



DETERMINATION OF WATER QUALITY INDEX AND PHYSICO-CHEMICAL PARAMETER VALUE OF THE RIVER GANGA AT PHAPHAMAU, ALLAHABAD

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ABSTRACT

The present study was carried out to calculate the water quality index of the river Ganga at Phaphamau, Allahabad. For the calculation of Water Quality Index physico-chemical parameters were monitored for the monsoon, winter and summer seasons. For the two consecutive years 2013-14 and 2014-15 the samples were collected and analyzed. The value of WQI indicates that water sampling at Phaphamau were severely polluted and not fit for human consumption. The analysis of Water Quality Index reveals that the water in the year 2013-14 were of better quality than in the year 2014-15. In the present investigation we concluded that the water quality of analysing sites under study not suitable for drinking purpose during any season. This paper dealt with the analysis of water sample of river Ganga at Phaphamau, Allahabad. From Allahabad the sites were taken Phaphamau that were located at 10 km distance from Allahabad main city.

KEYWORDS: Ganga, Physico-chemical parameters, Water quality index.

INTRODUCTION

Water is an essential constituent for the life of human beings as well as for our ecosystem. Without water, existent of life on earth are not possible. Human and other living organism die, agricultural activities not initiated, business also cannot operated^[1]. Domestic and industrial wastewater constitute as a constant polluting source, whereas surface runoff is a seasonal phenomena mainly controlled by climate^[2]. The intensive use of chemical fertilizers, poor waste management by industries and mass bathing activities during festivals *etc.* have led to environmental stress on water ecosystem^[3]. The values obtained from water quality index were compared from guidelines that used during measurement of water quality index. The water of the River Ganga at Phaphamau come under the poor quality of water. The water quality index >100 will be considered as severely polluted. The ecology of the River Ganga were affected by removal of water for irrigation, use of chemicals in agriculture, deforestation, atmospheric emissions from factories and automobiles sewage discharges. Water Quality Index (WQI) is commonly used for the detection and evaluation of water pollution and may be defined as “a rating reflecting the composite influence of different quality parameters on the overall quality of water.” The quality of water is getting vastly deteriorated due to unscientific waste disposal, improper water management and carelessness towards environment, which has also led to scarcity of potable water affecting the human health^[4]. The quality index comprised into two parts physico-chemical indices and biochemical indices. The physico-chemical indices are based on values of various physico-chemical parameters in a water sample. Water quality index is defined in terms of its physical, chemical and biological characteristics. Water quality index (WQI) has been developed with the aim of

providing summary information on quality. Overall water quality was expressed by single number. WQI can be used to summarize the large amounts of water quality database into simple terms for reporting to public in a reliable manner. WQI can be used to summarize the large amounts of water quality database into simple terms for reporting to environmental planners and public in a reliable manner.

METHODOLOGY

The physico-chemical characteristics of water like pH, Electrical conductivity, Total Dissolved solids (TDS), Total hardness, Alkalinity, Chloride, Sulphate and Nitrate were determined in summer, monsoon and winter according to standard methods^[5]. Here water quality index of the River Ganga has been calculated and subsequently modified by based on physico-chemical data. The water quality index has been calculated by using the standard of drinking water quality by the WHO, BIS, and ICMR. Therefore, the “Weight” for various water quality characteristics is assumed to be inversely proportional to the recommended standards for the corresponding parameters. According to this is

$$W_i = K/S_i$$

Where W_i is the unit weight and S_i is the recommended standard for the parameter. The constant of the proportionality K in equation can be determined from the condition.

$$W_i = K (1/S_i)$$

The quality rating q_i for the parameter P_i is calculated from the following equation.

$$q_i = 100 (V_i/S_i)$$

Where V_i is the observed value. The subindex S_i for the parameter P_i is given by

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$$(S_i) = (q_i w_i)$$

The overall WQI can be calculated by aggregating the quality rating (qi) or subindices, linearly or taking their weighted mean,

$$WQI = \left[\sum (q_i w_i / w_i) \right]$$

Water quality index represents the integrated effects of the relevant water quality variables. Table- 2 show drinking water standard & unit weights for all the parameters used

in calculating the WQI. [6] gave the rating of water quality as shown in Table-1. These 11 physico-chemical parameter were taken for calculating the water quality parameter. Hardness, pH, DO, BOD, COD, Nitrate, Total Dissolved Solids, Sulphate, Electrical conductivity, Total Alkalinity and Chloride. Drinking water quality standards (Maximum permissible limit) Standards are taken according to WHO, BIS, ICMR *etc.* Unit weight $W_i=1/S_i$ were taken from [7].

TABLE 1: Water quality rating.

