Journal of Resources Development and Management
ISSN 2422-8397 An International Peer-reviewed Journal
Vol.32, 2017

Natural Resource Mapping for Development Plan Using Geospatial Technology

Manish K. Tiwari Vivek Katare
Landuse and Urban Survey Division Madhya Pradesh Council of Science & Technology (MPCST), Bhopal, M.P.

Abstract
Geospatial technology includes three different technologies that are all related to mapping features on the surface of the earth. These three technology systems are RS (Remote sensing), GIS (Geographical Information System) and GPS (Global Positioning System).Geospatial technology and its scope of applications have undergone significant change since its advent. It has now been universally accepted as the most important modern tool for mapping and monitoring of various natural resources as well as amenities and infrastructure. The huge and voluminous spatial database generated from various remote sensing platforms needs proper management like storage, retrieval, manipulation and analysis to extract desired information, which is beyond the capability of human brain. This is where the computer-aided GIS technology came into existence. A GIS with major inputs from remote sensing satellites for natural resource management must be able to handle the spatio-temporal data, supporting spatio-temporal quarries and other spatial operations. Software and the computer-based tools are designed to make things easier to the user and to improve the efficiency and quality of information processing tasks. The Bina region has attracted the attention of the planners from the beginning of Five Year Plans for industrial development. A number of projects were carried out in individual districts (Sagar, Vidisha, Guna and Ashoknagar) which also gave fruitful results, but no serious efforts have been made for the entire region. No efforts were made to use geospatial technologies like remote sensing, GIS, GPS to prepare a well structured computerized database without which it is very different to retrieve, analyses and compare data for monitoring as well as for planning the developmental activities in future.
Keywords: Remote Sensing, GIS, GPS, Facilities & Amenities,

Introduction

Remote sensing and GIS will be effective tool to create database for natural resources assessment and management particularly for regional applications. Theme wise maps were generated using satellite data viz., geomorphology, geology, hydro geomorphology, Landuse/Landcover, soil, and drainage and watershed. Standard classification techniques are applied for mapping of individual themes in GIS. The main objective of mapping of natural resources is to assess potential and limitation of resource availability in the region.

The economic, social and cultural viability of any nation is mainly determined by the land and water resources that it has (Harahsheh, 2001). These natural resources are essential to the economy of a nation since they play a critical role in the provision of employment; they are a source of raw materials for various industries, acts as a source of food and income, medicine as well as energy. The aesthetic beauty that relates to natural resources is always regarded as the cultural representation of nations.

However, it is essential for nations to learn how to use these resources in a sustainable manner to ensure that their benefits are enjoyed in the present as well as future generations. This is because, these resources can be depleted if they are not utilized in an effective and efficient manner. At the present moment, the utilization of the resources present in the world has been overstretched due to the ever rising population of human beings (Swe, 2005). It is as a result of this population pressure that forest cover all over the world has declined due to human encroachment. This has greatly increased human/wildlife conflicts and encouraged the development of desert like conditions. Ultimately, the depletion of natural resources has led to an increase in the cost of living, changes in weather patterns and a decline in the economic, social and cultural benefits that were accrued as a result of their utilization.

Due to these constraints, there is a dire need to ensure that these resources are effectively managed. A lot of management practices have been advanced in the field of natural resource managed to achieve this goal. Some of them have been effective while others have failed to achieve the desired outcome. However, with the current trend in the advancement in the field of information technology, natural resource managers have now laid a lot of emphasis on the use of remote sensing and GIS technologies in the management of natural resources. These technologies provide a platform through which managers can generate informative data and information that can be used to make sound decisions for sustainable development. For over three decades now, the use of land-based satellite remote sensing has been in application in almost all realms of earth sciences. All through this time, remote sensing and GIS technologies have always generated informative data that have led to the sustainable management.

Aim and Objectives

1. To prepare the landuse landcover map of Bina industrial region using geospatial technology.
2. To evaluate potentiality of the natural resources of the study area.
3. To prepare development plan of the study area for future development.

