Need of Remote Sensing and Geographical Information System in Urban Planning, a Case of Housing Colony in Bhopal City, Madhya Pradesh, India

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Abstract— *Remote Sensing is the science and art of obtaining information about an object, area or phenomenon through analysis of the data acquired by the device which is not in contact with the object, area or phenomenon under consideration.*

Geographic Information System (GIS) is an organized activity by which people measure and represent geographic phenomena then transform these representations into other forms while interacting with social structures. The primary benefit of Geographical Information Systems is the ability to interrelate spatially multiple types of information assembled from a range of sources.

In Urban Planning, GIS is one of the most important tools. Urban planners use GIS both as a spatial database and as an analysis and modeling tool. The applications of GIS vary according to the different stages, levels, sectors, and functions of urban planning. In this paper we explore the connections between GIS and urban neighbourhood spaces with example of colonies in Bhopal city, Madhya Pradesh.

The paper concludes with a description of a specific application of GIS functions used for spatial planning analysis. It discusses the scope of GIS and tries to overcome the limitation of analysis part in planning studies. It further elaborates the accuracy, accessibility and visibility dimension with the example of housing colonies in Bhopal city.

Key Words *— Remote Sensing, GIS, Housing Colonies.*

Introduction -

Remote Sensing:

Remote Sensing is defined as the science and art of obtaining information about an object, area or phenomenon through analysis of the data acquired by the device which is not in contact with the object, area or phenomenon under consideration. It is the measurement of object properties on Earth's surface using data acquired from aircraft and satellites. It attempts to measure something at a distance, rather than in situ, and, for this research's purposes, displays those measurements over a two-dimensional spatial grid, i.e. images. Remote-sensing systems, particularly those deployed on satellites, provide a repetitive and consistent view of Earth facilitating the ability to monitor the earth system and the effects of human activities on Earth.

Remote sensing involves, Measuring and recording of electromagnetic energy by the sensors mounted on aircraft or satellite reflected from or emitted by object from vantage point above the surface and Relating of such measurements to the nature and distribution of surface materials and atmospheric conditions.

There are many electromagnetic (EM) band-length ranges Earth's atmosphere absorbs. The EM band

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ranges transmittable through Earth's atmosphere are sometimes referred to as atmospheric windows.

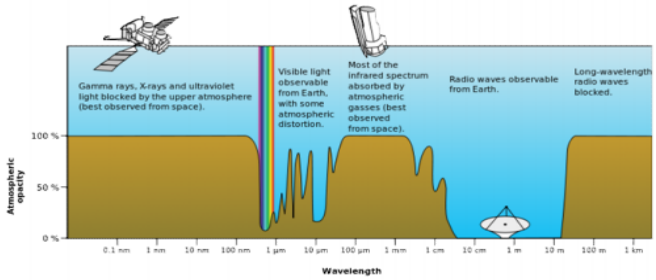

Figure: 1 Rough plot of Earth's atmospheric transmittance (or opacity) to various wavelengths of electromagnetic radiation.
Source: Vectorized by User:Mysid in Inkscape, original NASA image from File:Atmospheric electromagnetic transmittance or opacity.jpg.

The human eye only detects, viz. the reflective solar radiance humans actually see, that part of the EM scale in the band length range 0.4 – 0.7 µm. But remote sensing technology allows for the detection of other reflective and radiant (e.g. thermal) energy band-length ranges that reach or are emitted by Earth's surface, and even some Earth's atmosphere reflects, e.g. the EM reflective qualities of clouds. Hence, for viewing purposes red, green, and blue (RGB) false color assignments are used to express the reflective qualities of objects in these EM band-length groups, and the combination and mixing of these false color assignments express the true physical reflective qualities of all objects present in an image.

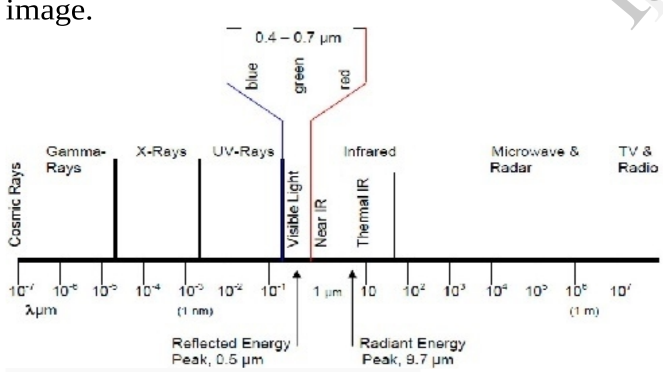

Figure: 2: The electromagnetic Spectrum.

