INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

www.ijabpt.com ISSN : 0976-4550

Volume-6, Issue-3, July-Sept-2015 Coden IJABFP-CAS-USA Copyrights@2015

Received: 23rd May-2015 *Revised: 17th June -2015* *Accepted: 17th June-2015*

Research article

A CORRELATION AND REGRESSION STUDY ON THE GROUNDWATER QUALITY IN ALIGARH CITY, UTTAR PRADESH

Ummatul Fatima[*1] and Shahida Perween[2]

[1]Department of Statistics & Operations Research, Aligarh Muslim University, Aligarh, U.P.-202002, INDIA

[2]Department of Civil Engineering, Aligarh Muslim University, Aligarh, U.P.-202002, INDIA

[*]Corresponding author: fatimau2011@yahoo.com

ABSTRACT: Ground water is the vital source of sustenance and survival of every living organism. The present study aimed at a statistical regression analysis of Groundwater at 16 locations of Aligarh city, Uttar Pradesh. A correlation study has been carried out amongst all possible pairs of 15 physico-chemical parameters viz., pH, total acidity, phenolphthalein alkalinity, total alkalinity, total hardness, calcium, magnesium, dissolved oxygen, chemical oxygen demand, turbidity, electrical conductivity, total solid, total dissolved solid, total suspended solid and chloride to assess groundwater quality. The correlation analysis provides an excellent tool for the prediction of parameter values within reasonable degree of accuracy. The existence of strong correlation between Total Hardness & Magnesium and Total Dissolved Solid & Total Solid are ascertained. The analysis reveals that the groundwater of the area needs some treatment before consumption and it also needs to be protected from the perils of contamination.

Key words: Groundwater, Physico-chemical parameters, Correlation co-efficient, Regression analysis.

INTRODUCTION

Water quality is based on the physical and chemical constituents due to weathering of parent rocks and anthropogenic indispensable source of our life. Particularly, in rural areas it accounts for 88% of the drinking water (Singh *et al*., 2014). Ground water is the major source for drinking and domestic purposes in both rural and urban areas (Tiwari *et al*., 2014). Scarcity of clean and potable drinking water has emerged in recent years as one of the most serious developmental issues in many parts of West Bengal, Jharkhand, Orissa, Western Uttar Pradesh, Andhra Pradesh, Rajasthan and Punjab (Tiwari *et al*., 2014). Water pollution in mining areas is mainly due to overburden (OB) dumps, surface impoundments, mine water, industrial effluents, acid mine drainage, tailing ponds etc. (Singh *et al*., 2013). Access to drinking water in India has increased over the past few decades with the tremendous adverse impact of unsafe water for health (Singh *et al*., 2013). Ground water is one of the earth's most important, renewable and widely distributed resources. About 97.2% of water on earth is salty and only 2.8% is present as fresh water, from which about 20% constitutes groundwater (Kumar *et al*., 2011). It is generally considered least polluted compared to other inland water resources. However, studies indicate that ground water is not absolutely free from pollution though it is likely to be free from suspended solids. Due to rapid growth of population, industrialization and urbanization, there have been intense human activities and interference into nature leading to an over-exploitation and severe pollution stress on natural water bodies. Improper waste disposal and unscientific anthropogenic practices over the years have adversely affected the surface and ground water quality. The major problem with the ground water is that once contaminated, it is difficult to restore its quality. The solution is non-trivial because of complex dynamics involved in the ground water flow, which requires simultaneous solution of complicated geochemical and hydrological equations. Hence there is a need for and concern over the protection and management of ground water quality. Groundwater investigation consists of both quality and quantity determination (Sajil *et al*., 2011). It is well known that no straightforward reasons can be ascribed for deterioration of water quality, as it is dependent on several water quality parameters.

There exist strong correlations among different parameters and a combined effect of their inter-relationship indicated the water quality. Correlation analysis is a useful statistical tool to determine the extent to which changes in the value of an attribute are associated with the changes in another attribute (Ahmed, 2011). Water quality performs important role for all living beings. The physical and chemical parameters of water play a significant role in classifying and assessing water quality. It is the basic duty of every individual to conserve water resources (Jothivenkatachalam *et al*., 2010). In general weathering, dissolution and base-exchange processes control the levels of cationic concentrations in groundwater (Janardhana *et al*., 2010). Many investigations have been conducted on anthropogenic contaminants of ecosystems [Heikka, 2007] and reported that drinking water quality is affected by the presence of different soluble salts (Sonawane *et al*., 2010). It is important to know the quality of groundwater because it is the major factor which decides its suitability for domestic, agriculture and industrial purposes (Raju *et al*., 2009). The quality of surface water within a region is governed by both natural processes such as precipitation rate, weathering processes and soil erosion and anthropogenic effects such as urban, industrial and agricultural activities and the human exploitation of water resources. (Liao *et al*., 2007, Mahvi *et al*., 2005, Nouri *et al*., 2008 and Jarvie *et al*., 1998). Ground water quality has become an important water resources issue due to rapid increase of population, rapid industrialization, unplanned urbanization, flow of pollution from upland to lowland, and too much use of fertilizers, pesticides in agriculture (Joarder *et al*., 2008). Many researchers have focused on the hydro-chemical characteristics and contamination of groundwater in different basins as well as in urban areas that resulted due to anthropogenic intervention, mainly Statistical Analysis Of The Groundwater Samples From Bapatla Mandal, Guntur District, Andhra www.iosrjournals.org 28 | Page by agricultural activities and domestic wastewater (Singh *et al*., 2008, Xiang *et al*., 2008, Xiang *et al*., 2009 and Shrestha *et al*., 2010). The importance of groundwater as a fresh water source for drinking, industrial and domestic purposes is growing in most parts of world. Water scarcity is one of the major challenges in the environment which has resulted in the continent's underdevelopment, lack of safe drinking water and adequate sanitation. Fresh water makes up only about 2.5% of the total global water resource and the remainder is saltwater (Ranjan *et al*., 2006). Groundwater is the prime resource of raw water under such conditions. One of the most significant environmental problems in coastal Andhra Pradesh is the increase in salinity of the groundwater. The source of salinity and the mechanism of groundwater salinization in the coastal Andhra Pradesh are not known. Consequently there are several possible sources of salinity; solutes may be concentrated by evaporation of the flood water or the flow and groundwater seepage receives salt from the Bay of Bengal- Salt water intrusion, Determining the source of salinity and the mechanism of groundwater salinization is vital for future water management plans, including the design and drilling of new wells (Marie *et al*., 2001). A systematic study of correlation and regression coefficients of the water quality parameters not only helps to assess the overall water quality but also to quantify relative concentration of various pollutants in water and provide necessary for implementation of rapid water quality management programs (Kumar *et al*., 2010 and Dash *et al*., 2006). The objective of the present work is to discuss the suitability of groundwater for human consumption through correlation and regression analysis of important water quality parameters.