Study Area

Madhya Pradesh has been divided into seven regions. Due to rapid development of Bina and area around Sagar district, M.P. GOVT. declared this as Region No. 8 in 1999. Which is named by Bina Petrochemical/Industrial region? The two major projects Bina refinery and J.K. thermal power plant were establish in Bina and Vijaypur town. Four districts i.e. Sagar, Vidisha, Guna and Ashoknagar formed this region. The Bina Industrial Region lies between the 23o 0` to 25o 10` N Latitudes and 76o 50` to 79o 10` E Longitudes, total Geographical area 28534.60 km2 and total Population as per the census 2011 is 59, 22, 424 lakh. Figure 1.0 showing in Location map of the study area.

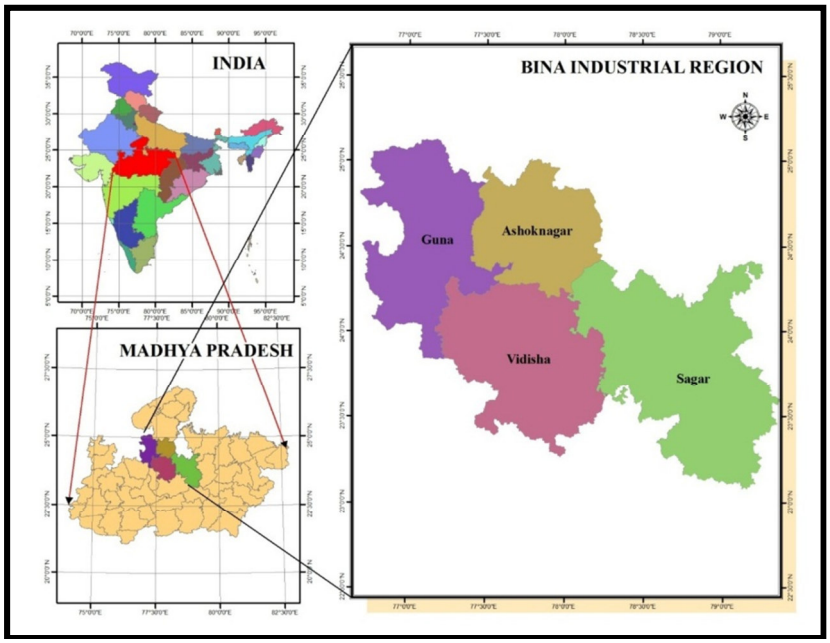

Figure 1.0 Location Map of the Study Area

Methodology

The prime objective of the present research work is to evaluate and map natural resource potential using geospatial technology. Natural resource potential was assessed in terms of landuse/landcover, geology, geomorphology, drainage and soil using remote sensing technology.

Database consist of both spatial and non-spatial data which is designed and organized keeping in view, input data requirements of different planning sectors like industry, transport, communication, agriculture, water, facilities and amenities for the region.

Mapping & Analysis

Socioeconomic development of any country, state or region is based on natural resources like water resources, land resources etc. Due to increase in population, these resources are over stretched often leading to depletion. To prudently manage these delicate resources, remote sensing and GIS techniques can be applied for effectively measure to generate data and information for resource management in a sustainable manner.

- **Geology**

The preparation of geological map used digital data from the reference map of Geological Survey of India. District Resource Map (DRM) was overlaid on the satellite data to mark geological features on the bases of the available geological maps; published literature and other information were also used to enriching the geological details. The doubtful areas were verified on the ground and after incorporating suitable corrections geological map was finalized.

- **Geomorphology**

The geomorphological map was prepared by demarcating the lithology and geomorphic units and landform using satellite data on 1:50,000 scale. Geomorphic units, landforms were delineated based on photographic and geo-technical elements like tone, texture, shape, color, association etc. structural information like fold, faults,

fractures, lineaments, structures, trend lines and lithology was also incorporated to asses ground water potential of the area.

The legend was classified based on origin chronology. The youngest geomorphic units were placed on the top and oldest at the bottom of the legend. The available geomorphological maps, published literature and other information were also used to enriching the geomorphological details. The doubtful areas were verified on the ground and after incorporating suitable corrections geomorphological map was finalized.