Geographic Information Systems (GIS):

Geographic Information System (GIS) is an organized activity by which people measure and represent geographic phenomena then transform these representations into other forms while interacting with social structures.

The primary benefit of Geographic Information Systems (GIS) is the ability to interrelate spatially multiple types of information assembled from a range of sources. These data do not necessarily have to be visual. Shape files are helpful for interpolating and visualizing many other types of data, e.g. demographic data. Many study and research models rely on the ability to analyze and extract information from images by using a variety of computer available research tools and then express these findings as part of a project with images in a variety of layers and scenes.

When utilizing satellite images to assess most types of land cover change, primarily those involving change in vegetation coverage, variations in climate must be considered. For better control and accuracy in these analyses, comparing images acquired during the same month or season is advisable. But due to the limited availability of satellite images, obtaining materials corresponding both spatially and temporally to the location and period under research are not always possible. Furthermore, annual and seasonal climate data are not always available for the region or temporal period being researched. Sometimes, changes in average rainfall, temperature, etc. must be inferred using more macro regional or global data.

Urban planning and GIS:

Urban planning is one of the main applications of GIS. Urban planners use GIS both as a spatial database and as an analysis and modelling tool. The applications of GIS vary according to the different stages, levels, sectors, and functions of urban planning. With the increase in user-friendliness and functions of GIS software and the marked decrease in the prices of GIS hardware, GIS is an operational and affordable information system for planning. It is increasingly becoming an important component of planning support systems.
Recent advances in the integration of GIS with planning models, visualisation, and the Internet will make GIS more useful to urban planning. The main constraints in the use of GIS in urban planning today are not technical issues, but the availability of data, organisational change, and staffing.

GIS deals with spatial objects, their properties, and their relationships to each other. Planners analyze the past and the present, and then project to the future. GIS, on the other hand, is not in itself future-directed. However, it does a very good job of enabling us to store, process and visualize current and past information. Models are used to assist planners in looking to the future. They permit scenario building and provide an important aid to future-directed decision-making. Planning, however, is more than models and GIS. While databases and spatial information systems are important components of current planning activities, planners deal with constituencies, power relationships, and complex urban and regional problems.

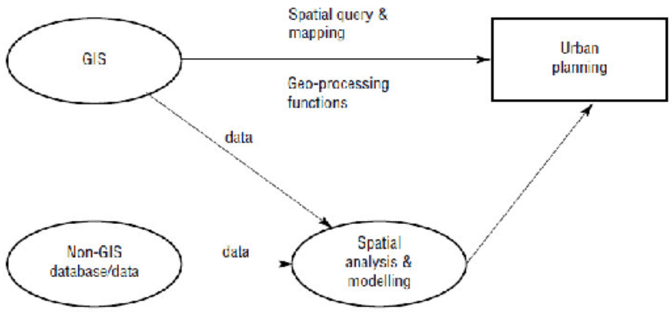

Figure: 3: Linkages of GIS and Urban Planning.

Current GIS support efficient data retrieval, query, and mapping. Planners can also extract data from their databases and input them to other modelling and spatial analysis programs. When combined with data from other tabular databases or specially conducted surveys, geographical information can be used to make effective planning decisions. Database management, visualisation, spatial analysis, and spatial modelling are the main uses of GIS in urban planning (Levine and Landis 1989; Marble and Amundson 1988;Webster 1993, 1994). GIS is used for the storage of land use maps and plans, socioeconomic data, environmental data, and planning applications. Planners can extract useful information from the database through spatial query. Mapping provides the most powerful visualisation tools in GIS. It can be used to explore the distribution of socioeconomic and environmental data, and display the results of spatial analysis and modelling exercises. Spatial analysis and modelling are used for spatial statistical analysis, site selection, and identification of planning action areas, land suitability analysis, land use transport modelling, and impact assessment. Interpolation, map overlay, buffering, and connectivity measurement are the most frequently used GIS functions in spatial analysis and modelling. The use of the above functions varies according to different tasks and stages of urban planning.

The many benefits in using GIS in urban planning include (Royal Town Planning Institute 1992):

● improved mapping – better access to maps, improved map currency, more effective thematic mapping, and reduced storage cost;

● Greater efficiency in retrieval of information;

● Faster and more extensive access to the types of geographical information important to planning and the ability to explore a wider range of 'what if' scenarios;

● improved analysis, better communication to the public and staff;

● improved quality of services, for example speedier access to information for planning application processing.

