

Graphical Interpretation of Ground Water Quality and Its Suitability for the Domestic and Agricultural Purpose in Nanded Tehsil

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ABSTRACT: GRAPHICAL interpretation is main tool in hydrochemical studies, which is use for summarizing and presenting water quality data. Hydrogeochemical characteristics of groundwater and its suitability for various purposes such as domestic and irrigation has evaluated in Nanded Tehsil. Total 16 groundwater samples have collected from dug well during period of post monsoon season 2016 at various location of having a coordinates point. For calculating 13 parameters such as pH, TDS, EC, TH, Total alkalinity, Sulphate, Chloride, sodium, potassium, Nitrate, Calcium and Magnesium have been considered and analyzed. Then, its suitability for drinking and agriculture purposes has been calculated from EC, TDS, sodium adsorption ratio (SAR), residual sodium carbonate (RSC), and %Na which having various ranges from excellent to unsuitable, majority of the groundwater samples are suitable for both purposes.

KEYWORDS: GroundWater Dug well, hydrochemical, physicochemical.

I. INTRODUCTION

Water is the easily available, cheapest material in earth. In various purposes, water can be used based on its unique physical and chemical properties. Ground water is the purest form of water when compare to surface water. Ground water is used for domestic, industrial and irrigational purposes all over the world. In the last few decades there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. Water is a universal solvent and it dissolves the minerals from rocks in which it is stored and then chemical and physical attributes of ground water depend on geology of particular area, rapid urbanization especially in developing countries like India has affected the availability and quality of ground water. Most of the population from rural as well as urban areas depends mainly on groundwater for various purposes. Irrigation is necessary for agricultural production in infertile and semiarid regions where rainfall is not sufficient to up hold crop growth.

The quality of ground water may also vary with depth of water table, seasonal changes and composition of dissolved salts depending upon sources of the salt and sub-surface environment also untreated effluents from industrial and domestic sectors have also polluted the groundwater to a considerable extent. Evaluation of groundwater quality requires determination of ion concentrations from which decide the suitability for domestic and irrigation purposes. Chemical reactions such as weathering, rainfall, dissolution, ion exchange, and various biological processes commonly take place below the earth surface. Hydrogeochemical study is a useful tool to identify these processes that are responsible for groundwater chemistry. The water quality depends upon the geological setting, natural movement of water, rock types, aquifer materials, climatic variation, residence time of water, and inputs from soil during percolation of water. The study area is Nanded Tehsil where most of the People in this area depend upon Groundwater activity. Hence, the study careered out for determination of water suitability for irrigation and drinking purposes.

II. STUDY AREA

The study area situate in Nanded district of Maharashtra , bounded by latitudes with 19° 03' to 19° 17' N and longitudes 77° 10' to 77° 25' E. The study area is situated in the southeast part of Deccan volcanic province. Groundwater occurs in that region at limited quantity in varying disproportionately in aquifers. Weathering, faulting, and fracturing of the Deccan trap rocks is mainly caused due to secondary porosity and lithology, degree of weathering, and nature and intensity of the openings (faults, fractures, joints, etc.) is control the movement of ground water while flowing through aquifer. The geological formation is mainly occurred due to Deccan Basalt flows viz., fractured, jointed, and compact basalt, vesicular, amygdaloidal, weathered, Etc.

III. METHODOLOGY

The water samples have been collected during Post-monsoon to widely covering the Water quality variation. A total of 16 water samples have collected from dug wells in the post-monsoon season of 2016.

