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STUDY OF HYDROCHEMISTRY OF WAINGANGA RIVER DESAIGANJ(WADSA) IN GADCHIROLI DISTRICT OF MAHARASHTRA STATE (INDIA),WITH REFERENCE TO CORRELATION STUDY.

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ABSTRACT

In present study the physico-chemical parameters of the Wainganga river at Desaiganj (Wadsa) in Gadchiroli district of Maharashtra are studied during July 2013 to June 2014 from four different sites. These samples are analyzed for physico-chemical parameters like temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), total alkalinity (TA), total hardness (TH),calcium (Ca^{2+}), magnesium (Mg^{2+}),chloride (Cl^{-}), fluoride (F^{-}), iron (Fe^{2+}), sulphate ($SO_4^{-\ -}$), nitrate (NO_3^{-}) and phosphate (PO_4^{3-}) are determined. The results are compared with standards prescribed by WHO. An attempt has also been made to establish coefficient of correlation between above parameters to identify water quality. Monthly variation appeared to have influenced on water parameters. Statistical analysis shows that many of the parameters bear a good positive correlation and some bear a negative correlation.

Key words : *Hydrochemistry, Coefficient of correlation, Water quality, Wainganga river water, Desaiganj (Wadsa), Gadchiroli district.*

Introduction: Water is second to oxygen as being essential for life. People can survive days, weeks as even longer without food but only about four days without water [1] .Earth is also called as "blue planet" because 70 % area of it has been covered by water resource. The total water amount on the earth is about 1.35 billion cubic kilometers. About 97.1 % has been locked into oceans as saltwater. Ice sheets and glaciers have arrested 2.1 %. Only 0.2 % is the fresh water present on the earth, which can be used by human for variety of purposes. Remaining 0.6 % is in underground form. Surface water resources have played an important role throughout history in the development of human civilization. About one third of the drinking water requirement of the world is obtained from surface sources like rivers, canals and lakes.It is a fact that good water quality produces healthier humans than one with poor water quality [2] . Water is one of the most common yet the most precious resources on earth without which there would be no life on earth. Pollution is a serious problem, as almost 70% of Indian water resources and a growing number of its water reserves have been contaminated by biological, organic and inorganic pollutants.

River Wainganga, the most sacred and important river of Gadchiroli District, is regarded as the life-line of Gadchiroli District. The Wainganga River is the main river which flows along the border of the Chandrapur and Gadchiroli district.Though the water is primarily use to satisfy the drinking needs of people near the river. However, the recent population explosion, unplanned urbanization, industrialization, changes inland use pattern and life style of inhabitants in the vicinity of rivers exerted enormous pressure on this natural resources and thereby bringing about degradation to a greater extent. Rapidly increasing population indiscriminate urbanization and unplanned industrialization along the rivers as well as in the catchment areas have put tremendous stress on water resources and their quality. Indiscriminate discharge of

industrial effluent in rivers has been a common phenomenon leading to sever depletion of water quality and aquatic life.The waste containing heavy metals produced by industries are released directly into aquatic resources including rivers without any or with only partial pre-treatment. Heavy metals thus discharged persist in the aquatic bodies and bioaccumulate along the food chain [3].

The maintenance of healthy aquatic ecosystem is depended on the physico-chemical properties and biological diversity.Nowadays naturally existing dynamic equilibrium of water bodies like rivers, lakes and canals are affected by the human activities [4]. Factors that are directly or indirectly polluting the river ecosystems includes population growth, unplanned growth of city area, urbanization, agricultural land expansion and lack of awareness among the local residents. All such activities and pollution causing factors are decreasing the utility of water day by day .

During last decade, this is observed that the ground water get polluted drastically because of the increased human activities The river water is becoming polluted due to discharge of industrial effluents, domestic, and other various sources which need special attention Physico-chemical analysis is the prime consideration to assess the quality of water for its best usage say for drinking, bathing, fishing, industrial processing and so on, Therefore, the objective of this study was to assess the quality of river Wainganga at four sites.

Material and Method

Study Area : Desaiganj (Wadsa) is a town and taluka of Gadchiroli district, in the Nagpur division of the Central Provinces. The town is situated on the left bank of the River Wainganga, The Wainganga is a river of India which originates about 12 km from Mundara village of Seoni district in the southern slopes of the Satpura range of Madhya Pradesh, and flows course of approximately 360 miles. After joining the Wardha, the united stream, known as the Pranahita, ultimately falls into the Godavari river at Kaleshwaram, Telangana [5].

Sampling and Collection of water samples : With the objective in view the present work is planned to assess the quality of water from four different sites of Wainganga river in Gadchiroli district for physico-chemical parameters and the results are compared with the standards given by WHO to determine the extent of pollution. Water samples were collected in the double stoppered polythene containers of two liters capacity in the first week of each month once in a month, from the four selected sites at 9.00am to 11.00am of River Wainganga for analyzing the water quality parameters within a period of 12 months from July 2013 to June 2014.

The main objective of study is :

. To evaluate the physico – chemical properties of water.

. To compare the result with WHO [6,7].

