Hydrochemical Characteristics and Quality Assessment of Groundwater in Parts of Kannad, District Aurangabad (MS) INDIA.

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Research Article

Abstract: An attempt has been made to appreciate the quality and the suitability of groundwater for drinking and irrigation. In order to attend this objective, a total of 20 representative water samples were collected from dug wells; and analyzed for pH, total dissolved salts, electrical conductivity, total hardness, calcium, magnesium, sodium, potassium, chloride, sulphate, bicarbonate and nitrate. Based on the physicochemical analyses, irrigation quality parameters like sodium absorption ratio (SAR) and residual sodium carbonate (RSC), was calculated. The suitability of the water from the groundwater sources for drinking purposes was evaluated by comparing the values of different water quality parameters with WHO and BIS guideline values for drinking water. A preliminary hydrochemical characterization shows that most of the samples are within permissible limit for drinking water standards. The correlation of the analytical data has been attempted by plotting graphical representations such as U.S. Salinity Laboratory, which are employed to critically study the geochemical characteristics of groundwater which indicates that groundwater is suitable for irrigation purpose.

***Keywords*:** Groundwater quality, physicochemical parameter, irrigation, Kannad, Aurangabad, India.

Introduction:

Groundwater is a vital natural resource for the reliable and economic provision of potable water supply in both the urban and rural environment. It thus plays a fundamental role in human well-being as well as that of aquatic and terrestrial ecosystems. Groundwater is a vital natural resource, which is most important ingredient in multifarious facets of human civilization. It is an essential constituent of all animal and vegetable matters and inseparable commodity of animal and plant lives. Water quality has significant role in human health and sustenance of human, animals and plants. The quality of groundwater within a region is governed by both natural processes such as precipitation rate, weathering processes and soil erosion and anthropogenic effects such as urban, industrial and agricultural activities and the human exploitation of water resources. Fresh water is limited, but demand is increasing day by day. Where surface water is not available, sufficient, convenient, or feasible for consumption, but groundwater potential is suitable in quantity or quality, groundwater consumption has great importance (P.Ravikumar *et a*l. 2011),in the background of preserving this most important natural asset, the water utility management is the key area that managers need to focus upon.

Fresh and clean water is of fundamental importance to the survival, protection and development of human needs. The movement of groundwater is controlled by physical and geochemical properties of (i) contaminant (ii) the groundwater and (iii) the geological system through which the contaminated groundwater is flowing. Presence of some ionic contents beyond certain limits may make it unsuitable for irrigation, domestic or industrial use (Purushtotham et al.,2011;Deshpande and Aher,2011).Hydrogeochemistry of groundwater is important for sustainable development and effective management of the groundwater resource.

Today the environment has become foul, contaminated, undesirable, and therefore harmful for the human health; Quality of groundwater available for drinking in India is variable from place to place; In present investigation, the 20 groundwater samples collected from the study area (Fig.2) are subjected various laboratory analysis.

Hydrogeological Setup:

The entire study area are occupied mainly by succession of basaltic lava flows belonging to Deccan trap of upper Cretaceous to lower Eocene age with small alluvial patches of recent age. Each flow occur in layered sequences and represented by massive unit at the bottom and vesicular unit at the top of the flow and is separated by the occurrence of red bole which shows time gap between flows. The main water bearing formations of the study area are weathered zeolitic basalts as well as weathered fractured and jointed massive basalt. Due to presence of alternate units of vesicular and massive basalt, it acts as multi-aquifer system. The soil of the study area is mostly formed from igneous rocks and are black, medium black, shallow and calcareous types having different depths and profiles.

Methods of Investigation:

Twenty groundwater samples from different villages of the study area were collected and analyzed for major parameters (Table.2).The samples were collected in pre cleaned polyethylene containers of one liter capacity. The samples were collected from those wells only which are extensively used for drinking and irrigational purposes. Field samples were analyzed immediately (APHA, 1992) for hydrogen ion concentration (pH) and electrical conductivity (EC), using pH and EC meters and other parameters were analyzed immediately in the lab as per the standard methods for examination of water and wastewater (APHA, 1991) and Trivedi and Goel (1984).all results are compared with standard limit recommended by the (BIS,1991) and (WHO,1993).

