International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Assessment of Groundwater quality for irrigation in the Tattekere watershed, Periyapatna and Hunsur taluks in Mysore District, Karnataka, India

Ramakrishna†, D.Nagaraju†, A. Balasubramanian†, and Siddalingamurthy. S†*

†Department of Earth Science, Manasagangothri, University of Mysore, Mysuru -570 006.

Accepted 22 March 2015, Available online 29 March2015, **Vol.5, No.2 (April 2015)**

Abstract

Suitability of groundwater for irrigation was assessed in the study area in Mysore District, Karnataka based on various water quality parameters. From the study of suitability of the groundwater from the irrigational point of view, it is seen that Sodium Adsorption ratio (SAR) of all the water samples are of excellent class. On the basis of Residual sodium carbonate (RSC), all the water samples are of Good class. The water from deeper aquifers has better quality in general than that of the shallow aquifers. The groundwater of the study area is suitable for irrigation purposes except some cases where the water is saline in nature and has magnesium hazard. In order to achieve the set objectives various infrastructure like well designed monitoring network for groundwater levels, installation of digital water level recorders (DWLR'S) upgrading of water quality laboratories, establishment of data centers were implemented over the period of project.

Keywords*: Water quality, sodium adsorption ratio, Residual Sodium Carbonate, Deeper aquifers.*

1. Introduction

Groundwater can play an important role in Indian agriculture and in shaping the country's economy. A good quality of groundwater can help in the better yield of crops. Water used for irrigation purpose should have certain quality specifications. The suitability of water for irrigation mainly depends upon the tolerance of plants to certain chemical constituents, properties of soils and irrigation practices. Groundwater always contains some amount of constituents dissolved in it. The excess quantity of soluble salts may be harmful for many crops because their presence affects the soil structure, permeability and aeration. Hence, it is essential to properly evaluate groundwater quality for irrigation purpose.

2. Study Area

The study area comprises of Piriyapatna and Hunsurtaluks, Mysore district of Karnataka. It lies between latitude 12º15'00" to 12º25'47"and longitude 75º58'48" to 76º15'36" and falls in the Survey of India Toposheet numbers 57D/2, 57D/3, 57D/4, 57D/7, 57D/8, 57D/11, 48P/14, 48P/15. It covers an area of 320.00sq. kms. It is in the 788 m elevation(altitude). The climate of the area is subtropical monsoon type with hot (Maximum temperature 37^{0}C) summer and a relatively cold winter (minimum temperature 24^{0}C). The rainfall is quite erratic, and mean annual rainfall is 858 mm with 62 rainy days. The major crops grown are Ragi, maize and tobacco. Most of the people of the area depend on agriculture as their livelihood and as the agriculture is mostly rain-fed, people suffer due to erratic rain fall pattern.

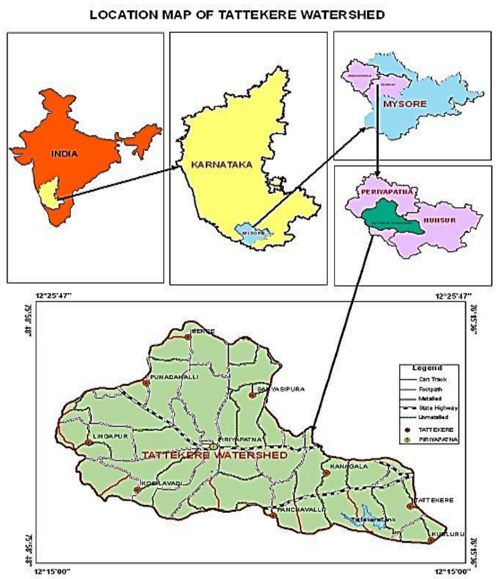


Fig.1 Location map of the area

*Corresponding author: Ramakrishna

Table 1 Chemical composition of groundwater of Tattekere Watershed, Mysore district, Karnataka

