Application of Remote Sensing, GIS and Geo-Electrical Methods for Ground Water Exploration in Zaheerabad, Medak Dist. A.P., India.

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ABSTRACT : Land and water are two broad components on which the entire biotic community thrive. In the study area the main rock types are basalts and laterites. The main landform units in this province are-valley fills, lower plateau and upper plateau. Occurrence of groundwater in hard rock terrain is mainly controlled by structures, landforms, lithology and recharge conditions. Remote Sensing technology is today widely used in survey and management of natural resources. The technology has been found to be very effective in identification of potential zones for ground water exploration. Thematic maps on geology, structures and geomorphology has been prepared using satellite data. Geo-electrical resistivity survey was conducted in the study area.

Finally, by integrating the geology, geomorphology, structures and the geophysical data, the groundwater potential of the study area has been prepared. Criteria for GIS analysis have been defined on the basis of groundwater conditions and geo-electrical resistivity data in the area and appropriate weightage has been assigned to each information layer according to relative contribution towards the desired output.

The study indicates that in basaltic/lateritic terrain groundwater occurrence is more dependent on fractures. Ground water potential is good in the valley fills, moderate in the lower plateau and poor in the upper plateau.

Based on the study an action plan for groundwater development in the study area has been suggested like development of percolation/water retention ponds at the sites identified, tube wells/bore wells along the lineament zone, utilisation of paleo channels for storing the flood water.

The results obtained encourage the use of integrated approach of Remote Sensing, GIS and Electrical resistivity survey for ground water potential mapping.

INTRODUCTION: Land and water are two broad components on which the entire biotic community thrives. The available surface water resources are inadequate to the entire water requirements for all purposes. So the demand for ground water has increased over the years. The spectra of a great thirst are looming ahead of us. In most states in India withdrawal of groundwater both for agricultural and industry needs has been more than what can be recharged. And almost everywhere callously handled waste management has ended in polluting not just rivers but aquifers as well. The powerful cash crop lobby too has played its part in guzzling resources. The assessment of quality and quantity of groundwater is essential for the optimal utilisation. The interpretation of satellite data in conjunction with sufficient ground truth information makes it possible to identify and outline various ground features such as geology, structure, geomorphic features and their hydraulic characters (Das.et.al. 1997), that may serve as direct or indirect indicators of the presence of groundwater (Ravindran and Jayaram 1997).

The main source of groundwater is precipitation within the region, which reaches the sub-surface formation in two ways: (a) by direct percolation and (b) surface run-off through existing or previously utilised drainage channels. Geology, geomorphology, structure and climatic condition are the controlling factors for ground water storage, occurrence and movement in hard rock terrain. These features are not observed on the surface by the naked eye but these parameters can easily be picked up through satellite remote sensing. As the art of remote sensing process has unique potentiality of vividly displaying the size, shape, pattern and spatial distribution of various aquifer system, their signature of deformation and the morphogenitic landforms. Better interpretation of hydrogeological data often requires that their spatial location be incorporated into the analysis. Geographic information system can be used for storing hydrogeological data as well as their spatial locations in relational database (Shahid, S & Nath,S.K., 2000). It also provides the facility to analyse the spatial data objectively using various logical conditions. As a result, nowadays, GIS is widely used for spatial modelling of hydrogeological prospect of a large area with more reliability. Examples from recent literature spotlight several uses of GIS as applied to ground water exploration. Gustafson (1993) used GIS for the analysis of lineament data derived from SPOT imagery for groundwater potential mapping. Minor et.al., (1994) developed an integrated interpretation strategy to characterise ground water resources for identification of well locations in Ghana using GIS as the unifying element. For the assessment of groundwater resources of Northwest Florida water management district, Richards et.al. (1996) took the advantage of GIS for spatial analysis and data visualisation. Krishnamurthy et.al.(1996) developed a GIS based model for delineating ground water potential zones of Marvdaiyar basin Tamilnadu, India by integrating different thematic layers derived from remote sensing data. The field verification of this model established the efficacy of GIS in demarcating the potential groundwater reserves. Application of GIS for groundwater resource assessment has also been reported by Sander (1997), Teeuw (1999) and others.

