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PHYSICO-CHEMICAL PROPERTY AND PARAMETRIC CORRELATION OF GROUND WATER OF DIFFERENT VILLAGES IN BARA TEHSIL, ALLAHABAD, U.P

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ABSTRACT

Characterization of the physiochemical parameters of groundwater from five different locations in Bara Tehsil, Allahabad District, U.P. (India) was carried out. To assess the quality of ground water each parameter was compared with the standard desirable limits prescribed by Bureau of Indian Standard (BIS). Systematic calculation was made to determine the correlation between physic chemical parameters at each site. It is concluded that the water quality of water supply systems in different locations of Bara Tehsil, Allahabad District is of medium quality and can be used for domestic use after suitable treatment. Suitable suggestions were made to improve the quality of water.

Key words: Physiochemical Parameters, Ground water quality, Pollution.

INTRODUCTION

Water covers 78% of the earth's surface, yet water available for human use is limited. Groundwater is the primary source of drinking water for rural areas in India. Being a basic need of human development, health and wellbeing, safe drinking water is an internationally accepted human right (WHO, 2001), which has been enlisted as one of the ten targets in the Millennium Development Goals (MDGs). As a decentralized source of drinking water and myriads of other services for millions of rural and urban families, groundwater as a natural resource plays a crucial role which, accounts for nearly 80 per cent of the rural domestic water needs, and 50 per cent of the urban water needs in India (Kumar *et al.,* 2005). Much of the current concern with regards to environmental quality is focused on water because of its importance in maintaining the human health and health of the ecosystem.

Fresh water is finite resource, essential for agriculture, industry and even human existence, without fresh water of adequate quantity and quality, sustainable development will not be possible (Kumar, 1997). According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its quality cannot be restored back easily and to device ways and means to protect it. Water related diseases are among the most common causes of illness and death, affecting mainly the poor in developing countries. The quality of water at any monitoring location reflects several major influences, including the anthropogenic inputs, atmospheric inputs, climatic condition; etc Concentrations of all kinds of pollutants have an influence on the water quality and also determine the use of water. It is, therefore, necessary to monitor water quality, understand the chemical characteristics and provide a reliable assessment of water quality (Zhang, X.*et al.*, 2010)

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MATERIALS AND METHODS

The present region of Bara Tehsil (Allahabad District) is situated with latitudes of 25°28′N 81°50′E, at the meeting point of the three sacred rivers of Saraswati, Yamuna and the Ganges. In the ancient days, the area was known as Vats country. There are 7 Tehsils in the district along with development blocks which are 20 in number. Selected villages of Bara Tehsil for assessing water quality are- Site 1(Semera), Site 2(Gauhania), Site 3(Amreha), Site 4(Jasara), Site 5(Khatangia). The present study comprises and interpretation and analysis of water samples collected from four selected villages and compared with Standard values recommended by BIS.

Study area

The Bara Tehsil is small and situated in district Allahabad in the state of Uttar Pradesh, India. The main profession of Bara Tehsil is agriculture though there are many people those work in other cities such as Mumbai, Delhi, Allahabad, other state of India. This town is well connected with the main district Allahabad. Bara Tehsil has mix population of Hindus, Muslims and other religion. The ground water (Hand pump) samples were collected from selected villages of Bara Tehsil

for the assessing the water quality for drinking purposes. The sampling sites are rural places and the samples are the major source of drinking water.