Result and Discussion:

Groundwater quality for drinking purpose

The pH values of groundwater ranged from 7.4 to 8.1 with an average value 7.75. This shows that the groundwater of the study area is mainly alkaline in nature and all the samples are within the permissible limit prescribed by BIS (1991), (Table.2). The value of EC varied from 321 µmhos/cm to 2221 µmhos /cm with an average value of 988.6 µmhos/cm. The maximum limit of EC in drinking water is prescribed as 1500 µmhos /cm as per WHO (1993) standard. 4 samples (20%) were exceeds the permissible limit. Electrical conductivity is an indication of the concentration of total dissolved solids and major ions in a given water body (Deshpande and Aher, 2012). The TDS value ranged from 207 to 1567 mg/L with a mean of 654 mg/L. The BIS specifies a desirable total dissolved solids limit of 500mg/L and a maximum permissible limit of 2,000mg/L, and study area shows 12 samples (60%) are below desirable limit and 8 samples (40%) were exceeding desirable limit but below permissible limit (Table.1). Water with high total dissolved solids generally is inferior palatability. The presence of calcium (Ca^{2+}) in drinking water is natural geological source and agricultural wastes. Calcium (Ca^{2+}) values ranged from 16 to 113 mg/L with an average value of 59.2 mg/L, the desirable limit of Calcium (Ca) for drinking water is specified by BIS (1991) as 75 mg/L and a maximum permissible limit of 200 mg/L. It is observed that 15 samples (75%) are below desirable limit and 5 samples (25%) were exceeding desirable limit but below permissible limit as prescribed by BIS (1991) (Table.1). Magnesium (Mg^{2+}) concentration varies from 15 mg/L to 98 mg/L with mean values of 38 mg/L (Table.2). According to BIS (1991) the desirable values of Mg^{2+} is 30 mg/L and a maximum permissible limit of 100 mg/L, where 8 samples (40%) below desirable limit and 12 samples (60%) samples were exceeding desirable limit but within the maximum permissible limit (Table.1). A total hardness value varies from 92 to 590 mg/l with a mean values 294 mg/L. The desirable limit of total hardness (TH) for drinking water is specified by BIS (1991) as 300 mg/L and a maximum permissible limit of 600 mg/L. It is observed that 11 samples (55%) below desirable limit and 9 samples (45%) samples were exceeding desirable limit but within the maximum permissible limit (Table1). Sodium (Na^+) and Potassium (K^+) are present in a number of minerals. Sodium (Na^+) and Potassium (K^+) values ranged from 22 to 120 mg/L and 1 to 4 mg/L with an average value of 51.1 to 1.7 mg/L respectively (Table.2). Alkalinity is the measure of the capacity of the water to neutralize a strong acid. The Alkalinity in the water is generally imparted by the salts of carbonates, silicates, etc. together with the hydroxyl ions in free state, the bicarbonate alkalinity (HCO_3^-) varies from 52 to 443 mg/L with an average value of 219.5 mg/L (Table.2). The Chloride (Cl^-) ion concentration varied between 43 to 230 mg/L with a mean values 99.7 mg/L. It is observed that all the samples are below desirable limit prescribed by BIS (1991) (Table.2). The nitrate (NO_3^-) in the study area varies from 10 mg/L to 67 mg/L (Table 1) and all samples are within the permissible limit (>45) prescribed by WHO (1993) and BIS (1991). Nitrogen in groundwater is mainly derived from organic industrial effluents, fertilizer or nitrogen fixing bacteria, leaching of animal dung, sewage and septic tanks through soil and water matrix to groundwater (Richard, 1954; Reddy, *et al*, 2012). Sulphate (SO_4^{2-})

content in groundwater is made possible through oxidation, precipitation, solution and concentration, as the water traverses through rocks. The (SO_4^{2-}) values of groundwater ranged from 11 to 151 mg/L with an average value 60.5 mg/L (Table.2).

Groundwater quality for irrigation purpose

The water used for irrigation is an important factor in productivity of crop, its yield and quality of irrigated crops. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Sodium absorption Ratio (SAR) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.

