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Impact of anthropogenic activities on water quality of prominent water bodies of Varanasi, UP, India

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Abstract

The was conducted to assess the impact of various types of anthropogenic religious activities on water quality of three ponds Ishwargangi Pond, Kurukshtera Pond and Pushkar Pond of Varanasi. The physico-chemical parameters studied were pH, Turbidity, Total Dissolved Solids (TDS), Total Hardness, Calcium, Magnesium, Total Alkalinity, Chloride, Phosphate, Sulphate, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The water quality characteristics revealed significant increase in the values of turbidity, Chloride, Phosphate, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) as compared to the permissible limit of drinking and irrigation water quality standard (BIS, IS-10500, FAO). The result of Pearson correlation analysis exhibited statistically significant positive correlations between Total dissolved solids (TDS) & pH ($r=0.8671$, $p<0.05$), TDS & Total Alkalinity ($r=0.6284$, $p<0.05$), TDS & Biochemical oxygen demand (BOD) ($r=0.6757$, $p<0.05$), Total hardness & Calcium ($r=0.9545$, $p<0.01$) and Total hardness & Magnesium ($r=0.9985$, $p<0.01$). The value of Phosphate shown statistically significant negative correlation with turbidity ($r=-0.6169$, $p<0.05$), Sulphate ($r=-0.7068$, $p<0.05$). This study revealed all three ponds have objectionable water quality especially with respect to human health, biotic life and entire ecosystem. Therefore, water of these water bodies needed to be regularly changed after mass bathing to protect the aquatic component from different contaminations. Therefore water from these water bodies need to be changed regularly to protect the aquatic life from different contaminations. The other measures includes establishment of comprehensive water quality monitoring, citizen awareness with a proper urban drain disposal system to prevent water bodies of Varanasi from pollution.

Keywords: Anthropogenic | Physico-chemical parameters | Correlation analysis | Contaminations

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Introduction

Water is the most delicate part of the environment which is essential for all organisms for their survival. Freshwater bodies (ponds, kunds) are important wetlands constructed by man from ancient times to store rain water in India (Arya *et al*., 2011; Matta, Gagan, 2014a). The water bodies are often used for various types of anthropogenic religious activities like offering flower, mass bathing, immersion of idol are also one of the important causes that affect the water quality of a water body (Nagar *et al.*, 2016 ; Yadav *et al*., 2013). These ponds are located mainly near the vicinity of temples and are being used for bathing and performing various religious activities (Chaturvedi and Kumar, 2011; Matta, Gagan, 2014b). All these anthropogenic activity on pond ultimately, deteriorate the water quality, increase the accumulation of toxic chemical and sediment and also the shrinkage of pond`s catchment area. In Varanasi the pond water is mainly affected due to the flow of pilgrims for ritual activities throughout the year and disposal of wastes originating from the temples (Gupta et al, 2011).

The physico-chemical parameters play an important significance in determining the status of aquatic life as well as the suitability of water for drinking, bathing, fishing, irrigation *etc*. (Sharma *et al*., 2009). Therefore the present study was conducted to assess the impact of various types of anthropogenic religious activities on water quality of ponds of Varanasi. This study can be used for awareness of general public and policy makers to enhance the water quality of ponds of Varanasi.

Materials and Methods

Study Area

Water samples were collected from the three ponds Iswargangi, Kurukshetra and Pushkar located at the different sites of Varanasi city during January to March 2016 (fig.1). The list of sampling sites and their geo-coordinates are shown in table-1

Site No.	Name of Water Bodies	Location	Latitude	Longitude
1	Ishwargangi Pond	Ausanganj, Nati Imli	25°32'56"N	83°0'86"E
2	Kurukshtera Pond	Assi, Durgakund	25°29'01"N	83°0'19"E
3	Pushkar Pond	Ravindrapuri	25°28'57"N	83°0'39"E

Table 1: The list of selected water bodies, their location and geo-coordinates

Sample Collection

Water samples were collected regularly at an interval of fifteen days from selected water bodies in triplicate, in 1 litre clean plastic bottles previously cleaned by distilled water and transported to laboratory for physico-chemical analysis.

