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Appraisal of Groundwater Quality in parts of Ranjangaon Shenpunji Area of Aurangabad District, Maharashtra

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ABSTRACT

This study was carried out to evaluate groundwater quality of thirty groundwater samples were analyse from Ranjangaon Shenpunji village, Aurangabad District. The groundwater quality ions such as Total hardness and calcium 100% of the groundwater samples are exceeding maximum permissible limit and total dissolve solids 40%, Chloride 30%, Magnesium 73.33% and sulphate 76.67% is exceeding maximum permissible as per the world health organization and bureau of Indian standards level for drinking water. The plot of major ions in the piper diagram reveals that 100% groundwater samples are fall in Ca-Cl water type.

KEYWORDS: *Groundwater quality, Drinking water, Piper diagram, Ranjangaon Shenpunji.*

INTRODUCTION

Water resource which is the spine and crucial element of life, is needed in adequate quantity and quality to meet the increasing demand for domestic, agricultural and industrial processing operations (Fenta et al., 2014; Shanableh and Merabtene, 2015; Arefayne et al., 2015). It is also a key resource in all economic activities ranging from agriculture to industrial purpose. Groundwater is a precious and most widely distributed natural resource of the earth, which it is dynamic and it gets replenishment from the precipitation (Sunandana, 2019). Groundwater forms the prominent source of fresh water available for human consumption (Raghunath, 1990). The groundwater quality deteriorates by the time it accumulates in the aquifer to the moment it is discharge from the dug wells and bore wells

(Suthar et al., 2008; Singh et al., 2012). But the anthropogenic activities had affected the quality of groundwater at the worth scale. Surface water has been the major source of water for domestic, agricultural and industrial purposes.

The quality of groundwater plays a vital role in the development of socio-economic rural areas as it is directly related to human health and plant growth. Quality of water varies from place to place (it is with the depth of water table) and from season to season and thus, is primarily govern by the extent and composition of base rocks in the aquifer and dissolved solid present in it (Mondal et al., 2010). Chemical analysis forms the basis of understanding of the quality of water in relation to source, geology, climate and use. Water quality analysis is one of the most important aspects for groundwater studies. It is revealing that quality of groundwater is suitable for domestic, drinking and agricultural purpose. Recently, however, due to the high population growth, the interest in the exploitation of groundwater over the years has increased and so is the need for water quality assessment for enhanced socio-economic growth and development (Ishaku, 2011).

The groundwater quality evaluation is not only necessary to know the suitability but also for planning the management of groundwater in a more sustainable way to meet the existing and future demand for various purposes.

STUDY AREA

The study area falls within the state of Maharashtra, Aurangabad district. The study area lies between latitude 19^0 55′ to 19^0 45′ N and East longitude 75^0 10′ to 75^0 15′ covers an area of 150 sq.km area and the study area is represented on Survey of India Toposheet No. 47 M/1 (Fig.1). The climatic condition of the district is characterized by a hot summer and a general dryness throughout the year except during the south west monsoon season, in Aurangabad rainy season start from the month of June to September and October to February winter season and March to May summer season. The average rainfall in Aurangabad district is 734 mm and minimum temperature is 23 D.C. and maximum temperature is 39 D.C.

