

SEAMLESS MOSAIC OF HYDROGEOMORPHOLOGICAL MAPPING OF ANDHRA PRADESH USING REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

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ABSTRACT

Andhra Pradesh covers diversified geology, topography and climate. The prevalent rock formations range in age from Archaean to Recent and vary widely in composition and structure. Similarly, the variations in the landforms are also significant. The topography and rainfall virtually control runoff and groundwater recharge. The objective of the study is to prepare the seamless mosaic of ground water prospects maps, corresponding to Survey of India (SOI) toposheet on 1:50,000 scale, covering all the habitations. There are 302 SOI toposheets on 1:50,000 scale covering entire Andhra Pradesh. The map shows a) prospective zones for groundwater occurrence b) tentative locations for constructing recharge structures. On screen visual interpretation of IRS 1C/1D satellite data (precision geocoded images) is used as the input for preparation of the groundwater prospects maps. The methodology consists of a) creation of individual thematic layers on lithology, geomorphology, structures, hydrology along with base map details in conjunction with limited field work / existing data, and b) derivation of hydrogeomorphic units by integrating the thematic data. There are seventeen layers generated from digital SOI toposheets, satellite data and layers prepared interactively in each map. The data base for entire State was created by different government and private organizations at different times and there is no boundary matching among many toposheets for various themes. All these corrections are made using SOI toposheets and satellite data and mosaiced all the layers seamlessly. Thus, the data created at different stages is organised into a digital database as per the standards and specifications furnished by Rajiv Gandhi National Drinking Water Mission (RGNDWM) project Phase-III. The database consists of basic data as different layers, individual thematic maps and base map details and integrated groundwater prospects map as a final output in GIS format.

INTRODUCTION

Groundwater is a major source for all purposes of water requirements in India. More than 90% of rural and nearly 30% of urban population depend on it for drinking water. It accounts for nearly 60% of the total irrigation potential in the country, irrigating about 32.5 million hectares (NRSA. 2007). The dependency on the ground water is expected to increase in future due to increase in population.

The occurrence and distribution of the ground water is not uniform throughout the State and varies significantly based on geology, rainfall and geomorphology. Andhra Pradesh has diversified geology, topography and climate. The prevalent rock formations range in age from Archaean to Recent and vary widely in composition and structure. Similarly, the variations in the landforms are also significant. They vary from the rugged mountainous terrains to the flat alluvial plains of the river valleys, coastal tracts. The rainfall pattern also shows similar region wise variations. The topography and rainfall virtually control runoff and ground water recharge.

Rugged topography, compact and fissured nature of the rock formations combine to give rise to discontinuous aquifers with limited to moderate yield potentials. The near surface weathered mantle forms the all important ground water reservoir, and the source for circulation of ground water through the underlying fracture systems. In the hard rock terrain, deep weathered pediments, low-lying valleys and abandoned river channels, generally contain adequate thickness of porous material to sustain ground water development under favourable hydro-meteorological conditions.

The coastal and deltaic tracts in the State are receptacles of thick alluvial sediments. Though highly productive aquifers occur in these tracts, salinity hazards impose quality constraints for ground water development. The quality of ground water in both hard rock and alluvial terrains is by and large fresh and suitable for all uses. But in coastal areas, estuarine tracts, the degree of mineralization in ground water is rather high and salinity hazards are not uncommon. Keeping in view of the importance of ground water in different sectors, the Govt. of India conceived a national project entitled “Rajiv Gandhi National Drinking Water Mission” to map the entire country from ground water prospects point of view on 1:50,000 scale. The project is sponsored by Ministry of Rural Areas and Employment, Govt. of India through National Remote Sensing Centre (NRSC), ISRO, Govt. of India. Hydrogeomorphological/ground water prospects mapping of Andhra Pradesh (Fig.1) is covered under Rajiv Gandhi National Drinking Water Mission (RGNDWM) in Phase I&III.

