



RESEARCH ARTICLE

Monitoring of Physico-Chemical analysis on water quality status of three lakes (Antiya Taal, Pani Ki Dharamsala, Laxmi Bai Taal) in Jhansi city, Uttar Pradesh, India.

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Abstract

In order to understand the water quality of Antiya Taal, Pani Ki Dharamsala, and Laxmi Bai Taal, Physicochemical parameters were studied and analyzed for the period of six month by bimonthly i.e. August 2014 to January 2015. Water being an excellent solvent tends to dissolve the minerals in the geological system. In this paper chemical analysis of the lakes water has been carried out in the Centre region of Jhansi city. Physicochemical parameters of the samples were measured temperature, pH, electrical conductivity, salinity, turbidity, total dissolved solids, total solid, Alkalinity, total hardness, free CO₂, chloride, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total organic carbon and heavy metals following standard methods. The results revealed that there was significant variation in some physicochemical parameters and most of the parameters were in abnormal range and indicated bad quality of lake water.

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INTRODUCTION

Jhansi is well known district of Bundelkhand region of Uttar Pradesh, India. Jhansi region lies between 24° 11' N to 25° 57' N latitudes and 78° 7' E to 79° 23' E longitudes and situated in south western part of Uttar Pradesh. The Antiya Taal, Pani Ki Dharamsala and Laxmi Bai Taal are three century old lake situated in the central part of the Jhansi city. Water is extremely essential for survival of all living organisms. Over one billion people worldwide have no access to safe drinking water Peeler *et al.*, (2006). The quality of water is vital concern for mankind since it is directly linked with human welfare. Since it is a dynamic system, containing living as well as nonliving, organic, inorganic, and soluble as well as insoluble substances. So its quality is likely to change day by day and from source to source.

Rapid industrialization and indiscriminate use of chemical fertilizers and pesticides in agriculture are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota. Due to use of contaminated water, human population suffers from water born diseases. It is therefore to check the water quality at regular interval of time. Considering the above aspects of water contamination, the present study was undertaken to investigate the possible impact of the water quality of three lakes water sample in different two locations of each lake in Jhansi city

Materials and methods:

Description of Study Area:

Antiya Taal is a water reservoir receiving municipal waste water and sewage from Jhansi city. Lakes are stagnant surface water bodies, receive and stores rain fall water. It is located between latitude 25° 12' N-12° 16' N and longitude 78° 18' E-78° 23' E in Jhansi City, Bundelkhand region, Central India. Taal is shallow with an area of 0.32 Km² and is surrounded by residential houses in all sides. Pani Ki Dharmashala is a small pond and now it is polluted

so the water is of no use. It is located between latitude $25^{\circ}27'44''\text{N}$ and longitude $78^{\circ}34'32''\text{E}$ in Jhansi city and In Jhansi city, Laxmi Bai Taal is a rain feed pond to store the rain water. It is a part of historical, cultural and recreational life of Jhansi city. It is located between longitude of $78^{\circ} 37' \text{ E}$ and $25^{\circ} 27' \text{ N}$ of latitude. It is approximately 32.52 hectare in its full spread with an average depth of 2.5 m.

Water Sampling:

During the study, sampling was carried out at two different sites of three Taal. The sampling and physicochemical analysis of water for this study has been started in the month of August 2014 and extended July 2015 with one month gap. Samples are collected in polythene bottles. Before sampling bottles are soaked in HCL and rinsed with double distilled water. Neck of the bottles is tightly sealed. After rinsing samples are collected from two different sites of all three lakes namely AS1 and AS2 for Antiya Taal, PS1 and PS2 for Pani Ki Dharamsala and LS1 and LS2 for laxmi Bai Taal.

Physicochemical Analysis:**Temperature:**

The temperatures of the samples were measured at the point of collection using mercury in glass thermometer.

pH:

pH is termed as negative logarithm of the H_2 ion concentration. The pH is determined by digital pH meter which gives direct values of pH

Electrical conductivity, Salinity and turbidity:

These are determined by multi parameter unit.

Total Alkalinity:

It was determined by titrimetric method using standard solution of 0.01M HCl and methyl orange as indicator.

Total Hardness:

It was measured using EDTA (Ethylene – Di amine Tetra – Acetic Acid) as titrant with ammonium chloride and ammonium hydroxide buffer solution and Erichrome Black T as indicator. Chloride content: It was determined by Mohr's method using silver nitrate as titrant and potassium chromate solution as indicator.

Total Dissolved Solid and total solid:

This was determined by evaporation method in an oven maintained at 200°C for 2hrs.

Dissolved Oxygen and Biochemical Oxygen Demand:

Winkler's method was followed for the analysis of DO and BOD.

Determination of COD and TOC:

The COD (Chemical Oxygen Demand) is closely related to the laboratory standard method named Dichromate-Method. With this method the chemical oxygen demand is determined during chromic acid digestion of organic loads in waste water. Based on this method the COD became a commonly used sum parameter in waste water analysis. It is used for planning of waste water treatment plants, for controlling the cleaning efficiency and for the calculation of waste water taxes.

Heavy metals:

We apply an ICP MS method (mass spectrometer with inductively coupled plasma), which has even lower detection and quantification limits and also allows several elements to be detected simultaneously.