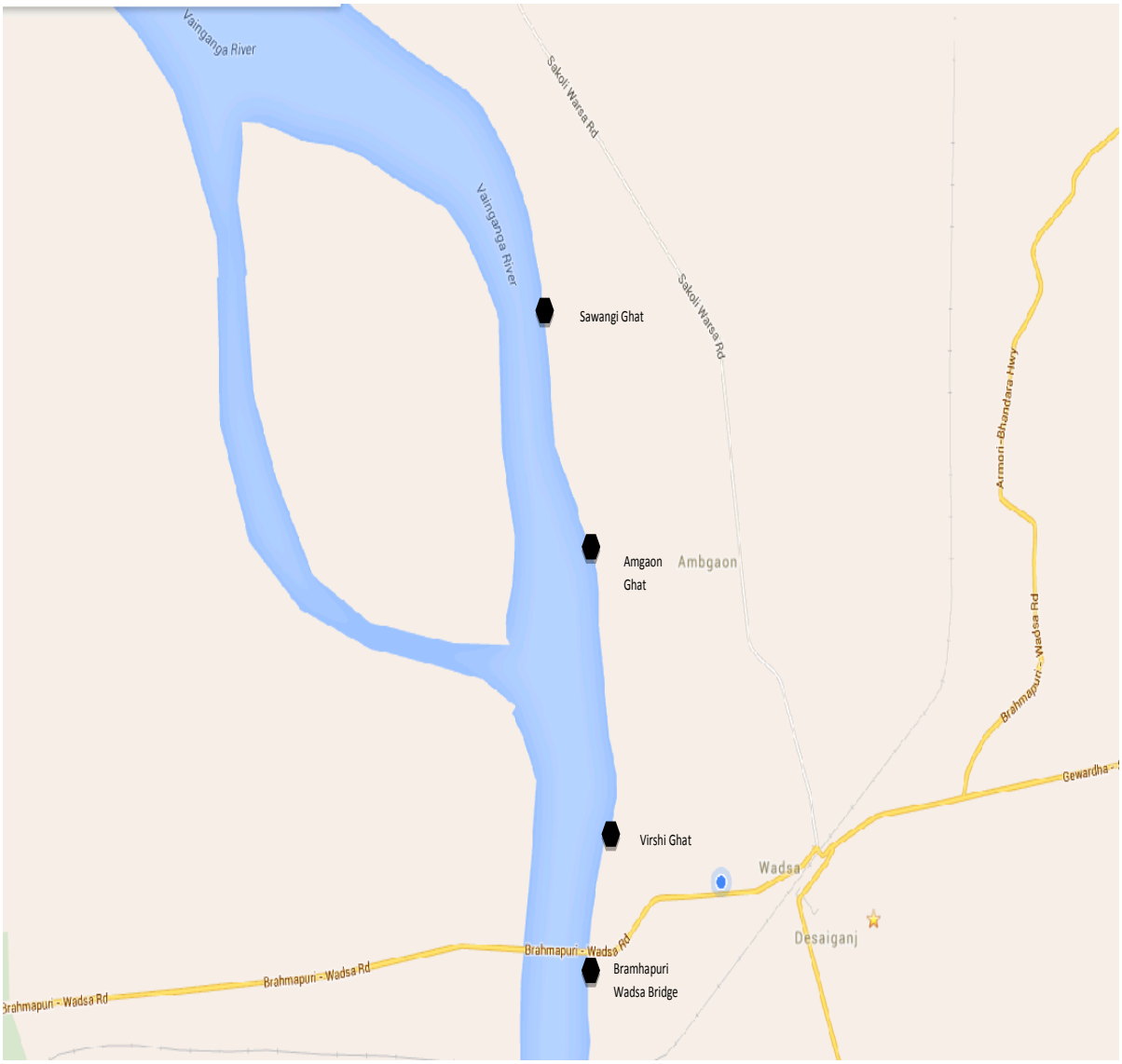
Table 1: Sampling sites of Wainganga river at Desaiganj (Wadsa)

Sampling sites	Place
W_1	Near bridge on Desaiganj-Bramhapuri highway
W_2	Virshi Ghat
W_3	Amgaon Ghat
W_4	Sawangi Ghat

Methodology:

The temperature, pH, conductivity and total dissolved solids of the water samples are determined on the spot using a thermometer, pH meter, conductometer and TDS meter respectively. The physico-chemical analysis of samples of drinking water are carried out according to standard methods of APHA. [8]

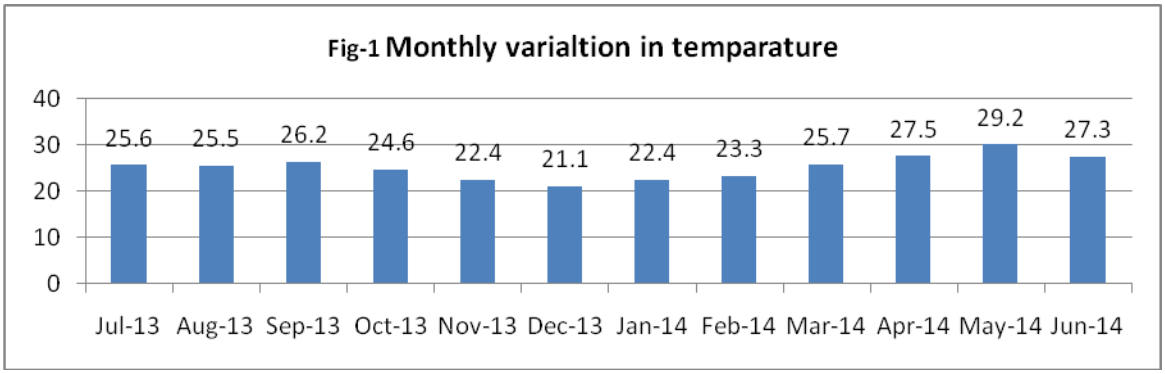
MAP OF WAINGANGA RIVER – DESAIGANJ WADSA AREA (Showing Four Spots)



Result and Discussion The water from the study area has no colour and no odour. Taste of the water in most of the locations pleasant in taste. The physico-chemical characteristic provides a fair idea of the water quality in any water body. The results of the monthly variation in the physico-chemical parameters of Wainganga River are summarized in table 2 . Here the values are the mean values of four different sites (W_1 to W_4) and these values are compared with standards given by WHO.

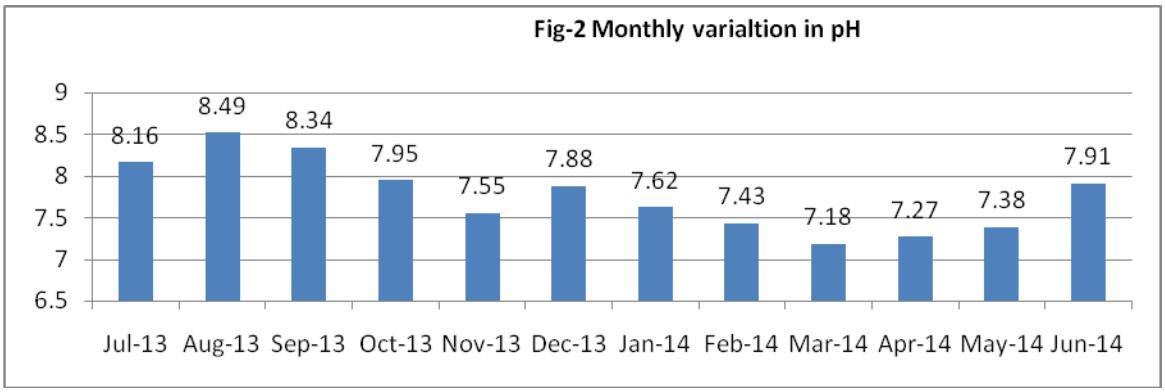
Temperature

In an established system, the temperature of water controls the rate of all chemical reactions and affect fish growth, reproduction and immunity. Drastic temperature changes can be fatal to fish. [9] In the present study, temperature ranges from 21.1^{0}C to 29.2^{0}C. Similar results were reported by Shivanikar et.al.(1999) [10] in the river Godavari. The low water temperature in the winter might be due to high water levels and lower solar radiation whereas maximum in the summer might be due to low water level, greater solar radiation and clear atmosphere.



