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WATER QUALITY OF TWO CENTURY OLD FRESHWATER POND OF ORAI, JALAUN DISTRICT BUNDELKHAND REGION, U.P., INDIA

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Abstract
Orai is a city and a municipal board in Jalaun district in the Indian state of Uttar Pradesh. Historical Place in Orai is Mahil Talab (lake) which was constructed by Raja Mahil. Mahil Talab is located in center of the city. The physico chemical characteristic and metal concentrations were studied. Water samples were collected quarterly from ten different sites from Mahil pond during the month of November 2006 to April 2008. In cationic abundance sodium is followed by magnesium, potassium and calcium (Na> Mg > K > Ca) in pond water throughout the year. The tolerance limit for TDS, SAR and % Na of water use for irrigation has been found to be fair for TDS with some exception, unsuitable for SAR and unsuitable for % Na. Nitrate, Sulphate and Phosphate were found to below the permissible limit of WHO. The presence of heavy metals followed by Mn>Pb>Fe>C>Zn>Cu>Al>Cd in the pond water throughout the year. Co, Ni and Hg were not detected in any season.

Key Words: Cationic abundance, fragile environment, heavy metals, Mahil talab.

Introduction
India's environment is becoming fragile and environmental pollution is one of the undesirable side effects of industrialization, urbanization, population growth and unconscious attitude towards the environment (Singh and Chandel, 2006). Water pollution has now reached a crisis point specifically in developing world. Almost every water body is polluted to an alarming level. Thus, estimation of quality of water is extremely important for proper assessment of the associated hazards (Warhate et al, 2006). Aquatic ecosystem are not only source of water and resources, such as fish and crop for household and agro industrial uses, but are vital parts of natural environment on which economic systems are parasites and depend for their survival (Rai and Pal, 2001).

Aquatic ecosystems are getting polluted day by day due to growth of the industrial corridor, nutrient loading and rapid anthropogenic activities especially in developing countries. Due to addition of domestic waste (sewage), phosphate, nitrate etc. from wastes or their decomposition products in water bodies, they become rich in nutrients, especially phosphates and nitrate ions. Thus with the passage of these nutrients through such organic wastes, the water bodies become highly productive or eutrophic and the phenomenon as eutrophication in lake which is increasing day by day. The oxygen content of lake is also low due to oxygen depletion waste generated by anthropogenic activities.

Water chemistry had a great role in influencing phytodiversity in lake which act either as a filter or pollution source for the plankton in open waters (Ali et al, 1999). The water quality of urban Lakes/Pond has deteriorated sufficiently to cause serious disturbance to the biodiversity of Lake/Pond environments. Due to lack of proper planning and negligence of regulations, an appreciable amount of environmental degradation and ecological damage to Lake/Pond water.

Materials and Methods
Orai is a city and a municipal board in Jalaun district in the Indian state of Uttar Pradesh. It is the district headquarters for Jalaun District which is part of Jhansi division. Because of its proximity to Industrial city Kanpur, This city has already seen a good growth in Industrial area and going forward to become an industrial hub after Kanpur. Orai is located at 25.98° N and 79.47° E. As of 2001 India census, Orai had a population of 139,444. This place has a composite climate (very hot during summers and very cold during winters). Relative humidity remains about 40-50%. Historical Place in Orai is Mahil Talab which was constructed by Raja Mahil. Mahil Talab is located in center of the city.

Water samples were collected quarterly from ten different sites of Mahil Pond during the month of November 2006 to April 2008. Samples were collected in good quality screw-capped high density pre-sterilized polypropylene bottles of one liter capacity, labeled properly and analyzed in the laboratory. Preservation and analysis of water samples were based on standard method proposed by American Public Health Association (APHA, 2005). pH, EC, TDS, Temp. and DO were analyzed on the spot by water quality analyzer kit (Elico, PE 138). NO_3, PO_4 and SO_4 were analyzed by UV Visible Spectrophotometer (Elico, SL 159). Na and K was analyzed by Flame Photometer

(Systronic 130). The water quality was tested for its use for irrigation and interpreted in terms of Sodium Absorption Ratio (SAR) and % Na.

