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Hydrogeochemical Studies of Chennur Mandal, Kadapa District, Andhra Pradesh, India using Geospatial Techniques

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Abstract

Hydro-chemical investigation was undertaken in the Chennur mandal to ascertain the groundwater quality and its suitability for drinking and irrigation purposes. In this context, twenty seven (27) representative groundwater samples were collected from different dug/bore wells based on their importance in drinking and analysed. Physicochemical parameters like pH, EC and TDS; cations viz., Ca, Mg, Na and K; and anions include CO3, HCO3, SO_4, NO^3, F, Cl were determined to authenticate the groundwater suitability for drinking. The pH of ground water in the study area is ranging from 7.7 to 8.8 The total hardness of the groundwater in the study area is ranging from 12 to 78 mg/l. Water hardness is primarily due to the result of interaction between water and the Geological formation. The calcium concentration of groundwater in the study area is ranging from 8 to 36 mg/l during the pre-monsoon period. The chloride concentration of the ground water in the study area ranging from 16.9 to 232.2 mg/l during pre-monsoon period. The bicarbonate concentration of the groundwater in the study area in ranging from 48.8 to 280.6 mg/l during the pre-monsoon period. The fluoride concentration of the groundwater in the study area ranging from 0.78 to 2.62 mg/l during the pre-monsoon period. Low concentration of fluoride (0.78 mg/l) is observed in Nazeerbegpalle village and high concentration of fluoride (2.62 mg/l) is observed Ramanapalle village. Proper deflouridation techniques have to follow to monitor fluoride contamination.

Keywords: Hydro-Geochemical, Irrigation, Drinking, P^H, Groundwater.

1. Introduction

Drinking water is an important resource that needs to be protected from pollution and biological contamination. Underground water is clean but it depends upon quality and quantity of materials dispersed and dissolved in it. Water picks up impurities in during its flow, which are harmful to man and vegetation. The reason for contamination and pollution of water in the natural surroundings and in the storage are pesticides, fertilizers, industrial wastes, inorganic and organic salts from top soil and geological strata (Nanoti, 2004). The domestic water bodies are being used for cattle drinking, human bathing, cloths washing and other domestic purposes. The quality of groundwater is highly related with local environmental and geological conditions. The quality of soil and rock and the water table determines the quality of groundwater. Groundwater constitutes an important source of water for drinking, agriculture and industrial production. The use of groundwater has increased significantly in the last decades due to its widespread occurrence and overall good quality. The contribution from groundwater is vital; because about two billion people depend directly upon aquifers for drinking water, and 40 percent of the world's food is produced by irrigated agriculture that relies largely on groundwater (Morris et al., 2003). Despite its importance, contamination from natural, human activities, steady increase in demand for water due to rising population and per capita use, increasing need for irrigation, changes in climates and overexploitation etc., among others has affected the use of groundwater as source of drinking water.

Multidisciplinary scientific integrate surveys were generally carried out to quantify the resource potential of the area, to know the status of exploitation of resources and to identify any degradation due to unscientific management. The investigation agents broadly outline the development options based on available resources. The thematic maps produced on resources will enable planners to formulate programme to optimize productivity from existing resources, and to initiate measures to correct imbalances due to unscientific management and inherent deficiency. Environmental mapping and resource evaluation survey of Chennur Mandal of Kadapa District is taken up identification of areas for further development.

Analysis of remotely sensed data for drainage, geological, geomorphological and lineament characteristics of terrain in an integrated way facilitates effective evaluation of ground water potential zones. Similar attempts have been made in the generation of different thematic maps for the delineation of ground potential zones in different part of the study area. (Obi Reddy et al., 1994; Krishna Murthy and Srinivas, 1995; Rao et al;, 1996; Srinivasa Gowd et al., 1998). A total of three thematic maps such as geological, geomorphological and hydrological maps were prepared based on image interpretation studies with limited field checks and analysis of available database. The lithological map portrays distribution of several of rock types and structural maps shows the structural frame work of the area. The geomorphology map depicts the various landforms evaluate through timely by geomorphic process and is a basic input to evaluate resource potential associated with the landforms. The hydrological map provides a basis for potential and non potential areas for groundwater development based on geomorphological, geological and structural information.