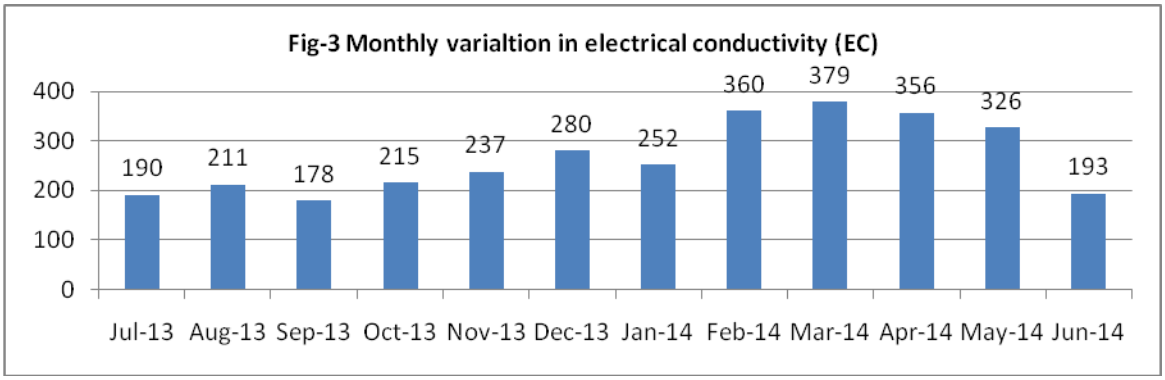
pH

pH that maintains the acidic or basic property, is a vital characteristic of any aquatic ecosystem since all the biochemical activities and retention of physico-chemical attributes of the water are greatly depend on pH of the surrounding water. Most of the similar study suggested that water samples are slightly alkaline due to presence of carbonates and bicarbonate [11,12] . In present study the pH value varies between 7.18 to 8.49, which are within the permissible limit of WHO. Which found minimum in Summer and maximum in monsoon. Similar results were reported by Mohd. Abdur Rafiq and Khan, (2002) in the river Godavari. [13]



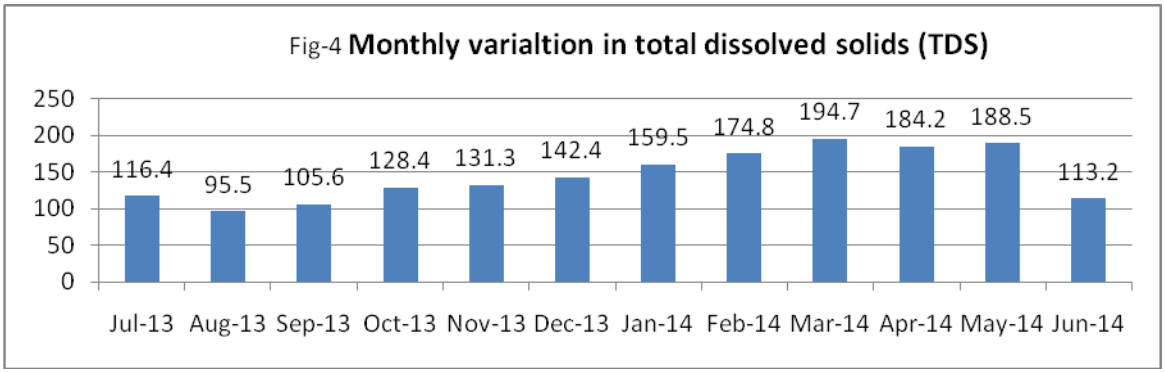
Electrical Conductivity (EC)

Electrical conductivity (EC) is the measure of water capacity to convey electric current, it signifies the amount of total dissolved salts. In present study EC value varies from 178 to 379 micro-Siemens, which are within the permissible limit of WHO. Which found minimum in monsoon and maximum in Summer. The maximum value during summer might be due to increased concentration of dissolved solids, usually due to less flow of water, increased evaporation.Similar results were reported by Bobdey (2002) in the river Wainganga, Pauni, Dist:Bhandara and Dahegaonkar (2008) in the three lotic ecosystems, Chandrapur. [14,15]



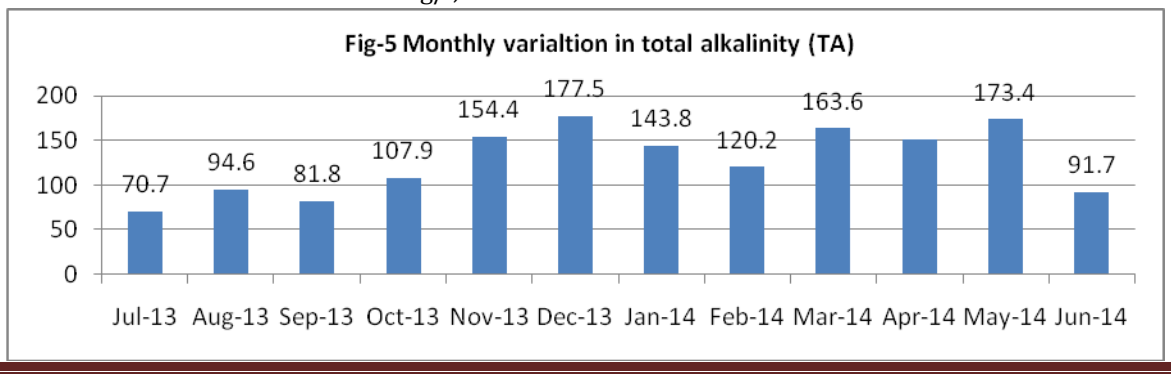
Total Dissolved Solids (TDS)

Total dissolved solids (TDS) indicates the general nature of water quality or salinity. In present study TDS value varies from 95.5 to 194.7 mg/l, which are within the permissible limit of WHO. Which found minimum in monsoon and maximum in Summer. Higher values in summer might be due to more rate of evaporation and less flow of water. Similar result were reported by Chavan (2009) in Wainganga river near Bramhapuri District Chandrapur [16].



