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GIS based Land Information System for Medchal Mandal of R.R. District

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Abstract— Modern technologies of remote sensing and GIS like geo-data processing, earth observation data processing and analysis are needs for researchers. This work dedicates to create a land information system over agricultural, rural and urban development areas of Medchal Mandal of Rangareddy Dist. The main task of the work is to set up a land information database in GIS database. The main function of the work is starting with acquisition of existing geodata and information, maintenance, utilization and transferring of data. In this paper, applications of Remote Sensing and GIS for various advance classification techniques together with their accuracy based on performance evaluation, on land use studies are given emphasis. The research conducted on Medchal Mandal, Rangareddy District, Telangana, India. The goal of the research is to develop a land valuation method based on a land information system for selected areas. The establishment of a land information system for mandal will contribute to the National Land Information System. It is very important to analysis and uses the outcomes on a national level and to give knowledge on Geographic Information System to researchers and land managers in the land management sector. The results will promote good governance and offer fact based information to decision makers.

Keywords—Remote Sensing, Geographic Information System, Land Use / Land Cover

I. INTRODUCTION

It is very important to learn and use Geographic Information Systems and Remote Sensing applications for our professional needs nowadays. Modern technologies of remote sensing like geo-data processing and earth observation data processing and analysis are essential for young researchers for the development of the society on large-scale. This research work is dedicated to create a land information system [1] over agricultural, rural and urban development areas of Medchal Mandal of R.R. District. The main objective of the work is to establish a land information system with database which is based on a Geographic Information System. Present research work is useful to establish and maintain a geodatabase, multi user access to that database, follow international standards for geographic information system and to avoid data redundancy of different organization. Developing nations, as business developing countries, must have sufficient information on many interrelated aspects of its activities in order to make decision policies. Land use is only one such aspect, but knowledge about land use and land cover has become increasingly important as the Nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitat. Land use / Land Cover data are needed in the analysis of environmental processes and problems that must be reached if conditions and standards are to be improved at present scenario [2]. The usages of remote sensing and GIS techniques have become increasingly important in describing a variety of satellite-derived data sets and their application to understand changes in the landscape. It is especially useful in areas that are not accessible. The present work envisages assessing the land resources of the total villages covering approximately 176.17sq km. An integrated approach of Remote Sensing and GIS for land use land cover mapping has been followed. The study has helped to identify the problems and potential of the area to generate a land resource database for overall development. Remote Sensing data both in image form and in digital format is utilized for deriving information about resources either adopting visual interpretation techniques or computer aided analysis. Using ground truth information, the Remote Sensing data are analyzed, interpreted and generated maps which are related to resources. A Geographic Information System (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. The acronym GIS is sometimes used for geographical information science or geospatial information studies to refer to the academic discipline or career of working with geographic information systems and it is a great domain within the academic discipline of geomatics.

The rest of paper is organized as mentioned. Section II explains the methodology, Section III deals with back ground and data used, Section IV explain the research objectives and analysis, Section V explains the results and discussions and finally, Section V explains the conclusion of the research.

II. METHODOLOGY

II.I Description of The Study Area

II.I.I Location and Extent

Medchal mandal of Rangareddy district is located in the Telangana State, situated within the geographic co-ordinates of 17° 38' North latitude and 78° 29' Eastern longitude. Medchal mandal is located in the North-Western part of the district with a geographical area of 176.17sq.km. The mandal has 29 revenue villages. The details of the village areas are given in the Table 1. The study used a satellite geocoded imagery (IRS 1D LISS-III), Survey of India toposheet 56 K/6, 10 on 1:50,000 scale. The digital data was processed for geometric and radiometric corrections using ERDAS image processing software. ArcGIS 9.3.1 and ERDAS Imagine 9.1 softwares are used generate the outputs of the study area. For processing the image, ERDAS was considered. The study was applied both visual image interpretation in order to generate various thematic maps. Detailed village map is given in the Figure1.

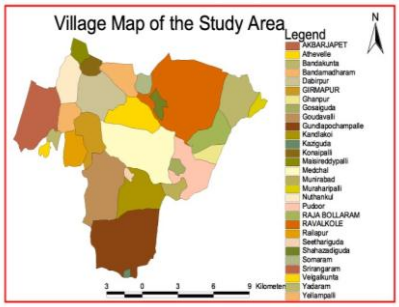

Figure 1. Village Map of Medchal Mandal

II.I.II Preparation of Base Map

The base map is the essential need for any mapping using remote sensing techniques or by ground methods. It is the map which is used for collection and representing the thematic information on a common uniform scale. The major features like important town or villages, rivers, reserved forest area and transport network are required to trace. The base map has been prepared mainly using the geocoded satellite imagery and SOI toposheets on 1:50,000 scale. The detailed base map of the study area is shown in Figure 2.

