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HYDROGEOCHEMICAL ASSESSMENT FOR DRINKING AND IRRIGATION PURPOSES OF ROOMA, KANPUR, UTTER PRADESH, INDIA

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Abstract: This study is aimed to assess the groundwater excellence within the Rooma, Kanpur, Utter Pradesh, India. Fifteen groundwater samples were collected and investigated for diverse geochemical parameter viz, pH, total dissolved solids (TDS), total hardness (TH), cations and anions, electrical conductivity, bicarbonate (HCO3-), chloride (Cl-), sulphate (SO42-), fluoride (F-), calcium (Ca2+), magnesium (Mg2+), sodium (Na+) and potassium (K+). The results are evaluated and compared with WHO and BIS water quality standards. Piper trilinear diagram for geochemical classification indicates 44% and 60% groundwater and surface water samples of Ca2+-Na+-HCO3- type and 29% belong to Na+-HCO3- type. Wilcox diagram, sodium adsorption ratio (SAR), percent sodium (Na%), residual sodium carbonate and permeability index which indicate that majority of groundwater samples are useful for irrigation purposes. The groundwater of the study region is neutral to slightly alkaline nature. On the basis of TDS, all the samples are within the range of desirable to permissible for drinking and agriculture purpose.

Index Terms **- Groundwater Quality, Drinking purpose, irrigation purpose.**

I. INTRODUCTION

Water is an essential natural resource and an absolute necessity for sustenance of life (Narshima et al. 2013). Water is not only the most important essential constituent of all animals, plants and other organisms but it is also pivotal for the survivability of the mankind in the biosphere (Mahadevvasamy et al. 2011, Malyan et al. 2014).Most of the surface waters in India, including both rivers and lakes are getting increasingly polluted due to onslaught of human activities of diverse nature. The demand for water has increased over the years and this has led to water pollution. India is heading towards a freshwater crisis mainly due to improper management of water resources and environment crisis is already evident in many parts of India, varying in scale and intensity. It is estimated that nearly 70% of our water sources are polluted. The growing scales of cultural and technological development pose new threats to water quality. In India, there is clear visible threat to the quality of water. The predicted water demand for future is alarming (Sayyed et al. 2011).Groundwater is an important source of water supply throughout the world. It is the primary source of water for human consumption as well as for agricultural and industrial uses in many regions all over the world (Sayyed et al. 2011, Jena et al. 2012). The rapid urbanization, deforestation and industrialization are causing severe impacts on groundwater and affecting its quality and quantity. In recent years it has been recognized that the quality of groundwater is equally important as the quantity. The present realization is clear about the limited resources and competing demands.

This indeed has placed urgency on the observation and the protection of the quality of groundwater. In huge times, huge population growth, intense urbanization, increasing industries and tremendous agricultural activities all over the world have contributed to tremendous increase in demand for freshwater for household applications, agricultural and industries (Adimalla and Venkatayogi 2018; Alexakis and Tsakiris 2010). Due to insufficient supply of surface water, most of the people in arid and semiarid regions in India are depending primarily on groundwater for their daily needs and irrigation usages. He et al. (2015) have estimated that more than 1.5 billion people worldwide rely on groundwater as their chief source of drinking water. Hence, it is concluded that the groundwater is an elixir of life and other hand groundwater resource is facing more problems in recent years including quality aspects especially in arid and semiarid regions.

1.1 Study Area

The proposed groundwater quality study will be carried out in Rooma city. Rooma is a satellite town situated about 20 kilometres East of Kanpur, India and a major industrial and institutional centre on Kanpur-Prayagraj Highway of National Highway-19. It is one of major towns enlisted in Kanpur metropolitan area.

1.2 Regional Geology of the study area

The older alluvium, alluvial deposit mostly occurring in the central part were deposited during lower to Upper Pleistocene period. The newer alluvium deposited during Pleistocene to Recent period mostly occurring along the course of rivers.

The soil of the district exhibits a great variety of compaction and appearance. The major part of the district consists of ordinary soils known locally as Bhur sand on ridges, Matiyar or clay in depressions and Domat or Loam in the plains. The 'Reh' prevails in the clay dominant areas.

1.3Geomorphology and soil type of the study area

Major physiographic unit of the study area is central ganga alluvial plain and major soil type

II Materials and Methods

2.1 Materials:

The different types of materials will be used in the present study as follows:

2.1.1 Data Required:

Hydrogeological data will be collected from the Central Groundwater Board (CGWB), Kanpur, Government of India, Ministry of water resource.

Published geological data and soil data of the study area on 1:50000 scale collected from Geological Survey of India (GSI), Ministry of mines, Government of India.