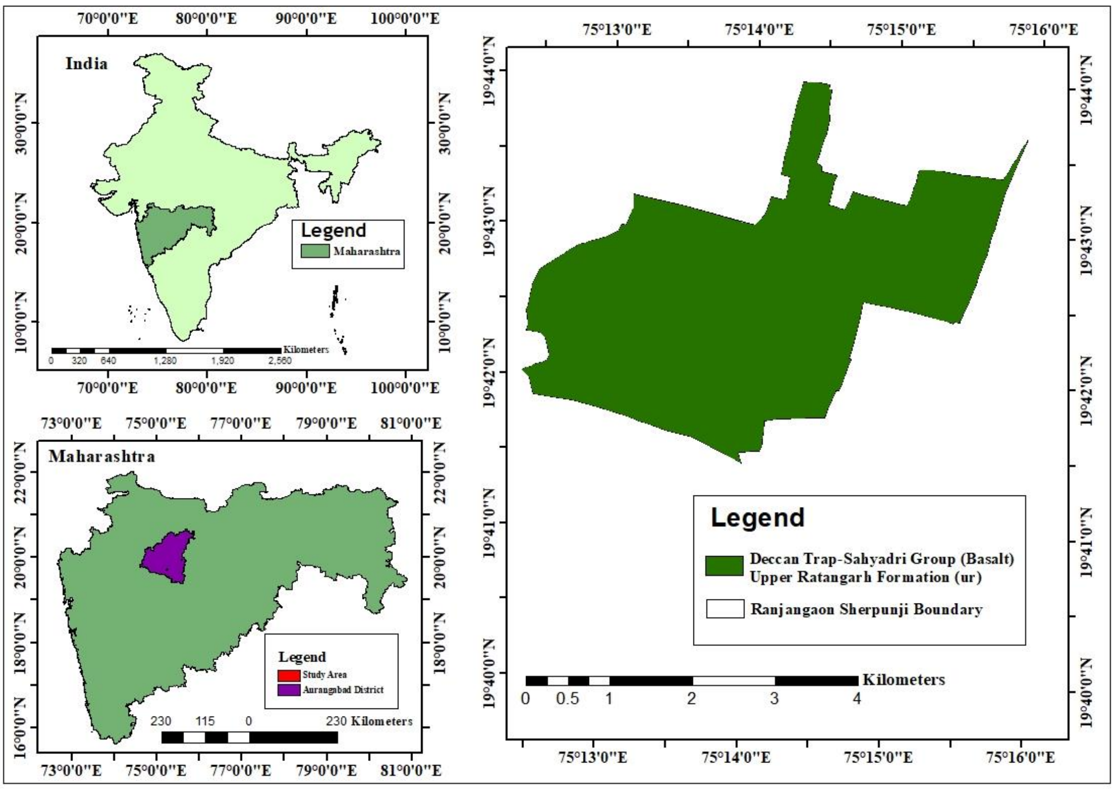

Figure 1: Location map of study area

METHODOLOGY

The present study is based on 30 groundwater samples were collected from different dug wells and bore wells during 2013 to evaluate the physico-chemical parameters. The pH, EC and TDS is determined by using electronic meter (Elico), total hardness, calcium, chloride and bicarbonate was determined using the method of titrimatically. Sodium and potassium were determined by using flame photometer and sulphate was determined by using visible spectrometer. The standard methods of collection and analysis of water samples were followed given by APHA (1993).

Table 1: Physico-Chemical Parameter of Groundwater for Post Manson Season 2013

Well No	pH	EC	TDS	Cl	TH	Mg	Ca	HCO_3	Na	K	SO_4
		µs/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	7.25	1200	780	159.04	1957.54	423.43	88.97	325	25	1	270
2	6.97	1600	1040	177.5	2163.65	449.30	129.05	330	86	1	446
3	7.2	2200	1430	390.5	1896	321.97	230.86	348	135	1	400
4	7.19	2800	1820	710	1660	255.60	245.28	360	172	2	368
5	7.12	3000	1950	575.1	1704	259.01	257.31	435	182	1	303
6	7.31	2600	1690	579.36	670	36.99	207.61	310	155	1	307
7	7.12	2400	1560	576.88	1500	244.88	198.79	415	145	1	1748
8	7.24	2000	1300	379.14	672.51	65.93	161.12	445	110	2	1399
9	7.05	2200	1430	279.74	1650	274.65	210.01	510	136	1	432
10	6.86	2100	1365	320.46	1040	128.24	206.01	495	102	1	856
11	6.94	1600	1040	213	1278	211.72	164.32	415	86	2	1833
12	7.16	1500	975	180.34	808	102.90	154.7	330	56	3	1811
13	7.02	2600	1690	454.4	862.66	74.23	223.64	560	158	1	726
14	7.87	2600	1690	471.44	958.74	104.02	213.22	510	158	2	610
15	6.82	2900	1885	533.92	945.6	52.47	292.58	395	172	1	447
16	6.78	3700	2405	289	1025.2	92.89	258.11	455	234	2	722
17	6.69	3400	2210	695.8	865.26	33.84	290.98	336	215	1	580
18	6.76	3000	1950	620.54	1201.5	110.51	299.79	370	190	1	563
19	6.94	2900	1885	475.7	1305	223.19	156.31	120	165	2	565
20	7.19	3500	2275	1065	1230.25	91.88	341.88	336	220	1	686
21	6.83	3100	2015	673.08	1152.3	124.88	256.51	415	182	1	671
22	6.65	4700	3055	1212.68	1202.2	131.69	265.32	80	315	1	602
23	7.03	4600	2990	1144.52	1209	130.90	269.33	190	186	1	610
24	6.72	2800	1820	1002.52	1625.25	174.35	364.72	280	138	2	93
25	6.78	2300	1495	660.3	1225.2	131.92	274.14	330	138	1	603
26	6.07	4800	3120	1153.4	1553.35	205.16	285.36	290	315	1	888
27	7.09	4900	3185	1174.34	1144.2	164.42	188.37	305	320	2	151
28	7.22	3700	2405	1292.2	1535.25	161.18	350.29	270	235	1	827
29	6.88	6400	4160	1590.4	1220	147.75	246.09	280	552	1	1064
30	7.03	3800	2470	2073.2	1102	65.23	334.26	190	415	1	961
Min	6.07	1200	780	159.04	670	33.84	88.97	80	25	1	93
Max	7.87	6400	4160	2073.2	2163.65	449.30	364.72	560	552	3	1833
Avg	6.99	3030.0	1969.50	704.12	1278.76	166.50	238.83	347.67	189.93	1.3	718.07

GEOLOGY AND HYDROGEOLOGY

Geologically, the study area is part of Deccan volcanic province (DVP) and mainly composed of basaltic rock. The Ranjangaon Shenpunji industrial area of Aurangabad is also underlain and surrounded mainly by basaltic lava flows belonging to the Deccan volcanic province (DVP) having age of Upper cretaceous to Eocene. The lava flows are horizontal and each flow has separate two units. The upper layers formed by vesicular and amygdule zeolitic basalt whiles the bottom layer consists of massive basalt. The lava flows are individually different in their ability to receive as well as hold water in storage and to transmit it (Figure 1).