WQI level	Water quality rating
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very poor
>100	Unfit for drinking purpose

TABLE 2: Drinking water quality standards (Maximum permissible limit) Standards are taken according to WHO, BIS, ICMR *etc.*

Parameters	Standard Values	$W_i=1/S_i$
Hardness	300	0.003
pH	6.5-8.5	0.14
DO	5.00	0.2
BOD	5.00	0.2
COD	10.00	0.1
Nitrate	20	0.05
Total Dissolved Solids	500	0.002
Sulphate	200	0.005
Electrical Conductivity	300	0.0033
Total Alkalinity	120	0.008
Chloride	250	0.004

TABLE 3: Analysis of Physico-chemical Parameter of River Ganga at Phaphamau (Allahabad)

Parameter	Physico-chemical parameter value of water							
	Year 2013-14				Year 2014-15			
	Winter	Summer	Monsoon	Mean ± SD	Winter	Summer	Monsoon	Mean ± SD
pH	8.2	8.6	8.3	8.36±0.20	8.3	8.9	8.5	8.56±0.305
Ec(µmhos/cm)	449	542	528	506.3±50.14	445	535	525	501.6±49.32
DO(mg/l)	7.95	6.95	7.3	7.4±0.507	8.2	7.25	7.32	7.59±0.529
BOD(mg/l)	6.25	9.72	9.47	8.48±1.93	7.25	10.2	12.4	9.95±2.58
COD(mg/l)	28.2	35.5	40.5	34.7±6.18	29.6	36.2	38.2	34.6±4.50
TA(mg/l)	143	249	288	226.6±75.03	147	259	298	234.6±78.38
TH(mg/l)	141	163	177	160.3±18.14	149	169	179	165.6±15.27
Chloride(mg/l)	16.8	27	31.9	25.23±7.70	17.9	33	35.9	28.93±9.66
TDS(mg/l)	252	290	312	284.6±30.35	255.2	299	316	290±31.36
Nitrate(mg/l)	0.7	1.12	0.2	0.67±0.46	0.08	1.16	0.4	0.54±0.55
Sulphate(mg/l)	13	23	12.4	16.13±5.95	15	24	14	17.66±5.50

RESULTS & DISCUSSION

For the calculation of water quality index the values of various physico-chemical parameters were taken are presented in table: 3. Season wise water quality index for two years are presented in table 4 and 5. The water quality index of winter, summer and monsoon season for the year 2013-14 are 135.3, 170.5 and 136.3. Whereas for the year 2014-15 the water quality index of winter, summer and monsoon are 153.3, 176.9 and 191.3 respectively, which indicate the poor quality of water [8, 9]. The maximum value of WQI in the year 2013-14 were recorded 170.5 in summer season it was followed by 136.3 in monsoon season and minimum 135.3 in winter season. Whereas in the year 2013-14 it were recorded maximum 191.3 in monsoon season it was followed by 176.9 in summer season and minimum 153.3 in winter season. The water

quality index value for the year 2013-14 was of better quality as comparison to the year 2014-15. Integrated effects of the relevant water quality variables were represented by water quality index. 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 and fit for human use and $WQI > 100$ reflects its unsuitability for human use [10]. This clearly indicates that water samples of this region are highly polluted. They are not suitable for drinking purpose and other useful human activities [11].

TABLE 4: Water quality index of River Ganga at Phaphamau in year 2013-14

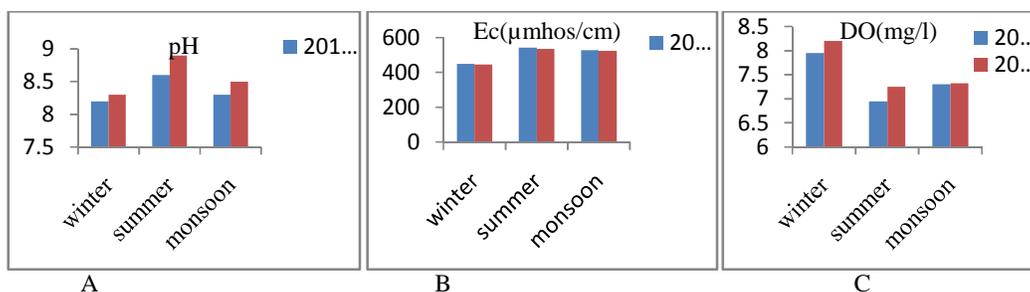
Parameters	2013-14										
	Standard Values (Sn)	Unit Weight (Wn) Wi=I/Si	Winter	Quality rating (Qn)	WnQn	Summer	Quality rating (Qn)	WnQn	Monsoon	Quality rating (Qn)	WnQn
Hardness	300	0.003	141	47.0	0.141	163	54.3	0.162	177	59.0	0.177
pH	-	0.14	8.2	117	16.3	8.6	122	17.08	8.3	118	16.5
DO	6.00	0.2	7.95	159	25.4	6.95	139	27.8	121.6	24.32	4.8
BOD	5.00	0.2	6.25	125	25	9.72	194.4	38.8	9.47	189.4	37.8
COD	10.00	0.1	28.2	282	28.2	35.5	355	35.5	40.5	405	35.5
Nitrate	20	0.05	0.7	3.5	0.175	1.12	5.6	0.28	0.2	1.0	0.05
Total Dissolved Solids	500	0.002	252	50.4	0.100	290	58.0	0.116	312	62.4	0.124
Sulphate	200	0.005	13	6.5	0.032	23	11.5	0.057	12.4	6.2	0.031
Electrical Conductivity	300	0.0033	449	149	0.491	542	180	0.594	528	176	0.580
Total Alkalinity	120	0.008	143	119	0.952	249	207.5	1.66	288	240	1.92
Chloride	250	0.004	16.8	6.72	0.026	27	10.8	0.043	31.9	12.7	0.050
		Wn=0.7 153			WnQn= 96.8			WnQn= 122.0			WnQn= n=97.5