RESULTS AND DISCUSSION

With increase in anthropogenic inquisitive as a concern 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 consistent picture of the conditions prevailing in water body. The average results of the Physico-chemical parameters for Antiya Taal, Pani Ki Dharamsala and Laxmi Bai Taal samples are presented in graphs.

Temperature:

Temperature is the most important factor for physiology of aquatic life and important in determining physicochemical properties of water. It is found negatively correlated with DO and pH (Das. 2000) and positively correlated to turbidity and BOD (Pradhan *et al.*2003). In present study, the water tm of AS_{av} , PS_{av} and LS_{av} are 35.4 , 38.5 , 34.8°C (Aug-Sept), 32.5 , 27 , 28.5°C (Oct –Nov) and 9.3 , 9 , 10°C (Dec-Jan) respectively.

Note- AS_{av} -average value of Antia Site, PS_{av} average value of Pani Ki Dharamsala site, LS_{av} - average value of laxmitaal site

pH:

Ellis (1937) has observed that the pH range of 6.7 to 8 is suitable for growth of aquatic life. Mostly, fishes and other aquatic life lived at 7 pH but less than 6 and more than 8pH the aquatic population decreased. The pH Range of present study are found slightly alkaline, the average pH of AS_{av}, PS_{av} and LS_{av} are respectively 9.15, 9.56, 7.8 (Aug-Sept), 8.9, 7.9 and 8.7(Oct- Nov) and 8.5, 9.1, 8.2 (Dec-Jan).

Conductivity:

Conductivity is the measure of how well a solution conducts electricity and correlated with salt contents. Conductivity is also used to give a rough estimate of total dissolved solid in water. In present study conductivity is recorded as 455.0, 449.0, 1022.0 uH (Aug-Sept), 444.0, 421.0, 1015.0 uH (Oct-Nov) and 426.0, 410.0, 1003.0 uH (Dec-Jan) in AS_{av}, PS_{av} and LS_{av} water samples respectively.

Salinity:

High salt contents may render water unsuitable for domestic, agricultural or industrial use or may affect its suitability for aquatic life. The average range of salt in present study area is 224.0, 221.0, 513.0 (Aug-Sept), 211.0, 219.0, 503.0 (Oct- Nov) and 205, 216, 494 (Dec-Jan) in respectively Antiya Taal, Pani Ki Dharamsala and Laxmi Bai Taal.

Turbidity:

Water transparency is an important factor that control energy relationship at different trophic levels. It is essentially a function of reflection of light from the surface and is influenced by the absorption characteristics of both water and of its dissolved and particulate matter (Stepane K.M. 1959). Turbidity is positively correlated with temperature. Turbid water is usually an aesthetic problem. It is frequently caused by runoff from disturbed area around the pond. Muddy water is very common in new pond and usually disappears as vegetation grows around the pond in established pond. In our study, the amount of turbidity recorded higher amount in Laxmi Bai Taal is 120.0 NTU (Aug-Sept), 112.0 NTU (Oct-Nov), 105.0 NTU (Dec-Jan) and lower in Pani Ki Dharamsala is 100.0 NTU, (Aug-Sept) 96.0 NTU(Oct-Nov), 88.0 NTU (Dec-Jan) and Antiya Taal is 27.0 NTU (Aug-Sept), 23.0 NTU (Oct-Nov) 19.0 NTU(Dec-Jan) respectively.

Total Dissolved Solids (TDS):

It indicates the general nature of salinity of water. It signifies the inorganic pollution load of water system (Usha *et al*; 2008). Dissolved solids are mainly due to carbonates, chlorides, sulphates, nitrates, phosphates, Ca, Mg, Na, K, Fe, Mn, etc. In present study, maximum TDS was recorded at Laxmi Bai Taal 723.0 mg/L (Aug- Sept), 760.0 mg/L (Oct- Nov) and 735.0 mg/L (Dec-Jan) and at Antiya Taal and Pani Ki Dharamsala, TDS is 320.0 mg/L, 317.0 mg/L (Aug- Sept), 380.0 mg/L 360.0 mg/L (Oct- Nov) and 365.0 mg/L, 347.0 mg/L (Dec-Jan) respectively.

Total solid (TS):

Total solids are a mixture of the suspended and dissolved solids in water. Total solids are those that can be retained on a water filter and are capable of settling out of the water column into the stream bottom when stream velocities are low. In present investigation total solid in Antiya Taal and Pani Ki dharamsala and Laxmi Bai Taal is 560.0 mg/L, 8680.0 mg/L, 1120.0 mg/L (Aug-Sept), 540.0 mg/L, 9600.0 mg/L, 1280.0 mg/L (Oct-Nov) and 505.0 mg/L, 9480.0 mg/L, 1310.0 mg/L (Dec-Jan).

Alkalinity:

Alkalinity of water is a measure of weak acid present in it and of the cations balanced against them (Sverdrup *et al.*, 1942). Total alkalinity of water is due to presence of mineral salt present in it. It is primarily caused by the carbonate and bicarbonate ions (Singh *et al.*, 2010). Alkalinity of water sample is its quantitative capacity to neutralize a strong acid to a designated pH. It is sum of all titrate bases. Average range of alkalinity of all three Taal (ASav, PSav and LSav) is 178.90 mg/L, 184.50, mg/L, 162.0 mg/L in Aug-Sept, 202.0 mg/L, 186.0 mg/L, 168.0 mg/L in Oct-Nov and 187.0 mg/L,195.0 mg/L,171.50 mg/L in Dec-Jan.

