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Original Research Paper

Earth Science

GEOHYDROLOGICAL AND HYDROGEOCHEMICAL STUDIES OF VEERAPUNAYUNIPALLE MANDAL, YSR KADAPA DISTRICT, ANDHRA PRADESH

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ABSTRACT

Groundwater is the world's largest accessible freshwater and important resource for drinking water supply, irrigation and industrial purposes as well as for global food security. Approximately one-third of the world's population depends on groundwater for drinking purpose. Geology of an area, the degree of chemical weathering of various rock types and anthropogenic factors affect the chemistry of groundwater. Drinking water is an important resource that needs to be protected from pollution and biological contamination. Water is vital to health, well-being, food security and socioeconomic development of mankind. Underground water is clean but it depends upon quality and quantity of minerals dispersed and dissolved in it. Therefore, the presence of contaminants in natural fresh water continues to be one of the most important environmental issues in many areas of the world, particularly in developing countries where several communities are far away from potable water supply. Low- income communities, which rely on untreated surface water and groundwater supplies for domestic and agricultural uses are the most exposed to the impact of poor water quality. The aim of this study is to conduct an assessment of the Geohydrological and Hydrogeochemical Studies of Veerapunayunipalle Mandal, YSR Kadapa District, Andhra Pradesh. The proposed study area in the Veerapunayunipalle Mandal of YSR Kadapa District and is shown in the figure 1. The study area falls in the survey of India Toposheet No: 57 J/06 and J/11 on 1:50,000 scale. Twenty two samples of ground water using for drinking and agricultural purpose were collected from either hand pumps or open wells at different villages of Veerapunayunipalle Mandal of YSR Kadapa District, during the summer season month of January 2019. The pH of ground water in the study area is ranging from 7.7 to 8.9. The total hardness of the groundwater in the study area is ranging from 159 to 878 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 12 to 164 mg/l during the post-monsoon period. The chloride concentration of the ground water in the study area ranging from 106 to 8734 mg/l during post-monsoon period. The bicarbonate concentration of the groundwater in the study area is ranging from 61 to 195 mg/l during the post-monsoon period.