In massive unit of Deccan Trap Basalt, ground water occurs in soil cum weathered mantle, joints, cracks and other weaker zones. The superior section of the massive traps demonstrate persistent spheroidal weathering and exfoliation favourable for retaining more ground water in these rocks in comparison to compact massive unit. The difference in the productivity of groundwater in various layers arises as a result of their inherent physical properties such as porosity and permeability. The groundwater occurs under water table conditions and is mainly controlled by the extent of its secondary porosity i.e., thickness of weathered rocks and spacing of joints and fractures. The highly weathered vesicular basaltic trap and underlying weathered jointed and fractured massive basalt constitutes the main water yielding zones (CGWB, 2001; Deshpande and Aher, 2012)

RESULT AND DISCUSSION

Physicochemical characteristics of Groundwater quality and hydrogeochemical facies

The groundwater quality is significant to understanding and main factor determining its suitability for domestic, drinking, agricultural and industrial use (Alam et al., 2012; Subramani et al., 2005). Table 2 illustrate the physicochemical parameters like (pH, EC, TDS, TH, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, Cl^{-} SO_4^{2-}) have been determined for thirty groundwater samples in the study area.

The pH is a term used universally to express the intensity of the acid or alkaline condition in a solution. The result revealed that the pH varies from 6.07 to 7.87 with an average 6.99. It is also observed that 100% of groundwater samples are below desirable limit in the study area (Table 1). From the figure 2 it is observed that towards the south-west and central portion showing higher value as compared to surrounding portion of the study area. Based on these the pH value of groundwater samples was found to be slightly alkaline in nature.

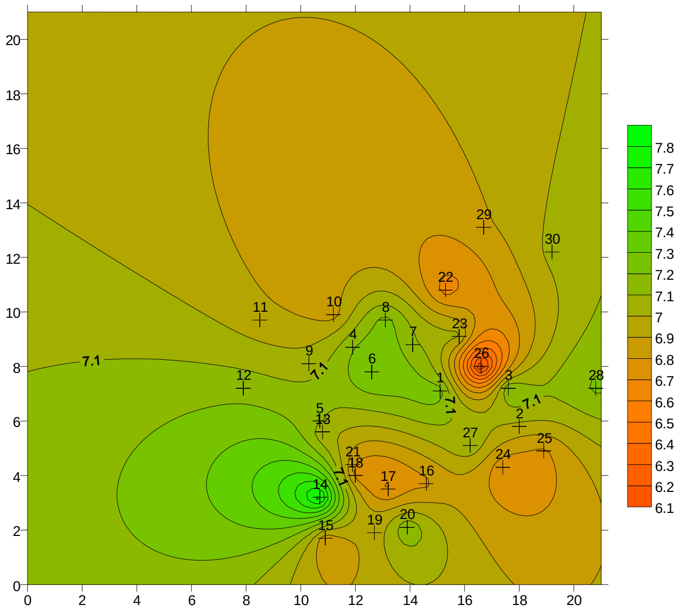

Figure 2: Showing pH pattern of study area

EC measures the ability of materials to conduct an electric current. Higher EC indicates enrichment of salts in the groundwater. In the study area electric conductivity (EC) at 25° C ranges from 1200 to 6400µS/cm with an average 3030 µS/cm (Table. 1). EC is an approximate index of the total content of dissolved substance in water. It depends upon the type of ion present, temperature and concentration (Hem, 1985). EC can be classified as type I is the enrichment of salts are low (EC<1500 µS/cm), type II if the enrichment of salts is medium (1500 to 3000 µS/cm) and type III if the enrichment of salt high (>3000 µS/cm), Prasanth et al., 2012). Based on these above classifications of EC 02 groundwater samples are found in type I (enrichment of salts low) then 17 groundwater samples found in type II (enrichment of salts medium) and 11 groundwater samples found n type III (enrichment of salts high). From the figure 3 towards the north-east portion observed higher values as compare to surrounding portion in the study area.