Serial No	Location	Ec	pH	Ca	Mg	Na	K	Na+K	HCO_3	CO_3	Cl	NO_3	SO_4	TDS
1	Kudluru	1220	7.09	165	73	93	5	98	530	10	230	62	89	795
2	Honnenahalli	1200	7.06	162	75	89	3	92	526	10	224	61.8	78	786
3	Hairige	733	8.1	33.6	47	64.5	2	66.5	310	10	88	0.21	28.3	480
4	Tattekere	730	7.65	18.2	34.5	51.3	1	52.3	300	10	40	0.5	13.8	478
5	Hunasegala	736	7.68	19	35	50	1.8	51.8	320	10	52	0.42	14	485
6	Nagamangala	740	7.72	18.8	34.9	50	2	52	294	10	63	0.8	22.8	500
7	Kanagala	746	7.75	19.2	34.6	51	2.2	53.2	264	10	55	10	15.6	490
8	Harinahalli	860	7.6	62	38	77	1	78	450	35	58	7	20,0	680
9	Karanakuppe	1020	6.85	160	75	59	3	62	486	10	198	18.8	75.4	700
10	Hammige	1185	6.28	175	80	68	2	70	505.7	10	210	14.5	81.8	810
11	Panchavalli	650	8.6	56	33	85	5	90	436.4	24	42	2.6	12	495
12	Satyagala	2320	7.25	16	68	458	8	466	646	42	322	12	225	838
13	Kampalapura	1100	7.02	47	55	375	5	380	520	36	204	22	28	760
14	Basalapura	2050	7.36	50	36	180	6	186	486	10	143	14.2	16.8	554
15	Tatanahalli	642	7.8	62	28	119	3	122	455	50	34	18	26	618
16	Hunasekuppe	1516	7.78	50	69	158	4	162	484	40	138	25	94	834
17	Mummadi Colony	86	8.32	60	28	123	0	123	340	38	66	16	54	615
18	Malangi	380	8.7	34	15	36	4	40	152	43	17	10	10	250
19	Hosuru	826	8.6	40	22	61	3	64	280	45	22	13	22.6	400
20	Habaturu	596	8.56	46	28	87	5	92	316	50	30	10	0.5	447
21	Timkapura	978	7.82	86	38	76	4	80	295	44	96	16	42	64
22	Ankanahalli	1016	7.76	54	58	180	6	186	712	10	86	14	52	1136
23	Abburu	628	7.82	66	28	89	3	92	378	48	14	15	16	580
24	Piriyapatna	610	7.8	48	30	106	6	112	318	35	54	16	48	725
25	Mallarajapatna	884	7.4	28	35.6	136	2	138	398.6	54.4	38.2	3.42	24	552
26	Doddavaddarakere	980	8	58	44	186	4	190	480	68	88	12.8	58	612
27	Sanyssipura	860	8.2	48	52	146	2	148	390	72	50	16	78	518
28	Hitnahalli	820	7.6	46	76	117	3	120	420	40	62	8.2	62	442
29	Ayichanahalli	830	8.3	45	43	256	4	260	573	72	76	12	120	600
30	Barse	1020	8.4	128	60	179	3	182	442	0	54	15.2	82	1082
31	Bekre	984	8	86	42	137	3	140	360	28	37	13.2	86	858
32	Komalapura	480	8.2	50	48	122	3	125	432	36	49	10	38	718
33	Basavanahalli	782	7.72	44	28	128	4	132	434	58	46	10	32	624
34	Punadahalli	548	8.48	58	34	87	3	90	435	26	44	3.8	14	496
35	Telaganakuppe	992	7.8	54	72	87	1	88	588	46	70	14.2	45	510
36	Vaddarapalya	834	7.62	48	58	72	0	72	410	34	58	6.4	36	420
37	Hunasavadi	712	8.08	56	34	78	2	80	395	46	16	18	16	518
38	Alanahalli	768	7.52	26	28	95	3	98	320	29	26	6.4	17.8	458
39	Navaluru	860	8.7	46	48	99	1	100	355	43	40	14	80	560
40	Bemmatti	1200	7.97	61	48	143	2	145	196	24	216	14	100	775
41	Lingapura	566	7.6	58	16	42	3	45	214	26	22	14	20	324
42	Kiranguru	1040	7.92	140	16	118	6	124	438	50	110	16	52	808
43	Belaturu	2080	7.8	46	68	542	4	546	905	93	205	14	342	1926
44	Chaudanahalli	840	8.43	69	28	76	2	78	328	48	59	13	20	520
45	Naralapura	995	8.4	30	48.6	70	2	72	328.4	33.8	47.8	10	30	528
46	Mutturu Colony	1000	7.66	126	37	49	1	50	421	29	78	15	50	560
47	Beguru	998	8.8	60	48	103	5	108	310	50	96	16	45	642
48	Cheppapura	782	8.5	62	36	109	3	112	408	54	28	34	30	600
49	Sulagodu	1018	8	48	79	45	5	50	437	43.6	60	12	24.6	618
50	Kogilavadi	812	7.62	75	40	102	3	105	478	40	50	18	10	676