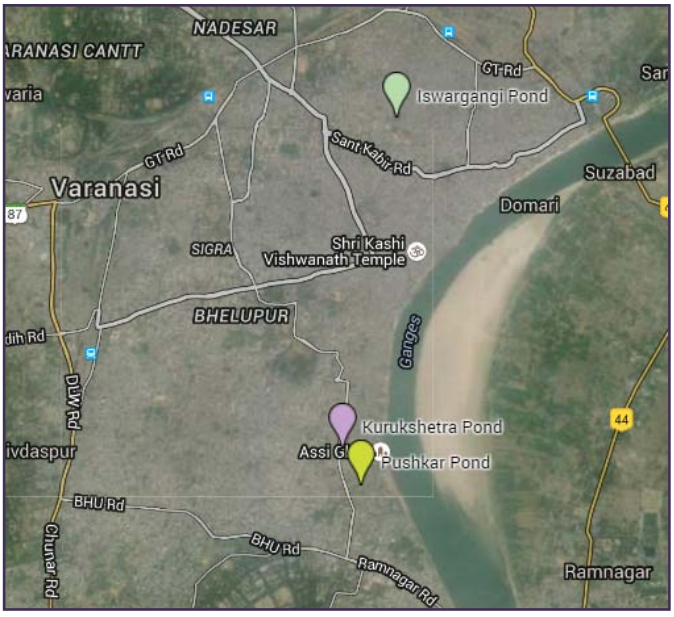

Figure-1: Locations of sampling sites snapped from Google Maps.

Physico-chemical Analysis

The samples collected from water bodies were analyzed for a number of physico-chemical parameters using the standard procedures (APHA, 2005). The parameters include, pH, Turbidity, Total Dissolved Solids (TDS), Total Hardness, Calcium, Magnesium, Total Alkalinity, Chloride, Phosphate, Sulphate, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

Statistical Analysis

The results obtained were compared to the permissible limit of drinking water quality standard (BIS, IS-10500). The Pearson correlation analysis was performed to determine the significant relationship between parameters / variables using SPSS.

Results and Discussion

Physico-chemical characteristics

The result observed in present study shows very high value of Turbidity, Total dissolved solid, Magnesium, Chloride, Phosphate, Biochemical Oxygen Demand and Dissolved oxygen in all three water bodies as compared to the permissible limit for irrigation water (FAO) and drinking water standard (BIS, IS-10500) (Table 2).

The mean pH value observed in the range between 6.75 to 7.50, indicates slight alkaline nature of water except Iswargangi pond. pH is an important limiting chemical factor for aquatic life. Higher pH of pond water affects most of the biological processes and biochemical reactions in water body that leads to disrupt the biodiversity of aquatic organisms (Arya *et al*., 2011; Matta, Gagan, 2015). Turbidity of water samples varied from 17.50 to 56.50 (NTU) and were exceeded from the standard value for both irrigation (FAO) and drinking water (BIS, IS-10500). The highest mean concentration was recorded as 56.50 (NTU) in Iswargangi pond and lowest as 17.50 (NTU) in Pushkar pond. Higher levels of turbidity may blocks out the light needed by submerged aquatic vegetation. It also can raise surface water temperatures above normal because suspended particles near the surface facilitate the absorption of heat from sunlight (Akasaka, 2010; Matta *et al.*, 2015a).

Water Quality Parameter	Ishwargangi Pond	Kurukshtera Pond	Pushkar Pond	Irrigation Standard BIS, FAO	Drinking Standard BIS
pH	6.75	7.50	7.50	6.5 - 8.5	6.5 - 8.5
Turbidity (in NTU)	56.50	33.00	17.50	-	5-10
TDS (in mg/l)	760.00	860.00	1035.00	2100.00	2000.00
Total Hardness (in mg/l)	315.00	193.50	217.00	-	600.00
Calcium (in mg/l)	80.50	49.26	56.07	-	200.00
Magnesium (in mg/l)	265.96	163.49	182.84	-	150.00
Total Alkalinity (in mg/l)	153.90	148.51	143.12	140	600.00
Chloride (in mg/l)	740.61	582.63	745.70	500.00	250.00
Phosphate (in mg/l)	87.00	94.00	128.50	0-2	5.00
Sulphate (in mg/l)	131.15	134.50	123.00	-	100.00
COD (in mg/l)	166.80	121.66	212.74	-	-
BOD (in mg/l)	160.00	139.00	141.00	100.00	-
DO (in mg/l)	1.54	2.21	3.07	-	-