Objectives

1. The present study aims to generate different thematic maps using satellite data along the ancillary data (Geology, Geomorphology, and Geohydrology).
2. To prepare action plan for water resources
3. Assessment of water quality by studying hydro-geochemistry.

2. Study Area

The climate of the study area is hot and semiarid. The monthly maximum, minimum and mean temperature as measured at Kadapa are 44°C, 14°C and 27°C respectively. The mean annual rainfall recorded at the Kadapa is 759 mm. The Kadapa district is aptly called the district of pennar as almost the entire district is drained by the Pennar River and its tributaries. The important tributaries joining the river from the north include the rivers Kunderu, Sagileru and Tummalavanka while those from the south include the rivers Chitravati, Papaghni, Buggavanka, Cheyyeru, and Kalletivagu. Bahuda, Mandavi, Pukkangi and Gunjaneru are the tributaries of the Cheyyeru. The rivers and streams in the district are mostly ephemeral under the influence of heavy spells of rainfall by cyclonic storms in the Bay of Bengal (MRK Reddy et al., 2000). The study area falls in the Survey of India Toposheet No: 57 J/14and J/15. The study area is shown in Figure 1.

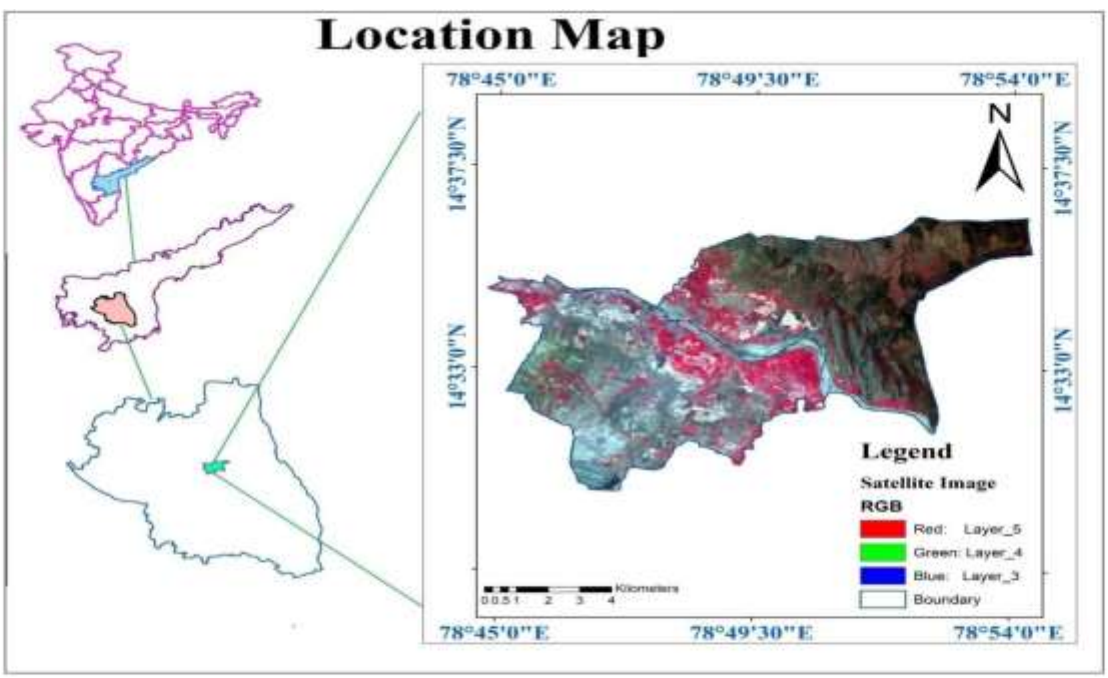

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Fig .1 Location map of the study area

2.1 Geology

The oldest rocks of the area belong to Late Archaean or Early Proterozoic era which are succeeded by rocks of Dharwarian Age and both are traversed by dolerite dykes (Murthy et al., 1979). The older rocks are overlain by rocks of Cuddapah Supergroup and Kurnool Group belonging to Middle and Upper Proterozoic Age. The main lithologic units consist chiefly of quartzite, limestone, and shale. Alluvium consisting of gravel, sand, silt and clay occur along the river courses in the study area (Fig.2).

