

Assessment of Physico-Chemical Parameters of River Ganga at Allahabad With Respect To WQI

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ABSTRACT: The present investigation reveals the seasonal changes in concentration of physico-chemical parameters in river Ganga at Allahabad. Water samples under investigations were collected from the different sites viz: Phaphamau, Dashashumedh Ghat & Sangam of Allahabad during summer, monsoon & winter seasons in year 2013-14. The physico-chemical parameter as Temperature, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total alkalinity (TA), Total Hardness (TH), Total Dissolve Solids (T.D.S), Turbidity & Chloride were used to analyse the pollution index of river Ganga at selected sites. A correlation matrix test was carried out to check the significant relationship among the physico-chemical parameters (significance level 0.05). Water Quality Index (WQI) was also calculated for all three sampling sites at Allahabad in three seasons. The results revealed that the water quality was severely polluted in monsoon and moderately polluted in winter season.

KEYWORDS: River Ganga, Physico-chemical properties, Correlation, Water quality index (WQI).

I. INTRODUCTION

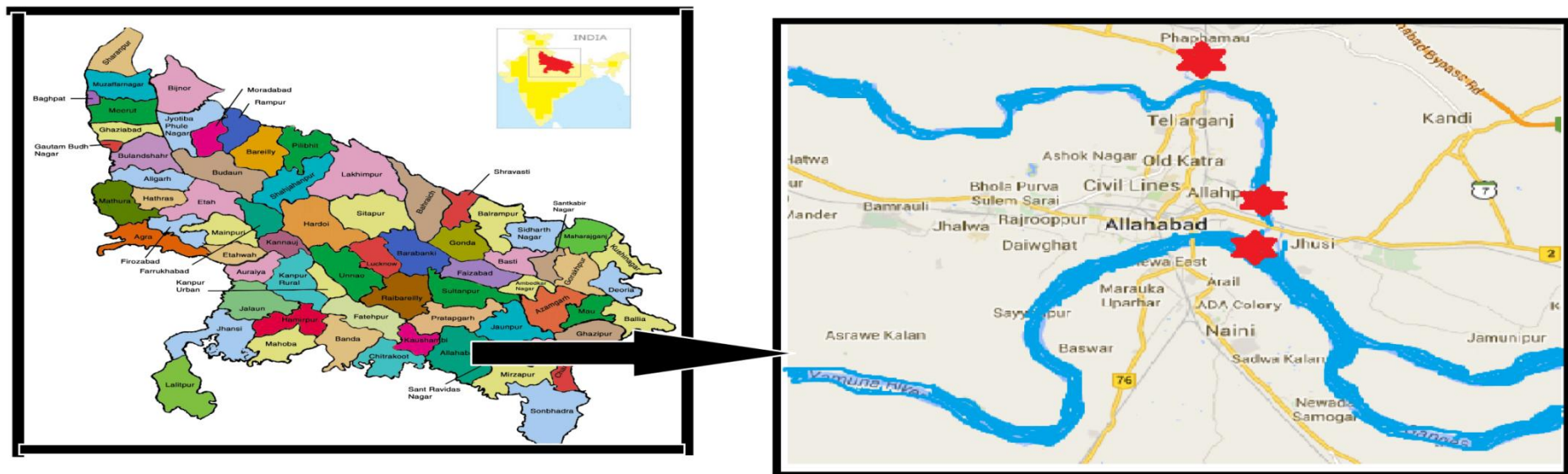
Water is one of the weirdest compounds and known for the elixir of life. Water has played an important role not only in the history of countries, but in religion, mythology, and art. Water in many religions cleanses the soul through holy water. Rivers are the most important natural resource for human development but it is being polluted by indiscriminate disposal of sewage, industrial waste and plethora of human activities, which affects its physico-chemical and microbiological quality. The potential cause of degradation of river water quality due to various point and nonpoint sources. Increasing problem of deterioration of river water quality, it is necessary to monitoring of water quality to evaluate the production capacity [8]. The major activities responsible for river pollution in Allahabad are due to sewage discharge, agriculture and industrial effluents mainly from Naini industrial area, Phaphamau area and Phulpur fertilizers factory which directly discharges into the river. The existing Sewage Treatment plants (STP) at Gaughat and Rajapur are not able to cope with the situation. [5]. WQI is widely used tool in different parts of the world to solve the problems of data management and to evaluate success and failures in management strategies for improving water quality. In the present paper an attempt has been made to assess the physico-chemical properties with respect to water quality index (WQI) in three seasons viz: summer, monsoon and winter during 2013-14 at three selected sites of Allahabad viz: Phaphamau, Dashashumedh Ghat and Sangam.