MATERIALS AND METHODS

Study area

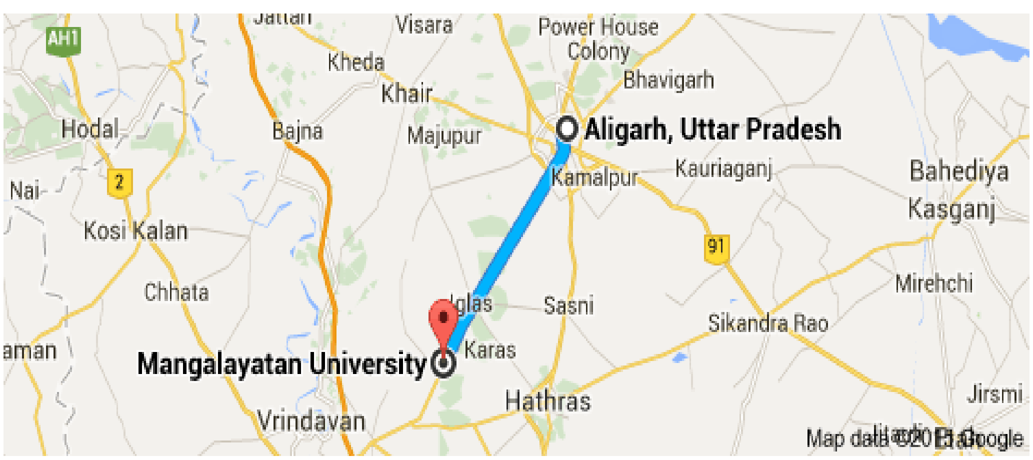

Figure No.1: Location of Aligarh to Mangalayatan University

Aligarh is a city located in Uttar Pradesh state of Northern India. The city is about 90 miles east to New Delhi, situated on a plain between the Ganges and Yamuna. The city is the administrative district of Aligarh District. Aligarh is located at the co-ordinates 27.88°N 78.08°E. It has an elevation of approximately 178 metres (587 feet). The Mangalayatan University is strategically located on the Aligarh-Mathura Highway having close proximities to the Yamuna Expressway in Uttar Pradesh.

Preparation of water samples

In the present investigation, sixteen groundwater samples were collected from sixteen different locations of Mangalayatan University to Sooth Mill, Aligarh district. The samples were collected in clean polythene bottles without any air bubbles. The bottles were rinsed before sampling and tightly sealed after collection and labelled in the field. The dissolved oxygen of the samples was measured in the field itself at the time of sample collection.

Analysis of water sample

Analysis was carried out for various water quality parameters such as pH, Toatal acidity, Phenolphthalein alkalinity, Total alkalinity, Total Hardness, Calcium, Magnesium, Dissolved oxygen, Chemical oxygen demand, Turbidity, Electrical conductivity, Total solid, Total dissolved solid, Total suspended solid and Chloride as per standard procedures recommended by APHA method (2005). The water quality parameter values are in mg/l except pH and EC in µs/cm.

Coefficient of Correlation (r)

The mathematical models used to estimate water quality require two parameters to describe the realistic groundwater situations. Correlation analysis measures the closeness of the relationship between chosen independent and dependent variables. This analysis attempts to establish the nature of the relationship between the variables and thereby provides a mechanism for prediction of forecasting [28]. In this study, the relationship of water quality parameters on each other in the data of water analyzed was determined by calculating correlation coefficient, r, by using the formula as given (Patil *et al*., 2010), (Jothivenkatachalam *et al*., 2010).

$$r = \frac{N\sum XY - \sum X \sum Y}{\sqrt{[N\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}} \qquad (1)$$

Where, X and Y be any two variables represents two different water quality parameters, N = number of data points.

Using equation (2) of straight line, to determine the straight linear regression

$$Y = aX + b \qquad (2)$$

Where, Y and X are the dependent and independent variable, a is the slope for the line, b is intercept on Y-axis.

The slope, a and intercept, b can be determined by using the formula as given in (3) and (4)

$$a = \frac{n\sum XY - \sum X \sum Y}{n\sum X^2 - (\sum X)^2} \qquad (3)$$

$$b = \frac{\sum Y - a\sum X}{n} \qquad (4)$$

RESULTS AND DISCUSSION

In this section, for the purpose of revealing the water quality of 16 groundwater samples of 16 different locations have been established by determining the physical and chemical characteristics as per standard methods (APHA, 2005). They have been listed systematically and represented in Table 2. The physical characteristics of the ground water under the study area are known by the physical parameters viz., pH, total dissolved solids and total solids. The chemical characteristics of the ground water under the study area are known by the chemical parameters viz.

Total acidity, Phenolphthalein alkalinity, Total alkalinity, Total Hardness, Calcium, Magnesium, Dissolved oxygen, Chemical oxygen demand, Turbidity, Electrical conductivity and Chloride and all the physicochemical analysis of the ground water are compared with the Indian Standards, WHO and ICMR are summarized in Table 1. pH, COD & Turbidity variations, Total Hardness, Calcium Hardness & Magnesium Hardness variations, Total Alkalinity, Conductivity & Chloride variations and Total Acidity, Phenolphthalein Alkalinity & DO variations during the study period are presented in Figure 2, 3, 4 and 5 respectively.

Table 1: Comparison of groundwater quality with drinking water standards, WHO, ICMR AND INDIAN

Parameters	**WHO**		**ICMR**		**BIS**	
	P	**E**	**P**	**E**	**P**	**E**
pH	7-8.5	6.5-9.5	7-8.5	6.5-9.2	7-8.3	8.5-9
EC	750	2500	300	-	750	2250
Alkalinity	200	600	-	-	200	600
Turbidity	5	10	5	25	5	10
TH	300	600	300	600	100	500
Calcium	75	200	75	200	75	200
Magnesium	30	150	50	150	50	150
Chloride	200	1000	250	1000	250	1000
Acidity	-	-	-	-	-	-
TDS	1000	2700	500	2000	500	2700
TS	2000	-	-	-	-	-
TSS	500	-	1000	-	-	-
DO	5	6	5	6	5	6
COD	10	-	10	-	10	-

Where, P = Permissible limit, E = Excessive limit, and all the parameters are expressed in mg/l, except pH and electrical conductivity (µ mho/ cm or µS/cm).

