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Geoinformatics Technology Use in Town Planning

Sandeep Shukla[1], Dr. Rekha Vishwakarma[2]

[1]Research Scholar, Siddharth University Kapilvastu, Siddharth Nagar, U. P., India
Email: Sandeepshukla7870[at]gmail.com
[2]Associate Professor, M. L. K. PG College, Balrampur, U. P., India
Email: drrekhavishwakarma1969[at]gmail.com

Abstract: ***Nearly half of the glob's Population now resides in town areas. People are leaving rural areas in developing nations where the population is rapidly expanding. In less than two decades, over two billion people will be pushed into town areas, some of which are already crowded by the combination of these factors. The circumstances that many new town residents find there only make things worse. The majority of town growth occurs without formed planning constraints, which exacerbates hygienic and health issues while also raising economic and social pressures. The ability to bring people together, share and improve ideas, help decision making and evaluate projects are the key benefits of geoinformatics technology in town planning.***

Keywords: Geoinformatics, Town Planning, Remote Sensing, GIS

1. Introduction

Town is occasionally used as a substitute for city or country. Sometimes, the word town is short for township. On the basis of their economic character, towns today can be distinguished from townships. In a town, the majority of the population will typically rely on manufacturing, commerce and public services for a living as opposed to primary sector industries like agriculture or allied activities. The modern phenomenon of extensive suburbans growth, satellite urban development, and the migration of city dwellers to villages has complicated the definition of towns further by resulting in communities that are urban in terms of their economies and cultures but lack other characteristics of town localities. Town planning is a technical and political process concerned with the development and design of land use and land cover including water, air and the infrastructure passing into and out of town areas, such as transportation, communications and distribution networks. Town planners design cities and create plans for future improvements and growth. These plans include much of what you see when moving through an urban environment: streets, parks, public spaces, and more. Town planners deduced that situating people far from industrial centers, foul odors and pollution would improve public health.

It is during this time that zoning ordinances came into effects separating city areas into residential, business and industrial districts. Town planners, therefore, must also plan for what to do with the vacant land created when people or businesses more away. Town planners do their best to plan for an unpredictable future. Fortunately for today's town planners, technology has advanced in a way that can help. Geoinformatics (Remote sensing and Geographical Information System (GIS)) have become an in valuable tool for town planners, providing support for database creation, spatial analysis and modeling and visualization. “Geoinformatics is the science and technology concerned with structure and character of special information, its capture, classification and qualification as well as its storage processing, portrayal and dissemination including the infrastructure required to secure this information's best use”by P. L. N. Raju, the author of Fundamentals of Geographic Information Systems. Geoinformatics has been grouped broadly under technical geography along with fields like geographic information science. The technologies enabling the procedures of spatial data capture, analysis and display from the basis of Geoinformatics. The theory and applications of geodesy are included in and significantly relied upon in both geomatics and geoinformatics. Geographic information system (GIS), aerial image interpretation, web mining and other digital spatial data sources are becoming more and more important in geography and earth science. Geoinformatics including human-computer interaction, wired and wireless networking technologies, Geospatial analysis and modeling the creation of Geospatial datasets and information systems architecture. Geoinformatics analysis geoinformation via geocomputation and geovisualiztion. Many fields benefits from geoinformatics including town planning and urban planning, land use management, agriculture, public health etc. Geoinformatics becomes very important technology to decision makers across a wide range of discipline, researchers and academia, industries, environmental agencies, national survey and mapping organizations.

2. Remote Sensing Applications in Town Planning

India's urban development complexity is so extreme that it requires immediate attention and thoughtful physical planning of the cities and towns (Sokhi and Rashid, 1999). The dynamic character of land use environmental necessitates both small and large scale analysis. Therefore, it is necessary and fundamental for policy makers to integrate like remote sensing into town planning and management. Up to present, Maps and land survey records from the 1960s and 1970s were used for urban studies, but now the trend has shifted to using digital, multi spectral image acquired by EOS and other Sensors. First-generation satellite sensors like Landsat MSS and WAS started the trend toward employing remotely sensed data in town research, which was then fueled by a variety of second-generation satellites like Landsat TM, ETM+, and SPOT HRV. The recent release of a third generation of