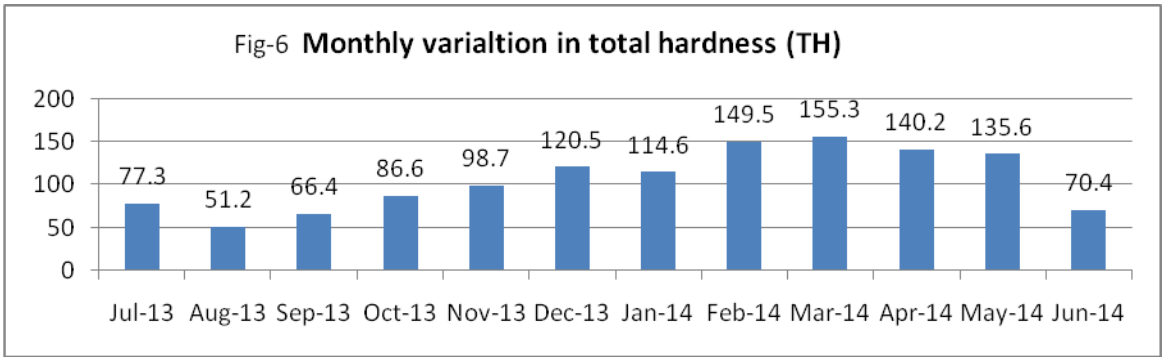
Total Alkalinity (TA)

Total Alkalinity (TA) of water is its capacity to neutralize acids and it is normally due to the presence of bicarbonates, carbonates and hydroxide compound of calcium, sodium and potassium. In present study, the alkalinity values varies from 70.7 to 177.5 mg/l, which are within the permissible limit of WHO. Which found minimum in monsoon and maximum in Winter. Similar result were reported by Chopra et. al. (1993) in Yamuna river [17].



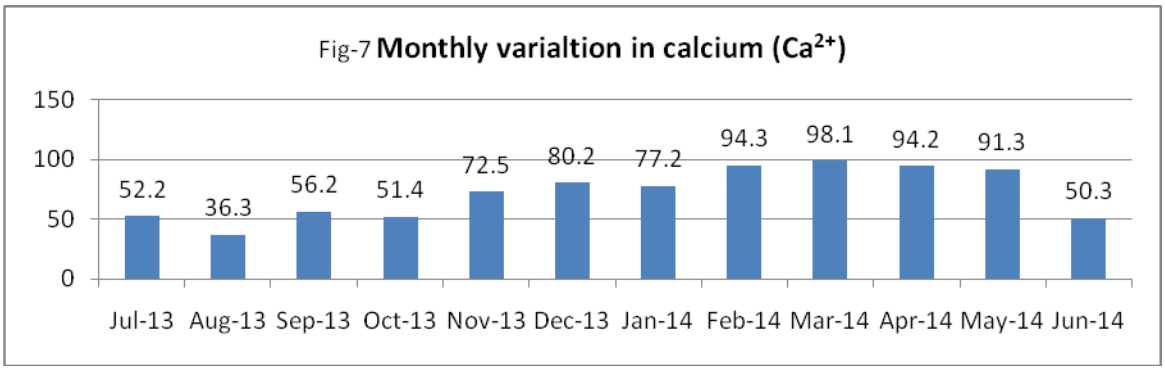
Total Hardness (TH)

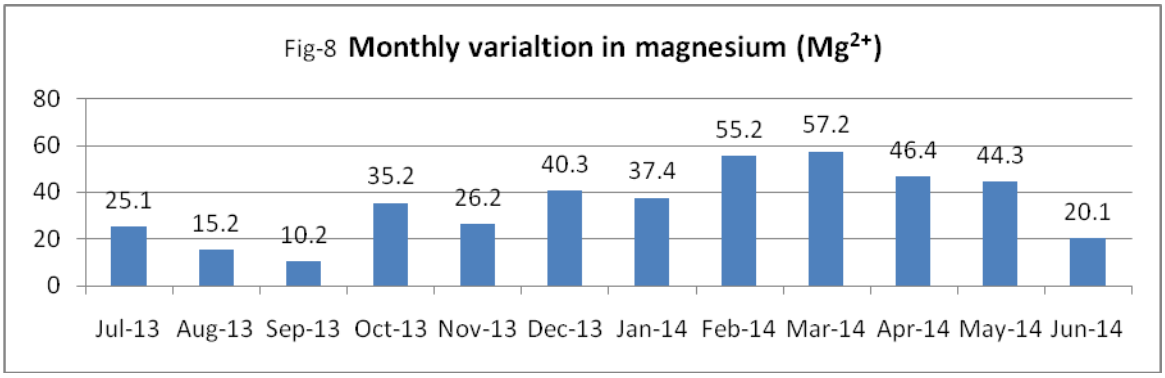
Total Hardness (TH) is the property of water which prevents the lather formation with soap and increases the boiling points of water [18] Hardness of water mainly depends upon the amount of calcium or magnesium salt or both. In present study TH value varies from 51.2 to 155.3 mg/l, which are within the permissible limit of WHO. Which found minimum in monsoon and maximum in Summer. Similar result were reported by Mohanta and Patra (2000) in Sanamachhakandana river [19].



Calcium (Ca^{2+}) and Magnesium (Mg^{2+})