Table 2: Characteristics of ground water

S.No	pH	TA	Phe.A	T.Alk	TH	Ca	Mg	DO	COD	Turbidi	EC	TS	TDS	TSS	Cl
1	7.8	48	100	744	232	140	92	12.2	0	1	1253.73	1660	840	820	169.947
2	7.6	24	72	580	296	112	184	14.3	0	0	1313.43	1060	880	180	153.952
3	8.5	16	92	488	252	108	144	13.7	3.2	1	835.82	680	560	120	75.9764
4	7.8	28	32	480	228	152	76	13.3	4.8	1	1074.62	840	720	120	149.954
5	7.9	32	72	476	136	80	56	14.3	16.6	0	1611.94	1280	1080	200	115.964
6	8.1	40	40	520	236	100	136	12.7	3.52	0	1522.38	1300	1020	280	99.969
7	7.7	40	20	524	280	152	128	14.7	4.8	0	1880.59	1420	1260	160	193.94
8	8.1	24	32	760	160	108	52	11.8	3.2	0	716.41	600	480	120	59.98
9	7.7	64	60	460	360	212	148	14.3	1.6	3	1552.23	1140	1040	100	199.938
10	7.7	64	40	500	220	140	80	11.6	10.6	0	1373.13	1080	920	160	209.935
11	7.6	36	84	420	340	176	164	12.7	6.72	0	1761.19	1260	1180	80	279.913
12	7.8	36	56	380	180	132	48	12	3.2	0	567.164	1060	380	680	69.9783
13	7.7	36	40	440	252	144	108	10.4	3.2	0	2000	1800	1340	460	69.9783
14	7.4	68	20	680	408	144	264	12.7	5.76	1	3343.28	2540	2240	300	279.913
15	7.6	72	64	500	580	252	328	15.7	3.2	1	334.283	2280	2240	40	299.907
16	7.3	116	12	508	688	328	360	12.7	3.84	0	3910.44	2860	2620	240	259.919
mean	7.8	46.5	52.25	528.8	303	155	148	13.1	4.64	0.5	1565.67	1428.8	1175	253.8	168.073
samp	0.1	631	722.1	12058	22126	3946	9009	1.88	16.6	0.667	879632	422505	427120	51912	6771
SD	0.3	25.1	26.87	109.8	148.7	62.8	94.92	1.37	4.08	0.816	937.887	650	653.54	227.8	82.2861
CV	3.6	54	51.43	20.77	49.09	40.5	64.13	10.5	87.9	163.3	59.9034	45.495	55.621	89.79	31.6583
max	8.5	116	100	760	688	328	360	15.7	16.6	3	3910.44	2860	2620	820	299.907
min	7.3	16	12	380	136	80	48	10.4	0	0	334.283	600	380	40	59.98

Where, TA-Total acidity, Phe.A-Phenolphthalein alkalinity, T.Alk-Total alkalinity, TH-Total hardness, *Ca*-Calcium hardness, *Mg*-Magnesium hardness, DO-Dissolved oxygen, COD-Chemical oxygen demand, EC-Electrical conductivity, TS-Total solids, TDS-Total dissolved solids, TSS- Total suspended Solid, Cl-Chloride, S.D-Standard deviation, C.V.-Co-efficient of variation in %, Min-Minimum, Max-Maximum. (Note: all parameters are in mg/l except pH, EC in µS/cm and Turbidity in NTU)

In this study, the numerical values of correlation coefficient, r for the 13 water quality parameters are tabulated in Table 3.

Table 3: Correlation co-efficient of different parameters

	paramet	pH	TA	TH	Ca	Mg	DO	COD	Turbidity	EC	TS	TDS	TSS	Cl
aramet	1													
pH	-0.617	1												
TA	-0.279	0.069	1											
TH	0.627	-0.64	-0.066	1										
Ca	0.644	-0.647	-0.186	0.9131	1									
Mg	0.556	-0.575	0.0187	0.9629	0.7691	1								
DO	-0.173	-0.055	-0.119	0.3222	0.1949	0.376	1							
COD	0.087	-0.036	-0.262	-0.2452	-0.233	-0.23	0.039	1						
urbidit	-0.069	0.038	0.0312	0.1954	0.2496	0.1411	0.356	-0.3	1					
EC	0.42	-0.606	0.0806	0.5155	0.4303	0.5231	-0.17	0.13	-0.0894	1				
TS	0.654	-0.738	0.0855	0.7977	0.6762	0.8026	0.048	-0	-0.0013	0.7	1			
TDS	0.684	-0.737	0.0236	0.8786	0.7313	0.893	0.224	0.05	0.03998	0.69	0.943	1		
TSS	-0.1	0.006	0.1822	-0.2531	-0.174	-0.281	-0.52	-0.3	-0.1224	0.02	0.153	-0.18	1	
Cl	0.471	-0.731	0.0111	0.7479	0.6699	0.7288	0.382	0.06	0.22914	0.43	0.643	0.745	-0.31	1

Where, TA- Total alkalinity, TH-Total hardness, *Ca*-Calcium hardness, *Mg*-Magnesium hardness, DO-Dissolved oxygen, COD-Chemical oxygen demand, EC-Electrical conductivity, TS-Total solids, TDS-Total dissolved solids , TSS- Total suspended Solid, *Cl*-Chloride.

Table 4: Computation of regression line for various samples

Sample	X	Y	N	$\bar{X}$	σ_x	$\bar{Y}$	σ_y	$r = \frac{N\sum XY - \sum X \sum Y}{\sigma_x \sigma_y}$	Regression Line Y on X
Ca & *TH*	*Ca*	*TH*	16	155	62.81	303	148.7	0.9131	$Y = 2.1617X - 32.0635$
Mg & *TH*	*Mg*	*TH*	16	148	94.92	303	148.7	0.9629	$Y = 1.5085X + 79.742$
TS & *TH*	TS	*TH*	16	1428.75	650.0038	303	148.7	0.7977	$Y = 0.1825X + 42.2531$
TDS & *TH*	TDS	*TH*	16	1175	653.54	303	148.7	0.8786	$Y = 0.1999X + 68.1175$
Cl & *TH*	*Cl*	*TH*	16	168.0728	82.2861	303	148.7	0.7479	$Y = 1.3515X + 75.8496$
Mg & *CaH*	*Mg*	*CaH*	16	148	94.92	155	62.81	0.7691	$Y = 0.5089X + 79.6828$
TS & *CaH*	*TS*	*CaH*	16	1428.75	650.0038	155	62.81	0.6762	$Y = 0.0653X + 61.7026$
TDS & *CaH*	*TDS*	*CaH*	16	1175	653.54	155	62.81	0.7313	$Y = 0.0703X + 72.3975$
Cl & *CaH*	*Cl*	*CaH*	16	168.0728	82.2861	155	62.81	0.6699	$Y = 0.5113X + 69.0644$
TS & *MgH*	*TS*	*MgH*	16	1428.75	650.0038	148	62.81	0.8026	$Y = 0.1172X - 19.4396$
TDS & *MgH*	*TDS*	*MgH*	16	1175	653.54	148	62.81	0.8930	$Y = 0.1297X - 4.3825$
Cl & *MgH*	*Cl*	*MgH*	16	168.0728	82.2861	148	62.81	0.7288	$Y = 0.8407X + 6.7080$
TS & *Cond.*	*TS*	*Cond.*	16	1428.75	650.0038	1565.7	937.89	0.7006	$Y = 1.0109X + 121.3086$
TDS & *Cond.*	*TDS*	*Cond.*	16	1175	653.54	1565.7	937.89	0.6915	$Y = 0.9923X + 399.6512$
TDS & *TS*	*TDS*	*TS*	16	1175	653.54	1428.75	650.0038	0.9430	$Y = 0.9379X + 326.7611$
Cl & *TS*	*Cl*	*TS*	16	168.0728	82.2861	1428.75	650.0038	0.6434	$Y = 5.0823X + 574.5545$
Cl & *TDS*	*Cl*	*CaH*	16	168.0728	82.2861	1175	653.54	0.7449	$Y = 5.9161X + 180.6718$
TH & *pH*	*TH*	*pH*	16	303	148.7	7.7687	0.2792	– 0.6401	$Y = -0.0012X + 8.1329$
Ca & *pH*	*Ca*	*pH*	16	155	62.81	7.7687	0.2792	–0.6474	$Y = -0.0029X + 8.2149$
Cond. & *pH*	*Cond.*	*pH*	16	1565.7	937.89	7.7687	0.2792	–0.6062	$Y = -0.0002X + 8.0513$
TS & *pH*	TS	*pH*	16	1428.75	650.0038	7.7687	0.2792	–0.7384	$Y = -0.0003X + 8.2220$
TDS & *pH*	TDS	*pH*	16	1175	653.54	7.7687	0.2792	–0.7366	$Y = -0.0003X + 8.1386$
Cl & *pH*	*Cl*	*pH*	16	168.0728	82.2861	7.7687	0.2792	–0.7314	$Y = -0.0025X + 8.1860$