2.2 Geological Structures

2.2. 1 Structure

Bedding, joints, faults, lineaments, folds, fractures are some of the structure elements interpreted using satellite imagery No: 57 J/14, and J/15. Dykes and faults, Lineaments are the most important structures developed in the area. The lineament either coincide with the drainage directions, alignment with the tanks, vegetation etc.

2.2.2 Bedding

Bedding is manifested by colour banding or compositional layering as observed the formation. The trend of the bedding varies from NW-SE to NNW-SSE with shallow dips (8^0-15^0) two wards NE or ENE.

2.2.3 Lineaments

In the central part of area a major lineament is abuting from Tipparajupalli to Pendlimarri. Another lineament is extending from Eguvapalli to Shivapalle. Quartz reefs are observed in this lineament.

2.2.4 Faults

The faults are manifested either dykes or displacement of the litho unit or Gulcheru quartzite, and Nandyal shale. Another major fault is EW trending, extends from Diguvapalle to Jangamreddipalle.

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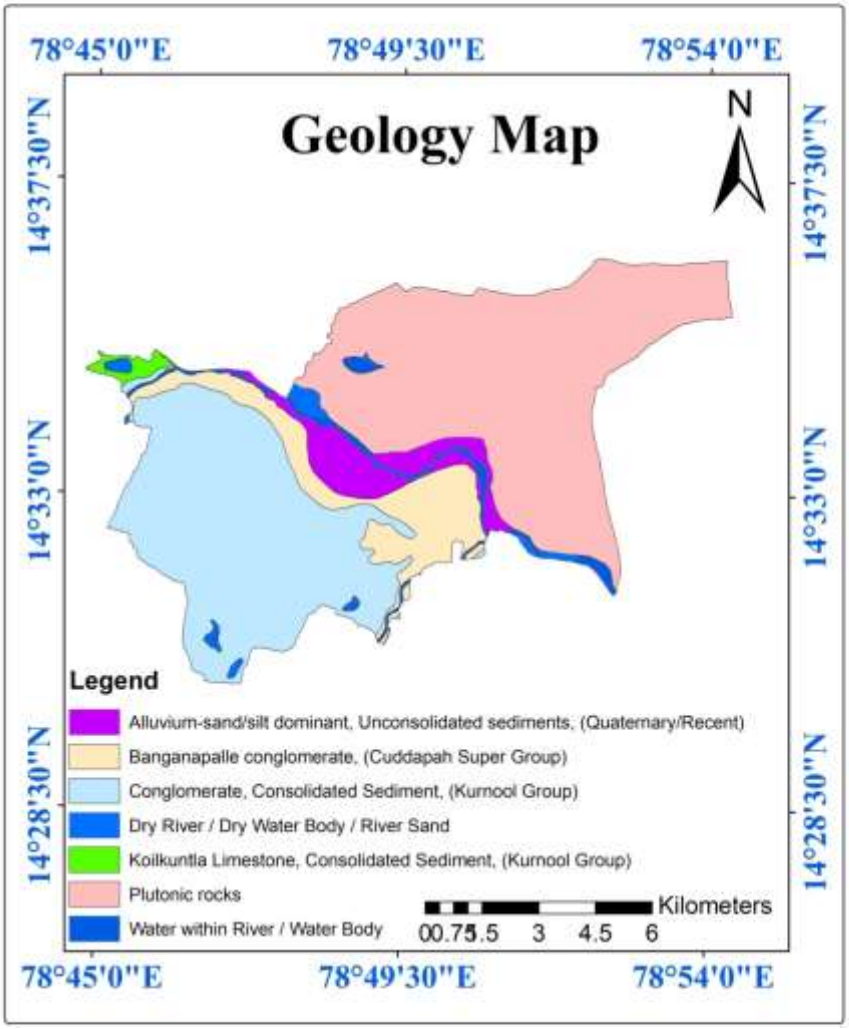

Fig. 2 Geology map of the study area

3. Methodology

Twenty seven samples of groundwater used for drinking purpose were collected from either ground water or surface water at different villages of Chennur Mandal of Kadapa District during post-monsoon season in the year 2015. This season was selected because in this season often contamination increases due to low dilution and this tends to the accumulation of ions. Before sampling, the water left to run from the source for few minutes. Then water samples collected in pre cleaned, sterilized polyethylene bottles of one litre capacity. The samples were analyzed to assess various physicochemical parameters according to APHA (2007).