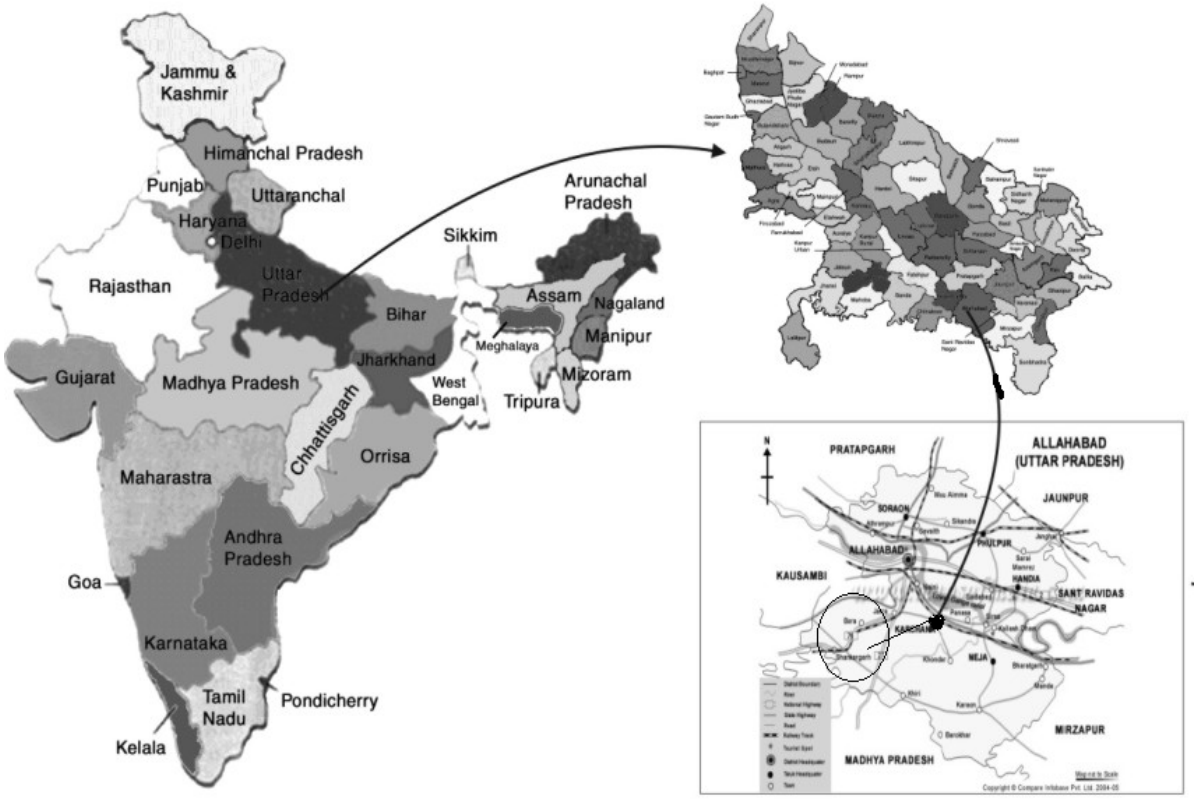

Fig. Map of study area

Preparation of water samples

Ground water were collected in clean plastic canes during January 2014 to April 2014 from five villages in Bara Tehsil without any air bubbles. A total of 65 samples were collected from different villages. Prior the collection, the well cleaned sample canes were rinsed thoroughly with the water sample and immediately closed tightly. The hand pump continuously pumped prior to the sampling for avoid contamination from the surface.

Analysis of water samples

The Physico-chemical analysis of ground water was carried out for various water quality parameters such as Temperature, pH, EC, Total Dissolved Solid, Turbidity, Sulphate, Total Hardness, Chloride, Iron, and Fluoride as per standard procedures.

RESULTS AND DISCUSSION

Site 1 (SEMERA)

Perusal of the data appended in the Table 1 showed that in Site 1 (SEMERA) colour of water sample is clear and pH was found to be neutral in nature in most of samples range between 6.83-7.49. Temperature was found to in range of 21.50-29.20.Variation in temperature may be due to different timings of collection and influence of season. Turbidity of water samples were found to be between 0.55-2 NTU in all the samples. TDS was found to be between 1044-1427 mg/l which has crossed the standard desirable limit of 500mg/l prescribed by BIS, 1991 in most of the water samples but is within the permissible limit of 2000mg/l. Alkalinity of the water samples was found between 369-585 mg/l which has crossed the standard desirable limit of 200mg/l but is within the permissible limit of 600mg/l. The mean value of acidity was found to be 106.46 mg/l as $CaCO_3$, with a maximum and minimum value of 192 mg/l and 24.0mg/l as $CaCO_3$ respectively. The standard deviation was in the range of 29.12 and 44.67 mg/l as $CaCO_3$. Chloride was found to be between 93.81-362.85 which has crossed the standard desirable limit of 250mg/l prescribed by BIS, 1991 but is within the permissible limit of 1000mg/l.Total Hardness was found to in the range of 344- 1062 mg/l which has crossed the desirable limit of 300mg/l and permissible limit of 600mg/l prescribed by BIS, 1991. Calcium hardness as ($CaCO_3$) values of ground water was recorded between 180-576 mg/l which in most of the months were above the desirable and permissible limit prescribed by BIS, 1991i.e.75-200mg/l.

Magnesium hardness as $CaCO_3$ was recorded between 42-486 mg/l which was above the desirable limit of 30mg/l and permissible limit of 100mg/l. Sulphate was between 3.39-115.30 mg/l which was found to be well within the desirable limit of 200mg/l prescribed by BIS, 1991. Iron values were recorded between 0.15-1.00 mg/l which was found to be well within the maximum permissible limit 1.00mg/l prescribed by BIS, 1991. Fluoride was found to in the range of 0.40-0.90mg/l which is found to be well within the desirable limit prescribed by BIS, 1991. Relations between the physicochemical parameters measured in all water samples in the site 1 are explained on the basis of the values of linear

Pearson's correlation coefficients presented in Table 2. Analysis of correlation coefficients ($p = 0.05$) shows that some common relations only for variables describing pH showed that negative correlation Total hardness (-0.75), Acidity (-0.57), Alkalinity (-0.06), Fluoride (-0.39), Sulphate showed that strong positive correlation with Alkalinity (0.63)and Chloride (0.65) and Iron showed that negative correlation with Fluoride (-0.29) similar results was obtained by Singh *et al.,* (2010).

Site 2 (GAUHANIA)

Table 3 showed that in Site 2 (GAUHANIA) the pH was found to be neutral in nature in most of samples range between 7.29-7.84.Temperature was found to in range of 25.00-29.20.Variation in temperature may be due to different timings of collection and influence of season. Turbidity of water samples were found to be between 0.58-4.00 NTU in all the samples. TDS was found to be between 595-804 mg/l which has crossed the standard desirable limit of 500mg/l prescribed by BIS, 1991 in most of the water samples but is within the permissible limit of 2000mg/l. Alkalinity of the water samples was found between 260-483 mg/l which has crossed the standard desirable limit of 200mg/l but is within the permissible limit of 600mg/l. The mean value of acidity was found to be 60.62 mg/l as $CaCO_3$, with a maximum and minimum value of 110 mg/l and 35 mg/l as $CaCO_3$ respectively. The standard deviation was in the range of 29.12 and 44.67 mg/l as $CaCO_3$.

