

Implementing GIS and Remote Sensing for City planning and Management

Mr. Sujit Pavaskar, Mr. Deepak Rajaram

Audyogik Shikshan Mandal's

Institute of Management & Computer Studies (IMCOST), Thane, India

Abstract

The geographical information system (GIS) is a tool used generally for any computer based capability for manipulating geographical data. The hardware and software functions of GIS include data input, data storage, data management (data manipulation, updating, changing, exchange) and data reporting (retrieval, presentation, analysis, combination, etc.)

We all know that some GIS will fail, however, when failure does occur and a re-appraisal is performed, the lessons can be published so that other users may profit from the experience. This paper appraises the GIS implementation in city planning; it identifies the reasons for its present failure and suggests ways for a successful implementation that could be more generally applicable, especially in developing and developed countries.

Keywords

Geographical Information System (GIS), city planning, GIS data management, Geographic Information Policy and Standards, Urban Planning and development, spatial data, thematic mapping, aerial photography, urban planners

Introduction

According to the recent census study it has been found that there has been rapid growth of population around two and half times during the last fifty years. But urban India has increased nearly five times. In 2001, 306.9 million Indians (30.5%) were living in nearly 3,700 towns and cities spread across the country, and it is expected to increase to over 400

million and 533 million by 2011 and 2021 respectively.

The major concern for India's urban and town planners for efficient urban development is the major issue of continuous growth of population. New technology such as aerial as well as satellite based automated system must be used to keep an eye on the growing population. These automated systems allow us to collect lot of physical data very easily, with high speed and on repetitive basis, and together with the help of GIS it enables us to analyze the data spatially, offering new possibilities of generating various options, thereby optimizing the whole planning and development process.

One of the main applications of GIS is urban planning. Spatial database and modelling tool are used by the Urban Planners with the help of GIS. GIS applications may differ according to levels, stages and sectors. Due to the user-friendliness, low price hardware and functions provided by GIS software made it very popular in the recent years. GIS has become an important component of planning support systems. Integration of GIS with planning models, visualization, and the Internet will make GIS more useful to urban planning. The major problems in using GIS for urban planning are not the technical issues, but the lack of data, changes in organizational and staffing.

Geographic Information System

Geographic Information System has obtained an ever increasing importance and it has been widely accepted as a decision-making tool in urban planning. Geographic Information System enables us to access large volumes of data and information. It also allows in manipulating data in order to select, update, combine, and model and display the information.

Many countries have invested large sums of money for acquiring advanced computer for

developing their cities and have faced disappointment despite the advantages of a GIS in land use planning and management. Particularly in situations where there was little or inadequate understanding of computer based systems such investment have been largely unutilized. The use of technologies such as GIS has been hindered by a lack of skilled personnel, inadequate techno-scientific structures, and difficulty in transferring information to end-users and by insufficient international cooperation to boost local research and improve information flow. GIS has proved to be a very useful and powerful tool for urban planning and management.

The need for effective urban planning continues to grow as the world progresses towards development, the issue of urban planning becomes more complicated. In today's technology we focus on urban planning rather than modify the infrastructure that was built a long time ago. There can be some situation in the near future where we will need to stop urbanization which means that we will always try to fit in the previously established infrastructure. For example, Global warming, deforestation

The use of GIS in Urban Planning

GIS were developed in the late 1960s but, due to its high cost of hardware and limited capabilities in the software it was rarely used in the early days. In the initial stages of development software systems focused on computer mapping with few analytical functions. The most powerful software at that time was grid based (e.g. IMGRID). In recent years the prices of hardware, computer storage, and peripherals, decreased substantially and has made GIS more affordable, less time consuming and more workable.

GIS is one of the powerful computerized systems which integrates the data from various sources and helps in making decisions effectively for urban planning. GIS serves both as a database and as a toolbox for urban planning and development. Using the geo-relational model spatial and textual data can be stored and fetched from database. Current GIS software systems support efficient data retrieval, storage, query, and mapping. Current GIS system enables planners to extract data from their databases and input them together modeling and spatial analytical program. Geographical information can be used to make effective planning decisions which can be made by combining data from databases, surveys. GIS acts as a toolbox which allows planners to perform spatial analysis. It also enables the planners to use geo-processing functions such as map overlay, connectivity measurement, and buffering.

Land is a valuable resource that constantly appreciates in value. Due to the lack of technology in the past years it is impossible to achieve the data and information which we can gather today. The world today is advancing faster than ever with big leaps and bounds made in the field of technology. In order to achieve our objectives we need highly specialized GIS equipment, advanced software's and adequately skilled labor. Urban planning and management is a complex task. One cannot complete the urban planning and management without the use of a powerful analytical tool like GIS.