- **Landuse/Landcover**

Information on land use land cover pattern, especially the extent and spatial distribution is a prerequisite for the preparation of the development plan of the study area. The landuse/cover information helps in formulation of policies and programs for regional development. Therefore, an attempt has been made here to adopt a sustainable landuse/cover classification system for use with high spatial resolution IRS-P6 LISS IV MX data. The important points adopted in developing this classification system are:

A minimum level of accuracy (about 90 to 95 percent or better) has been tried in the interpretation of the data.

A fair level of reliability of interpretation for the several categories including in the classification system was attained but difficulty was experienced in differentiating commercial areas which are within the residential localities. Therefore, separate categories for the commercial areas were not attempted during interpretation.

For success of any planning activity, detailed and accurate information regarding the landcover and the associated landuse is of paramount importance. In order to undertake a proper, systematic and structured landuse/landcover mapping. The present Landuse/cover classicification adopted by National Remote Sensing Center (NRSC).

- **Drainage**

Survey of India topographic map of 1:50,000 were used for preparation of drainage, surface water body/watershed boundary. Major rivers and stream network were drowning from SOI toposheets. Drainage prepare from SOI maps were further updated using satellite data particularly when new stream are formed due to erosional activates.

Watershed management implies rational utilization of land and water resources for optimum and sustainable production with the minimum hazards to natural resources and the environment. It requires collection and analysis of a great deal of information on the physical relationship of soil -water to land management, which would ensure economic progress of the region (Charkraborti, 1993).

According to the Guidelines of all India Soil and Land use Survey (AIS & LUS 1990) of the Ministry of Agriculture GOI. However, future subdivision of the watershed was carried out on the bases of criteria developed by National Remote Sensing Centre (NRSC), Department of space, Govt. of India for the development of land resources (Technical Guidelines, IMSD, 1995).

- **Slope/DEM**

The generation of slope and Digital Elevation Model, (DEM) has been prepared using the SRTM data with the help of Arc GIS 9.2. DEM is a digital representation of continuous variation of topographic surface with the elevation or ground height above any geodetic datum. Slope map has been generated using the '3d analysis' and extension tool of Arc GIS.

- **Soil Resource Map (SRM)**

Soil resource map on 1:50,000 Scale, prepared by All India Soil & Land use survey, New Delhi has been used along with the soil profile data at series level has been used in the present study. The digital soil data contain 16 digit soil codes in association with soil series. The data attribute table (DAT) of soil layer contains information on taxonomy, capability, suitability, irritability, PH and Hydrological condition of soil.

- **Hydro-Geomorphological Map (HGM)**

Introduction on landforms is an important input for land management, soil mapping and identification of potential zones of groundwater occurrence. The aspects of morphography, morphogenesis is vital inputs in preparation of geomorphological maps. Apart from the landform characteristic, the geological information like lithology and structures also plays an important role in identifying the groundwater potential zones. In the present study were used different layers for preparation of hydro-geological map such as geology, geomorphology, Drainage, Slop/DEM etc.

Development Plan

The preparation of sustainable regional development plan, it is a prerequisite to understand linkages and interactions that exist between different components of the regional environment. Secondly, the data collected on different aspects of the regional environment has to be translated into useful information for the purpose of regional development. Thirdly, there is also a need to aggregate this information according to administrative/natural and hierarchical units. Basic caveat for this is the availability of systematic, detailed,

reliable, timely and accurate information on various facets of regional environment. The RS/GIS based data analysis having advantage over conventional method of surveying as by the time the plan is made using conventional surveys, the data becomes old and the plan may not be suitable for implementation. It is in this context, the Orbital Remote Sensing (RS) data and Geographic Information System (GIS) techniques play a major role by providing reliable, accurate, timely, periodic data and methods of integration of spatial and non-spatial data to create various planning scenarios for decision making. This type of planning scenarios helps planners and administrators to view various advantages and disadvantages of different perspectives and select best perspective for implementation and monitoring (Pathan et al, 1989, 1993 and 1997).

Rapid urbanization and consequent haphazard growth of cities is a global phenomenon and India is no exception. This is resulting in deterioration of loss of agricultural lands, open spaces, loss of water bodies, depletion of ground water aquifer zones, water contamination, health hazards and many micro-climatic changes. It is therefore desirable to plan for the region and cities falling within the region in an integrated manner so that in due course of time controlled development will take place.