Chloride was found to be between 22.66-147.44 mg/l which is found to be well within the desirable limit of 250mg/l prescribed by BIS, 1991.Total Hardness was found to in the range of 238-496 mg/l which has crossed the desirable limit of 300mg/l but is within the permissible limit of 600mg/l prescribed by BIS, 1991. Calcium hardness as (CaCo3) values of ground water was recorded between 86-212 mg/l which in most of the months were above the desirable limit but within the permissible limit prescribed by BIS, 1991i.e.75-200mg/l. Magnesium hardness as $CaCO_3$ between 26-326 mg/l which was above the desirable limit of 50mg/l and permissible limit 100mg/l. Sulphate was between 0.91-60.37 mg/l which was found to be well within the desirable limit of 200mg/l prescribed by BIS, 1991. Iron values were recorded between 0.19-0.98 mg/l which was found to be well within the maximum permissible limit 1.00mg/l prescribed by BIS, 1991. Fluoride was found to in the range of 0.33-0.81mg/l which is found to be well within the desirable limit prescribed by BIS, 1991

Relations between the physicochemical parameters measured in all water samples in the site 2 are explained on the basis of the values of linear Pearson's correlation coefficients presented in Table 4. Analysis of correlation coefficients ($p = 0.05$) shows that some common relations only for variables describing EC showed that negative correlation with Acidity (-0.20), Sulphate showed that strong positive correlation with Alkalinity (0.50) and Chloride (0.94) and Fluoride showed that negative correlation with Total hardness (-0.23) similar results was obtained by Abdullah *et al.,*(2012).

Site 3 (AMREHA)

Perusal of the data appended in the Table 5 showed that in Site 3 (AMREHA) the pH was found to be neutral in nature in most of samples range between 7.57-8.01.Temperature was found to in range of 25.10-29.00.Variation in temperature may be due to different timings of collection and influence of season. Turbidity of water samples were found to be between 1-2.53 NTU in all the samples. TDS was found to be between 780-1024 mg/l which has crossed the standard desirable limit of 500mg/l prescribed by BIS, 1991 in most of the water samples but is within the permissible limit of 2000mg/l. Alkalinity of the water samples was found between 370-609 mg/l which has crossed the standard desirable limit of 200mg/l and permissible limit of 600mg/l.

The mean value of acidity was found to be 56.62 mg/l as $CaCO_3$, with a maximum and minimum value of 116 mg/l and 24.0 mg/l as $CaCO_3$ respectively. The standard deviation was in the range of 29.62 to 44.67 mg/l as $CaCO_3$.Chloride was found to be between 26.02-95.23 which is found to be well within standard desirable limit of 250mg/l prescribed by BIS, 1991. Total Hardness was found to in the range of 186-322 mg/l which has crossed the desirable limit of 300mg/l and found to be well within permissible limit of 600mg/l prescribed by BIS, 1991.Calcium hardness as (CaCo3) values of ground water was recorded between 66-170 mg/l which in most of the months were above the desirable limit but within the permissible limit prescribed by BIS, 1991i.e.75-200mg/l. Magnesium hardness as $CaCO_3$ between 16-154 mg/l which was above the desirable limit of 50mg/l and permissible limit 100mg/l. Sulphate was between 1.09-42.28 mg/l which was found to be well within the desirable limit of 200mg/l prescribed by BIS, 1991.

Iron values were recorded between 0.35-0.99 mg/l which was found to be well within the maximum permissible limit 1.00mg/l prescribed by BIS, 1991.Fluoride was found to in the range of 0.0.03-0.33mg/l which is found to be well within the desirable limit prescribed by BIS, 1991. Relations between the physicochemical parameters measured in all water samples in the site 3 are explained on the basis of the values of linear Pearson's correlation coefficients presented in Table 6. Analysis of correlation coefficients ($p = 0.05$) shows that some common relations only for variables describing pH showed that negative correlation Acidity (-0.38), Total hardness (-0.10), Sulphate showed that strong positive correlation with Total hardness (0.52) and Chloride (0.72) and Iron showed that negative correlation with Alkalinity (-0.25) similar results was obtained by Obiefuna and Sheriff (2010).

Site 4 (JASARA)

Perusal of the data appended in the Table 7 showed that in Site 4 (JASARA) the pH was found to be neutral in nature in most of samples range between 7.06-8.60.Temperature was found to in range of 23.50-29.00.Variation in temperature may be due to different timings of collection and influence of season. Turbidity of water samples were found to be between 0.83-4.00 NTU in all the samples. TDS was found to be between 620-922 mg/l which has crossed the standard desirable limit of 500mg/l prescribed by BIS, 1991 in most of the water samples but is within the permissible limit of 2000mg/l.Alkalinity of the water samples was found between 257-436 mg/l which has crossed the standard desirable limit of 200mg/l but is within the permissible limit of 600mg/l. Magnesium hardness as $CaCO_3$.