The present work envisages to assess the groundwater resources of the following villages Kohir, Pichagarah, Hoti, Digwal, Raipalli, Pistapur, Algole, Didgi, Kothur, Bardipur, Malkapur, Regintal, Hadnur in and around Zaheerabad town covering approximately 150 sq.km's. An integrated approach of Remote Sensing, GIS and Electrical Resistivity for groundwater potential mapping has been followed. The study has helped to identify the problems and potential of the area to generate a water resource database for overall development on a sustainable basis. In this regard the micro watershed scheme has been followed wherein harvesting of water resource judiciously in a smaller hydrological unit has the prime importance. Thus the right mix of technology and traditional wisdom would be a winning combination, a plan that integrate- mega projects with micro efforts like rain harvesting and watershed management. A parched India will take the shine off a resurgent India.

DESCRIPTION OF THE STUDY AREA: Situated at a distance of 100 kms from Hyderabad, the capital of Andhra Pradesh the study area in Medak district lies between 17°35′ and 17°50′ of north latitudes and 77°30′

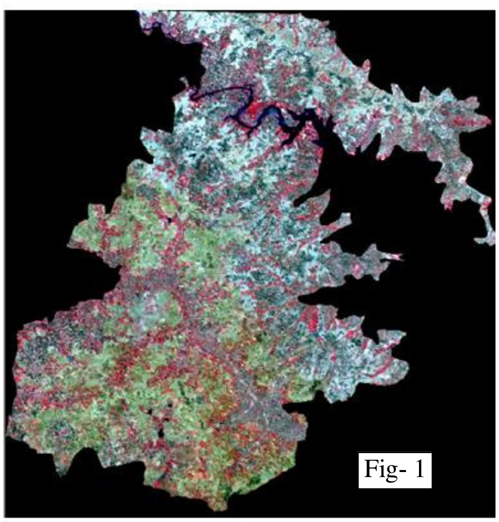

Fig- 1

IRS- 1C LISS III DATA OF THE STUDY AREA

and 77°40′ of east longitude (fig) falling in survey of India toposheet no.56G/9 & G/10. The area comprises of several villages and the major town is Zaheerabad, which is on Hyderabad-Mumbai national highway no.9.

The area is marked with plateau, valley, scrap, forest and ephemeral streams within an altitudinal range of 610-660 metres above msl. Normal average rainfall is estimated to be 926 mm. The past ten year average show that the rainfall has been below the average. The area is hot for most part of the year. During summer the maximum temperature is around 42°C (107.6°F) and the minimum temperature is around 26°C(78.8°F). May is the hottest month. During winter the maximum temperature is around 29°C(84.20°F) and the minimum temperature is around 14°C(57.2°F). December is the coldest month. It experiences mostly tropical climate. The river Manjera and its tributaries mainly drain the area.

