

Studies of Physico-chemical Status of the Ponds at Varanasi Holy City under Anthropogenic Influences

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Abstract

Scarcity of water, pollution load, political issues and rising population has drawn a great attention for proper management of water resources such as surface water in 21st century. India is one of the developing country having prosperous fresh water resources in the form of rivers, kunds, ponds and lakes etc. Varanasi is a religious city and is popularly known for its mythological ponds & kunds. The developments, urbanization and load of the various pollutant sources lead to deterioration of the ponds. In 1980 decades there were about 110 Ponds and kunds in Varanasi but now it is not more than 56. In the present paper physico-chemical quality parameters of eight major sacred ponds existing from ancient time at the Varanasi city studied in the year 2012-13. The important water quality parameters studied were temperature, pH, conductivity, total dissolved solid (TDS), oxidation reduction potential (ORP), acidity, chloride, total alkalinity, hardness, nitrate, phosphate, dissolve oxygen (DO), biochemical oxygen demand (BOD). The experimental results suggest that nitrate (52 mg/L), BOD (2.5mg/L), TDS (2420 mg/L) and phosphate (7.5 mg/L) were very high as compared to the permissible limit of drinking and irrigation water quality standard (BIS, IS-10500, FAO). Among all eight ponds the Durgakund, Lahartara and Adityanagar ponds site have objectionable water quality especially with respect to human health, biotic life and entire ecosystem. The catchment area study to find out the major contributor of the deterioration in water quality of these ponds reveal various ritual activities, municipal waste water, washing discharge of temple effluents and animals waste.

Keywords: Ponds; BOD; TDS; nitrate; physico-chemical characteristics.

1. Introduction

Water resources are declining day by day at the faster rate due to rapid urbanization and population load. Deterioration of the water quality is now a global problem (Mahananda et al, 2010). From ancient times the rain water is being stored in small water body like ponds and kunds in most of the area in India. This water body work as water reservoir for various purposes throughout the year (Arya et al, 2011). Varanasi is the holy city of India. Pilgrims come for ritual activities throughout the year in this heritage city of Uttar Pradesh, India. The important ponds and kunds (sacred water body near the temple) are very often used for religious activities. There are several well known ponds such as Durgakund, Laxmikund, and Suryakund in Varanasi. Recently, Pal et al has reported that the several ponds in Varanasi are in highly polluted situation due to various anthropogenic activities (Pal et al, 2012). Anthropogenic activity on pond ultimately, deteriorate the water quality, accumulation of toxic chemical and sediment, shrinkage of catchment area leads to loss of aesthetic value (Chaurasia and Pandey 2007). The pond water is mainly affected due to pilgrims and ritual activities by the people living in the nearby areas (Gupta et al, 2011a).

In India, man-made ponds have been used as an alternate source of drinking water and employed for washing of clothes and bathing purposes by washer men and local people (Prakash et al, 2009). In Varanasi ponds are typically situated near vicinity of temples. Therefore two major sources of pollutants are bathing especially the people coming to temple for worship purpose and disposal of wastes originating from the temples (Chaturvedi and Kumar, 2011). Rapid growth of urban areas directly or indirectly affected existence of the ponds such as over exploitation of resources and improper waste disposal practice (Murhekar 2011).

The physico-chemical parameters have important significance in determining the trophic status of aquatic habitats (Sharma et al, 2009). The accumulation of various kinds of pollutants and nutrients through the domestic sewage, municipal effluents, and agricultural runoff in to the ponds leads changes in the physic-chemical characteristics of fresh water. Current study was under taken to investigate water quality of Varanasi pond because of its importance in ground water recharging, irrigation and drinking purpose. Study of physico-chemical characteristic of any water body largely depends on its existing meteorological conditions and structural status of its catchment area (Arya et al, 2011a).

2. Sample Collection and Sampling Sites

Water samples were collected from the eight ponds shown in figure of different area of Varanasi holy city for the analysis of physico-chemical parameters. Locations of sites have snapped from Google Earth (fig.1). Samples were collected in plastic containers (Can) previously cleaned by distilled water. During sampling, containers were dipped

and then filled it at a depth of 30 centimeter below the surface of the pond from each of the eight sampling sites. The samples were labeled and transported to the laboratory, stored at 4⁰C in the refrigerator for analysis of selected parameters. The city of Varanasi is located in the middle Ganges valley of North India. The city is bounded by 25° 19' 60 N Latitude and 83° 0' 0 E Longitude. The standard methods of APHA (1995) were followed for the analysis of physico-chemical parameters.