II.II Method

The methodology of the research is to prepare thematic maps with the application of remote sensing and GIS. The real work involved a comprehensive gathering of information and linked to the related activities. The development and planning of such a vast area for a proposed project requires various data information from the field to identify the terrain characteristics, etc. This is composed of getting use space images and GIS, complemented with ground truth as well as making use of the available information from several concerned sources and sectors in the study area [3]. The flow chart showing the methodology of land resources analysis is given in Figure 3.

Table 1. Villages of the mandal with area extent

Village Name	Area (Sq.km)	Village Name	Area (Sq.km)
Akbarjapet	0.862	Munirabad	1.890
Athvelle	6.977	Muraharipalli	1.211
Bandakunta	1.023	Nutankal	5.234
Bandamadharam	3.103	Pudoor	8.077
Dabirpur	9.395	Railapur	4.000
Ghanapur	2.127	Rajabolaram	5.395
Girmapur	5.870	Ravalkole	28.694
Gosaiguda	1.126	Srirangaram	12.026
Goudavalli	13.505	Seethariguda	0.545
Gundlapochampalle	20.820	Shahazadiguda	1.462
Kandlakoi	8.625	Somaram	1.720
Kaziguda	0.309	Velgalkunta	0.717
Koinaipalli	1.909	Yadaram	8.037
Maisireddypalli	1.909	Yellampalli	4.660
Medchal	17.580		

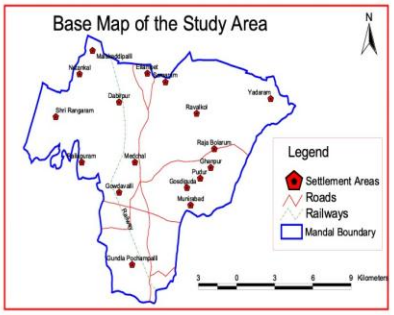

Figure 2. Base Map of the Medchal Mandal

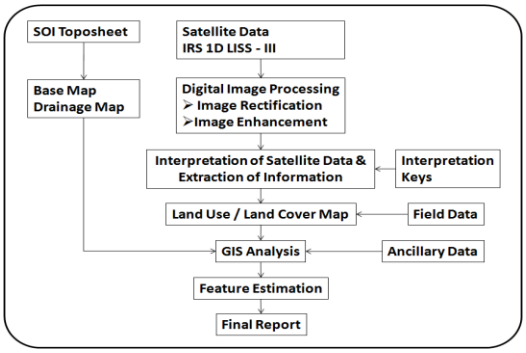

Figure 3. Methodology Flowchart

II.III Physiography

The study area has an altitude of about 602 meters (1975 ft.) above sea level. In terms of topographic features, the area is mostly flat with gentle slopes. The higher elevation points and drainage pattern can be easily spotted on the satellite image. The groundwater availability is about 2275 ha.m. This place was once resort for Nizams who constructed beautiful mansion here, there are famous Temples.

II.IV Climate and Rainfall

The climate of the mandal is very hot. Temperature starts rising slowly from March and reaches its peak by May. The annual normal rainfall in this mandal is only 842 mm. The bulk of the rainfall is received through the southwest monsoon during June to September, while some rainfall is also received through the northeast monsoon between October and December. The mandal gets the benefits of both the South - West and North - East Monsoons. The mercury touches up to 44° centigrade and the minimum night temperature is 18°centigrade.

II.V Flora and Fauna

The north-western and north-eastern terrain is covered by reserved forests marked as mixed jungle. The plains mainly have agricultural activity with paddy, mangoes, sunflower and other plantations. Thorny bushes and scrubs are also observed in certain areas.

II.VI Agriculture

The people of the mandal overwhelmingly depend on agriculture for their sustenance. About 80 % of the total population depend on Agriculture and allied activities. The principle crops in the mandal are Ground Nut, Paddy, Cotton, Jowar, Bajra, Chillies, sun flower and Maize.