II. MATERIAL AND METHODS

2.1 Study Area

Allahabad is one of the largest cities of North Indian state of Uttar Pradesh. It is spread across an area of 3,424 km² and lies between North latitudes 24°47' and 25°47' and East longitudes 81°09' and 82°21' with total population of 62,36,447 as per 2001 census (density: 85 persons/ km²). Allahabad is considered a very sacred place as it is located where rivers Ganges, Saraswati and Yamuna unite. Being the oldest Indian city, it has many temples and also plays an important role in Hindu scriptures.

Figure 1: Map of Uttar Pradesh showing Allahabad city and an enlarged view of Allahabad city showing study sites



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2.2 Sample collection

The water samples were collected from three sites viz: Phaphamau, Dashashumedh Ghat and Sangam for physico-chemical analysis during three seasons viz: summer, monsoon and winter for the year 2013-2014. Parameters like temperature, pH and dissolved oxygen (DO) were estimated at the spot immediately after the collection of the samples whereas water analysis relating to other chemical factors was done in the laboratory.

2.3 Physico-chemical analysis

The water samples were brought to the laboratory in ice boxes and subjected to the analysis of BOD (by incubating diluted samples at 25° C for 5 days in dark), COD (by dichromate reflux method using a ferroin indicator), Alkalinity (estimated by titration with standard sulphuric acid using phenolphthalein and methyl orange as indicator), Hardness (estimated by titration with EDTA solution using Erichrome black-T dye as indicator), TDS (by Evaporation method), Turbidity (by Nephelometer) and Chloride (by Mohr's argentometric method using Potassium chromate as indicator)

2.4 Calculation of WQI

Water Quality Index (WQI) may be defined as the rating that reflects the composite influence of a number of water quality factors on the overall quality of water. It reduces the large amount of water quality data to a single numerical value. It is one of the most effective ways to communicate information on water quality trends to policy makers, to shape sound public policy and implement the water quality improvement programmes efficiently. [16]

Different water parameter were considered for calculation of water quality index [4] [7] [10] [11] [13] [14]

Water Quality Index (WQI) = $\sum q_i w_i$

Where q_i (water quality rating) = $100 \times (V_a - V_i) / (V_s - V_i)$,

When V_a = actual value present in the water sample

V_i = ideal value (0 for all parameters except pH and DO which are 7.0 and 14.6 mg l⁻¹ respectively).

V_s = standard value.

If quality rating $q_i = 0$ means complete absence of pollutants,

While $0 < q_i < 100$ implies that, the pollutants are within the prescribed standard.

When $q_i > 100$ implies that the pollutants are above the standards.

W_i (Unit weight) = K/S_n .

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$$\text{Where K (constant)} = \frac{1}{\frac{1}{V_{s1}} + \frac{1}{V_{s2}} + \frac{1}{V_{s3}} + \frac{1}{V_{s4}} + \dots + \frac{1}{V_{sn}}}$$

Sn = 'n' number of standard values.

According to Sinha et al., (2004), the range of water quality index (WQI) is given in Table-1.

TABLE 1: Categories the water quality index (WQI) with range of pollution.