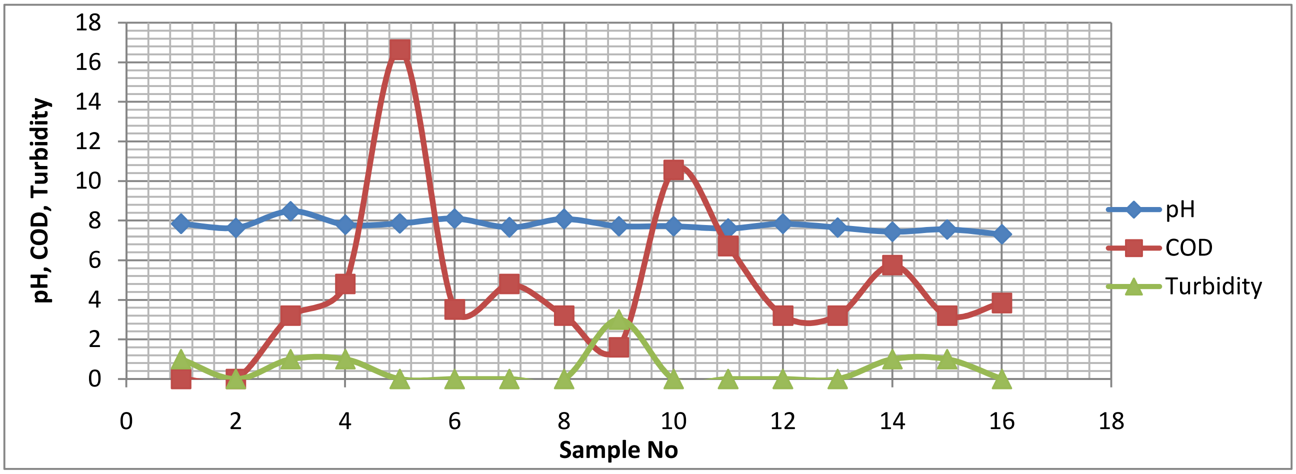

Figure No. 2: pH, COD, Turbidity variations during the study period

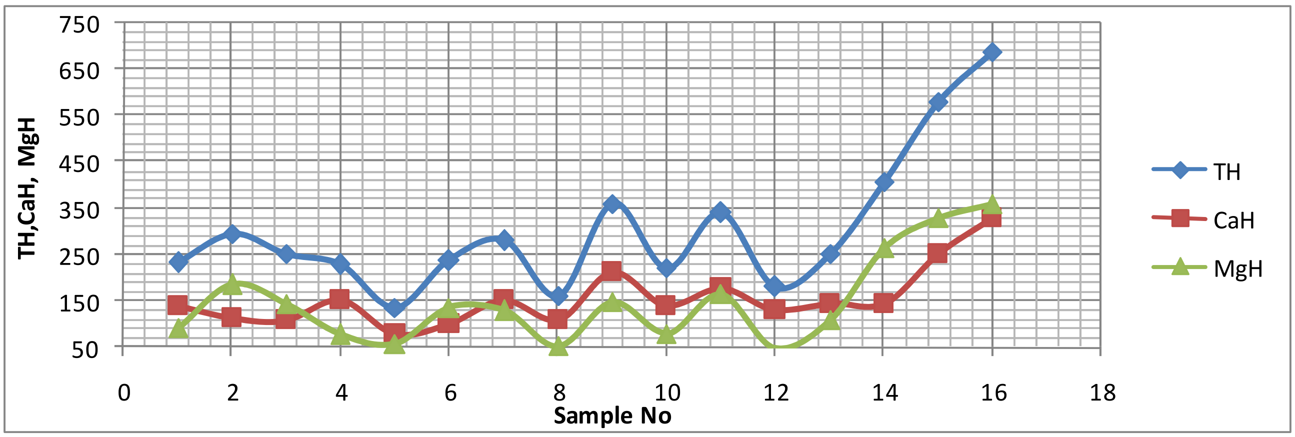

Figure No. 3: Total Hardness, Calcium Hardness, Magnesium Hardness variations during the study period

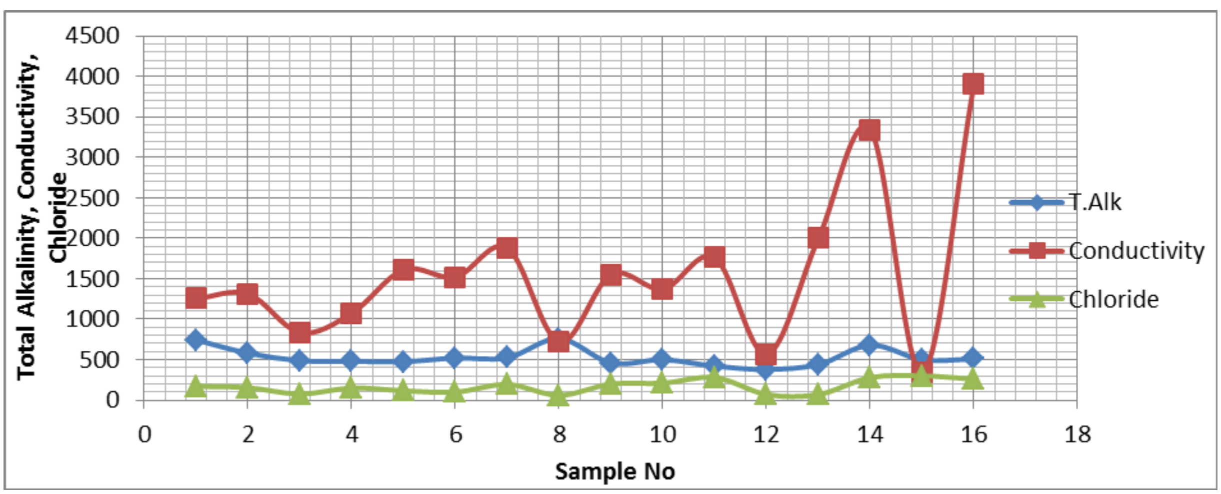

Figure No.4: Total Alkalinity, Conductivity, Chloride variations during the study period

