alkalinity	-0.770	0.784	-0.568	0.628	0.817	1.000				
TH	-0.696	0.710	-0.483	0.500	0.785	0.986	1.000			
Ca	-0.450	0.468	-0.265	0.295	0.538	0.857	0.915	1.000		
Mg	-0.632	0.651	-0.443	0.530	0.671	0.957	0.971	0.960	1.000	
Cl	-0.996	0.996	-0.928	0.801	0.967	0.815	0.752	0.512	0.682	1.000

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium,Ca=Calcium, Mg=Magnesium, and Cl=Chloride

Table 8: Correlation matrix for various physicochemical parameters at S3

	pH	temp	DO	BOD	COD	Alkalinity	TH	Ca	Mg	Cl
pH	1.000									
Temp	-0.951	1.000								
DO	0.931	-0.982	1.000							
BOD	-0.652	0.799	-0.878	1.000						
COD	-0.935	0.899	-0.925	0.763	1.000					
Alkalinity	-0.912	0.880	-0.793	0.426	0.722	1.000				
TH	-0.817	0.862	-0.933	0.932	0.937	0.550	1.000			
Ca	-0.902	0.977	-0.990	0.896	0.923	0.761	0.939	1.000		
Mg	-0.761	0.885	-0.943	0.987	0.832	0.565	0.952	0.953	1.000	
Cl	-0.970	0.973	-0.981	0.805	0.974	0.820	0.926	0.974	0.884	1.000

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium and Cl=Chloride.

Table 9: Correlation matrix for various physicochemical parameters at S4

	pH	Temp	DO	BOD	COD	Alkalinity	TH	Ca	Mg	Cl
pH	1.000									
Temp	-0.976	1.000								
DO	0.983	-0.972	1.000							
BOD	-0.956	0.973	-0.973	1.000						
COD	-0.826	0.927	-0.828	0.877	1.000					
Alkalinity	-0.696	0.773	-0.608	0.662	0.867	1.000				
T H	-0.509	0.563	-0.377	0.413	0.662	0.945	1.000			
Ca	-0.719	0.764	-0.616	0.627	0.811	0.980	0.960	1.000		
Mg	-0.430	0.497	-0.305	0.323	0.629	0.913	0.985	0.936	1.000	
Cl	-0.924	0.979	-0.920	0.968	0.962	0.818	0.598	0.772	0.524	1.000

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium and Cl=Chloride.

Table 10: Correlation matrix for various physicochemical parameters at S5

	pH	Temp	DO	BOD	COD	Alkalinity	TH	Ca	Mg	Cl
pH	1.000									
Temp	-0.993	1.000								
DO	0.979	-0.991	1.000							
BOD	-0.734	0.768	-0.827	1.000						
COD	-0.931	0.942	-0.908	0.746	1.000					
Alkalinity	-0.735	0.756	-0.674	0.293	0.818	1.000				
TH	-0.561	0.564	-0.454	0.028	0.670	0.954	1.000			
Ca	-0.690	0.665	-0.566	0.054	0.676	0.903	0.934	1.000		
Mg	-0.646	0.606	-0.506	-0.031	0.594	0.829	0.882	0.989	1.000	
Cl	-0.961	0.963	-0.925	0.746	0.991	0.838	0.698	0.743	0.675	1.000

Whereas, Temp = Temperature, DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, COD = Chemical Oxygen Demand, TH=Total Hardness, Ca=Calcium, Mg=Magnesium and Cl=Chloride.

Conclusion

Statistical analysis to determine the physico-chemical characteristics of Laxmi Tall water. The water samples collected from different locations to determine a correlation between different parameters. In essence the physico-chemical composition of this Tall water reveals that it is of highly polluted characteristics. The quality of water is deteriorating day by day due to inflow of domestic sewage and municipal waste. Study shows that Laxmi Tall water exhibits very low DO, high BOD, COD and alkalinity. higher pH value with slightly alkaline nature of water.

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