Category	WQI	Range of Pollution
I.	<50	Slightly polluted
II.	51-80	Moderately polluted
III.	80-100	Excessively polluted
IV.	>100	Severely polluted

III. RESULT AND DISCUSSION

The physico-chemical characteristics of river Ganga at three sites viz: Phaphamau, Dashashumedh Ghat and Sangam are shown in table (2). During the investigation period temperature varied from 17.5^oC to 30.5^oC. Sculthorpe (1967) has reported that pH, free CO₂ and NH₃ are more critical factors in the survival of aquatic plants and fishes than the oxygen supply. The result shown that the pH values are alkaline in all three sites and are very close to permissible limits. Ganga water contained highest dissolved oxygen during winter season, followed by a gradual decrease to its lowest values during monsoon season. The higher concentrations of DO was recorded during winter season mainly due to low turbidity & increased photosynthetic activity of the green algae found on the submerged stones and pebbles [6]. The maximum DO 11.2 mg/l was recorded in winter season at Sangam & minimum 7.86mg/l at Phaphamau during monsoon season. The BOD ranged from 4.37mg/l at Sangam to 7.75 mg/l at Phaphamau. The COD ranged from 19.74 mg/l at Sangam to 85.4 mg/l at Phaphamau. Total Alkalinity (TA) ranged from 113.9 mg/l at Sangam to 147.6 mg/l at Phaphamau. The hardness of water is mainly governed by the content of calcium and magnesium salt during the investigation. The hardness varied from 92.5 mg/l at Sangam to 125.2 mg/l at Phaphamau. Total Dissolved Solids (T.D.S) ranged from 184.8 mg/l at Sangam & 270.6 mg/l at Dashashumedh Ghat. The turbidity in the river Ganga was lowest during winter season. From summer onwards the water became turbid due to rapid melting of snow & rains. The maximum turbidity 13.2 NTU was observed in monsoon season at Phaphamau & minimum 4.15 NTU was observed in winter season at site Sangam. The chloride varied from 8.2 mg/l at Sangam to 21.36 mg/l at Phaphamau site. Water quality index (WQI) is the most effective way to communicate water quality. Water quality index (WQI) = 0 means complete absence of pollutants. When 0 < 100, indicates the water is under consideration & fit for human use and WQI > 100 reflects its unsuitability for human use [3]. At Phaphamau, the minimum and maximum value of WQI observed as 90.91 and 214.99 in winter & monsoon season respectively, while at Dashashumedh site