Table 1. Ground water quality of Semera Village (site 1) in Bara Tehsil

Site	Sampling Date	Parameter														
		Colour	Temp	pH	EC	TDS	Turbidity	Sulphate	Total Hardness	Ca Hardness	Mg Hardness	Acidity	Alkalinity	Chloride	Iron	Fluoride
SEMERA	1-Jan-14	Clear	23.5	7.29	1.74	1083	1	4.33	486	370	116	24	416	107.44	0.33	0.84
	10- Jan14	Clear	21.5	7.21	1.56	1044	2	5.14	538	496	42	59	390	101.07	0.53	0.57
	20-Jan-14	Clear	27	7.49	1.85	1427	1	4.10	344	206	138	63	410	93.81	0.99	0.67
	30-Jan-14	Clear	28	6.83	1.82	1427	2	3.39	1062	576	486	147	580	107.97	0.15	0.82
	9-Feb-14	Clear	29	7.03	.97	1227	1	3.84	552	408	144	192	438	115.05	0.38	0.78
	19-Feb-14	Clear	29	7.07	1.05	1255	2	7.52	728	300	428	110	425	340.19	1.00	0.74
	1-Mar-14	Clear	29	7.1	2.1	1272	1	10.55	644	280	364	122	402	322.85	0.82	0.76
	11-Mar-14	Clear	29	7.2	2.2	1403	1	49.69	658	340	318	148	369	283.20	0.74	0.80
	21-Mar-14	Clear	29.2	7.1	2.4	1426	1	115.30	694	370	324	78	585	362.85	0.90	0.52
	31-Mar-14	Clear	29.2	7.23	2.1	1250	1	103.53	652	190	462	82	578	325.68	0.24	0.78
	10-Apr-14	Clear	29.2	7.44	1.24	1243	2	90.45	624	180	444	100	574	272.58	1.00	0.40
	20-Apr-14	Clear	29.2	7.18	1.74	1170	2	43.81	506	196	310	124	500	230.10	0.93	0.90
	30-Apr-14	Clear	29.2	7.16	1.54	1169	2	43.59	490	194	296	135	492	226.56	0.96	0.89
MIN			21.50	6.83	0.97	1044	0.55	3,39	344	180	42	24.00	369	93.81	0.15	0.40
MAX			29.20	7.49	2.40	1427	2.00	115,30	1062	576	486	192	585	362.85	1.00	0.90
MEAN			27.85	7.18	1.72	1261.23	1.38	37.33	613.69	315.85	297.85	106.46	473.77	222.26	0.69	0.73
STDEV			2.49	0.17	0.44	129.03	0.48	41.46	170.89	126.55	145.49	45.14	81.54	103.98	0.32	0.15
BIS Std	Desirable Limit			6.5	-	500	5	200	300	75	30		200	250	0.3	1.0
	Permissible Limit			8.5	-	2000	10	400	600	200	100		600	100	1.0	1.5

All values are in mg/l, except Temp, pH, EC and Turbidity. Unit of Temp are ^{0}C, EC are µs/cm and Turbidity is NTU.

Table 2. Correlation Matrix for studied parameters

	Temp	pH	E.C	TDS	Turbidity	Sulphate	Total Hard	Ca Hard	Mg Hard	Acidity	Alkalinity	Chloride	Iron	Fluoride
Temp	1													
pH	-0.21	1.00												
E.C	0.06	0.01	1.00											
TDS	0.55	-0.16	0.45	1.00										
Turbidity	-0.28	-0.09	-0.58	-0.34	1.00									
Sulphate	0.46	0.22	0.41	0.23	-0.34	1.00								
Total Hard	0.26	-0.75	0.12	0.42	0.21	0.08	1.00							
Ca Hard	-0.47	-0.64	0.00	0.06	0.18	-0.43	0.56	1.00						
Mg Hard	0.72	-0.32	0.14	0.44	0.09	0.46	0.69	-0.22	1.00					
Acidity	0.63	-0.57	-0.28	0.27	0.03	-0.11	0.35	0.11	0.32	1.00				
Alkalinity	0.43	-0.18	0.14	0.26	0.02	0.68	0.46	-0.10	0.63	0.04	1.00			
Chloride	0.64	-0.06	0.31	0.24	-0.34	0.67	0.22	-0.45	0.65	0.09	0.29	1.00		
Iron	0.34	0.42	-0.07	0.13	-0.03	0.19	-0.40	-0.61	0.06	-0.02	-0.13	0.43	1.00	
Fluoride	0.13	-0.39	0.05	-0.15	0.03	-0.40	-0.01	-0.01	0.00	0.33	-0.24	-0.17	-0.29	1.00

Table 3. Ground water quality of Gauhania Village (site 2) in Bara Tehsil

Site	Sampling Date	Parameter														
		Colour	Temp	pH	EC	TDS	Turbidity	Sulphate	Total Hardness	Ca Hardness	Mg Hardness	Acidity	Alkalinity	Chloride	Iron	Fluoride
GAUHANIA	1-Jan-14	Clear	25	7.29	0.97	685	1	1.38	300	184	116	40	395	42.48	0.19	0.55
	10- Jan14	Clear	26	7.41	0.85	647	1	1.83	270	160	110	45	314	36.82	0.19	0.33
	20-Jan-14	Clear	26.3	7.52	0.92	771	1	1.18	496	170	326	35	408	30.44	0.95	0.41
	30-Jan-14	Clear	27	7.35	0.95	778	1	1.45	260	150	110	60	483	36.46	0.98	0.55
	9-Feb-14	Clear	29	7.41	0.84	595	1	0.91	238	212	26	110	270	22.66	0.53	0.51
	19-Feb-14	Clear	28	7.45	0.91	602	2	0.99	242	106	136	70	298	56.29	0.73	0.75
	1-Mar-14	Clear	28.5	7.44	1.20	705	1	1.85	246	96	150	65	274	71.86	0.66	0.63
	11-Mar-14	Clear	28.2	7.43	1.15	772	1	15.52	314	172	142	60	260	88.50	0.84	0.60
	21-Mar-14	Clear	29.2	7.33	1.32	756	4	50.13	308	208	100	36	458	112.75	0.64	0.48
	31-Mar-14	Clear	28.5	7.54	1.34	778	1	53.40	364	172	192	45	432	133.10	0.54	0.59
	10-Apr-14	Clear	28.5	7.84	1.35	804	2	60.37	434	134	300	61	418	147.44	0.52	073
	20-Apr-14	Clear	28.5	7.54	1.1	766	2	27.24	256	86	170	78	412	87.62	0.91	0.78
	30-Apr-14	Clear	28.5	7.43	1.2	756	2	26.16	264	86	178	83	405	80.54	0.93	0.81
MIN			25	7.29	0.84	595	0.58	0.91	238.00	86.00	26.00	35.00	260.00	22.66	0.19	0.33
MAX			29.20	7.84	1.35	804	4.00	60.37	496.00	212.0	326.00	110.00	483.00	147.44	0.98	0.81
MEAN			27.78	7.46	1.08	724.23	1.51	18.65	307.08	148.92	158.15	60.62	371.31	72.84	0.66	0.59
STDEV			1.29	0.14	0.19	70.65	0.96	22.68	79.55	43.89	80.65	21.46	77.10	40.26	0.27	0.14
BIS	Desirable Limit			6.5	-	500	5	200	300	75	30	-	200	250	0.3	1.0
Std	Permissible Limit			8.5	-	2000	10	400	600	200	100	-	600	1000	1.0	1.5