Kharif and Rabi are the two crop seasons in the study area. Paddy is the principal crop of this area. In addition, maize, ragi, black gram, til, ground nut, mustard, sugar cane, potato, and wheat are also cultivated. The river and tank waters are not available in many places and moreover rain water irrigation is not dependable. Hence groundwater(Bore-well) is the only source to be developed for irrigation.

The major drainage system in the area is controlled by Cauvery River with tributaries the Shimsha, the Hemavati,Arkavati, Honnuhole,Kabini, Bhavani River, Lakshmanatirtha,Lokapavani, Noyyal and the Amaravati River. The soil map can be used for identifying the suitable areas for specific uses, viz., agriculture, horticulture, sericulture, agro-forestry, agri-horti-silvopasture etc. The location map of the study area is shown in **Fig. 1.**

3. Objectives of the area

Preparing water resource action plan leading up to treatment of drainage lines, checking runoff and soil

Table.2 Different Chemical Parameters of Tattekere watershed at periyapatna and Hunsur taluks, Mysore District, Karnataka.

SL No.	Village name	TDS	EC	Indices of base Exchange		Scholler's water types	RSC	SAR	PI Field	Saturation Indices		Cl	Handa's Class	Stuyfzand's				Gibbs Plot
				IBE-1	IBE-2					Ca	Equi.pH			Ground Water Facies	Water Type	Sub Type(Based on ALK)	Sign Enmt	
1	KUDLURU	795	1220	0.3432	0.1875	III	-5.22	1.6	39	0.39	0.74	230	A1C3S1	Ca mixed	f	ALK -HIGH	(+)	ROCKINTERACTION
2	HONNENAHALLI	786	1200	0.394	0.2247	III	-5.3	1.5	38	0.37	0.7	234	A1C3S1	Ca mixed	f	ALK-HIGH	(+)	ROCK INTERACTION
3	HAIRIGE	480	733	-0.165	-0.0681	III	-0.13	1.74	61	0.49	0.83	88	A1C3S1	Mg HCO_3	F	ALK-MOD-HIGH	(+)	ROCKINTERACTION
4	TATTEKERE	478	730	-1.197	-0.2435	I	1.12	1.73	71.1	-7.9	0.14	40	B1C2S1	Mg HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
5	HUNASEGALA	485	736	-0.838	-0.2092	I	1.02	1.79	68.8	-6.58	0.24	52	B1C2S1	Mg HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
6	NAGAMANGALA	500	740	-0.541	-0.1706	III	0.6	1.82	67.7	-7.25	0.24	63	B1C2S1	Mg HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
7	KANAGALA	490	746	-0.626	-0.1886	I	0.57	1.76	69.6	-8.63	0.21	55	B1C2S1	Mg HCO3	F	ALK- HIGH	(+)	ROCK INTERACTION
8	HARINAHALLI	680	860	-1.286	-0.2319	I	1.64	2.01	60.7	0.72	0.8	58	B1C3S1	Mg HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
9	KARANAKUPPE	700	1020	0.5173	0.2841	III	-5.86	1.01	32.7	-5.87	0.45	198	A1C3S1	Ca HCO3	f	ALK-HIGH	(+)	ROCK INTERACTION