The population for the year 2021 and 2031 was determined on the basis of standard statistical methods. It has been observed that the population of the region will grow from about 59 lakh (2011) to about 84 lakh by 2031. The additional area required for urban development to meet the needs of 25 lakh population over the year 2031 was determined based upon a population density of 212 persons per sq km (Urban Development Planning, Formulation and Implementation [UDPFI] guidelines). Additional area required for recreational, industries, transport and suggestion for conservation of land for agriculture have been assessed. Considering the present density of population, additional area required for urbanization would be 322 sq km. To meet the additional demand of this land, an integrated analysis based upon different physical characteristics of the terrain viz. land use/land cover, hydrogeomorphology, groundwater prospects, and infrastructure facilities was carried out. Regional planning scenarios have been generated on the basis of integrated analysis in GIS environment.

Proposal for suitable areas for industries are incorporated both for urban and regional area. The inherent idea for structuring the regional plan is based on promoting an immediacy or closer interaction between the exiting industries and industries coming in future and support infrastructure like commercial, industrial social and physical infrastructure. Such a structure for the region will promote an efficient relationship between work, living and leisure areas, while promoting necessary green buffer between the industrial and residential areas.

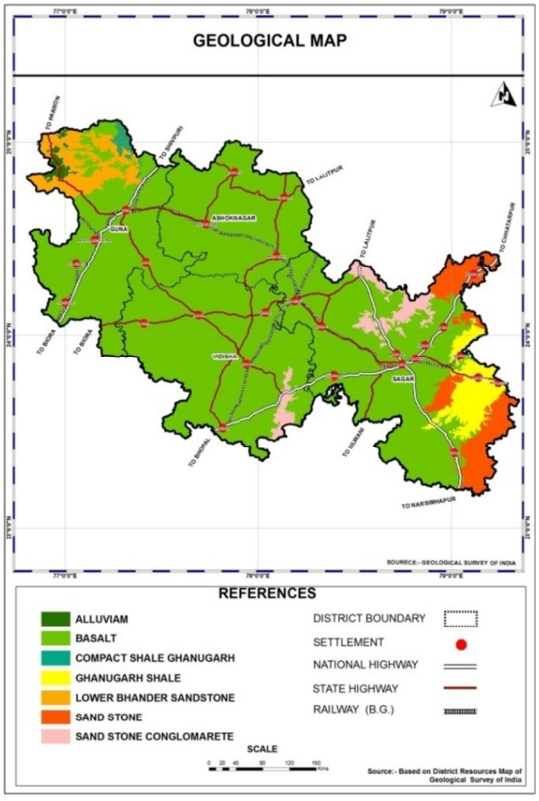

Figure 4.0 Geological Map of Study Area

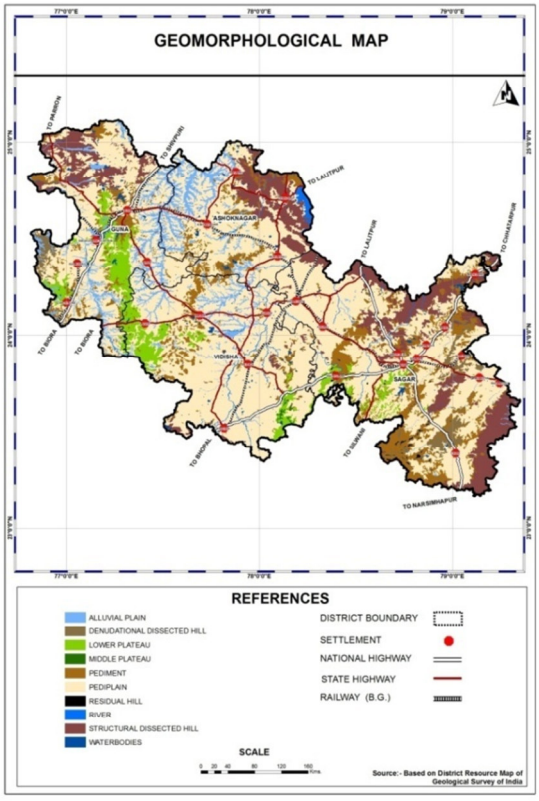

Figure 5.0 Geomorphological Map of the Study Area

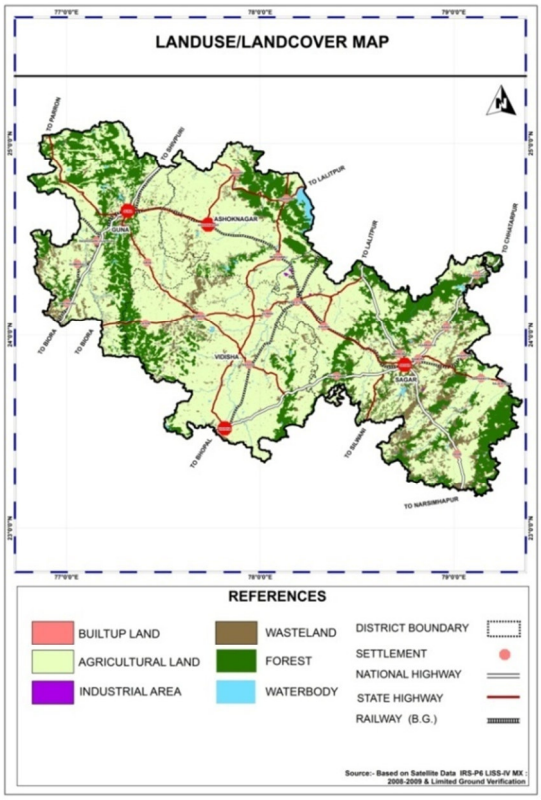

Figure 6.0 Landuse/landcover Map of the Study Area

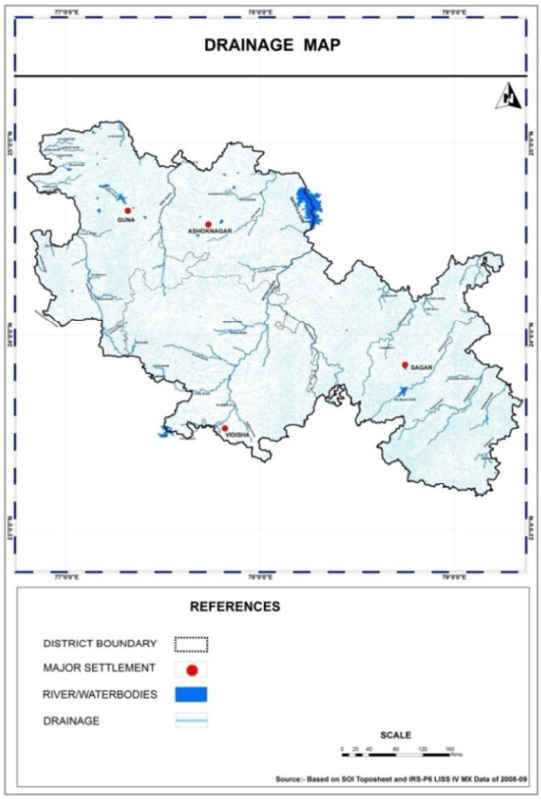

Figure 7.0 Drainage Map of the Study Area

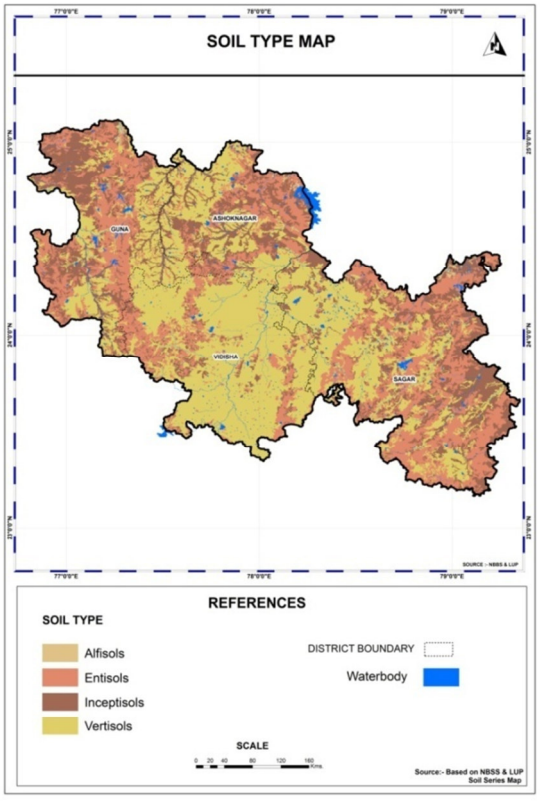