2.1.2 Instrument required:

Global positioning system (GPS) is a satellite navigation system used to determine the ground position of an object.

2.2 Methods:

The various methods of study instituted in execution of this research work, are as follows:

2.2.1 Collection of water sample and analysis:

In order to effectively carryout present studies systematic sampling will be collected from surface water and groundwater of the study area. The water sample will be store in plastic bottles to avoid contamination of the cations and securely corked and sealed with paper and candle wax to prevent oxidations of the water. The water samples will be collected as per the standard protocol prescribed by APHA-AWWA-WEF (1995) during pre-monsoon period. The locations of sample point will be collect using Global positioning system (GPS).

2.2.2 Laboratory Analysis of groundwater Samples:

Collected samples will be analysed as per the Standard protocol given by APHA-AWWA-WEF (1995). The physio chemical parameter will be analysed in the laboratory.

2.2.3 Data Interpretation and suitability study:

Analysed water quality data will be compared with Standards know the suitability for drinking and irrigation purpose.

III Results and Discussion

In the study area, fifteen water sample (N=15) were collected from different locations and various sources:

The samples were analyzed for different physiochemical parameters and for major cations calcium, magnesium, sodium and potassium (Ca, Mg, Na & K) and major anions Carbonate, Bicarbonate, Chloride, Sulphate and Fluoride (CO_3, HCO_3, Cl^-, SO_4, F^-) by using standard method given in APHA. The obtained chemical analysis result and Bureau of Indian Standard (BIS-10500:2012) limit for drinking water were summarized in Table-1 and Table-2.

Table 1 Physicochemical parameters in water of Rooma Industrial area

S. No.	Sample code	Source	pH	EC at 25°C (µS/cm)	TDS (mg/l)	TH	TA
1	RO-1	HP	7.7	185	118	70	70
2	RO-2	HP	7.49	671	429	255	175
3	RO-3	HP	7.57	570	365	250	150
4	RO-4	HP	6.96	661	423	260	140
5	RO-5	Well	7.3	625	400	190	165
6	RO-6	HP	7.53	836	535	295	255
7	RO-7	HP	7.58	690	442	185	155
8	RO-8	HP	7.4	656	420	265	220
9	RO-9	HP	7.34	1049	671	435	230
10	RO-10	HP	7.27	1685	1078	465	300
11	RO-11	HP	7.33	1239	793	375	290
12	RO-12	HP	7.25	1654	1059	480	275
13	RO-13	HP	7.48	1346	861	300	245
14	RO-14	HP	7.67	1475	944	215	280
15	RO-15	HP	7.27	1890	1210	520	275
		Min					
		Max					
		Ave					
	BIS Acceptable Limit		6.5	-	500	200	200
	BIS permissible Limit		8.5	-	1500	600	600

Table 2 Major ions in ground and surface water of Rooma Industrial area

S.no.	Sample code	HCO_3	Cl	SO4	F	Ca	Mg	Na	K
1	RO-1	85	14.2	2.5	0.2	24	2.4	9.7	2
2	RO-2	214	95.9	20.6	0.2	76	15.6	25.3	1.4
3	RO-3	183	71.0	14.9	0.1	80	12	11.1	0.5
4	RO-4	171	99.4	26.5	0.0	86	10.8	21.3	2.5
5	RO-5	201	67.5	49.7	0.2	60	9.6	34.5	12
6	RO-6	311	78.1	54.1	0.3	86	19.2	36.7	0.9
7	RO-7	189	99.4	46.2	1.1	56	10.8	52.9	11.7
8	RO-8	268	60.4	25.8	0.2	64	25.2	23.1	0.5
9	RO-9	281	149.1	52.6	0.1	110	38.4	46	0.7
10	RO-10	366	266.3	89.5	0.0	98	52.8	103.5	1
11	RO-11	354	166.9	72.0	0.1	110	24	69	1.9
12	RO-12	336	312.4	49.9	0.3	176	9.6	87.4	0.6
13	RO-13	299	195.3	75.7	0.2	84	21.6	101.2	1.3
14	RO-14	342	227.2	102.5	0.7	54	19.2	207	5.5
15	RO-15	336	337.3	103.2	0.3	160	28.8	92	3
Minimum									
Maximum									
Average									
BIS Acceptable Limit		-	250	200	1.0	75	30	-	-
BIS permissible Limit		-	1000	400	1.5	200	100	-	-

3.1 Groundwater quality for irrigation purposes:

To know the suitability of ground water for irrigation purposes various parameters such as Sodium Adsorption Ratio, Percent sodium, Magnesium Ratio and Permeability Index (SAR, %Na, KR, MR and PI).