10	HAMMIGE	810	1185	0.5449	0.3057	III	-5.06	1.03	34	-5.72	-0.1	210	A1C3S1	Ca HCO3	f	ALK-HIGH	(+)	ROCK INTERACTION
11	PANCHAVALLI	495	650	-2.303	-0.331	I	2.44	2.36	70	0.78	1.7	42	B1C3S1	Ca HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
12	SATYAGALA	838	2320	-1.226	-0.6602	IV	5.59	11.3	88.2	-4.17	-0	322	B3C5S3	Na+K Mixed	B	ALK- HIGH	(+)	ROCKINTERACTION
13	KAMPALAPURA	760	1100	-1.01	-0.5452	I	5	7.53	88.9	-2.21	-0	204	B2C3S2	Na+K HCO3	f	ALK-HIGH	(+)	ROCK INTERACTION
14	BASALAPURA	554	2050	-1.005	-0.4566	IV	2.84	4.9	80.5	-1.2	0.46	143	B2C3S1	Na+K HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
15	TATANAHALLI	618	642	-4.712	-0.454	I	3.73	3.33	75.5	-0.89	0.96	34	B2C3S1	Na+K HCO3	F	ALK-HIGH	(+)	ROCKINTERACTION
16	HUNASEKUPPE	834	1516	-0.787	-0.2636	IV	1.09	3.44	64.6	-1.21	0.88	138	B1C3S1	Mg HCO3	F	ALK-HIGH	(+)	ROCKINTERACTION
17	MUMMADI OLONY	615	86	-1.943	-0.4399	I	1.54	3.37	72.7	0.74	1.34	66	B2C3S1	Na+K HCO3	F	ALK-MOD-HIGH	(+)	ROCKINTERACTION
18	MALANGI	250	380	-2.627	-0.2934	I	0.99	1.44	71	-0.03	1.13	17	B1C2S1	Ca HCO3	g	ALK - MOD	(+)	ROCKINTERACTION
19	HOSURU	400	826	-3.975	-0.3644	I	1.92	2.14	72.1	0.57	1.4	22	B1C2S1	Ca HCO3	g	ALK-MOD-HIGH	(+)	ROCKINTERACTION
20	HABATURU	447	596	-3.316	-0.3999	I	2.69	2.53	75.9	0.6	1.4	30	B1C3S1	Ca HCO3	F	ALK-MOD-HIGH	(+)	ROCKINTERACTION
21	TIMKAPURA	6.4	978	-0.188	-0.0686	I	-0.57	1.74	53.7	-1.26	0.91	96	A1C3S1	Ca HCO3	F	ALK-MOD-HIGH	(+)	PRECIPITATION
22	ANKANAHALLI	1136	1016	-4.592	-0.4696	II	-0.47	5.43	65.2	0.17	1.28	86	A3C5S2	Na+KMixed	F	ALK-HIGH	(+)	EVAPORATION
23	ABBURU	580	628	-8.249	-0.3892	I	2.74	2.3	70.6	-1.35	0.89	14	B1C3S1	Ca HCO3	g	ALK-MOD-HIGH	(+)	ROCKINTERACTION
24	PIRIYAPATNA	725	610	-2.197	-0.4383	I	1.51	3.12	73.5	-2.5	0.7	54	B2C3S1	Na+K HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
25	MALLARAJAPATNA	552	884	-4.569	-0.5531	I	4.02	4.08	82.9	-3.78	0.16	38	B2C3S1	Na+K HCO3	F	ALK-HIGH	(+)	ROCKINTERACTION
26	DODDAVADDARA KERE	612	980	-2.328	-0.5005	I	3.62	4.58	74.9	0.81	1.16	88	B2C3S1	Na+K HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
27	SANYASIPURA	518	860	-3.193	-0.4219	I	2.73	3.4	70.5	0.69	1.15	50	B1C3S1	Mg HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
28	HITNAHALLI	442	820	-1.461	-0.2651	I	1.22	2.3	61.3	-2.35	0.52	62	B1C3S1	Mg HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
29	AYICHANAHALLI	600	830	-4.273	-0.6325	II	5.16	5.6	84.1	6.01	6.65	76	B2C3S2	Na+K HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
30	BARSE	1082	1020	-1.883	-0.3119	II	0.99	2.48	66.5	0.83	1.61	54	B1C3S1	Ca HCO3	F	ALK-MOD-HIGH	(+)	EVAPORATION