satellite sensors with a very high spatial resolution (5 meters/pixel) is encouraging. For town applications, the combined high resolution PAN and LISS III data can be used successfully. Town planning greatly benefit from data from IRS P-6 satellites with onboard sensors, particularly LISS IV Mono and Multi spectral (MX) with 5.8 meter/pixel spatial resolution. The availability of ever-higher resolution satellite imageries is a miracle of remote sensing technological advancement. These include the IRS-P6 Resourcesat imagery with a 58 metre resolution in multi spectral mode, the IRS-1D Pan image with a 5.8 metre resolution, the Cartosat-I imagery with a 2.5 metre resolution and stereo capabilities, the Cartosat-II imagery with a 1 metre resolution, the IKONOS imageries of Space Imaging with a 4 metre in multi spectral mode and a 1 metre in panchromatic mode, the Quickbird imagery of With substantially increased technical limitations, these high resolutions of the sensors offer a new methodology in the application.

In addition to being valuable for cartographic purposes, P-6 data can be used for cadastral mapping, updating terrain visualization, creating a national topographic database, planning utilities, and other GIS tasks that are required for metropolitan areas. The satellite will be useful for creating 2-5 metre contour maps and will offer cadastral level information up to a 1: 5, 000 scale (NRSA 2005). To extract valuable information from an image, numerous more stages of digital image processing and modeling are needed. Depending on the demands of the particular challenge, appropriate techniques must be adopted for a certain theme. The integration of many different spatial attributes from many sources with the remote sensing data is necessary since remote sensing may not give all the information required for a comprehensive assessment. Through the use of GIS, spatial data are integrated and their combined analysis is carried out. It is a system that uses computers to help in the collection, storage, retrieval, analysis, and 9 presentations of both geographic and non-spatial attribute data.

The use of remote sensing technology can result in innovation in the planning process in a number of ways, including:

i. The digitization of planning base maps and different layout plans has made it easier to update base maps whenever changes in terms of land development or other factors have occurred. Due to their lack of size, digital maps offer versatility. It is possible to superimpose any two digital maps with various scales. Digital maps' capacity to insert new survey data or changed base maps makes this possible. Similar to how revenue maps may be reasonably accurately superimposed on base maps, this technique has many advantages over manual work.
ii. Due to the availability of information and maps in digital format, it is possible to correlate different layers of data about a feature from satellite imagery, planning maps, and revenue maps with the use of image processing tools such as ERDAS Imagine, ENVI, and PCI Geomatics, ILWIS. Such superimposed maps, available in GIS programmes like Map info, Geomedia, Arc View, Auto CAD Map, and Arc GIS, offer useful data for urban planning, implementation, and management.
iii. For change detection analysis and site selection for certain facilities, such as hospitals, restaurants, solid waste disposal facilities, and industries, remote sensing techniques are very helpful. Here, an effort has been made to show how remote sensing techniques can be used for base mapping, land-use and cover mapping, detecting and mapping urban change, mapping urban infrastructure and utilities, and managing urban population.

2.1 Land Consumption Rates: Consumption rates are the proportions of land usage to population growth. They are a reliable indication of the how effectively land is being used. These ratios are used by remote sensing sensors to direct town planners and designers in managing town expansion at various scales. Hence ensuring effective and efficient land use.

2.2 Aerial photography and satellite data in town studies: For the majority of purposes, it is necessary to classify specific observations into categories. There isn't a single best category for describing land use and land cover. Even when an objective numerical approach is utilised, there are various points of view in the classification process, and the process itself has a tendency to be subjective. In reality, there is no rational reason to believe that a single, thorough inventory would suffice for more than a short period of time, given how frequently land use and land cover patterns change in response to changes in the demand for natural resources. Table 1 provides a portion of the proposed urban land use classification for the National Urban Information System (NUIS).

2.3 Town Environmental: The town environment is a crucial factor in figuring out a particular towns quality of life and how it affects the border environment water shortage, industrial air pollution, poor waste management etc. Are a few environmental challenges that have been noticed throughout town planning. Information is generated by remote sensing using environmental parameters. As a result, it makes it possible for town planners to keep an eye on urban environmental problems and establish and establish sensible rules to govern them.