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4. Results and Discussion

Table: 1 Physico Chemical Parameters of ground water of the study area

S No	pH	EC (μs)	TDS (ppm)	Chloride	Total Hardness	Fluoride (ppm)	Carbonate CO_3	Bi carbonate (HCO_3)	Calcium
1	8.32	3740	1630	93.7	72	1.09	24	122	36
2	8.16	2920	1220	53.3	48	1.97	252	48.8	12
3	8.78	2400	1060	55.4	30	2.61	12	85.4	12
4	8.13	2210	960	46.8	42	0.9	12	73.2	16
5	8.22	2260	990	51.1	36	1.51	12	73.2	20
6	8.06	2310	1010	61.8	54	1.2	6	48.8	12
7	8.12	2620	1160	78.8	78	1.43	12	85.4	20
8	8.14	2690	1170	232.2	24	2.93	12	122	20
9	8.14	3160	1430	72.4	42	1.35	198	85.4	24
10	8.37	6200	2760	102.7	54	1.03	60	48.8	12
11	8.57	5980	2630	127.8	48	1.27	24	280.6	8
12	8.63	4740	2040	70.3	36	0.774	6	244	16
13	8.42	2310	990	51.1	48	1.35	42	244	12
14	8.06	1640	730	42.6	42	1.38	6	146.4	16
15	8.62	3680	1630	78.1	36	1.11	0	61	20
16	7.86	3150	1340	16.9	66	0.732	6	158.6	32
17	7.96	2540	1120	62.7	72	0.967	6	109.8	28
18	8.08	3740	1660	80.4	72	0.848	6	122	28
19	7.59	4470	1970	90.1	72	0.885	6	122	36
20	7.7	3790	1630	78.1	30	0.963	12	170.8	24
21	7.88	3450	1500	71.2	12	1.3	6	146.4	28
22	7.97	2220	230	35.2	30	0.505	12	73.2	28
23	7.98	2290	990	51.0	54	1.25	12	97.6	36
24	7.81	4980	2170	101.2	54	1.32	6	122	28
25	7.41	3080	1210	79.8	36	0.892	0	48.8	16
26	8.15	4010	1960	89.1	48	2	6	195.2	20

27	8.19	3840	1620	77.2	18	1.54	6	109.8	20

4.1 Salient features of major ion chemistry

4.1.1 p^H

The pH of water is very important of its quality and provides important piece of information in many types of geochemical equilibrium or solubility calculations (Hem, 1991). The limit of pH value for drinking water is specified as 6.5 to 8.5 (ISI, 1983).

In most natural waters, the pH value is dependent on the carbon dioxide-carbonate-bicarbonate equilibrium. As the equilibrium is markedly affected by temperature and pressure, it is obvious that changes in pH may occur when these are altered. Most ground waters have a pH range of 6 to 8.5 (Karanth, 1987). The pH of groundwater in the study area is ranging from 2.45 to 8.54. pH values for all the samples are within the desirable limits. It is observed that most of the groundwater is alkaline in nature. Though pH has no direct effect on the human health, all biochemical reactions are sensitive to variation of the pH.

4.1.2 Total Hardness

Hardness is an important criterion for determining the usability of water for domestic, drinking and many industrial purposes (Karanth, 1987) and results from the presence of divalent metallic ions, of which calcium and magnesium are the most abundant in the groundwater. Other elements could be included are strontium, barium and some heavy metals. These, however are seldom determined under usually present in insignificant amounts relative to calcium and magnesium.

