ISSN: 0976-3376

Available Online at http://www.journalajst.com

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

Asian Journal of Science and Technology
Vol. 09, Issue, 07, pp.8490-8497, July, 2018

RESEARCH ARTICLE

GROUNDWATER QUALITY ASSESSMENT USING CHEMICAL IDICES AND GIS MAPPING OF KARWI AREA, MANDAKINI RIVER BASIN, UTTAR PRADESH, INDIA

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ARTICLE INFO

Article History:
Received 05th April, 2018
Received in revised form
10th May, 2018
Accepted 07th June, 2018
Published online 30th July, 2018

Key words:
GIS, Groundwater quality,
Remote Sensing, GPS, Slope,
Modis, Landset,
Land use/Land Cover.

ABSTRACT

The paper deals with problem of water quality become more important than quantity in parts of Mandakini River Basin, Chitrakoot district, Uttar Pradesh. Based on the integrated studies, it has been observed that the lithology, geomorphology, lineaments, slope, effluents, sewage disposal, soil and land use/land cover was generated from Modis, Landsat ETM + data and Survey of India, (Nos.63 C/15 and 63 C/16; Figure 1.1) on 1:50,000 scale and integrated data with raster based Geographical Information System (GIS) to identify the groundwater quality of an area. Water quality is also affected due to human activities like improper agricultural practice, industrial wastes and municipal solid wastes. In context to the above issues an attempt has been made to study the geochemistry of groundwater available in Karwi Area, Mandakini River Basin, Chitrakoot district, Uttar Pradesh. The water samples have been analysed for anions and cation. The anomalies are highlighted by the concentration maps chart and the same has been interpreted. The final result represents the favourable quality of the groundwater in the study area is suitable for both domestic and agricultural activity as of now.

INTRODUCTION

The hydrochemical study infers the quality of water with purpose of aptness for the domestic, drinking, agriculture and industrial uses. The variation of ground water quality in an area is a function of physical and chemical parameters, which are significantly influenced by rock water interaction and any type of anthropogenic activities. The chemical parameters of ground water play a important role in categorization and evaluating of water quality. It is observed that the criteria used in the classification of waters for a particular purpose considering the individual concentration may not find its suitability for other purposes and better results can be obtained only by considering the combined chemistry of all the ionic characters (Handa, 1964, 1965; Hem, 1985; and Simpi *et al,* 2011). Chemical classification also throws light on the concentration of various predominant cations, anions and their interrelationships. Ground water is used for agricultural, domestic and industrial purposes. It accounts for about 50% of livestock and irrigation usage and just under 40% of water supplies, while in rural areas, 98% of domestic water use is from ground water (Todd, 1980). He (Todd, 1980) remarked that the ground water is often high in mineral content such as calcium and magnesium salts, iron and manganese depending on the chemical composition of the stratum through which the rock flows.

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Tebbute, (1992) noted that pathogenic organisms are rarely found in ground water, since poor well construction or being associated with bedrock aquifers in which large openings afford direct connection between the surface and ground water causes most well pathogenic contamination.To establish quality criteria, the measures of physical, chemical, and biological constituents must be spe-cified, together with standard methods for comparing results of water quality analyses (Todd, 1980; McCutcheon *et al.*, 1993). In the Chitrakoot region, ground water chemical analysis has been conducted by Garg, (2003), Nim *et.al.,* (2005), and Gupta *et. al.,* (2009), Gupta, (2010). The present study by author deals with delineation of chemical quality of ground water of the Karwi area of Chitrakoot district, Uttar Pradesh for the assessment of ground water suitability for domestic, drinking and agriculture applications.

Study area: The Karwi study area is located within latitude 25° 11' 20" to 25° 16' 30" N and longitude 80° 50' 30" to 80° 57' 06" E in the south-western part of Chitrakoot district, Uttar Pradesh (Survey of India Toposheet Nos.63 C/15 and 63 C/16; Figure 1.2). This Karwi area belongs to the northern Vindhyan (Vindhyachal) Range, which is restricted to 183.23 Sq km. The area is mainly drained by Mandakini River system. The Karwi is situated on Jhansi-Manikpur railway line and study area is well connected with Banda, Manikpur, Satna and Allahabad by both road and rail.

