Geospatial Database Creation for Town Planning Using Satellite Data under GIS Environment

Dr. Kavita[#1] , Dr. M. Anji Reddy[*2]
Associate professor, Dept. of Civil Engineering, Institute of Aeronautical Engineering, Dundigal, Hyderabad- 500043
Director of Research and Development Cell, Jawaharlal Nehru Technological University Campus, Kukatpally, Hyderabad 500 085

Abstract:
In the recent days cities of India are experiencing an accelerated rate of growth from the time when independence and are now budding as centers of domestic and global investments in an period of economic reforms, globalization and liberalization . This has produced opportunities for planning professionals and technologists to direct and build up the procedure of considered development and management utilizing contemporary technologies. The ease of access of high resolution data from remote sensing satellites has revolutionized the practice of thematic mapping and geospatial database formation, particularly, in the perspective of urban and regional planning. Further, GIS (Geographic Information System) has emerged as a influential tool to integrate and analyze the a variety of thematic layers all along with non- spatial information to generate and imagine different planning scenarios for decision making. The growing demands in town planning and management sectors call for incorporated application of remote sensing and GIS for sustainable growth and development of urban areas. The current work deals with the development of geospatial database for urban planning of karamchedu mandal of Prakasam District, Andhra Pradesh State in India through the use of satellite data and other collateral data under GIS environment. High resolution IRS-LISS-IV MX (5.8mt) digital data has been used for the analysis and extraction of the land use and land cover pattern of Karamchedu Mandal. A variety of thematic layers generated include land use pattern, water supply, road network , soil map, geomorphology map, etc. and these have been integrated with socio-economic and demographic data of the city to model the urban growth of the city.

Keywords-*Town planning, GIS, Geospatial, Remote Sensing , Database, GUI.*

I. INTRODUCTION

Urbanization is a outline of urban development that is a response to composite sets of social, economical and political forces and to the physical geography of an area. Urbanization plays very important part of contemporary world which plays a indirect control of financial development of any country [8]. Urban planning is mainly resource development, resource generation and resource management exercise. The good organization of urban settlements mainly depends upon how well they are designed, how economically they are developed and how proficiently they are managed [6]. Growth of local economies, and consequently Urban extension, is determined by a number of factors, Including transportation networks (land, water and air), Population increases (both in term of local birth rate and Influx from other areas) and the amount of available land for developments [5]. The proper design, planning and organization of urban land use demands a careful balancing of many goals, viz., explore for desirable land uses, efficient and sustainable managing practices, attached with connections among the environment, society and economy. One of the foremost reasons underlying the increasing interest in multi-criteria Analysis for land use administration is the need for an incorporated approach to such multifaceted problems. The urbanization may consequence in the loss of natural resources, agricultural lands and open space. The good organization and sustainability of land management will be maximized when systems of land use are well-suited to the resources of a specified area. The awareness of spatial distribution and performance of earth resources is crucial for making land management decisions for a area. Land cover can be resolute either by remote sensing data or ground based survey. Urban land environment represents one of the most challenging areas for remote sensing analysis due to high spatial and spectral diversity of surface materials [3]. Further, geospatial database design under GIS environment is very important in the development of Planning support systems. However, the design methodology of spatial database hasn't been developed sufficiently in urban research compared with the analytical modeling and faux.

II. REMOTE SENSING FOR URBAN PLANNING

Taking into consideration the fact that natural resource evaluations at regional level are prolonged, expensive and frequently go beyond realistic potential, one of the main aim of such activities is to competently study the environmental patterns of ground resources and to observe spatial interactions and relationships among physical variables from different places. This involves use of remote sensing technique for uninterrupted updating of the land use/ land cover of the region of concentration and for identifying ecological constraints for the growth of most Possible land use practices in that area. Further, the probable land degradation can also be examine based on the precise environmental variables, particularly when a particular land use type is to be adopted. These aspects can be dealt with concurrently also by establishing a uncomplicated modeling structure within a uniform System, whose procedure and outputs can be useful for planning at a predefined scale [1].