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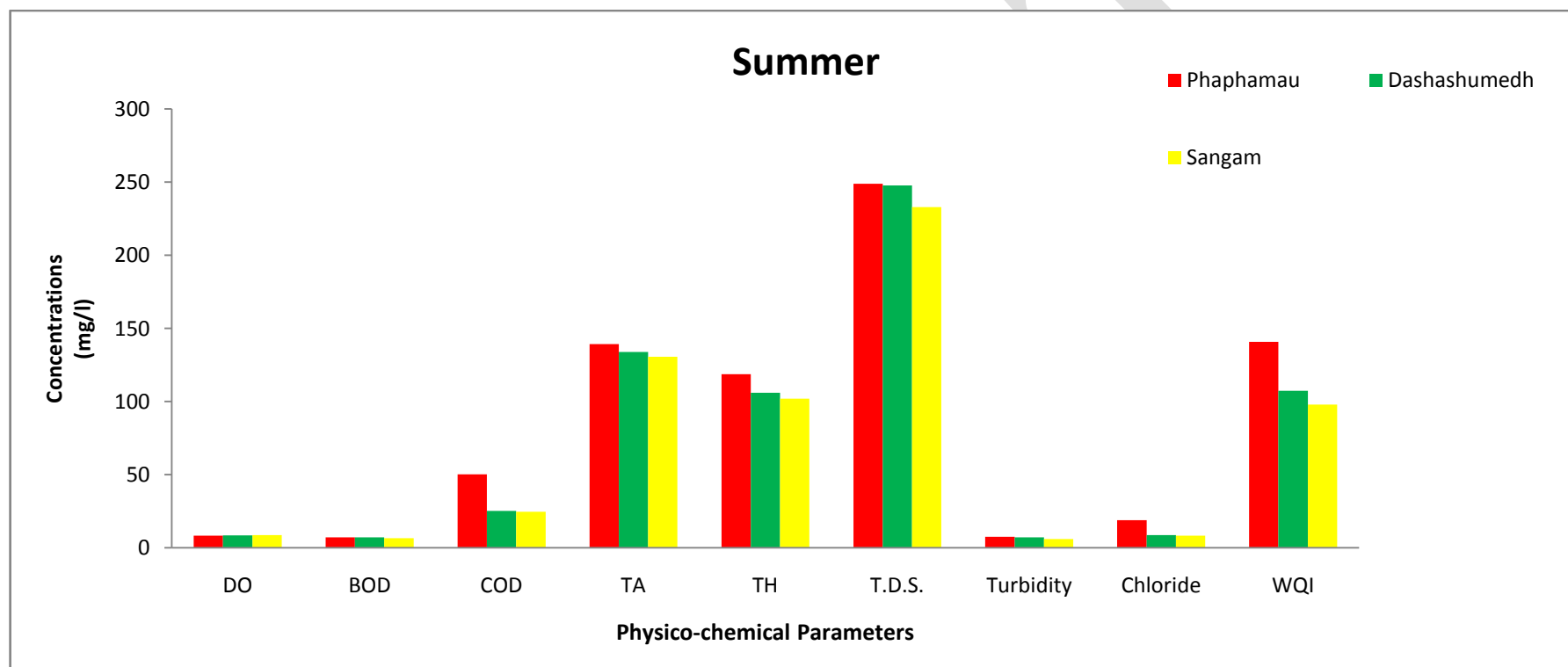
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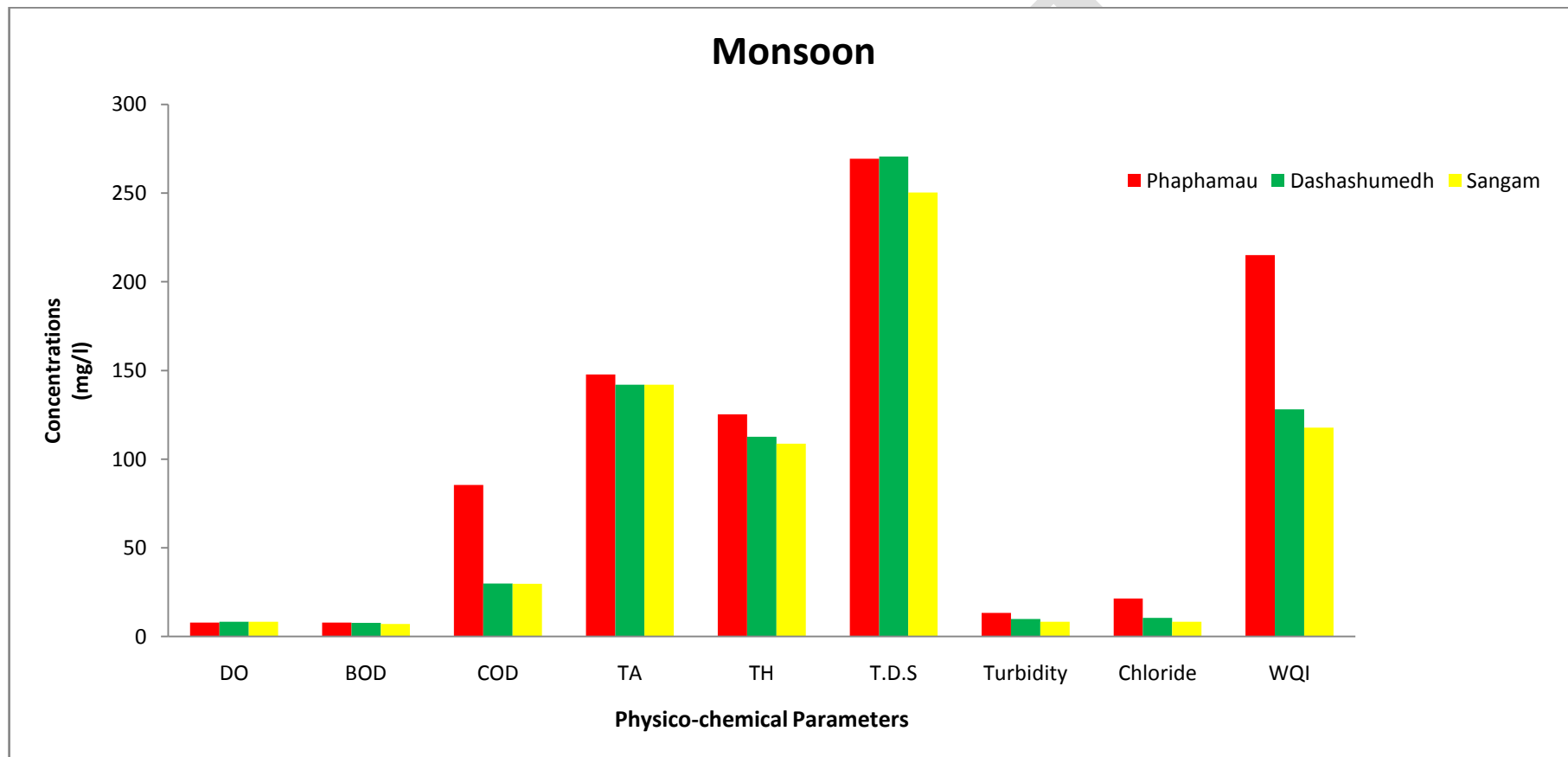
the minimum & maximum value of WQI observed as 75.29 & 128.03 in winter and monsoon season respectively. However in case of Sangam site, the minimum & maximum value of WQI observed as 68.82 and 117.73 in winter & monsoon season respectively. Table (3) depicts the correlation matrix among various water quality parameters. It is revealed that pH exhibited positive correlation with all parameters except DO, whereas DO showed negative correlation with all parameters, thus it can be served as a single useful pollution index of water quality, as with rise in the value of these parameters decreases the DO concentration.[9]