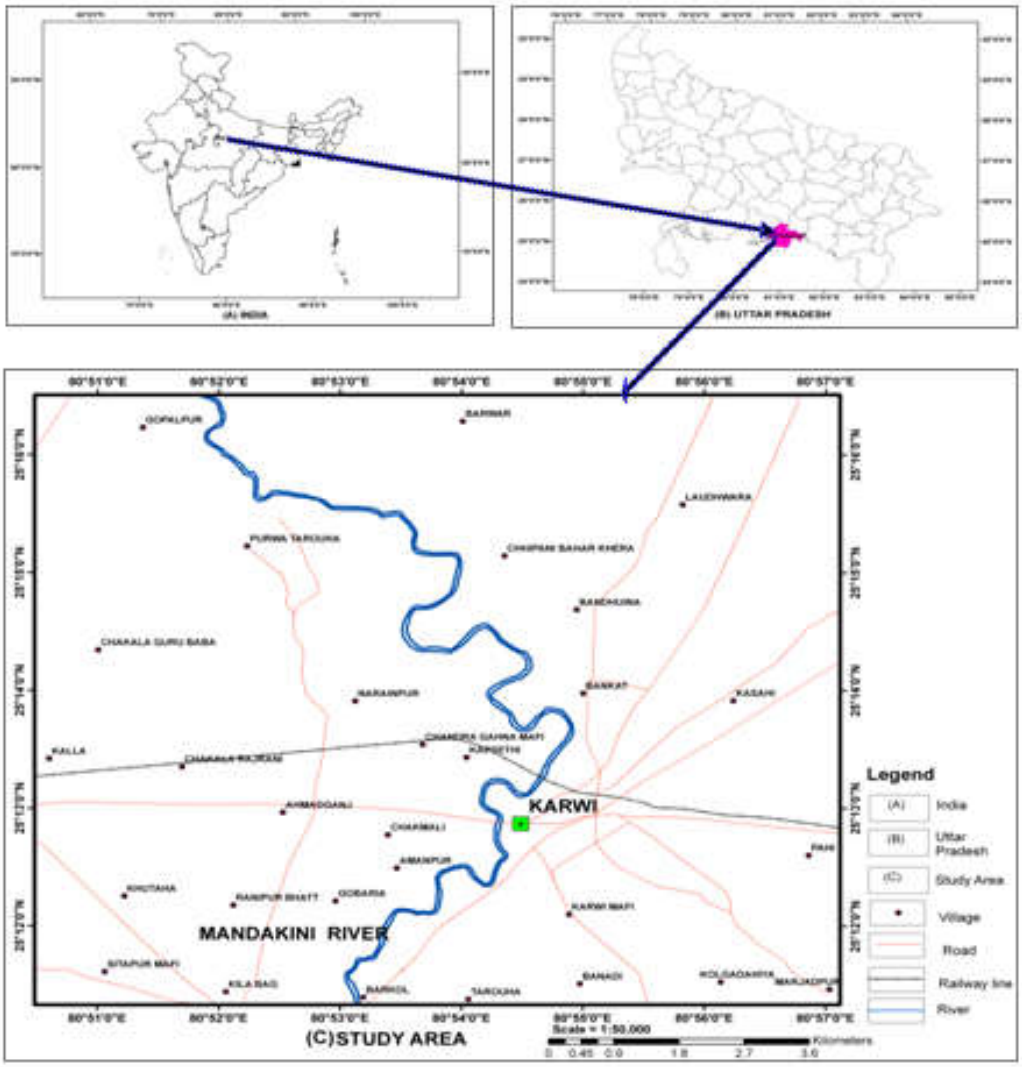

Figure: 1.1. Location map of Karwi study area, Chitrakoot district, Uttar Pradesh

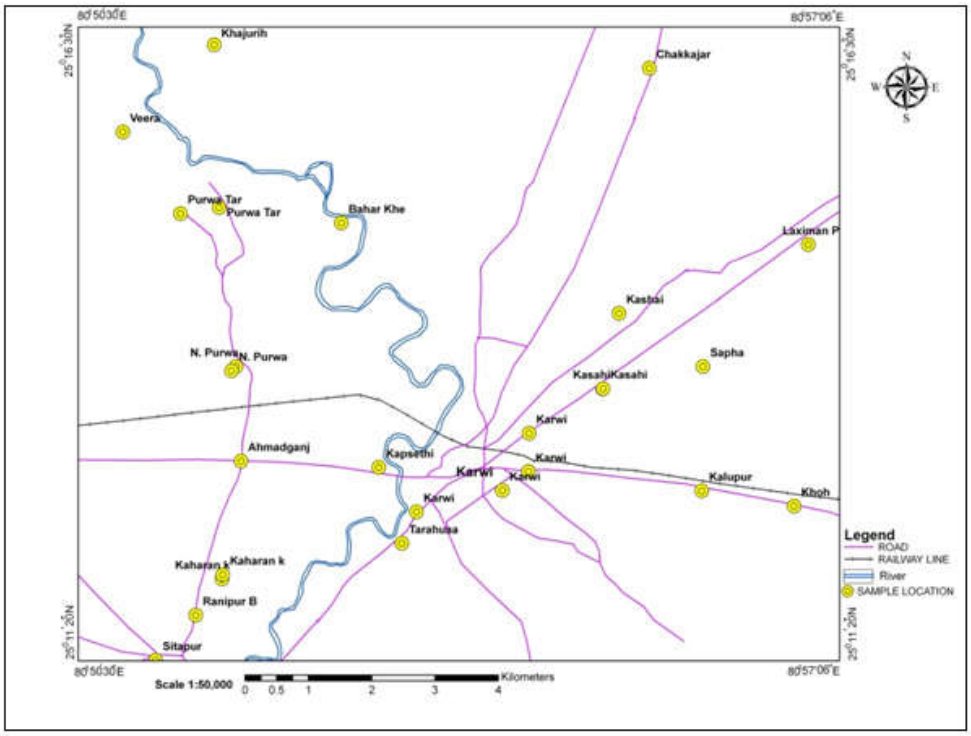

Figure 1.2 Map showing location of ground water samples of Karwi area, Chitrakoot District, Uttar Pradesh