Figure 8.0 Soil Map of the Study Area

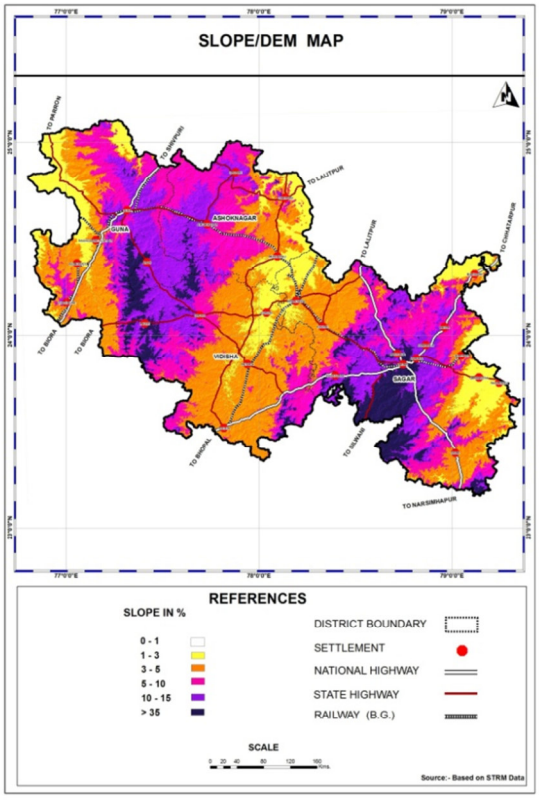

Figure 9.0 Slope/DEM Map of the Study Area

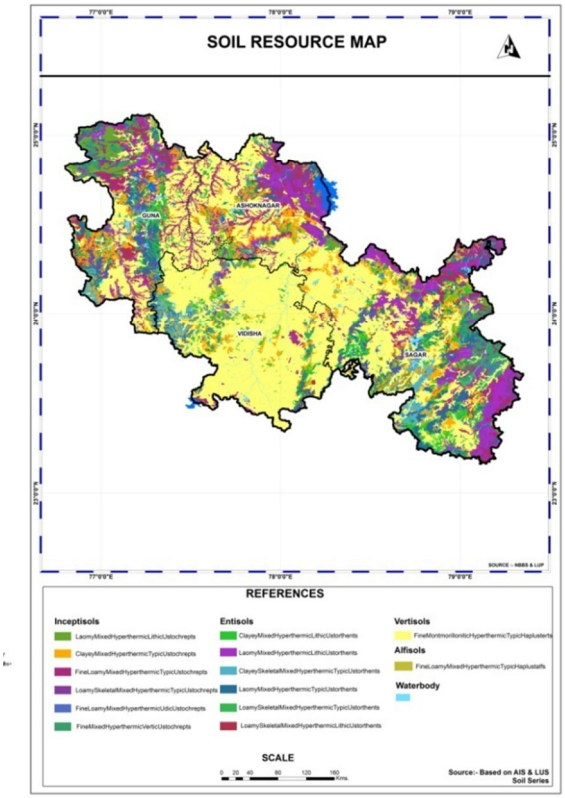

Figure 10.0 Soil Resource Map of the Study Area Area

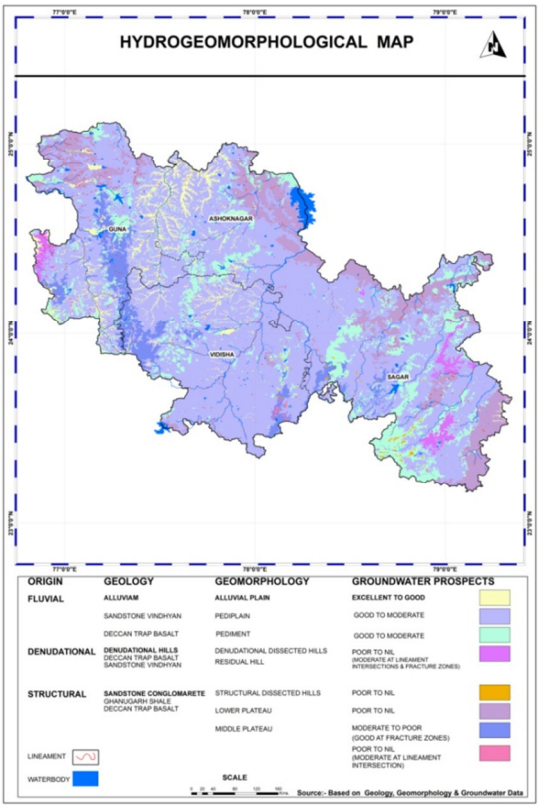

Figure 11.0 Hydrogeological Map of the Study

Table 1 Area Distribution of Geological Formation		
Geological Type	**Area in (ha)**	**Percentage**
Alluvium	14969.21	0.53
Basalt	2338569	81.96
Ghanugarh shale	131105.2	4.60
Lower bhander sandstone	111524.53	3.91
Sandstone	173878.53	6.07
Sandstone Conglomerate	83413.9	2.93
Total	**2853460.00**	**100.00**

Table 2 Area Distribution of Different Geomorphological Units		
Geomorphic Unit	**Area in (ha)**	**Percentage**
Alluvial Plain	131222	4.60
Dissected Denudational hill	43899	1.53
Lower Plateau	152466	5.35
Middle Plateau	3424	0.11
Pediment	384637	13.48
Pedi plain	1771126	62.07
Residual hill	4889	0.18
Dissected Structural hill	361797	12.68
Total	**2853460.00**	**100.00**