Total Hardness:

The water containing excess hardness is not desirable for potable water as it forms scales on water heater and utensils when used for cooking and consume more soap during washing of clothes (Gupta *et al*; 2009). Total hardness is the parameter of water quality used to describe the effect of dissolved minerals (mostly Ca and Mg),determining suitability of water for domestic, industrial and drinking purpose attributed to presence of bicarbonates, sulphates, chloride and nitrates of calcium and magnesium(Taylor, 1949). During investigation of Antiya Taal ,Pani Ki Dharamsala and Laxmi Bai Taal total hardness recorded as 325.50 mg/L, 301.0 mg/L, 265.0

mg/L in Aug- Sept, 295.0 mg/L, 270.0 mg/L, 355.0 mg/L, in Oct-Nov and 245.0 mg/L, 276.50mg/L, 263.0 mg/L in Dec-Jan.

Free CO₂:

Respiratory activity of aquatic organisms and the process of decomposition are important sources of CO₂ in bodies of surface water (Saxena. 1987). Anaerobic decomposition of the decaying hyacinth leaves or detritus on the bottom and within the mat the respiratory activities of the inhabiting organisms, are responsible for high level of this gas. In present investigation free CO₂ is very high in all sites of these three lakes. The average free CO₂ has been observed at ASav is 0.0 mg/L in Aug-Sept, 2.86 mg/L Oct- Nov and 5.35 mg/L in Dec-Jan, at PSav is 26.60 mg/L in Aug-Sept, 36.0 mg/L Oct- Nov and 34.50 mg/L in Dec-Jan and at LSav is 48.40 mg/L in Aug-Sept, 228.40 mg/L Oct-Nov and 157.0 mg/L in Dec-Jan. In our study result showed high CO₂ and low DOES it mean water is highly polluted.

Chloride:

High concentration of Chloride is considered to be the indicator of pollution due to organic wastes of animal or industrial origin. Chlorides are troublesome in irrigation water and also harmful to aquatic life (Rajkumar *et al.*, 2004). People adapted to higher chloride in water are subjected to laxative effects. Chloride in natural water results from agricultural activities, industries and chloride rich rocks. High concentration of chloride is due to the invasion of domestic wastes and disposals by human activities. The average value of chloride in the present study period is observed as at ASav is 63.90 mg/l in Aug- Sept, 60.35 mg/L Oct- Nov and 54.30 mg/L in Dec-Jan, at PSav is 67.45 mg/l in Aug-Sept, 81.68 mg/L in Oct-Nov and 74.0 mg/L in Dec-Jan , at LSav is 127.80 mg/l in Aug-Sept, 116.0 mg/L in Oct-Nov and 112.40 mg/L in Dec-Jan.

