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Hydrogeological and Geochemical Aspects of Groundwater in Pullampet, Kadapa District, Andhrapradesh

KEYWORDS

Geo Chemical characteristics, Lithological characteristics, Domestic, Agriculture

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ABSTRACT *Quality of water is one of the vital aspects of agriculture. A knowledge of chemical quality of water is essential for evaluating its usability for domestic, agricultural, industrial and other purposes. Ground water is used for domestic, industrial water supply and for irrigation all over the world. In the present paper is an attempt is made to bring out the relationship between the quality of groundwater and lithological characteristics of different rocks present in the Pullampet mandal, kadapa district, Andhra Pradesh. Forty water samples are collected in different locations of pullampet mandal, and nineteen chemical constituents were analyzed. The laboratory analysis and the interpretation of the samples are systematically carried out and the results are represented numerically and graphically .The geochemical characteristics of groundwater samples are correlated with geological, pedagogical and topographical conditions which have a direct bearing upon the accumulation of salts on the study area.*

INTRODUCTION:

Water is one of the most essential components for the existence of life on earth. There is a need to alter in physical, chemical properties of environment of water. Since, Water Quality Index is one of the most effective expressions, which reflect a composite influence of contributing factors on the quality of water for any water system. (K.Raju and T.Damodharam) Therefore, present work deals with the quality of water in Pullampet mandal. It lies in a semi-arid tract situated in kadapa district, Andhra Pradesh. The area is located between the north latitudes 13^0 58^1 to 14 $^013^1$ and the east longitudes79^003^1 to 79^017^1.(figure 1).The total geographical area of the mandal is about 406.63 square kms. Generally the climate of the area is hot semi-arid .The study area an annual average rainfall of 719mm. The soils of this area are grey, light brown and reddish brown in colour. The rock formations in the study area forms a part of the Cuddapah basin and is located in the southern most part of the basin. The major portion of the mandal is comprised of Cuddapah super group of rocks of upper Proterozoic age.

GEOLOGY:

The rock formations in the study area represent a suite of sedimentary and metamorphic rocks formed during pre-Cambrian times. Lithologically the cuddapah formations are predominantly argillaceous sequence with subordinate calcareous sediments. Characteristically each group starts with quartzite and ends with dolomite or shale / phyllite. Structurally, the rocks have a general trend of NNW-SSE with dips of formations generally varying from 10-40^0. The Nagari quartzite is exposed mainly in the southern part of the study area. This is dominantly an arenaceous consisting of conglomerate quartzite, quartzite with shale formations. The Pullampet formation rests over the Nagari quartzite conformably in the southern part of the study area with purple shale, carbonaceous shale and calcareous shale with prominent intercalations of dolomite limestones..

METHODOLOGY:

Sampling of groundwater has been carried out as per the established norms. The mode of collection of 40 water samples collected from different wells and bore wells are analyzed systematically as given by Rainwater and Thatcher (1960). Brown et al (1970) and Hem(1970).The constituents analyzed and the parameters computed include Silica, Calcium, Magnesium, Sodium, Potassium, Carbonate, Bicarbonate Sulphate, Chloride, Dissolved solids, Hardness as $caco_3$,Alkalinity as $caco_3$, Non-carbonate hardness, Specific Conductance, P^H , Hydrogen-ion-concentration, Sodium Adsorption ratio, percent sodium, potential salinity and residual sodium carbonate.

RESULTS AND DISCUSSION:

The locations from where the water samples are collected are shown in the figure.1. Table-1 gives the maximum, minimum and mean values of the different constituents and other characteristics of the water analysis of all the samples.

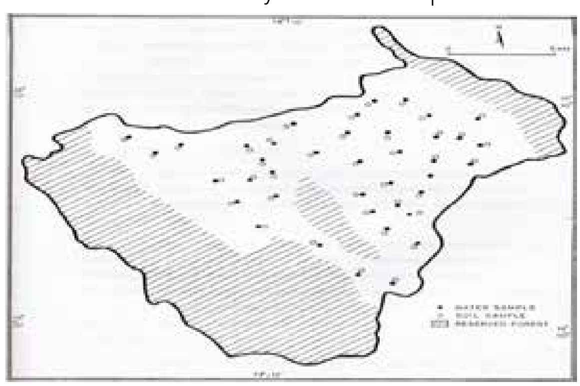

Figure – 1: Location of water samples

S.No.	Constituents	Min. Value	Max. Value	Mean
1.	Silica (Sio_2)	6	45	18
2.	Calcium (Ca)	26	84	51
3.	Magnesium (Mg)	18	83	49
4.	Sodium (Na)	18	240	83.6
5.	Potassium (K)	1	44	12.9
6.	Carbonate (CO_3)	0	62	31.65
7.	Bicarbonate (HCO_3)	155	440	264.275
8.	Sulphate (SO_4)	10	85	49.125
9.	Chloride (Cl)	35	383	158.125
10.	Total Dissolved Solids	360	1158	655.875

