Application of Remote Sensing and GIS Technique in Ground Water Exploration: An Approach

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Abstract: - This article describes the aspect of geo-environment and portable ground water zone of a watershed of the study area using Remote Sensing (RS) and Geographical Information System (GIS). Initially, based on satellite imagery, topographical, geomorphologic and hydro geological features are demarcated as a promising zone for ground water exploration in the study area. The socio-economic development of any country is based on land resources and water resources. Due to increasing the rate of population, these resources are over stretched often leading to resource depletion. Therefore there is need to prudently manage these delicate resources. RS & GIS techniques can be applied effectively to generate data and information for sustainable development. After more than twenty-five years of satellite-based land remote sensing experimentation and development, these technologies reached almost all sectors of earth sciences application. The use of remote sensing data and derivative information has ever promise of entering into mainstream of governing at local and regional level. This article enumerates the overview of mapping and management of natural resource using RS & GIS Techniques.

Keywords: - Remote Sensing, GIS, Ground water exploration, Geo-environment.

Introduction: - Ground water is the last component of the hydrologic cycle to realize the benefits of remote sensing. Ways in which remote sensing can be more effectively used for future ground water studies are suggested. The rapidly expanding human population, large scale changes in landuse / land cover and burgeoning development project and improper use of watersheds has all caused a substantial decline of natural resources of the country. Absence of reliable and updated information and data on natural resources, their conservation values and socioeconomic importance has greatly hampered development of policy, legislation and administrative intervention by the state. Increasing population, modern industrial and agricultural activities are not only creating more demand for ground water resource due to the inadequate availability of surface water resources, but are also polluting ground water resources by releasing untreated wastes. Consequently, these activities have resulted in an increase of research, not only with regard to ground water resources but also with an emphasis on locating ground water of good quality for human consumption. The present paper focused on the study of the soil, vegetation, lineament, geomorphology and geology of the study area. Major problem with the region is identified as rapid growth of population and unplanned growth of the city horizontally in all direction. Many of the developments have come up in the recent years, which have affected the various regions in a drastic way. So there is a need for proper planning and careful handling of this alarming situation. Remote sensing for natural resource exploration activities for large areas requires airborne surveys using drone to facilitate detailed information for subsurface features and low-cost imagery is an important advantage for environment and natural resource management, particularly in developing countries such as India (Singh 2015). The study focused on development of RS and GIS based analysis and methodology in the region for ground water recharge and exploration. Now days GIS is widely used for spatial modeling of hydro geological prospect of a large area with more reliability.

Objective: - This article seeks to demonstrate the usefulness of GIS technology in conjunction with Remote Sensing for exploration of ground water, its mapping and management for enhancing management decision making capabilities.

The main objectives of the paper are as follows:

- Investigate and apply various strategies for classification of these data in extracting earth resources information such as geology, land use and land cover, soil, geomorphology, vegetation and lineament for ground water exploration and identification of ground water potential zones.

- Evaluate the utility of multispectral data from one season over those from another

- Become aware of emerging innovative approaches to the analysis of satellite remote sensing and ancillary earth resources data

- Develop an organized, logical approach to computer-assisted processing of earth resource data for effective natural resource management and provide an insight to the researchers in analysis in technical way.

Data and Materials: - Satellite Data: Satellite Imagery like, IRS, Cartosat, AVIRIS etc. (Microwave, Optical and Hyperspectral)

Collateral Data: - Topographic map, Geology Map, Soil map, Rainfall map, Well inventory data, pre - mansoon and post- mansoon data etc.

A brief methodology for execution of the research work is explained as follows :

Methodology Input data: - The procured satellite data of the study area were used for Geology, Geomorphological, Soil, Vegetation and Land use Land cover mappng. Published soil maps, topographic maps, climatic data etc. are also were collected and used as collateral data.

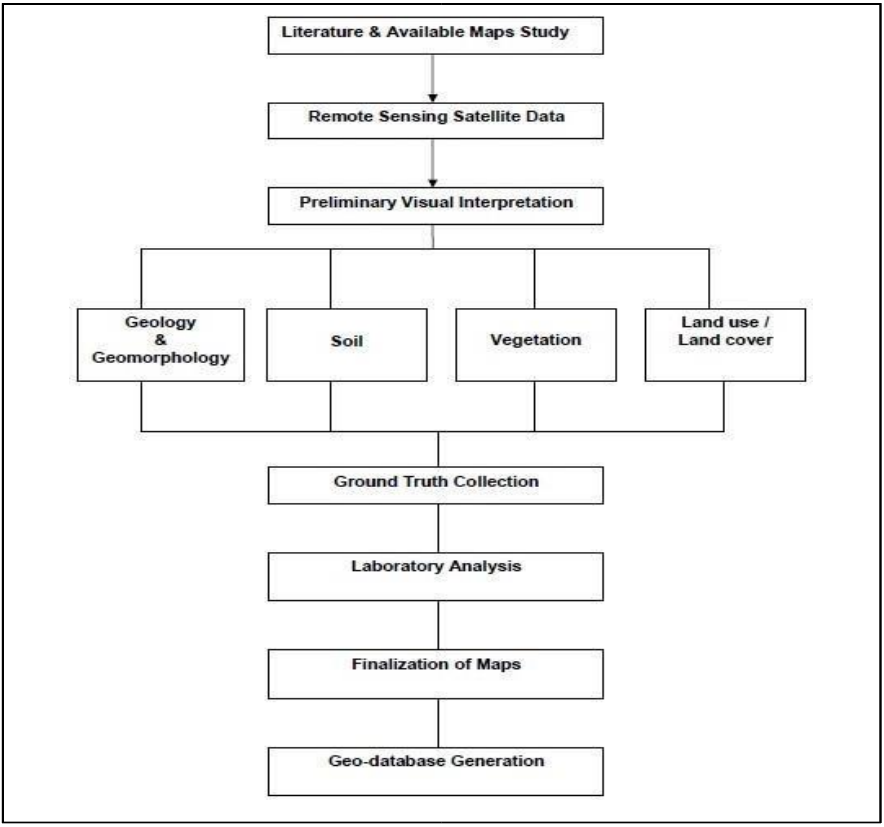
Data Processing: - The satellite data geo-referenced and suitable Image enhancements process are applied to facilitate the delineation and interpretation of different thematic information.