TABLE 2: Water quality index (WQI) with using specific physico-chemical parameters at three selected sites of Allahabad.

S.N	Parameters	Seasons	Temp (°C)	pH	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TA (mg/L)	TH (mg/L)	T.D.S. (mg/L)	Turbidity (NTU)	Chloride (mg/L)	Water Quality Index (WQI)
	Standard (WHO)		-----	6.5-8.5	5.00	6.00	10.00	-----	500.00	500.00	5.00	200.00	
	Wi (Unit Weight)		-----	-----	0.2472	0.206	0.1236	-----	0.00247	0.00247	0.2472	0.00618	
1.	Phaphamau	Summer	30.5	8.48	8.21	7.21	50.17	139.30	118.6	248.9	7.56	18.81	140.78
		Monsoon	27.20	8.25	7.86	7.75	85.40	147.66	125.2	269.33	13.20	21.36	214.99
		Winter	18.5	8.15	10.6	5.84	27.20	128.50	93.52	212.4	5.11	11.00	90.912
2.	Dashashumedh Ghat	Summer	25.8	8.42	8.39	7.06	25.21	133.8	105.90	247.7	7.21	8.60	107.22
		Monsoon	22.00	8.28	8.33	7.70	29.76	142.00	112.6	270.60	9.80	10.52	128.03
		Winter	18.2	8.14	11	5.13	22.00	119.90	90.82	189.6	4.26	7.90	75.29
3.	Sangam	Summer	24.3	8.48	8.58	6.51	24.70	130.5	101.9	232.8	5.92	8.20	97.82
		Monsoon	21.6	8.22	8.31	6.98	29.72	142.00	108.7	250.3	8.22	10.50	117.73
		Winter	17.5	8.12	11.2	4.37	19.74	113.9	92.5	184.8	4.15	8.21	68.82

Figure 2: Seasonal changes in concentration of taken physico-chemical parameters with respect to WQI of River Ganga at three sites of Allahabad.