KEYWORDS : Geohydrology, Hydrogeochemistry, Drainage, Veerapunayunipalle, Kadapa

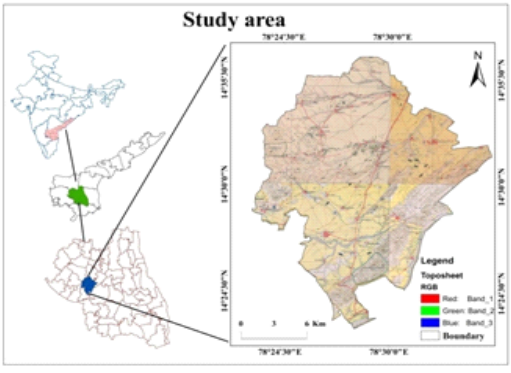

Fig.1. Location map of the study area

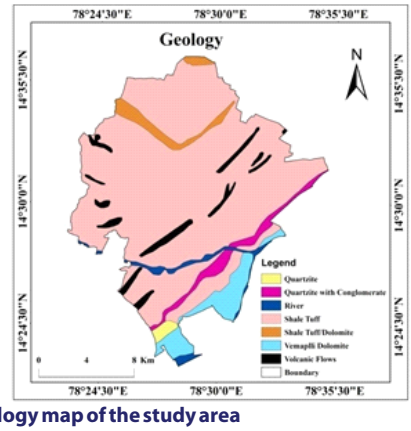

Fig.2 Geology map of the study area

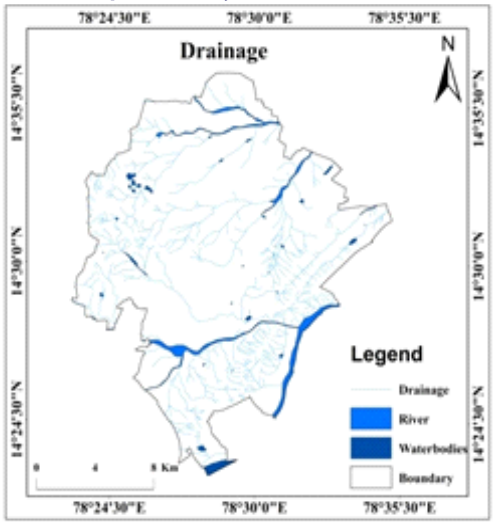

Fig.2. Drainage map of the study area

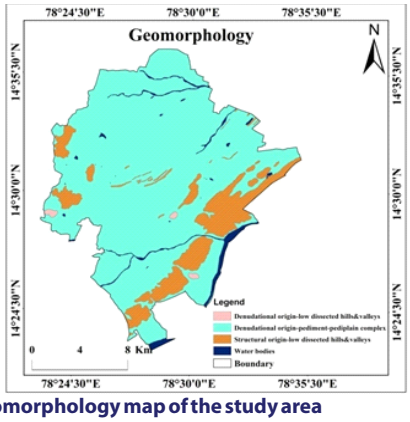

Fig.3. Geomorphology map of the study area

INTRODUCTION

Geochemical processes occurring within the groundwater and reactions with aquifer minerals have a profound effect on water

quality. Hydrogeochemical composition of groundwater can also be indicative of its origin and history of the passage through underground materials with which water has been in contact. It may also contain some harmful contaminants through the process of seepage from the surface water and biological activities. On the other hand, the surface water contains a lot of organic matter, mineral nutrients and other contaminants brought by run-off from agriculture fields, fertilizers, pesticides, soil particles, waste chemicals from industries and sewage of cities and rural areas. 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 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 Veerapunayunipalle Mandal of YSR 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. (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 (Figs.2, 3 & 4). 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.

Objectives

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

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 YSR district is aptly called the district of Pennar as almost the entire district is drained by the Pennar River and its tributaries. 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. The study area falls in the Survey of India Toposheet No: 57 J/06 and J/11.

Geology

The oldest rocks of the area belong to Late Archaean or Early Proterozoic era which is 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 Super group and Kurnool Group belonging to Middle and Upper Proterozoic Age. The main lithological 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.

GROUP	FORMATION	LITHOLOGY
Kurnool Group		
----------Unconformity----------		
Chitravati Group	Tadipatri Formation	Shale, Tuff
Pulivendula Quartzite		Quartzite, Conglomerate
----------Unconformity----------		
Papaghni Group	Vempalle Formation	Basic flows, Dolomite, Shale
----------Unconformity----------		
Peninsular Gneissic Complex	Granite Gneisses, Schist, Granitoids with acidic and basic intrusive	

Cuddapah Supper Group

The Cuddapah Super Group is represented by thick sequence of sedimentaries unconformably overlain by the place or basement complex. In the study area Cuddapah Super Group is represented by rock types belonging to Papaghni group covering an area about 180 sq km.

Basic intrusives

These dykes are generally medium grained and consists mainly of plagioclase, pyroxenes. Field evidence shows that they are of two generation of dykes. The spectral characteristics of these litho units are tone, texture and linear ridge. These dykes are easily delineated during interpretation.

Geological Structures

Structures

Bedding, joints, faults, lineaments, folds, fractures are some of the structure elements interpreted using satellite imagery No: 57 J/06, and J/11. 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.

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^{o}-15^{o}) towards NE or ENE.

Geomorphology

Geomorphology involves study of landforms, reconstruction of process responsible for their origin and study of influence of tectonics in time space frame. The geomorphological mapping includes inventory and classification of landforms. Each landform depends by its composition depth of weathering structural frame and the environment which includes soil cover, hydrology and hydrogeology. The landforms are classified on the basis of mode of origin, relief slope factor and surface cover. The landforms occurring in the area are grouped as pediplain, residual hill, and structural hill.

Hydromorphology

Ground water occurrence in hard rock terrain is confined to certain landform and fractures. As the aquifer material and alluvium is usually confined to certain landform. Further lineaments, landform development and their elevation and their elevation and distribution is controlled by faults, streams, segments and fractures.

It is a map which depicts various aspects of geomorphology, geology and character of aquifers so as to have an idea of the possibility of ground water in different units. The hydromorphologic

map is to be prepared by demarcating the geomorphic units as the landforms as an important input for land management, soil mapping and identification of potential zones of ground water occurrence. The geological details like lithology, rock types and structural details are also depicted on this map since this information is necessary in identifying the ground water potential. For instance pediment, pediplain without fractures, joints and lineaments normally moderate to poor ground water prospect whereas the same geomorphic unit with a network of fractures, joints indicates good ground water prospects. Similarly pediplain area of crystalline/metamorphic rock is marked by poor to moderate ground water prospect whereas the same unit in sandstone or limestone sedimentary rock may have a good to moderate prospect.

METHODOLOGY

Twenty three samples of groundwater used for drinking and agricultural purpose were collected from ground water at different villages of Veerapunayunipalle Mandal of YSR District during post-monsoon season in the year 2019. 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.