III. BACKGROUND AND DATA USED

III. I. Background

RangaReddy District was formed on 15th August, 1978 by carving out some portion of Hyderabad Urban Taluks & the merger of the entire Rural and Urban Areas of the remaining Taluks of Erstwhile Hyderabad District. This District is primarily the rural hinterland for Hyderabad City feeding the powerful commercial centre with various raw materials, agriculture produce and finished products. It was named after Deputy Chief Minister of Andhra Pradesh Sri K.V. Rang Reddy. The District is located in the Central Part of the Deccan Plateau and lies between 16°30' and 18°20' of North Latitude and 77°30' and 79°30' of East Longitudes. The district is bounded on the North by Medak District, East by Nalgonda District, South by Mahaboobnagar District, West by Gulbarga District & North West of Bidar District of Karnataka State. It covers an area of 7564.88 Sq. Kms. As compared to other districts, Rangareddy district forms a fairly developed district of our nation and one that has to endure a semiarid, drought prone environment. In terms of topographic features, the area is mostly flat with gentle slopes, except in the eastern, northern and southern margins where prominent hills mark slopes >350. In general the area faces an acute water scarcity problem and ironically inherits rich fertile soil types. However, an attempt is made to give a few details in respect of previous account in the concerned topics.

III. II. Data Sets and Softwares Used

The remote sensing satellites constellation those are operational in Polar Sun Synchronize orbit for developmental projects [4].

1. IRS ID LISS III FCC Scale 1:50,000
2. Survey of India toposheets no. 56 k / 6 and k / 10.
3. Published Reports and Literature.
4. Ground Data.

A general idea regarding the different kinds of softwares that were brought into use for the present study can be perceived below:

1. ArcGIS 9.3.1
2. EARDAS Imagine
3. Global Mapper
4. Google Earth

IV. RESEARCH OBJECTIVES & ANALYSIS

The primary objectives of the study are: Generation of land use / land cover and creation of digital database and integration with base details and to generate seamless data at mandal level, generation of report, tables, charts and maps, preparation of LULC information systems for easy query and retrieval of geodatabase.

1. To prepare land use land cover mapping to evaluate the land resources of the mandal using satellite data.
2. To create and organize an error free digital data for the natural resources in the form of separate layers.
3. To analyze the land resource data and integrate in GIS domain.

Presently the basic information on land use/land cover in Medchal mandal of Ranga Reddy district is available at 1:50,000 scale. To begin with the preparation and its management is worthwhile to analyze the available information and integrate in the process of mapping. Therefore in this study an attempt has been made to prepare land use land cover mapping to analyze the available land resource information and integrate them to generate further action plans for land resource management.

IV. I. Interpretation of Satellite Data and Extraction of Information

Image interpretation is defined as the extraction of qualitative and quantitative information in the form of a map about the shape, location, structure, function, quality, condition, relationship of and between the objects, etc. by using human

knowledge or experience. Image interpretation in satellite remote sensing can be made using a single scene of a satellite image, while usually pair of stereoscopic aerial photographs are used in photo interpretation to provide stereoscopic vision. Following is the flow chart showing typical flow of image interpretation process (Figure 4).

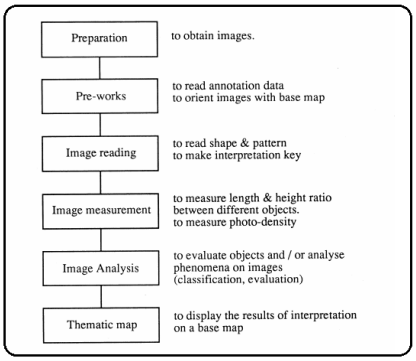

Figure 4. Image Interpretation Process

Image reading is an elemental form of image interpretation. It corresponds to simple identification of objects using elements such as shape, size, pattern, tone, colour, texture, shadow and other associated relationships. Image reading is usually implemented with interpretation keys with respect to each object. Image measurement is extraction of physical quantities, such as length, location, height, density, temperature and so on, by using reference data or calibration data deductively or inductively. Image analysisis understanding of the relationship between interpreted information and the actual status or phenomenon, to evaluate the situation [5].

IV. II. Land Use/Land Cover Mapping

Land Use / Cover is defined as observed economical physical features on the Earth's Surface [6]. Data input refers to procedure of automatization of the data and the conversion into forms that can be stored and analyzed in computers. This procedure is basic fundamental in each and every Geographic Information System and it differentiates with reference to the model (vector or raster) and the origin of data [7]. The main methods of data input are

1. Surveying and other ground measurements.
2. Scanning and Digitizing of existing maps, pictures and layouts.
3. Photogrammetry, Remote sensing.
4. Data transfer from other GIS in specific formats that are supported from the systems
5. Global positioning systems (GPS).

V. RESULTS AND DISCUSSIONS

On the basis of the image interpretation and limited field checks, thematic maps such as land use/land cover, drainage maps were prepared to study the various land resources in the study area.