The water samples were taken in evaporating dishes and acidified to methyl orange with conc. HNO_3. Further 5mL conc. HNO_3 was added and evaporated to 10mL. Then it was transferred to a 125mL conical flask. 5 mL of conc. HNO_3 and 10mL $HCLO_4$ (70 %) were added. Then heated gently, till white dense fumes of $HCLO_4$ appear. The digested samples were cooled at room temperature, filtered through Whatman No. 41 and finally the volume was made upto 100mL with double distilled water. Then this solution was boiled to expel oxides of nitrogen and chlorine. The solution was used for the determination of heavy metals. The metals were analyzed by Atomic Absorption Spectrophotometer (Perkin Elmer 200). The tolerance limits for some parameters recommended by Wilcox (1965) are given below: -

The Na % describing the Sodium hazard giving by (Warhate et al, 2006)-

$$\% Na = 100 X Na^+ / (Na^+ + Ca^+ + Mg^+ + K^+)$$

Table 1. Classification of water for irrigation use based on TDS, SAR and % Na

Classification	TDS (ppm)	SAR	Na %
Excellent	< 200	< 10	<20
Good	200-500	10-18	20-40
Fair	500-1500	18-26	40-60
Unsuitable	>1500	>26	>60

The Sodium or Alkali hazard in the use of water for irrigation is determined by absolute and relative concentration of cation and is expressed in terms of Sodium Absorption Ratio (SAR) and it can be estimated by formula (Singh, 2002):

$$SAR = Na^+ / [(Ca^+ + Mg^+)/2]^{1/2}$$

Where, concentrations are expressed in milli equivalent per litre (meq/l.)

Results and Discussion

Table 2. Physico chemical properties of water in Mahil Pond during the month of November 06 - April 08

Sample No.	pH	EC	Temp.	Total Hardness	Alkalinity	TDS	DO	BOD	COD	NO_3	PO_4	SO_4	Na	K	Ca	Mg	% Na	SAR
1.	8.29 ± 0.015	2805.16 ± 32.208	20.98 ± 1.973	352.67 ± 4.482	838.50 ± 16.00	1406.17 ± 14.51	6.17 ± 0.364	3.20 ± 0.229	217.17 ± 5.226	16.57 ± 0 .242	3.55 ± 0.221	18.00 ± 0.299	521.28 ± 2.085	51.54 ± 0.734	15.85 ± 0.486	76.11 ± 0.88	78.41 ± 0.094	76.95 ± 0.639
2.	8.27 ± 0.018	2624.83 ± 18.023	21.07 ± 1.949	338.17 ± 3.068	585.17 ± 15.04	1410.83 ± 11.74	5.62 ± 0.266	2.83 ± 0.256	194.33 ± 3.552	15.00 ± 0.103	2.63 ± 0.160	20.65 ± 0.358	528.05 ± 3.954	54.31 ± 0.707	14.92 ± 0.509	73.14 ± 0.814	78.76 ± 0.146	79.61 ± 0.726
3.	8.28 ± 0.022	2730 ± 29.260	20.72 ± 1.961	344.33 ± 3.457	548.33 ± 10.08	1452.00 ± 6.80	5.90 ± 0.238	2.80 ± 0.249	188.33 ± 4.081	12.20 ± 0.422	1.80 ± 0.112	15.13 ± 0.751	532.80 ± 2.158	52.98 ± 0.950	16.23 ± 0.533	73.85 ± 0.696	78.83 ± 0.137	79.44 ± 0.318
4.	8.28 ± 0.012	2685.5 ± 16.992	20.97 ± 2.00	340.67 ± 5.065	554.50 ± 10.40	1466.67 ± 10.40	5.70 ± 0.157	3.00 ± 0.258	197.17 ± 3.801	16.17 ± 0.139	3.50 ± 0.256	22.20 ± 0.623	521.32 ± 1.766	57.38 ± 1.109	14.67 ± 0.604	73.91 ± 1.275	78.13 ± 0.118	78.40 ± 0.577
5.	8.26 ± 0.014	2609.33 ± 13.145	20.82 ± 1.928	362 ± 4.633	675.83 ± 24.84	1456.33 ± 6.49	5.80 ± 0.196	2.58 ± 0.176	215.83 ± 5.575	16.62 ± 0.193	2.80 ± 0.159	17.68 ± 0.487	529.85 ± 4.287	54.45 ± 0.90	18.71 ± 1.025	76.64 ± 1.079	77.95 ± 0.175	76.83 ± 0.960
6.	8.34 ± 0.015	2600.83 ± 12.887	20.92 ± 1.950	361.83 ± 5.00	593.33 ± 23.26	1486.33 ± 12.30	5.53 ± 0.181	2.58 ± 0.191	228.67 ± 4.738	15.62 ± 0.493	2.02 ± 0.137	20.60 ± 0.123	536.63 ± 4.705	53.45 ± 0.987	18.66 ± 0.408	76.63 ± 1.328	78.29 ± 0.094	77.79 ± 0.745
7.	8.33 ± 0.025	2609.5 ± 13.845	21.08 ± 1.992	344 ± 3.894	538.83 ± 14.28	1463.67 ± 9.424	5.42 ± 0.197	2.52 ± 0.150	209.50 ± 3.145	11.58 ± 0.495	2.58 ± 0.114	23.20 ± 0.620	538.22 ± 3.433	54.65 ± 1.795	16.11 ± 0.539	73.83 ± 0.873	78.82 ± 0.154	80.32 ± 0.811
8.	8.28 ± 0.018	2617.83 ± 12.914	20.90 ± 1.962	343.50 ± 3.150	523.50 ± 7.55	1446.33 ± 6.896	6.02 ± 0.218	2.68 ± 0.156	197.50 ± 3.176	15.02 ± 0.274	3.18 ± 0.117	17.73 ± 0.282	544.17 ± 3.595	56.87 ± 1.071	15.97 ± 0.528	73.80 ± 0.530	78.77 ± 0.159	81.29 ± 0.862
9.	8.35 ± 0.030	2565.5 ± 7.943	20.92 ± 1.962	354.50 ± 5.045	532.17 ± 8.21	1490.33 ± 5.249	5.60 ± 0.231	2.52 ± 0.199	217.33 ± 4.040	14.42 ± 0.321	2.22 ± 0.117	17.25 ± 0.555	548.65 ± 4.469	56.13 ± 0.75	17.92 ± 1.057	75.29 ± 1.237	78.60 ± 0.171	80.45 ± 0.918
10.	8.35 ± 0.037	2673.33 ± 21.413	20.88 ± 1.948	351.17 ± 1.883	600.33 ± 10.43	1479.17 ± 17.164	5.63 ± 0.219	2.58 ± 0.190	213.00 ± 8.294	15.88 ± 0.461	2.75 ± 0.144	20.40 ± 0.219	531.82 ± 6.123	55.31 ± 0.829	17.23 ± 0.795	74.90 ± 0.601	78.28 ± 0.133	78.36 ± 0.732