Table 2: Physico-chemical characteristics of water samples

TDS were ranging from 760 to 1035 mg/l and all were below the permissible value for both irrigation (FAO) and drinking water (BIS). The highest concentration was observed as 1035 mg/l in Pushkar pond and lowest as 760 mg/l in Iswargangi pond. Total dissolved solids in pond water come from urban discharge of sewage waste, soap, detergents (Tripathi and Viswakarma 2015). The mean value of total hardness was observed between 193.50 to 315 mg/l in all pond water, which is below the permissible limit for drinking water (BIS, IS-10500). The high content of calcium and magnesium in addition to sulphate and nitrate in the sewage waste discharge in responsible for increasing total hardness of pond water. The hardness of water helps to protect aquatic organisms against harmful effects of pH fluctuation and metal ions (Thakor *et al*., 2011; Matta *et al.*, 2015b). The concentration of Calcium in water samples were observed between 49.26 to 80.50 mg/l and all samples were within the permissible limit of drinking water (BIS, IS-10500). Higher concentration of Calcium may cause incrustation in water supply structure and adversely affect on domestic use (Raghavendran, 1992). The values of magnesium observed between 163.49 to 265.96 mg/l and all the values were above the permissible limit for drinking water (BIS, IS-10500). Higher concentration of Magnesium in water is probably due to the high decomposition rate of organic matter, high evaporation and other anthropogenic activities. Magnesium associated with the sulphate ion has a laxative effect on persons unaccustomed to it (Parveen *et al*., 2012).

The mean total alkalinity was varied from 143.12 to 153.90 mg/l. All the values were exceeded the permissible limit for both irrigation (FAO) and drinking water (BIS, IS-10500). The higher alkalinity may be due to the large scale use of banks as open latrine and washing of excrete in nearby the ponds. Alkalinity also increases the amount of dissolved carbonate, which leads to gives undesirable taste to water (Radhakrishnan et al. 2007; Tripathi and Viswakarma 2015). The degradation of plants, other organism and organic waste might also increase in carbonates and bicarbonates thereby the alkalinity (Chaurisa and Pandey, 2007). The value of chloride was observed between 582.63 to 745.70 g/l. The all three ponds samples chloride value were exceeded the permissible limit for both irrigation water (FAO) and drinking water (BIS, IS-10500) except Kurukshetra pond (582.63 mg/l). Chloride exceeding 250 mg/l in drinking water imparts salts taste to water and causes laxative effects. The higher value of chloride is toxic to fish and aquatic organisms, even in very small amounts (Tripathi and Viswakarma 2015). Phosphate values varied from 87 to 128.50 mg/L, which is above the permissible limit for both irrigation (FAO) and drinking water (BIS, IS-10500). This might be due to discharge of domestic sewage, or leaching of fertilizers used in nearby agricultural field. The phosphorus nutrient is needed for the algal growth, which is a key element in metabolic reactions of aquatic organisms and responsible for eutrophicaton of ponds (Sachin Mishra *et al*., 2014; Matta *et al.*, 2015c). Sulphate value of all three ponds of Varanasi ranged between 123 to 134.50 mg/l, which is below the permissible limit for drinking water (BIS, IS-10500). Sulphate remains in the pond and

does not biodegrade hence higher concentration of sulphate in pond water can be toxic to fish and other organisms.

COD value varied from 121.66 to 212.74 mg/L. This may be due waste water discharge from dying units located near ponds. The BOD value was observed between 139.00 to 166 mg/l, which is above the permissible limit for irrigation water (FAO). This may be due to high temperature and algal bloom in ponds and water hyacinth that covered the whole pond so no sunlight can penetrate in the pond. It is harmful for the aquatic life present in that pond. BOD depends on temperature, extent of biochemical activities and concentration of organic matter and microbial population such as bacteria and fungi (Prasanna and Ranjan, 2010; Sachin Mishra *et al*., 2014). The DO value of all three ponds varied from 1.54 to 3.07 mg/l. The lower DO value of Iswargangi pond was might be due to the high rate of oxygen consumption by oxidisable matter, which may affect the diversity of aquatic life living in it (Gupta et al, 2011; James et al, 2013).