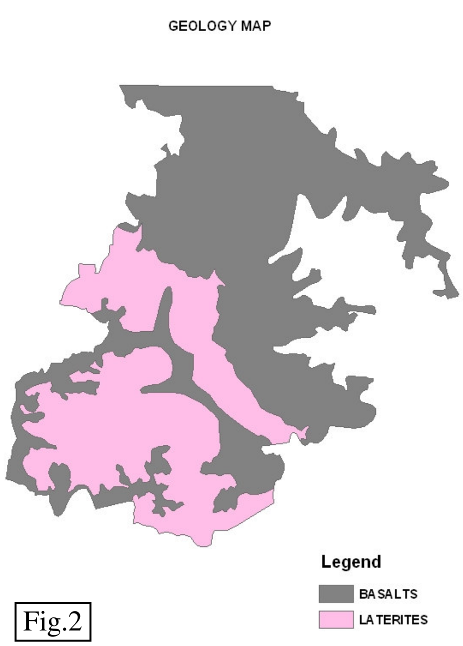

Fig.2

GEOLOGY, GEOMORPHOLOGY & GROUNDWATER CONDITIONS OF THE STUDY AREA: It is well established that geology plays a vital role in the distribution and occurrence of groundwater, Krihnamurthy and Srinivas (1995). In the present study geological mapping is done using IRS-1C, LISS-III image, (Fig 1.) using image processing software ERDAS for better exposition of hydro-geological features. GIS package ARC-INFO is used for the mapping of the features. Basalts are showing bluish tone with coarse texture and the laterites show greenish tone. The geological map is shown in (fig.1). Basalts occurring in and around Zaheerabad exhibit both vesicular and non-vesicular forms. The non-vesicular massive units are fine grained, dense and compact, they are dark in colour. In some places they show columnar and spheroidal structures and commonly show well-developed joints in various directions. The vesicular type of basalts is highly altered which gave rise to laterites. In the study area there are 9 flows of traps of which the first seven flows are not weathered and still they appear as basaltic in composition, whereas the 8th and 9th flow has been completely weathered and altered to laterites. Thus laterites occur as cap rocks over basalts and form flat plateaus and tablelands at elevation range from 600 to 660 asl. Laterites have a typical reddish brown colour. They have cavities often filled with yellowish to reddish clayey material. A zone of lithomargic clay marks the contact between the traps and the laterites. The lithomarge is siliceous and exhibit brown to brownish green colour with soapy touch. It is slightly hard to break. It is locally called as "Sapa Murram" Venkatramna (1991). In the study area the different stratification types of laterites are as given below.

Table- 1
Geological succession in the study area

Vesicular laterites	3 to 8 meters
Pisolitic Laterites	2 to 7 meters
Compact and Massive Laterites	5 to 15 meters
Lithomarge	
Basalts (Deccan traps)	

Apart from the geology as discussed in the study area three types of geomorphic units are identified Plateau, Escarpment and filled in valley. In the lateritic terrain, plateaus are hard and compact at surface grading into clayey at depths. These are flat uplands capped by hard crust of laterite grading downwards into lithomargic

BoreHole Locations

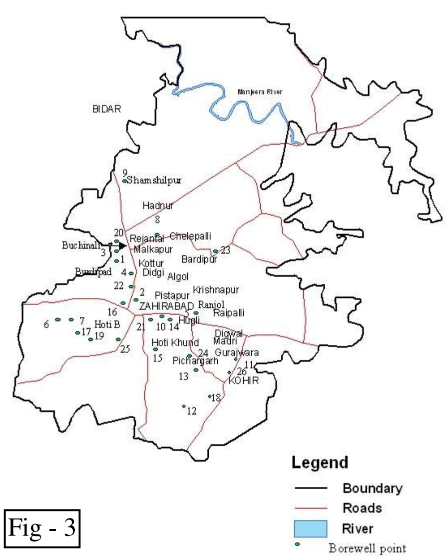

Fig - 3

clays and deeply weathered bedrock/saprolite.

The scarp region may be considered a sub-unit of plateau portion having a thin soil cover, is contiguous patch seen in the south-eastern part adjacent to valley. Dense scrub vegetation is supported in the absence of hard laterite exposure hither and thither.

In the area the valleys are formed due to removal of hard crust of laterite consisting of detrital/concretionary laterite. These concretionary detrital laterites rest over lithomargic clay.

In the area dugwells and borewells are tapping the groundwater. In the plateau regions, the edges are not favourable for groundwater exploitation. Interior parts of the plateau can give moderate yields from the weathered zones. Such parts are suitable for deep dugwells/borewells/tubewells. Fault/fractures zones act as potential areas for groundwater harvest.