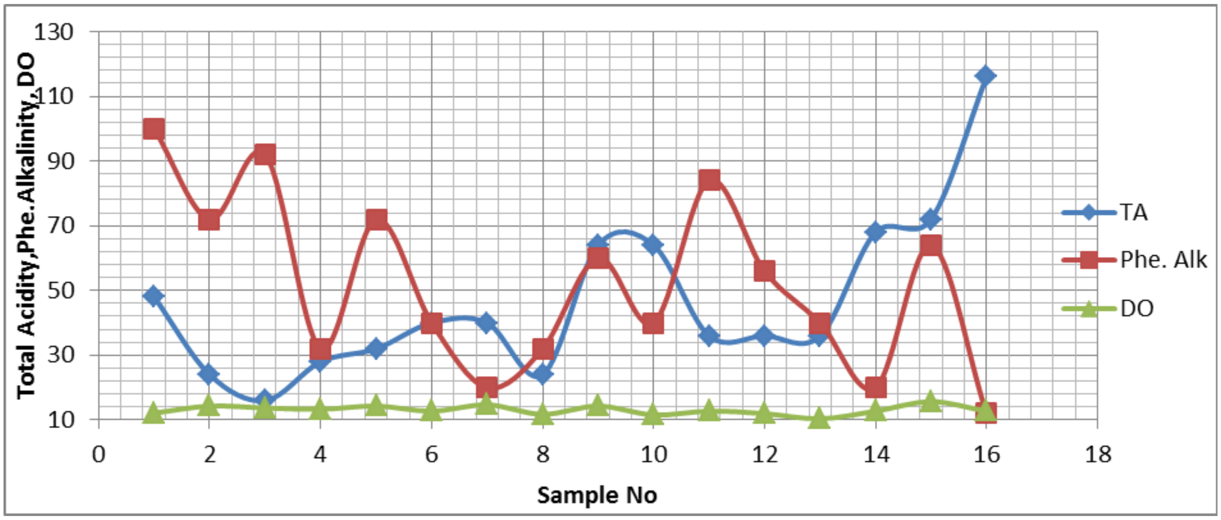

Figure No.5: Total Acidity, Phenolphthalein Alkalinity, DO variations during the study period

Correlation and Regression Analysis

The values of regression coefficient are more than 0.90 i.e. there is more than 90% association in data and this correlation coefficient measures the degree of association. The greater the value of regression coefficient, the better is the fit and more useful the regression variables. Considerably, significant highest positive correlation has been observed between *Mg* and TH (r = 0.9629), *Mg* and *Ca*H (r = 0.7691), TDS and *Mg*H (r = 0.8930), TDS and Conductivity(r = 0.7006), TDS and TS (r = 0.9430), Chloride and TDS(r = 0.7449) similarly highest negative correlation has been observed between the parameters *Ca*H and pH(r = -0.6474), TS and pH(r = -0.7384). In our study the correlation is said to be perfect as the deviation in one variable is followed by a corresponding and proportional deviation in the other. The value of correlation coefficient lies between -1 and +1. The high values of correlation co-efficient, r as shown in Table 4, were observed for the regression analysis, regression equations were formed and regression lines are drawn as shown in Figures 6, 7, 8, 9, 10, 11, 12 and 13 respectively.