31	BEKRE	858	984	-3.124	-0.369	II	1.4	2.61	69.2	0.76	1.05	37	B1C3S1	Ca HCO3	F	ALK-MOD-HIGH	(+)	EVAPORATION
32	KOMALAPURA	718	480	-2.492	-0.373	I	2.63	2.87	71.5	0.72	1.19	49	B1C3S1	Mg HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
33	BASAVANAHALLI	624	782	-3.825	-0.5027	I	4.18	4.01	80.3	-1.56	0.75	46	B2C3S1	Na+K HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
34	PUNADAHALLI	496	548	-2.153	-0.3201	I	2.3	2.32	68.5	0.79	1.59	44	B1C3S1	Ca HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
35	TELAGANAKUPPE	510	992	-1.224	-0.1959	I	1.33	1.98	52.7	-0.46	1.07	70	B1C3S1	Mg HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
36	VADDARAPALYA	420	834	-0.914	-0.1717	I	0.68	1.65	55.6	-1.71	0.63	58	B1C3S1	Mg HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
37	HUNASAVADI	518	712	-6.707	-0.3507	I	2.41	2.08	66.4	0.76	1.14	16	B1C3S1	Mg HCO3	g	ALK-HIGH	(+)	ROCK INTERACTION
38	ALANAHALLI	458	768	-4.81	-0.5277	I	2.61	3.18	83.3	-5.42	0.15	26	B2C3S1	Na+K HCO3	g	ALK-MOD-HIGH	(+)	ROCK INTERACTION
39	NAVALURU	560	860	-2.854	-0.3522	II	1.01	2.46	63.8	0.67	1.63	40	B1C3S1	Mg HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
40	BEMMATTI	775	1200	-0.035	-0.0335	IV	-2.98	3.37	60.9	-2.98	3.37	216	A2C3S1	Mg Mixed	f	ALK-MOD-HIGH	(+)	ROCK INTERACTION
41	LINGAPURA	324	566	-2.153	-0.2663	I	0.16	1.35	62.1	-3.3	0.41	22	B1C2S1	Ca HCO3	g	ALK-MOD-HIGH	(+)	ROCK INTERACTION
42	KIRANGURU	808	1040	-0.738	-0.2247	I	0.54	2.65	58.9	0.13	1.42	110	B1C3S1	Ca HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
43	BELATURU	1926	2080	-3.106	-0.7104	II	10	12	87.2	-0.28	1.13	205	B1C2S1	Ca HCO3	f	ALK-VERY-HIGH	(+)	EVAPORATION
44	CHAUDANAHALLI	520	840	-1.038	-0.2272	I	1.23	2	62.5	0.76	1.5	59	B1C3S1	Ca HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
45	NARALAPURA	528	995	-1.322	-0.2443	I	1.01	1.89	63.2	0.95	2.11	48	B1C3S1	Mg HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
46	MUTTURUCOLONY	560	1000	0.0119	0.0029	III	-1.47	1.01	41.7	-0.01	1.1	78	A1C3S1	Ca HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
47	BEGURU	642	998	-0.574	-0.1956	I	0.51	2.41	62.1	0.68	1.74	96	B1C3S1	Mg HCO3	F	ALK-MOD-HIGH	(+)	ROCK INTERACTION
48	CHEPPAPURA	600	782	-5.166	-0.4224	I	2.43	2.8	68.2	0.79	1.62	28	B1C3S1	Ca HCO3	g	ALK -HIGH	(+)	ROCK INTERACTION
49	SULAGODU	618	1018	-0.285	-0.0517	I	-0.28	1.03	43.8	0.75	1.03	60	A1C3S1	Mg HCO3	F	ALK-HIGH	(+)	ROCK INTERACTION
50	KOGILAVADI	676	812	-2.237	-0.3264	I	2.13	2.43	63.5	-0.49	0.89	50	B1C3S1	Ca HCO3	F	ALK -HIGH	(+)	ROCK INTERACTION