All values are in mg/l, except Temp, pH, EC and Turbidity. Unit of Temp are ^{0}C, EC are µs/cm and Turbidity is NTU.

Table 4. Correlation Matrix for studied parameters

	Temp	pH	E.C	TDS	Turbidity	Sulphate	Total Hard	Ca hard	Mg Hard	Acidity	Alkalinity	Chloride	Iron	Fluoride
Temp	1.00													
pH	0.31	1.00												
E.C	0.57	0.43	1.00											
TDS	0.14	0.40	0.68	1.00										
Turbidity	0.44	0.11	0.47	0.22	1.00									
Sulphate	0.54	0.57	0.87	0.61	0.62	1.00								
Total Hard	-0.19	0.57	0.27	0.56	0.03	0.38	1.00							
Ca hard	-0.16	-0.31	-0.15	-0.13	-0.04	0.03	0.25	1.00						
Mg Hard	-0.10	0.73	0.35	0.62	0.05	0.36	0.85	-0.30	1.00					
Acidity	0.52	0.08	-0.20	-0.39	-0.12	-0.17	-0.54	-0.29	-0.38	1.00				
Alkalinity	-0.09	0.11	0.35	0.65	0.48	0.50	0.36	0.04	0.33	-0.42	1.00			
Chloride	0.56	0.60	0.94	0.60	0.51	0.94	0.31	-0.15	0.39	-0.18	0.32	1.00		
Iron	0.38	0.09	0.11	0.46	0.12	-0.01	0.07	-0.41	0.29	0.24	0.22	0.02	1.00	
Fluoride	0.48	0.38	0.42	0.20	0.27	0.31	-0.23	-0.74	0.18	0.48	0.05	0.45	0.41	1.00

Table 5. Ground water quality of Amreha Village (site 3) in Bara Tehsil

Site	Sampling Date	Parameter														
		Colour	Temp	pH	EC	TDS	Turbidity	Sulphate	Total Hardness	Ca Hardness	Mg Hardness	Acidity	Alkalinity	Chloride	Iron	Fluoride
AMREHA	1-Jan-14	Clear	25.1	7.63	1.13	796	2	1.18	250	164	86	53	408	27.79	0.92	0.03
	10- Jan14	Clear	26.1	7.72	1.11	805	1	1.92	188	112	76	42	450	34.16	0.96	0.03
	20-Jan-14	Clear	26	7.82	1.14	958	2	1.22	236	166	70	24	580	26.02	0.88	0.06
	30-Jan-14	Clear	27	7.57	1.22	892	1	1.11	204	116	88	75	609	32.04	0.35	0.18
	9-Feb-14	Clear	28.1	7.62	1.27	780	2	1.09	186	170	16	116	468	28.67	0.36	0.18
	19-Feb-14	Clear	27	7.96	1.33	812	3	1.88	196	70	126	43	370	84.61	0.48	0.30
	1-Mar-14	Clear	28.5	7.86	1.36	824	2	2.10	188	66	122	56	376	80.00	0.99	0.28
	11-Mar-14	Clear	29	7.67	1.43	886	2	12.62	248	94	154	88	382	78.94	0.82	0.16
	21-Mar-14	Clear	29	7.69	0.01	951	2	37.27	322	128	94	25	529	95.23	0.66	0.07
	31-Mar-14	Clear	29	7.88	0.08	934	1	37.71	284	168	116	34	538	86.91	0.81	0.25
	10-Apr-14	Clear	29	8.01	1.45	914	1	38.36	216	170	46	63	548	83.54	0.81	0.33
	20-Apr-14	Clear	29	7.96	1.57	1024	1	42.28	222	102	120	56	483	82.48	0.68	0.17
	30-Apr-14	Clear	29	7.86	1.47	1020	1	39.23	220	98	122	61	471	81.42	0.70	0.17
MIN			25.10	7.57	0.01	780.00	1.00	1.09	186.00	66.00	16.00	24.00	370.00	26.02	0.35	0.03
MAX			29.00	8.01	1.57	1024.00	2.53	42.28	322.00	170.00	154.00	116.00	609.00	95.23	0.99	0.33
MEAN			27.83	7.79	1.12	892.00	1.60	16.77	227.69	124.92	95.08	56.62	477.85	63.22	0.72	0.17
STDEV			1.41	0.15	0.50	83.81	0.59	18.55	40.55	38.82	37.33	25.65	79.48	27.89	0.21	0.10
BIS Std	Desirable Limit			6.5	-	500	5	200	300	75	30	-	200	250	0.3	1.0
	Permissible Limit			8.5	-	2000	10	400	600	200	100	-	600	1000	1.0	1.5

All values are in mg/l, except Temp, pH, EC and Turbidity. Unit of Temp are ^{0}C, EC are µs/cm and Turbidity is NTU.

