

Remote Sensing and GIS for efficient Urban Planning in India**D.P.Tiwari, IAS**

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INTRODUCTION

The urban areas in the developing world are under constant pressure of a growing population. Indian cities are experiencing an accelerated pace of growth since independence. Cities are now emerging as centers of domestic & international investments in an era of economic reforms, liberalisation and globalization. This has created opportunities for technologists and planning professionals to guide and develop the process of planned development and management.

Efficient urban information system is a vital pre-requisite for planned development. The increasing demands in urban planning and management sectors call for co-ordinate application of Remote sensing and Geographic Information System(GIS) for sustainable development of Urban areas. There is an urgent need to adopt Remote Sensing and Geographic Information System approach in urban development. and monitoring process for implementing pragmatic plan of Urban development. The plan must incorporate an integrated approach of spatial modeling using Remote Sensing Data, GIS database and GPS solutions. 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 availability of high resolution data from IRS –1C and 1D satellites has revolutionized the process of thematic mapping and spatial data base creation, specially, in the context of urban and regional planning. Whereas the technologies such as GIS has emerged as a powerful tool in integrating and analyzing the various thematic layers alongwith attribute information to create various planning scenarios for decision making . Remote Sensing (RS) data provides reliable, timely, accurate, and periodic data, while Geographic Information System (GIS) provide various methods of integration tools to create different planning scenarios for decision making. Therefore, the task force on urban and rural studies setup by the Planning Commission suggested the use of RS and GIS techniques for meeting the information and analysis needs of urban areas.

Urbanisation in India

The urban population of India has rapidly increased in recent years. In 1961 about 79 million persons lived in urban areas of the country, by 2001, their number had gone up to over 285 million, an increase of over 350 percent in the last four decades, which will increase to over 400 million by the year 2011 and 533 million by the year 2021. In 1991 there were 23 metropolitan cities which have increased to 35 in 2001.

URBANIZATION TRENDS IN INDIA 1951 – 2001

Census	Total Population (Million)	Urban Population (Million)	% of Urban population to total Population	Decadal Urban growth rate (percent)
1951	361.08	62.44	17.29	-
1961	439.23	78.93	17.97	26.41
1971	548.15	109.11	19.91	38.24
1981	683.32	159.46	23.34	46.15
1991	846.30	217.61	25.71	36.47
2001	1027.01	285.00	27.78	36.47

As a result, most urban settlements are characterised by shortfalls in housing and water supply, inadequate sewerage, traffic congestion, pollution, poverty and social unrest making urban governance a difficult task. Urban Local Bodies [ULBs] which are statutorily responsible for provision and maintenance of basic infrastructure and services in cities and towns are under fiscal stress. According to Census of India 2001, there are 5621 ULBs in the country classified into three major categories of municipal corporations (500), municipalities (50-500) and town committees (5-50) .

The 74th Constitutional Amendment Act (CAA74) mandates compulsory reconstitution of municipal bodies within a stipulated time-frame, thus ensuring continuity of local representatives. The twelfth schedule of the CAA74 has listed 18 functions and responsibilities to local bodies. These are :

1. Urban planning, including town planning;
2. Regulation of land use and construction of buildings;
3. Planning for economic and social development;
4. Roads and bridges;
5. Water supply for domestic, industrial, and commercial purposes;
6. Public health, sanitation, conservancy, and solid waste management;
7. Fire services;
8. Urban forestry, protection of the environment, and promotion of ecological aspects;
9. Safeguarding the interests of weaker sections of society, including the handicapped and mentally retarded;
10. Slum improvement and up-gradation;
11. Urban poverty alleviation;
12. Provision of urban amenities and facilities such as parks, gardens, and playgrounds;
13. Promotion of cultural, educational and aesthetic aspects;
14. Burials and burial grounds; cremation grounds and electric crematoria;
15. Cattle pounds, prevention of cruelty to animals;

16. Vital statistics, including registration of births and deaths;
17. Public amenities including street lighting, parking lots, bus-stop, and public conveniences;
18. Regulation of slaughterhouses and tanneries.