Values are mean ± SE (n=6); Units: - Concentration in mg/l, except pH; Temperature (ºC); EC (µS/cm); SAR (meq/l)

Table 3. Metal contamination in water of Mahil Pond during the month of November 2006 to April 2008

Sample No.	Al	Cd	Cr	Cu	Co	Fe	Pb	Mn	Ni	Zn	Hg
1.	0.014 ± 0.0007	0.0013 ± 0.00008	0.052 ± 0.004	0.0148 ± 0.001	ND	0.601 ± 0.017	1.170 ± 0.003	2.421 ± 0.014	ND	0.070 ± 0.002	ND
2.	0.015 ± 0.0008	0.0013 ± 0.00008	0.0538 ± 0.0018	0.015 ± 0.001	ND	0.578 ± 0.009	1.180 ± 0.002	2.440 ± 0.015	ND	0.074 ± 0.001	ND
3.	0.015 ± 0.001	0.0014 ± 0.0001	0.0597 ± 0.0034	0.014 ± 0.0006	ND	0.603 ± 0.013	1.176 ± 0.003	2.703 ± 0.026	ND	0.073 ± 0.001	ND
4.	0.014 ± 0.001	0.0012 ± 0.00008	0.0588 ± 0.0028	0.012 ± 0.0005	ND	0.588 ± 0.014	1.178 ± 0.0016	2.681 ± 0.018	ND	0.071 ± 0.001	ND
5.	0.014 ± 0.001	0.0014 ± 0.00008	0.06 ± 0.003	0.013 ± 0.0007	ND	0.566 ± 0.012	1.182 ± 0.002	2.643 ± 0.018	ND	0.074 ± 0.001	ND
6.	0.015 ± 0.0009	0.0013 ± 0.0001	0.0568 ± 0.004	0.013 ± 0.0005	ND	0.613 ± 0.011	1.186 ± 0.002	2.600 ± 0.031	ND	0.072 ± 0.001	ND
7.	0.014 ± 0.001	0.0015 ± 0.0001	0.065 ± 0.002	0.014 ± 0.0006	ND	0.608 ± 0.007	1.183 ± 0.002	2.533 ± 0.731	ND	0.074 ± 0.001	ND
8.	0.014 ± 0.0009	0.0014 ± 0.0001	0.059 ± 0.0028	0.011 ± 0.0003	ND	0.586 ± 0.015	1.276 ± 0.067	2.635 ± 0.760	ND	0.074 ± 0.001	ND
9.	0.014 ± 0.001	0.0015 ± 0.0001	0.056 ± 0.0019	0.013 ± 0.0006	ND	0.575 ± 0.015	1.181 ± 0.001	2.473 ± 0.713	ND	0.073 ± 0.0007	ND
10.	0.014 ± 0.001	0.0013 ± 0.0001	0.0563 ± 0.001	0.014 ± 0.0006	ND	0.610 ± 0.009	1.184 ± 0.001	2.643 ± 0.027	ND	0.075 ± 0.001	ND