3.1.1 Sodium Adsorption Ratio (SAR):

SAR being a measure of alkali/sodium hazard to crops is an important parameter for assessing the suitability of the ground water for irrigation purposes. Richard's (1954) has given following formula for calculation of SAR value, where all ions in meq/l

$$SAR = [Na]/\{[Mg] + [Ca]/2\}^{1/2} \quad \text{.....(1)}$$

The suitability of the water for irrigation decreases with increasing SAR value. Specifically, the sodium reacts with soil and reducing its permeability. The ground water samples are having SAR value < 10 and come in excellent class that indicates concentration of sodium, calcium and magnesium is appropriate and quality of groundwater is suitable for irrigation. In all the water samples of study area having SAR value is less than 10 hence suitable for irrigation purpose.

3.1.2 Percent Sodium (%Na):

Irrigation water having high concentration of dissolved Na^+ involves base exchange reactions with alkaline earth metals of the soil. These reactions reduce the permeability and cause poor internal drainage and air circulation in soil. Sodium content in natural water is expressed in terms of percent sodium (%Na) is calculated by using the following formula, where all ions in meq/l

$$Na\ \% = [Na] + [K]/\{[Na+ [K] + [Mg]+[Ca]\}\times 100 \quad \text{.....(2)}$$

In most of the water samples of study area are suitable for irrigation purpose irrigation purpose.

3.1.3 Magnesium Ratio (MR):

Magnesium Ratio (MR) is calculated applying following equation in which the ions are expressed in meq/l.

$$MR = (Mg*100) / (Ca+ Mg).....(3)$$

MR value >50 is considered unsuitable for irrigation. In the study area calculated magnesium ratio is less than 50 in all the water samples that indicates water is suitable for irrigation.

3.1.4 Permeability Index (PI):

Doneen (1964) formulated an equation to determine the permeability index (PI) to study the suitability of water for irrigation as continuous application of water may affect soil permeability by precipitation of certain elements in the top soil thus reducing void space hindering water dynamics. The PI can be determined applying following formula in which all the ions are in meq/l.

$$PI = ((Na+ (\sqrt{HCO_3}) / (Ca+ Mg+ Na)*100.....(4)$$

PI = 25%-75% - Class-II - suitable for irrigation

PI >75% -Class-I - unsuitable for irrigation

In most of the samples calculated PI value is in between 25% & 75% that shows that water is comes in class-II category and suitable for irrigation.

Table 3 Irrigation Water Quality parameters of Rooma Industrial Area

S.No.	Location	Source	SAR	%Na	K I	M R	P I
1	RO-1	Well	0.5	25.3	0.3	14.1	88.2
2	RO-2	Well	0.7	18.3	0.2	25.3	48.0
3	RO-3	Well	0.3	9.0	0.1	19.8	40.5
4	RO-4	Well	0.6	16.0	0.2	17.1	42.5
5	RO-5	Well	1.1	32.3	0.4	20.8	62.7
6	RO-6	HP	0.9	21.6	0.3	26.9	51.6
7	RO-7	Well	1.7	41.3	0.6	24.1	67.8
8	RO-8	Well	0.6	16.2	0.2	39.3	49.4
9	RO-9	Well	1.0	18.9	0.2	36.5	38.9
10	RO-10	Well	2.1	32.9	0.5	47.0	50.6
11	RO-11	HP	1.6	29.0	0.4	26.4	51.6
12	RO-12	Well	1.7	28.5	0.4	8.2	45.9
13	RO-13	HP	2.5	42.6	0.7	29.7	63.7
14	RO-14	Well	6.2	68.1	2.1	36.9	85.6
15	RO-15	Well	1.8	28.2	0.4	22.9	44.2
	Suitable		<10	<20	<1	<50	25-75
	Marginal suitable		10-26	20-60	-	-	-
	Unsuitable		>26	>60	>1	>50	> 75

CONCLUSION

The ground water in study area is neutral to slightly alkaline in nature. Its classification based on major ions, total alkalinity and total hardness show that ground water is suitable for drinking and domestic purposes. The ground water is suitable for irrigation purposes with reference to various computed parameters such as soluble, sodium adsorption ratio (SAR), percentage of sodium (%Na), magnesium ratio (MR), and Permeability Index (PI) etc. Ground water is bicarbonate and mixed type. Similarly, industrial parameters i.e. ions parameters are calculated in ground water and most of these protect the machinery from scaling or corrosion effects, except in few locations where water is corrosive in nature. It is observed that most of ions are increasing with time and circumstances while in few of the ions have no changes occurs in concentration.

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