The degree of hardness in water is commonly based on the following classification

Hardness classification of water

(After Sawyer and Mc Carty)

Hardness, mg/l as $CaCO_3$	**Water class**
0-75	Soft
75-100	Moderately hard
150-300	Hard
Over 300	Very hard

The total hardness of the groundwater in the study area is ranging from 80 to 880 mg/l. The limit of total hardness for drinking water is specified as 300 mg/l (ISI, 1983). Water hardness is primarily due to the result of interaction between water and the geological formations. Groundwater of the entire study area exceeds the desirable limits. Granitic rocks significantly contribute to groundwater hardness.

4.1.3 Calcium

The range of calcium content in groundwater is largely dependent on the solubility of calcium carbonate, sulfate and rarely chloride. The solubility of calcium carbonate varies widely with the partial pressure of CO_2 in the air in contact with the water. The salts of calcium and magnesium are responsible for the hardness of water. The permissible limit of calcium in drinking water is 75 mg/l (ISI, 1983). The calcium concentration of the groundwater in the study area is ranging from 40 mg/l to 350 mg/l during pre-monsoon period.

4.1.4 Chloride

Chloride bearing rock minerals such as sodalite and chlorapatite which are very minor constituents of igneous and metamorphic rocks, and liquid inclusions which comprise very insignificant fraction of the rock volume are minor sources are chloride in groundwater. It is presumable that the bulk of the chloride in groundwater is either from atmospheric sources or sea-water contamination. Most chloride in groundwater is present as sodium chloride, but the chloride content may exceed the sodium due to base-exchange phenomena (Karanth, 1985) and also weathering of phosphate minerals and domestic sewage (Karanth, 1987). The upper limit of chloride concentration for drinking water is specified as 250 mg/l (ISI, 1983). The chloride concentration of the groundwater in the study area is ranging from 127.8 to 2016.4 mg/l during pre-monsoon period.

4.1.5 Total Alkalinity (CO_3 and HCO_3)

The primary source of carbonate and bicarbonate ions in groundwater is the dissolved carbon dioxide in rain, which, as it enters the soil, dissolves more carbon dioxide. An increase in temperature or decrease in the pressure causes reduction in the solubility of carbon dioxide in water (Karanth, 1989). The alkalinity of natural water is due to the salts of carbonates, bicarbonates, borates, silicates and phosphates along with hydroxyl ions in the free salt. However, the major portion of the alkalinity in natural water is caused by hydroxide, carbonate and bicarbonates, which may be ranked in order of their association with pH values. The bicarbonate concentration of the groundwater in the study area is ranging from 24.4 mg/l to 1146.8 mg/l during pre-monsoon period. The permissible limit of carbonate (CO_3) in drinking water is 10 mg/l and the rejection limit is 50 mg/l. The permissible limit of bicarbonate (HCO_3) in drinking water is 500 mg/l. (Todd, 1980). Most of the water samples of the study area contain no carbonate ions.

5. Conclusion

The pH of groundwater in the study area is ranging from2.45 to 8.54. pH values for all the samples are within the desirable limits. It is observed that most of the groundwater is alkaline in nature. The electrical conductivity of the groundwater is ranging from 357 µSiemens/cm-4180 µSiemens/cm at 25°C. The pH and EC were measured with pH meter and conductivity meter respectively. The Total Hardness of the groundwater in the study area is ranging from80 to 880 mg/l. The limit of Total Hardness for drinking water is specified as 300 mg/l (ISI, 1983). Water hardness is primarily due to the result of interaction between water and the geological formations. Groundwater of the entire study area exceed the desirable limits. The calcium concentration of the groundwater in the study area is ranging from 40 mg/l to 350 mg/l during pre-monsoon period.. The upper limit of chloride concentration for drinking water is specified as 250 mg/l (ISI, 1983). The chloride concentration of the groundwater in the study area in ranging from 127.8 to 2016.4 mg/l during pre-monsoon period. The bicarbonate concentration of the groundwater in the study area is ranging from 24.4 mg/l to 1146.8 mg/l during pre-monsoon period. The fluoride concentration of the groundwater in the study area is ranging from 0.411 mg/l to 6.18 mg/l during pre-monsoon period. Low concentration of fluoride (0.411 mg/l) is observed in Kalamalla village and high concentration of fluoride (6.18 mg/l) is observed in the village Peddanapadu. Proper deflouridation techniques have to be followed to monitor fluoride contamination.