The use of remote sensing technique in the field of urban expansion practices is very general because of some particular and useful features that can be summarize as:

- synoptic vision of huge areas;
- usable in unreachable areas;
- fast data attainment;
- making the imperceptible visible (spectral range);
- time-marked articulate spatial information;
- digital (semi) automatic processing possibilities.

III. ROLE OF GEOGRAPHIC INFORMATION SYSTEM (GIS)

A GIS is an information system that is intended to work with data referenced by geographic coordinates. A GIS can be consideration of a sequence of process for working with spatial data, their storage and analysis to the use of the derived information for some administrative process. GIS can play an extremely important role in resource Management, environment monitoring, land use and planning activities [7]. Remote Sensing provides dependable, timely, precise, and periodic data while GIS provides a variety of methods of Integration tools to create different planning scenarios for decision making. Through the use of advance technology, system and sensors, data are collected from peoples and objects - then processed in real-time [9]. Advances in GIS-based tools and Databases have made it easier to construct and model the urban pattern of an area [4]. At the same Time, growing concerns over the impacts of developments of urban patterns has forced planners to take on efforts to believe and examine land use from a local point of view. Hence, there is an Urgent requirement to adopt remote sensing and GIS based approach in urban development and monitoring process for implementing realistic plan of urban expansion. GIS and remote sensing technologies have the Capabilities to present necessary physical contribution and intelligence for, formulation of Planning proposals, preparation of base-maps and to act as monitoring tool during execution phase of any urban planning scheme. Thus, GIS and remote sensing are rising as a powerful land related technologies for monitoring and proper management of land.

IV. OBJECTIVES OF THE PRESENT WORK AND STUDY AREA

The main objective of the present work is to build up a inclusive geospatial database for Town planning for Karamchedu mandal, Prakasam district, India through the use of satellite and other collateral data under GIS environment.The Karamchedu mandal , taken as the study area for the present work, at Longitude of $80^0$11’5.64’’ to $80^0$22’15.80’’ and Latitude of $15^0$56’56’’ to $15^0$47’22’’. Area of Karamchedu mandal is 163.220 sq km (approximately). It has a total population of 39,356. as per 2001 census records. The maximum temperature is 42.50 and minimum temperature 24.2°C while the normal rainfall of the mandal is 950.2mm and the maximum rainfall is 1355.4mm. The location map of Karamchedu mandal is shown in Figure 1. The study area falls in Survey of India (SOI) topographical maps (66A01NE, 66A01SE and 66A05NW 66A05SW) at 1:25,000 scale.

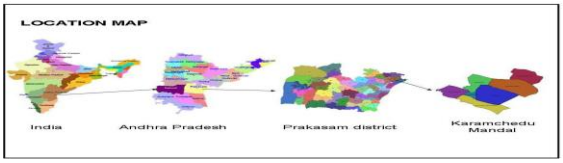

Figure 1 Showing Location Map of the Study Area

V. METHODOLOGY ADOPTED

For the development of geospatial database for karamchedu mandal, ArcGIS 10.2.1 software has been used. The land use/ land cover map has been prepared from IRS-P6 LISS-IVMX data using digital image Processing techniques. The ERDAS Imagine 8.6 software has been used for this purpose. The spatial and non-spatial databases have been created individually and then connected together through the use of common identifiers under GIS environment. A computer program has been developed in Visual Basic 6.0, implementing the ArcObjects of ArcGIS to develop the menu driven GUI (Graphical User Interface), incorporating the various elements of geospatial database. The development of GUI will make geospatial database more user-friendly and interactive.