erosion, improving the storage capacity of tanks for human and agriculture purposes, recharge of groundwater, overall development of agriculture productivity and employment generation.

4. Geological setting and Methods

Geologically, the study area is mainly composed of igneous and metamorphic rocks of Pre-Cambrian age either exposed at the surface or covered with a thin mantle of residual and transported soils. The different generations of (at least three) folds, faults, joints etc. affect the rocks of the area. On the other hand, the structural disturbances are responsible for creating secondary porosities in the hard rocks helping in the storage and movement of groundwater.

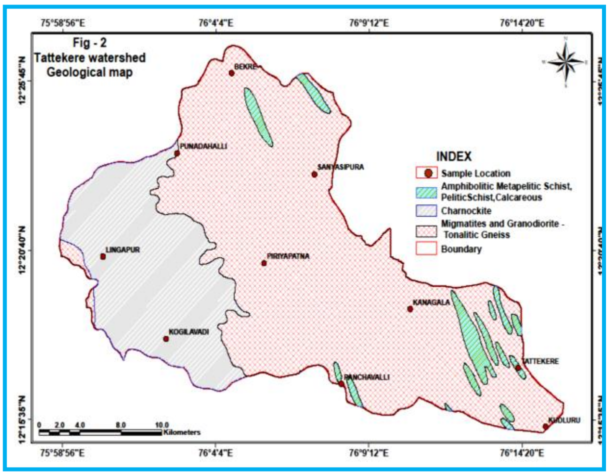


Fig.2. Geology of the area

The rock types of the area charnockite and granite. A fairly wide area consists of charnockite series of rocks particularly along the southwestern part of the area.
The intervening area consists of granitic gneiss with thin beds, lenses and elongated runs of various amphibolite schist, hornblende schist and metabolitic schist. Dolerite dyke patches are more in the northwestern and southeastern part of the area. The spatial distributions of different units are given in **Fig 2.**

5. Methodology

Fifty (50) numbers of ground water samples (41 from tube wells and 9 from dug wells) were collected systematically during the (2012-13) from the study area. The analysis was done by standard methods proposed by APHA (1985) to find out various physico-chemical parameters such as hydrogen ion concentration (pH), electrical conductance (EC), total dissolved solids(TDS), total hardness (TH), total alkalinity (TA), carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), chloride (Cl^-), sulphate (SO_4^{2-}), nitrate (NO_3^-), fluoride (F^-), sodium(Na), potassium(K), calcium (Ca) and magnesium(Mg). The pH, EC, TDS, temperature etc. were determined in the field. The range of concentrations of various physico-chemical parameters are given in Table 1.

Several factors like total dissolved solids (TDS), percent sodium (%Na), residual sodium carbonate (RSC), sodium adsorption ratio (SAR), permeability index (PI) and potential soil salinity (PS) etc. which are calculated from the above parameters **(Table-2)** decide the suitability of water for irrigation. In addition to the above, other characteristics such as the nature and composition of the soil, subsoil, depth of water table, drainage conditions, topography, climate, type of wells, crop pattern, cultural practices etc. also decides whether a particular quality of water is detrimental to crop or not.

6. Results and discussions

The average values of irrigation water quality parameters in the study area are given in Table - 2. Some of the factors which decide the suitability of the water for irrigation are described below.

6.1 Salinity Hazard

The specific electrical conductance indicates the salinity hazard for irrigation. Excess sodium content in water makes it unsuitable for soil. Water with high bicarbonates and relatively low calcium is also known to be hazardous for irrigation (Richards, 1954). The total concentration of soluble salts is important to identify salinity hazard because salt tolerance capabilities of plant species are different. Groundwater of the study area can described to be having low salinity to high salinity on the basis of TDS content**(Table 1).** The salinity hazard can also be expressed in terms of potential soil salinity (PS) of the water samples.

Potential Soil Salinity (PS)

Potential soil Salinity (PS) is an important criterion for classification of irrigation waters. The PS as determined by the formula (Doneen, 1962) is given as follows:

$$P.S = Cl^- + \frac{1}{2} SO_4^{2-}$$

where the ionic concentrations are expressed in meq/l. With respect to Potential soil Salinity (P.S) for irrigation, fifty samples of the study area are classified as 48 samples can be "Excellent to Good" category and only 2 samples are of "Injurious to unsatisfactory" category in the year 2012-13.

6.2 Sodium Hazard

Sodium has a tendency to react with soil reducing its permeability. Water with high sodium content may produce harmful levels of sodium in most soils and requires special water and soil management practices like application of gypsum (Karanth, 1989). If the proportion of sodium is high, the alkali hazard is high and vice versa. But if calcium and magnesium are predominant, the hazard is less. The sodium percent of water samples can be expressed by %Na (Percent Sodium) and SAR (Sodium Adsorption Ratio).