Table 6. Correlation Matrix for studied parameters

	Temp	pH	E.C	TDS	Turbidity	Sulphate	Total Hard	Ca hard	Mg Hard	Acidity	Alkalinity	Chloride	Iron	Fluoride
Temp	1.00													
pH	0.38	1.00												
E.C	-0.11	0.18	1.00											
TDS	0.51	0.40	-0.10	1.00										
Turbidity	-0.20	-0.06	0.09	-0.48	1.00									
Sulphate	0.74	0.51	-0.27	0.78	-0.54	1.00								
Total Hard	0.25	-0.10	-0.78	0.43	-0.02	0.52	1.00							
Ca Hard	-0.18	-0.17	-0.35	0.00	-0.29	0.11	0.32	1.00						
Mg Hard	0.28	0.22	0.01	0.31	0.31	0.20	0.23	-0.71	1.00					
Acidity	0.21	-0.38	0.51	-0.33	0.03	-0.22	-0.48	0.01	-0.26	1.00				
Alkalinity	0.04	-0.06	-0.34	0.50	-0.65	0.30	0.27	0.57	-0.44	-0.20	1.00			
Chloride	0.80	0.62	-0.20	0.45	0.03	0.72	0.37	-0.41	0.58	-0.23	-0.20	1.00		
Iron	-0.13	0.24	-0.05	0.03	0.13	0.06	0.17	0.01	0.24	-0.47	-0.25	0.09	1.00	
Fluoride	0.55	0.61	0.22	0.00	0.10	0.23	-0.30	-0.22	0.12	0.24	-0.10	0.55	-0.24	1.00

Table No. 7. Ground water quality of Jasara Village (site 4) in Bara Tehsil

Site	Sampling Date	Parameter														
		Colour	Temp	pH	EC	TDS	Turbidity	Sulphate	Total Hardness	Ca Hardness	Mg Hardness	Acidity	Alkalinity	Chloride	Iron	Fluoride
JASARA	1-Jan-14	Clear	23.5	8.6	1.06	759	2	2.15	586	290	296	45	257	41.24	0.55	0.89
	10- Jan14	Clear	26	7.2	1.03	763	1	2.73	442	258	184	62	260	37.17	0.84	1.23
	20-Jan-14	Clear	24.5	7.35	1.03	876	2	1.62	448	386	62	44	411	40.00	0.68	1.13
	30-Jan-14	Clear	26.2	7.06	1.12	922	2	1.81	704	286	418	88	436	35.05	0.34	0.87
	9-Feb-14	Clear	28.1	7.56	1.15	763	4	1.41	510	460	50	79	262	34.34	0.24	0.87
	19-Feb-14	Clear	27	7.54	1.19	788	2	1.65	630	236	394	65	282	115.05	0.42	1.02
	1-Mar-14	Clear	27.5	7.46	1.24	784	2	2.03	586	204	382	78	272	109.74	0.89	0.87
	11-Mar-14	Clear	27.5	7.24	1.27	775	3	19.33	488	184	304	92	262	88.50	0.37	0.88
	21-Mar-14	Clear	28	7.2	1.17	841	3	54.05	518	232	286	33	332	111.51	0.82	0.88
	31-Mar-14	Clear	28	7.46	1.28	742	2	53.62	520	190	330	61	362	99.47	0.87	0.98
	10-Apr-14	Clear	28.2	7.61	1.3	620	2	53.18	522	92	430	92	398	88.50	0.90	1.02
	20-Apr-14	Clear	28.5	7.39	1.35	878	2	35.31	426	92	334	79	296	88.50	0.57	0.84
	30-Apr-14	Clear	29	7.3	1.25	799	2	35.96	402	86	316	75	258	89.39	0.55	0.83
MIN			23.50	7.06	1.03	620.00	0.83	1.41	402.00	86.00	50.00	33.00	257.00	34.34	0.24	0.83
MAX			29.00	8.60	1.35	922.00	4.00	54.05	704.00	460.00	430.00	92.00	436.00	115.05	0.90	1.23
MEAN			27.08	7.46	1.19	793.08	1.99	20.37	521.69	230.46	291.23	68.69	314.46	75.27	0.62	0.95
STDEV			1.62	0.38	0.11	75.83	0.78	22.67	86.50	111.06	122.65	19.06	65.70	32.33	0.23	0.12
BIS Std	Desirable Limit			6.5	-	500	5	200	300	75	30	-	200	250	0.3	1.0
	Permissible Limit			8.5	-	2000	10	400	600	200	100	-	600	1000	1.0	1.5

All values are in mg/l, except Temp, pH, EC and Turbidity. Unit of Temp are ^{0}C, EC are µs/cm and Turbidity is NTU.