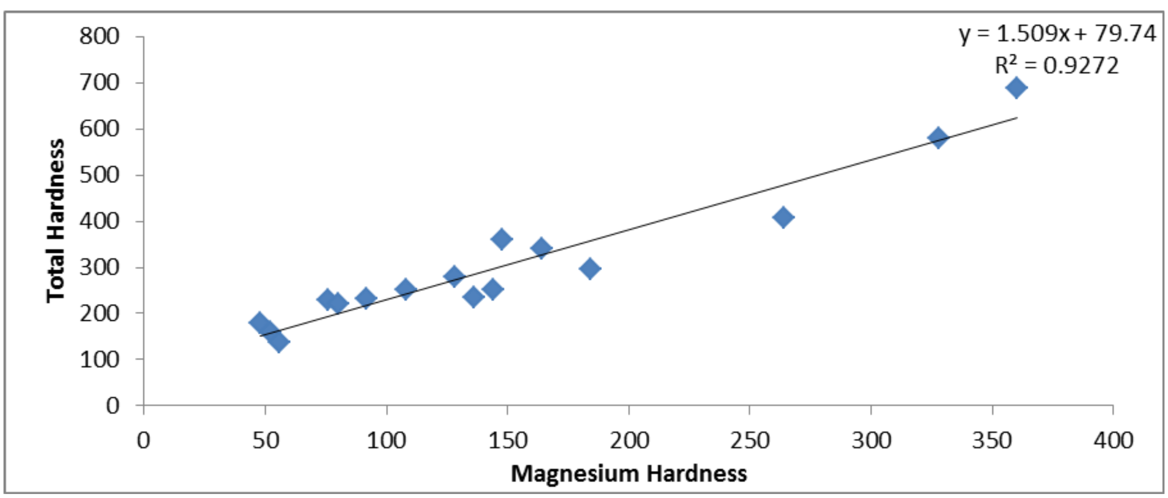

Figure No. 6: Regression Line for Total Hardness v/s Magnesium Hardness in mg/l

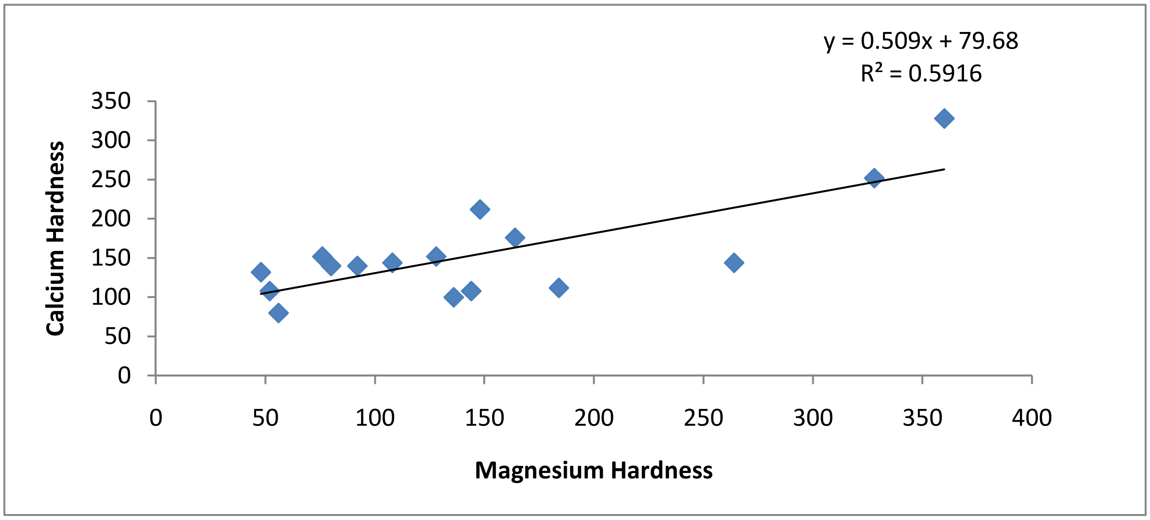

Figure No.7: Regression Line for Calcium Hardness v/s Magnesium Hardness in mg/l

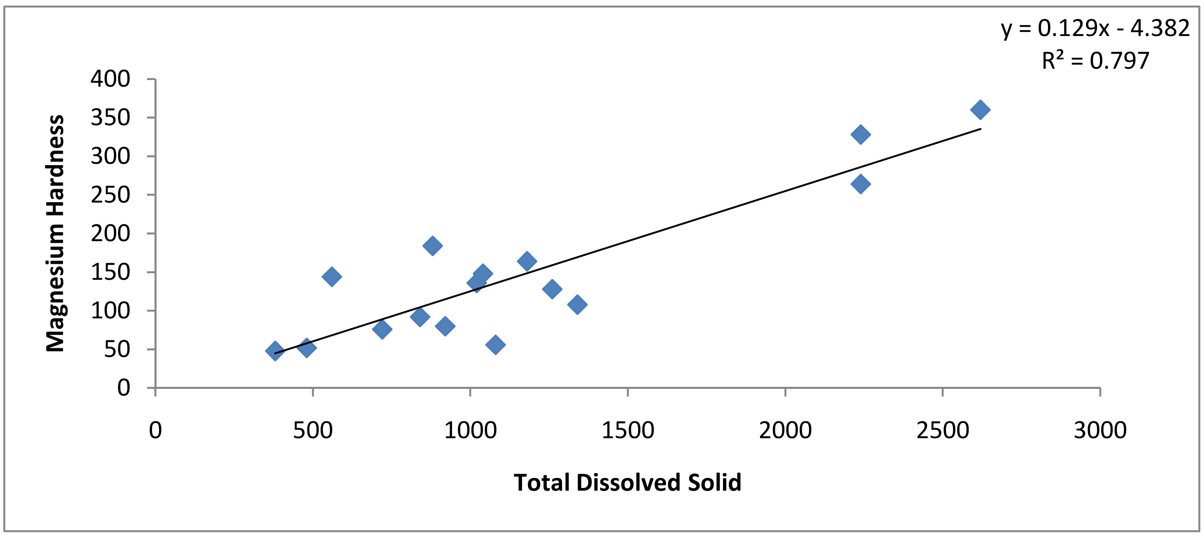

Figure No.8: Regression Line for Magnesium Hardness v/s Total Dissolved Solid in mg/l