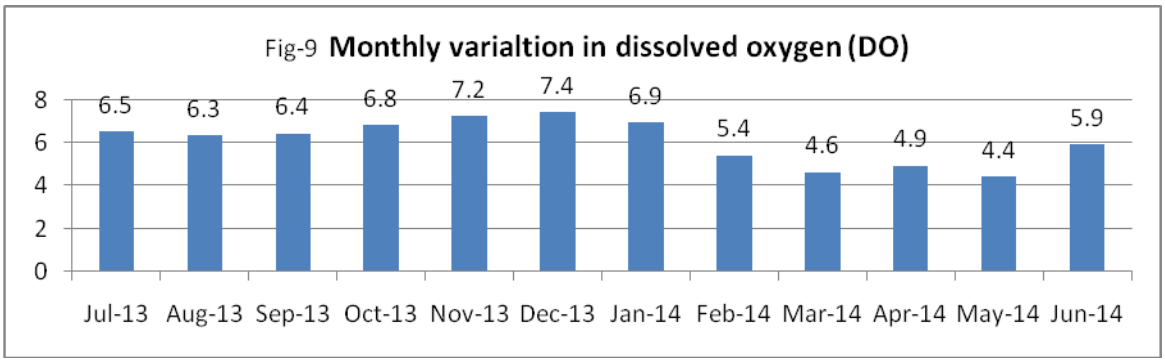
Calcium and magnesium are exist in surface and ground water mainly as carbonates and bicarbonates. Lake water contributed calcium as due to higher proportion of calcium in the surrounding rocks and soils which is essential for plant precipitation of lime, bone building etc. The main source of magnesium is sewage inflows and minerals generate from soil erosion and are important for enzyme activation, growth of chlorophyll and phytoplankton [20] . In present study Ca^{2+} value varies from 36.3 to 98.1 mg/l., whereas Mg^{2+} value varies from 10.2 to 57.2 mg/l, which are within the permissible limit of WHO. Which found minimum in monsoon and maximum in Summer. Similar result were reported by Mohanta and Patra (2000) in Sanamachhakandana river .





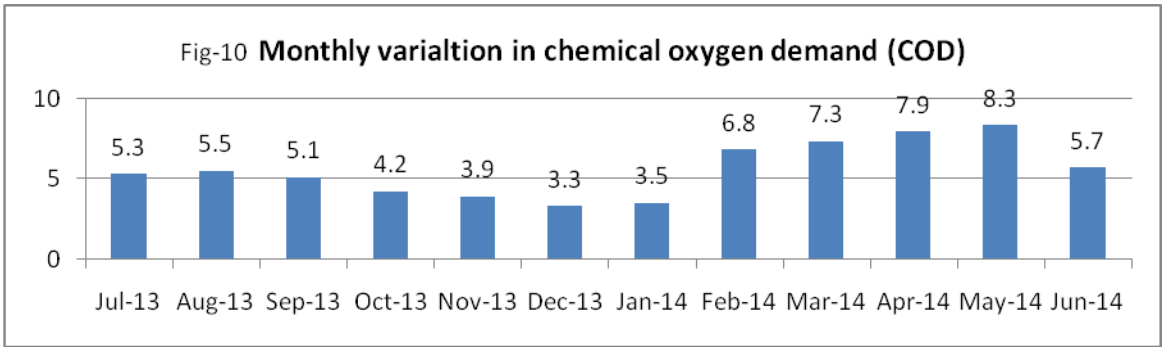
Dissolve Oxygen (DO)

Dissolved oxygen shows an inverse relationship with water temperature. Higher values of DO observed during winter, when temperature was lowest, might be due to the fact that the solubility of oxygen in water increases with decrease in temperature [21]. In present investigation DO values varies from 4.4 to 7.4 mg/l, which are within the permissible limit of WHO. Which found minimum in Summer and maximum in. winter . Similar result were reported by Zafar Javeed (1991) in Godavari river [22].



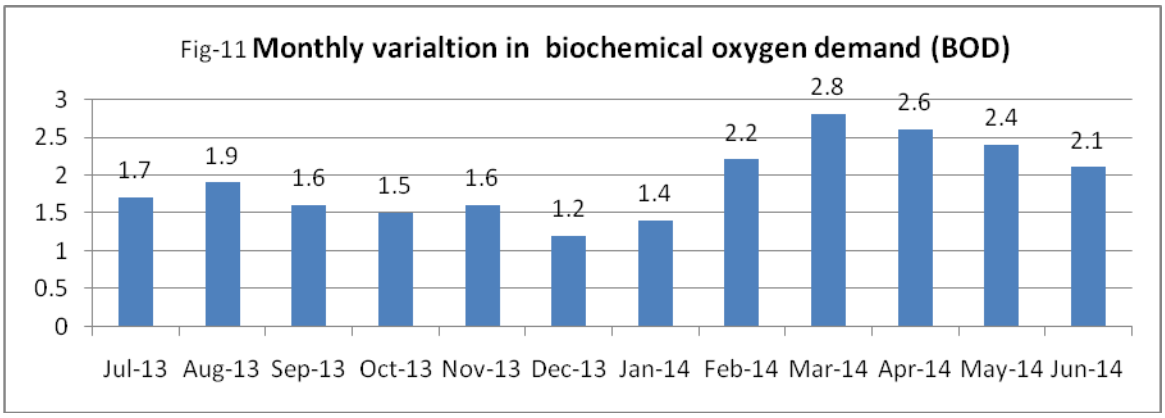
Chemical Oxygen Demand (COD)

Chemical oxygen demand may be define as, the amount of oxygen required by the organic matter present in the water for its oxidation by strong chemical oxidant. Chemical Oxygen Demand (COD) provides a measure of the oxygen equivalent of that portion of the organic matter in a water sample that is susceptible to oxidation under test condition. In present study, COD values varies from 3.3 to 8.3 mg/l, which are within the permissible limit of WHO. Which found minimum in winter and maximum in Summer. Similar result were reported by Srinivasrao et.al., (2007) in Godavari river [23].



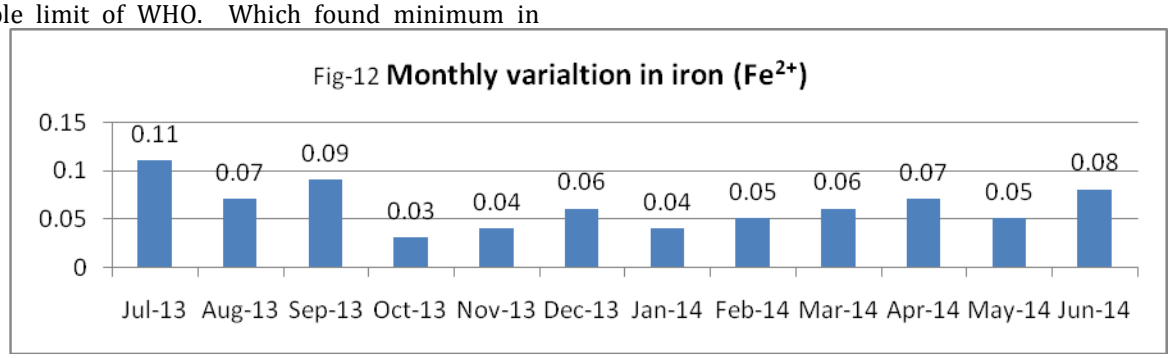
Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand (BOD) is an important parameter of water quality which measures the quantity of oxygen consumption by microorganisms during decomposition of organic matter. BOD is usually used for determining the oxygen demand of municipal or industrial discharge. High BOD indicates high scale contamination of organic matter in the water. Though high BOD is always accompanied by low DO level, counter result is obtained in our study which is comparable to the study of Anhwange on river Benue, Nigeria (Anhwange et al. 2012) [24].In present study, BOD values varies from 1.2 to 2.8 mg/l, which are within the permissible limit of WHO. Which found minimum in winter and maximum in Summer Similar result were reported by Malviya et.al. (1990) in Narmada river [25].