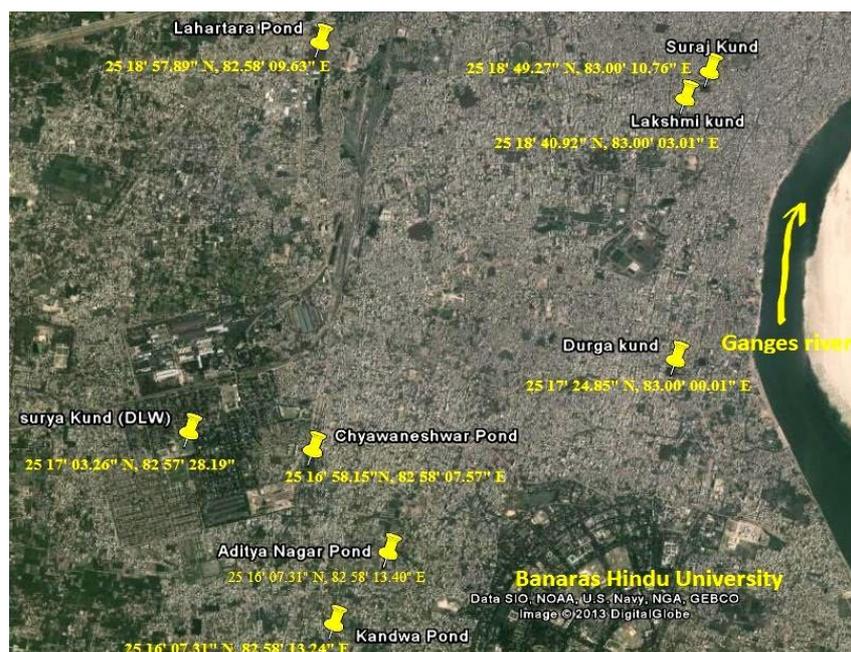


Fig. 1: Location of sampling sites with their coordinates (longitude and latitude).

3. Material and Methods

The samples were analyzed for sixteen selective major parameters shown in table 1. Each of the Ponds water samples were analyzed for pH, Oxidation reduction potential by pH meter and Electrical conductivity was analyzed by using conductivity meter. Hardness, Acidity, Chloride and Total Alkalinity were estimated by titrimetric methods. Sodium, Potassium and Calcium were estimated by flame photometer. The Nitrate and Phosphate were analyzed by the U.V., Visible Spectrophotometer. Total dissolved solid and Total suspended solid were estimated by calculation method. Dissolved Oxygen and Biochemical Oxygen Demand were estimated by Winkler's Method. The experimental results were compared to the permissible limit of drinking and irrigation water quality standard (BIS, IS-10500, FAO).

4. Results and Discussion

In the present investigation Nitrate, Phosphate, Biochemical Oxygen Demand and Total dissolved solid were very high in Durgakund, Lahartara and Adityanagar sample

site as compared to the permissible limit of drinking and irrigation water quality standard (BIS, IS-10500, FAO). Thus the data of study indicate that the ponds are highly polluted and unsafe for human use.

Table 1: Results of physico-chemical parameters of various ponds at Varanasi as studied in the present investigation.

Sampling sites Parameters	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈	Irrigation Standard s- BIS, FAO	Drinking Standard s- IS: 10500
pH	8.10	7.90	8.39	8.62	7.54	7.66	8.70	6.41	6.5 – 8.5	6.5 to 8.5
Conductivity (mS/m)	0.43	0.13	0.55	0.81	0.31	0.56	0.58	0.14	2.25	
TDS (mg/L)	1720	2330	1590	1650	1290	2340	2420	2080	2100	2000
TSS (mg/L)	1360	1640	870	650	910	1020	1122	1420		
Oxidation reduction potential (mV)	-77	-43	-83	-97	-86	-43	-98	-10		
Acidity(mg/L)	NIL	8		No relaxation						
Chloride (mg/L)	53.25	67.45	117.20	131.35	60.40	40.28	71.00	78.10	500	600
Total Alkalinity (mg/L)	210	294	292	352	256	260	400	240	140	600
Hardness (mg/L)	146	202	206	268	154	172	356	264		600
Nitrate (mg/l)	39	52	48	35.50	12.5	44.25	50.50	47.50	5.30	45
Phosphate (mg/L)	7	7	7	2	3	2	6	6	0-2	5
Dissolved Oxygen (mg/L)	4.4	4.6	3.9	4.2	5.2	5.6	3.2	3.8		
Biochemical Oxygen Demand (mg/L)	1.6	1.8	2.2	1.4	1.0	1.3	2.5	2.2	100	
Na (mg/L)	69.4	75	93.5	93.4	72.8	40.8	72.9	59.3		100

Ca (mg/L)	54.3	61.6	90.9	29.1	60.8	38.1	45.2	67.2		200
K (mg/L)	15.3	18.9	11.8	24	21	6.9	14.4	18.4		12

Sampling sites-S₁- Suryakund (DLW), **S₂**- Durgakund, **S₃**- Laxmikund, **S₄**- Surajkund, **S₅**- Kandwa pond, **S₆**- Chyawaneshwar, **S₇**- Lahartara Pond, and **S₈**- Aditya Nagar. Bureau of Indian Standards (BIS), Food and Agriculture Organization (FAO), Indian Standard (IS).