%Na = (Na++K+) x 100 / (Ca+2 +Mg+2 +Na+ +K +)

SAR= Na+/√(Ca+2 +Mg +2)/2

where the ionic concentrations are expressed in meq/L

The percent sodium of the study area samples varies from 36 to 542. According to ISI standards, maximum percent sodium of 60 is recommended for irrigation. Few samples have values beyond the desirable limit. Wilcox (1955) proposed a classification for irrigation water based on electrical conductance (EC) and percent sodium (%Na) which are shown in **Table-2.** It is seen that majority of groundwater samples of the study area fall under "excellent to good" class but a few fall under "good to permissible" class and "permissible to doubtful" class. Only two samples fall under "doubtful to unsuitable" class".

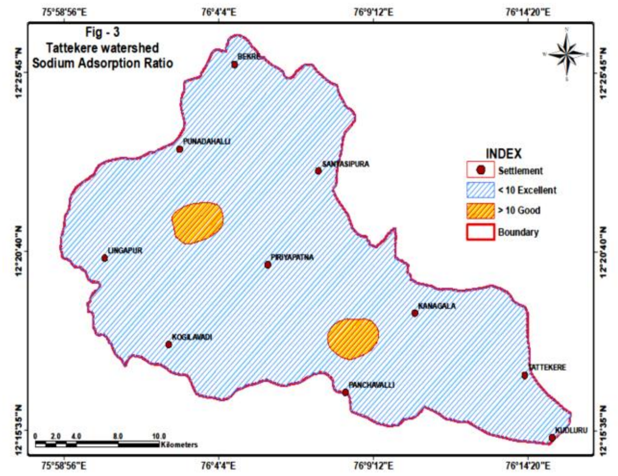


Fig.3 SAR of the area

The SAR values of the samples vary from 1.0063 to 11.9513 and that of samples vary from 1.00 to 8.00. Since all the values are less than 10 and only 2 samples are >10.**(Fig-3).** The water samples can be classified as "excellent" for irrigation. There is a direct correlation between the SAR value of water and extent to which sodium is adsorbed by the soil. When SAR values are plotted against EC values in U.S. Salinity Diagram (Richards, 1954) all the samples fall in the field of "Good Waters" for irrigation but distributed in C_1S_1, C_2S_1 and C_3S_1 fields.

6.3 Residual Sodium Carbonate (RSC)

The concentration of bicarbonate and carbonate also play a vital role for classification of irrigation waters. The relative abundance of sodium with respect to excess of carbonate and bicarbonate over alkaline earth affects the suitability of water for irrigation purpose and this excess is denoted by Residual Sodium Carbonate (RSC) and is determined by the formula (Richards, 1954) as given below.

$RSC = (CO_3^{2-} + HCO_3^-) – (Ca^{+2} + Mg^{+2})$

where the concentration of ions is expressed in meq/L

The RSC values of all the groundwater samples of the study area can be classified as "Good" for irrigation since all the values are less than 1.25 to 2.5.

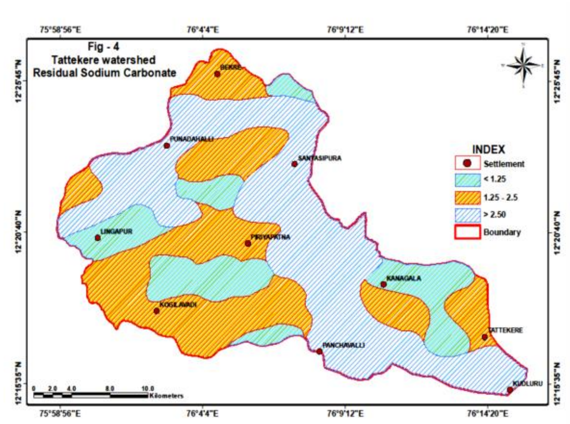


Fig.4 RSC of the area

6.4 Permeability Index (PI)

The permeability of soil is affected to a considerable extent by the composition of water used for irrigation. It is influenced by the relative concentration of sodium, calcium, magnesium, and bicarbonate. Doneen (1964) developed a criterion to assess the suitability of water for irrigation based on permeability index (PI) which can be determined by the formula given below.