RESULTS AND DISCUSSION

Concept of Ground Water Quality

The concept of ground water quality seems to be clear, but the way of how to study and evaluate it still remains tricky (Badiker et al., 2007). Consider that the definition of water quality is not objective, but is socially defined depending on the desired use of water. Different uses require different standards of water quality.

Water Quality Standards / Guidelines: The Guidelines for drinking-water quality: The Guidelines describe reasonable minimum requirements of safe practice to protect the health of consumes and/or derive numerical "guideline values" for constituents of water or indicators of water quality. In order to define mandatory limits, it is preferable to consider the guidelines in the context of local or national environmental, social, economic and cultural conditions (WHO, 2008).

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

S. No.	Total Hardness	Cl	CO3	HCO3	pH	EC	TDS	Ca	Mg
Units	Mg/L	Mg/L	Mg/L	Mg/L		us/m	Mg/l	Mg/l	Mg/l
1	439	199	24	73	8.5	1334	667	28	90
2	817	830	36	61	8.3	3690	1840	104	135
3	427	604	48	85	8.0	2686	1339	92	48
4	750	8734	48	88	3.5	1665	8240	52	151
5	342	199	36	67	8.0	1520	1264	40	59
6	525	575	54	63	8.0	2708	1374	152	35
7	878	944	60	69	8.1	3670	1840	100	153
8	476	284	24	76	8.3	2530	1264	32	96
9	683	334	30	79	8.6	2151	1073	132	86
10	817	497	42	77	8.4	3070	1540	36	177
11	549	476	54	80	8.1	2925	1456	156	39
12	708	597	30	98	8.1	4220	2130	80	123
13	683	753	24	100	8.1	3190	1590	80	117
14	366	753	-	104	8.1	5480	2730	80	40
15	878	454	-	108	7.8	1695	8460	28	196
16	659	241	-	76	7.7	1679	8380	40	136
17	427	156	-	84	7.9	1370	6830	164	61
18	415	106	58	146	8.3	1426	7130	60	64
19	305	185	28	76	8.5	2044	1017	40	50
20	159	547	38	195	8.9	1705	853	20	26
21	634	284	55	171	8.5	2252	1126	52	122
22	317	227	43	185	8.5	1974	9860	12	70

Salient features of major ion chemistry

Hydrogen Ion Concentration (pH)

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 7.0 to 8.4 (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 7.7 to 8.9. 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.

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 CaCO3	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 159 to 878 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.

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 12 mg/l to 164 mg/l during post-monsoon period.

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 and also weathering of phosphate minerals and domestic sewage (Karanth, 1989). 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 106 to 8734 mg/l during post-monsoon period.

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 61 mg/l to 195 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.

CONCLUSION

The pH of groundwater in the study area is ranging from 7.7 to 8.9. 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 1334 µSiemens/cm-5480 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 from 159 to 878 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. The calcium concentration of the groundwater in the study area is ranging from 40 mg/l to 304 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 106 to 8734 mg/l during post-monsoon period. The bicarbonate concentration of the groundwater in the study area is ranging from 61 mg/l to 195 mg/l during post-monsoon period.

REFERENCES:

1. APHA (2007) Standard methods for the examination of water and wastewater. American Public Health Association, Washington, DC.
2. Babiker I., Mohamed M., Hiyama T. (2007) Assessing groundwater quality using GIS. Water Resources Management 21, 699 – 715.
3. BIS (1991) Specification for drinking water IS: 10500:1991, Bureau of Indian Standards, New Delhi.
4. ISI (1983) Drinking water standards, Table 1, Substance and characteristics affecting the acceptability of water for domestic use 18, 10500. Indian Standard Institution, New Delhi.
5. Krishnaswamy VS (1981) Geological and mineral map of Cuddapah basin. Geol. Surv. India.
6. Karanth KR (1989) Groundwater assessment, Development and Management. Tata McGraw-Hill, New Delhi, p 720.
7. Karanth, K. R., Jagannathan, V., Prakash, V. S. & Saivasan, V. (1992) Pegmatite: a potential source for sitting high yielding wells. J. Geol. Soc. India 39, 77-81.
8. 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.
9. 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
10. Srinivasa Gowd, S (2005) Assessment of Groundwater Quality for Domestic and Irrigation Purposes: a case study of Peddavanka Watershed, Anantapur District, Andhra Pradesh, India Environmental Geology, 48 702-712.
11. Todd DK. (1980). Groundwater Hydrology, John Wiley & Sons Inc. New York. 520 p.
12. World Health Organization, (2008) Guidelines for drinking-water quality. Third edition.