Sodium absorption Ratio (SAR)

The sodium hazard is typically expressed as the sodium adsorption ratio (SAR). Sodium adsorption ratio varied from 0.9 to 3.4 (Table 2). Todd (1980) classified irrigation water with SAR values less than 10 as excellent and the water is evaluated suitable for any crop Lower the ionic strength of Sodium, greater the sodium hazard; and conversely, if Calcium and magnesium predominant, the hazard is low, SAR values 10-18 are good, 18 to 26 are fair and about 26 are said to be unsuitable for irrigation (USDA, 1954, Aher and Deshapnde, 2011). The sodium adsorption ratio values for each water sample were calculated by using equation given by Richard (1954). Sodium adsorption ratios for groundwater samples of the study are less than 10 indicate excellent quality for irrigation. There is a significant relationship between SAR values of irrigation water and the extent to which sodium is absorbed by the soil. If the water used for irrigation is high in Sodium and low in Calcium, the cation-exchange complex may become saturated with Sodium (Tatawat and Singh Chandel, 2007). The US salinity Laboratory of the Department of Agriculture adopted certain techniques based on which the suitability of water for agriculture is explained. The correlation between sodium-absorption ratio and electrical conductivity was plotted on the US salinity diagram, in which EC is taken as salinity hazard and SAR is taken as alkalinity hazard. The plots of groundwater chemistry of study area in USSL diagram are shown (Fig.1) and it was found that 55 % of samples fall in the field of C_2-S_1 indicating medium salinity and low alkalinity hazard, 45 % of the samples fall in the field of C_3-S_1, indicating water of high salinity and low sodium, which can be used for irrigation in almost all types of soil.

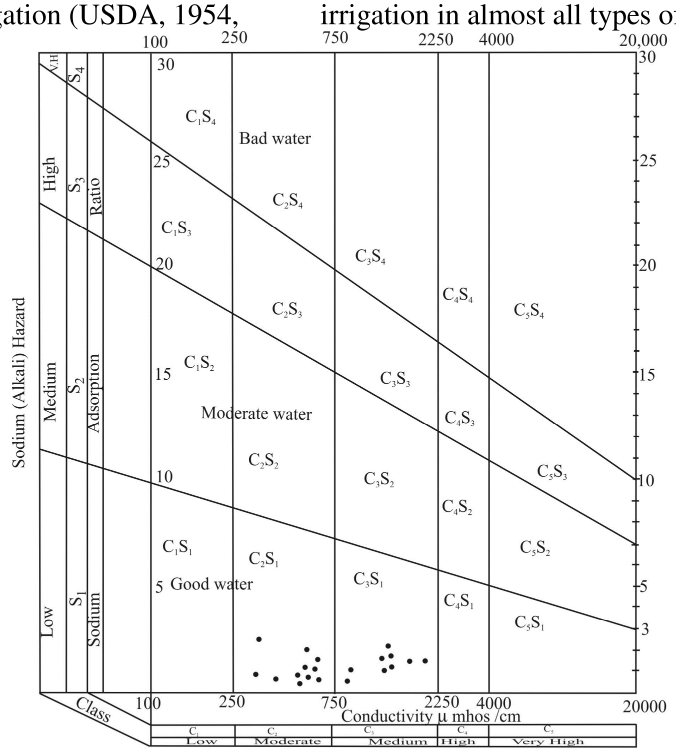

Fig.1 US Salinity diagram of groundwater in study area

Residual Sodium Carbonate (RSC)

In water having high concentration of bicarbonates, there is tendency for calcium and magnesium to precipitate as carbonates. To qualify this effect, an experimental parameter termed as residual sodium carbonate can be calculated. According to the US Department of Agriculture, water having less than 1.25 or equal to 1.25 epm of RSC is safe water for irrigation purpose, water is having less than 1.25 to 2.5 epm of RSC is marginally suitable for irrigation purpose whereas water having more than 2.5 epm of RSC is not suitable for irrigation purposes. Based on RSC values, all the samples of study area had values less than 1.25 and were safe for irrigation.

Conclusions:

Hydrochemical parameter and quality assessment data of groundwater in parts of Kannad, was compared with BIS (1991) and WHO (1993) shows that groundwater of the study area is suitable for drinking purposes and public health. The values of sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) are within permissible limit indicating groundwater is suitable for irrigation. The values of EC and SAR of groundwater samples have been plotted in U.S. salinity diagram indicating that 55% samples fall in C_2-S_1 and 45% samples falls in C_3-S_1 category showing moderate to high salinity and low sodium hazard. Overall the groundwater quality of the study area is suitable for the domestic as well as irrigation purpose.