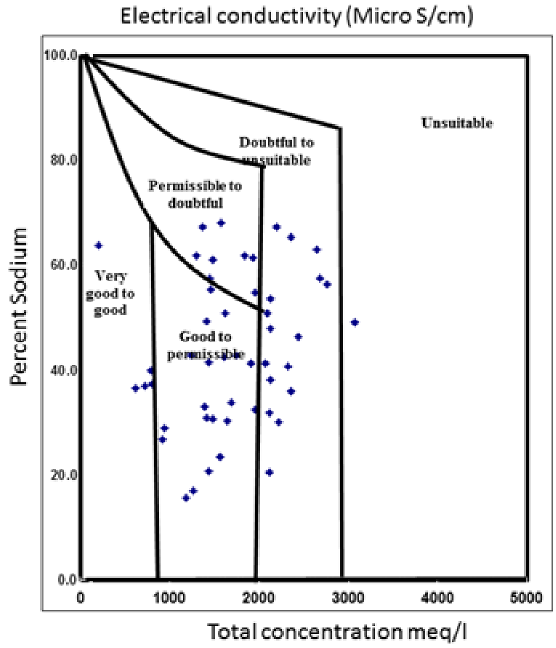
$$\mathbf{P.I. = \{(Na^+ + \sqrt{HCO_3^-})/(Na^+ + Ca^{+2} + Mg^{+2})\} X100}$$

where all the concentrations are expressed in meq/L

The P.I. of the groundwater samples of the area varies from 32.74 to 88.92of the samples can be said to be in class-II (marginally safe)and the rest are in the class-I (safe).

6.5 Magnesium hazard

A ratio of $(Mg^{+2}$ x100)/ $(Ca^{+2} + Mg^{+2})$ is used as an index of magnesium hazard of irrigation water. If this ratio is less than 50, no magnesium hazard is found. In the study area, the Mg – ratio varies from 15 to 80%. It is found that 14 have Mg – ratio of more than 50 and hence can create Mg-hazard to a considerable extent by the water used for irrigation.



Wilcox Diagram

Table 2a: Physico-chemical quality of groundwater samples of the study area

(Sd=Standard Deviation, Min= Minimum, Max= Maximum)					
Sl No	Parameters	Groundwater samples			
		Min	Max	Mean	Sd
1	EC	86	2320	925.06	393.59
2	pH	6.28	8.8	7.87	0.52
3	Ca2+	16	175	62.87	39.72
4	Mg2+	15	80	44.6	17.87
5	Na +	36	542	122.19	98.08
6	K +	0	8	3.18	1.68
7	Na+K	40	546	125.37	98.85
8	HCO_3	152	905	414	130.98
9	CO_3	0	93	35.67	19.72
10	Cl	14	322	84.24	69.91
11	NO3 -	0.21	62	14.38	11.65
12	SO4 2-	0.5	342	52.61	57.27
13	TDS	64	1926	629.3	264.91

Table 2b: Range of concentration of parameters used for irrigation purpose

Sl No	Parameters	Groundwater samples			
		Min	Max	Mean	Std. Dev.
1	EC in µmho/cm	86	2320	925.1	393.6
2	TDS in mg/L	64	1926	629.3	264.9
3	%Na	20.87	84.72	18.92	51.09
4	SAR	5.42	71.79	17.38	13.91
5	RSC in meq/L	-5.85	10.04	1.28	2.81
6	Mg Hazard	15	80	44.6	17.87
7	PI	32.74	88.92	65.8	13.37

Conclusion

From the study of suitability of the ground water from the irrigational point of view, it is seen that Sodium Adsorption ratio (SAR) of all the water samples in the area of “excellent” class. On the basis of Residual sodium carbonate (RSC), all the water samples are of “good” class. The water from deeper aquifers has better quality in general than that of the shallow aquifers. The groundwater of the study area is suitable for irrigation purpose except some cases where the water is saline in nature. The U.S. Salinity Diagram (Richards 1854) for classification of irrigation water of the waters can be classified as “Good Waters” for irrigation. According to Wilcox (1955) diagram, it is seen that majority of groundwater samples of the study area falls under “excellent to good” class but a few fall under “good to permissible” class and “permissible to, Bhavani Riverdoubtful” class. Only three samples are fall under “Doubtful to unsuitable” class”. The major concern is the magnesium hazard in a number of areas and hence appropriate measures need to be undertaken to combat the hazard.

All the values are in mg/L except EC, pH and temperature; EC is in µmho/cm, Temp. is in ^{0}C, Sd is the standard deviation(2a)and (2b).

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