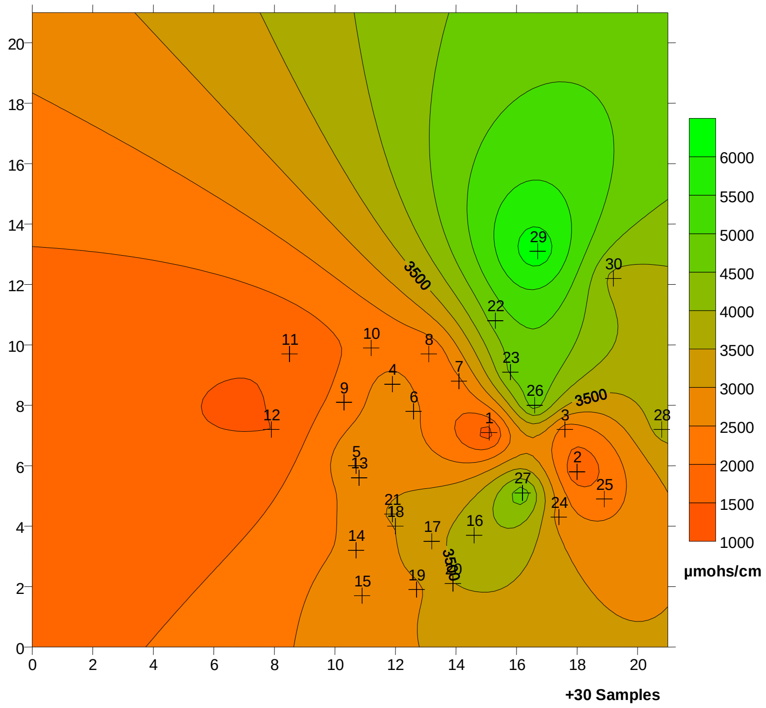

Figure 3: Showing EC pattern of study area

The TDS values of groundwater samples varies from 780 to 4160 mg/L with an average 1969.50 mg/L. According to Frezzy and Cherry, (1979) classification the TDS is <1000, 1000 to 10,000, 10,000 to 100000 and >100000mg/L indicated the fresh water type, brackish water type, Saline water type and Brine water type. Based on above classification 02 groundwater samples comes under the fresh water type (<1000 mg/L) and 28 groundwater samples comes under the brackish water type (1000-10,000 mg/L) (Table 1). It is also observed that the 60% of groundwater samples found in maximum desirable limit but below permissible limit and 40 groundwater samples are exceeding maximum permissible limit in the study area (Table 2) as prescribed by BIS (2012) and WHO (2011) (Table 3). From figure 4 towards the northern portion showing higher values as compare to surrounding portion in the study area. Higher concentration of TDS in the groundwater samples is due to leaching of salts from soil and also industrial waste as well as domestic sewage which may percolate into the groundwater, which may lead to increase in total dissolved solids values (Deshpande et. al., 2015).

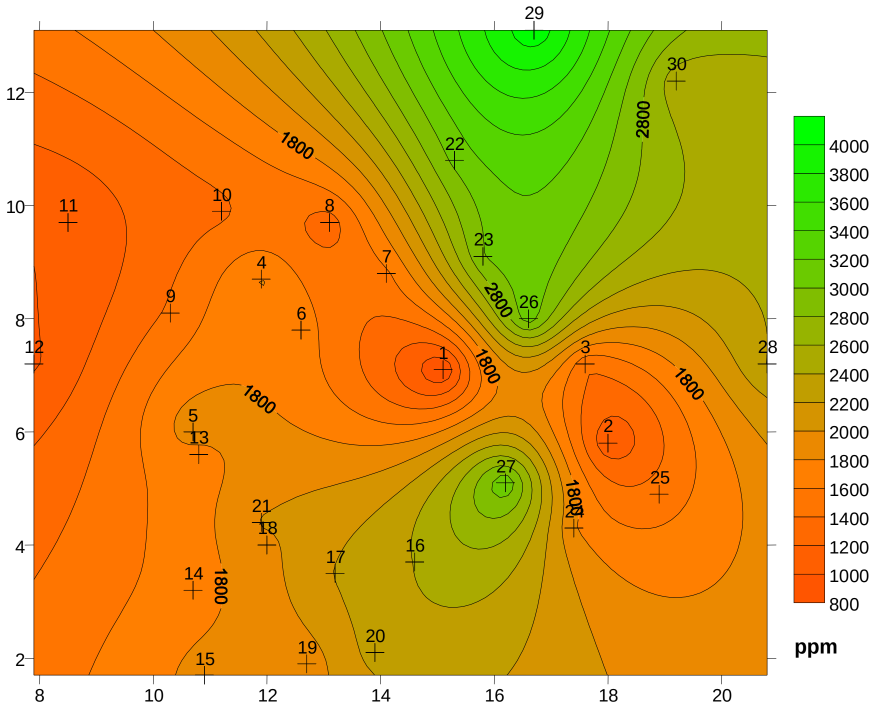

Figure 4: Showing TDS pattern of study area

The total hardness in groundwater samples ranges from 670 to 2163.65 mg/L with an average 1278.76 mg/L (Table 1). It is also seen that the 100% of groundwater samples are exceeding maximum permissible limit (Table 2) in the study area according to WHO (2011) and BIS (2012) (Table 3). From figure 5 it is observed that towards the centre and eastern portion showing higher values as compare to surrounding portion in the study area. According to BIS (2012) and WHO (2011) the water sample is not suitable for drinking purposes.