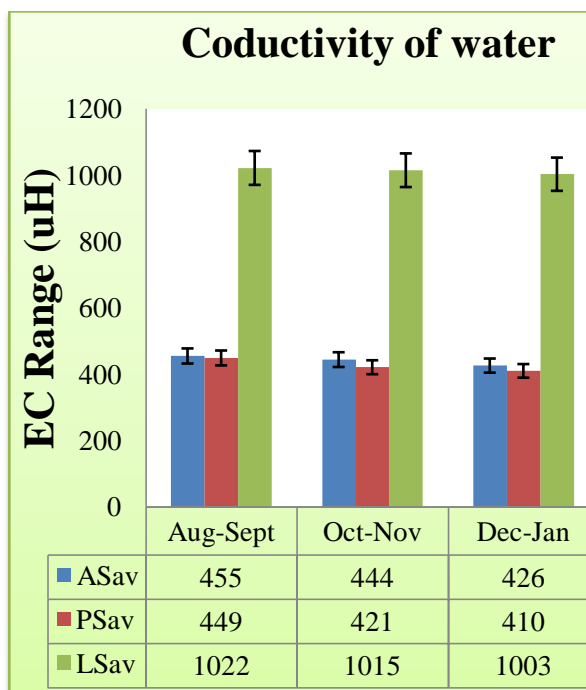
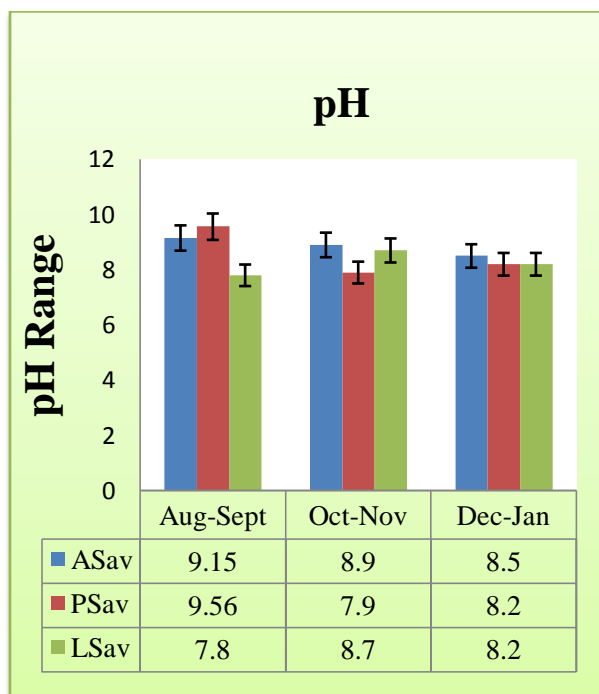
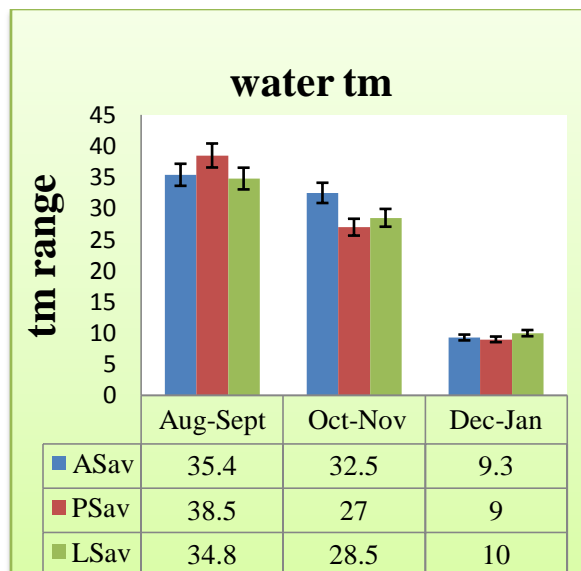
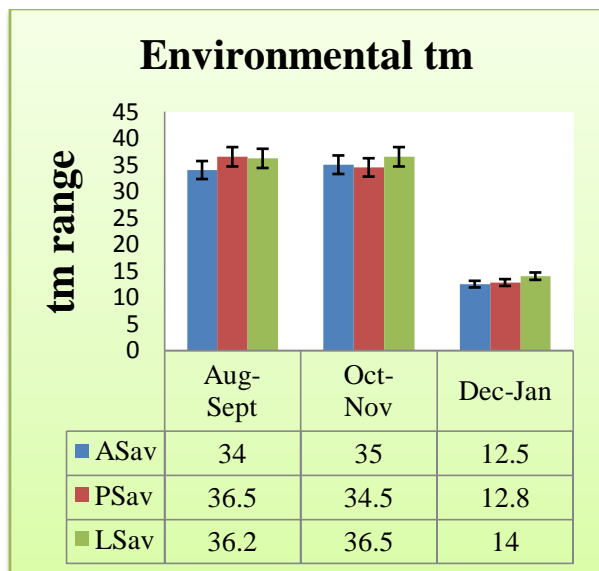
Dissolved oxygen:

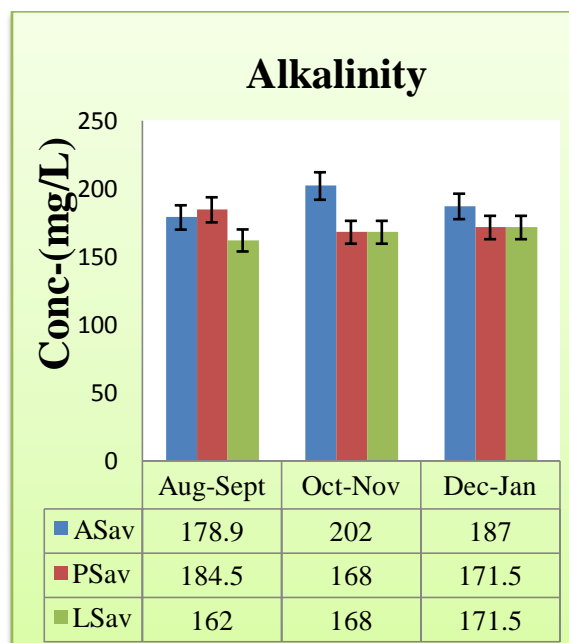
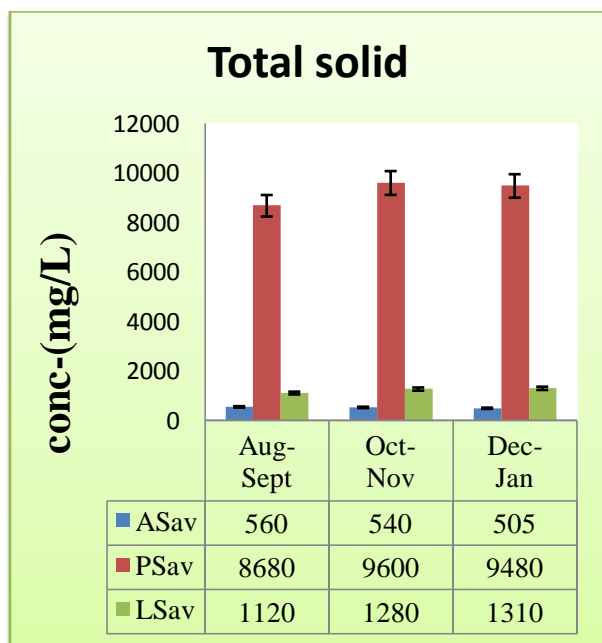
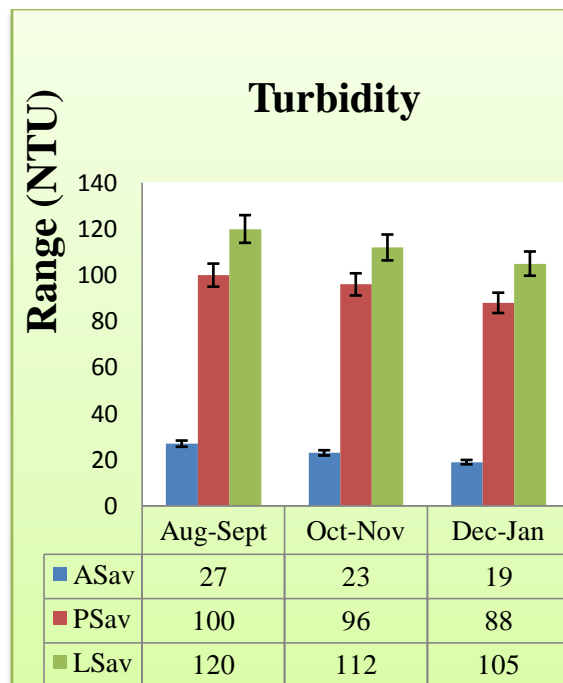
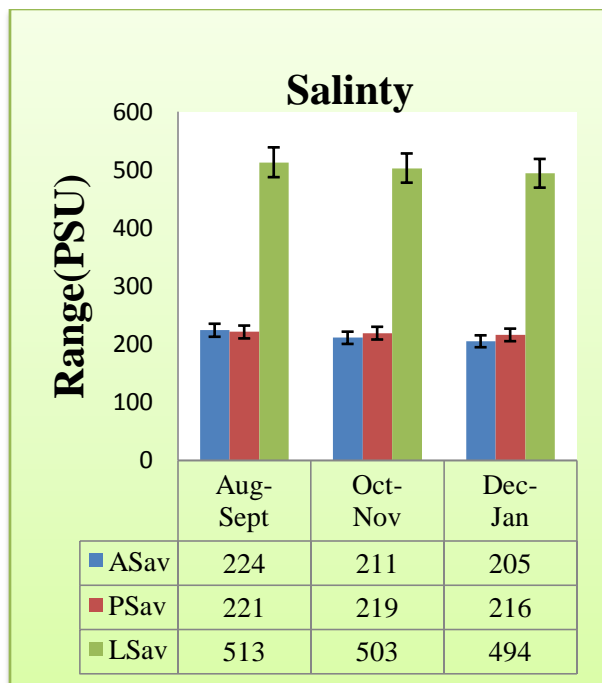
The deficiency of the oxygen in the water is shelter for bacteria and other pathogens, which are anaerobic and injurious to human health (Radhakrishnan *et al.*, 2007). The condition in case of dissolved oxygen (DO) is slightly complicated since in contrast to other pollutants, the quality of water is enhanced if it contains more oxygen. An ideal DO value of 5.0 mg/l is the standard for drinking water (Bhanja *et al.*, 2000). In natural waters, DO values are varying according to the physicochemical and biological activities. In the present investigation the average of DO have been found in Antiya Taal is 2.96 mg/l in Aug-Sept, 2.75 in Oct-Nov and 3.0 mg/L in Dec-Jan. In Pani Ki Ddharamsala it has been found in average of 4.64 mg/l in Aug-Sept, 4.25 mg/L in Oct-Nov and 4.70 mg/L in Dec-Jan whereas in Laxmi Bai Taal, it has been found 1.10 mg/l in Aug-Sept, 1.90 mg/L in Oct- Nov and 2.10 mg/L in Dec-Jan. Present DO showed that the all three Taal has polluted but in which laxmi Bai Taal is highly polluted.