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11.	Hardness as $Caco_3$	225	536	342.625
12.	Alkalinity as $Caco_3$	128	361	221.625
13.	Non –Carbonate Hardness	0	193	78.175
14.	Specific Conductance (Micromhos / Cm at 25^0 C)	600	1930	1080.888
15.	P^H	7.5	8.8	8.152
16.	Sodium Adsorption Ratio	0.482	5.078	1.906
17.	Percent sodium	12.389	59.042	33.365
18.	Potential Salinity	1.351	11.519	4.987
19.	Residual Sodium Carbonate	0.082	0.137	0.016

TABLE – 1: AVERAGE RESULTS OF CHEMICAL PARAMETERS

The sulphate concentration in the water samples ranges from 10.0 to 85.0 mg/l with an average value of 49.1 mg/l. The presence of sulphate can be explained partly due to the oxidation of pyrite and barite occurring in shales and partly to contamination of sulphate fertilizers.

The P^H of the water samples ranges 7.5-8.8 with a mean value of 8.2, indicating alkaline nature with the presence of carbonate ion. Non carbonate hardness is present in 76% of the samples indicating total hardness to exceed carbonate hardness in those cases. Total dissolved solids can be estimated reasonably by multiplying specific conductance with 0.63, but according to Hem (1970), this factor varies from 0.54 to 0.96 and more usually from 0.55 to 0.75.

The average value of TDS in the study area is 655.8 ppm with a minimum of 360 ppm and a maximum of 1158 ppm. The concentration of TDS is obviously due to the intense weathering noticed in the shales and quartzites in the area. Majority of the water samples in the study area are suitable for drinking and irrigation.

The minimum and maximum values vary widely due to the first ten variables which reflect the basic characteristics of the chemical constituents. When specific conductance and dissolved solids are plotted on arithmetic graph, a positive correlation is observed as shown in figure 2. Ground water for various purposes, especially for drinking and agriculture are classified by international organizations and individual researchers based on the concentration of total dissolved solids.

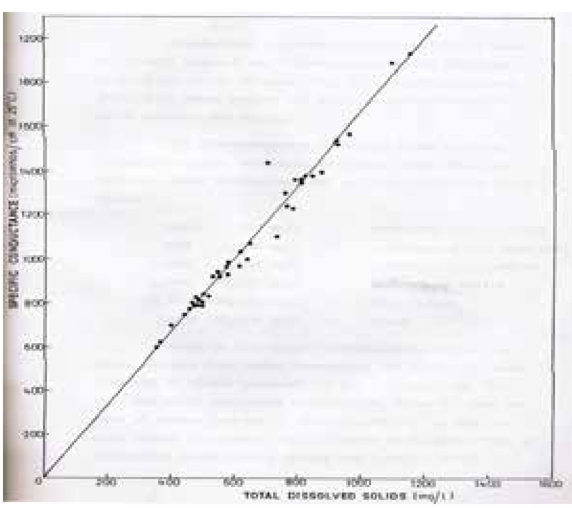

Figure – 2: Total dissolved solids as a function of specific electrical conductivity

Sodium Adsorption Ratio:
The U.S. Salinity laboratory of the Department of agriculture has recommended the determination of sodium adsorption ratio (SAR) to classify water because of its direct relation to the adsorption of sodium by soil. It can be computed from the equation:

SAR = Na / (Ca + Mg) / 2.

Where, all ionic concentrations are expressed in milli-equivalents/L. Based on SAR values, has classified waters in terms of their use in irrigation as given below:

High SAR values in irrigation water will generally contribute the development of excess sodium in soil. SAR values of 18 and above are considered high, between 10 and 18 medium and below 10 are low. When values are 10 and below, these waters normally do not create problems of sodium hazards. In the study area all most all waters are categorized as good for irrigation. A graphic classification proposed by the U.S. salinity laboratory which is widely used is based on SAR and specific conductance. It is shown in the figure 3.

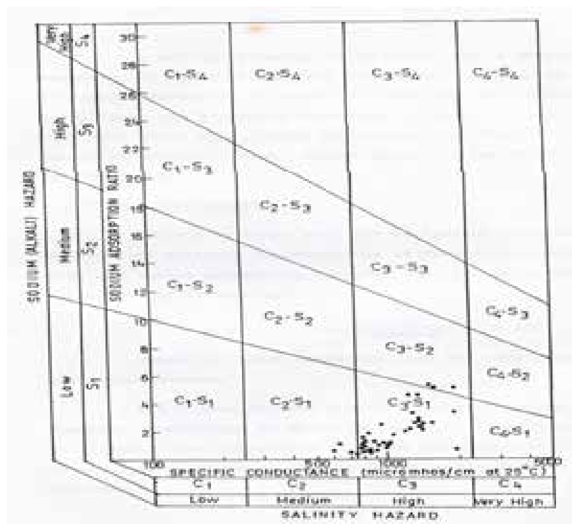

Figure – 3: Salinity Hazard and Sodium Hazard relationship

As per the classification, 4 water samples amounting to about 10 per cent fall under $C_2 – S_1$ group. 33 samples amounting to about 82.5 per cent fall under $C_3 – S_1$ group and 3 samples amounting to about 7.5 per cent fall under $C_3 – S_2$ group indicating that the salinity hazard is medium to high, Sodium hazard is low to medium in the waters.