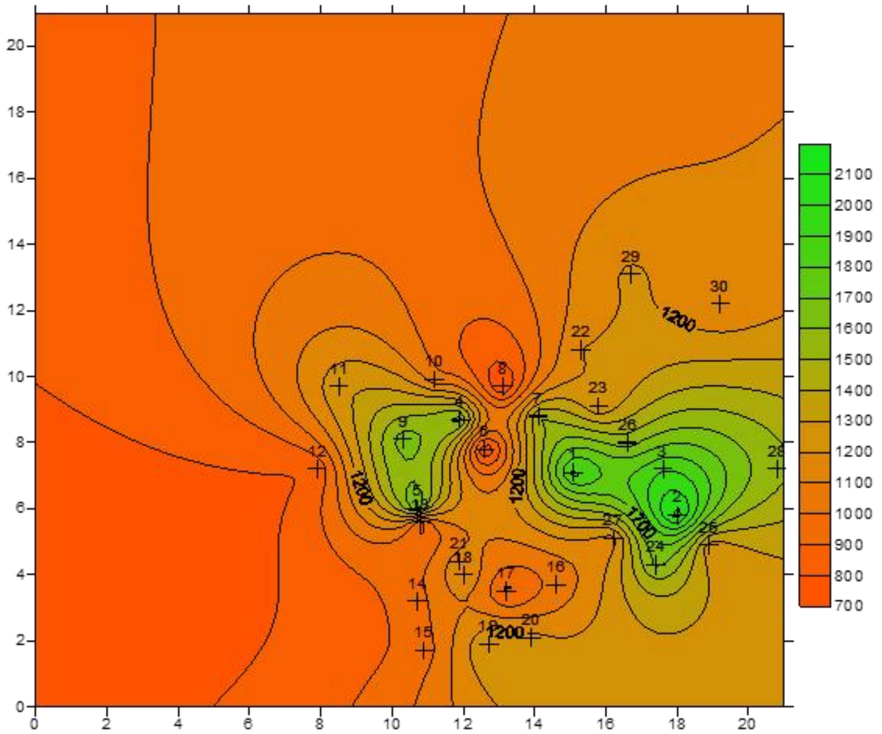

Figure 5: Showing TH pattern of study area

Calcium generally occurred in groundwater as mineral like feldspar, pyroxene and amphibole which are the prime contributors in major rock types. The calcium concentration of values ranges from 88.97 to 364.72 mg/L with an average 238.83 mg/L (Table 1). It is also seen that the 100% of groundwater samples are exceeding maximum permissible limit (Table 2) and from the figure 6 towards the southern-eastern portion showing higher values as compare to surrounding portion in the study area. As per prescribed by the WHO (2011) and BIS (2012) all groundwater samples are found in not suitable for drinking purpose.

A large number of minerals contain magnesium it is washed out from the rocks and subsequently end in up water. Chemical industries add magnesium to plastic and other materials. The Mg values ranges from 33.84 to 449.30 mg/L with an average 166.50 mg/L (Table 1). It is also observed that 26.67% of the groundwater samples are exceeding desirable limit but below maximum permissible limit and 73.33% of the groundwater sample are exceeding maximum permissible limit (Table 2) in the study area as prescribed by the BIS (2012) and WHO (2011) (Table 3). From the figure 7 central portion of the study area showing higher values as compared to the surround portion. The high calcium and magnesium concentration in groundwater could be cause in the water to be considered as hard type of water.