Importantly the CAA74 expressly recognizes a role for the ULBs within the constitutional framework and provides for devolution of financial powers from the state government for strengthening of municipal finances. The CAA74 also provides for constitution of Ward Committees in municipalities with a population of more than 300 thousand, Metropolitan Planning Committees and District Planning Committees for consolidation and preparation of plans of spatial, economic and social development. From a "top down" approach, the emphasis has thus shifted to the "bottom up" approach. In view of the challenges facing by ULBs the planners have to prepare themselves for a new role and much wider responsibilities. As a bridge between the civil society and the politico-economic structure, the planner have to perform the role of the catalysts of change. With the ongoing globalization, economic liberalization and devolution of power to local bodies, gone are the days of armchair professionals.

Urban planning and Development

It is now being recognised that urban areas are the engines of growth at both regional and national level. To facilitate and sustain this growth, cities have to provide both a high quality of life and an efficient infrastructure for economic activities.

Year	% Urban Population to Total Population	% Contribution to National Income
1951	17.3	29
1981	23.3	47
1991	25.7	55
2001	28.5	61

Urban planning is basically resource generation, resource development and resource management exercise. The efficiency of urban settlements largely depends upon how well they are planned, how economically they are developed and how efficiently they are managed. Planning inputs largely govern the efficiency level of human settlements. Urban planning and development refers to a process that harnesses spatio-economic potential of an area for the benefit of the people. Its scope ranges from a cluster & houses to the entire settlement and beyond to a region and even the nation as a whole. Urban planning includes preparation / rendering of –

- 1- Perspective Plan
- 2- Development Plan
- 3- Annual Plan
- 4- Schemes and projects
- 5- Participatory approach for supply of land and infrastructure development.

The urban development planning process in the past has been unduly long and has been largely confined to the detailing of land use aspects. The plans have paid inadequate attention to the provision of trunk infrastructure, environmental conservation and financing issues. They have been unrealistic and have not been accompanied by investment programmes and capital budgets. The planning and plan implementation processes have not paid adequate attention to the integration of land use and transport planning. The fact that transport is a key determinant of land use and "leads" development is sometimes ignored. A Development Plan is essentially a blue-print for development, which seeks to guide development along desired lines for a particular horizon year. In addition to the general layout, it addresses issues related to development on virgin land,

heritage conservation, environment, improvement of an old city etc. At present, hardly 30 percent of the urban centers have some sort of Master Plan, which in many cases, is just a policy document. It is estimated that there are about 1600 master plans prepared by various Agencies responsible for plan preparation but their implementation is not encouraging. The implementation of master plan facilitates the orderly and planned development of cities in a sustainable manner, which would ultimately help in good governance.

The Master plan Approach - Objectives and Functions

The master plan, which was perceived to be a process rather than a conclusive statement, provides guidelines for the physical development of the city and guides people in locating their investments in the city. In short, Master Plan is a design for the physical, social, economic and political frame work for the city, which greatly improve the quality of Urban Governance also.

The functions of the Master Plan / Development plan are as follows :

- i) To guide development of a city in an orderly manner so as to improve the quality of life of the people
- ii) Organise and coordinate the complex relationships between urban land uses
- iii) Chart a course for growth and change, be responsive to change and maintain its validity over time and space, and be subject to continual review
- iv) Direct the physical development of the city in relation to its social and economic characteristics based on comprehensive surveys and studies on the present status and the future growth prospects; and
- v) Provide a resource mobilization plan for the proposed development works.

The Constitution (74th) Amendment Act, 1992 provides for a democratic and participatory planning process so as to incorporate the needs of the people, particularly the poor and socially disadvantaged, in the planning process. The Act stipulates the setting up of District planning Committees (DPCs) and Metropolitan Planning Committees (MPCs) for integration of spatial and economic development and rural and urban planning. The DPCs / MPCs need to be constituted under the State Acts. A three tier planning structure is envisaged in the states – Panchayats / Municipalities level, district and metropolitan level and state level. Under this framework, Panchayats/ Municipalities would prepare plans for their areas which would be consolidated at the district level in the form of draft district development plans. The metropolitan development plan would be prepared by the MPCs. All district and metropolitan development plans would then lead to the formulation of a plan at the state level.