MATERIALS AND METHODS

Ground water samples were collected from 26 open dug well sites of the Karwi, Chitrakoot district, Uttar Pradesh, (Figure 1.2), following the procedure of Trivedi and Goel, (1984) and NEERI, (1986). The procedure of collection of ground water samples involved sampling site selection and sampling equipments. The collected ground water samples were transferred into pre-cleaned polythene containers for chemical analysis. The analytical data have been used for determining chemical quality of ground water suitability for the domestic, drinking, agriculture/irrigation. The methodology used for chemical analysis of ground water of Karwi area, includes determination of physico-chemical parameters both in the field and laboratory. The standard methods of chemical analysis recommended by APHA (1998), WPCF (1985), Trivedi and Goel (1984) and NEERI (1986) were adopted for determination of various physico-chemical parameters. The collected water samples were analyzed for determinations of various physico-chemical parameters such as Colour, Odour, Taste, TDS, pH and Electrical Conductivity and ionic concentrations such as cations- Ca, Mg, Na, K and anions- Cl, SO_4, HCO_3, CO_3, F by using standard methods of chemical analysis.

RESULT AND DISCUSSION

Ground water samples collected from 26 locations of Karwi area, Chitrakoot district, Uttar Pradesh are displayed herein (Figure 1.2). The physical and chemical parameters of ground water have been analyzed to determine suitability of ground water quality for different uses. The results of physico-chemical analysis of ground water are displayed (Table 1.1 and 1.2).

Physical parameter: The analysis of physical parameters measurement of Colour, Odour, Taste, pH, Electrical Conductivity and TDS are evaluated of dug well samples (Table 1.1).

Colour: Colour has been used as a qualitative character of the water It may be/ present due to toxic organic substances in water. All the ground water samples of study area are colourlrss and suitable for the applications.

Odour: Odour is the most common observation in water quality. It is human perception of water quality. The odour of waste waters is determined by the diverse sources of information household, industrial, agricultural, atmospheric and by the products interaction of their components. The odour of potable water is often determined by the substances used for its preliminary treatment. All the ground water samples of study area are odourless.

Taste: Taste depends on the stimulation of the human receptor cells that are located in the taste-buds (WHO, 2004). The sense of smell is more sensitive than the best taste in drinking water is measured by taste tests such as the threshold test or taste rating tests. All the ground water samples of study area are tasteless.

pH: The pH influences the taste and odour of a substance significantly, especially when it controls the equilibrium concentration of the neutral and ionized forms of a substance in solution. The minimum pH value is 7.3 mg/l of Bahar Khera Village and the maximum value is 7.8 mg/l obtained of Kaharan ka Purwa, Near Purwa Tarahuaa.

Electrical Conductivity: Electrical conductivity is a very useful property since values are affected by such things as a substance, chemical composition, and the stress state of crystalline structures. The electrical conductivity value can be used for measuring the purity of water, sorting materials, checking for proper heat treatment of metals, and inspecting for heat damage in some materials. Electrical conductivity has been obsrved within the range of 768 (μmho cm^{-1}) of Bahar Khera village to 976 (μmho cm^{-1}) of the Kaharan ka Purwa village.

Total Dissolved Solids: Total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and Nitrates of Calcium, Magnesium, Sodium, Potassium, Manganese, organic matter salt and other particles. In the present area, total dissolved solids value vary from 499 mg/l of Bahar Khera village to 648 mg/l Kasahi Village.

Chemical Parameters: The chemical parameters of ground water have been analysed in dug well water samples of the study area. The analyzed ionic values of cations (Calcium, Magnesium, Sodium, Potassium) and anions (Chloride, Sulphate, Carbonate, Bi-carbonate, Fluoride) are represented in (Table 1.2).

Total Hardness: Hardness is the property of water that prevents the lather formation with soap and increases the boiling points of water. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The hardness values reveal a variation range from 312 mg/l Ahmadganj to 395 mg/l Near Purwa Tarahuaa Villages in the Karwi study area

Calcium: Calcium is directly related to hardness. It is calculated from total hardness as mg/l. The minimum Calcium value is 78.4 mg/l Ahmadganj village and the maximum value is 112 mg/l obtained of Near Purwa Tarahuaa village.

Magnesium: Magnesium has been calculated from total hardness as mg/l. Magnesium concentration varies from 27.18 mg/l near Purwa Tarahuaa village to 33.46 mg/l of the Karwi city.

