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DEVELOPMENT OF REMOTE SENSING & GIS BASED APPLICATION FOR WATERSHED MODELING AND MAPPING - A CASE STUDY OF RANGA REDDY DISTRICT, TELANGANA

D.Narender Research Scholar, Department of Environmental Studies, Institute of Science, GITAM University, Vishakhapatnam-530045, A.P, India

K.Suresh Kumar Assistant Professor in Department of Environmental Studies, Institute of Science, GITAM University, Vishakhapatnam-530045, A.P, India

ABSTRACT The present study was carried out to develop watershed management using IRS-ID PAN and LISS-III geocoded data on 1:50000 scale. The information on Base, Drainage, Lithology, Structure, Landuse/Landcover, Slope, Geomorphology and Hydrology maps were generated and integrated to prepare Watershed Modeling concept for the study area. Geographical Information system was used to prepare database on the above layers, analysis of relationship and integrated map preparation. The study area has a complex geomorphology. The result in the form of integrated map could be properly analyzed using the advantage of technology like Remote Sensing and GIS as the methodology included analysis of land/water resources and their interpretation. This type of integrated study is very useful for the decision makers to protect the Natural Resources.

KEYWORDS : Watershed Modeling, Remote Sensing and GIS, Integrated study.

1. Introduction

Water is a vital natural resource, water is a key resource in all-economic activities ranging from agriculture to industry. Only a tiny fraction of the planet's abundant water is available to us as fresh water. About 97% is found in the oceans and is too salty for drinking, irrigation, or industry. The remaining 3% is fresh water. About 2.997% of it is locked up in ice caps or glaciers or is buried so deep that it costs too much to extract. Only about 0.0035 of Earth's total volume of water is available.

In India of total available water resource 1869 bcm (Billion Cubic Meter) , the usable, water resources are only 1122 bcm, which consists surface water 690bcm, ground water 432 bcm, which the present per capita available water resources is 1122cm and by 2050 it is likely to reduce to 748 cm. When the countries per capita water availability is less than 1700 cm it is considered as water stress country.

In present days, usage of surface and groundwater is increasing due to rapid urbanization, industrial growth and agricultural utilizations. Consequently, rapid depletion of surface and ground water is taking place. The conventional methods like geological and geophysical studies are generally used to locate bore well points. Compare to the conventional methods Remote Sensing is the advanced technology, because of its wide coverage and repetitivity, to identify sub-surface water resources.

2. Description of Study Area

The study area Ranga Reddy districts of Telangana, India and is situated between 78 30' and 78 45' East longitudes and 17 15' and 17 30' North latitudes. The district Rangareddy occupies an area of 7493.00 sq.km. The climate in the district is characterized by hot summers and is generally dry except during the south-west monsoon season. The average annual rainfall in the district is 812.5 mm, the bulk of which is received through the south-west monsoon during June to September.

3. Study Objectives

1. Preparation of thematic maps using survey of India toposheets and satellite imagery using V.I.P Technique.
2. Collect and enhance spatial data for use in a watershed modeling environment, with clear rationales for selection of specific data sets.
3. Construct a working GIS software environment that provides an integrating interface for selected models/procedures used for evaluating hydrologic, economic, and ecological effects of land use changes.

4. Methodology

4.1 Data collection:

Different data products required for the study include Survey of India (SOI) toposheet. Fused data of IRS–1D (5.8 m- Resolution) PAN and LISS-III satellite imagery obtained from National Remote Sensing Agency (NRSC). Collateral data collected from related organizations, comprises of collateral data and demography data.

4.2 Database creation:

Satellite imageries are georeferenced using the ground control points with SOI toposheets as a reference and further merged to obtain a fused, high resolution (5.8m of PAN) and colored (R, G, B bands of LISS-III) output in ERDAS Image processing software. The study area is then delineated and subsetted from the fused data based on the latitude and longitude values and a final hard copy output is prepared for the generation of thematic maps using visual interpretation technique.

4.2.1 Spatial Database:

Creating a GIS spatial database is a complex operation, which involves data capture, verification and structuring processes. Because raw geographical data are available in many different analogue and digital forms such as toposheets, aerial photographs, satellite imageries and tables. Out of all these sources, the source of toposheet is of much concern to natural resource scientist and an environmentalist. In the present study, the fallowing layers generated from toposheet and satellite data using visual interpretation technic.

Base map, drainage map, and Slope map prepared using Road networking, drainage pattern and Contours, Spot heights from SOI Toposheet. The procedure consists of a set of image elements, which help in the recognition or interpretation of various land use /land cover features systematically on the enhanced satellite imagery during the classification of features (Thomas M. Lillesand, 2000). The thematic maps generation system used in this study is the system, which is pioneered by United States Geological Survey (USGS) and is modified by National Remote Sensing Agency (NRSA) according to Indian conditions. A preliminary image classification key is prepared for the fussed pictorial data and is used during interpretation process. The base map is overlaid on the satellite imagery. Then the different thematic layers features are extracted from the satellite pictorial data.

The doubtful areas (due to similar spectral response and spectral signature) identified during the preliminary image classification are listed out before ground verification. The doubtful areas are physically verified and field observation about terrain condition and land use pattern.

Based on the ground information collected, corrections and modifications of miss classified details and doubtful areas are carried out on enhanced imageries for final thematic maps. So as to extract the entropy or information extent in accordance with the above thematic maps. At the end of the interpretation process the above thematic maps in the form of paper-based maps.

