Applications of New & Emerging Forms of Geospatial Data in Urban Studies

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Abstract— The availability of high resolution data from remote sensing satellites has revolutionized the process of thematic mapping and geospatial database creation, specially, in the context of urban and regional planning. Further, Geographic Information System (GIS) has emerged as a powerful tool in integrating and analyzing the various thematic layers along with attribute information to create and visualize various planning scenarios for decision making. The increasing demands in urban planning and management sectors call for integrated application of remote sensing and GIS for sustainable development of urban areas. The various thematic layers (land use pattern, road network, water supply, solid waste disposal, soil map, ground water potential map, etc) can be generated which is then integrated with socio-economic and demographic data of the city to model the urban growth of the city. The present work is trying to emphasise the importance of geo spatial data in urban studies and to accentuate the future of applications of geo-spatial data in urban studies.

Key words: Urban Planning, GIS, Geospatial, Image Processing, Database, GUI

I. INTRODUCTION

With the development of new forms of geospatial data in recent years, the new and emerging forms of geospatial data, geographic information and geo social networking data are gaining much interest. Considering the fact that natural resource assessment at regional level are time-consuming, costly and often exceed practical possibilities, one of the important aims of such activities is to efficiently study the geographical patterns of land resources and to observe spatial interactions and relationships among physical variables from one place to other. This involves use of remotely sensing techniques for continuous updating of the land use/ land cover of the area of interest and for identifying environmental constraints for the development of most probable land use practices in that area. Further, the potential land degradation can also be examined based on the measured environmental variables, especially when a particular land use type is to be adopted. These aspects can be dealt with simultaneously also by establishing a simple modelling framework within a standardized system, whose procedure and outputs can be useful for planning at a predefined scale (Baja et al., 2002).

The use of remote sensing techniques in the field of urban development practices is very common because of some specific and useful features that can be summarized as:

- synoptic view of large areas;
- usable in inaccessible areas;
- fast data acquisition;
- making the invisible visible (spectral range);
- time-stamped coherent spatial information;
- Digital (semi) automatic processing possibilities.

Satellite remote sensing data is used to study and monitor land features, natural resources and dynamic effects of human activities on urban areas. A broad base map of the city and adjacent regions indicating physical features may be prepared quickly with the help of satellite imageries. Using the ground truth or interpretation key, the remote sensing data is analysed, interpreted and maps related to existing features, land use, resource analysis, etc. could be generated.

The information derived from remote sensing data has to be reliable and therefore must carry some sort of quality label. The usefulness of this quality label is visible when combining different data sets in a GIS or when using it as input for different spatial models (Hagman, 1998).

It should be noted, that this rise of big data is not only embodied in traditional academic achievements boom, but also in new characteristics covering academic community expansion and amalgamation, self-organized research institutes development, and academic-industry-media integration. Specifically, academic community expansion is embodied in a deeper cooperation among geography, urban planning and information science,

However, Geospatial data is information that has a geographic aspect to it. In other words, the records in this type of information set have coordinates, an address, city, postal code or zip code, included with them. The most obvious example is a road map. We see the rendered result, but the features on the map are stored with this type of information included in them. There are two basic types or forms of geospatial data:

- Vector

This form uses points, lines, and polygons to represent spatial features such as cities, roads, and streams.

- Raster

This form uses cells (computer often use dots or pixels) to represent spatial features. Cities are single cells, roads are linear sequences of cells, and streams are collections of adjacent cells. An example of this is remote satellite data.

II. DEVELOPMENT OF GEOSPATIAL DATABASE

The details of thematic maps can be created along with their attributes for the development of geospatial database is discussed as under:

A. Creation of Spatial Database

Knowledge of spatial land cover information is essential for proper management, planning and monitoring of resources. An urban plan must incorporate an integrated approach of spatial modelling using remote sensing and GIS. This helps in evolving efficient and economical models for development and location of industries, education, housing, water supply, service facility and disposal system, etc. The spatial data comprises of the following:

B. Land Use/ Land Cover Map

Land utilization pattern of any city should be obtained first which can be digitally processed or a final product. Land use/ land cover classes then have to be delineated: urban/ built-up, vegetation, forestland, barren land, sandy area, and water bodies. A spectral based strategy with supervised classification can be undertaken with the assistance of visual analysis of a displayed colour composite. Ground data collection should be conducted to study land use patterns and characteristics in relation to their spectral response pattern on the satellite image. Ground data is necessary to select training areas before spectral based classification techniques to derive thematic information.

C. Road Network Map

The road map of a city is to be prepared from a City Development Plan, and should be updated by field surveys. The road network has to be carefully divided in categories firstly, major roads, including the highways crossing the city, and secondly streets, comprising of the roads joining the internal habitations of the city.

D. Water Supply Map

The water supply map along with the location of water supply reservoir for should be simultaneously prepared to correlate with other data base.

E. Solid Waste Disposal Map

The solid waste disposal map of a city is another important data for geospatial database development in urban planning.

F. Soil Map & Ground Water Potential Map

The soil map and ground water potential map of a city also is to be generated for making the spatial database more comprehensive.

G. Creation of Non-Spatial Database

The non-spatial database comprises of demographic and socio-economic data which can be obtained from Census report and field visits. The non-spatial data should be entered in tabular format.