Sodium: The Karwi area, Chitrakoot district, Uttar Pradesh of Sodium concentrations were found to be in the range between 15.4 mg/l Kasahi village to 35.2 mg/l of Kalupur Village.

Potassium: The major source of potassium in natural fresh water is weathering of rocks but the quantities increase may be attributed to excess of use of fertilizer and disposal of waste water. The maximum potassium content is recorded at 10.0 mg/l Kaharan ka Purwa to 27.5 mg/l at Sitapur Villages.

Chloride: Chloride in surface and ground water from both natural and anthropogenic sources, such as use of inorganic fertilizers, animal feeds, industrial effluents, irrigation drainage. The chloride concentration serves as an indicator of pollution by sewage.

Table 1.1 Physical parameters of dug well water samples of the Karwi area.

S.No.	Location/ Village	Colour	Odour	Taste	pH	EC(µmho cm^{-1})	TDS (mg/l)
1	Ranipur Bhatt	Colourless	Odourless	tasteless	7.5	796	517
2	Kaharan ka Purwa	Colourless	Odourless	tasteless	7.8	976	623
3	Kapsethi	Colourless	Odourless	tasteless	7.7	880	572
4	Near Purwa Tarahuaa	Colourless	Odourless	tasteless	7.7	905	589
5	Near Purwa Tarahuaa	Colourless	Odourless	tasteless	7.8	910	592
6	Veera	Colourless	Odourless	tasteless	7.6	863	578
7	Kashai	Colourless	Odourless	tasteless	7.5	792	527
8	Kasahi	Colourless	Odourless	tasteless	7.7	958	648
9	Karwi	Colourless	Odourless	tasteless	7.6	865	562
10	Khoh	Colourless	Odourless	tasteless	7.6	852	554
11	Karwi	Colourless	Odourless	tasteless	7.5	857	558
12	Karwi	Colourless	Odourless	tasteless	7.7	969	641
13	Tarahuaa	Colourless	Odourless	tasteless	7.6	870	564
14	Kalupur	Colourless	Odourless	tasteless	7.6	855	558
15	Karwi	Colourless	Odourless	tasteless	7.8	960	642
16	Purwa Tarahuaa	Colourless	Odourless	tasteless	7.6	878	571
17	Bahar Khera	Colourless	Odourless	tasteless	7.3	768	499
18	Ahmadganj	Colourless	Odourless	tasteless	7.4	788	512
19	Kasahi	Colourless	Odourless	tasteless	7.5	792	515
20	Sitapur	Colourless	Odourless	tasteless	7.5	786	514
21	Kaharan ka Purwa	Colourless	Odourless	tasteless	7.8	972	632
22	Purwa Tarahuaa	Colourless	Odourless	tasteless	7.6	868	573
23	Sapha	Colourless	Odourless	tasteless	7.6	793	517
24	Laximan Pur	Colourless	Odourless	tasteless	7.5	795	532
25	Chakkajar	Colourless	Odourless	tasteless	7.6	853	562
26	Khajuriha	Colourless	Odourless	tasteless	7.6	871	556

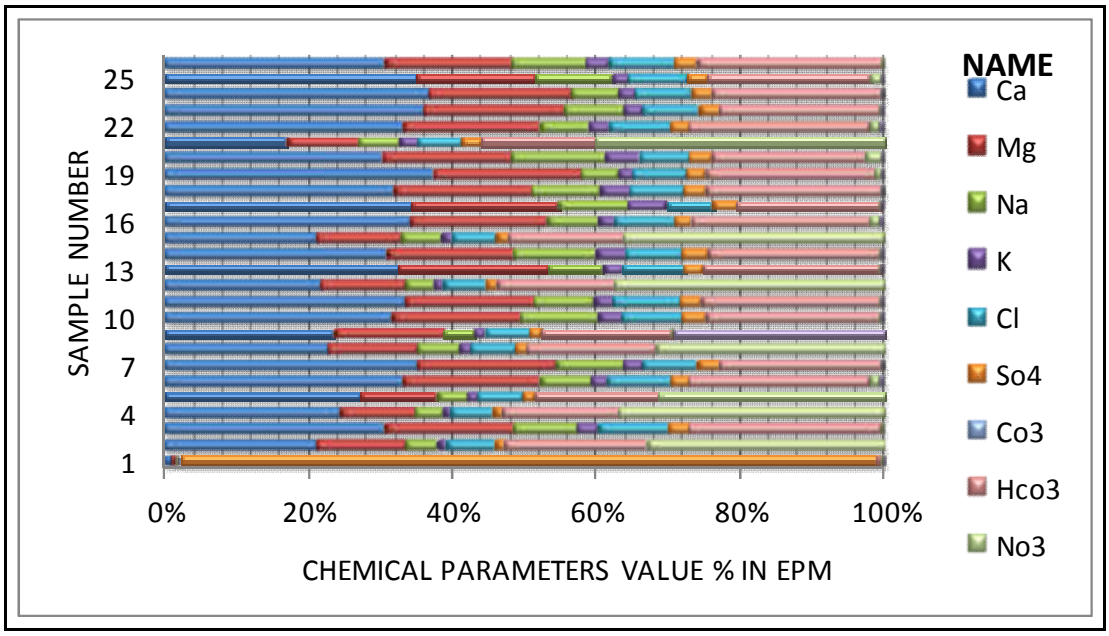

Figure: 1.3. Graphical representation of Collins Bar diagram, Karwi area

People accustomed to higher chloride in water are subjected to laxative effects. It showed marked variation during the study area with a range of 30 mg/l in Bahar Khera village and 52 mg/l in the Purwa Tarahuaa.