The 12th Schedule of the Constitution (74th Amendment) Act lists the 18 functions of the municipalities which among others include: (i) urban planning including town planning; (ii) regulation of land use and construction of buildings; and (iii) planning for economic and social development. For a rational integration of spatial and economic development, functions related to spatial and socio economic planning and development should be assigned to Urban Local Bodies (ULBs). For an effective urban planning system, there is the need to have a package of inter-related plans at three levels namely long-term perspective structure plan (20-25 years) short term integrated infrastructure Development plan (5 year) and Annual Action plan as part of Infrastructure Development plan. The short-term integrated Infrastructure plan and Annual plan could be in the form of “rolling” plans to enable the ULBs to continuously review and monitor the plan, and to update it every year / five years. The aim should be to make urban planning system as a continuous process. Each level of plan must include measures for infrastructure development and environmental conservation :

- i) Perspective Structure Plan : The long-term Perspective Structure Plan could be prepared by the MPCs broadly indicating goals, policies and strategies for spatio-economic development of the urban settlement. The perspective plan may include :
 - Physical characteristics and natural resources:
 - Direction and magnitude of growth and development – area and population (Demography)
 - Arterial / grid road network and mass transit corridors with modular development block.
 - Infrastructure network – water, sewage, drainage, roads, bus and truck terminals, rail network, etc.
 - Broad compatible and mixed land use packages and zones :
 - Community open space system and organization of public spaces :
 - Environmental conservation and preservation of areas of architectural, heritage and ecological importance ;
 - Major issues and development constraints;
 - Financial estimates and fund flow patterns; and
 - Policy and plans for EWS housing.
- ii) Infrastructure Development Plan : Integrated infrastructure Development Plan should be prepared by ULBs in the context of the approved Perspective Plan. The scope of the Plan should cover an assessment of existing situation, prospects and priorities and development including employment generation programs, economic base, transportation and land use, housing and land development, environmental improvement and conservation programs. The development plan may include.
 - Identification of gaps and shortcomings in the delivery of municipal services;
 - Identification of service and remunerative projects and their prioritisation along with capital budgeting and investment programmes; and
 - Housing and land development programmes, including identification of areas for residential and non-residential development and development of trunk infrastructure.
- iii) Annual Plan : Within the framework of Development Plan, Annual action plans for the urban areas should be prepared by the ULBs specifying the projects and schemes with costing and cash flow for both on-going and new projects. The Annual action plan should provide an in-built system for implementation of the Development Plan. In this plan various urban development schemes should be integrated spatially and financially. Annual plan may consist of :
 - targets to be achieved – physical and fiscal;
 - fund flow ; and
 - Project design and specification, including tender document for implementation.
- iv) Projects and Schemes : As part of the Development plans and Action plans, projects and schemes within towns / cities could be taken up for any area / activity related to housing,

commercial centers, industrial areas, social and cultural infrastructure, transport, environment, urban renewal etc. by governmental bodies / local agencies / private sector and through public private-partnership. Such projects could be both long-term and short-term and in conformity with the development requirements of the respective town / city.

Stages of Urban planning

Urban areas face critical environmental problems which are manifested at the time of crises. To avoid such occurrences the first requirement is quantification and "resource potentiality", its availability and consumption in the urban areas which requires a comprehensive urban information system (UIS) to be developed to cater to the developmental needs of the growing urban areas.

- Thematic map preparation from satellite data using visual interpretation techniques.
- Generation of spatial framework in GIS environment for perspective and development plans.
- Integration of thematic maps using GIS techniques for urban sprawl analysis and urban land use change analysis.
- Area required for urbanisation will be determined on the basis of population projection of the city and its growth centers.
- Calculation of land requirements for urban development based on the carrying capacity of the region.
- Projection urban land use suitability analysis.
- Urban environmental sensitivity analysis based upon both physical as well as air quality parameters.
- Determination of composite functionality index to setup various amenities such as educational, medical, recreational etc.

