

# DEVELOPMENT OF RESOURCE MONITORING SYSTEMS WITH INTEGRATED REMOTE SENSING AND GIS ENVIRONMENT

**Saxena, A.**

Architecture and Planning Dept, MANIT, Bhopal, India.

E-mail: [arunasaxena2000@yahoo.com](mailto:arunasaxena2000@yahoo.com)

## 1. INTRODUCTION

The urbanization process in India, its pace of growth has accelerated over the past ninety years. The process of urban development is guided and co-ordinate by the development plan of the city. Most of the major cities of India do have development plans, but these plans are often vitiated at various stages of its implementation, mostly in qualitative terms and provision of basic facilities. In most of the sectors of development, the intent of the proposals is not adequately translated into the envisaged physical framework thus creating differentiated, disjointed and undesirable urban growth. When the demands are not met in a guided manner, illegal occupation of sites and services, land use transformation, unauthorized constructions takes place and this is where the degradation of urban environment starts of and the issue of monitoring urban resources assume importance.

In the process of monitoring urban development, the need for data input in terms of latest unbiased information has been a serious constraint. Non-availability of suitable spatial data i.e. up to date maps at appropriate scale is a bottleneck. Invariably by the time the data is collected by conventional method which is later used, analyzed and plans made, gets outdated. It is here that remote sensing technology can come to the aid of planners in terms of making an inventory of existing land use and constant monitoring and subsequent preparation of urban plans. After data capturing through remote sensing technology, it will be supplemented by data organizing and processing technology like GIS for deriving the maximum benefit. The technology are expected in the long run to contribute in planning practices (Planning implementation and monitoring)

## 2. NEED OF THE RESEARCH WORK

An effective monitoring system for resource and environmental monitoring would certainly yield the development to be in the desired manner.

## 3. MONITORING: ESSENTIAL TOOL FOR URBAN PLANNING AND MANAGEMENT

The responsibility of planners does not end with the formulation of Development Plan. It is expected that they build up a knowledge base to keep aware of one going implementation activity in the city. This activity is called as Monitoring. It is a tool of the implementing agency to keep records of the various activities planned in implementing any plan.

Projects/Plans/Programme which do not have an effective monitoring system are more likely to suffer delays and cost over runs, to exclude or under represent certain sectors of the target population, to have problems of quality control; or to take longer to detect differences among the implementing agencies or between the agencies and beneficiaries.

The report on National Commission on Urbanization has highlighted the need for monitoring the Urban Development as "Development Plan making system has inherent limitations. It does not involve monitoring, Feed back and Redirection, to keep the long policy perspective of 15-20 years up to date".

For having a planned development particularly of fast growing urban centers, I intend to study Bhopal a fast growing capital city of Madhya Pradesh. Bhopal is a national priority city as identified by the National Commission on the urbanization.

The first Development Plan for the city (BDP 1991) was published in 1975. The second Development Plan (BDP 2005) came into operation on June 9, 1995. The evaluation of the implementation of the Development Plan (1975 – 91) states that there are large areas of unintended growth (Development of Unauthorized colonies, squatter settlement) and development of areas with inadequate physical and social infrastructure. The reason for this is analyzed to be "Absence of a system of continuous monitoring of plan implementation, its feedback and setting up required corrective measure."

Aims And Objectives of the study was to prepare the landuse/landcover map of study area using multirate satellite imageries & to evolve a monitoring modal for planned development. The research tried to find out the results by integrative various techniques and methods related to Imageries interpretation and GIS in obtaining a reliable database or various aspects of land use and changes for different time periods. This would help to frame remedial guidelines for existing system.

#### 4. BHOPAL

Development of the city since 1973 has taken place mainly in south direction and to some extent in eastern direction, with exception of Bairagarh. Gradually these scattered developments converted into four different townships. *Reasons for development outside municipal limits* are low land Values, not much legal control, rigid nature of development plan, nearness to work centers & on-responsive attitude of local bodies.

##### 4.1 Monitoring and Plan Preparation Process

- Although there is a provision of review of Development Plan/Zonal plans as and when needed but in the absence of monitoring mechanism, no feed back is gathered which resulted in unauthorized colonization in planning unit 3&4.
- No such mechanism to monitor unintended growth

##### 4.2 Monitoring implementation status Development Plan 1975-1991

- 70% implemented.
- Disjointed and undesirable urban spread
- Unauthorized colonization

This was result of lack of current information available about buildings in a city and lack of a system of continues monitoring of the Plan implementation, its feedback and setting up required corrective measures.