VI. DEVELOPMENT OF GEOSPATIAL DATABASE

For creation of spatial digital database both spatial and Attribute data is required. Spatial data consist of base, transport, land use/land cover, drainage, soil and geomorphology maps. The attribute data consist of socio-economic and collateral data. For developmental planning, it is necessary to prepare thematic maps. These maps are prepared using satellite imageries and toposheets data using visual interpretation and digital interpretation techniques. The details of thematic maps created along with their attributes for the growth of geospatial database for Karamchedu mandal are discussed under successive heads.

A. Creation of Spatial Database

Familiarity of spatial land cover information is necessary for proper organization, development and monitoring of Resources. An urban plan must include an incorporated approach of spatial modeling using remote sensing and GIS. This helps in developing well-organized and cost-effective models for growth and location of industries, Education, housing, water supply, service facility and disposal system, *etc*

1) Land Use/ Land Cover Map

Land utilization pattern of Karamchedu mandal has been obtained by digitally processing the IRS P6 LISS IV MX (Figure 2). In karamchedu mandal, eighteen land use/ land cover classes have been delineated (Table 1) A spectral based strategy with supervised classification was undertaken with the support of visual analysis of a Displayed color composite. Ground truth data collection is conducted to study land use patterns and characteristics in Relation to their spectral response pattern on the satellite image. Ground truth data was necessary to select training areas before spectral based classification techniques were used to derive thematic information.

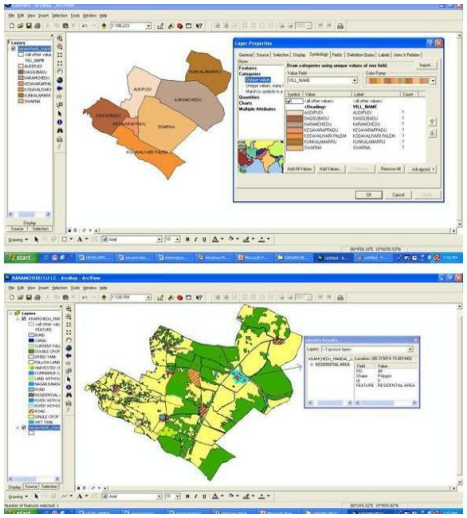

Figure 2 Landuse/ Landcover map

Class	Area (Km^2)
bund	0.34
canal	1.316
current fallow land	0.55
double crop	56.97
dried tank	0.371
fallow land	0.011
harvested crop	1.295
kommamur canal	0.599
land without scrub	0.292
nagarjunasagar jawahar canal	0.164
pond	0.033
residential area	3.74
river with water	0.917
river without water	0.527
road	2.53
single crop	83.93
wet tank	0.787

Table 1 Showing the Land use/ Land Cover area in (km^2)

2) Road Network Map

The road network map of karamchedu mandal has been prepared from Survey of India toposheet map and updated with high resolution satellite Imagery and field surveys. The road network of Karamchedu mandal has been divided in two four categories firstly, cart track, metalled road, pack track and unmetalled road. On 1: 25, 000 scale map (Figure 3).

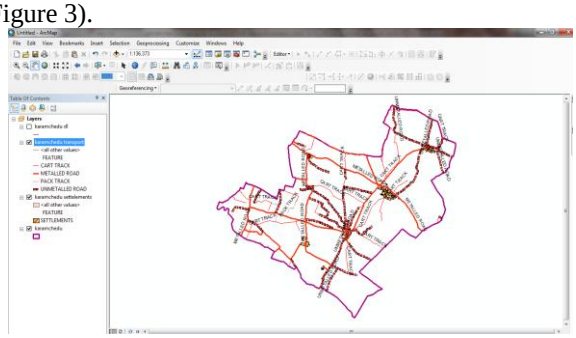

Figure 3 Transportation Map of Karamchedu Mandal

3) Water Supply Map

The water supply map along with the location of water tanks of Karamchedu mandal has been prepared from the Survey of India toposheet map on 1;25,000 scale (Figure 4).