Correlation analysis

Among the various physiochemical parameters of surface water, only few parameters exhibited significant correlations (Table 3). In present study the value of Total dissolved solids (TDS) shown a statistically significant positive correlation with pH (r=0.8671, p<0.05), Total Alkalinity (r=0.6284, p<0.05), Biochemical oxygen demand (BOD) (r=0.6757, p<0.05). This indicates that an increased load of dissolved solids influence the pH, total alkalinity and BOD value of surface water (Dabgerwal and Tripathi, 2016; Eucharista et al, 2016). The values of Phosphate shown statistically significant negative correlation with turbidity (r=-0.6169, p<0.05), Sulphate (r=-0.7068, p<0.05) and positive correlation with chemical oxygen demand (COD) (r=0.8261, p<0.05). The positive correlation of COD and phosphate indicates that increased load of COD through urban discharge in water bodies increases Phosphate concentration, which leads to cause eutrophication. The negative correlation of Phosphate and turbidity indicates that the oxidation of Phosphates improves the clarity of water through increasing settling rate of suspended solids (James *et al*., 2013).

Level of Significance	Positively correlated Parameters	Negatively correlated Parameters
α= 0.05	TDS & pH (r=0.8671) Total Alkalinity & Turbidity (r=0.7206) Total Alkalinity & TDS (r=0.6284) BOD & TDS (r=0.6757) Sulphate & Chloride (r=0.7158) COD & Phosphate (r=0.8261)	Phosphate & Turbidity (r=-0.6169) Phosphate & Sulphate (r=-0.7068)
α= 0.01	Calcium & Total Hardness (r=0.9545) Magnesium & Total Hardness (r=0.9985) Calcium & Magnesium (r=0.9366)	-

Table 3: List of significant positive and negative correlated water quality

Total hardness was found to have significant positive correlation with Calcium (r=0.9545, p<0.01) and Magnesium (r=0.9985, p<0.01). Similarly the value of Calcium and Magnesium also shown significant positive correlation (r=0.9366, p<0.01). Significant positive correlation between turbidity and total alkalinity (r=0.7206, p<0.05) indicates that the transparency of water is influenced by the increasing concentration of carbonate,

bicarbonate and hydroxide alkalinity of water (Vishwakarma and Tripathi, 2015). Similarly significant positive correlation between Sulphate and Chloride ($r=0.7158$, $p<0.05$) indicates that the disposal of sewage and cattle house waste water in water bodies increases the chloride concentration that leads to increase Sulphate load in water (Singh et al., 2015).

Conclusion

The study revealed that the water quality of all the three water bodies of Varanasi is declining due to use of water bodies bank for cloth washing, animal bath, performing religious activities and direct discharge of flower waste, temple effluents, animals waste, and municipal waste water. The result of physico-chemical parameters clearly shows that the water is not good for human consumption. Therefore water from these water bodies need to be changed regularly to protect the aquatic life from different contaminations. The other measures includes establishment of comprehensive water quality monitoring, citizen awareness with a proper urban drain disposal system to prevent water bodies of Varanasi from pollution.

References

Akasaka, M.,; Takamura, N.; Mitsuhashi, H. and Kadono, Y. (2010): Effects of land use on aquatic macrophyte diversity and water quality of ponds. *Freshwater Biology*, *55*(4), 909-922.

APHA (2005): *Standard Methods for the Examination of Water and Wastewater*, APHA, AWWA, WPCF, Washington, DC, USA.

Arya, S.; Kumar, V.; Raikwar, M. and Dhaka, A. (2011): Physico-chemical Analysis of Selected Surface Water Samples of Laxmi Tal (Pond) in Jhansi City, UP, Bundelkhand Region, Central India. *Journal of Experimental Sciences*, *2*(8), 01-06.

Bhatnagar, A.; Devi, P. and George, M. P. (2016): Impact of mass bathing and religious activities on water quality index of prominent water bodies: A multilocation study in Haryana, India. *International Journal of Ecology*, 2016, 01-08.

Chaturvedi, V. and Kumar, A. (2011): Diversity of culturable sodium dodecyl sulfate (SDS) degrading bacteria isolated from detergent contaminated ponds situated in Varanasi city, India. *International Biodeterioration & Biodegradation*, *65* (7), 961-971.

Chaurasia, M. and Pandey, G. C. (2007): Study of physico-chemical characteristics of some water ponds of Ayodhya-Faizabad. *Indian Journal of Environmental Protection*, *27*(11), 10-19.

Dabgerwal, D. K. and Tripathi, S. K. (2016): Assessment of surface water quality using hierarchical cluster analysis. *International Journal of Environment*, *5*(1), 32-44.