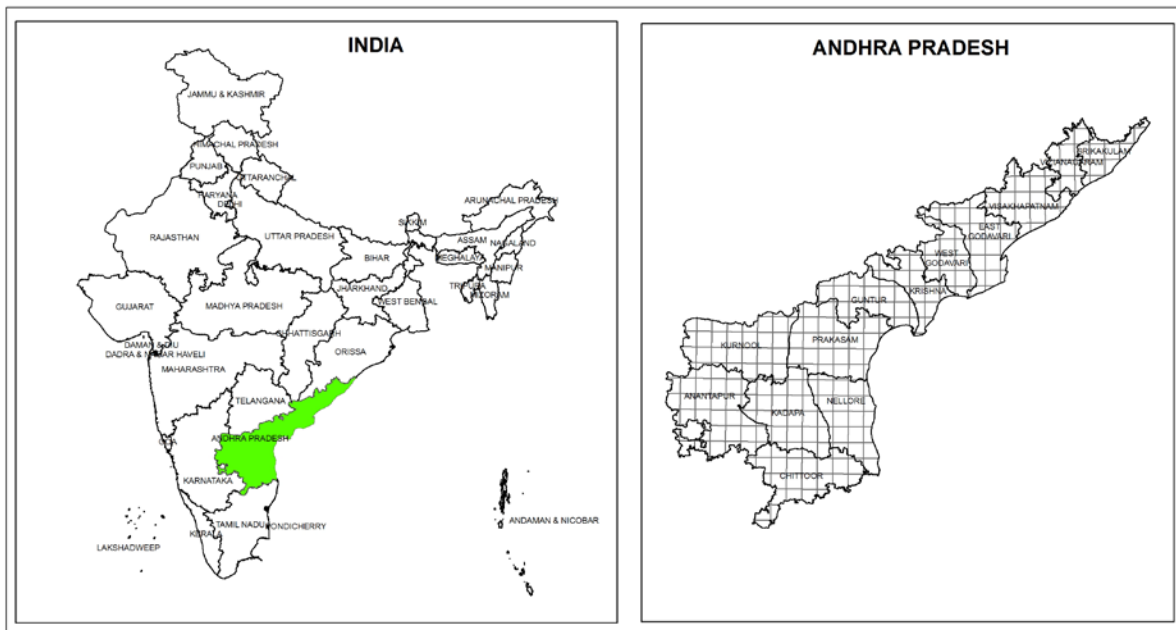


Fig.1. Location Map Showing Andhra Pradesh with SOI Topogrid and District Boundaries

OBJECTIVES

1.The objective of the study is to prepare the “ground water prospects maps”, corresponding to Survey of India toposheet on 1:50,000 scale, covering all the habitations. The map shows a) prospective zones for ground water occurrence b) tentative locations for constructing recharge structures.

2.The information provided in the ground water prospects maps form a suitable database for narrowing down the target zones and systematic selection of sites for drilling, after conducting follow-up ground survey, to establish drinking water sources to all the non covered and partially-covered habitations from supply of drinking water point of view. Besides this the database also provides information for selection of sites for construction of recharge structures to improve the sustainability of drinking water sources, wherever required.

METHODOLOGY

Earlier, NRSC carried out a major project entitled “Integrated Mission for Sustainable Development (IMSD)” on 1:50,000 scale. All the Drought Prone Area Programme (DPAP) Districts of Andhra Pradesh are covered. Some of the Districts are covered completely and some partially under this project. Hydrogeomorphological mapping is one of the thematic layers generated for preparation of action plan under IMSD. A comprehensive manual was prepared by NRSC for generation of several thematic layers on 1:50,000 scale under IMSD (NRSA, 1995). However, in present study, emphasis was given to hydrogeomorphological/ground water prospects mapping for drinking water affected villages. The methodology involves basically a systematic procedure

evolved to prepare a ground water prospects map using satellite data and GIS techniques in conjunction with limited field work. Various steps involved in the preparation of ground water prospects maps are furnished as a flow chart in Fig.2. The total methodology can be divided into two main parts. The first part deals with the delineation of hydrogeomorphic units considering parameters influencing the hydrogeological properties.

It consists of creation of individual thematic layers on lithology, geomorphology, structures, hydrology along with base map details based on the onscreen interpretation of satellite data in conjunction with limited field / existing data, and derivation of hydrogeomorphic units by integrating the thematic data.