GIS finds its use in urban planning as an analytical and modeling tool. It can be applied to a wide range of addressing problems related to data base structures, simple and complex analytical models alike. GIS can be useful for conducting a feasibility study of a location for a specific purpose e.g. ascertaining the suitability of a location for the construction of a bridge or dam. GIS helps us in monitoring the spatial data. Feasibility study of even smaller structures like schools, colleges, playgrounds and hospitals is essential and can be easily conducted with the help of GIS. In the areas where variety of designs or alternative plans are required, the use of GIS can be combined with specialized and more sophisticated equipments to produce better outputs.

Many benefits in using GIS in urban planning are as follows:

- **Improved mapping** – GIS provides better access to maps. It helps us by providing improved map currency. It enables to show a particular theme connected with a specific geographic area which is also known as thematic mapping and it also has very less storage cost.
- **Efficient retrieval**- Data and information can be efficiently retrieved by making use of GIS which is very useful for urban planning and development.
- **'What if' scenarios**- Faster and more extensive access to the types of geographical information important to planning and the ability to explore a wider range of different scenarios.
- **Improved analysis**- GIS helps us to analyze the data very efficiently by making use of advanced technology
- **User friendly**- GIS has very interactive interface and it provides us with all the tools necessary for urban planning and development. It enables better communication to the public and staff.

- **Quality of service-** It provides improved quality of services, for example speed access to information for planning, development and application processing.

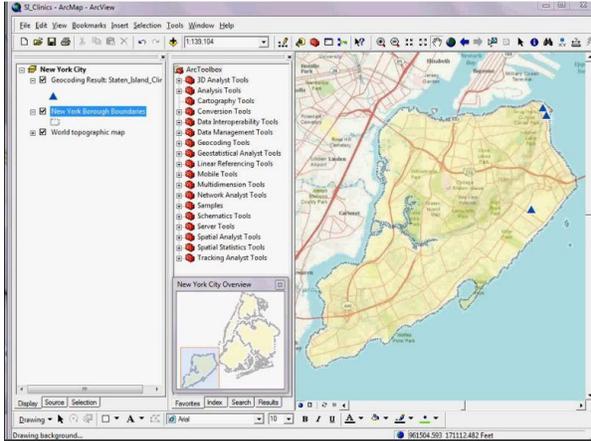


Fig. 1 Analysis using ArcGIS software

Methodology

The following methodology was adopted in the present study,

- The base map of the study area was prepared using existing map which made plotting the data on the maps easier.
- Using GIS technique, the thematic maps have been designed and prepared to show a particular theme connected with a specific geographic area.
- Plotting, Digitizing, Editing & labeling the various thematic maps, Integration and Preparation of derived maps using GIS software.

Main Requirements for Urban Planners

Apart from using mapping techniques which includes large-scale detail and quantitative representation of relief indicated by contour lines. Planners collect information on existing land utilization and their periodic updation and monitoring using GIS and Remote Sensing. By making the use of appropriate technique and methodology the same data products can be used to:

- Monitoring and updating the thematic maps on regular basis

- Study of urban building structures, population estimation and other physical aspects of urban environment
- It is easier for urban planners to detect slum areas as GIS keeps on monitoring and updating the system
- Study of transportation system used in current geographical area
- By making use of thematic maps it enables urban planners to separate different catchments areas
- Analyzing the vacant space is easier for Urban Planners.

Analysis

The analysis and overview are based on relevant literature, amnesty laws, statistics from the City Statistics Institute created in few years back. Different thematic maps for particular geographical locations, various master plans and reconstruction upgrading plans has been introduced, field surveys, data from concerned authorities and from the reports written by these authorities and organizations. The urban planners must make use of following parameters during analysis of geographical area which are listed below:

- Population information provided by the census for the particular geographical area
- Depending upon the area number of storey's can be decided
- Planning should be properly done so that sufficient public services are provided to the people
- Public services must be nearby

Urban Planning and development

GIS finds a important role in the field of Urban Planning and development. The features of GIS which makes it important in the Urban Planning and development are as follows:

- Multiple data can be entered and integrated;
- The system can maintain data consistency;
- Updating of data can be done every easily and efficiently;
- Data can be stored and retrieved in a precise manner.

Integration of spatial and other kinds of information can be done using GIS within a single system. Analyzing geographical data can be done in a

user-friendly framework which is provided by GIS. Geographical Information System allows us to manipulate and display geographical knowledge by putting maps and other kinds of spatial information into digital forms.