2.4 Town Infrastructure: Town infrastructure refers to the services, buildings and installation required for a town to operate. They consist of transportation systems, public building and network of power and water. The town is ability to increase its infrastructure development opportunities is greatly assisted by remote sensing.

Table 1: Remote Sensing Satellites/Sensors and their Application in Town Studies

Platform and Sensor System	Spatial resolute (m, pixel)	Year of operation	Mapping scale	Extractable Information
Landsat (MSS) IRS-1A & 1B (LISS-I)	80 72	1972 1988 & 1991	1: 1,000,000 1: 250,000	Broad land-use/land-cover and urban sprawl
Landsat TM IRS-1A & 1B (LISS-II) IRS-1C & 1D (LISS-III) SPOT HRV-I (MLA) IRS-1D(LISS-IV)	30 36 23 20 5.8	1982 1988 & 1991 1995 & 1997 1998 2003	1: 50,0000 1: 5,000	Thematic data for broad structural plans and spatial strategies
ASTER VNIR (0.52-0.86 µm) SWIR(1.60-2.43 µm) TIR(8.125-11.65 µm)	 15 30 90	1999	1: 250,000 1: 50,000	Land-use/land-cover, urban sprawl, ecological monitoring data
SPOT HRV-II (MLA) IRS-1C &1-D (PAN)	10 5.8	1998 1995 & 1997	1:25,000 1:10,000	Data for land-use/land-cover for urban area
MOMS-II	4	1983	1:8,000	Land-use/land-cover details
IKONOS Quickbird	1.0 0.61	1999 2001	1:4,000 1:2,000	Cadastral map, detailed information extraction for urban planning and infrastructure mapping
CARTOSAT-1 CARTOSAT-2	2.5 1.0	2005 2007	1:4,000 1:1,000 1:2,000	Large scale cartographic work and DM generation cartographic applications at cadastral level, urban and rural infrastructure development and management
ALMAZ	1.0		1: 4,000 1: 2,500	Ground plans and urban design.
RESOURCESAT-I (LISS-IV)	5.8	2003	1:10,000 /1:4,000	Monitoring the urban growth, Inventory of land-use/ land-cover.

Source: Modified after Atiqure Rahman (2006)

Table 2: Urban Land Use Classification

Level I	Level II	Level III	Level IV
Built up	Built up (Urban)	High Density residential	High rise apartments/ flats
	Built up (Rural)	Medium Density residential	Medium rise apartments/flats
		Low Density residential	Low rise apartments/flats
			Row houses
			Slum and squatters
		Industrial	Service industry
			Light industry
			Extensive industry
			Heavy industry
			Hazardous
		Mixed built up	
		Recreational	Parks/gardens
			Playgrounds
			Historical monuments
			Cinema halls
			Swimming pools
			Major function halls
		Public and Semi Public	Educational
			Hospital
			Cantonment
			Religious
			Government institutions
			Petrol Pump
			Fire stations
			Police stations
			Others
		Communications	Post Office
			Telegraph office
			Radio TV station
			Others
		Public utilities and facilities	Water treatment plant
			Landfill/dumping
			Electric power plant
			Sewerage treatment plant
			Others
		Commercial	
		Transportation	Bus terminus
			Railway stations
			Air port
			Others
		Reclaimed/vacant land	Layouts/plotted land

2.5 Base maps for urban areas: Base maps are large scale maps that show prominent physical and cultural characteristics and are a requirement for urban planners. For surveying difficult-to-survey remote terrain and high-altitude towns like Leh, Puri, Himachal Pradesh, etc., base maps can also be created using orthophotographs. In many cases, remote sensing has made data collecting for base maps possible where field surveying has been hindered by factors like expense, timing, and terrain. These foundation maps can serve as the framework for the generation of information that was previously unavailable to community, regional, and urban planners as well as management of natural resources. For the ever-increasing demand for current, precise base maps at a scale of 1: 5, 000 for urban planning purposes and the development of new residential sites, IRS P-6 (multispectral) data with 2.5 m/pixel spatial resolution can be used.