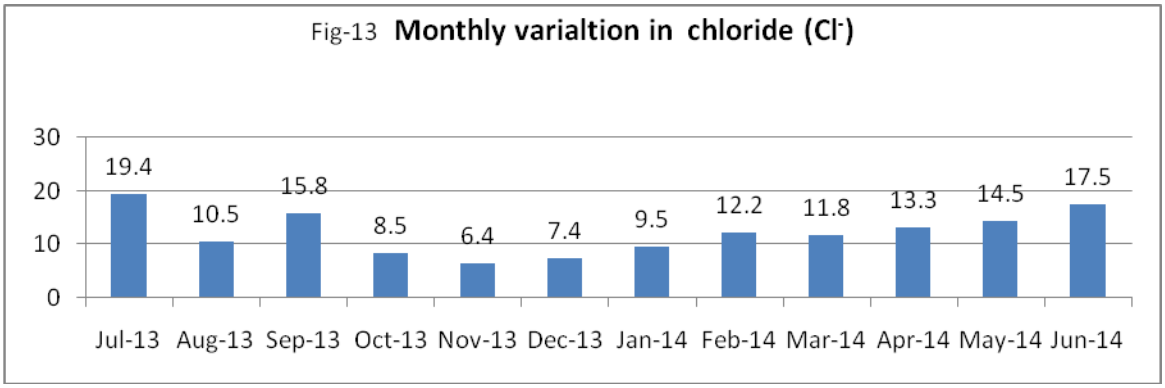
Iron (Fe^{2+})

Iron is one of the most important constituent of blood in human and other living organism. Iron is an essential element for human nutrition and metabolism but in excess quantities results in toxic effect like hemochromatosis in tissues. In present study, Fe values varies from 0.03 to 0.11 mg/l. which are within the permissible limit of WHO. Which found minimum in winter and maximum in monsoon. Pathak. H. et. Al. (2012) reported iron values are higher in monsoon , which could be due to acidification of water by elevated microbial degradation of organic debris and concentrated dissolved solids in monsoon period in Sagar city [26].



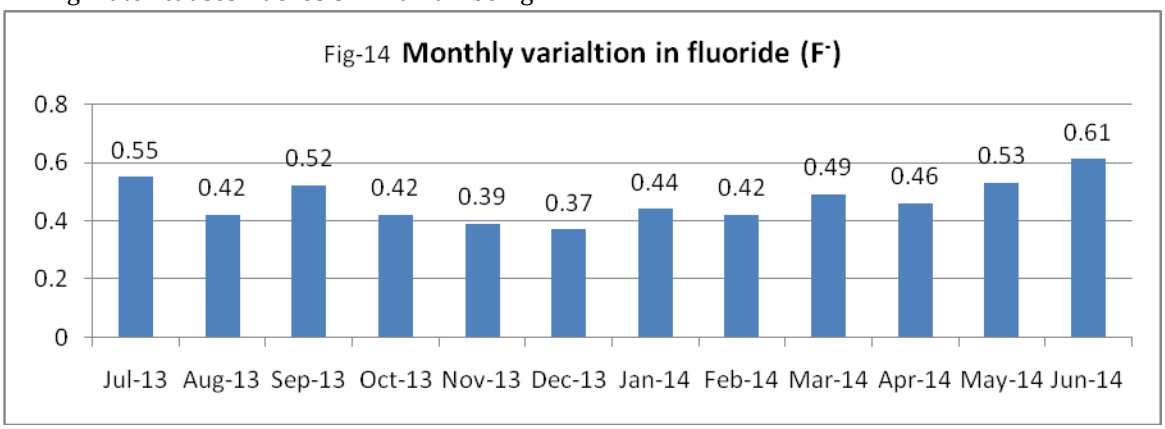
Chloride (Cl^-)

Main sources of chloride in river water are from industrial effluents, agricultural run-off, pesticides ,insecticides etc if present. Chloride gas is highly toxic but Chloride ions are essential for life [27]. The Chloride value varies from 6.4 to 19.4 mg/l. which are within the permissible limit of WHO. Which found minimum in winter and maximum in monsoon. Similar result were reported by Chugh, (2000) in the river Ganga [28]. High chloride ion concentration indicates organic pollution in water. The higher content of chlorine in water bodies in various seasons is due to animal origin like human faeces and sewage inflow from various industries which contain pesticides, polychlorinated biphenyls (PCBs). Chloride increases with the increasing degree of eutrophication.



Fluoride (F^-)

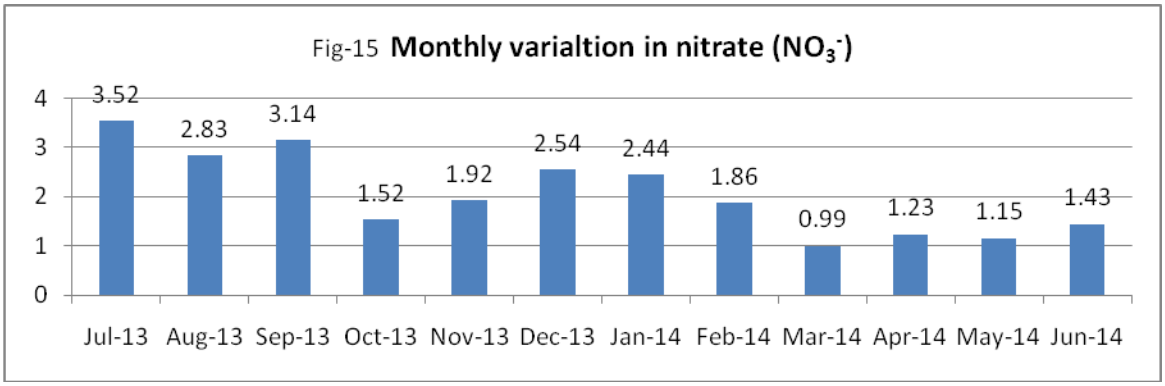
Probable source of Fluoride in Indian water seems to be that during weathering and circulation of water in rocks and soils, fluorine is leached out and dissolved in ground water. Excess intake of fluoride through drinking water causes fluorosis in human being [29]. In present analysis fluoride value varies from 0.37 to 0.61 mg/l, which are within the permissible limit of WHO. Which found minimum in winter and maximum in monsoon. Nazneen Sadat (2012) reported minimum value in monsoon and maximum value in Summer , in Godavari river [30].