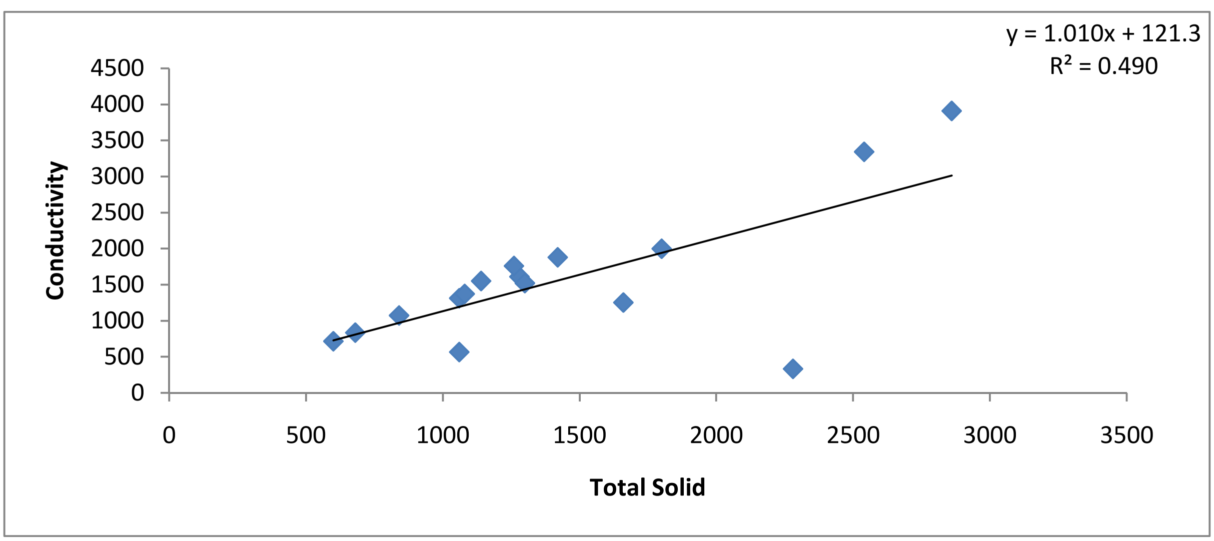

Figure No.9: Regression Line for Conductivity v/s Total Solid in mg/l

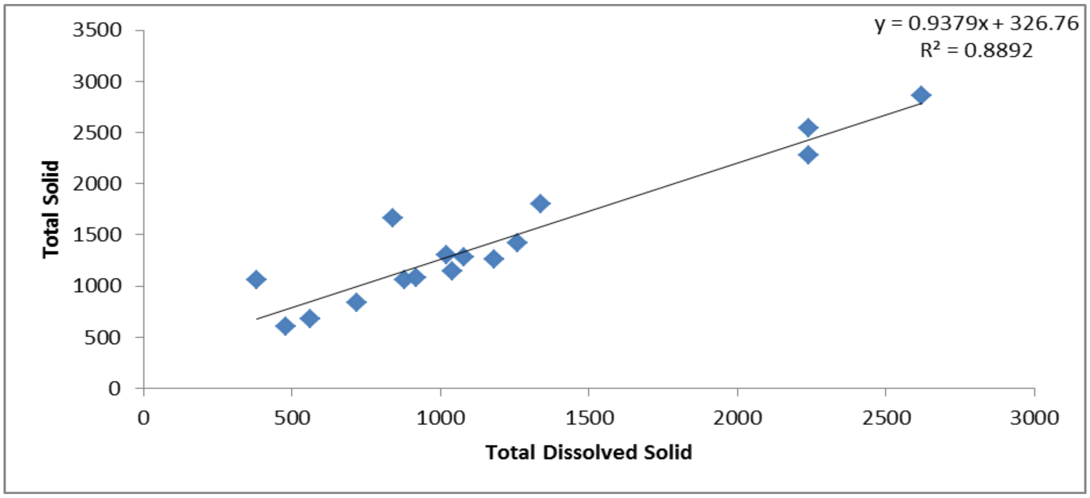

Figure No.10: Regression Line for Total Solid v/s Total Dissolved Solid in mg/l

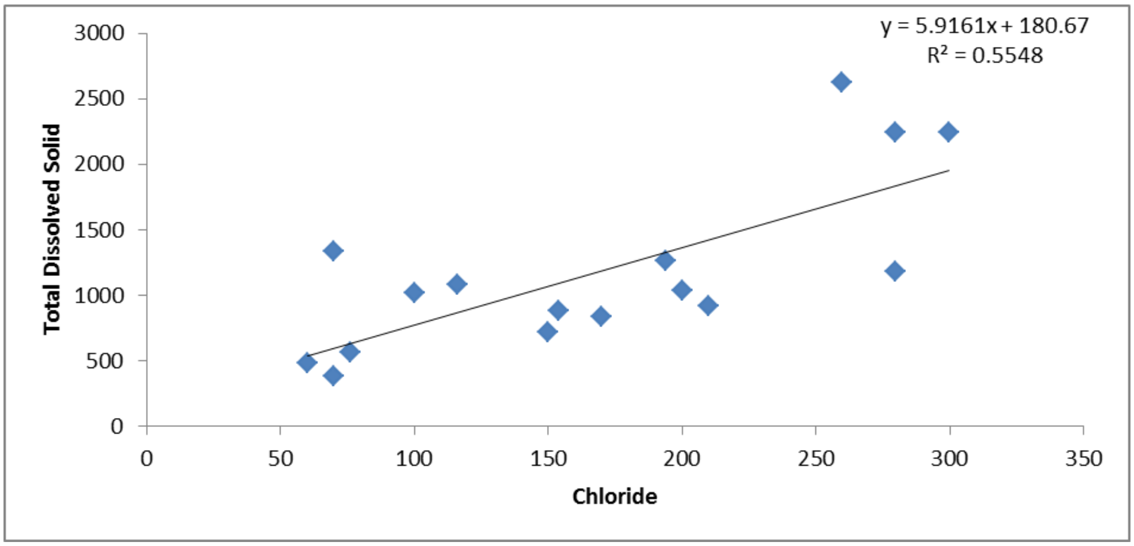

Figure No.11: Regression Line for Total Dissolved Solid v/s Chloride in mg/l

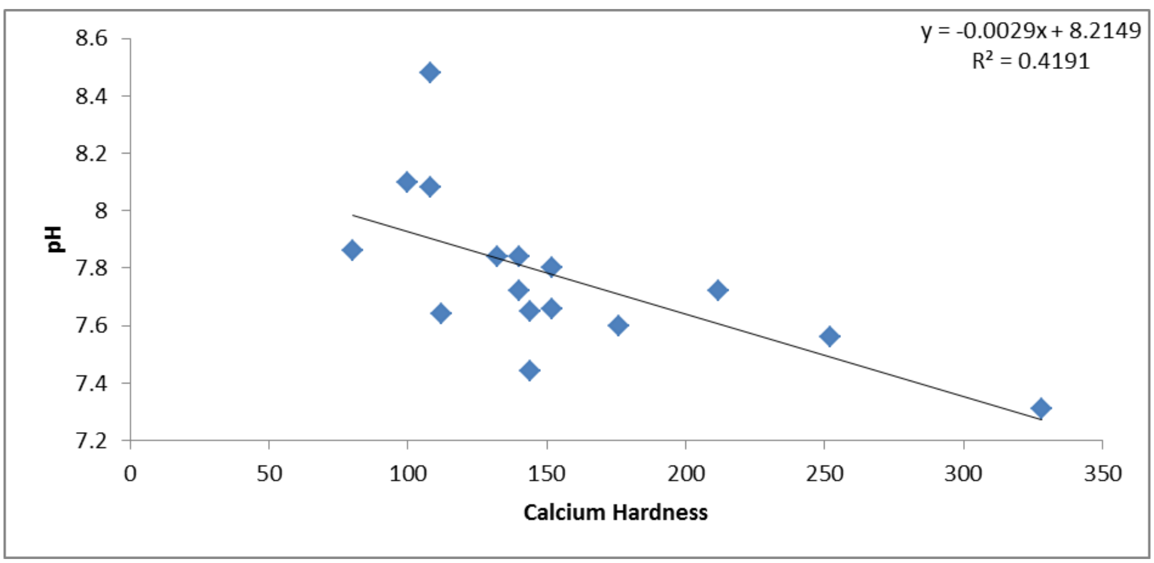

Figure No.12: Regression Line for pH v/s Calcium Hardness in mg/l

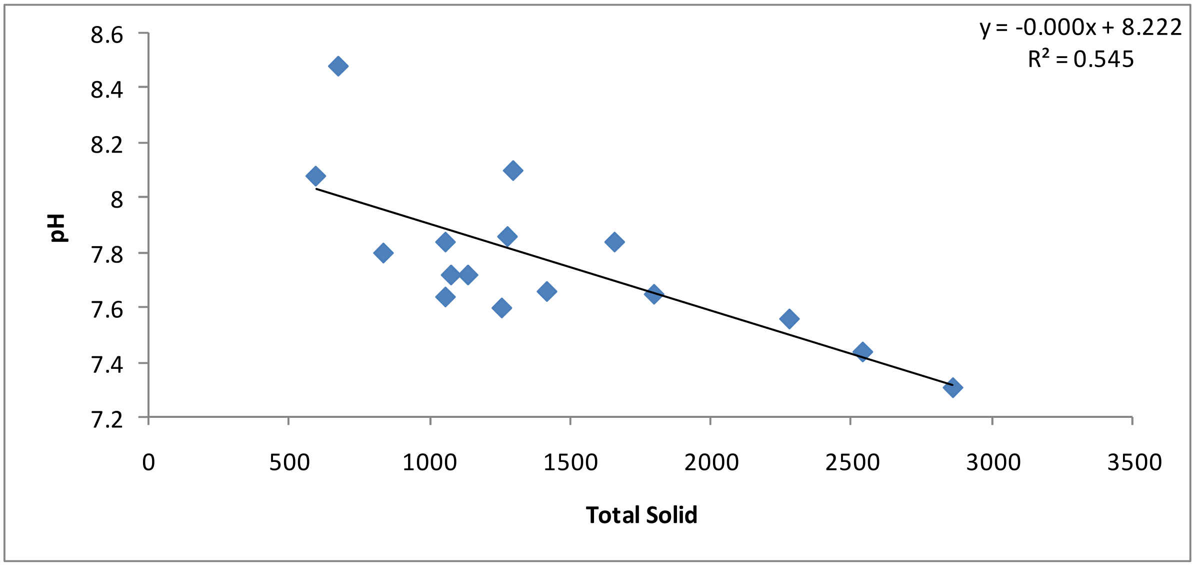

Figure No.13: Regression Line for pH v/s Total Solid in mg/l

CONCLUSION

The statistical regression analysis has been found a highly useful technique for the linear association between various physicochemical parameters and it may be treated as one step ahead towards the drinking water quality management. A linear regression analysis technique has been proven to be a very useful tool for monitoring drinking water and has a good accuracy. A systematic correlation and regression in this study shows that there is a significant linear relationship among different pairs of water quality parameters. The linear correlation is very useful to get fairly accurate idea of quality of the ground water by determining a few parameters experimentally. It can be concluded that the total dissolved solids and electrical conductivity are important physicochemical of drinking water quality parameters, because they are correlated with most of the water parameters. This study showed or proved that all the physicochemical parameters of drinking water in Aligarh city are more or less correlated with each other, especially strong correlation observed between Total Hardness & Magnesium and Total Dissolved Solid & Total Solid.