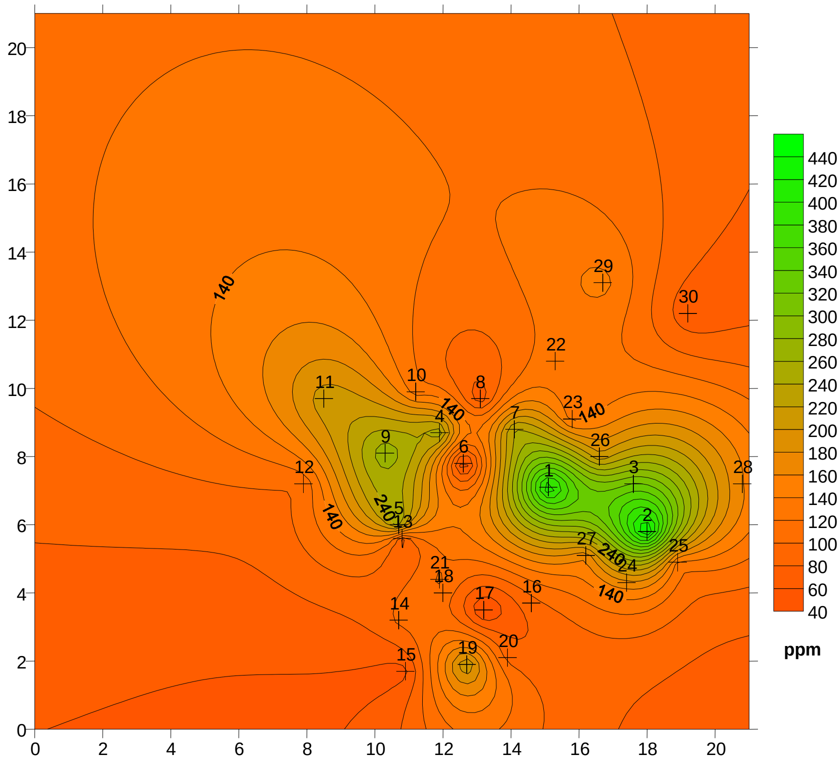

Figure 6: Showing Ca pattern of study area Magnesium

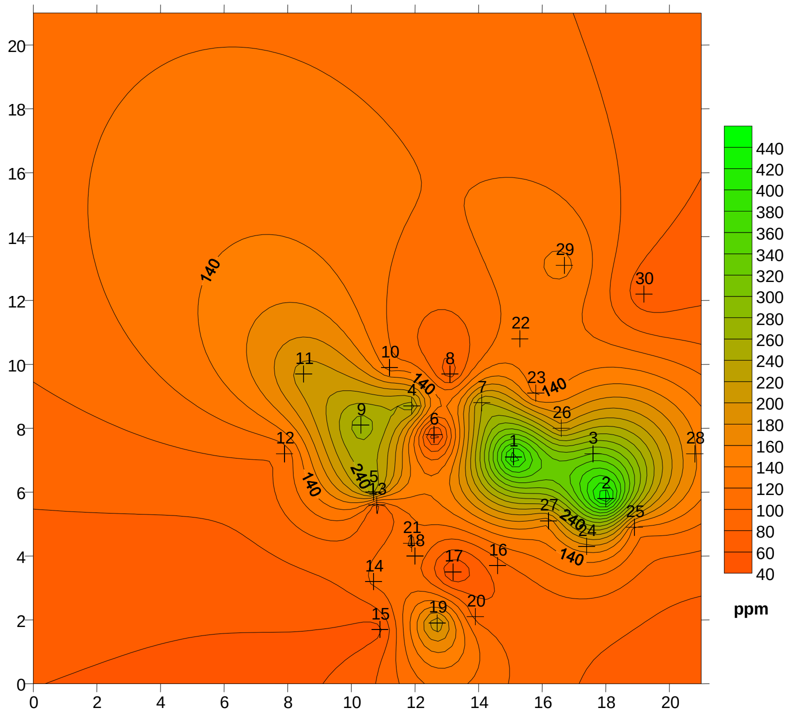

Figure 7: Showing Mg pattern of study area

Chloride concentration varies from 159.04 to 2073.2 mg/L with an average 704.12 mg/L. according to WHO (2011) and BIS (2012). It is also observed that 13.33% of the groundwater samples is desirable limit, 56.67% groundwater samples observed maximum desirable limit but below maximum permissible limit and 30% groundwater samples exceeding maximum permissible limit in the study area. From the figure 8 observed that towards the eastern portion of the study area chloride concentration is higher as compare to the surrounding portion of the study area. The higher concentration in the groundwater may be attributed to the percolation of domestic sewage, industrial waste and irrigated land water (Bhatia, 2003).

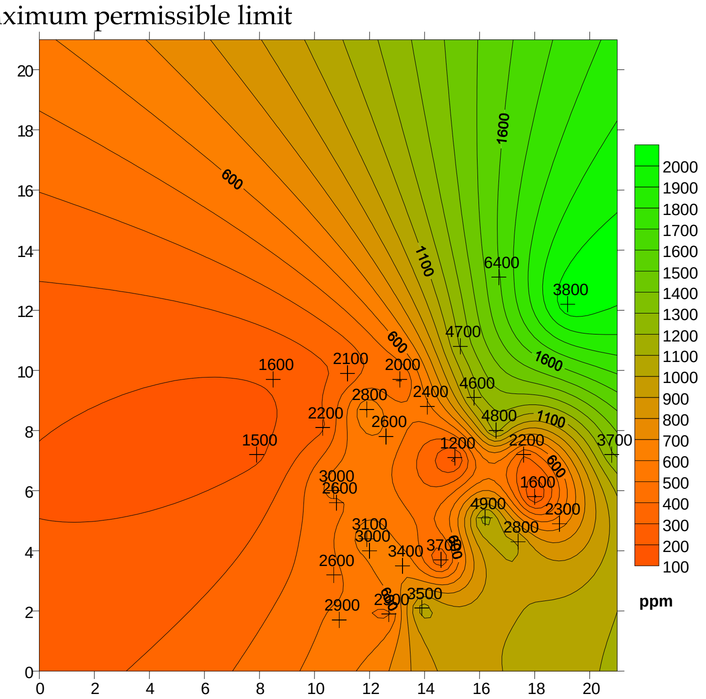

Figure 8: Showing chloride pattern of study area

The bicarbonate concentration of groundwater samples ranges from 80 to 560 mg/L with an average 347.67 mg/L. The higher concentration in the groundwater points indicates the dominance of minerals dissolution (Stumm and Morgan, 2012). It is also observed that 13.33% of the groundwater samples is desirable limit, 86.67% groundwater samples observed maximum desirable limit but below maximum permissible limit in the study area. From the figure 9 observed that towards the central and western portion higher concentration as compare to the surrounding portion of the study area. Higher concentration of bicarbonate in groundwater samples indicate to the dominance of minerals dissolution (Stumm and Morgan, 2012).