Nitrate (NO_3^-)

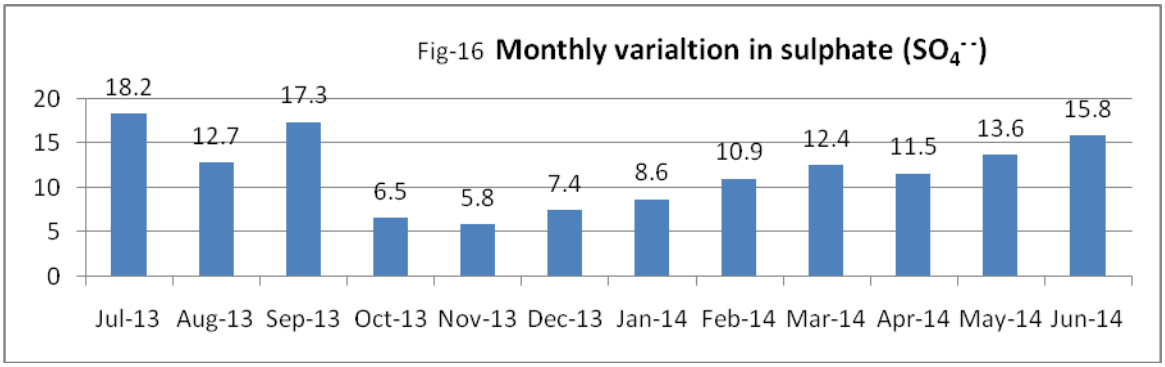
Surface water contains nitrate due to leaching of nitrate with the percolating water. Surface water can

also be contaminated by sewage and other wastage rich in nitrates . In present study, nitrate value varies from 0.99 to 3.52 mg/l, which are within the permissible limit of WHO. Which found minimum in summer and maximum in monsoon. Similar result were reported by Arvind Kumar and Singh (2002) in Mayurakshi river [31].



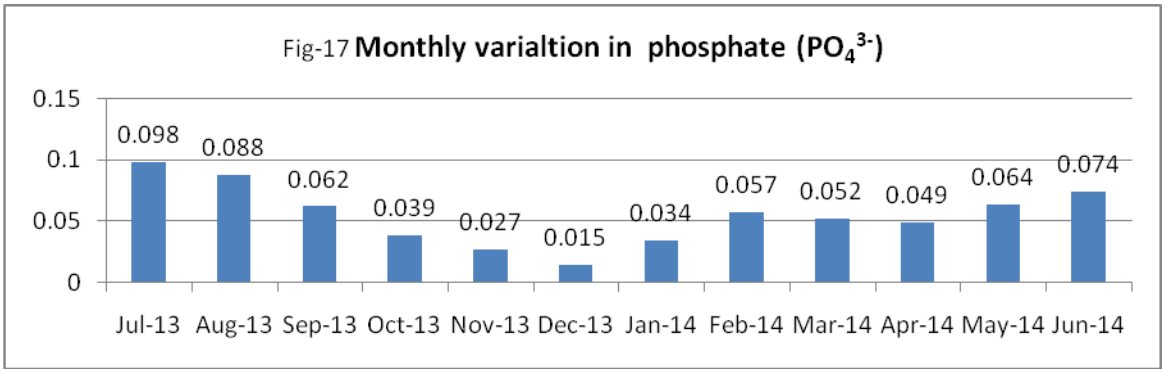
Sulphate (SO_4^{--})

Sulphate is one of the least toxic anions for drinking water. But it is important due to its cathartic effect in some human when present in excessive amount. Sulphate may occur due to industrial discharge, contaminant from mines, paper mills etc. In present study values of sulphate varies from 5.8 to 18.2 mg/l, which are within the permissible limit of WHO. Which found minimum in winter and maximum in monsoon. Similar result were reported by Kulshreshtha et.al, (1992) in Manasarovar reservoir [32].



Phosphate (PO_4^{3-})

Phosphates may occur in surface water as a result of domestic sewage, detergents and agricultural effluent with fertilizers. The high level of both phosphates and nitrates can lead to eutrophication, which increases algal growth and ultimately reduces dissolved oxygen in the water [33]. Here the phosphate value varies from 0.015 to 0.098 mg/l, which are within the permissible limit of WHO. Which found minimum in winter and maximum in monsoon. Similar result were reported by Chavan (2009) in Wainganga river near Bramhapuri District Chandrapur.



Correlation Coefficient (r) between different parameters:

In the present study the Correlation Coefficient (r) between different parameter pairs in computed by taking the average values as shown in table 3. The interrelationship studies between different variables are very helpful tool in promoting research and opening new frontiers of knowledge. The study of correlation reduces the range of uncertainty associated with decision making [34]. The water temperature has been found to show negative correlation (r = -0.744)with DO. pH shows positive correlation with half of the parameters. EC shows negative correlation (r = -0.682)with DO. DO shows negative correlations with maximum parameters except pH. thus it can be served as a single useful pollution index of water quality, as with rise in the value of most of these parameters decreases the DO concentration [35]. Chloride (Cl^-), fluoride (F^-), iron (Fe^{2+}), sulphate (SO_4^{--}), nitrate (NO_3^-) and phosphate (PO_4^{3-}) shows positive correlation with maximum parameters.

Conclusion

This study provides an informative primary data on water quality parameters and helps to understand the contamination of Wainganga river water and its possible influence on the the ecological system.

This study would help the water quality monitoring and management in order to improve the quality of water with maintaining better sustainable management. The water quality can be improved by creating awareness in local public about the degrading status of river, by making farmers understand about proper use of fertilizers and pesticides in farms and also formulating action plan to save the river from drastic pollution. In above study, most parameter are within the permissible limit given by WHO standards. In maximum locations it must be noted that a water quality of Wainganga river at Desaiganj (Wadsa) dist. Gadchiroli is good for domestic and drinking purpose..