Value = Mean ± SE (n=6); Unit- mg/l; ND= Not detected

The average value of physico-chemical properties and Heavy metal concentration of the Mahil pond water during the month of November 2006 to April 2008 are given in Table 2 and 3. Temperature of Mahil pond water sample ranged between 16.0-30.5ºC. The pH of water sample ranges from 8.14 - 8.56 which indicate alkaline nature of water. The ranges of Electrical Conductivity in study area are 2524 – 2970 µS/cm. Total Dissolved Solid (TDS) ranges from 1336 – 1586 mg/l. DO 4.0 – 7.2 mg/l; BOD 1.4 – 4.2mg/l; COD 176 – 256 mg/l. Nitrate is an important Plant nutrient and causes eutrophication in receiving water bodies. NO_3 values are below WHO guideline (1993) of 50mg/l (10.10–18.4 mg/l). SO_4 values are also below WHO guideline of 500 mg/l (10.5–26.0 mg/l). PO_4 ranges from 1.30–4.8 mg/l. The major cations include Ca, Mg, Na and K. The cationic chemistry is dominated by sodium and magnesium. In cationic abundance sodium is followed by magnesium, potassium and calcium (Na> Mg > K > Ca) in both lakes throughout the year (Table 2 and 3).

The tolerance limit for TDS, SAR and % Na of water use for irrigation recommended by Wilcox (1965) the data has been found to be fair for TDS with some exception, unsuitable for SAR and unsuitable for % Na (Table 1,2 and 3).

The effluents are usually treated by physicochemical treatment followed by biological treatment process. However, such treatment systems are not effective for removal of color, dissolved solids, trace metals etc. and the effluents are directly discharged into drains, public sewers, rivers etc. These effluents containing trace metals, when discharged on agricultural land for irrigation, increase the metal content of the soils and availability of metals to plants. Some of the metals are concern because of their toxicity to plant (Cu and Zn) while others (As, Cd, Pb etc.) are hazardous to human health (Singh and Chandel, 2006).

In the present study following metals were analyzed such as Al, Cd, Cr, Cu, Co, Fe, Pb, Mn, Ni, Zn and Hg. In these metals Al, Cd, Cu and Zn found to be under the permissible limit according to WHO (1993) in the pond water. Co, Ni and Hg were not detected in Mahil Pond in any seasons. However the concentrations of Cr, Fe Pb, Ni and Mn are far above the permissible limit of WHO throughout the year. In the month of May to July 2007 the concentration of all heavy metals were increased due to shortage of water in the lakes and in rainy season the concentration of heavy metal are decreased due to dilution of water.

Conclusion

Various biological and abiological factors affect the potentiality of algae growing under polluted water environment. The natural water body of the present

lake is continuously getting contaminated by the discharge of sewage, industrial and other wastes. The water quality and pollution of surface water disrupts algal communities which can affect the entire aquatic food web that will result is a serious threat to life (Rai and Pal, 2001).

Our study is first of its kind in this historical aquatic body. Present investigation will helpful to the planner, researchers of the pollution control board for further study or adapting control strategies for the mitigation of environmental contaminants.

It is concluded that water samples from the lake during the November 2006 to April 2008 have been found to be good and fair for TDS with some exception, unsuitable for SAR and unsuitable for % Na that means it is not suitable for even agricultural purposes. The cationic chemistry is dominated by sodium and magnesium. Overall metal concentration are Mn>Pb>Fe>Cr>Zn> Cu> Al>Cd in the pond water. Co, Ni and Hg are totally absent in all seasons in the pond.

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