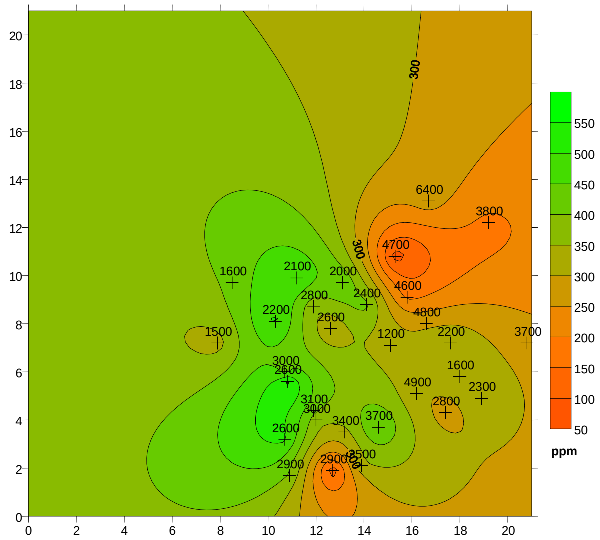

Figure 9: Showing bicarbonate pattern of study area

Sodium in groundwater is related to weathered rock forming minerals like sodium plagioclase, potassium plagioclase as well as anthropogenic sources like domestic, industrial and animal waste. The range of sodium in groundwater of this area varies from 25 to 552 mg/L with an average 189.93mg/L (Table 1). From figure 10 observed that towards the north-east portion higher concentration as compare to the surrounding portion of the study area.

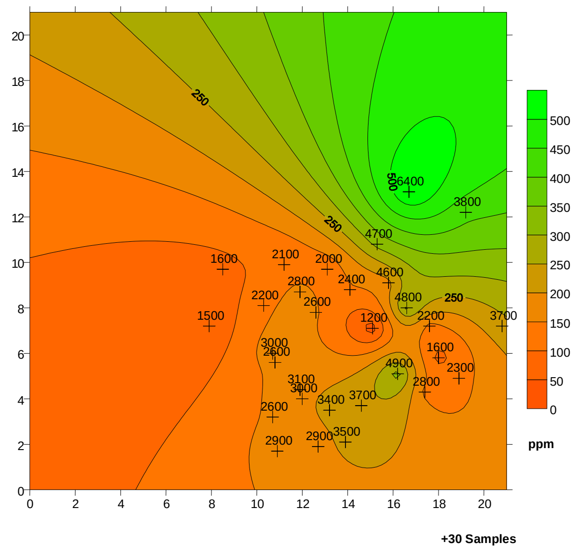

Figure 10: Showing sodium pattern of study area

Potassium is an essential element for humans, plants and animals and derived from the food chain mainly from vegetation and soil. The main source of potassium in ground water includes rainwater weathering of potassium bearing silicate minerals, use of potash fertilizers and use of surface water for irrigation (Aher and Deshpande, 2016). The potassium concentration in groundwater samples varies from 1 to 3 mg/L with an average 1.3 mg/L. The concentration in groundwater samples of sodium (Na^+) varies from 25 to 552 mg/L with an average 189.93 mg/L in the study area.

The sulphate concentration in the study area ranges from 93 to 1833 mg/L with an average 718.07 mg/L (Table 1).from the figure 11 towards northern and western portion observed the higher concentration as compare to the surrounding portion of the study area. It is also observed that 06.06% of the groundwater samples is desirable limit, 16.67% groundwater samples observed maximum desirable limit but below maximum permissible limit and 76.67% groundwater samples exceeding maximum permissible limit (Table 2) in the study area as prescribed by BIS (2012) and WHO (2011). (Table 3).

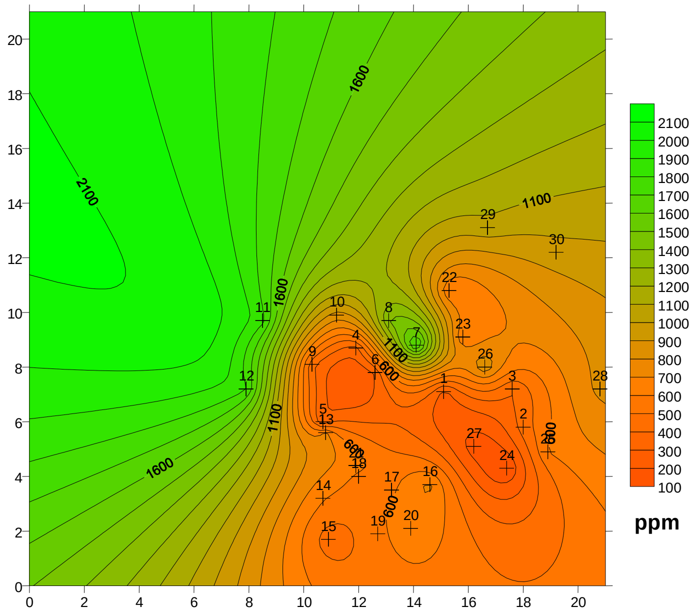

Figure 11: Showing sulphate pattern of study area

Table 2: Quality of groundwater Ranjangaon Shenpunji industrial area Aurangabad
DL=Desirable Limit, MPL= Maximum Permissible Limit