Data Interpretation: - Visual and digital interpretation methods were used to prepare pre-field interpreted map. The satellite data is interpreted based on photo elements like tone, texture, size, shape, pattern, aspect, association etc. These prefield interpreted maps and digitally enhanced satellite data were used on the ground to identify different elements of various themes.

Field Verification and Data Collection: - Suitable field sampling designs in terms of line transects/quadrants were used to assess the interpreted elements and relate with satellite data. The field data collections were added by GPS in order to locate the ground verification points on the image and for further incorporation of details. For the all sample collection and field points visited attribute information on vegetation, geomorphologic, soil and topographic parameters were collected. The sample points were based on the geological / Geomorphological / soil heterogeneity, mapped from the satellite data.

Finalization of Maps: - Based on the pre-field interpretation, ground truth verification and available secondary information final maps were prepared in 1: 25000 scales. Towards this both visual and digital approaches can be conjunctively use.

The methodology flow chart is given below :



Methodology Flow Chart

Discussion

Land use\ Land Cover: - Today, land use and land cover (LULC) mapping has a great significance in scientific research, in planning and in natural resource management (Singh & Dubey 2012). LULC map were prepared using satellite data (fig. 1). The classification scheme is designed keeping in view of the management practices addressing each landuse/ landcover parcel, amenability of these parcels for identification/mapping in dataset. Under the Level-I classification, Built up, Cultivated areas, Woody vegetation, Grasslands, Wastelands, and Water bodies were classified.

In addition subclasses of Level-I LULC classes observed based on spectral satellite data, evaluated on the ground to characterize the information classes. The LULC classes were visually interpreted based on tone/texture, contextual and ground information. LULC mapping is very important to know the detail overview to the region it will help to identify the area covered by different classes/object on the earth.

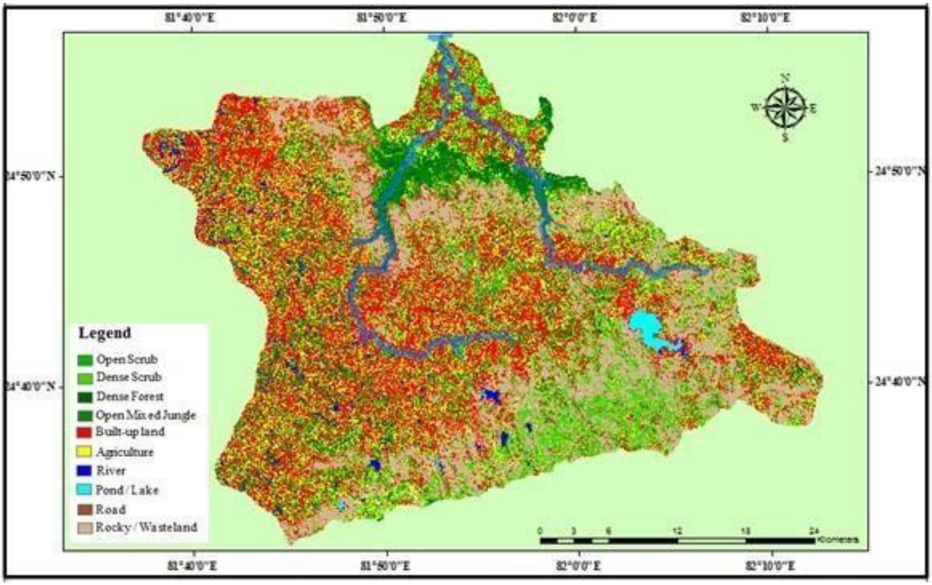


Fig. 1: LULC Map of Naina – Gorma Basin, Rewa District (Source: Singh & Dubey, 2012)

Vegetation: - The vegetation cover map was generated using satellite data (IRS Resourcesat, LISS III & IV). The vegetation in the study area is regulated by climate, seasonality, physiographic, geomorphologic and soil regimes. The vegetation is broadly demarcated into natural and managed vegetation. Phyto-sociological analysis carried out after collecting sufficient number of sample data from the natural vegetated areas. The vegetation map further stratified into dense and open canopy density classes. Further different categories of vegetation under each of the community were extracted and analyzed to understand the percentage of vegetation present in the vacant land (fig. 2). Such information on spatial distribution in qualitative and quantitative terms would be useful in further exploring and analyzing the aspects of biodiversity and ecological conservation. So the researcher can use these above details to generate the vegetation map using GIS and RS technique.