Due to the integrated technology of GIS and Remote Sensing it has become very popular and is widely used in different applications. These two technologies are complementary, as they are simply variants of the digital spatial data. GIS and Remote Sensing have become inseparably linked in many application fields. In the past two decades the use of spatial information, GIS, Remote Sensing information has been greatly improved and which plays a vital role in the field of urban planning and development.

Spatially accurate and timely information on land use and changing pattern is required for urban planning and development. Monitoring is very important as it provides the planners and decision-makers with required information about the current state of development and the further changes that can occur. Remote sensing and Geographical Information system (GIS) provides vital tools which can be applied in the analysis at the district and as well as at the city level.

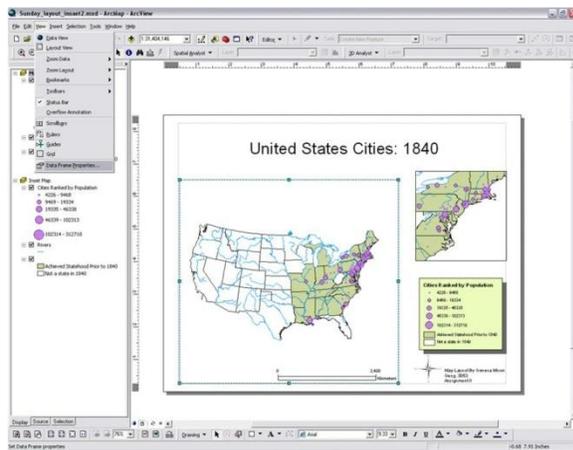


Fig. 2 Map view: Cities in United States

Remote sensing and its types

Remote sensing and GIS is the collection of information about an object or phenomenon without making physical contact with the object. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals (e.g.

electromagnetic radiation emitted from aircraft or satellites).

There are two main types of remote sensing which are as follows:

- **Passive remote sensing:**

The energy required by the passive remote sensing is collected by sensors which are provided by the environment. Reflected sunlight is the most common source of radiation measured by passive sensors. Examples of passive remote sensors include film photography, infrared, charged coupled devices, and radiometers.

- **Active remote sensing:**

Active remote sensing provides the way of transmitting energy which allows the energy to be reflected on the nearby environment and then recollects the energy using sensors. RADAR and LiDAR are examples of active remote sensing where the time delay between emission and return is measured, establishing the location, speed and direction of an object.

Remote Sensing GIS applications in urban planning

Remote sensing makes it possible to collect data on dangerous or inaccessible areas. Remote sensing applications include monitoring deforestation in areas such as the Amazon Basin, glacial features in Arctic and Antarctic regions, and depth sounding of coastal and ocean depths. Remote sensing collects the data very efficiently from the ground and also reduces the cost. Remote Sensing ensures that in the process of collecting data from environment the areas or objects are not disturbed.

Orbital platforms collect and transmit data from different parts of the electromagnetic spectrum, which in conjunction with larger scale aerial or ground based sensing and analysis, provides researchers with enough information to monitor trends such as El Nino and other natural long and short term phenomena. Other uses of remote sensing includes different areas of the earth sciences such as natural resource management, agricultural fields such as land usage and conservation, wild life, and national security and overhead, ground based and standoff collection on border areas.

By satellite, aircraft, spacecraft, buoy, ship, and helicopter images, data is created to analyze and compare things like vegetation rates, erosion, pollution, forestry, weather, and land use. These things can be mapped, imaged, tracked and observed using remote sensing. The process of remote sensing is also helpful for city planning and development, archaeological investigations and analysis, military observation and collecting data from surface features of the Earth.

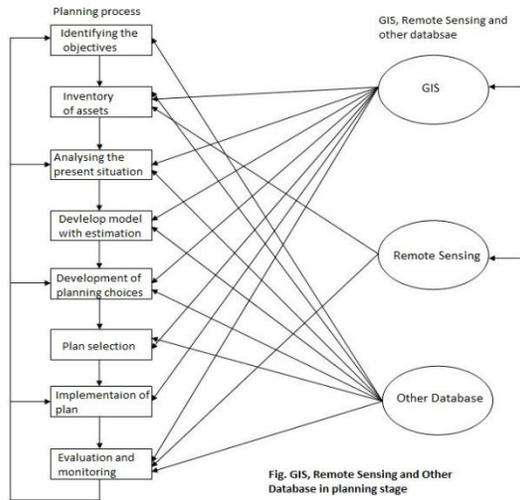


Fig 3. GIS, Remote Sensing and Other Database in planning stage

Use of Aerial Photography in Urban Planning

Urban planning and development makes use of aerial photographs for monitoring and analysis. In India, city planning and development has been largely confined to aerial photography. It is being used for generation of base maps and other thematic maps for urban areas and development. It has also proved to be cost, time effective and reliable. Aerial photography provides information pertaining to land features, land use, built up areas, city infrastructure, physical aspects of environment etc. Aerial photography uses various types of cameras and sensors black and white, color, color infrared. Because of security concerns related to aerial photography, the use of photogrammetric techniques was confined to smaller cities. Aerial photographs provide information that can significantly improve the effectiveness of city and town planning and management in India. They are also relatively low in cost, accurate, reliable and can be obtained on desired scale. But they are not useful in large metropolitan areas due to security issues.