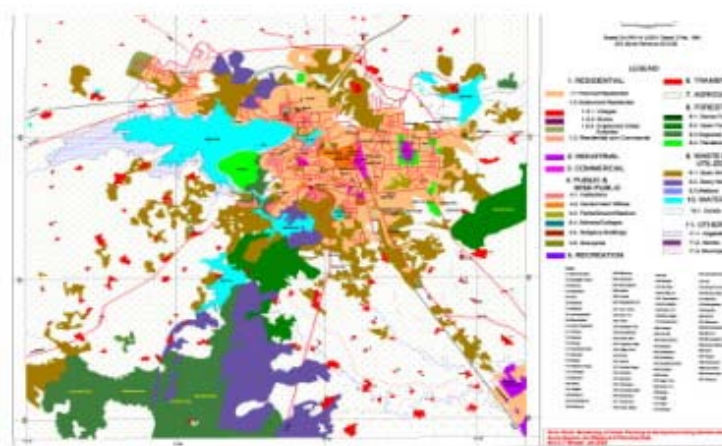


Figure 1. Landuse 1991 IRS IA/aerial photographs.

Table 1. Landuse changes (area in hectare).

Landuse	BDP1991	IRS-IA-1991	change
residential	4050.00	3220.00	830.00
commercial	405.00	219.00	186.00
industrial	1135.00	700.00	435.00
Public & semipublic	1215.00	1025.00	190.00
Public utilities	280.00	200.00	80.00
recreation	1415.00	1235.00	180.00
transportation	1620.00	1012.00	608.00
total	10120.00	7611.00	2509.00

Using combine programme in GIS, development plan and landuse 1991 made by using IRS IA are combined to find out landuse changes

BDP1991 VS Actual situation 1991:

- 3583 hect. Was found as undesirable landuse. In other words 35.40% in 1991 differs from development plan proposals.
- Out of landuse residential 4050.00 hect. 3220.00 hect. Developed in 1991(79.78%). But 20% area developed as undesirable, unintended growth in the form of unauthorized colonies along Raisen, Hoshangabad, Kolar and Bairagard road.436 hect.agriculture land had been converted into residential land. A 1269.00hect.residential area was not implemented.
- Areas between railway station and BHEL were lying undeveloped.
- Residential areas of narella shankari and village semarakala were underutilized. Therefore 400 hect. Land was lying vacant here.
- Out of landuse commercial 405 hect. 219 hect. Developed (54%).out of developed land 77.5 hect developed as per BDP.141.5 hect developed as unintended/undesirable growth. New commercial center did not grow up. Mostly residential area converted to commercial area.186 hect. Could be developed causing excessive pressure on the few city center-CBD of old Bhopal, new market.
- Out of landuse industrial 1135.00 hect. 700.00 hect. Developed (61%).Out of developed land 624.00 hect developed as per BDP. 76 hect developed as unintended/undesirable growth. Mostly within city in old city commercial areas converted to small scale industries
- 436.00 hectares of land has developed into unauthorized colonisation.such development had come up where agriculture land had been purchased by private party and they later either cut into plots and sold to people or developed as unauthorized colonies and sold to people. Such areas are mostly without proper roads, drainage, public & semipublic facilities. In such areas people have their own bore well and septic tank system.

## 5. BDP-2005

BDP-2005 conceives city of Bhopal as a network of self contained sub-cities each containing sectors, sub-sectors and neighborhoods

## 6. MONITORING OF COMPONENTS OF FIRST PHASE STUDIED THROUGH IRS IC DATA

### 6.1 Transformation Process

The dynamic change from rural to urban land use is so fast that the resultant need and complex uses coupled with shortage of land have led to speculation and increase in land values. The ever-growing difference between the demand and supplies of house sites and units coupled with B.D.A's restriction on other forms of supply and very high cost of land in the city have increased the pressure of fringe area tremendously which has given rise to proliferation of unauthorized development of land uses-residential and industries, etc.