Gupta, A. K.; Mishra, K.; Kumar, P.; Singh, C. and Srivastava, S. (2011): Impact of religious activities on the water characteristics of prominent ponds at Varanasi (UP), India. *Plant Archives*, *11*(1), 297-300.

Indian standard drinking water, Specification (First Revision) IS-10500:2012. BIS, New Delhi, India

James, A.; Nath, S.; Thomas, T.; Sharma, A.; and Kumar, S. (2013): Water Quality of Ponds in Allahabad City. *Asian Journal of Environmental Science*, 8(2), 90-94.

Krishnan, R. R.; Dharmaraj, K. and Kumari, B. R. (2007): A comparative study on the physicochemical and bacterial analysis of drinking, borewell and sewage water in the three different places of Sivakasi. *Journal of Environmental biology*, *28*(1), 105-108.

Matta, Gagan (2014a): "A study on physico-chemical Characteristics to assess the pollution status of river Ganga in Uttarakhand." Journal of Chemical and Pharmaceutical Sciences. 7(3): 210-217.

Matta, Gagan (2014b): "WATER QUALITY ASSESSMENT OF GANGA CANAL SYSTEM." *Journal of Advanced Scientific Research* 5.4.

Matta, Gagan (2015): Effect of water quality on phytoplankton ecology of Upper Ganga Canal, International Journal of Scientific & Engineering Research, Volume 6, Issue 2, 762-768.

Matta, Gagan; Kumar, Ajendra; Srivastava, Sachin; Singh, Vikas and Dhingra, Gulshan K. (2015a): Impact assessment on water quality of Ganga Canal System in Himalayan Region. International Journal of Scientific & Engineering Research, Volume 6, Issue 5, pp 1524 – 1531.

Matta, Gagan; Pandey, R. R. and Saini, K. K. (2015b): Assessment of pollution on water quality and phytoplankton diversity in canal system of River Ganga. *World Journal of Pharmaceutical Research*. Vol. 4(11): 889-908

Matta, Gagan; Srivastava, Sachin; Pandey, R. R. and Saini, K. K. (2015c): Assessment of physicochemical characteristics of Ganga Canal water quality in Uttarakhand. *Environ Dev Sustain*. DOI 10.1007/s10668-015-9735-x

Mishra, S.; Singh, A. L.; and Tiwary, D. (2014): Studies of Physico-chemical Status of the Ponds at Varanasi Holy City under Anthropogenic Influences. *International Journal of Environmental Research and Development*, *4*(3), 261-268.

Parveen, N. and Rohan, Y. (2012): Heavy metal contaminations in sagar lake and drinking water sources of sagar city. Int. J. Appl. Biol. pharmaceut. Technol., Vol.3, 379-389.

Prasanna, M. B. and Ranjan, P. C. (2010): Physico chemical properties of water collected from Dhamra estuary. *International journal of environmental sciences*, *1*(3), 329-334.

Raghavendran, K. (1992): Quality assurance for drinking water mission to village. *Ecology*, *6*(8), 13-25.

Sharma, K. K.; Verma, P. and Sharma, S. P. (2009): Physico-chemical assessment of three freshwater ponds of Jammu (J&K). *Current World Environment*, *4*(2), 367-373.

Singh, P.; Chaturvedi, R. K.; Mishra, A.; Kumari, L.; Singh, R.; Pal, D. B. and Mishra, P. K. (2015): Assessment of ground and surface water quality

along the river Varuna, Varanasi, India. *Environmental monitoring and assessment*, *187*(4), 1-10.

Thakor, F. J.; Bhoi, D.; Dabhi, H.; Pandya, S. and Chauhan, N. B. (2011): Water Quality Index (WQI) of Pariyej Lake Dist. Kheda-Gujarat. Current World Environment 6: 225-231.

Tripathi, S. K. and Vishwakarma, S. K. (2015): Physico - Chemical and Statistical Evaluation of Bore Well Water in Two Villages of Varanasi (Up), India. *International Journal of Scientific Research in Environmental Sciences*, 3(9), 0314-0321.

Yadav, P.; Yadav, V. K.; Yadav, A. K. and Khare, P. K. (2013): Physico-Chemical Characteristics of a Fresh Water Pond of Orai, UP, Central India. *Octa Journal of Biosciences*, 1(2), 177-184.