For obtaining accurate land usedata the following points should be considered:

- **Imagery characteristics:** Characteristics of imagery includes scale of the photography, resolving power of film, adjusting contrast and sharpness, wavebandused, format of image.
- **Land use characteristics:** This includes relationship between form and function, multiple utilization of land, type of land, the amount of ground control, any change since imagery was obtained.
- **User characteristics:** interpretation skills of individual planner, use of stereoscopic techniques which creates impression of depth and solidity as the photographs are taken from different angle.

Application of Remote Sensing

Remote Sensing technology may lead to innovation in the planning process in various ways:

- (i) Due to the use of digitization in making base maps for planning sudden changes in base maps or layout plans can be updated at regular intervals etc. Superimposition of any two digital maps which are on two different scales is feasible. Due to the capability of digital maps facilitates insertion of fresh survey or modified maps into existing base maps. Similarly superimposition of revenue maps on base maps with reasonable accuracy is of great advantage compared to manually done jobs.
- (ii) Since all the information and maps are available in digital format, combining various layers of data and information about a feature from satellite imagery, planning maps and revenue maps is feasible with the help of various image processing software like ERDAS Imagine, ENVI and PCI Geomatica, ILWIS. Such super imposed maps in GIS software like Map info, Arc View, Auto CAD Map and Arc GIS etc. provide valuable information for planning, development, implementation and management of urban areas.
- (iii) The techniques used by Remote Sensing are extremely helpful for identifying change detection analysis and selection of sites for specific facilities, such as hospital, playgrounds, schools, colleges, restaurants, solid waste disposal and industry. An

attempt has been made here to demonstrate the potentials of remote sensing techniques in base mapping, land use and land cover mapping, urban change detection and mapping, urban infrastructure and utilities mapping, urban population estimation, management etc.

Problems and Issues

Many problems arise when Geographical Information System (GIS) is used during interpretation of different urban land use, land cover features. While making use of GIS in analyzing geographical area another problem which can arise is that some of the buildings may or may not be identified. On the contrary, many of the times individual houses cannot be always being identified, the exact position or boundary of the houses and city blocks can often be identified; sometimes it can be interpreted through satellite images.

In this context, GIS and urban remote sensing must be able to provide planners with certain key, data sets that are relevant to urban studies like location and extent of urban areas, the primary infrastructure and transportation networks, ability to monitor changes in these features over time and space.

Conclusion

- Remote Sensing and GIS can provide us with robust results by extracting urban land cover information.
- In developed and developing countries the use of GIS plays a very important role. In the past few years many planning departments have shifted their focus from mapping systems to GIS.
- Due to user-friendliness and number of function providing capability has made GIS very popular.
- The remarkable decrease in the prices of hardware components has made GIS affordable to the end-user and a comfortable tool for planning.
- Recent advances and integration of GIS with geo-spatial planning models, visualization, and the Internet will make GIS more useful to urban planning and development.

- Today, the main issues of using GIS in urban planning are not only the technical issues, but lack of data and information.

Acknowledgment

Sujit Pavaskar and Deepak Rajaram would like thank our college for providing us an opportunity to do the research on this topic. We would also like thank Proff. Ramesh Mahadik for approving this research topic and providing us constant support and guidance.

References:

1. <http://www.gislounge.com/gis-urban-planning/>
2. <https://www.esri.com/library/bestpractices/urban-regional-planning.pdf>
3. <http://www.esri.com/industries/planning>
4. <http://geospatialworld.net/paper/application/ArticleView.aspx?aid=1420#>
5. http://www.gim-international.com/issues/articles/id424-Benefits_of_GIS_in_Urban_Planning.html
6. http://gisp.asia/blog_gisp/?page_id=332
7. <http://www.gisdevelopment.net>
8. <http://geospatialworld.net/Paper/Technology/ArticleView.aspx?aid=25039>

1. **Mr. Sujit Pavaskar – Currently pursuing Master’s in Computer Application (Third year) at ASM’s Institute of Management & Computer Studies (IMCOST), Mumbai.**
2. **Mr. Deepak Rajaram – Currently pursuing Master’s in Computer Application (Third year) at ASM’s Institute of Management & Computer Studies (IMCOST), Mumbai.**