GEOPHYSICAL SURVEY THROUGH VERTICAL ELECTRICAL SOUNDINGS (VES): The inverse slope vertical electrical resistivity (VES) method as suggested by Sankarnaryan & Ramanuja Chary (1967) is used to investigate the nature of sub-surface formation by studying the variations in their electrical properties. This method assumes considerable importance in the field of ground water exploration because of its ease of operation, low cost and its capability to distinguish between the saline and fresh water zone. This method was tested widely in India, using it in different geological situations. It was found to give good results correlating well with borehole data. This method is simple and gives resistivities and depths directly from the plot of the field data on a linear graph. In the present study more than 100 VES data are collected. Resistivity in the study area varies from 25Ωm to 900Ωm and this has been correlated by the borehole data. At Buchinihalli borehole point no.1the depth of drilling was upto 50 meters the water bearing zone was between 28-32 meters, the top weathered morram 4-14 meters showed a resistivity of 85Ωm, the semi-weathered zone gave resistivity of around 129Ωm and the deeper levels the resistivity increases when the massive basalt is struck. The value is as high as 837Ωm as seen in point no.2 near Burdipad. However these wells are yielding water as high as 400 to 600lpm, because of good weathered zone. Another well near the basalt laterite contact bore point no.3 showed resistivity value of 46Ωm between 20-60 meters and 372Ωm between 72 to 84 meters. The litho-log for this well showed the occurrence of redbole of 4 meters thickness at a depth of 72 meters and the yield was 400 to 800lpm. However in contrast to the above the well at Ranjole south of Zaheerabad bore hole point no.5, this has a weathered profile of about 20 meters with a average resistivity of 260Ωm suddenly the resistivity beyond 20 meters is high where the basalt is struck, and when drilling was done the well went dry. Yet another well at point no.7 at Kasimpur which is at the basalt-laterite contact gave no yields with resistivity values of 710Ωm and 1522Ωm. Borewell at point no. 8 yielded around 600lpm. For this bore point the geophysical data gave the following values 89Ωm till 18meters and 194Ωm till 35 meters, the litholog indicated massive basalt after this depth where the resistivity is high. This bore point was selected along the lineament and was successful (Fig-4). Wells drilled at point 12,13,14,15 and 16 which are well within the laterites gave average resistivity of 150Ωm and less till the depth of 30 meters and the values increased once the massive basalt layer is touched. At point no.16 near Zaheerabad, which is in the plateau region comprise of thick laterites and is along the lineament, the litholog data indicates murram with resistivity of 109Ωm has thickness of nearly 16meters, murram with clay at a depth of 24-50 meters has resistivity value of 83Ωm followed by 153Ωm. The total depth of the well is 100 meters with casing of 66 meters and the yield is nearly 600lpm. The values of 95Ωm, 48Ωm, 92Ωm, 195Ωm at point no.18 showed yields of 600lpm which is within the laterite area. Similar is the situation for the well, dug near lineament for the sample at point no. 19 south of

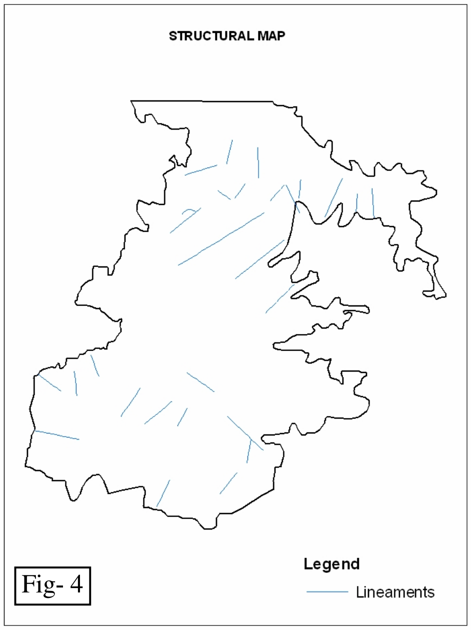

Fig- 4

Zaheerabad. Sample point no.23 occurring near a lineament and at basalt laterite contact gave good yields with resistivity values of 197Ωm and 139Ωm. Similar situation is at points 23,24 and 25. Thus in the study area the resistivity range for good yielding laterites range between 110-230Ωm.(Fig-3)

CONCLUSIONS: Integration of remote sensing, geological, structure, morphological and geophysical data over an study area of 150sq.km in and around Zaheerabad of A.P. has helped in locating potential water bearing zones. The major litho unit in the study area is laterite. Water bearing characters of laterites vary from place to place. The rock is composed of disconnected vesicles. Multidimensional features may serve as infiltration path for ground water replenishment.

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