Table 3: Town planning stages and base map requirements

S. No	Planning stage	Base map scale
1.	Master Plan / Landuse Plan	1:10,000 & larger
2.	Zoning Plan	1:4,000
3.	Inner City/Urban Cadestre	1:1,000 to 1:2,000
4.	Urban slums/Unauthorised Developments/ Encroachments	1:5,000 to 1:1,000

2.6 Town exposure and Sustainability: When people, building homes and other tangible are situated in hazard-prone locations, the town is said to be exposed. When this happens, there is a significant danger of exposure to hazards due to increased population expansion, migration and economic development. Towns grow as a result of the exposure.

Remote sensors use a variety of technical and sources to gather data for exposure data sets. It enables town to manage and mitigate the expected risk when it is hard to avoid.

2.7 Town Growth and Land Use Pattern: The land use pattern on the other hand is set up for a number of reasons. These patterns include barren lands, cultivable waste land and forest areas. Therefore, Knowledge about town planning collected by remote sensing contributes in town planners ability to track and assess the development of towns and patterns of land use. Remote sensors also help in the analysis of historical land use and land cover imagery time series. One of the most important natural resources is land. Urban population increase, urban sprawl-induced land use changes, industrial development, and other factors are causing unplanned and inappropriate use of land, which is turning usable land into wastelands. The strain on the land is controlled by changes in the pattern of land use and land cover over time (Sengupta and Venkatachalam, 2001). Urban growth is so dynamically complex that it necessitates the immediate perspective planning of cities and towns (Sokhi and Rashid, 1999). Remote sensing use to in sustainable development to measure, integrate and present critical information for decision making while undertaking such developments in town. A system of classifying land uses is necessary for the mapping and monitoring of land use and land cover. The infrared False Colour Composite (FCC) image is one of the most often utilised data formats for information extraction regarding the land-use and land-cover. By using image interpretation, which typically employs three techniques—photo interpretation, spectral analysis, and data integration—information about the physical world is extracted from such images. Table 4 summarises the picture features and visual interpretation methods of various land-cover and land-use categories as described by Prasad and Sinha (2002).

2.8 3D and 4D Town Modelling: To imagine a certain town or terrain, 3D are employed. Monitoring a city's dynamics and alterations is possible in 4D. Additionally, the technical process of monitoring the city can make use of 3D and 4D models. Town planners can utilize computerized visualization techniques to entice the public to participate in town planning with the use of information gathered from remote sensing.

2.9 Radar Application in Town Setting: In a town setting, radar application entails identifying and finding items that reflect signals such as vehicles, people and the surrounding environment. Town planners and urban designers can improve the monitoring and detection of the targeted objects in town utilizing radar application methods by using remote sensing. Which offers the pertinent information they need.

2.10 Town Population Modeling: population modeling is a tool used to identify and describe the relationship between a subjects physiological characteristics and observed drug exposure or response. Town planners use the information obtained from remote sensing to organize for the appropriate decision against the effects of population modeling.

2.11 Synthesis and Analysis of Town Data: Combining and looking at concepts from a specific project that is going on in a certain town are part of data synthesis and analysis. It displays products, pattern, and components that work well together in a city. By giving a variety of opinions or ideas, it also contributes to the evaluation of the concepts.

2.12 Town Expansion: Town Expansion refers to the quick geographic expansion of cities and towns. It is brought on by industrialization, the growth of educational and recreational amenities, the expansion of transportation and communication networks and the movement of people seeking white collar jobs from rural to urban area. In order to produce data that will help town planners take into account changes in the city during planning, remote sensing is used in the expansion of towns.