References:

[1] Aher K.R. and Deshpande S.M. (2011): Assessment of Water Quality of the Maniyad Reservoir of Parala Village, district Aurangabad: Suitability for Multipurpose Usage, *Recent Trends in Science And Technology,* Vol.1, (3), pp 91-95.

[2] APHA (1992). Standard Methods for the Examination of Water and Waste Waters, American Public Health Association, 18th Edition, Washington, DC.

[3] BIS (1991). Specifications for Drinking Water, IS: 10500: 1991, *Bureau of Indian Standards,* New Delhi, India.

[4] Deshpande S.M., and Aher, K.R. (2011). Quality Characterization of Groundwater of Tribakeswar-Peth area of the Nashik district and its Suitability for Domestic and Irrigation Purpose. *Gondwana Geological Magzine,* Vol. 26 (2).

[5] Deshpande S.M.and Aher K.R.(2012):Evaluation of Groundwater Quality and its Suitability for Drinking and Agriculture use in Parts of Vaijapur, District Aurangabad, MS, India, *Research Journal of Chemical Sciences*, vol.2(1), pp 25-31.

[6] Purushtotham, D., Rao, A.N., Ravi Prakash, M., Shakeel Ahmed and G. Ashok Babu (2011). Environmental impact on groundwater of Maheshwaram watershed, Ranga Reddy district, Andhra Pradesh*, Jour. of Geological society of India,* Vol. 77, pp 539.

[7] P. Ravikumar., R. K. Somashekar, and Mhasizonuo Angami (2011). Hydrochemistry and evaluation of groundwater suitability for irrigation and drinking purposes in the Markandeya River basin, Belgaum District, Karnataka State, India, *Environ Monit Assess*,173:459–487, DOI 10.1007/s10661-010-1399-2

[8] Reddy, L Chandra Sekhar., Deshpande, SM., Reddy, KV Ramana.,and Aher, KR (2012). Hydro Geochemical Processes in the Groundwater Environment of Vemula area, Kadapa District, South India, *Recent Trends in Science and Technology,* Vol. 3 (1), pp 18-24.

[9] Richard, L.A. (1954): Diagnosis and improvement of Saline and Alkali Soils, Agric. Handbook 60, *U.S. Dept. Agric.,* Washington, D.C., 160 pp

[10] Tatawat, R. K.,and C.P. Singh Chandel (2007). Quality of ground water of Jaipur city and its suitability for domestic and irrigation purpose, *Applied Ecology and Environmental Research* vol. 6(2) pp 79-88.

[11] Trivedi, R.K. and Goel,P.K.,(1984). Chemical and biological methods for water pollution studies. *Environmental Publications Karad*, India 215.

[12] Todd, D.K. (1980): Ground water Hydrology, *John Willey & sons publishers*, New York

[13] U.S. Department of Agriculture (USDA) (1954): Diagnosis and Improvement of Saline and Alkali Soils, Handbook 60. *U.S. Department of Agriculture*, Washington, D.C.

[14] World health organization.(1993) *Guidelines for drinking water*. Vol.1. (pp. 52-82). Geneva.