Fluoride: The probable source of high fluoride in 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 on human being. In all samples, the minimum fluoride content is recorded at 0.3 mg/l Karwi and maximum 1.3 mg/l Purwa Tarahuaa in the study area.

Sulphate: Sulphate is a naturally occurring substance that contains sulphur and oxygen. It is present in various mineral salts that are found in soil.

Sulphate forms salts with a variety of elements including barium, calcium, magnesium, potassium and sodium. The concentration of Sulphate range between 15 mg/l Kaharan ka Purwa to 23 mg/l Sitapur in the ground water of the study area.

Nitrate: Ground water contains nitrate due to leaching of nitrate with the percolating water. Ground water can also be contaminated by sewage and other wastes rich in nitrates. The nitrate content in the study area varied in the minimum range 0.4 mg/l of Kaharan ka Purwa, Purwa Tarahua, Kasahi villages and maximum value 20.8 mg/l obtained in Ranipur Bhatt village.

Iron: Iron is a common constituent in soils and ground water. It readily participates in subsurface redox reactions and under some conditions can cause problems with ground water

Table.1.2 Chemical parameters of dug well water sample Karwi, Chitrakoot District, Uttar Pradesh (in ppm / mg/l)

S.No	VILLAGE	pH	EC(µmhoc m^{-1})	TDS (mg/l)	TH as$CaCO_3$ (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Cl (mg/l)	F (mg/l)	SO_4 (mg/l)	CO_3 (mg/l)	HCO_3 (mg/l)	NO_3 (mg/l)	Iron (mg/l)
1	Ranipur Bhatt	7.5	796	517	352	87.2	32.52	24.8	12.4	36.0	0.9	18.0	Nil	188	20.8	0.18
2	Kaharan ka Purwa	7.8	976	623	338	83.6	29.72	19.2	10.0	49.0	0.0	15.0	Nil	236	0.4	0.16
3	Kapsethi	7.7	880	572	318	80.0	28.64	26.3	14.5	45.0	0.0	19.0	Nil	212	1.0	0.00
4	Near Purwa Tarahuaa	7.7	905	589	395	108.0	27.65	18.7	10.3	45.0	0.0	15.0	Nil	215	0.5	0.00
5	Near Purwa Tarahuaa	7.8	910	592	392	112.0	27.18	20.2	11.6	46.0	0.0	16.0	Nil	218	0.4	0.00
6	Veera	7.6	863	578	377	92.0	32.01	22.6	12.0	43.0	1.3	17.0	Nil	213	11.5	2.40
7	Kashai	7.5	792	527	370	96.7	31.89	28.9	15.0	36.0	0.6	21.0	Nil	186	0.9	0.13
8	Kasahi	7.7	958	648	365	93.2	31.03	27.2	13.7	44.0	0.0	19.0	Nil	221	0.4	0.13
9	Karwi	7.6	865	562	348	84.8	33.01	18.3	10.0	40.0	0.1	15.0	Nil	196	2.8	0.00
10	Khoh	7.6	852	554	320	81.6	28.16	32.6	16.3	38.0	0.8	21.0	Nil	190	1.8	0.00
11	Karwi	7.5	857	558	346	84.5	33.46	24.3	12.8	41.0	0.3	18.0	Nil	192	2.1	0.00
12	Karwi	7.7	969	641	369	94.8	31.08	19.1	11.0	46.0	0.0	16.0	Nil	218	0.5	0.12
13	Tarahuaa	7.6	870	564	350	84.8	33.02	23.0	12.3	41.0	0.3	17.0	Nil	194	2.6	0.00
14	Kalupur	7.6	855	558	323	81.8	28.18	35.2	21.2	37.0	0.7	22.0	Nil	192	1.9	0.00
15	Karwi	7.8	960	642	370	95.2	32.03	28.2	13.0	48.0	0.0	19.0	Nil	220	0.5	0.14
16	Purwa Tarahuaa	7.6	878	571	372	96.0	32.04	22.0	12.4	42.0	1.2	17.0	Nil	210	12.5	2.50
17	Bahar Khera	7.3	768	499	360	89.6	33.01	29.2	26.0	30.0	0.6	20.0	Nil	160	1.6	0.20
18	Ahmadganj	7.4	788	512	312	78.4	28.16	27.0	19.7	32.0	0.4	19.0	Nil	180	1.3	0.28
19	Kasahi	7.5	792	515	378	97.6	32.52	15.4	10.7	35.0	0.5	15.0	Nil	186	0.8	0.15
20	Sitapur	7.5	786	514	348	86.2	31.52	42.3	27.5	34.0	0.7	23.0	Nil	183	19.8	0.16
21	Kaharan ka Purwa	7.8	972	632	330	83.2	29.61	31.5	24.6	52.0	0.0	21.0	Nil	240	0.6	0.16
22	Purwa Tarahuaa	7.6	868	573	378	94.1	32.01	23.0	14.7	43.0	1.3	18.0	Nil	212	11.5	2.4
23	Sapha	7.6	793	517	382	98.1	32.4	25.6	13.0	38.0	0.8	19.0	Nil	185	0.7	0.17
24	Laximan Pur	7.5	795	532	372	96.7	31.43	19.4	11.7	37.0	0.6	17.0	Nil	187	0.9	0.13
25	Chakkajar	7.6	853	562	326	82.6	28.07	34.3	23.3	39.0	0.7	21.0	Nil	191	1.3	0.00
26	Khajuriha	7.6	871	556	314	82.0	28.12	31.7	17.2	43.0	0.0	20.0	Nil	208	1.1	0.10