Table 2: Monthly mean value of physico-chemical parameters of wainganga river water at Desaiganj from July 2013 to June 2014

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Months	Physico-chemical parameters																
	Temp	pH	EC	TDS	TA	TH	Ca^{++}	Mg^{++}	D.O.	COD	BOD	Fe^{++}	Cl^{-}	F^{-}	NO_3^{3-}	SO_4^{2-}	PO_4^{3-}
Jul-13	25.6	8.16	190	116.4	70.7	77.3	52.2	25.1	6.5	5.3	1.7	0.11	19.4	0.55	3.52	18.2	0.098
Aug-13	25.5	8.49	211	95.5	94.6	51.2	36.3	15.2	6.3	5.5	1.9	0.07	10.5	0.42	2.83	12.7	0.088
Sep-13	26.2	8.34	178	105.6	81.8	66.4	56.2	10.2	6.4	5.1	1.6	0.09	15.8	0.52	3.14	17.3	0.062
Oct-13	24.6	7.95	215	128.4	107.9	86.6	51.4	35.2	6.8	4.2	1.5	0.03	8.5	0.42	1.52	6.5	0.039
Nov-13	22.4	7.55	237	131.3	154.4	98.7	72.5	26.2	7.2	3.9	1.6	0.04	6.4	0.39	1.92	5.8	0.027
Dec-13	21.1	7.88	280	142.4	177.5	120.5	80.2	40.3	7.4	3.3	1.2	0.06	7.4	0.37	2.54	7.4	0.015
Jan-14	22.4	7.62	252	159.5	143.8	114.6	77.2	37.4	6.9	3.5	1.4	0.04	9.4	0.44	2.44	8.6	0.034
Feb-14	23.3	7.43	360	174.8	120.2	149.5	94.3	55.2	5.4	6.8	2.2	0.05	12.2	0.42	1.86	10.9	0.057
Mar-14	25.7	7.18	379	194.7	163.6	155.3	98.1	57.2	4.6	7.3	2.8	0.06	11.8	0.49	0.99	12.4	0.052
Apr-14	27.5	7.27	356	184.2	150.7	140.2	94.2	46.4	4.9	7.9	2.6	0.07	13.3	0.46	1.23	11.5	0.049
May-14	29.2	7.38	326	188.5	173.4	135.6	91.3	44.3	4.4	8.3	2.4	0.05	14.5	0.53	1.15	13.6	0.064
Jun-14	27.3	7.91	193	113.2	91.7	70.4	50.3	20.1	5.9	5.7	2.1	0.08	17.5	0.61	1.43	15.8	0.074
Min	21.1	7.18	178	95.5	70.7	51.2	36.3	10.2	4.4	3.3	1.2	0.03	6.4	0.37	0.99	5.8	0.015
Max	29.2	8.49	379	194.7	177.5	155.3	98.1	57.2	7.4	8.3	2.8	0.11	19.4	0.61	3.52	18.2	0.098
WHO 2011	**-**	**6.5-8.5**	*** 1000**	**600**	**500**	**500**	**100**	*** 100**	*** 7.5**	*** 10**	*** 6**	**0.3**	**250**	**1.5**	*** 50**	**250**	*** 0.1**
mean	25.1	7.76	264.8	144.5	127.5	105.5	71.2	34.4	6.1	5.6	1.9	0.06	12.2	0.47	2.05	11.7	0.055
median	27.3	7.91	193	113.2	91.7	70.4	50.3	20.1	5.9	5.7	2.1	0.08	18	0.61	1.43	15.8	0.07
S.D.(±)	1.6	0.10	50.7	22.2	25.3	24.8	14.8	10.1	0.1	0.1	0.1	0.01	3.7	0.10	0.44	2.9	0.013

(All parameters are in mg/l except pH and EC. EC is in micro-Siemens,)

Table no. 3 Correlation Coefficient (r) among the studied physico chemical parameters of Wainganga river at Desaiganj (Wadsa) Dist.- Gadchiroli.(2013-2014).

	Temp	pH	EC	TDS	TA	TH	Ca^{++}	Mg^{++}	*D.O.*	*COD*	*BOD*	Fe^{++}	Cl^{-}	F^{-}	NO_3^{3-}	SO_4^{2-}	PO_4^{3-}
Temp	1.000																
pH	-0.058	1.000															
EC	0.066	-0.862	1.000														
TDS	0.128	-0.934	0.937	1.000													
TA	-0.200	0.747	-0.716	-0.747	1.000												
TH	-0.059	0.920	-0.951	-0.970	0.765	1.000											
Ca^{++}	-0.035	0.915	-0.920	-0.950	0.786	0.979	1.000										
Mg^{++}	-0.086	0.862	-0.928	-0.928	0.681	0.958	0.879	1.000									
D.O.	0.744	-0.573	0.682	0.672	-0.230	-0.553	-0.544	-0.529	1.000								
COD	0.781	-0.489	0.625	0.584	-0.145	-0.473	0.473	0.444	-0.976	1.000							
BOD	0.669	-0.595	0.681	0.619	-0.211	-0.522	0.507	0.508	-0.951	0.935	1.000						
Fe^{++}	0.380	0.474	-0.359	-0.408	0.597	0.414	-0.358	-0.461	0.073	-0.172	-0.090	1.000					
Cl^{-}	0.697	0.193	-0.195	-0.126	0.573	0.215	-0.186	-0.239	0.430	-0.485	-0.359	0.806	1.000				
F^{-}	0.749	0.095	-0.238	-0.100	0.443	0.229	-0.195	-0.262	0.437	-0.430	-0.380	0.621	0.906	1.000			
NO_3^{3-}	-0.338	0.779	-0.652	-0.684	0.568	0.615	-0.572	-0.631	0.627	-0.541	-0.662	0.544	0.178	-0.053	1.000		
SO_4^{2-}	0.664	0.342	-0.248	-0.233	0.596	0.316	-0.267	-0.361	0.391	-0.444	-0.326	0.871	0.947	0.841	0.317	1.000	
PO_4^{3-}	0.622	0.435	-0.299	-0.346	0.709	0.447	-0.469	-0.383	0.343	-0.429	-0.329	0.706	0.797	0.665	0.306	0.841	1.000

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