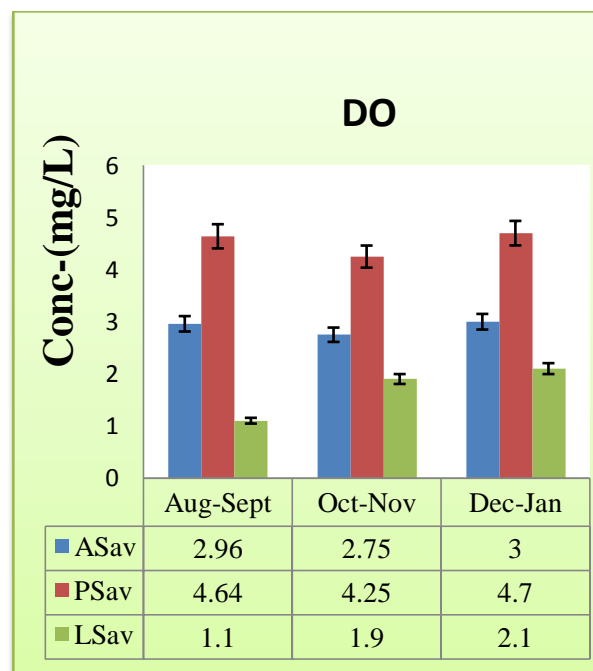
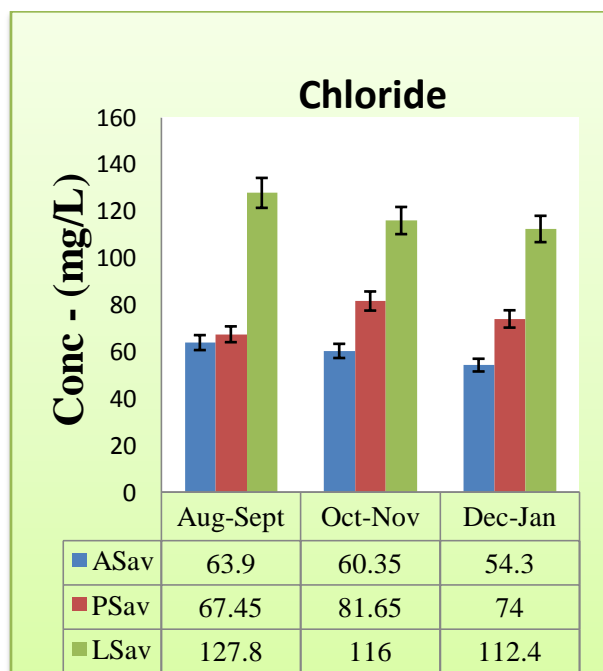
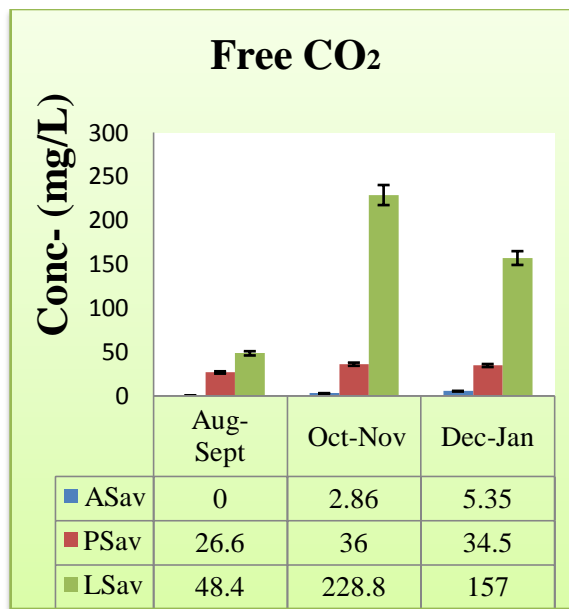
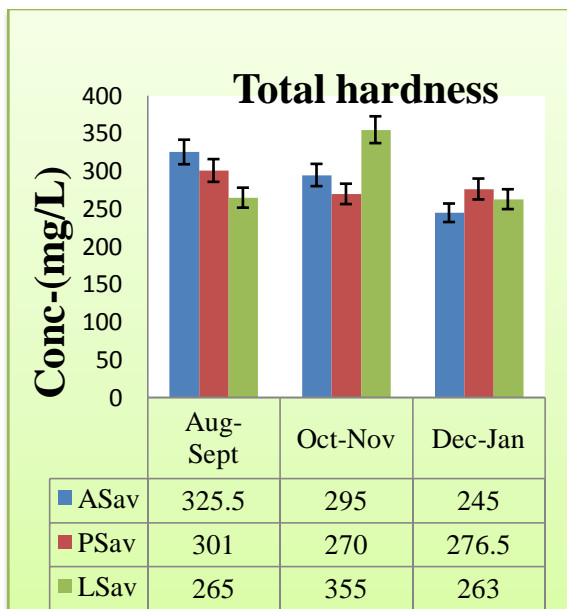
Biological Oxygen demand:

Biological Oxygen demand is the rate of removal of oxygen by microorganisms in aerobic degradation of the dissolved or even particulate organic matter in water. In drinking water BOD is absolutely not desired. Wahlquist (1972), McVea and Boyd (1975) and Balasooriya *et al.*; (1984) reported an increase in BOD due to water hyacinth infestation. According to WHO report, BOD has been a fair measure of cleanliness of any water on the basis that values less than 1-2 mg/l are considered clean, 3.0 mg/l fairly clean, 5.0 mg/l doubtful and 10.0 mg/l definitely. The average BOD has been observed at ASav is 34.0 mg/l in Aug-Sept , 38.0 mg/L in Oct-Nov and 35.50 mg/L in Dec-Jan, at PSav is 66.0 mg/l in Aug-Sept , 74.0 mg/L in Oct-Nov and 69.0 mg/L in Dec-Jan, at LSav is 52.20 mg/l in Aug-Sept, 41.0 mg/Lin Oct Nov and 38.0 mg/L in Dec-Jan. BOD of all these sites is higher than WHO which means Pani ki Dharamasala has more microbial activity because it has more BOD than Antiya Taal and Laxmi Bai Taal.