Abreviations: pH = Hydrogen ion , EC = Electrical Conductivity , TDS = Total Dissolved Solids T H = Total Hardness as $CaCO_3$, Ca = Calcium, Mg = Magnesium, Na = Sodium, K = Potasium, Cl = Chloride, F = Fluoride, SO_4 = Sulphate, CO_3 = Carbonate, HCO_3 = Bi-carbonate, NO_3 = Nitrate.

Table.1.3 Chemical Parameters (in epm) of dug well water samples, Karwi area, Chitrakoot District, Uttar Pradesh

S.No.	Ca	Mg	Na	K	Cl	SO_4	CO_3	HCO_3	NO_3	F
1	4.351	2.675	1.078	0.317	1.015	0.374	Nil	3.081	0.335	0.047
2	4.171	2.444	0.835	0.255	1.297	0.312	Nil	3.868	6.452	0.000
3	3.992	2.355	1.144	0.370	1.269	0.395	Nil	3.474	0.016	0.000
4	5.389	2.274	0.813	0.263	1.269	0.312	Nil	3.523	8.065	0.000
5	5.588	2.235	0.878	0.296	1.297	0.333	Nil	3.573	6.452	0.000
6	4.590	2.633	0.983	0.306	1.213	0.353	Nil	3.491	0.185	0.068
7	4.825	2.623	1.257	0.383	1.015	0.437	Nil	3.048	0.014	0.031
8	4.650	2.552	1.183	0.350	1.241	0.395	Nil	3.622	6.452	0.000
9	4.231	2.715	0.796	0.255	1.123	0.312	Nil	3.212	0.045	5.264
10	4.071	2.316	1.418	0.416	1.071	0.437	Nil	3.114	0.029	0.042
11	4.216	2.252	1.057	0.327	1.156	0.374	Nil	3.146	0.033	0.015
12	4.730	2.556	0.830	0.281	1.297	0.333	Nil	3.573	8.065	0.000l
13	4.231	2.716	1.000	0.314	1.156	0.353	Nil	3.179	0.041	0.015
14	4.081	2.318	1.531	0.542	1.043	0.458	Nil	3.146	0.030	0.036
15	4.750	2.634	1.226	0.332	1.354	0.395	Nil	3.605	8.065	0.000

Continue …….

15	4.750	2.634	1.226	0.332	1.354	0.395	Nil	3.605	8.065	0.000
16	4.790	2.635	0.957	0.317	1.184	0.333	Nil	3.441	0.201	0.063
17	4.471	2.715	1.270	0.664	0.864	0.416	Nil	2.622	0.025	0.031
18	3.912	2.316	1.174	0.503	0.902	0.375	Nil	2.950	0.020	0.021
19	4.870	2.675	0.64	0.273	0.987	0.312	Nil	3.048	0.129	0.026
20	4.301	2.512	1.840	0.703	0.959	0.478	Nil	2.999	0.319	0.036
21	4.151	2.435	1.370	0.629	1.466	0.645	Nil	3.933	9.678	0.000
22	4.695	2.633	1.000	0.375	1.213	0.374	Nil	3.523	0.185	0.068
23	4.895	2.665	1.113	0.332	1.071	0.395	Nil	3.032	0.011	0.042
24	4.825	2.585	0.843	0.299	1.043	0.353	Nil	3.064	0.014	0.031
25	4.825	2.309	1.492	0.340	1.100	0.437	Nil	3.130	0.200	0.036
26	4.091	2.312	1.378	0.439	1.213	0.416	Nil	3.409	0.017	0.000

Table.1.4. Chemical Parameters (% in epm) of dug well water samples Karwi area, Chitrakoot District, Uttar Pradesh