Table No. 8. Correlation Matrix for studied parameters

	Temp	pH	E.C	TDS	Turbidity	Sulphate	Total Hard	Ca hard	Mg Hard	Acidity	Alkalinity	Chloride	Iron	Fluoride
Temp	1.00													
pH	-0.49	1.00												
E.C	0.81	-0.17	1.00											
TDS	-0.19	-0.40	-0.25	1.00										
Turbidity	0.40	-0.02	0.23	-0.14	1.00									
Sulphate	0.62	-0.17	0.65	-0.31	0.15	1.00								
Total Hard	-0.29	0.18	-0.17	0.11	0.00	-0.35	1.00							
Ca hard	-0.54	0.13	-0.75	0.25	0.37	-0.65	0.25	1.00						
Mg Hard	0.28	0.01	0.56	-0.15	-0.34	0.34	0.48	-0.73	1.00					
Acidity	0.48	-0.27	0.55	-0.22	0.12	-0.02	0.10	-0.34	0.38	1.00				
Alkalinity	-0.13	-0.30	-0.06	0.21	-0.15	0.23	0.30	0.06	0.15	0.00	1.00			
Chloride	0.61	-0.16	0.72	-0.20	0.07	0.56	-0.01	-0.65	0.58	0.04	-0.15	1.00		
Iron	0.06	-0.03	0.10	-0.36	-0.38	0.48	-0.24	-0.39	0.18	-0.31	0.19	0.35	1.00	
Fluoride	-0.40	-0.12	-0.51	-0.22	-0.48	-0.19	-0.19	0.22	-0.33	-0.28	0.21	-0.28	0.41	1.00

Table 9. Ground water quality of Khatangia Village (site 5) in Bara Tehsil

Site	Sampling Date	Water Quality Parameters														
		Colour	Temp	pH	EC	TDS	Turbidity	Sulphate	Total Hardness	Ca Hardness	Mg Hardness	Acidity	Alkalinity	Chloride	Iron	Fluoride
KHATANGIA	1-Jan-14	Clear	25	8.48	0.84	612	1	0.48	498	260	238	34	273	30.09	0.39	0.69
	10- Jan14	Clear	25	7.21	0.87	646	1	0.76	500	210	290	81	310	35.05	0.32	0.80
	20-Jan-14	Clear	26	7.47	0.85	704	1	0.35	270	172	98	50	451	36.82	0.39	1.22
	30-Jan-14	Clear	27	7.39	0.9	746	1	0.46	574	160	414	76	947	34.52	0.42	0.88
	9-Feb-14	Clear	27.5	7.1	1.07	711	1	0.48	568	320	248	132	369	44.43	0.68	0.80
	19-Feb-14	Clear	26.5	7.27	1.06	708	1	0.58	426	180	246	76	332	95.93	0.61	0.93
	1-Mar-14	Clear	27.5	7.23	1.07	718	1	1.12	404	156	248	88	314	93.99	0.82	0.95
	11-Mar-14	Clear	28	7.21	1.08	725	1	3.86	378	184	194	100	296	92.93	0.98	0.93
	21-Mar-14	Clear	28.5	7.26	1.05	787	5	13.30	484	244	240	48	385	84.43	0.45	0.88
	31-Mar-14	Clear	28.5	7.33	1.14	725	1	15.04	476	156	320	59	406	90.80	0.57	0.97
	10-Apr-14	Clear	28.5	7.75	1.2	668	2	15.69	464	96	368	86	438	98.24	0.60	1.01
	20-Apr-14	Clear	28.5	7.52	1.21	768	1	13.12	380	80	300	90	346	101.78	0.86	0.78
	30-Apr-14	Clear	28.5	7.42	1.11	816	1	13.08	400	76	324	92	326	99.47	0.83	0.75
MIN			25.00	7.10	0.84	612.00	0.50	0.35	270.00	76.00	98.00	34.00	273.00	30.09	0.32	0.69
MAX			28.50	8.48	1.21	816.00	5.00	15.69	574.00	320.00	414.00	132.00	947.00	101.78	0.98	1.22
MEAN			27.31	7.43	1.03	718.00	1.27	6.02	447.85	176.46	271.38	77.85	399.46	72.19	0.61	0.89
STDEV			1.32	0.36	0.13	55.54	1.18	6.70	83.54	70.91	79.51	25.66	173.19	30.08	0.21	0.14
BIS	Desirable Limit			6.5	-	500	5	200	300	75	30	-	200	250	0.3	1.0
Std	Permissible Limit			8.5	-	2000	10	400	600	200	100	-	600	100	1.0	1.5

All values are in mg/l, except Temp, pH, EC and Turbidity. Unit of Temp are ^{0}C, EC are µs/cm and Turbidity is NTU.

Table 10. Correlation Matrix for studied parameters

	Temp	pH	E.C	TDS	Turbidity	Sulphate	Total Hard	Ca hard	Mg Hard	Acidity	Alkalinity	Chloride	Iron	Fluoride
Temp	1.00													
pH	-0.34	1.00												
E.C	0.88	-0.27	1.00											
TDS	0.73	-0.50	0.48	1.00										
Turbidity	0.43	-0.05	0.18	0.46	1.00									
Sulphate	0.78	0.04	0.73	0.47	0.51	1.00								
Total Hard	-0.08	0.02	-0.10	-0.19	0.18	-0.09	1.00							
Ca hard	-0.45	-0.02	-0.48	-0.40	0.07	-0.55	0.48	1.00						
Mg Hard	0.32	0.04	0.33	0.16	0.13	0.40	0.62	-0.39	1.00					
Acidity	0.35	-0.56	0.47	0.23	-0.33	-0.06	0.17	-0.03	0.20	1.00				
Alkalinity	0.04	-0.08	-0.23	0.19	0.13	-0.11	0.38	-0.12	0.50	-0.06	1.00			
Chloride	0.78	-0.25	0.88	0.52	0.23	0.67	-0.35	-0.60	0.16	0.23	-0.34	1.00		
Iron	0.64	-0.29	0.72	0.47	-0.18	0.27	-0.34	-0.39	-0.01	0.62	-0.34	0.73	1.00	
Fluoride	0.07	-0.25	-0.03	-0.03	-0.07	-0.03	-0.54	-0.19	-0.40	-0.19	0.20	0.07	-0.12	1.00