Table 4: Land-cover/land-use and their image characteristics

Land-cover/land- use	Image characteristics
1. Settlements	Light grey clustering with particular patterns for the urban area. There may be brownish maroon patches for in between vegetation. For the rural settlement there occur no particular patterns of such image characteristics.
2. Agriculture	Identify rabi if the month of data acquisition is January or February or March and colour is brown red. (a) For the kharif crops same characteristics in image occur if the image data are acquired in the month of September, October or November. (b) Fallow land is identified by light grey colour within cropped area (red colour). (c) Plantation occurs as brownish maroon patches.
3. Forest (a) Dense forests (b) Degraded forest (c) Forest blank (d) Forest plantation	Dense forests are identified by dark red colour patterns. In the case of degraded forest the dark red colour patterns contain small brown or white patches. The blanks in the forest show creamy patches in the dark red/background. Forest plantations are identified by dark red colour sign of particular pattern.
4. Waste Land (a) Muddy water logging (b) Clear water logging (c) Temporary water logging (d) Permanent water logging (e) Marshy area water logging (f) Gullied land (g) Land with scrub (h) Land without scrub (i) Sandy area	Muddy water logging occurs as blackish or deep blue spots while clear water logging area is identified by dark/bright blue patches. Comparing the images of rainy season and out of rainy season identifies temporary and permanent water logging. Marshy area is recognized as a sign of vegetation (red/pink spots) in the water logged (blackish blue/bright blue) area. Gullied land occurs as white/grey spot. The image of land with scrub contains white patches in the land area. Sandy area is classified as bright white coloration along the course of river.
5. Water bodies (a) River/stream (b) Canal (c) Lake/ reservoirs (d) Embankments	River/stream is identified as long non-linear path coloured with dark blue/bright blue line in white background. Canals are identified as line segments sign of water bodies. Lake/reservoirs are identified as patterns along the river. Embankment occurs as light grey structure along the river.
6. Others	Grasslands are identified as uneven appearance characterized by red (light to medium grey tones) Snow is identified as white patches on the hills.

Source: Prasad and Sinha (2002)

3. Conclusion

In the new era of globalisation and economic liberalisation, planning and managing towns/cities would be a hard endeavor requiring new talents and methodologies. Indian towns will have to compete with other town to draw in investments, and as a result, factors like infrastructure quality, the availability of energy-efficient services, and environmental conditions in a town will be important factors in this rivalry in addition to economic stability. The field of town planning as a whole will need to confront these problems and act quickly. It is important to remember that town theory is still static and that understanding the spatial dynamics of towns is difficult. These are capable of providing the physical input and intelligence required for base map development, proposal planning, and acting as a monitoring tool during the implementation phase (s). A powerful tool for mapping and monitoring ecological changes in the urban core and in peripheral land-use planning, satellite remote sensing with repetitive and synoptic viewing capabilities, as well as multispectral capabilities, will help to reduce unplanned town and the associated loss of natural surroundings and biodiversity.

References

[1] Patel, D.P. and Srivastava, P.K.,(2013)," Flood Hazards Mitigation Analysis Using Remote Sensing and GIS: Correspondence with Town Planning Scheme. Water Resour Manage". https://doi.org/10.1007/s11269-013-0291-6.
[2] M. Kumar. Kamal, (2014), "Geoinformatics Role in Urban Planning Process," International Journal of Current Research. https://www.journalcra.com/sites/default/files/issue-pdf/5266.pdf
[3] Rahman Atiqure, (2006), "Application of Remote Sensing and GIS Technique for Urban Environment Management and Development of Delhi, India", Applied Remote Sensing for Urban Planning Governance and Sustainability, http://www.springerlink.com/index/x5w74277j3I13959pdf.
[4] Verma K. Ravindra and Tiwary K. Rajendra,(2009),"Application of Remote Sensing and GIS Technique for Efficient Urban Planning in India", Conference Paper.
[5] https://www.researchgate.net/publication/234097016
[6] https://www.researchgate.net/publication/215658152_Geoinformatics_for_urban_and_regional_planning
[7] https://www.researchgate.net/publication/259572943_Role_of_Geoinformatics_in_Urban_Planning
[8] https://en.wikipedia.org/wiki/Town
[9] https://www.unearthlabs.com/blogs/gis-uses-urban-planning
[10] https://en.wikipedia.org/wiki/Geoinformatics
[11] https://www.indiastudychannel.com/resources/130752-What-is-Geo-informatics-and-application-of-Geoinformtics.aspx