Table 1: Physicochemical characteristics of ground water in the study area

Sr No.	Sample	Representation	Depth (m)	Well
1	Markad	SM ₁	2.0	Dug well
2	Malarak	SM ₂	3.9	Dug well
3	Limgav	SM ₃	5.3	Dug well
4	Dhanegav	SM ₄	9.8	Dug well
5	Pasadgov	SM ₅	7.8	Dug well
6	Sugavkhuard	SM ₆	8.3	Dug well
7	Babulgav	SM ₈	6.9	Dug well
8	Nearli	SM ₇	4.4	Dug well
9	Markad	S ₁ M ₁	2.30	Dug well
10	Malarak	S ₁ M ₂	4	Dug well
11	Limgav	S ₁ M ₃	5.4	Dug well
12	Dhanegav	S ₁ M ₄	11	Dug well
13	Pasadgov	S ₁ M ₅	8	Dug well
14	Sugavkhuard	S ₁ M ₆	8.4	Dug well
15	Babulgav	S ₁ M ₈	7	Dug well
16	Nearli	S ₁ M ₇	5	Dug well

Table 2: Comparison of chemical composition of water with WHO (2006) and ISI (1995), BIS (IS: 10500) in mg/L (Except EC and pH), EC in µs/cm

Parameter	WHO standards	BIS standards	Effects
pH	6.5-8.5	6.5-8.5	Taste, affects mucous membrane
TDS	500-1500	500-2000	Gastrointestinal irritation
EC	1500	-	Crop productivity
TH	100-500	300-600	Scale formation, encrustation in water supply, urolithiasis and adverse effects on domestic use

Ca	75-200	75-200	Scale formation
Mg	50-150	30-100	Encrustation in water supply encephalitis and adverse effects on domestic use
Na	200-600	200	Vomiting, elimination of salts from body, convolutions, etc.
K	30	-	Bitter in taste
CO ₃	-		-
HCO ₃	-		-
Cl	200-600	250-1000	Salty taste, corrode pipes
NO ₃	50	45-100	Blue baby syndrome
SO ₄	200-400	200-400	-

Table 3 Methodology for the calculation of various indices of groundwater for agriculture Suitability of groundwater for agricultural

IV. RESULT AND DISCUSSION

The analytical results of all the parameters for the groundwater samples in post monsoon season 2016 are represented in Table 4. The concentration of major ions (Ca, Mg, Na, K, CO₃, HCO₃, Cl, SO₄, NO₃,) and important physicochemical parameters such as pH, EC, and total dissolved solids (TDS) has determined for the domestic and agricultural suitability.

Table: 4 Physicochemical characteristics of groundwater in the study area

Sample	pH	EC	TDS	TH	Ca	Mg	Na	K	CO ₃	HCO ₃	Cl	SO ₄
SM ₁	7.9	1110.11	710.40	142	32	20	90	2.20	20	150	103	4.46
SM ₂	8.0	1696.00	1017.60	200	55	29	104	3.80	30	160	142	7.21
SM ₃	7.6	1740.00	1078.20	100	60	37	144	4.20	30	240	160	19.53
SM ₄	7.2	1200.20	758.12	190	36	22	120	2.40	40	270	220	15.20
SM ₅	6.9	1218.10	730.86	204	40	16	70	5.30	60	190	180	3.84
SM ₆	7.5	1064.00	727.76	194	47	26	55	7.20	30	170	152	8.45
SM ₇	7.3	1054.00	653.48	226	52	30	30	2.80	40	180	138	15.11
SM ₈	7.8	1460.00	885.78	245	55	33	60	6.10	50	230	125	23.00
S ₁ M ₁	8	1574	1007	212	35	45	96	2.30	30	170	107	5.64
S ₁ M ₂	8.1	2018	1352	290	57	30	110	4.10	40	180	145	7.45
S ₁ M ₃	7.8	1800	1134	220	65	51	156	4.40	50	260	167	20.23
S ₁ M ₄	7.3	1342	832	210	45	43	127	2.60	70	290	230	16.00
S ₁ M ₅	7.2	1300	793	230	44	31	73	5.40	50	220	190	4.50
S ₁ M ₆	7.8	1123	674	240	50	41	57	7.30	70	180	156	10
S ₁ M ₇	7.4	1230	752	240	56	69	34	3.30	60	220	145	16
S ₁ M ₈	7.8	1680	1075	320	62	50	66	6.30	60	230	130	25
Average	7.6	1320	880	217	47	36	87	4.30	40	190	150	15
Sodium adsorption ratio (SAR)					SAR=Na ⁺ /[(Ca ²⁺ +Mg ²⁺) ^{1/2}]							
Residual sodium carbonate(RSC)					RSC=(Hco ₃ ⁻ +co ₃ ²⁻) - (Ca ²⁺ +Mg ²⁺)							
Magnesium adsorption ratio (MAR)					MAR=(mg ²⁺ * 100)/(Ca ²⁺ +Mg ²⁺)							
Percentage sodium (%Na)					%Na=[(Na ⁺ +k ⁺)/(Ca ²⁺ +Mg ²⁺ +Na ⁺ +k ⁺)]*100							