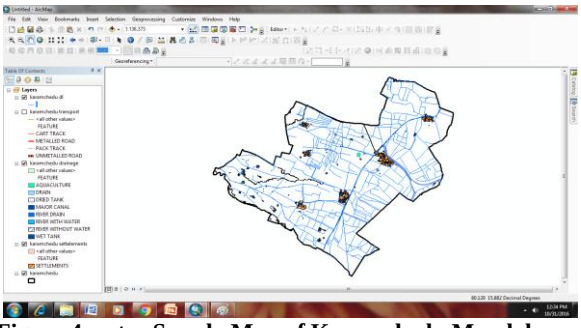

Figure 4 water Supply Map of Karamchedu Mandal

4) Geomorphology Map

The Geomorphologic map is prepared by demarcating the geomorphic units and land forms. All

available geomorphic units and forms are listed after interpreting the study area. All the listed geomorphic units and landform details are grouped/classified as per the origin like fluvial, alluvial, structural, etc. The geological details like lithology/rock types and structural details are also delineated using available geological/geomorphological maps of the area. Then these geological details are incorporated on geomorphological map for identifying the Where in the same unit in sandstone or limestone/sedimentary rock can have a good to moderate prospect. The geomorphic units are delineated based on the image characteristics like tone, texture, shape, color, associations, background, etc. The following geomorphic units are delineated in study area. (Figure 5)

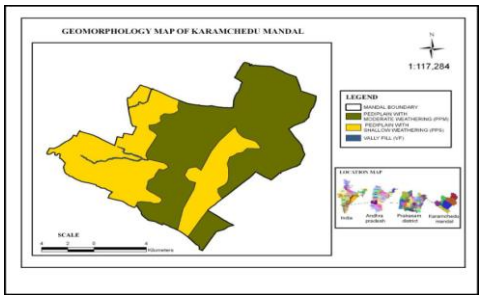

Figure 5 Showing Geomorphology Map of Karamchedu Mandal

E. Soil Map:

The soil map of Karamchedu mandal have also been generated for making the Spatial database more comprehensive. (Figure 6)

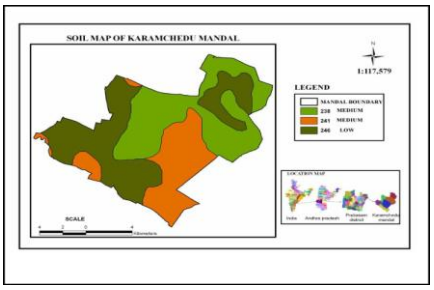

Figure 6 Showing Soil map of Karamchedu Mandal

B. Creation of Non-Spatial Database

The non-spatial database comprises of demographic and socio-economic data which has been obtained from Census 2001 and limited field visits. The non-spatial data has been entered in tabular format.

C. Integrated Geospatial Database

For the development of integrated geospatial database, the spatial database has to be appropriately connected to nonspatial database through the use of ordinary identifiers. The variety of elements of spatial database have been Properly linked with their consequent attributes. Thus, the attribute data in tabular format has been incorporated with the city map of karamchedu by joining the tables with thematic layers. The integrated geospatial database has thus been generated for karamchedu city under GIS environment.(Figure 7)

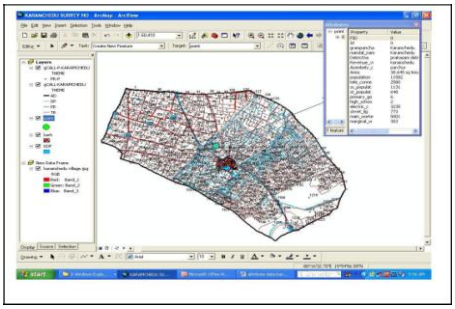

Figure 7 Showing Integration of Geospatial Data Base in GIS Environment

VII.DEVELOPMENT OF GRAPHICAL USER INTERFACE (GUI)