Urban Planning Surveys

The preparation of any plan for the development of urban area requires reliable factual data regarding existing physical and social-economic conditions such as housing, transport, industries, social services and recreational facilities. The process of collection such data is called a planning survey, which consist of the following components –

- 1- Preparation of Base Map.
- 2- Existing land use survey
- 3- Utilities and the Services survey
- 4- Community facilities survey
- 5- Sample household survey for collecting essential data.

For the urban development plans the base maps are to be drawn on large scale and should show all physical topography, cultural features, administrative and planning boundaries. Innovative techniques for preparation of base maps are–

- 1- Aerial Photography
- 2- Remote Sensing
- 3- Geographical Information System.

Aerial Photography

Now a day's Aerial photography is being used for generation of base maps and other thematic maps for urban areas as it proves to be cost and time effective and reliable. Wealth of information pertaining to land features, land use, built up areas, city structure, physical aspects of environment etc is available from the aerial photography.

Remote Sensing

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 city region, 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, broad settlement structure, resource analysis etc could be generated. Remote sensing data can be effectively integrated with the conventional data for analysis, planning and decision making.

Geographical Information System

GIS is a computer based system, capable of input, storage, manipulation, analysis of data useful for planning, decision making and implementation. It is a powerful tool which helps planners to view different scenarios and their outcome so that an optimal strategy may be chosen for planning and development. GIS is basically a map processing technique. Once the spatial and attribute data is generated in GIS, its application areas are many and varied. Planning agencies can acquire the P.C. based GIS system, available in the market, to have quick analysis of geo-referenced data for planning and development.

Modifications in the Urban planning approach:

For a more dynamic urban planning exercise, the following modifications in the planning approach are recommended :

- i) Flexibility : Plans must have flexibility to provide for ever-growing and ever-expanding city boundaries and provide quality of life to all inhabitants. The plan should be flexible to respond not only to the present needs but also the changing conditions in foreseeable future.
- ii) Role of Actors : People's participation in preparation of policies, perspective plan, development plan and annual plans should be ensured through elected representatives in the municipal council / corporation and ward committees.
- iii) Information system : A well maintained information system can make possible the fine-tuning of the plan proposals at the various stages of implementation of the plan according to the changing urban scenario.
- iv) Urbanisable Areas : The development potential may be assessed for the areas located in the periphery of the developed areas. A profile of the development potential and the possibility of optimizing the existing infrastructure should determine the prioritisation of development of these areas.
- v) Growth Centers : Given the paucity of resources, it would be more feasible and desirable to promote strategic development initiatives in the selected secondary cities, growth center and their hinterlands. In the growth centers, the location of infrastructural and environmental services could form the 'core' of the Development Plan.
- vi) Policy Guidelines : Policy guidelines notified under law, can help in identifying priority areas, subsequent modifications in the plans and administration in general.
- vii) Mixed Land Use: With a view to provide for development, the zoning regulations need to be simplified. The land use package should not be allowed to be changed by any authority, except as a part of the review of the Development Plan at the city / town level.
- viii) Financial Planning: Land development and infrastructure investment need to be coordinated through integration of physical, financial and investment planning. There is

the need to link spatial development plan with resource mobilization plan focusing on credit enhancement mechanisms.

- ix) Land Policy and Management : As opposed to the process of compulsory land acquisition, and the related issue of low compensation rates, the ULBs should adopt collaborative approaches within the existing legal framework.
- x) Legal Framework : Plan implementation would call for a legal framework so as to make it enforceable and mandatory. The legal framework has to be supported by an effective and efficient machinery which would see that no distortion of master plan proposals take place at the ground level.
- xi) Standards : Plot sizes, layout and social overheads need to be designed to reduce costs aligned to the affordability of different income groups and also the sale price for lower income groups can be reduced by differential pricing.
- xii) Building Bye-laws : Building bye laws and zoning regulations for the city / town should match the local needs. However, the existing bye-laws need to be simplified and transparent, and there should not be an element of discretion. Adequate provision for parking facilities should be made.
- xiii) Database at Metropolitan, district and state levels :
The planning exercise need continuous data collection, analysis interpretation and updating of data. A computer-generated data base and information system in GIS environment should be developed at various levels which would provide support to planners in development planning.