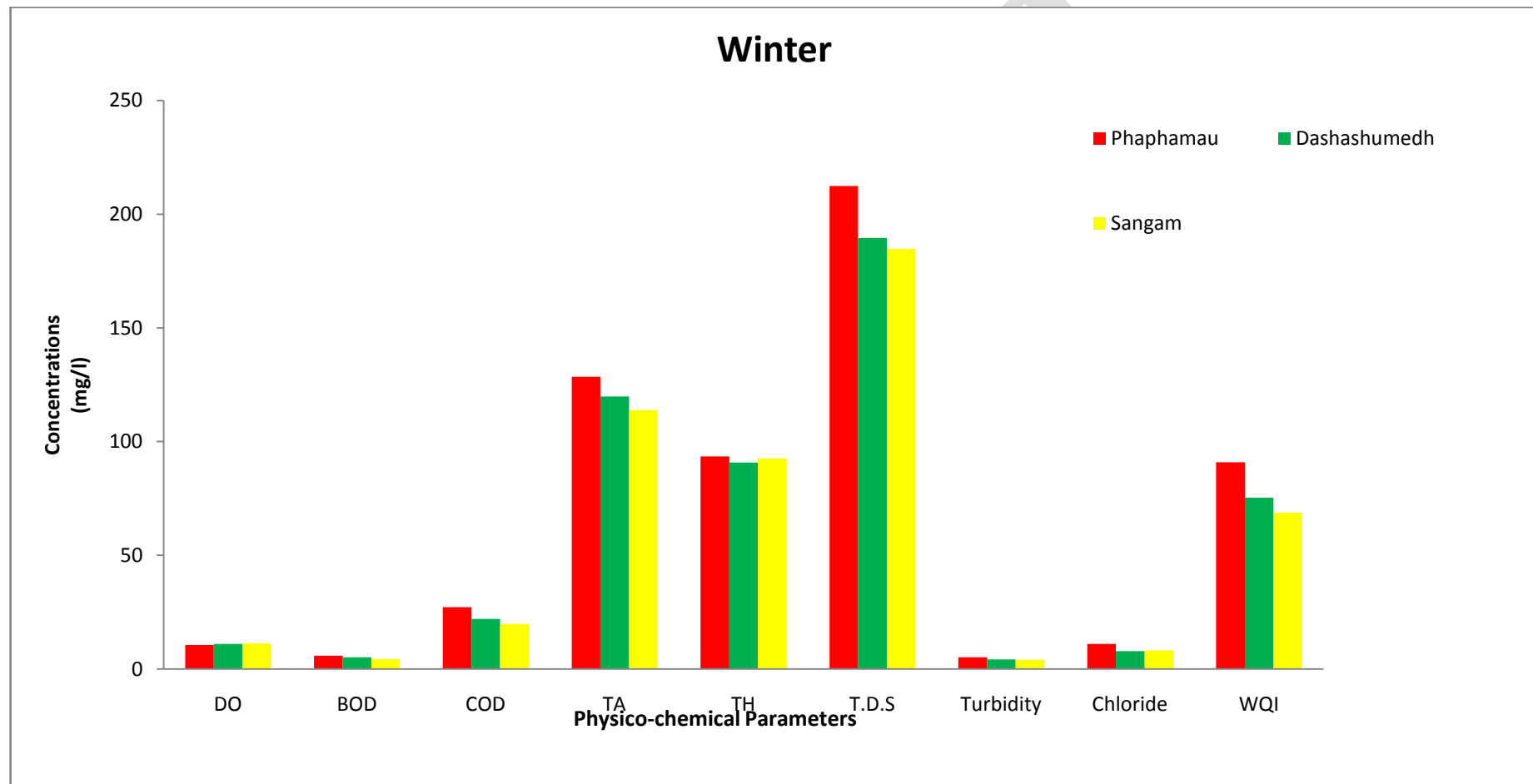


TABLE 3: Correlation matrix among the various physico-chemical parameters (significant level at 0.05)