Visual Basic (VB), an extension of the BASIC programming language combined with a graphical user interface, is an ideal programming language for developing sophisticated professional applications for Microsoft Windows. It makes use of Graphical User Interface for creating robust and powerful applications. The GUI as the name suggests, uses illustrations for text, which enable users to interact with an application. This feature makes it easier to comprehend things in a quicker and easier way. The attribute and collateral data obtained and collected during fieldwork and the spatial data prepared during the study (maps obtained) are together related in a user-friendly manner in the form of a decision support system using VB software. This system named as a Decision Support System, is a user-friendly system in which the end user can access the information and make a decision by mere clicking the options. The system is designed in Integrated Development Environment (IDE), a term commonly used in the programming world to describe the interface and environment that is used to create the application we need and can function on a desktop computer. ArcGIS provide an infrastructure for application customization that lets one to make user-specific and user-friendly module framework to serve the specific needs of the enduser [2]. The main toolbar of the GUI developed in the present work has been

shown in Figure 8 , Figure 9, figure 10 and Figure 11 which highlights the use of the geospatial database.

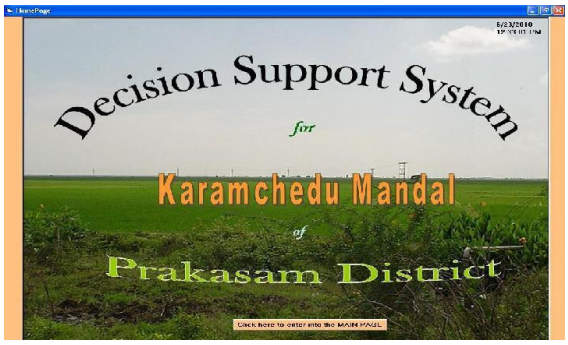

Figure 8 Showing the Main Page of GUI

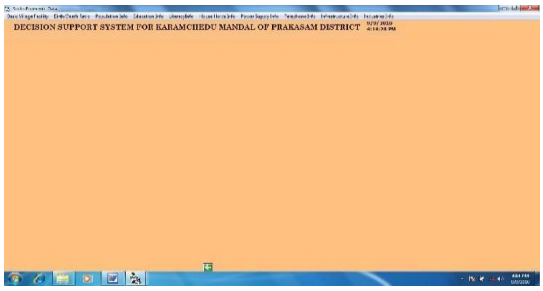

Figure 9 Showing the Main Toolbar

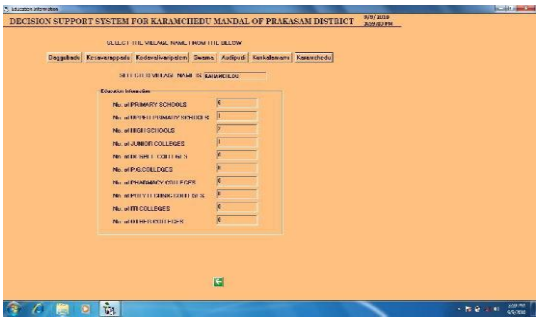

Figure 10 Showing the Socio- Economic Information of the Karamchedu Mandal

Figure 11 Showing the Facilities of Karamchedu Mandal

VIII. CONCLUDING REMARKS

A Geographical Information system (GIS) and remote sensing based geospatial database has been developed to assess map and monitor the urban Land utilization outline in karamchedu mandal. The geospatial database is modular and can be updated to accommodate supplementary information about the mandal in the form of new thematic layers in future so as to make it more inclusive. The Graphical User Interface GUI developed by incorporating the various components of geospatial database and implementing it under GIS environment will help the planners of karamchedu mandal in making more conversant decisions in the field of town planning and management. The menu driven and user interactive Graphical User Interface (GUI) developed is expected to enhance the suitability and utilization of integrated geospatial database among planners and decision makers. The GIS based geospatial database structure developed in the present work may be adopted for other urban cites by making modifications in the input parameters.

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