

# Evaluation of Water Quality: Physico – Chemical Characteristics of Ganga River at Kanpur by using Correlation Study

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**Abstract:** We present an extensive investigation of physico-chemical parameters of water samples of Ganga river at Kanpur. Water samples under investigations were collected from Jalsansthan Benajhawar Kanpur sampling station during pre monsoon (April - May), monsoon (July - August) and post monsoon (October - November) seasons in the year 2008. Correlation coefficients were calculated between different pairs of parameters to identify the highly correlated and interrelated water quality parameters and t-test was applied for checking significance. The observed values of different physico-chemical parameters like pH, temperature, turbidity, total hardness (TH), Iron, Chloride, total dissolved solids (TDS),  $\text{Ca}^{2+}$ ,  $\text{Mg}^{+2}$ ,  $\text{SO}_4^{-2}$ ,  $\text{NO}_3^-$ ,  $\text{F}^{-1}$ , total alkalinity (TA), Oxygen consumption (OC), Suspended solids (SS) of samples were compared with standard values recommended by world health organization (WHO). It is found that significant positive correlation holds for TA with  $\text{Cl}^-$ ,  $\text{Mg}^{+2}$ ,  $\text{Ca}^{+2}$ , TH, TDS, fluoride and OC. A significant negative correlation was found between SS with chloride,  $\text{Mg}^{+2}$ , TDS, fluoride and OC. All the physico - chemical parameters for pre monsoon, monsoon and post monsoon seasons are within the highest desirable or maximum permissible limit set by WHO except turbidity which was high while  $\text{NO}_3^-$ ,  $\text{Cl}^{-1}$  and F are less than the values prescribed by WHO. [Nature and Science. 2009;1(6):91-94]. (ISSN: 1545-0740).

**Keywords:** Physico-chemical parameters, correlation, t-test.

## 1. Introduction

It is a fact that good water quality produces healthier humans than one with poor water quality. Ganga River is life line of Kanpur and its water is used for domestic and agriculture purposes therefore, effective maintenance of water quality is required through appropriate measurements. Physico-chemical and micro-biological characteristics may describe the quality of water (Sinha, 1986), therefore, an analysis on physico-chemical parameters of Ganga water was made by many workers (Mehrotra, 1990; Sinha et.al. 2000) Regular monitoring of all the parameters is very difficult and laborious task even if adequate manpower and laboratory facilities are available. Therefore, statistical correlation technique has been used for comparison of physico-chemical parameters. The present work deals with the study of 15 physico-chemical parameters like pH, temperature, turbidity, TH, Fe,  $\text{Cl}^-$ , TDS,  $\text{Ca}^{2+}$ ,  $\text{SO}_4^{-2}$ ,  $\text{NO}_3^-$ ,  $\text{F}^{-1}$ , TA,  $\text{Mg}^{+2}$ , OC, SS of Ganga river water in Kanpur. The observed values of various physico-chemical parameters of water samples were compared with standard values recommended by World Health Organization (WHO) and are given in Table-1. The objective is to minimize the complexity and dimensionality of large set of data. Systematic calculation of correlation coefficient between physico-chemical parameters has been carried out and significant correlation has been further verified

by using t- test. (Bhandari and Nayal, 2008; Garg et.al, 1990; Sarkar et. al., 2006).

## 2. Experimental

Water samples were collected from Jalsansthan Benajhawar Kanpur sampling station during pre monsoon (April - May), monsoon (July - August) and post monsoon (October - November) phase in year 2008. During sampling pH, temperature, and turbidity were determined using digital pH meter, thermometer and turbidimeter respectively. F<sup>-</sup> and nitrate was estimated using colorimetric method. The laboratory analysis of samples was done using standard methods (APHA, 1998), titrimetric method was used for the determination of total alkalinity and gravimetric method for total dissolved solid and total suspended solids. Mohr's argentometric titration method was used for chloride (Vogel, 1978). Sulphate was estimated using turbidometric method (Vogel, 1978) Whereas  $\text{Ca}^{+2}$ ,  $\text{Mg}^{+2}$  and TH was determined by EDTA titrimetric method (Vogel, 1978). Atomic absorption spectrophotometer was used for determination of Fe and Cr contents. All the chemical used were of AR grade. In order to calculate correlation coefficients, correlation matrix was constructed by calculating the coefficients of different pairs of parameters and correlation for significance was further tested by applying t-test

(<http://www.spss.com>) decreases or increases with increasing or decreasing n values of chloride ion.