The pH values were found in the range 6.41 to 8.70 and thus slightly alkaline trend reveals in every ponds site except Aditya Nagar. The pH affects most of the biological processes and biochemical reactions in water body (Arya et al, 2011a, b). Conductivity values were ranging from minimum 0.13 (mS/m) to maximum 0.81 (mS/m), which was found below the permissible limit (2.25 (mS/m) of irrigation standard. It may be due to presence of low amount of minerals. The Conductivity of water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions or sodium, magnesium, calcium, iron, and aluminum cations. Oxidation reductions potential were ranging between -98 mV to -10 mV. Oxidation reductions potential values were varied as pH fluctuates. As the pH goes up, the mill volt reading on ORP meter were going to down. Acidity was present in only one pond of Aditya Nagar site (**S₈**), which was very low (8 mg/L) and in other ponds acidity was absent. It might be due to high temperature that reduces the solubility of CO₂. The chloride values were ranging between 40.28 to 131.35 mg/L in all pond water samples, which was found within the permissible limit for drinking water (600 mg/L) and irrigation (500 mg/L) prescribed by IS: 10500 and BIS, FAO. Hardness values were fluctuating between maximum 356 mg/L to minimum 146 mg/L, which was found within permissible limit of irrigation and drinking standard. The entire ponds sample showed higher alkalinity values than the permissible limit (140 mg/L) of irrigation standard, FAO and lower values than the permissible limit (600 mg/L) of drinking standard, BIS.

The values of DO, BOD and TDS varied from 3.2 mg/L to 5.6 mg/L, 1 mg/L to 2.5 mg/L and 1290 mg/L to 2340 mg/L respectively. The maximum value of DO was found to be 5.6 mg/L in Chyawaneshwar pond water (**S₆**) and the minimum value of DO was found to be 3.2 mg/L in Lahartara pond (**S₇**). The lower DO value of Lahartara pond was might be due to the high rate of oxygen consumption by oxidisable matter. Dissolved oxygen is an important parameter in water quality assessment and reflects the physical and biological processes of aquatic life. Biochemical Oxygen Demand depends on temperature, extent of biochemical activities and concentration of organic matter and microbial population such as bacteria and fungi (Prasanna and Ranjan, 2010). During the study period, Maximum BOD value (2.5 mg/L) was found in Lahartara pond and minimum (1mg/L) in Kandwa pond (**S₅**). The dissolved oxygen plays a major role in survival of aquatic life (Gupta et al, 2011a, b). Anthropogenically, TDS is increased mostly by sewage waste, soap and detergent. It represents all the charged ions, cations and anions, as well as the uncharged and molecular species.

Phosphate and Nitrate values varied from 2 mg/L to 7 mg/L and 12.5 mg/L to 50.50 mg/L respectively. This might be due to discharge of domestic sewage, or

leaching of fertilizers used in nearby agricultural field. Phosphate concentration was found above the permissible limit (2 mg/L, FAO) of irrigation standard in all ponds site except Surajkund and Chyawaneshwar site. The phosphorus nutrient is needed for the algal growth, which is a key element in metabolic reactions of aquatic organisms and responsible for eutrophication of ponds. Nitrate concentration above the permissible limit (45 mg/L) in drinking water affect the oxygen carrying capacity in the infant's blood known as methemoglobinemia (blue baby syndrome).

Higher value of sodium in Laxmikund (93.5 mg/L) may be due to high rate of mineralization in the sediments. Calcium concentration were ranging between maximum 90.9 mg/L to minimum 29.1 mg/L and found below permissible limit of drinking standard. Potassium content in the water samples were ranging from 24.0 mg/L to 6.9 mg/L. Maximum value (24 mg/L) was found in Surajkund and minimum (6.8mg/L) in Chyawaneshwar pond.

The water samples from Durgakund, Lahartara and Adityanagar sites showed very objectional water quality as compared to other sites. The deterioration in water quality in these ponds and kunds is due to use of soaps, detergents, worship materials, plastics and direct discharge of temple effluents, animals waste, and municipal waste water. From the mythological point of view, the ponds are related to religious sentiments but from the scientific point (Gupta et al, 2011a, b, c).of view, the pond water is not suitable for human consumption.

5. Conclusion

Results of physico-chemical parameters of various ponds at Varanasi as studied in the present investigation clearly shows that the water is not good for human consumption and also struggling for their existence. So there is an immediate need of restoration, improvement and proper management of these secret water bodies for the human and environment.

6. Remedies and Measures

There is a need of awareness among the local people to maintain the ponds and kunds at least their optimum quality and purity levels. The onset of monsoon helps in diluting the pollutants but awareness and proper management practices such as planting trees around ponds, regularly recharging during summer period, removal of sediments from the bottom of pond, removal of floating debris from the pond surface, diversion of sewage discharge to proper disposal site and proper enforcement of law and policy might be very successful.

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