Sr. No.	Parameters	<DL	>DL<MPL	>MPL
1	PH	100	-	-
2	TDS	-	60	40
3	TH	-	-	100
4	Ca	-	-	100
5	Mg	-	26.67	73.33
6	HCO3	13.33	86.67	-
7	Cl	13.33	56.67	30
8	SO4	06.06	16.67	76.67

Table 3: Drinking water standards for physical chemical parameter

Physical and chemical parameter	**Unit**	**WHO international standards, 2011**		**Bureau of Indian Standards, Ref. IS 10500:2012**	
		Acceptable Desirable limit	**Maximum Permissible Limit**	**Acceptable Desirable limit**	**Maximum Permissible Limit**
pH	---	6.5-8.5	8.5-9.2	6.5-8.5	No Relaxation
Total Dissolved Solids	mg/L	500	1500	500	2000
Total Hardness	mg/L	100	500	200	600
Calcium	mg/L	75	200	75	200
Magnesium	mg/L	30	150	30	100
Chloride	mg/L	200	600	250	1000
Total Alkalinity	mg/L	200	600	200	600
Sulphate	mg/L	200	400	200	400

HYDROCHEMICAL FACIES

In order to understand the water composition and chemical relationship between dissolve ions, the concept of hydrogeochemical facies of the investigated area is used in piper trilinear Piper (1953) diagram (Fig. 12). water type depends on lithological characteristics of aquifer, retention time and flow pattern of groundwater (Baghvand et al., 2010). Based on the results of the chemical analysis the groundwater samples fall in Ca-Mg-Cl-SO_4 water type in the study area.

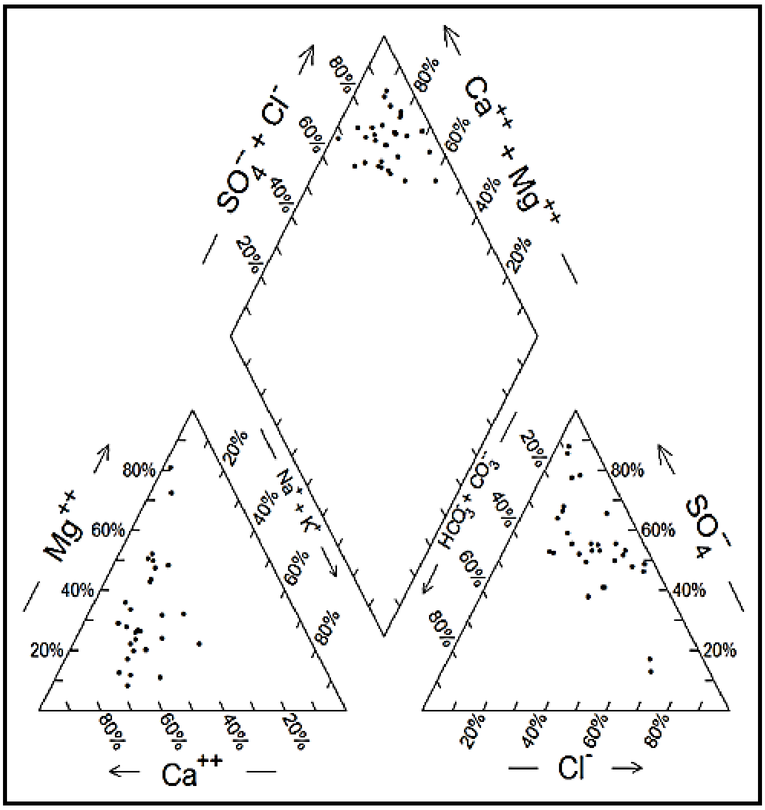

Figure 12: Piper trilinear diagram of the study area

CONCLUSION

Groundwater quality and its suitability for drinking and domestic purposes in Ranjangaon Shenpunji Aurangabad district have been evaluated. Results of the hydro chemicals analysis reveals that the groundwater is slightly alkaline in nature. Total hardness and Calcium exceeding maximum permissible limit. Also, TDS, Mg, Cl and SO_4 were few locations exceeding maximum permissible limit as prescribed by WHO and BIS for drinking water. Interpretation of hydrochemical analysis reveals that the groundwater in the study area very hard. The quality of groundwater was established to not fit for drinking purpose towards the northern and southern region in the study area. In generals, the dominant hydrogeochemical facies of groundwater were the Ca-Mg-Cl-SO_4 type. The analysis showed that the physicochemical parameters indicate the highly polluted water. This study provides the baseline for the groundwater chemistry in shenpunji Ranjangaon industrial its need to focus on specific contamination source and it mitigates. The overall geochemistry of the groundwater quality in the study area is controlled by the anthropogenic and industrial activity.

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