The mean value of acidity was found to be 68.69 mg/l as $CaCO_3$, with a maximum and minimum value of 92.0 mg/l and 33.0 mg/l as $CaCO_3$ respectively. The standard deviation was in the range of 29.62 to 44.67 mg/l as $CaCO_3$.Chloride was found to be between 34.34-115.05 which is found to be within the standard desirable limit of 250mg/l prescribed by BIS, 1991.

Total Hardness was found to in the range of 402-407 mg/l which has crossed the desirable limit of 300mg/l but within the permissible limit of 600mg/l prescribed by BIS, 1991. Calcium hardness as (CaCo3) values of ground water was recorded between 86-460 mg/l which in most of the months were above the desirable and permissible limit prescribed by BIS, 1991i.e.75-200mg/l. Magnesium hardness as $CaCO_3$ recorded between 50-430 mg/l which was above the desirable limit of 50mg/l and permissible limit 100mg/l. Sulphate was between 1.41-54.05 mg/l which was found to be well within the desirable limit of 200mg/l prescribed by BIS, 1991. Iron values were recorded between 0.24-0.90 mg/l which was found to be well within the maximum permissible limit 1.00mg/l prescribed by BIS, 1991. Fluoride was found to in the range of 0.83-1.23mg/l which is found to be well within the desirable limit prescribed by BIS, 1991.

Relations between the physicochemical parameters measured in all water samples in the site 4 are explained on the basis of the values of linear Pearson's correlation coefficients presented in Table 8. Analysis of correlation coefficients (p = 0.05) shows that some common relations only for variables describing pH showed that negative correlation TDS (-0.40), Acidity (-0.27), Fluoride (-0.51), Sulphate showed that strong positive correlation with Chloride (0.56) and Acidity showed that negative correlation with iron (-0.31) similar results was obtained by Florence *et al.* (2013).

Site 5 (KHATANGIA)

Perusal of the data appended in the Table 9 showed that in Site 5 (KHATANGIA) the pH was found to be neutral in nature in most of samples range between 7.10-8.48.Temperature was found to in range of 25.00-29.28 Variation in temperature may be due to different timings of collection and influence of season Turbidity of water samples were found to be between 0.50-5.00 NTU in all the samples. TDS was found to be between 612-816 mg/l which has crossed the standard desirable limit of 500mg/l prescribed by BIS, 1991 in most of the water samples but is within the permissible limit of 2000mg/l.

Alkalinity of the water samples was found between 273-947 mg/l which has crossed the standard desirable limit of 200mg/l and permissible limit of 600mg/l. The mean value of acidity was found to be 77.85 mg/l as $CaCO_3$, with a maximum and minimum value of 947 mg/l and 273 mg/l as $CaCO_3$ respectively. The standard deviation was in the range of 29.62 to 44.67 mg/l as $CaCO_3$Chloride was found to be between 30.09-101.78 which is found to be within the standard desirable limit of 250mg/l prescribed by BIS, 1991. Total Hardness was found to in the range of 270-574 mg/l which has crossed the desirable limit of 300mg/l but within the permissible limit of 600mg/l prescribed by BIS, 1991. Calcium hardness as (CaCo3) values of ground water was recorded between 76-320 mg/l which in most of the months were above the desirable and permissible limit prescribed by BIS, 1991i.e.75-200mg/l. Magnesium was recorded between 98-414 mg/l which was above the desirable limit of 50mg/l and permissible limit 100mg/l. Sulphate was between 0.35-15.69 mg/l which was found to be well within the desirable limit of 200mg/l prescribed by BIS, 1991.

Iron values were recorded between 0.32-0.98 mg/l which was found to be well within the maximum permissible limit 1.00mg/l prescribed by BIS, 1991.Fluoride was found to in the range of 0.69-1.22 mg/l which is found to be well within the desirable limit prescribed by BIS, 1991. Relations between the physicochemical parameters measured in all water samples in the site 5 are explained on the basis of the values of linear Pearson's correlation coefficients presented in Table 10. Analysis of correlation coefficients (p = 0.05) shows that some common relations only for variables describing pH showed that negative correlation EC (-0.27), Acidity (-0.56), Chloride (-0.25), Iron (-0.29), Fluoride (-0.25), Sulphate showed that strong positive correlation with Chloride (0.67) and Iron showed that negative correlation with Fluoride (-0.12) similar results was obtained by Jianhua *et al*.(2013).

The present research work Assessment of Ground water quality of Different Villages in Bara Tehsil, Allahabad District U.P. was the concern expressed for deterioration in the ground water quality (hand pumps). It is noticed that the survey study of the water quality parameters of groundwater from 5 different sites in Bara Tehsil showed that the Temperature, pH, EC, Chloride, Fluoride Iron, Sulphate, TDS, Alkalinity, Turbidity values are well within the permissible limits. This study reveals that groundwater is the only source for people in the study area, and the results of the chemical analysis of groundwater indicate considerable variation. Most of the water samples do not comply with BIS standards for drinking purposes. Regular chemical analysis must be done to ensure that the quality of the water in this area is not contaminated.

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