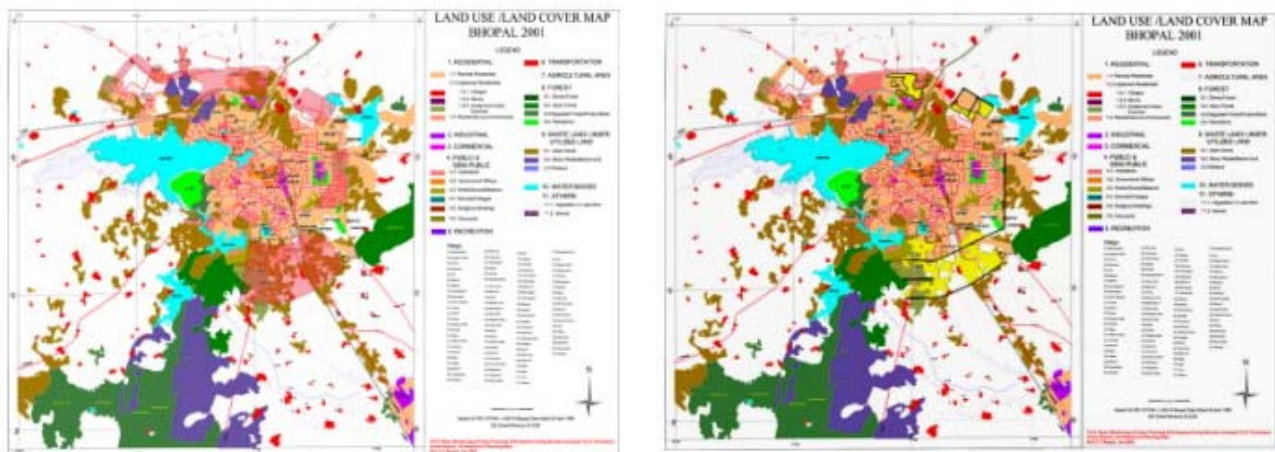


Figure 2. Land use cover map.

The fringe areas are generally within the jurisdiction of panchayat which has neither the financial resources nor the technical expertise to plan and manage the rapidly developing fringe. They use the municipal services without paying for it.

The property and service taxes are relatively higher in the city than in the fringe area and therefore attract industries which intensifies development. Like municipal areas, panchayats have no town planning rules, sub-division regulations and rules for provision of services suited to the dynamic situation of the fringe and haphazard development takes place. Since land in the city is beyond the reach of middle/low income group people, they look for land outside the city limit.

As a consequence of economic and speculative forces imposed on villages in the periphery of Bhopal, massive transformation in their physical form and socio cultural set up takes place, disrupting their age-old healthy relationship. After loss of agricultural land the villagers are forced to follow urban occupations to adjust to the changing needs.

The village starts transforming itself into an urban village, whose character is determined by the type of surrounding development.

## **7. STAGES OF TRANSFORMATION**

The process of transformation of villages from rural to urban can be broadly divided into following stages:

- Rural - Predominantly agricultural land use.
- Transitional
- Pretransitional - Gradual change starts in rural character.
- Transition - It can be categorized under urban extension.
- Post transition - Becomes almost part and parcel of urban area.
- Urban

Urbanization at the periphery of fast growing cities causes many sensitive land use issues related to housing, infrastructure services, loss of prime agricultural land etc., which can be categorized as.

- Unplanned development.
- Protection of environmental and ecological quality at the peripheries.
- Provision of infrastructure facilities.
- Legal problem

## **8. EFFECTS OF TRANSFORMATION**

### **8.1 Physical**

Reduction of agricultural land holdings, increase in abadi area and concentration of urbanized land, loss of fertile agriculture land, new buildings and built forms, increase in density.

### **8.2 Socio Economic**

Occupational change, immigration, out migration, increases in economic status of villagers but usually decrease in quality of life.

### **8.3 Functional**

Mixed use increases change from primary to tertiary, more dependence on the parent city.

### **8.4 Environmental and Ecological**

Decrease in open spaces and loss of rural character resource base drastically changes traditional sources of water are overloaded or lost. As a consequence villagers are forced to buy food grains rather than to grow.

### **8.5 Findings**

- Major land use- Residential
- Rigid nature of development plan & lack of monitoring mechanism could not guide development improper manner
- Unplanned Development occurred under reduced legal control.
- Because of lack of applicability of constructional rules the built form has achieved higher far 's
- Master plan Proposals are not based on ground realities
- Lack of provision of infrastructure and basic amenities.

It has been observed that wards located in the northern side of the city have shown a declining trend in the population's growth, whereas, wards located in the southern side has shown a accelerating trend in population growth.

## **9. ORGANIZATIONAL SETUP**

- A monitoring cell has been introduced as the apes of all.
- The monitoring cell should ensure the proper information flow between the development agencies of Bhopal.
- Annual report should be transparent and accessible to public.

Monitoring cell will be equipped with technical persons trained in remote sensing & GIS from MPCST. This monitoring committee will have representation from all concerned departments-BDA, CPA, PWD, PHE, MPHB, EPCO, SLUM BOARD, whose budget investment are involved in the city development process. The cell will be headed by divisional commissioner. The member secretary will be the chief executive officer of the development authority. Setting out yearly physical targets and identifying development roles of various development agencies

This monitoring cell will closely monitor the implementation status in the following areas: -

Land flow towards City infrastructure, road network, Housing, Industrial areas, Commercial area, Public & semi public, Public utilities, Recreation & open spaces, Forestation

Development report (ADP) by the plan monitoring committee.