PERCENT SODIUM:
Sodium concentration is important in classifying irrigation water because sodium reacts with soil to reduce its permeability. The use of percent sodium for adjudging the quality of groundwater for the use of agricultural purpose.

$$\text{Percent Sodium} = \frac{(Na+K)100}{(Ca+Mg+Na+K)}$$

Where all ionic concentrations are expressed in milli-equivalents/L. The figure - 4 widely used for evaluating water for irrigation on the basis of percent sodium and specific conductance is given wherein percent sodium is plotted against specific conductance. The diagram is divided into 5 distinct areas to rate the quality of water in terms of its usefulness for irrigation. They are: i) Excellent to good, ii) Good to permissible, iii) Permissible to doubtful, iv) Doubtful to unsuitable and v) Unsuitable.

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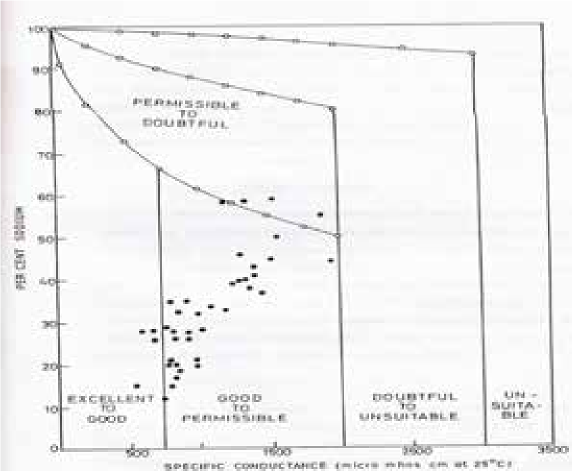

Figure-4: Plotting of Specific Conductance and per cent sodium for rating of irrigation waters (after Wilcox)

The diagram constitutes five categories of areas and rating of irrigation waters of the study area based on the diagram as follows:

Five samples amounting for 12.5 per cent fall in "Excellent to good area", thirty two samples amounting for 80 per cent fall in "Good to permissible", and three samples amounting for 7.5 per cent fall in "Permissible to doubtful area". According to this analysis 98% of the groundwater samples of the study area are suitable for irrigation purposes.

RESIDUAL SODIUM CARBONATE:

Further researches by the U.S. Salinity laboratory established that an additional hazard exists when bicarbonate is high and relatively calcium is low in waters are used for irrigation. Based on the residual sodium carbonate (RSC) irrigation waters have been classified into three classes as given below:

RSC (meq/L)	Irrigation class	No. of Samples	Percentage
<1.25	Safe	40	100
1.25 – 2.5	Marginal	0	0
>2.5	Unsuitable	0	0

According to this classification, 100% of the samples are in the safe class and are good for irrigation and domestic purposes.

CONCLUSION:

From the analyses of the water samples of the study area, it is revealed that the concentration of sodium, magnesium, calcium, bicarbonate and chloride ions dominate in the order given. Ionic exchange associated with clays influence the chemical composition of ground waters considerably and high sodium in waters can also be attributed to the use and reuse of water for irrigation. Carbonates are the general forms of the calcium in shales and alluvial deposits in the study area. Common cementing material between argillaceous grains is calcium carbonate.. Its geochemical behavior is different from that of calcium. The chemical characteristics of the ground water in the region are influenced by:

1. The geochemistry of rocks
2. Semi – arid climate with rain during the short monsoon period and no rain during the rest of the year.
3. Contamination of groundwater by polluted surface water
4. Direct entry of sewage water into wells of poor design and
5. The nature and extent of the use of water.

The primary source of carbonate and bicarbonate ions in groundwater is from carbon dioxide in rain (and snow). Decay of organic matter may also release carbon dioxide for dissolution. Therefore, whenever there is precipitation, the carbon dioxide derived from the degraded human waste when dissolved in water forms as carbonic acid (H2CO3) which attacks silicate and carbonate minerals during its percolation into the aquifer. Physical processes are largely responsible for chloride ions to circulate in the hydrological cycle. Chloride ions do not significantly enter into oxidation and reduction reactions. Chlorides in the study area are contributed largely due to the human activity. The most common type of water in which chloride is dominant ion is one which sodium is predominant cation.

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