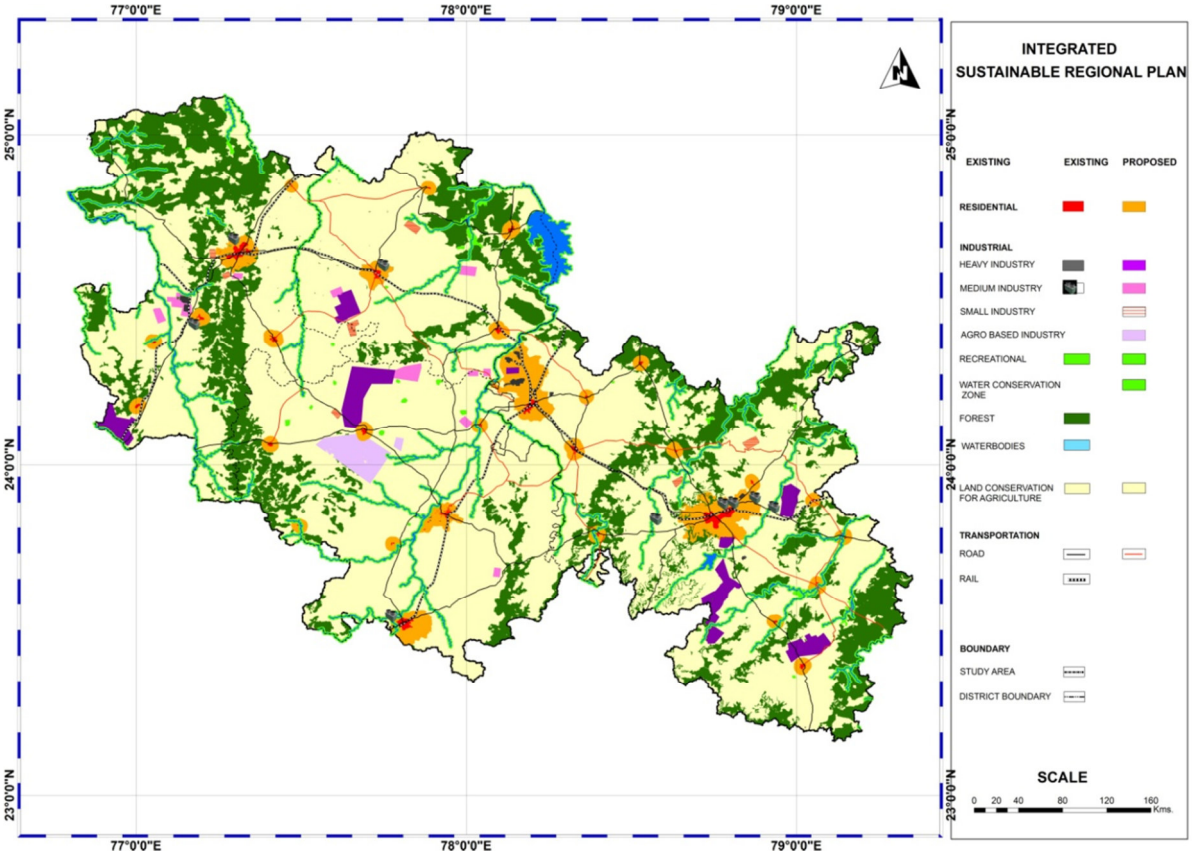

Figure 12.0 Sustainable Regional Plan of the Study Area

Conclusion

The socio-economic development of any country, state or region is based on Natural Resources like water resources and land resources. Due to increase in population, these resources are over stretched often leading to resource depletion. To prudently manage these delicate resources, remote sensing and GIS techniques can be applied effective measure to generate data and information for resource management in sustainable manner. After more than twenty-five years of satellite-based land remote sensing experimentation and development, this technology reached almost all sectors of earth science application. The use of remote sensing data and derivative information has ever promise of entering into mainstream of governing at local and regional level.

Remote sensing and GIS will be effective tool to create database for natural resources assessment and management particularly for regional applications. Theme wise maps were generated using satellite data viz., geomorphology, geology, hydrogeomorphology, landuse/Landcover, soil, and drainage and watershed. Standard classification techniques are applied for mapping of individual themes in GIS. The main objective of mapping of natural resources is to assess potential and limitation of resource availability in the region.

References

1. Ahluwalia, I. J. (1985). *Industrial growth in India: Stagnation since the Mid Sixties, New Delhi, Oxford University Press,* (1), 56-58.
2. Brundtland Commission (1987). World Commission on Environment and Development (WCED). Our common future. *Oxford: Oxford University Press,* 1987 p. 43