V.I Drainage Map

The mandal has no major rivers or tributaries. There are small lakes the major being the peddacheruvu and chinnacheruvu of which the latter has been converted into residential area. The drainage is structurally controlled mostly put on view in the form of straight stream courses. In terms of drainage morphometry, the drainage density was found to be relatively higher in the hilly tracts as compared to the plains. The drainage lines exhibit a highly dendritc and sub-dendritic pattern concentrated in the northern, north-eastern and north-western parts of the mandal and medium density sub-dendritic drainage pattern in the central and southern regions of the mandal. The drainage map prepared from the survey of India topographic maps is upgraded by the satellite image. The detailed drainage pattern can see in the given Figure.05. The main aim of this map is to understand the development of drainage system in the area. This has a direct bearing on the lithology and structure, which in turn play a major role in evaluation of ground water. The drainage in general indicates the lithology of the sub surface strata.

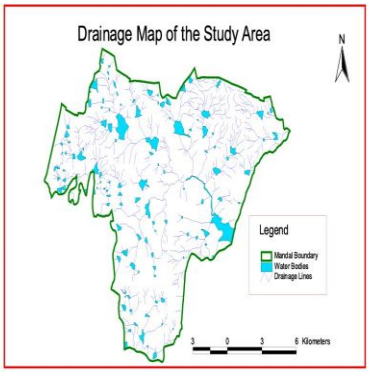

Figure 5. Drainage map of the mandal

V.II Land Use Planning

Land use planning in rural areas has received scant attention in comparison with town planning until recently [8]. This can hardly be justified in a country like India, which is predominantly agricultural. The planning of agricultural sector in rural areas has been carried out in laissez faire manner. Very few deliberate and cautious attempts were made to improve the countryside. The development of land use planning is not recent in its origin but its practice is truly recent [9]. A land use map gives s thorough and clear picture of land to the planners for the determination of future use and planning the agricultural sector to maintain the land potentials. In this way, land use planning is concerned with the future use of the land and the changing demands of the society.

The advent of computer and their ever-increasing power of handling large data sets and computations have provided us with tools to analyze data and obtain results within lesser time

than was required earlier. The availability of satellite data for large areas to assess the natural resources and reconnaissance surveys within a short period of time has forced us to use the information for planning and development [10]. The GIS as a tool to spatially correlate information and look at it in a new perspective has helped the decision makers to take appropriate decision at right time. Within the availability of the above, the present study has successfully proved the validity of the adoption of new technology in the planning and development. The use of remotely sensed data for such study is appropriate to the extent of saying that; it is the most suited technology to be used for a country as large as India and its resources study. The first task in this study was to take stock of the land resources, its use and misuse and finally suggest alternate land use, if necessary at all and/or land and water management practices for sustainable availability of resources. The first task in carrying out an integrated land use survey is to undertake an assessment of the land use pattern as a basis for subsequent field studies. This will indicate land capability, after which a land development plan indicating the best land use pattern for the area covered and taking into account all the relevant factors can be prepared. Land use/land cover mapping was done using two season data for Kharif and Rabi [11]. This is prepared by visual interpretation of satellite data. This is further supplemented by the information from topographical maps and other census. The interpreted maps are checked in the field and modifications if any are incorporated and the map is finalized [12]. The Land Use Land Cover map is given below Figure 6.

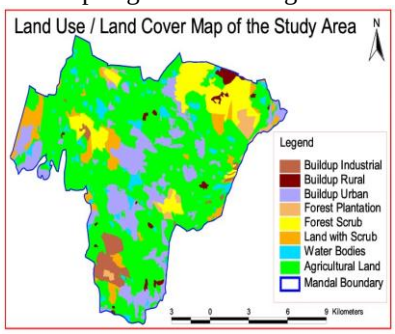

Figure 6. Land Use / Land Cover map of Medchal Mandal

Table 2. Classes of land along with their areal extent

S.No	Area	Area (sq.km)	% of area
1	Water Bodies	8.058	4.57
2	Land with scrub	10.459	5.94
3	Forest scrub	16.616	9.43
4	Forest plantation	3.700	2.10
5	Built-up urban	27.661	15.70
6	Built-up rural	2.486	1.41
7	Built-up industrial	5.719	3.25
8	Agriculture	101.471	57.60
	Total	176.17	100.00

V.III Land Use/ Land Cover Of The Mandal

The land use/ land cover categories of the study area have been grouped into eight classes Viz., built-up area, agricultural lands, forest scrub, water bodies and others as shown in the Table 2. The table gives details about these classes of land along with their areal extent.

V.III. I. Water Bodies

The lakes, tanks, and reservoirs are included in this category. There are some tanks of varying sizes spread over throughout the mandal. These are being used for irrigation and drinking purposes. Water bodies cover an estimated area of 8.058 sq km. It covers around 4.57 % of the total area of the mandal.