Figures:







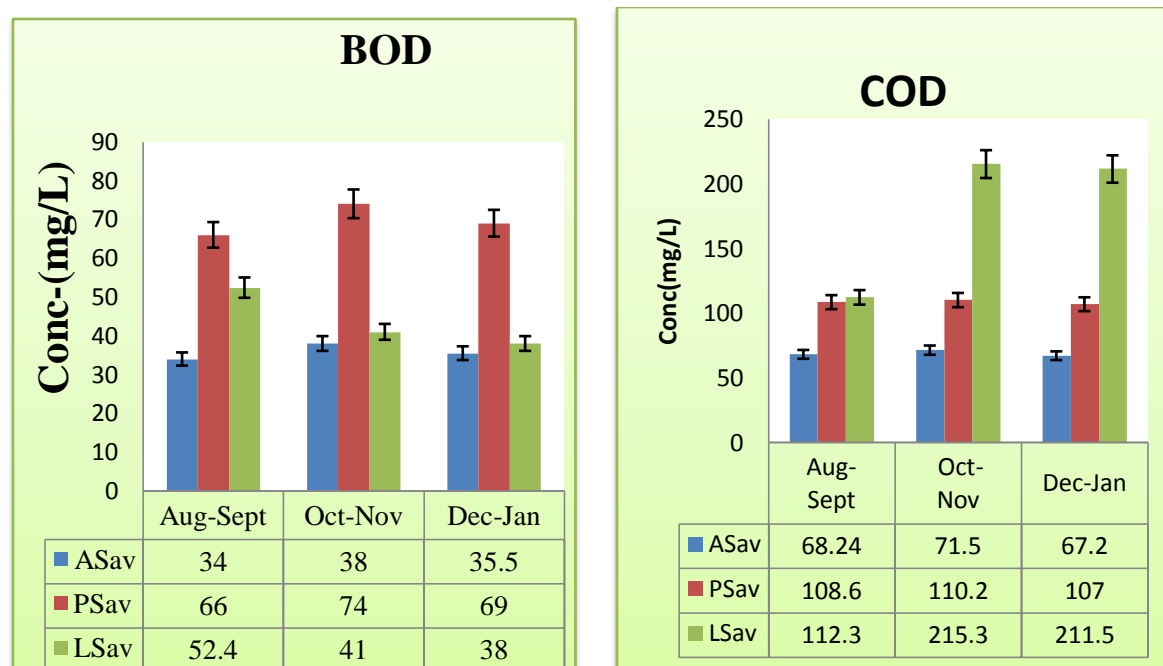


Table 1. Result of physicochemical analysis of water taken from two sites of each of three lakes (Antiya Taal, Pani Ki Dharamsala, and Laxmi Bai Taal) in Jhansi city, Uttar Pradesh, India Aug- Sept 2014.

S.No	Parameters	AS ₁	AS ₂	AS _{av}	PS ₁	PS ₂	PS _{av}	LS ₁	LS ₂	LS _{av}
1.	Environ tm(⁰ C)	33.6	34.4	34	36	37	36.5	36	36.4	36.2
2.	Water temp (⁰ C)	35	35.8	35.4	38.3	38.7	38.5	34.4	35.2	34.8
3.	PH	9.0	9.30	9.15	9.4	9.72	9.56	8.2	7.4	7.8
4.	Conductivity(μ H)	445	465	455	441	457	449	1010	1034	1022
5.	salinity	220	228	224	220	222	221	505	521	513
6.	Turbidity(NTU)	25	29	27	105	95	100	117	123	120
7.	TDS(mg/L)	312	328	320	320	314	317	728	718	723
8.	TS(mg/L)	550	570	560	8700	8660	8680	1115	1125	1120
9.	TSS(mg/L)	238	242	240	8380	8346	8363	385	407	396
10.	Acidity(mg/L)	23.2	24.8	24	38	38	38	55.3	56.7	56
11.	Alkalinity(mg/L)	177.8	180	178.9	191.8	177.2	184.5	159	165	162
12.	hardness(mg/L)	325	326	325.5	320	281	301	239	291	265
13.	Ca ⁺⁺	87	89	88	65	73	69	53.3	56.7	55
14.	Mg ⁺⁺	217	220	218.5	182	192	187	200	203	201.5
15.	Free CO ₂ (mg/L)	0	0	0	27	26.2	26.6	47.5	48.9	48.4
16.	Chloride(mg/L)	63.6	64.2	63.9	67.4	67.5	67.45	127.6	128	127.8
17.	DO(mg/L)	2.94	2.98	2.96	4.60	4.68	4.64	0	2.2	1.1
18.	BOD(mg/L)	32	36	34	67	65	66	52	52.8	52.4
19.	COD(mg/L)	68.20	68.2	68.24	107.8	109.4	108.6	212	212.6	212.3
20.	TOC(mg/L)	30.54	33.2	31.87	45.0	48.36	46.68	87.20	90.38	88.79

S.No	Heavy metals	AS ₁	AS ₂	AS _{av}	PS ₁	PS ₂	PS _{av}	LS ₁	LS ₂	LS _{av}
1.	Zn(mg/L)	0	0	0	0	0.60	0.60	1.18	1.22	1.20
2.	Pb(mg/L)	0	0	0	0	0	0	0.83	0.77	0.80
3.	Fe(mg/L)	0.31	0.33	0.32	0.66	0.70	0.68	2.69	2.65	2.67

Table 2. Result of physicochemical analysis of water taken from two sites of each of three lakes (AntiyaTaal, Pani Ki Dharamsala, and Laxmi Bai Taal) in Jhansi city, Uttar Pradesh, India Oct- Nov 2014.