Water quality index for the winter season = $WnQn/Wn = 135.3$
Water quality index for the Summer season = $WnQn/Wn = 170.5$
Water quality index for the Monsoon season = $WnQn/Wn = 136.3$

TABLE 5: Water quality index of River Ganga at Phaphamau site in year 2014-15

Parameters	2014-15										
	Standard Values (Sn)	Unit Weight (Wn) Wi=I/Si	Winter	Quality rating (Qn)	WnQn	Summer	Quality rating (Qn)	WnQn	Monsoon	Quality rating (Qn)	WnQn
Hardness	300	0.003	149	49.6	0.148	169	56.3	0.168	179	59.6	0.178
pH	-	0.14	8.3	118	16.5	8.9	127	17.7	8.5	121	16.9
DO	5.00	0.2	8.2	164	32.8	7.25	145	29	7.32	146	29.2
BOD	5.00	0.2	7.25	145	29	10.2	204	40.8	12.4	248	49.6
COD	10.00	0.1	29.6	296	29.6	36.2	362	36.2	38.2	382	38.2
Nitrate	20	0.05	0.08	0.4	0.02	1.16	5.8	0.29	0.4	2.0	0.10
Total dissolved Solids	500	0.002	255.2	51.04	0.102	299	59.8	0.119	316	63.2	0.126
Sulphate	200	0.005	15	7.5	0.037	24	12.0	0.06	14	7.0	0.035
Electrical Conductivity	300	0.0033	445	148	0.488	535	178	0.587	525	175	0.57
Total Alkalinity	120	0.008	147	122.5	0.98	259	215	1.72	298	248	1.98
Chloride	250	0.004	17.9	7.16	0.028	33	13.2	0.052	35.9	14.36	0.057
		Wn=0 .7153			WnQn =109.7			WnQn =126.6			WnQn= 136.9

Water quality index for the winter season = $WnQn/Wn = 153.3$
Water quality index for the Summer season = $WnQn/Wn = 176.9$
Water quality index for the Monsoon season = $WnQn/Wn = 191.3$