#### **10. TRAINING UNIT**

It is recommended that authorities should regularly sponsored personnel from different agencies to short term training programmes in remote sensing and GIS. Establishment of the training unit is also recommended to hold regular workshops, seminars and short-term courses on these techniques.

Thus an effective monitoring system using of remote sensing and GIS would ensure the judicious use of limited resources, helpful in highlighting the true picture of status of land for public usage, protection of prime agricultural land, control of sub-urban sprawl, control of growth, provision of adequate services, maintenance of life style in the face of growth, jurisdictional, legal and financial limitations, maintenance of environmental quality & the level of implementation of development plan which will also add the missing factor of responsiveness in the planning process.

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**Saxena, A.**

Architecture and Planning Dept, MANIT, Bhopal, India.  
E-mail: [arunasaxena2000@yahoo.com](mailto:arunasaxena2000@yahoo.com)

## **Aruna Saxena**

Proposed Position: Urban Planner  
Profession: Urban Planning and GIS Expert  
Date of Birth: 9<sup>th</sup> June, 1970  
Nationality: Indian

## **Membership of Professional Societies**

Institute of Town Planning, India  
Indian Society of Geomatics  
Indian Society of Technical Engineers  
Council of Architecture, India

## **Key Qualifications**

Aruna Saxena has around 11 years of experience of handling various planning projects. She is specialised in Human Settlement Analysis using remote sensing & GIS techniques. She has been involved in many development planning and landuse studies, fringe area studies, and appraisal of development plans etc. She has also carried out many research works in development sector including study the rapid growth of town around the inner city of Jaipur, study the change detection in landuse using multirate SPOT data, traffic congestion study and suggesting alternative alignment, study of urbanisation and trends of haphazard development of unauthorised colonies in fringe areas etc.

## **Relevant Previous Assignments**

<i>Urban Planner</i>	Monitoring of urban development of fringe areas: a case study of Bhopal (MP, India) using PAN (IRS-1C) imagery and GIS s/w ARCVIEW. Research project funded by Centre of Excellence under the grants received by Indo-UK project scheme	Bhopal, Madhya Pradesh
<i>Urban Planner</i>	Planning and monitoring of Jaipur City (Rajasthan , India) using Aerial Remote Sensing, SPOT imagery and GIS software	Jaipur, Rajasthan
<i>Urban Planner</i>	Appraisal of development plan with existing landuse study of Bangalore metropolitan city using Aerial remote sensing and GIS s/w USEMAP	Bangalore Karnataka

## **Education:**

Indian Institute of Remote Sensing, National Remote Sensing Agency (dept. of Space, Govt. of INDIA), Dehradun, UP	1995	PG Diploma In Human Settlement Analysis Using Remote Sensing Techniques
School of Planning and Architecture, New Delhi	1994	Master of Planning with specialisation in Urban Planning. <b>GOLD MEDALIST</b>
Maulana Azad College of Technology, Bhopal, MP	1992	Bachelor Of Architecture

## **Projects Completed**

*Research on the topic 'Monitoring of Urban Planning & Development of Fringe Areas using remote sensing & GIS – case study Bhopal*

The research is on the emergence of fringe zone with its complex problems of adjustments in between rural and urban ways of life which has lead to serious land use problem, unauthorised urban sprawl, high land values, speculation in land and related problems.

*Planning and monitoring of Jaipur City (Rajasthan ,India) using Aerial Remote Sensing, SPOT imagery and GIS software*

A research was done to study the rapid growth of town around the inner city of Jaipur(India). A basemap was prepared using Aerial photograph, regional study was done using SPOT (MLA) imagery and analysis was done using GIS s/w USEMAP

*Change detection in landuse and formalising the trends of Noida (UP, India) using multirate imageries and GIS*

A research was carried out to study the change detection in landuse using multirate SPOT data and analysis was carried out using USEMAP s/w of GIS

*Study of landuse/landcover and its changes in part of Bardez Taluka, Goa (India) through Aerial photography, SPOT imagery GIS s/w*

Landuse study was carried out to study the traffic congestion. An effort had been made to suggest an alternative road alignment to decongest the traffic flow in the city.