H. Integrated Geospatial Database

For the development of integrated geospatial database, the spatial database has to be properly linked to non-spatial database through the use of common identifiers. The various elements of spatial database should be properly linked with their corresponding attributes. Thus, the attribute data in tabular format will be integrated with the city map by joining the tables with thematic layers. The integrated geospatial database has thus been generated for a city under GIS environment

III. DEVELOPMENT OF GRAPHICAL USER INTERFACE (GUI)

An ActiveX DLL project in GIS can be created using Visual Basic 6.0 and Arc Objects of Arc GIS software to develop a menu driven application interface for planers and decision-makers for accessing the geospatial database in an interactive manner. The Arc Objects of Arc GIS provide an infrastructure for application customization that let one to make user-specific and user-friendly module framework to serve the specific needs of the end user (Burke, 2004).

The ActiveX DLL project comprises of various modules, class modules and forms built to complete GUI application for incorporation in ArcGIS. The GUI developed is menu driven and easy to use. It can be used easily by a person having basic computer skills but not possessing in-depth knowledge of GIS for extracting the information as per the requirements of an application. The main toolbar of the GUI developed in the present work has been shown in Figure 1 which highlights the use of the geospatial database.

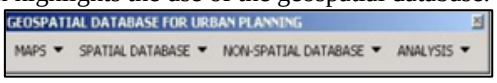

Fig. 1: Main Toolbar of GUI Developed

The developed GUI comprises of various menus and buttons to incorporate the spatial and non-spatial database which have been linked together. The GUI menu enlisting the spatial database containing land use/ land cover map, road network map, water supply map and solid waste disposal map, etc. is shown in Figure 2.

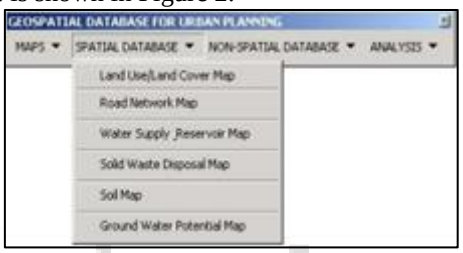

Fig. 2: Spatial Database Menu of GUI

Further, the developed GUI is integrated and implemented in Arc GIS, through the DLL file generated in Visual Basic and is shown in Figure 2

IV. THE FUTURE OF APPLICATIONS OF GEO-SPATIAL DATA IN URBAN STUDIES

Geo spatial data has been an important application for urban planning. In spite of various challenges (data quality assurance, data privacy, etc.), geospatial data will continue to play an increasing role in urban studies. Cities are considered complex systems and all the components are not working independently but interacting with each other. For the development of sustainable cities, urban planners and managers need to get a more comprehensive and up-to-date understanding of different aspects of cities. Diverse thematic maps will be developed to provide most up-to-date information of the local areas (streets or neighbourhoods). This will facilitate fast updates on local accommodation, amenities and environmental quality in cities. On the other hand, as human-centric design has an increasing influence on the development of smart and sustainable cities, the efficient and effective acquisition of individual-level data is extremely vital. To harness power for collecting individual data, an increasing number of location-based applications will be developed and used. In the near future, diverse location-based applications and embedded sensors will enable inhabitants to voluntarily collect real-time health-related information or built environment information align with their locations and activity types (e.g. work, rest, eat, sports).

In the future, new and emerging forms of geospatial data will be widely applied in addressing key issues in urban

studies, including sustainability, livability, vulnerability, pollution, health, wellbeing, housing, transport and crime. Accordingly, both hardware and software need to be upgraded to cope with massive unstructured datasets, and standardization of geospatial data structure needs to pay more attention to new and emerging forms of geospatial data.

V. CONCLUSION

A GIS and remote sensing based geospatial database can be easily developed to assess map and monitor the urban land utilization pattern of any city. The geospatial database is modular and can be updated from time to time to accommodate additional information about the city in the form of new thematic layers in future so as to make it more comprehensive. The GUI can be developed by incorporating the various components of geospatial database and implementing it under GIS environment that will help the city planners in making more informed decisions in the field of urban planning and management. The menu driven and user interactive GUI is expected to increase the acceptability and utilization of integrated geospatial database among planners and decision makers.

Cities and towns are undergoing unplanned and uncontrolled growth due to rapid urbanization, which lead to changes in land use pattern and transportation network. The lack of infrastructure facilities and utilities also has been a growing problem in urban areas. Thus, GIS is widely used as tools to digitize remotely sensed or cartographic data complemented with various ground-truth data, which are geo-coded using a global positioning system (GPS).

GIS can be used to analyze the spatial characteristics of the data over various digital layers despite lack of data of any city, and if, sequential data are available quantification of spatial changes becomes possible through overlay analysis. GIS is an expanding information technology for creating geo spatial databases with spatial information, which can be applied to both human settlements (e.g. demographic databases) and to the natural environment (e.g. distribution of populations and environmental factors). Most importantly, the combination of both types of database can ensure sustainable management. Creation of additional infrastructure in tune with the increasing population is essential for improved resource management and better living conditions. Therefore, with the availability of satellite data, spatial and non-spatial database can be created for urban infrastructure and transportation system planning, monitoring and implementation, mapping individual settlements and internal roads, urban complexes, urban utilities and urban land use mapping

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