S.No	Parameters	AS ₁	AS ₂	AS _{av}	PS ₁	PS ₂	PS _{av}	LS ₁	LS ₂	LS _{av}
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1.	Environ tm ($^{\circ}$ C)	35.6	34.4	35	33.8	35.2	34.5	36	37	36.5
2.	Water tm ($^{\circ}$ C)	32.5	32.5	32.5	26.5	27.5	27	28.3	28.7	28.5
3.	PH	8.6	9.12	8.9	7.8	8.0	7.9	8.5	8.9	8.7
4.	Conductivity(μ H)	448	440	444	416	426	421	1009	1021	1015
5.	salinity	209	214	211	219	219	219	501	505	503
6.	Turbidity(NTU)	23.5	22.5	23	98	94	96	109	115	112
7.	TDS(mg/L)	395	365	380	355	365	360	752	768	760
8.	TS(mg/L)	548	532	540	9565	9635	9600	1257	1303	1280
9.	TSS(mg/L)	153	167	160	9210	9270	9240	505	535	520
10.	Acidity(mg/L)	20.5	25.5	23	40	42	41	47.9	52.1	50
11.	Alkalinity(mg/L)	209	195	202	178	194	186	165	171	168
12.	hardness(mg/L)	290	300	295	264	286	270	363	347	355
13.	Ca++	65	54	59.5	51.5	58.5	55	69	72	70.5
14.	Mg++	237.5	250.5	244	216	231	223.5	234	252	243
15.	Free CO ₂ (mg/L)	2.72	3.0	2.86	35.9	36.1	36	226	230.8	228.4
16.	Chloride(mg/L)	61.7	59	60.35	78	85.3	81.65	112	120	116
17.	DO(mg/L)	2.7	2.8	2.75	4.0	4.5	4.25	1.9	1.9	1.90
18.	BOD(mg/L)	35	41	38	74	74	74	40.5	41.5	41
19.	COD(mg/L)	71.4	71.6	71.5	110.0	110.4	110.2	215.6	215.6	215.3
20.	TOC(mg/L)	33.75	34.75	34.25	46.0	47.60	46.80	89.0	90.0	89.50

S.No	Heavy metals	AS ₁	AS ₂	AS _{av}	PS ₁	PS ₂	PS _{av}	LS ₁	LS ₂	LS _{av}
1.	Zn(mg/L)	0	0	0	0.43	0.47	0.45	1.25	1.31	1.28
2.	Pb(mg/L)	0	0	0	0	0	0	0.80	0.86	0.83
3.	Fe(mg/L)	0.34	0.38	0.36	0.70	0.72	0.71	2.55	2.65	2.60

Table 3. Result of physicochemical analysis of water taken from two sites of each of three lakes (Antiya Taal, Pani Ki Dharamsala, and Laxmi Bai Taal) in Jhansi city, Uttar Pradesh, India Dec14- Jan 2015.

S.No	Parameters	AS ₁	AS ₂	AS _{av}	PS ₁	PS ₂	PS _{av}	LS ₁	LS ₂	LS _{av}
1.	Environ tm ($^{\circ}$ C)	12	13	12.5	12	13.6	12.8	13.8	14.2	14
2.	Water tm ($^{\circ}$ C)	9.0	9.6	9.3	9.2	8.8	9	9.5	10.5	10
3.	PH	8.3	8.7	8.5	9.0	9.2	9.1	8	8.4	8.2
4.	Conductivity(μ H)	417	435	426	415	405	410	1015	991	1003
5.	salinity	201	209	205	224	236	216	500	488	494
6.	Turbidity(NTU)	20	18	19	88	88	88	102	108	105
7.	TDS(mg/L)	359	371	365	345	349	347	726	744	735
8.	TS(mg/L)	495	515	505	9430	9530	9480	1309	1311	1310
9.	TSS(mg/L)	136	144	140	9085	9181	9133	583	567	575
10.	Acidity(mg/L)	21.5	20.5	21	42.4	45.5	44	52	46	49
11.	Alkalinity(mg/L)	186.5	187.5	187	193	197	195	171	172	171.5
12.	hardness(mg/L)	241	249	245	275	278	276.5	262	264	263
13.	Ca++	46	46	46	52	55	53.5	56.5	57.5	57
14.	Mg++	190	196	193	188	190	189	201	196	198.5
15.	Free CO ₂ (mg/L)	5.2	5.5	5.35	33.3	35.7	34.5	153	160	157
16.	Chloride(mg/L)	54	54.6	54.3	71.4	76.6	74	114	110.8	112.4
17.	DO(mg/L)	3.1	2.9	3.0	4.9	4.5	4.70	2.1	2.1	2.1
18.	BOD(mg/L)	35	36	35.5	70.4	67.6	69	36.3	39.7	38
19.	COD(mg/L)	67.4	67.0	67.2	107	107	107	212	211	211.5
20.	TOC(mg/L)	36.0	37.4	36.7	48.0	48.70	48.35	92.0	92.54	92.27

S.No	Heavy metals	AS ₁	AS ₂	AS _{av}	PS ₁	PS ₂	PS _{av}	LS ₁	LS ₂	LS _{av}
1.	Zn(mg/L)	0	0	0	0.53	0.57	0.55	1.25	1.21	1.23
2.	Pb(mg/L)	0	0	0	0	0	0	0.79	0.81	0.80
3.	Fe(mg/L)	0.34	0.34	0.34	0.76	0.78	0.77	2.78	2.82	2.80

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