Urban planning involves many functions, scales, sectors, and stages. In general, the functions of urban planning can be classified into general administration, development control, plan making, and strategic planning. General administration and development control are relatively routine planning activities, whereas plan making and non-routine strategic planning are undertaken much less frequently. The scale of the planning area covered can range from a whole city, to a sub-region of a city, a district, or a street block. The most frequently involved sectors of urban planning are land use, transport, housing, land development, and environment.

Case Study: Aradhna Nagar Colony, Bhopal

The use of GIS software in urban planning for showing landuse of small colony in Bhopal is explained here by following steps:

Step 1: Taking satellite image for base map preparation:

Satellite image of different resolution taken by different satellite can be used for this purpose. Satellite image from Google Earth was collected for same purpose and colony boundary was identified.

The satellite image was georeferenced in WGS_1984_UTM_Zone_43N coordinate system and Transverse_Mercator projection.

Figure: 4: Satellite image (Google Earth) of Aradhna Nagar Colony, Bhopal

Step 2: Layer Management: Roads

After georeferencing and site boundary delineation, area of colony was found 167406 sq.m.

We created layer of roads and shown road network in colony. The area and percentage of this landuse (roads) had been calculated which was found 28992 sq. m. and 17.32% respectively.

Figure: 5: Digitized satellite image (Roads) of Aradhna Nagar Colony, Bhopal

Step 3: Layer Management: Other Land use

After digitizing roads other land use such as built cover and open spaces were also digitized and area with percentage calculated which found as follows:

Table 1: Area Statement of Different Land use

Land use	Area (Sq. m.)	Percentage
Roads	28992	17.32
Built Cover	63354	37.84
Open Space	10619	6.35

Figure: 6: Digitized satellite image (Roads, Built Cover, Open Space) of Aradhna Nagar Colony, Bhopal

Step 4: Spatial Analysis for Road Clearance by using tools in GIS:

Intersection tool is useful to identify the overlap area while buffer helps to create a boundary around any shape. Its application is useful to find encroachment and reserving the space along roadside for various purposes such as footpath, road widening, service lines etc. These both tools might be integrated in a model which can be used for road clearance. Model was built as follow:

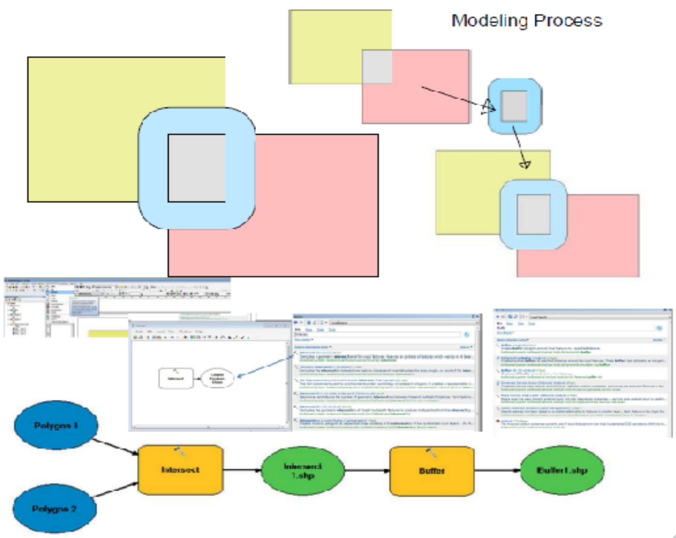

Figure: 7: Model Building for intersection and buffer

<u>Process of Model Building</u> –

Road polygon and Built Cover Polygon were fed to intersection tool and the new intersect shape was further fed to buffer tool which gives the final shape of buffer.

By using this model encroached area of built cover on road was identified which was found 36 sq.m also 1.2m offset to roads, area having 10260sq.m was reserved for footpath.

Figure: 8: Identified encroached built cover on road and 1.2m buffer along road for footpath

Conclusion:

Remote Sensing and GIS is the most useful tool for urban planning. With the above example we can conclude that GIS can help us for doing spatial planning analysis. It proves that the scope of GIS tries to overcome the limitation of analysis part in planning studies, such as lengthy area calculation and mapping. It further shows the accuracy in terms of area calculations and mapping. We have tried to improve accessibility and visibility dimension in terms of encroached area of built cover and footpath along road side.

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