A significant positive correlation was found between  $\text{Ca}^{2+}$  and TDS ( $r=0.816$ ,  $t = 8.711$ ). The magnesium content of Ganga water increases or decreases with increase or decrease in the value of TDS ( $r = 0.889$ ,  $t= 9.179$ ) and fluoride( $r = 0.977$ ,  $t = 6.239$ ) as it shows significant positive correlation with these parameters respectively

Total dissolved solid shows significant positive correlation with OC( $r = 0.827$ ,  $t = 9.07$ ) and fluoride ( $r = 0.89$ ,  $t = 9.051$ ), TDS shows significant negative correlation with SS ( $r = - 0.971$ ,  $t = 3.049$ ).SS shows significant negative correlation with OC( $r = - 0.894$ ,  $t = 3.817$ ) and fluoride( $r = - 0.928$ ,  $t = 4.016$ ).

Table 1. The average values of physico- chemical parameters of Ganga River water at Kanpur.  
HDL: Highest Desirable Limit; : MPL; Maximum Permissible Limit

NO.	PARAMETERS	UNITS	DRINKING WATER		Experimental Values (Range)
			WHO Standard		
			HDL	MPL	
1	Temperature	$^{\circ}\text{C}$	-	-----	22-30
2	Turbidity	NTU	5	10	18-470
3	pH value	-	6.5 to 8.5	No relaxation	8.4- 8.9
4	Total hardness (as $\text{CaCO}_3$ )	mg/l	300	600	122-212
5	Iron	mg/l	0.3	1.0	0.2-0.8
6	Chlorides	mg/l	250	1000	7-26
7	Dissolved Solids	mg/l	500	2000	256-500
8	Calcium	mg/l	75	200	28-48
9	Sulphate	mg/l	200	400	50-91
10	Nitrate	mg/l	50	No relaxation	0-1.772
11	Fluoride	mg/l	1.0	1.5	0-0.4
12	Total Alkalinity	mg/l	200	600	13-246
13	Magnesium	mg/l	30	150	9.23-26.24
14	Oxygen Observed from $\text{KMnO}_4$ at $37^{\circ}\text{C}$ in 3 hrs.	mg/l	3.0	No relaxation	2.4-7.8
15	Suspended Solids	mg/l	20	150	70-280

Table 2. Different Paired Samples Correlations<sup>9</sup>  
 Note: Significant if  $t_{0.05} > 2.14$

Paired Parameters	r	t	t <sub>0.05</sub>
Pair 1	pH & OC	0.821	4.762
Pair 2	TA & TH	0.97	4.694
Pair 3	TA & Ca <sup>+2</sup>	0.821	9.145
Pair 4	TA & Mg <sup>+2</sup>	0.851	10.179
Pair 5	TA & Cl <sup>-</sup>	0.91	10.511
Pair 6	TA & TDS	0.988	8.233
Pair 7	TA & OC	0.88	9.942
Pair 8	TA & Fluoride	0.836	9.85
Pair 9	TH & Mg <sup>+2</sup>	0.916	9.973
Pair 10	TH & Cl <sup>-</sup>	0.87	10.091
Pair 11	TH & TDS	0.993	8.653
Pair 12	TH & Fluoride	0.912	9.516
Pair 13	Ca <sup>+2</sup> & TDS	0.816	8.711
Pair 14	Mg <sup>+2</sup> & Cl <sup>-</sup>	0.872	2.175
Pair 15	Mg <sup>+2</sup> & TDS	0.889	9.179
Pair 16	Mg <sup>+2</sup> & SS	- 0.935	3.261
Pair 17	Mg <sup>+2</sup> & Fluoride	0.977	6.239
Pair 18	Cl <sup>-</sup> & TDS	0.877	9.256
Pair 19	Cl <sup>-</sup> & OC	0.985	4.639
Pair 20	Cl <sup>-</sup> & SS	- 0.923	3.348
Pair 21	TDS & OC	0.827	9.07
Pair 22	TDS & SS	- 0.971	3.049
Pair 23	TDS & Fluoride	0.89	9.051
Pair 24	OC & SS	- 0.894	3.817
Pair 25	S.S & Fluoride	- 0.928	4.016