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Fig. 2: Vegetation in the study region (Naina – Gorma Basin, Source: Singh V., 2016)

Soil: - The soil map was prepared using remote sensing satellite data (IRS- P6 LISS IV) and ground information. The soil can be classified in to following series level -

- Preliminary visual interpretation of satellite data
- Fieldwork to study important characteristics of soils and associated land characteristics such as landform, natural vegetation, slope etc.
- Laboratory analysis to support and supplement the field observations.
- Correlation and classification of soils into defined taxonomic units.
- Mapping of soils - that is establishing and drawing soil boundaries of different kinds of soils on standard geographical base map.
- Generation of Geo-database for Soil.

Soil map is helps to know the type of soil, its characteristics and texture of the soil present in the region. Coarse texture soil is very porous in nature and helps to infiltrate the water and recharge the ground water table.

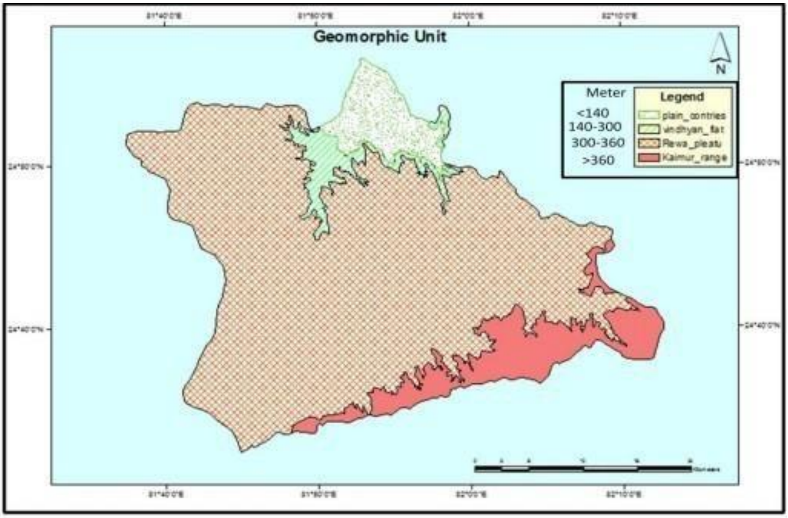

Fig.3: Geomorphology of the Naina – Gorma Basin, Rewa District (Source: Singh V., 2015)

Geology: - The geo-referenced satellite digital data were used to carry out 'on screen' vectorization of geological parameters.

1. Satellite data geo-referenced with the available map sheets.
2. LISS-III / LISS-IV and AWIFS data can be acquired for the entire study area
3. LISS-III was used for regional assessments and LISS-IV data can be use for detail assessments also.

These above said data sets were co-registered with other collateral data sets by taking common Ground Control points (GCP). The satellite data enhanced both in spectral and spatial domain. The geological structure was prepared with mainly on type of lineament with emphasis on length, Faults and thrusts. The geomorphological map (fig. 3) were prepared with emphasize on genetic classification of landforms. The ground observation must be incorporate at appropriate places to finalize post field map. Integrate to all the themes in GIS environment to generate hydrogeomorphology map.

Lineament: - Lineaments are natural features in the terrain that have linear fractures like faults and joints which can be interpreted directly from satellite imagery. Satellite imageries plays major role in the interpretation and identification of the lineaments for the site suitability analysis for ground water exploration. By visually interpretation the lineaments of the study area were picked up and traced on the basis of tonal, textural, soil tonal, vegetation, topographic and drainage linearity, curvilinear ties and rectilinear ties (Drury 1990; Gupta 1991; Lillesand and Kiefer 1994). Lineaments are the hydro-geologically very important and they provide the path ways for ground water movement and enhanced well yields (Magesh et al. 2011; Subba Rao et al. 2001). Those regions having very high lineament density actually are the good sites for ground water accumulation because lineament density of an area can indirectly reveal the ground water potential, since the presence of lineaments usually denotes a permeable zone.

Conclusion: - All the thematic maps like soil, geology, vegetation, geomorphology and lineament plays very important role in the ground water exploration in the region. Lineaments help to the movement of ground water in the area. Coarse texture soil, vegetative region and area having alluvial and black soil with porous structure are more suitable for ground water recharge. So, the generated theme can be implementing for further planning of the urban and rural area. The action plan report can be create using the geo-data database and total decision support system, develop to depict location and type of action/control measures recommended for sustainable development plan of natural resources. Zonal and community wise soil resource development plan, Water resource development plan, vegetation resource development plan, LULC plan can be develop using the personal geo-database of the respective theme.

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