The second part deals with the evaluation of hydrogeomorphic units based on hydrogeological characteristics of controlling parameters. It consists of a) estimation of ground water prospects by taking into account the well observatory data, and b) identification of suitable locations for constructing recharge structures along with prioritization of the units. The vector data of each toposheet consists of 17 layers thus created at different stages is organised into a digital database as per the standards and specifications furnished by RGNDWM Phase-III guidelines (NRSA, 2007).

Since no separate report is prepared for each map, an exhaustive self explanatory legend is designed containing two parts. The upper part of the legend provides map unit-wise ground water prospect information and lower part provides the symbology details about the base map, hydrological and geological information, colour scheme for representing the yield range and depth range of wells, location map, toposheet index, administrative index and other reference information. The format of the legend is fixed to maintain the standards and uniformity. The details furnished in the upper and the lower parts of the legend are map unit, geological sequence/rock type, geomorphic unit/landform, depth to water table and number of wells observed, recharge conditions, aquifer material, types of wells, suitable, depth range of wells (suggested), yield range of wells (expected), homogeneity in the aquifer and success rate of wells, water quality, ground water irrigated area, recharge structure suitable/priority, and problems/limitations/remarks. The lower part of the legend comprises of different symbols used in the map to represent the base map details, structural, hydrological and ground water prospects information, location map, toposheet index, administrative index, data used, etc.

The database consists of 1) basic data as different layers 2) individual thematic maps for all the four parameters and for base map details and 3) integrated ground water prospects map as a final output.