References:

[1]. Apambire WB, Boyle DR, Michel FA (1997) Geochemistry, genesis, and health implications of fluoriferous groundwater in the upper regions of Ghana. Environ Geol 33(1):13-24.
[2]. APHA (2007) Standard methods for the examination of water and wastewater. American Public Health Association, Washington, DC.
[3]. Ayoko G. , Singh K. , Balerea S., Kokot S. ,(2007) , "Exploratory multivariate modeling and prediction of

the physic – chemical properties of surface water and groundwater". Journal of Hydrology 336, 115- 124.

[4]. Babiker I. , Mohamed M. , Hiyama T. ,(2007) "Assessing groundwater quality using GIS". Water Resources Man agement 21,699 – 715.

[5]. BIS (1991), Specification for drinking water, IS: 10500:1991, Bureau of Indian Standards, New Delhi.

[6]. Chenini I. , Khemiri S. , (2009), "Evaluation of ground water quality using multiple linear regression and structural equation modeling". Int. J. Environ. Sci. Tech., 6(3), 509-519.

[7]. Frank RG. and Shannon M, (2005). Infant Methemoglobinemia: The Role of Dietary Nitrate in Food and Water. *Pediatrics*. 116:784.

[8]. ISI (1983). Drinking water standars, Table 1, Substance and characteristics affecting the acceptability of water for domestic use 18, 10500. Indian Standard Institution, New Delhi.

[9]. Todd DK. (1980). Groundwater Hydrology, Wiley-Indian Edition.

[10]. Krishnaswamy VS (1981) Geological and mineral map of Cuddapah basin. Geol Surv India.

[11]. Karanth KR (1989) Groundwater assessment, Development and Management. Tata McGraw-Hill, New Delhi, p 720.

[12]. Karanth, K. R., Jagannathan, V., Prakash, V. S. & Saivasan, V. (1992) Pegmatites: a potential source for sitting high yielding wells. J. Geol. Soc. India 39, 77-81.

[13]. Kazi T. , Arain M. , Jamali M., Jalbani N. , Afridi H., Sarfraz R ., Baig J., Shah A., (2009) "Assessment of water quality of polluted lake using multivariate statistical techniques: A case study". Ecotoxicology and Environmental Safety 72, 301 – 309.

[14]. Morris, B.L. et al. (2003), Groundwater and its susceptibility to degradation: a global assessment of the problem and options for management, Early Warning and Assessment Report Series.

[15]. Nanoti M, (2004). "Importance of water quality control in treatment and provision of safe public water supply", *National workshop on control and mitigation of excess fluoride in drinking water*, 5-7th Feb, 2004.

[16]. Ramakrishna Reddy M., Janardhana Raju N., Venkatarami Reddy Y., Reddy T.KV.K 2000 Water Resources Development and management in the Cuddapah district, India, Environmental Geology 39(3-4) January.

[17]. Solsona F., (2002). "Guidelines for Drinking Water Quality Standards In Developing Countries".

[18]. Srinivasa Gowd, S, Sudheer, A.S., Srinivasulu, S, and Sreedevi, P.D. (1998) Remote Sensing Analysis to Delineate Groundwater Potential Zones of Peddavanka Watershed, Anantapur District, A.P. Geographical Review of India 60, 145-154

[19]. Srinivasa Gowd, S and Govil, P.K. (2008). Distribution of heavy metals in surface water of Ranipet industrial area in Tamil Nadu, India, Environmental Monitoring and Assessment, 136, 197–207

[20]. Tambekar DH, Waghode SM, Ingole SG and Gulhane SR, (2008). Water quality index analysis of salinity affected villages from the Purna river basin of Vidarbha region. International Quarterly Scientific Journal Nature Environment and Pollution Technology, 7(4): 707 – 711.

[21]. World Health Organization, (2008), "Guidelines for drinking-water quality". Third edition.

[22]. Zuane J., (1997), "Handbook of Drinking Water Quality". Second Edition, John Wiley & Sons, Inc..