Sodium adsorption ratio (SAR)

SAR ratio measures the alkali/sodium hazard to the crop and, hence, considered to be an important parameter use for determining the suitability of groundwater for irrigation. This index quantifies the proportion of sodium to calcium magnesium ions in water and confirms the effects of these ions on soil structure and permeability. Generally, water having a low SAR value is good for irrigation. As per the SAR classification (Table 5), the groundwater samples (37.5 %) come under excellent water category for irrigation. It is observed that 37.5 % samples having SAR value is in between 10 and 18 which fall in good category; however, four samples(i.e 25 %) is doubtful for irrigation.

Table 5 Classification of ground water sample based on SAR

Classification	Class	Range	Sample numbers	Sample numbers	Sample numbers
SAR	Excellent	<10	6	37.5	6-8,14-16
	Good	10–18	6	37.5	1,2,5,9,10,13
	Doubtful	18-26	4	25	3,4,11,12
	Unsuitable	>26	0	0	0

Residual sodium carbonate (RSC)

RSC is important since it commonly used to assess the sodium permeability hazard by considering the bicarbonate/carbonate calcium/magnesium concentration in irrigation water. When RSC becomes too high, the carbonate combines with calcium and magnesium to form Solid material, which settles out of the water and ends with increase in SAR and sodium percentage. According to Richards (1954) classification (Table 6), RSC value (<1.25) (18%) groundwater samples are considered safe for irrigation. Water with RSC values (1.25–2.5) is a marginal class that includes 68.25 % samples; moreover, RSC values (>2.5) that show 12.5 % samples are supposed to be unsuitable for irrigation.

Table 6 Classification of water based on residual sodium carbonate (RSC) (Richards1954)

Classification	Class	Range	Sample numbers	Sample numbers	Sample numbers
RSC	Safe	<1.25	3	18	1-3
	Marginal	1.25–2.5	11	68.25	3,5,6-8,10,11,13-16
	Unsuitable	>2.5	2	12.5	2,4

Magnesium adsorption ratio (MAR)

MAR ratio characterizes the water suitability for irrigation by indicating the excess amount of magnesium over calcium. As per classification, Table 13 suggests that majority of the samples (i.e., 44 % samples) are unsuitable for irrigation and 58 % samples show their suitability for irrigation. Generally, the source of magnesium in groundwater is due to ion exchange of minerals from rocks and soils by water .The high MAR (>50) results in increase soil alkalinity and affects the crop yield.

Table 7 Classification of irrigation water based on magnesium (Ragunath1987)

Classification	Class	Range	Number of sample	Percentageof samples	Sample numbers
MAR	Suitable	<50	9	56	1-8,10
	Unsuitable	>50	7	44	9,11-16

Percentage sodium (% Na)

Percentage sodium is use for identify not only the soluble sodium content of the water but also used to expose the sodium hazard. Sodium by the process of Base Exchange replaces calcium in the soil, which reduces the soil permeability. it is observed that (19 %) of samples are in the good category for both drinking and irrigation use, most of

sample 62% of the samples are from groundwater sources permissible for drinking and irrigation and only 17 % of the samples are in the class of doubtful irrigation use.