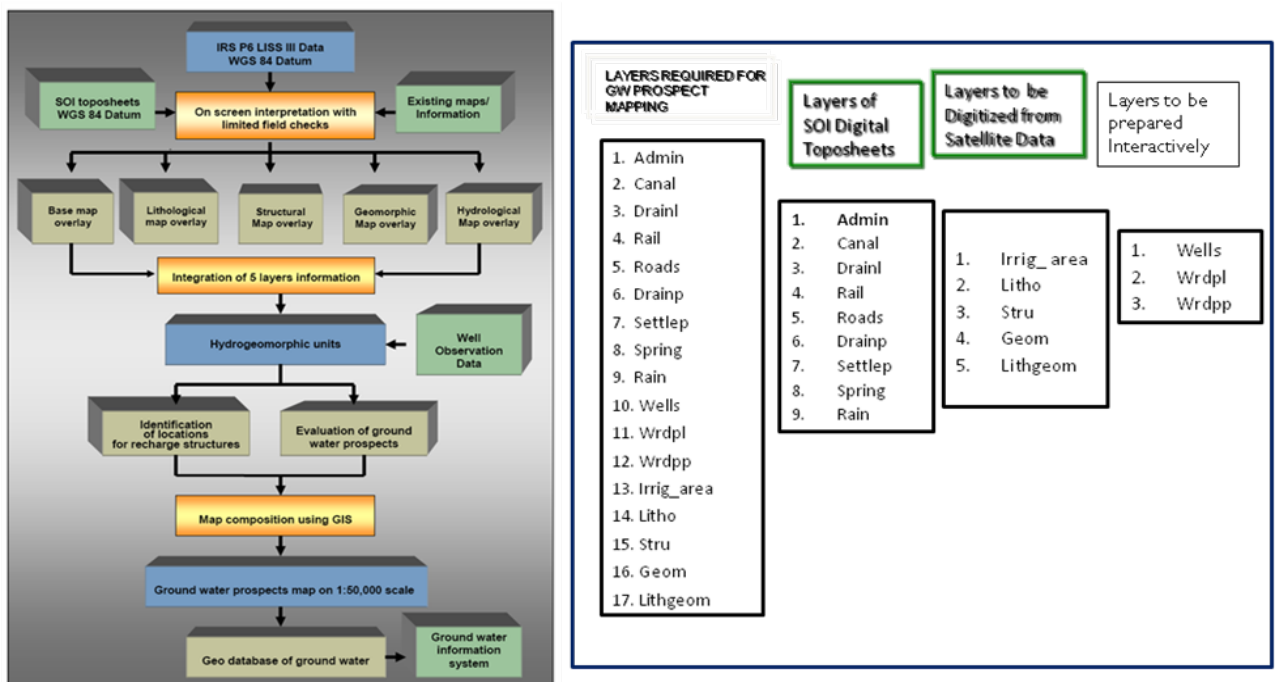


Fig.2 Flow Chart Showing the Salient Features of the Methodology

GENERATION OF SEAMLESS MOSAIC OF HYDROGEOMORPHOLOGICAL MAPS

The mapping is carried out on district wise on 1:50,000 scale. There are 302 Survey of India toposheets on 1:50,000 scale covering 13 districts of Andhra Pradesh (Fig.1) of which there are 233 effective toposheets. The IRS 1C/1D satellite data (precision geocoded images) with LCC projection have been used as the input for preparation of the ground water prospects maps for Phase-I and IRS-P6 LISS-III for Phase-III.

The Phase – I&II maps are generated using methodology and technical guidelines for preparation of ground water prospect maps (NRSA, 2003). During the process of generating the technical guidelines, several experts from Dept. of Space, ISRO, Central Ground Water Board, State Ground Water Dept., and Universities were consulted and their views and suggestions were incorporated. In the process of technological advancement and the improvement of satellite sensors, the need was felt that a project manual should be prepared for Phase III by expanding the scope of the ground water resources in terms of different geomorphic provinces. To generate the same the earlier technical guidelines were referred intensively for the preparation of this manual. Subsequently, based on the experience gained in the first two phases of mapping in the country technical guidelines are drastically improved for RGNDWM Phase-III (NRSA, 2007).

Earlier, under Phase-I, the maps are prepared by NRSC in association with various partnership institutions which include State Remote Sensing Centre, universities and private organizations. Nearly 70% of the Andhra Pradesh is covered under RGNDWM Phase-1 and A.P. Space Applications Centre carried out remaining 30% of mapping under RGNDWM Phase-III for Andhra Pradesh.

As the database for entire State was created by different government and private organizations at different times there is no boundary matching among many toposheets for various themes i.e. line and polygon features. All these corrections are made using SOI toposheets and satellite data and mosaiced all the layers seamlessly. Thus, the data created at different stages is organised into a digital database as per the standards and specifications furnished by RGNDWM Phase-III (NRSA, 2007).

RESULTS

These ground water prospects maps form a very good database and help the geologists of user departments in identifying potential zones around the problem villages, thereby narrowing down the target areas. Then, by conducting detailed ground hydrogeological and geophysical surveys within these zones, most appropriate sites can be selected for drilling. These maps should not be used directly for selection of sites without follow-up ground surveys. It is suggested that detailed hydrogeological / ground geophysical investigations have to be carried out in the prospective zones to obtain the exact information about the weathered zone, fractured zone, thickness of deposited material, depth and thickness of aquifers, presence of fractures in the subsurface and their subsurface configuration, information about the existing wells, etc. Subsequently, based on the confirmatory evidences obtained from ground geophysical / hydrogeological surveys, the sites have to be selected for drilling. These, ground water prospects maps serve the twin benefit of helping the field geologists to - 1) quickly identify the prospective ground water zones for conducting site specific investigations, and 2) select the sites for planning recharge structures to improve sustainability of drinking water sources, wherever required. The process of ground water development and management becomes more efficient and easier.

Overall 90% success rate has been reported in all the States on selection of sites for drilling. Many recharge structures have also been constructed using the information provided in these maps. As on 2007 the number of wells drilled using these maps in Andhra Pradesh are 34,698 with a success rate of 92.8% and number of recharge structures planned are 440 and constructed are 440 (NRSA.2007). Presently, all the seventeen layers are seamlessly mosaiced and geodatabase is created for the entire Andhra Pradesh. The database consists of 1) basic data as different layers 2) individual thematic maps for all the four parameters and for base map details and 3) integrated ground water prospects map as a final output in GIS format. All the ground water prospects maps on 1:50,000 scale are hosted on APSAC (apsac.ap.gov.in) and Bhuvan websites and they can be accessed. As an example 57F/10 Survey of India toposheet (Fig.3A) covering a part of Anantapuram District along with the detailed legend (Fig.3B) is shown.