S.No.	Ca	Mg	Na	K	Cl	SO_4	CO_3	HCO_3	NO_3	F
1	51.668	31.765	12.725	3.764	20.910	7.708	Nil	63.499	06.904	0.968
2	54.133	31.719	11.589	3.309	11.353	2.615	Nil	32.425	54.086	0.000
3	50.782	29.958	14.552	4.706	24.626	7.660	Nil	67.403	00.310	0.000
4	61.666	26.021	09.303	3.009	09.630	2.360	Nil	26.752	61.242	0.000
5	62.109	24.841	09.758	3.289	10.400	2.857	Nil	30.656	55.358	0.000
6	53.923	30.932	11.548	3.594	00.190	6.647	Nil	15.743	03.483	1.280
7	53.091	28.862	13.831	4.214	27.300	9.614	Nil	67.062	00.308	0.682
8	53.234	29.215	13.543	4.006	09.590	3.373	Nil	30.930	55.098	0.000
9	52.907	33.950	09.953	3.188	11.270	3.133	Nil	32.255	00.451	52.862
10	49.519	28.171	17.248	5.060	22.822	9.311	Nil	66.354	00.617	0.894
11	50.478	32.950	12.587	3.915	24.482	7.982	Nil	66.638	00.699	0.317
12	56.329	30.367	09.884	3.346	10.572	2.633	Nil	29.129	65.750	0.000
13	51.216	32.877	12.105	3.800	24.360	7.419	Nil	67.010	00.864	0.316
14	48.170	27.360	18.071	6.397	22.130	9.721	Nil	66.779	00.636	0.764
15	53.20	29.456	13.710	3.712	10.090	2.943	Nil	26.864	60.101	0.000
16	55.063	30.290	11.001	3.644	22.670	6.376	Nil	65.894	03.849	1.206
17	49.024	29.769	13.925	7.280	21.550	10.60	Nil	66.819	00.637	0.790
18	49.427	29.297	14.851	6.363	21.035	9.211	Nil	68.196	00.466	0.489
19	57.246	31.444	07.864	3.209	21.920	6.930	Nil	67.703	02.865	0.577
20	45.580	27.469	19.499	7.450	20.100	9.977	Nil	62.576	06.538	0.751
21	48.351	28.363	15.958	7.326	09.310	4.097	Nil	24.984	61.478	0.000
22	53.946	30.253	11.490	4.308	22.610	6.973	Nil	65.690	03.449	1.267
23	54.358	29.594	12.359	3.686	23.530	8.679	Nil	66.622	00.241	0.922
24	56.419	30.226	09.857	3.496	28.030	6.920	Nil	60.066	00.274	0.607
25	53.814	25.752	16.082	3.792	21.760	8.911	Nil	63.825	04.078	0.734
26	49.762	28.135	16.761	5.339	23.996	8.220	Nil	60.282	05.055	0.000

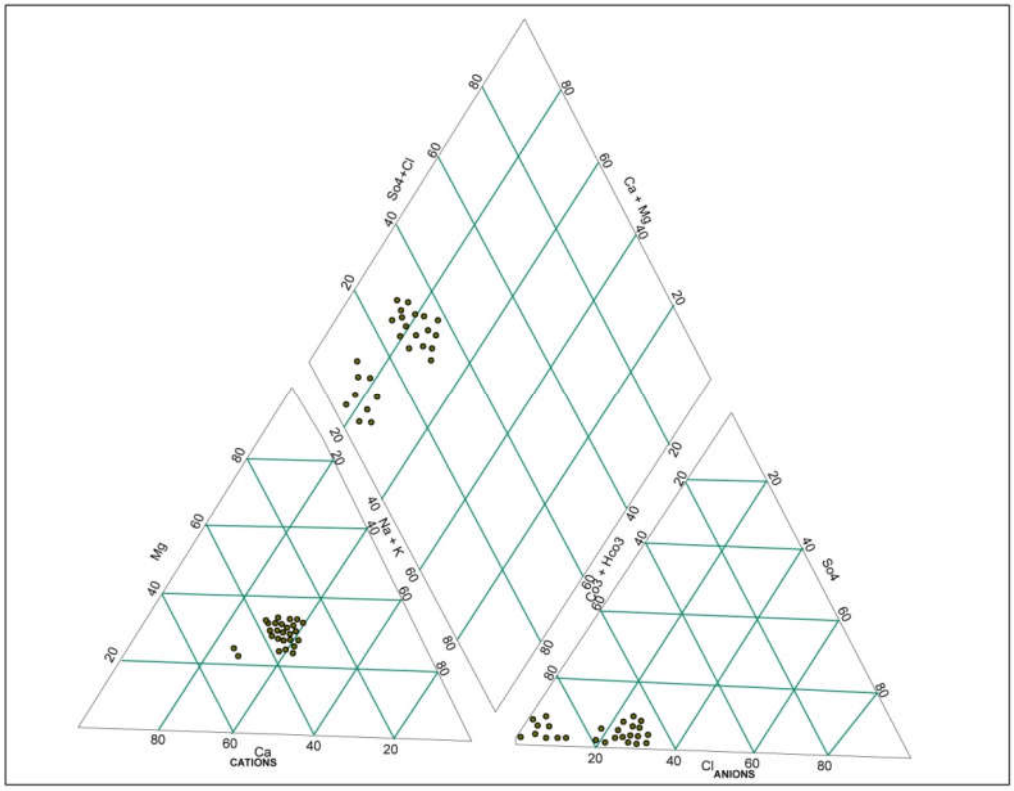

Figure: 1.4. Ground water samples of Karwi area, Chitrakoot District, plotted on Trilinear Piper's diagram