V.III. II. Land With Scrub

The land with scrub are the lands with soils that are too shallow; skeletal or chemically degraded lands with moderate to steep slope and are mostly covered with scrubs of different densities and varying height. The total area under this category is 10.459 sq km. It covers around 5.94 % of the total area of the mandal.

V.III. III. Forest Scrub & Plantation

This category includes the vegetated areas with a crown cover of less than 10% owing to over increasing pressure of population on land covering a geographical extent of 16.616 sq km. It covers around 9.43 % of the total area of the mandal. Plantations are taken in an area of 3.70 sq km of land. It occupies around 2.10 % of the total area of the mandal.

V.III. IV. Urban Built-Up Land

These are the areas of human habitation developed due to intensive non-agricultural use. The head quarter of the mandal is Medchal. The MediCiti Institute of Medical Sciences is located at Ghanapur village in Medchal mandal. Mediciti Hospital is attached to this institution. There are a few engineering colleges in the area, the major being the CMR Group of Institutions located in the Kandlakoya village. The urban built-up area covers an area of 27.661 sq km. It occupies around 15.70 % of the total area of the mandal.

V.III. V. Rural Built-Up Land

The rural built-up area covers an area of 2.486 sq km. It occupies around 1.41 % of the total area of the mandal.

V.III. VI. Built-Up Industrial

There are many industries and godowns located in all the villages of the mandal the major being Shantha Biotechnics (P) Ltd., located at Atevelle village in Medchal mandal, Ultra Tile(P) Limited., located in Kistapur, Medchal mandal.

V.III. VII. Agricultural Land

These lands are primarily used for production of food, fibre, commercial and horticultural crops. This category is by and

large is dependent on agro-climatic conditions and it is the dominant category in the study area. The use of multi temporal satellite data enabled sub-dividing this category into Kharif, Rabi, fallow, plantation and double cropped areas.

V.III.VII. I. Single Crop – Kharif & Rabi

Kharif are the areas, which generally have standing crops during July to September/October months that coincides with southwest monsoon. The data selected for delineating these areas generally commensurate with the standing crops in the peak growth stage i.e. before harvesting as on the date of satellite overpass. This category is seen as regular-shaped patches in the map. The major crops that are grown during this season are jowar, coriander, groundnut, redgram and sunflower. This area covers about 22.30% of the mandal. Rabi includes standing crops during October-March months. It is associated with area under good irrigation and areas abundant with paddy and other crops. It covers upto 13.20% of the mandal area.

V.III.VII. II. Double Cropped Area

These are the lands which support crops during both Kharif and Rabi seasons. This category is associated with fertile soils with irrigation facilities from diverse sources to support the crop growth. The spatial distribution of these areas is almost the same as Rabi and Kharif crops described in the Kharif cropland. It covers about 15% of the area in the mandal.

V.III.VII. III. Fallow Land

These are the agricultural lands temporarily allowed to rest uncropped during the agricultural year. This category could be delineated using temporal satellite data wherein the signatures of crops in the cropped areas are conspicuous by their absence as on the data of satellite overpass. There may be various reasons that may be attributed for keeping the land fallow – like social, economic and natural factors. This category occurs as small isolated pockets within cropland. It covers upto 4.10% of the mandal area.

V.III.VII. IV. Plantation

These occur on up-lands, foothills and occasionally in river plains. It covers 3% of the mandal area. The total agricultural area is 101.471 sq.km, which is 57.60% of the mandal area. It is evident that agriculture field is source for the food in the mandal.

VI. CONCLUSION

Remote sensing data is the final solution for large area coverage and temporal coverage of land area. Different layers of information generated from remotely sensed data provide an authentic input when used in a GIS. The analysis carried out in the present study uses primarily information generated from remotely sensed data. Error free digital data layers generated for land use / land cover, drainage map, village boundary map and base map. All the layers were brought to a common coordinate system. Various Land Use / Land Cover zones are extracted with the help of Geographic Information System, which helpful for decision maker for planning purpose. Finally prepared Land use/ land cover map which is important for engineers and developer in town planning, environment study and resource management. The present research demonstrates the applications of remote sensing and GIS for the preparation of accurate land use / land cover map depicting existing land classes for analyzing their pattern for the mandal by using digital processing techniques.

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Authors Profile

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Mr L Harish Kumar pursued Bachelor of Technology from CMR Technical Campus, Hyderabad in the year 2015. He is currently pursuing M.Tech from Loyola Institute of Technology & Management, Dhulipalla, India. His specialization is structural engineering. He has published 3 papers. He has 1 year experience in construction field.