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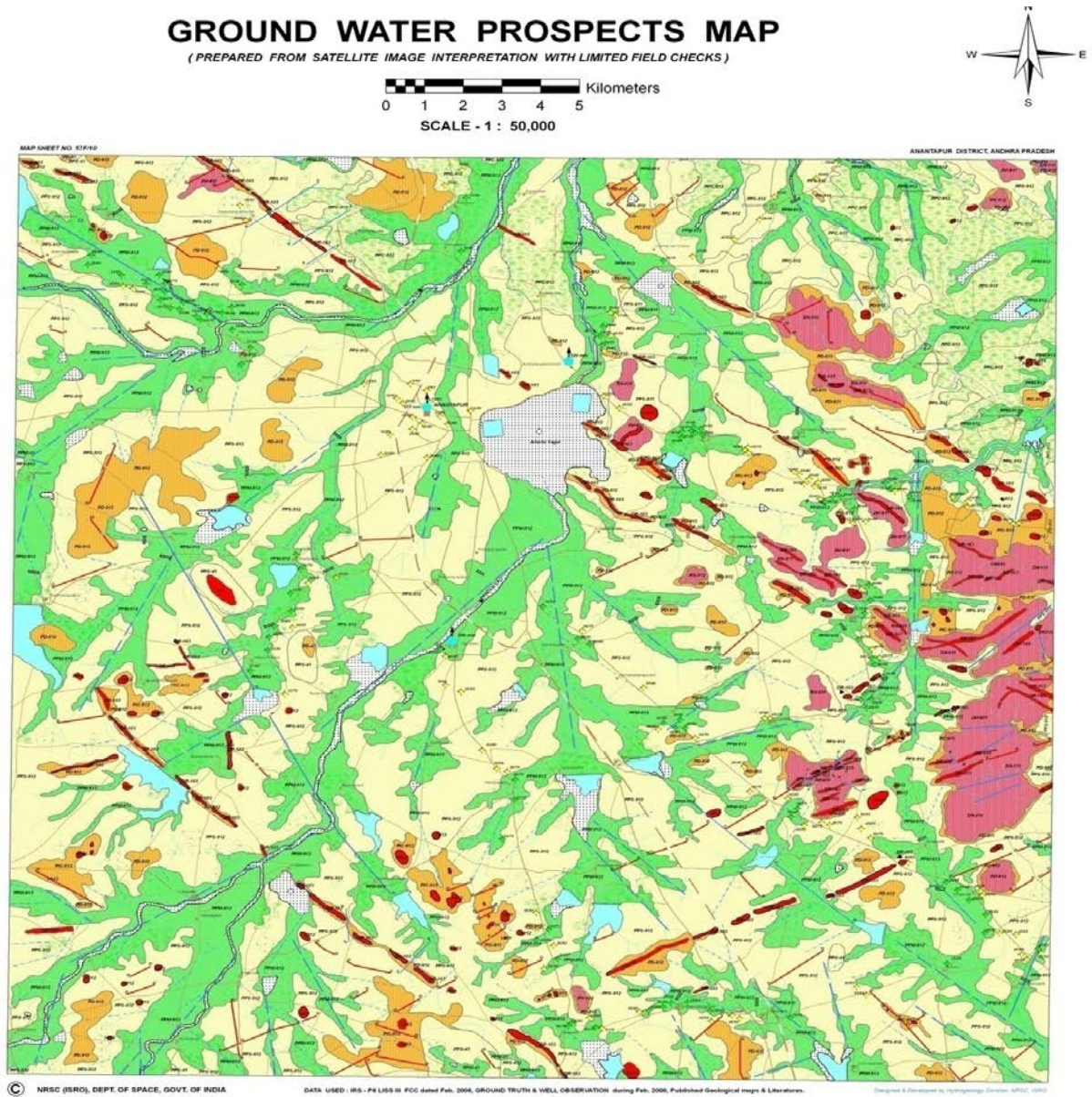


Fig.3A Hydrogeomorphological Map of Survey of India Toposheet 57F/10 covering part of Anantapur District, Andhra Pradesh