remediation systems. The purpose of this column is provide a broader setting for the impact of iron chemistry on ground water. In all samples the minimum iron content is recorded at 0.1 mg/l Khajuriha and maximum 2.4 mg/l Purwa Tarahuaa. A variety of graphical and multivariate statistical techniques have been developed since the early 1920 in order to facilitate the classification of waters, with the ultimate goal of dividing a group of samples into similar homogeneous groups. Several commonly used graphical methods and multivariate statistical techniques are including the Collins bar diagram and Pie diagram. The ground water dug well data of chemical analysis represented as numerous graphical methods have been developed over the years for interpreting water quality based on the chemical data of water (Guler *et.al.,* 2002). In the Karwi study area, ionic concentrations data of dug well water samples have been represented by the tabular form and graphical methods such as Bar diagrams (Figure 1.3). The ionic concentrations of dug well water samples of the study area have been measured and recorded in ppm (parts per million) or mg/l (milligrams per liter), and as epm (equivalent per million) or meq/l (milli equivalents per liter).

Collins bar diagram: Collins (1923) presented the first graphical technique in which the concentrations of individual major ions, both cations and anions are indicated by color or patterns on adjoining perpendicular bars. The height of the bar is proportional to the total concentration values (% in epm) of the cations and anions. As the sum of cations and anions should be equal, the height of the bar should be same for cations and anions. The height differences may arise due to not giving representation to other ions occurring in significant quantities, due to error in analysis (Karanth, 1987). For the Collins bar diagram cations and anions are plotted in the (Figure 1.3).

Trilinear piper's diagram: Hills (1940) and Piper (1944, 1953) designed a Trilinar diagram. The Trilinear Piper's diagram is wiedly used for ground water studies. It is contains three fields defended into two triangular and one dimensional shape. Trilinear Piper diagram is used in chemical relationship of ground water samples, which can show the percentage composition of different anions and cations were displayed on the Trilinear diagram. The cations and anions were plotted in left and right triangles as a single point. These points are projected into the central diamond-shaped area parallel to the upper edges of the central area.

All points in the diamond-shaped area represent total ionic distribution. For every water sample, a single point was obtained in the diamond-shaped area, which represents to the ionic circulation. The water samples is examined by plotting the cations and anions on Trilinear Piper's diagram Pipper, (1953), Handa, (1965), Lipson et.al., (2000), Barde and Asodekar, (2002). The Piper diagram provides a visual representation of the concentration of major ions in water, Hem, (1970). The dug well 26 water samples of Karwi area represented by depicted on the Trilinear Piper's diagram (Figure 1.4). The plots of ionic concentration on Piper's diagram reveal that the ground water is of the Ca, Mg, CO_3, HCO_3, type. The Piper diagram relations of water sample were found have calcium bicarbonate type of water since the concentration of cations (Ca+Mg) exceed over anions (SO_4+ Cl) were recorded less as compared to the concentration of carbonate and bi-carbonate anions.

Conclusion

The chemical analysis of ground water reveals that in general, it is favourable for domestic drinking and irrigation uses except at a few places were it requires to be properly treated before water supply. Ground water quality in Karwi study area, has been determined by chemical analysis. Ground water samples collected from 26 dug wells and were treated to chemical with a view to delineate suitable quality for the domestic, drinking, and agriculture uses. The physico-chemical parameters such as Colour, Odour, Taste, pH, Electrical Conductivity, and Total Dissolved Solids, have been determined. The presence of anions –HCo_3, Co_3, F, and cations includes – Ca, Mg, Na, and K have been determined by using standard methods of chemical analysis. All the samples are colourless, odourless and tasteless. The pH value ranges from 7.3 to 7.8, EC value ranges from 768 to 976 ppm, and TDS value ranges from 499 to 648 ppm. The chemical parameters include determination of the Calcium (28.4 to 112 ppm), Magnesium (27.18 to 33.46 ppm), Sodium (15.4 to 35.2 ppm), Potassium (10.0 to 27.5 ppm), Chloride (30 to 52 ppm), Sulphate (15 to 23 ppm), Nitrate (0.4 to 20.8 ppm), and Fluoride (0.3 to 1.3 ppm). The plots of ionic concentration on Piper's diagram reveal that the ground water is of the Ca Mg Co_3 HCO_3 type. In general, the ground water is suitable for domestic, irrigation and drinking purposes.

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