Water quality index and physico-chemical parameter value of the river Ganga

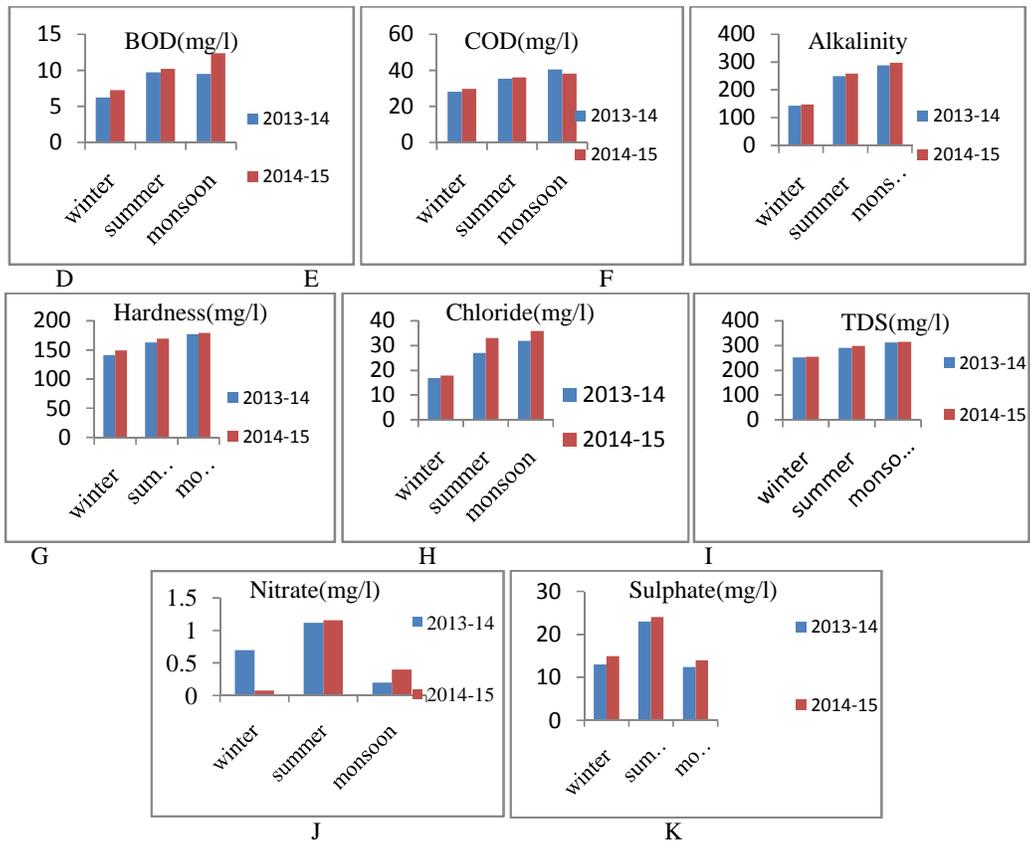


FIGURE 1: Graphs showing seasonal variations in pH, Electrical conductivity, DO, BOD, COD, Alkalinity, Total Hardness, Chloride, TDS, Nitrate and Sulphate (A to K) at different seasons of Phaphamau, Allahabad [U.P.] India. (During 2013-14 and 2014-15)

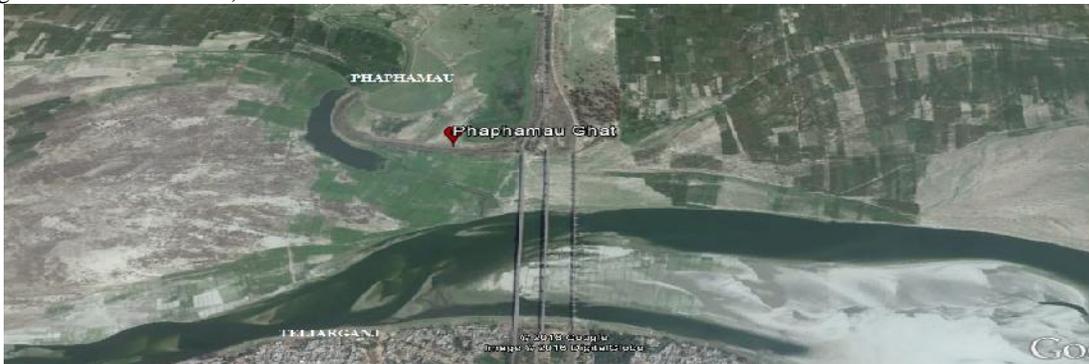


FIGURE 2: Showing study area map (Phaphamau site)

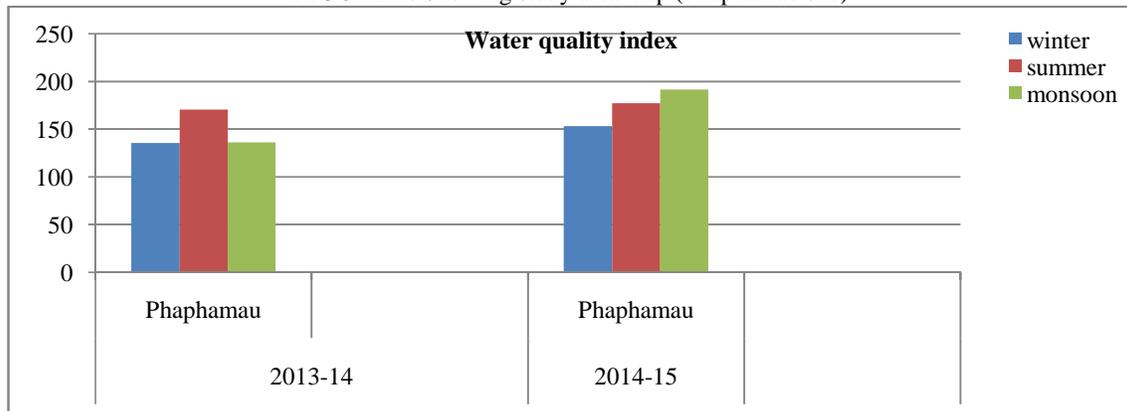


FIGURE 3: Graph showing water quality index in the winter, summer and monsoon season for the year 2013-14 and 2014-15 at the Phaphamau, Allahabad [U.P.] India.

CONCLUSION

In the present investigation water of River Ganga was found not to be good for drinking purpose at any season. The WQI starts increasing from summer to monsoon and it further increases from monsoon to winter season in the year 2013-14. It was also observed that the water in the year 2013-2014 was of have lower water quality index than in the year 2014-2015.

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