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

Priyanka Trivedi[1], Amita Bajpai[2] and Sukarma Thareja[1,*]

[1]Department of Chemistry, Christ Church College, CSJM Kanpur University, UP, India
[2]CWA Kanpur Jalsansthan Benajhawar, Kanpur
*E-mail address: sukarmathareja@yahoo.com

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) , Ca^{2+}, Mg^{+2} , SO_4^{-2} , NO_3^-, 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 Cl^-, Mg^{+2}, Ca^{+2}, TH, TDS, fluoride and OC. A significant negative correlation was found between SS with chloride, 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 NO_3^- , 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 , Cl^- , TDS , Ca^{2+}, SO_4^{-2} , NO_3^- , F^{-1}, TA, 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^- 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 Ca^{+2} , 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)

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 WHO Standard		Experimental Values (Range)
			HDL	MPL	
1	Temperature	^0C	- --	-----	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 $CaCO_3$)	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 $KMnO_4$ at 37^0C 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[9]
Note: Significant if t 0.05 >2.14

Paired Parameters		r	I t I
Pair 1	pH & OC	0.821	4.762
Pair 2	TA & TH	0.97	4.694
Pair 3	TA & Ca^{+2}	0.821	9.145
Pair 4	TA & Mg^{+2}	0.851	10.179
Pair 5	TA & Cl^-	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^{+2}	0.916	9.973
Pair 10	TH & Cl^-	0.87	10.091
Pair 11	TH & TDS	0.993	8.653
Pair 12	TH & Fluoride	0.912	9.516
Pair 13	Ca^{+2} & TDS	0.816	8.711
Pair 14	Mg^{+2} & Cl^-	0.872	2.175
Pair 15	Mg^{+2} & TDS	0.889	9.179
Pair 16	Mg^{+2} & SS	- 0.935	3.261
Pair 17	Mg^{+2} & Fluoride	0.977	6.239
Pair 18	Cl^- & TDS	0.877	9.256
Pair 19	Cl^- & OC	0.985	4.639
Pair 20	Cl^- & 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^{2+}(28 - 48 mg/l, SO_4^{-2} (50 – 91 mg/l), NO_3^-(0-1.772 mg/l), F^{-1} (0-0.4 mg/l), TA (13 -246 mg/l) , Mg^{+2} (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^{2+}(r= 0.821, t = 9.145), Magnesium(r = 0.851, t = 10.179), Cl^- (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^{2+}, Mg^{2+}, Cl^-, total dissolved solids, OC and F^- also exhibit decrease or increase in their values.

Total hardness bears positive correlation with Mg^{2+} (r = 0.916, t = 9.973), Cl^- (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 $MgCl_2$ and Magnesium fluoride (Bhoi,2005) Sulphate and Nitrate ions bear negative correlation with Ca^{+2} indicating that Calcium sulphate and Calcium nitrate may be absent in water samples. NO_3^- shows negative correlation with Mg^{+2} which indicates that $Mg(NO_3)_2$ may be absent in water samples. Similarly Fe also shows negative correlation with Cl^{-1} and SO_4^{-2} 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^{2+}, (r = 0.872, t = 2.175), OC (r = 0.985, t = 4.639). It reveals that Mg^{2+} mainly remains present as $MgCl_2$. 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^{2+} and

OC increases or decreases, while suspended solids decreases or increases with increasing or decreasing n values of chloride ion.
A significant positive correlation was found between 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).

4.Conclusions

A large number of factors and geological conditions influence the correlations between different pairs of physico - chemical parameters of water samples directly or indirectly. All the physico-chemical parameters of Ganga river water at Kanpur for pre monsoon, monsoon and post monsoon for year 2008 are within the highest desirable limit or maximum permissible limit prescribed by WHO except turbidity, Fe contents and pH which recorded high values in all seasons, pre monsoon and monsoon season and pre monsoon season respectively .
Ganga water recorded higher values of Ca^{2+} than Mg^{2+} in all three seasons An appreciable significant positive correlation have been found for TA with TH, Ca^{+2}, Mg^{+2}, Cl^{-}, TDS, OC and F^{-}. and Cl^{-1} with Mg^{2+}, TDS, OC and TH. Total hardness has significant positive correlation with Mg^{+2}, Cl^{-1} and F^{-1} and TDS with Mg^{+2} and F^{-1} . SS show significant negative correlation with Mg^{+2} , TDS,. Cl^{-1}, OC and F^{-1} for all three seasons for year 2008
From the results of present study we conclude that Ganga water of Kanpur is though fit for drinking purposes yet it need treatment to minimize the contamination especially turbidity and Fe contents . To minimize the contaminations of Ganga river water at Kanpur the values of correlation coefficients and their significance level will help in selecting the proper experimental methods used for treatment of water.To create increasing awareness among the people to maintain the Ganga river water at its highest quality and purity levels, the present study may prove to be useful in achieving this goal.

Acknowledgment:
ST is grateful to Dr. Pervez E. Deen, Principal Christ Church College, Kanpur for his encouragement throughout the work.

Correspondence to:
Sukarma Thareja
Department of Chemistry, Christ Church College
CSJM Kanpur University
Kanpur 208001, UP, India
Telephone: +91- 0512- 2598306
Emails: sukarmathareja@yahoo.com; sukarma@iitk.ac.in

References

[1] Sinha U.K. ,Ganga pollution and health hazard, Inter – India Publication, New Delhi,1986
[2] Mehrotra M.N. J. of the Ind. Association of Sedimentologists,1990, 9 ,1-14
[3] Sinha A.K. , Singh V. P. And Srivastava K., Physico –chemical studies on river Ganga and its tributaries in Uttar Pradesh –the present status. In pollution and Biomonitoring of Indian Rivers.(ed.) Dr. R.K. trevedi. ABD publishers, Jaipur. 2000,1-29
[4] Bhandari N. S and Nayal K E-Journal of Chemistry, 2008, 5, No.2, 342-346
[5] Garg D. K, Goyal R. N and Agrawal V. P, Ind. J. Envir.Prot.1990, 10(5), 355-359.
[6] Sarkar M, Banerjee A , Pratim.P and Chakraborty S, J. Indian Chem. Soc., 2006 , 83, 1023-1027.
[7] Standard Methods for the Examination of Water and Waste Water, 20th Ed., APHA, AWWA, WEF. Washington DC, 1998
[8] Vogel A.I, A text book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis 4th Edition. The English Language Book Society and Langman.Co 1978 (a)837 (b) 328-329 (c)504-506
[9] SPSS Advanced Models™ 12.0 Web site at http://www.spss.com
[10] World Health Organization, Guidelines for drinking water quality-I, Recommendations, 2nd Ed. Geneva WHO, 1993.www.lenntech.com/drinking-water-standards.htm.
[11] Trivedi R.K and Goel P.K, Chemical and Biological Methods for Water Pollution Studies, Environmental Publication, India 1986
[12] Bhoi D. K, Raj D. S, Mehta Y M, Chauhan M .B and Machhar M .T, Asian J. Chem, , 2005, 17(1), 404 - 408.

Date of Submission: 30.8.2009