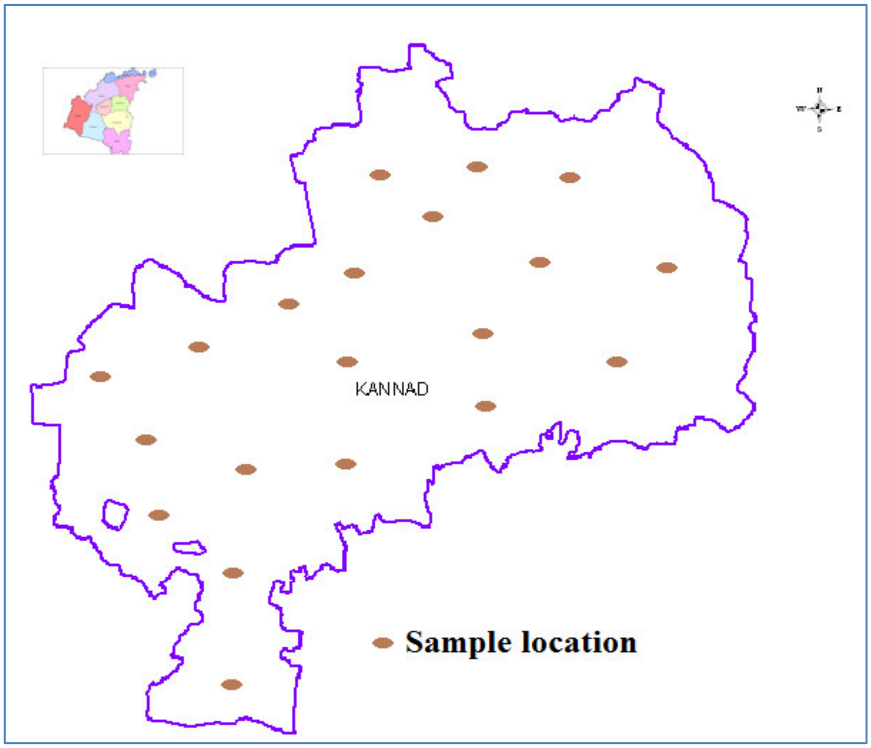

Fig.2. Location map of the study area

Table.1 Quality of groundwater in parts of Kannad, district Aurangabad.

Parameter	Desirable limit	Permissible limit	<DL (%)	>DL<MPL (%)	>MPL (%)
TDS	500	2000	60	40	-
Ca^{2+}	75	200	75	25	-
Mg^{2+}	30	100	40	60	-
Hardness	300	600	55	45	-
Cl^-	250	1000	100	-	-
NO_3^-	45	100	70	30	-

Table.2 Analytical data from the groundwater and irrigational specification values of study area

Sample No.	pH	EC ($\mu S\ cm^{-1}$)	TDS (mg/L)	Na^+ (mg/L)	K^+ (mg/L)	Mg^{2+} (mg/L)	Ca^{2+} (mg/L)	TH (mg/L)	HCO_3^- (mg/L)	SO_4^{2-} mg/L)	Cl^- (mg/L)	NO_3^- (mg/L)	SAR	RSC
1	7.4	806	520	35	1	38	66	310	301	32	65	40	1.20	-1.48
2	7.8	1745	1120	120	1	50	109	450	335	70	230	55	3.38	-4.06
3	7.9	1490	970	48	2	45	113	462	310	69	170	45	1.37	-4.26
4	7.6	1651	1070	98	3	35	106	390	341	67	190	46	2.98	-2.58
5	7.8	766	450	35	1	32	71	303	251	53	64	24	1.22	-2.06
6	7.5	2113	1567	67	1	70	17	325	172	98	121	62	2.27	-3.77
7	7.8	625	404	65	2	16	35	115	52	105	120	10	3.23	-2.21
8	7.9	598	387	23	1	21	37	187	201	11	43	12	1.06	-0.28
9	7.6	981	634	40	1	23	103	345	280	61	85	35	1.31	-2.45
10	7.8	2221	1465	78	1	98	35	590	443	120	150	67	2.17	-2.52
11	8.1	321	207	45	1	15	16	92	60	15	71	21	1.25	-3.58
12	7.5	680	442	34	1	39	48	276	123	55	65	37	2.75	-1.05
13	7.9	623	403	27	3	21	65	245	241	24	51	10	1.05	-1.02
14	7.4	1040	676	53	1	31	91	321	276	151	85	52	1.73	-2.57
15	8.1	321	207	45	1	15	16	92	60	15	71	21	2.75	-1.05
16	7.79	711	462	43	2	41	45	285	202	42	92	44	1.58	-2.30
17	7.6	661	423	23	3	24	71	267	161	37	61	41	0.85	-2.88
18	7.7	490	321	22	1	23	37	195	133	41	43	34	0.99	-1.55
19	7.9	710	462	47	4	42	46	284	201	46	91	44	1.71	-2.45
20	7.8	655	423	34	2	37	46	261	192	57	52	41	1.28	-2.19
Min.	7.4	321	207	22	1	15	16	92	52	11	43	10	0.9	-4.25
Max.	8.1	2221	1567	120	4	98	113	590	443	151	230	67	3.4	-0.27
Avg.	7.745	988.64	653.95	51.09	1.73	37.7	59.2	294.4	219.5	60.5	99.7	37.2	1.83	-2.31