*Appraisal of development plan with existing landuse study of Bangalore (India) metropolitan city using Aerial remote sensing and GIS s/w USEMAP*

Research on landuse was carried out to compare the development plan in order to identify the areas developed against zoning regulations and to see the forces acting behind unauthorised landuse transformation

*Monitoring of urban development of fringe areas: a case study of Bhopal (MP, India) using PAN (IRS-1C) imagery and GIS s/w ARCVIEW. Research project funded by Centre of Excellence under the grants received by Indo-UK project scheme of Rs1.00 lakhs, by the Govt.of india. Worked as project investigator*

The research was carried out to study urbanisation operating in fringe areas, the trends of haphazard development of unauthorised colonies coupled with inadequate infrastructure services and protection of prime agricultural land

*Monitoring of urban development of fringe areas: a case study of Bhopal (MP, India) using PAN (IRS-1C) imagery and GIS s/w ARCVIEW. Research project funded by Centre of Excellence under the grants received by Indo-UK project scheme of Rs1.00 lakhs, by the Govt.of india. Worked as project investigator*

The research was carried out to study urbanisation operating in fringe areas, the trends of haphazard development of unauthorised colonies coupled with inadequate infrastructure services and protection of prime agricultural land

*Development of remote sensing technology, under Modernisation & Removal of Obsolescence scheme, sponsored by MHRD (Ministry of HRD, New Delhi , India)under the grants of Rs5.00Lakhs,worked as project investigator.*

Being in charge of remote sensing lab, I updated the present lab with GIS s/w ARCVIEW (module Spatial Analysis, R2V, Image Analysis, Editing & Digitising), Bhopal PAN data (photographic & CD-ROM), Light Table, & digitizer. A seminar at national level is due in Dec 2001

### **Research Accomplishments**

- Ujjain Heritage Zone Project, the project was funded by EPCO & state Government for Ujjain city –1992.The overall project cost was above Rs.150 lakhs.The project coordinator was Architect Planner A.G.K Menon from INTACH(Indian National Trust for Art & Cultural Heritage),New Delhi 1990-1994.I worked for documentation and analysis work.
- International Level-“Transitional, transformation & development analysis of open spaces in inner city of Bhopal”-sponsored by HUDCO (Housing and Urban Development Corporation), HSMI (Human Settlement Management Institute),Ministry of Urban Development New Delhi, under the grants received Rs.42,000 by the Indo-Dutch collaboration, by the govt.of India 1996.I worked as co-investigator under project coordinator Dr.Ahutosh Sharma(Architect planner).This research project was an attempt to study ,analyse, evaluate and prepare proposal guidelines for open spaces in inner city of Bhopal.
- National Level-“Urban Renewal And Redevelopment Scheme For Disadvantaged Section Of The Society”-sponsored by MHRD (Ministry of Human Resource Development) New Delhi under the grants received of Rs8.00 lakhs 1999-2002. I am working as co-investigator under project coordinator Dr.Ahutosh Sharma (Architect Planner, MACT). Due to massive migration and high growth rate of population in urban areas the disadvantaged section of the society are forced to live or work in dilapidated and filthy conditions and continue to face problems relative to basic infrastructure services and many other urban stress. Thus it is intended to study, analyze, evaluate & propose models for urban renewal and redevelopment schemes. Land use plans have been made using LISS & PAN data of IRSID.
- National Level-“Sustainable Spatial Regional Planning For Tribal Areas of Madhya Pradesh”-sponsored by MHRD (Ministry of Human Resource Development) New Delhi under the Research and development scheme, the grants received of Rs8.00lakhs in March 2000-2004.The project intends to develop and provide guidelines for the tribes with their regional setting. It will explain how to achieve economic sustainability and rural/urban ties by means of

introducing spatial regional planning to bridge the gap between urban/rural and tribal area planning. Land use mapping is done using IRSID data.

- Conservation and Sustainable Development Strategy for Khajuraho Heritage Region. The research work done as a partial fulfilment of degree of master of urban development and planning, under my guidance.
- Bhoj Wetland, Bhopal (MP, India) using Remote Sensing data IRSID, IC, Landuse Mapping of Mandideep Industrial areas, Bhopal.

#### **Publications**

- Summary of project report on Study of landuse/landcover and its changes in part of Bardez Taluka, Goa (India) through Aerial photography, SPOT imagery GIS s/w
- Paper presented in National town & Country congress , Hyderabad (India) on information technology for urban and regional planning in new millennium: 'The Role of Remote Sensing and GIS in Urban Map Preparation'
- Paper presentation in 4<sup>th</sup> annual International Conference & Exhibition on GIS, Remote Sensing & GPS: 'Monitoring of Urban Fringe Areas using Remote Sensing & GIS'.

#### **Computer Proficiency**

MS word, Excel, PowerPoint, GIS Software etc.