ACKNOWLEDGEMENT

The authors are thankful to the concerned authorities of A.M.U., Aligarh for providing facilities to carry out this work.

REFERENCES

Ahmed A.Al-Othman. (2011). Correlation between some groundwater chemical parameters and soil texture index of different soils irrigated with treated domestic wastewater. Res. J. Env. Sciences: Vol.5, 7. 666-673.

APHA, AWWA and WPCF (1995) Standard methods for the examination of water and waste water. 19th Ed., APHA New York.

Dash J.R, Dash P.C. and Patra H.K. (2006). A Correlation and regression study on the ground water quality in rural areas around Angul-Talcher industrial zone. IJEP: Vol.26, 6. 550.

Heikka R.A. (2007). Multivariate monitoring of water quality: A case study of Lake Simple. Finland. J. Chemomet.: Vo.22. 747-751.

Janardhana R.N, Shukla U.K. and Prahlad R. (2010). Hydrogeochemistry for the assessment of groundwater quality in Varanasi: a fast urbanizing center in Uttar Pradesh, India. Environ Monit Assess: Vol.173. 279-300.

Jarvie H.P, Whitton B.A, and Neal C. (1998). Nitrogen and phosphorus in east coast British rivers, speciation, sources and biological significance. Sci. Total Env.: Vol. 210/211. 79-109.

Joarder M.A.M, Raihan F, Alam J.B, and Hasanuzzaman S. (2008). Regression analysis of groundwater quality data of Sunamganj District, Bangladesh. Int. J. Env. Res.: Vol.2, 3. 291-296.

Jothivenkatachalam K, Nithya A and Chandra Mohan S. (2010). Correlation analysis of drinking water quality in and around perur block of Coimbatore district, Tamil Nadu, India. Rasayan J. Chem.: Vol.3, 4. 649-654.

Kumar N and Sinha D.K. (2010). Drinking water quality management through correlation studies among various physicochemical parameters: a case study. Int. J. Env. Sci.: Vol.1, 2. 253-259.

Liao S.W, Gau H.S, Lai W.L, Chen J.J. and Lee C.G. (2007). J. Env. Manag: Vol.88, 2. 286.

Mahvi A.H, Nouri J.A, Babiei A, and Nabizadeh R. (2005). Int. J. Env. Sci. Tech.: Vol.2, 1. 41.

Marie A and Vengosh A. (2001). Sources of salinity in ground water from Jericho area, Jordan Valley. Ground water: Vol.39, 2 .240-248.

Nouri J.A, Karbassi R, and Mirkia S. (2008). Environmental management of coastal regions in the Caspian Sea. J. Env. Sci. Tech.: Vol.5, 1. 43-52.

Patil V.T, Patil P.R. (2010). Physicochemical analysis of selected groundwater samples of Amalner Town in Jalgaon District, Maharashtra, India. Electronic J. Chem.: Vol.7, 1. 111-116.

Rajesh kumar and Yadav, S.S. (2011). Correlation analysis of ground water quality in and around shahzad nagar block of rampur district, Uttar Pradesh, India. Int. J Chem. Sci: Vol.9, 1. 440-447.

Raju N.J, Ram P. and Dey S. (2009). Groundwater quality in the lower Varuna river Basin, Varanasi District, Uttar Pradesh. J. Geo. Soc. India: Vol.73, 2. 178-192.

Ranjan S.P, Kazama S and Sawamoto M. (2006). Effects of climate and land use changes on groundwater resources in coastal aquifers. J. Env. Manag. Vol.80, 1. 25-35.

Sajil Kumar, P.J, Jegathambal P and James E.J. (2011). Assessment of hydrochemistry and groundwater quality in the coastal area of South Chennai, India. Int. J. of Biology: Vol.5, 4.

Shrestha R.A, Kafle B.K and Sillanpaa M. (2010) Water quality of Dhulikhel area. Nepal Res. J. Chem. Env.: Vol.14, 2. 36–38.

Singh A.K, Mondal G.C, Kumar S, Singh T.B, Tewari B.K, Sinha A. (2008) Major ion chemistry, weathering processes and water quality assessment in upper catchments of Damodar River basin. *India. Env. Geo.* Vol.54. 745-758.

Singh A.K, Raj B, Tiwari A.K. and Mahato M.K. (2013). Evaluation of hydrogeochemical processes and groundwater quality in the Jhansi district of Bundelkhand region, India. Env. Earth Sci.: Vol.70, 3. 1225-1247.

Singh P.K, Tiwari A.K. and Mahato M.K. (2013). Qualitative Assessment of Surface Water of West Bokaro Coalfield, Jharkhand by Using Water Quality Index Method. Int. J. Chem. Tech. Res.: Vol.5, 5.

Singh P, Tiwari A. K. and Singh P. K. (2014). Hydrochemical characteristic and Quality Assessment of Groundwater of Ranchi Township Area, Jharkhand, India. Current World Environment: Vol.9, 3. 804-813.

Sonawane V.Y. and Khole A.M. (2010). Water quality of some drinking waters in Parbhani city: a case study. J. Chem. Pharm. Res.: Vol.2, 5. 104-107.

Tiwari A.K, Singh P.K. and Mahato M.K. (2014). GIS-Based Evaluation of Water Quality Index of Groundwater Resources in west Bokaro Coalfield, India. Current World Environment: Vol.9, 3. 843- 850.

Tiwari, A.K, and Singh, A.K. (2014). Hydrogeochemical investigation and groundwater quality assessment of Pratapgarh district, Uttar Pradesh, J. Geo. Soc. India: Vol.83, 3. 329-343.

Xiang H, Mika S, Bu D, Egil T, Gjessing. (2008). Water quality in the Tibetan plateau Metal contents of four selected rivers. Env. Poll. Vol.156, 2. 270-277.

Xiang H, Mika S, Gjessing E.T, and Vogt R.D. (2009). Water quality in the Tibetan plateau: major ions and trace elements in the hard waters of four major Asian rivers. Env. Poll.: Vol.407, 24. 270-277.

ISSN : 0976-4550

INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

Email : ijabpt@gmail.com

Website: www.ijabpt.com