Parameters	Temperature	pH	DO	BOD	COD	TA	TH	T.D.S	Turbidity	Chloride
Temperature	1									
pH	.947	1								
DO	-.901	-.714	1							
BOD	.825	.600	-.989	1						
COD	.524	.224	-.842	.914	1					
TA	.704	.439	-.943	.982	.974	1				
TH	.790	.552	-.978	.998 [*]	.936	.992	1			
T.D.S	.783	.542	-.975	.997 [*]	.940	.993	1.000	1		
Turbidity	.533	.233	-.847	.918	1.000 ^{**}	.976	.940	.944	1	
Chloride	.672	.399	-.927	.973	.983	.999 [~]	.985	.987	.985	1

IV. CONCLUSION

From the above analysis, it can be concluded that the water quality of river Ganga at Allahabad during study period, revealed that the water is not suitable for drinking purposes. Water quality index (WQI) showed Category (iv) in monsoon season and Category (ii) in winter because most of the parameters were within the norms in winter compared to other

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seasons. Its evaluation will not only be helpful to understand the seasonal quality of water but also has advantages for government agencies and institutions where regular water quality data is required.

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REFERENCES

1. APHA, Clescerl, L. S., Greenberg, A. E., Eaton A. D. (1998). Standard Methods for Examination of Water & Wastewater (20th edn.). Washington, DC.
2. Avnish Chauhan and Suman Singh (2010). "Evaluation of Ganga water for drinking purpose by water quality index at Rishikesh, Uttarakhand, India" Report and Opinion 2010; 2(9):53-61.
3. Bahera, H., Pal, L. and Rout, S.P. (2004). Seasonal variations in the water quality index for Vani Vihar leke in Bhuvaneshwar. *In: Water pollution* (Ed: Aravind Kumar). A.P.H. Publ. Corp, New Delhi. Pp. 199-209
4. Harkins, R. D. (1974): An objective water quality index. *J. water pollut. Contr. Fedr.*, 46, 589.
5. Jamshed Zaidi et al.(2013), "WQI status of groundwater based on specific physico-chemical characteristics around the Jhansi fort, Bundelkhand(India)", *International Journal of Advanced Engineering Technology*, Vol. IV, Issue II, pg.17-19
6. Joshi, D.M., Kumar, A. and Agarwal, N. (2009). Studies on physicochemical parameters to assess the water quality of river Ganga for drinking purpose in Haridwar district. *Rasayan J. Chem.* 2(1), 195-203.
7. K.Raja. (2012). Short essay on Ganga River Pollution.
8. Kesharwani etal. (2004). Determination of water quality index (WQI) of Amkhera pond of Jabalpur city (M.P.). *Ntl. J. Life Sci.*, 1, 61-66.
9. Khaiwal etal. (2003). Seasonal variations in physico-chemical characteristics of River Yamuna in Haryana and its ecological best-designated use. *Journal of Environmental Monitoring*, 5, 419-426.
10. Mishra, A. etal. (2009). Seasonal and Temporal Variations in Physico-chemical and Bacteriological Characteristics of River Ganga in Varanasi. *Int. J. Environ. Res.*, 3(3):395-402.
11. Mohanta, B.K. etal. Studies in the water quality index of river Sanamachhakananda at Keonjargarh, Orissa, India. *Pollut. Res.* 19, 377-85
12. Padmanabha, B. and Belagali, S.L. (2005). Comparative study on the water quality index of four lakes in the Mysore city. *IJEP*, 873-876
13. Sculthorpe, C. D. 1967. *Biology of Aquatic Vascular plants*. Edward Arlold. Pub. Ltd. London 610.
14. Tiwari, T.N. and Manzoor, A. (1988). Water quality index for Indian rivers. *In Ecology and pollution in Indian rivers* (Ed.: R.K. Trivedy). Ashish Publishing House, New Delhi. 271-286.
15. Tiwari, T. N., Das, S. C. and Bose, P.K. (1986). Water quality index for the river Jhelum in Kashmir and its seasonal variations. *Pollut. Res.*, 5, 1-5.
16. Tiwari TN, Mishra M. (1985) A preliminary assignment of water quality index of major Indian rivers, *IJEP*.;5:276-279.

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