### 3. Results and Discussion:

The observed pH value ranging from 8.4 to 8.9 show that the present water samples are slightly alkaline in pre-monsoon season. These values are within maximum permissible limit prescribed by WHO.(www.lenntech.com/drinking-water-standards.htm.) Other parameters like turbidity (18 - 470 NTU), TH (122 - 212 mg/l), Fe contents ( 0.2 - 0.8 mg/l), Chloride ( 7- 26 mg/l), TDS ( 256 - 500 mg/l),The Ca<sup>2+</sup>( 28 - 48 mg/l, SO<sub>4</sub><sup>-2</sup> ( 50 - 91 mg/l), NO<sub>3</sub><sup>-</sup>(0-1.772 mg/l), F<sup>-1</sup> ( 0-0.4 mg/l), TA (13 -246 mg/l) , Mg<sup>+2</sup> (9.23-26.24 mg/), OC ( 2.4-7.8 mg/l), SS ( 70 -280 mg/l) are found within the highest desirable or maximum permissible limit set by WHO.(Trivedi and Goel., 1986) However, turbidity and Fe contents are observed to be on higher side in all seasons and pre-monsoon and monsoon seasons respectively.

In the present study for the year 2008, pH shows significant positive correlation with OC ( $r = 0.821$ ,  $t = 4.762$ ). A significant positive correlation was found between total alkalinity and total hardness ( $r = 0.97$ ,  $t = 4.694$ ), Ca<sup>2+</sup> ( $r = 0.821$ ,  $t = 9.145$ ), Magnesium ( $r = 0.851$ ,  $t = 10.179$ ), Cl<sup>-</sup> ( $r = 0.91$ ,  $t = 10.511$ ), TDS ( $r = 0.988$ ,  $t = 8.233$ ), OC ( $r = 0.88$ ,  $t = 9.942$ ) and fluoride ( $r = 0.836$ ,  $t = 9.85$ ) This shows that with increase or decrease in the values of TA ; TH , Ca<sup>2+</sup>, Mg<sup>2+</sup>, Cl<sup>-</sup>, total dissolved solids, OC and F<sup>-</sup> also exhibit decrease or increase in their values.

Total hardness bears positive correlation with Mg<sup>2+</sup> ( $r = 0.916$ ,  $t = 9.973$ ), Cl<sup>-</sup> ( $r = 0.87$ ,  $t = 10.091$ ), TDS ( $r = 0.993$ ,  $t = 8.653$ ), and fluoride ( $r = 0.912$ ,  $t = 9.516$ ). It is suggested that total hardness of water samples is mainly due to the presence of the MgCl<sub>2</sub> and Magnesium fluoride (Bhoi,2005) Sulphate and Nitrate ions bear negative correlation with Ca<sup>+2</sup> indicating that Calcium sulphate and Calcium nitrate may be absent in water samples. NO<sub>3</sub><sup>-</sup> shows negative correlation with Mg<sup>+2</sup> which indicates that Mg(NO<sub>3</sub>)<sub>2</sub> may be absent in water samples. Similarly Fe also shows negative correlation with Cl<sup>-1</sup> and SO<sub>4</sub><sup>-2</sup> implying iron chloride and iron sulphate may be absent in water samples.

Chloride ion bears significant positive correlation with TDS ( $r = 0.877$ ,  $t = 9.256$ ), Mg<sup>2+</sup>, ( $r = 0.872$ ,  $t = 2.175$ ), OC ( $r = 0.985$ ,  $t = 4.639$ ). It reveals that Mg<sup>2+</sup> mainly remains present as MgCl<sub>2</sub>. Chloride ion showed negative significant correlation with SS ( $r = - 0.923$ ,  $t = 3.348$ ) so with increase or decrease in the values of chloride ion, the values of TDS, Mg<sup>2+</sup> and OC increases or decreases, while suspended solids

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