3. District Gazetteer (1979). Sagar, Vidisha, Guna. *Department of Culture Madhya Pradesh.*
4. Esch, T. (2011). *Exploiting Earth Observation in Sustainable Urban Planning and Management, the GEOURBAN Project Published in: Urban Remote Sensing Event (JURSE), 2011 Joint Sao Paulo Date of Conference: 21-23 April 2011Page(s):* 037 – 040 E-ISBN: 978-1-4799-0212-5.
5. Gupta, S. C., (1999). *Application of GIS and Remote Sensing techniques in water resources development.* Published in GIS Forum South Asia Vol.45 pp62.
6. Hassan, A. M. (2006). *A Regional Planning Application of Satellite Image Processing in Pakistan Published in: Advances in Space Technologies, International Conference on Islamabad Date of Conference: 2-3 Sept. Page(s*): 152 – 156 E-ISBN: 1-4244-0515-7 Print ISBN: 1-4244-0515-7.

7. Integrated Mission for Sustainable Development, (IMSD-1995). *Technical guidelines, Prepared By:* Mission Management Core Team Integrated Mission for Sustainable Development Integrated Surveys Group national Remote Sensing Agency Hydrabad.
8. Kasanko, M. (2007). *GEOLAND Spatial Planning Observatory: How Remote Sensing Data Can Serve the Needs of Urban and Regional Planning, Published in: Urban Remote Sensing Joint Event, Paris Date of Conference:* 11-13 April 2007 Page(s): 1 - 10 E-ISBN: 1-4244-0712-5.
9. Mishra, R. P. (1992). *Regional Planning Concepts, Techniques, Policies and Case Studies* p10.
10. National Bureau of Soil Survey & Land Use Planning (NBSS&LUP-1989). *Field Manual Bulletin, vol.12, NO.14 Indian council of Agric. res. Nagpur.*