Table 8 Classification of irrigation water based on sodium present (Doneen1962)

Classification	Class	Range	Number of sample	Percentage of samples
Percentage of Na (%)	0	0	0	0
	20-40	3	19	7,15,16
	40-60	10	62	2,5,6,8-14
	60-80	3	19	1,3,4
	>80	0	0	0

Electrical conductivity (EC)

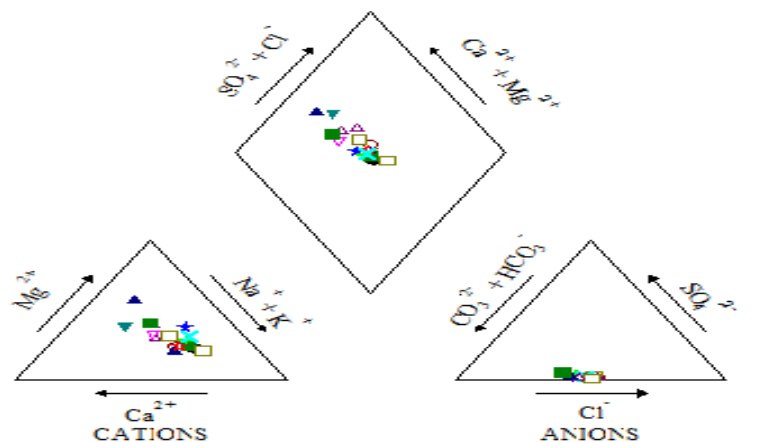
High concentration of EC affects the salinity hazard to water, which diminishes the soil permeability and crop productivity. The increase in salt concentration results in the continual moisture extraction by plant roots and evaporation. The uses of water moderate to higher salt result in saline conditions, even where drainage is satisfactory (Table 9) signifies that most of the groundwater samples (i.e. 94 %) of the study area are permissible for the agriculture purposes. Only 6 % of samples are in doubtful category. Various factors influence EC such as Geological formations, agricultural activities, and leaching of domestic, animal, and industrial.

Table 9 Classification of groundwater samples based on electrical conductivity (EC) (after Richards 1954)

EC range ($\mu\text{S}/\text{cm}$)	Range	Sample number	Sample number	Sample number
Below 250	Excellent	0	0	0
250–750	Good	0	0	0
750–2000	Permissible	94	15	1-8,10-16
2000–3000	Doubtful	6	1	9
>3000	Unsuitable	0	0	0

Piper trilinear diagram

The Piper trilinear diagram (Piper 1944) (Fig.1) illustrates that most of the groundwater samples represent $\text{Ca} + \text{Mg} > \text{Na} + \text{K}$ hydrochemical facies (alkaline earth exceeds alkalis). However, weak acid ($\text{CO}_3 + \text{HCO}_3$) > strong acid ($\text{SO}_4 + \text{Cl}$) representing most of samples and very few sample of strong acid exceed weak acid.



V. CONCLUSION

While performing chemical analysis on groundwater samples taken from various locations within the Nanded Tehsil. Noted that major water quality parameters (such as turbidity, pH, EC, TDS, carbonate and bicarbonate) and measures of agriculture-derived ion (such as potassium, phosphorus, and nitrogen), which reflects lower pollutant concentrations during the post-monsoon season, which highlights the effect of precipitation on groundwater quality.

Hydrochemical analysis data reveal that the region has high concentrations in the order of dominance of cation and anions are $\text{Na} > \text{Ca} > \text{Mg} > \text{K}$ and $\text{HCO}_3 > \text{Cl} > \text{CO}_3 > \text{SO}_4 > \text{NO}_3$, respectively. The evaluation of groundwater samples according to the WHO and BIS standards for domestic water purposes indicates TDS, TH, Ca, Mg, Na, and Cl are within the safe limits respectively; therefore, the groundwater samples confirm their suitability for drinking. Thus, the present work reveals that the most of the groundwater samples show their suitability for domestic, agriculture, and irrigation purposes. However, there are very few samples, which are problematic and need particular remedial measures.

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