4.2.2 Attribute database:

The thematic maps are converted to digital mode using scanning and automated digitization process. These maps are prepared to a certain scale and show the attributes of entities by different symbols or coloring. The location of entities on the earth's surface is then specified by means of an agreed co-ordinate system. It is mandatory that all spatial data in a GIS are located with respect to a frame of reference.

5. RESULTS AND DISCUSSION

5.1 Slope of study area: The slope categories observed in the study area are nearly level, very gently slope, gently slope, moderate slope and moderately steep slope. Run-off increases with higher slopes. Water infiltration rates are decreased with increasing in run-off. So, as infiltration rates are high at nearly levels that occupied most of the study area it can be predicted that high groundwater potentials at these level.

5.2.Landuse Land cover of study area: The landuse landcover categories such as built-up land, agriculture, forest, water body and wastelands have been identified and mapped from the study area. About 22.5% of the study area is under built-up land. Under this category, residential (64.43%), Industiral (13.82%) and village (21.74%) areas are observed. From the satellite data the agriculture area (33.1%) could be clearly delineated as four categories such as single crop, double crop, fallow land and plantations. Though single crop has been observed at various parts of the study area, most of it has been observed at southern part of the study area.

5.3 Geomorphology of study area:

The geomorphological classes observed in the study area are pediplain (75%), pediment (8%), pediment inselberg complex (16%) and dyke (1%). Pediplain with moderate weathering (ppm)(31.8%) and pediplain with shallow weathering (pps)(68.2%) are the pediplain classes observed in the study area. As weathering soil thickness is high for ppm (10-20m) than to pps (0-10m), infiltration rates are high for ppm. Thus, high groundwater potentials can be predicted at ppm than at pps. Moderate to poor yields of groundwater can be predicted at pediments based on the formation of rock structures. For pediment inselberg complex, inselberg form run-off zones, pediment contributes for limited to moderate recharge. As dike acts as a barrier for streams, moderate potential of groundwater can be get at one side of the dike and dried aquifier at another side.

5.4 Structures of study area:

Lineaments are the structural features observed in the study area. Of the lineaments conformed and inferred lineaments are observed. Conformed lineaments are observed at the places where drainage density is more, whereas inferred lineaments are observed at less drainage places. Thus, the places where conformed lineaments can be predicted as high groundwater potentials than from the places of inferred lineaments.

5.5 Geology of study area:

As almost entire study area (98%) is under predominantly granite and alkali feldspar granite suite; migmatite it can be predicted that very good-good-moderate yields of ground water potentials for the area.

5·6 Groundwater prospects map:

The groundwater prospects map shows the information of all the thematic maps data within that mainly the geological, geomorphological, structural and hydrological information and collateral data information of the study area integration of this information in this map all details of the geological, geomorphologic, structural and hydrological are observed and based on these details groundwater low potential areas are identified and to increase the groundwater potential artificial recharging structures construction sites are identified like check dams, percolation tanks etc., are recommended it depends on the topographic condition and hydrological capacity.

6.1 Conclusions:

The study area comprises part of Rangareddy districts. The area is drained by Musi river. The landforms observed in the study area are pediplains with moderate and shallow weatherings, pediments, pediment inselberg complex and dykes. The area is underlain mainly by oldest rocks of Archaean Group of pink and grey granites and lineaments, adamellite-granodiorite suites and migmatites. Structures observed in the study area are lineaments. Of the lineaments, conformed lineaments (along Musi river), inferred lineaments are observed in the study area. Though drainage network is distributed in the entire study area, most of it is distributed in the southern part of the study area. The major part of the settlement (part of Hyderabad) area occupied the NW part of the study area. The map showing four different potential zones for artificial recharge has been prepared for the study area. The final (groundwater prospects) map was prepared by integrating various thematic maps, viz., and geomorphological, structural, geological and hydrological maps. The present study shows that the areas to construct artificial recharge structures to improve surface and groundwater levels in the perspective of groundwater use for future generations with reference to watershed modeling concepts.

6.2 Recommendations:

Based on the above steps less ground water potential areas are identified keeping this in view in the future demand to increase the Ground water levels in the problematic area Artificial recharge structure construction areas are recommended

To improve the surface and groundwater level and to avoid further depletion of groundwater levels to construct the artificial recharge structures like roof top/road top rainwater harvesting structures, pits and scavenger wells are to be constructed in houses/ apartments and in most of the vacant areas such as Govt. Office premises, Public parks, School, College and University areas

Rangareddy District has no separate storm drainage system. Since it is mixed with the sewerage large quantities of storm runoff is lost, which could be used for recharge. It is suggested that wherever possible it can be separated and used for recharge with adequate planning.

Intense road network and development activities with less vacant land between dwelling units have reduced surface area. Such localities are to be prioritized and separate planning has to be taken up for recharge.

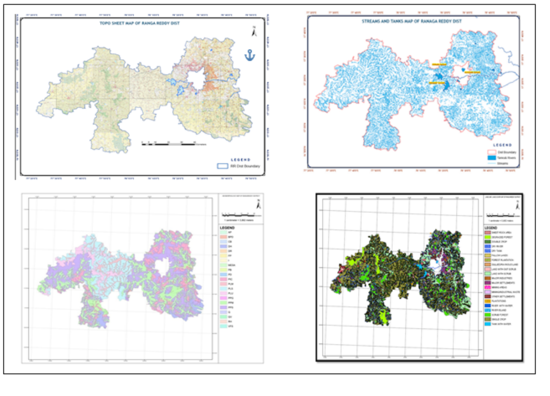

Figure-1: Showing the Georeferenced Topomap, Drainage Map, Geomorphology Map & Land Use/ Land Cover Map. (Source: SOI, NRSC & ARCGIS Software)

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