



**Research Article**

**MAPPING AND ANALYSIS OF POPULATION EXPLOSION OF BHOPAL DISTRICT  
MADHYA PRADESH, USING REMOTE SENSING & GIS TECHNIQUE**

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**ABSTRACT**

Urbanization is one of the most widespread anthropogenic causes of the loss of arable land, habitat destruction (Alphan, 2003), and the decline in natural vegetation cover. One of the major reasons of urbanization is rapid population growth in the urban area. Apparently, the urban population has grown exponentially and by 2011, for the first time in human history, more people in the world will be living in cities and towns than in rural areas. Furthermore, by 2017 the developing world is likely to have become more urban in character than rural, therefore, the vast majority of urban growth is now occurring in the developing world (UN-Habitat, 2003).

Digital change detection is the process of determining and/or describing changes in land-cover and land-use properties based on co-registered multi-temporal remote sensing data. Numerous researchers have addressed the problem of accurately monitoring land-cover and land-use change in a wide variety of environment. Remote sensing and GIS are now providing new tools for advanced ecosystem management.

One of the objectives of the study was to generate a spatial GIS database for the study area and to understand the urbanization process in the past 2-3 decades. Secondly and most importantly the main objective of this study is to quantify the sprawl of urbanization. Therefore, the built-up area was extracted and used to assess the urbanization.

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**INTRODUCTION**

Urban change detection refers to the general problem of monitoring the urban system and discerning changes that are occurring within the system that are of use to urban planners, managers and researchers (Bowden 1975). Therefore, the present study is aimed at assessing the urbanization in Bhopal over the period of 20 years (1990-2010) using remote sensing technology and spatial functionalities technique in Geographical information system (GIS). One of the objectives of this study is to prepare urban-GIS database which further aims at providing a platform for future environmental studies subjected to Land Use Land Cover (LULC) change. The key role of this study would be to contribute in preliminary impact analysis of urbanization. Therefore Geographic Information System (GIS) and remote sensing are powerful and cost effective tools for assessing the spatial and temporal dynamics of LULC (Lillesand & Kiefer, 2000). Remote sensing data provide valuable and moreover spatio-temporal data on the processes and patterns of LULC change, and GIS is useful for mapping and analyzing these patterns (Taubenbock et.al, 2009). In this study I explore the temporal and spatial characteristics of urban expansion and LULC change of Bhopal region from 1990 to 2010.

**Objective of the Study**

- ✓ To explore the spatial and temporal characteristics of urban expansion in this period.
- ✓ To assess the spatial and multi-temporal LULC change of Bhopal Region and to evaluate the LU/LC changes between 1990 - 2010.

**Location map of the Study Area**

Bhopal city is the capital of Madhya Pradesh State and it is located in the coordinates of 77.12o E, 23.21o N, by 77.12oE, 23.03o N. Bhopal city nestles in a hilly terrain, which slopes towards north and southeast. Hillocks of different altitudes are situated along the southwest and northwest portion of the city, these hillocks form a continuous belt from Singarcholi up to Vindhyaachal range. The elevation of the city ranges between 460 m and 625 m. The city enjoys a moderate climate. Normally temperature ranges between 50oF and 104oF although highest temperature occasionally rises to 110oF. In such moderate climate, residential areas can be developed at higher densities as three to four storied buildings can be constructed without causing discomfort to the occupants

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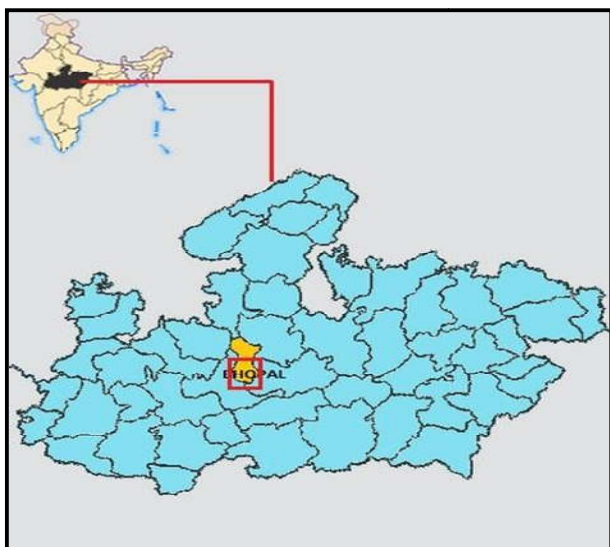


Fig 1 Location map of the Study Area

**METHODOLOGY**

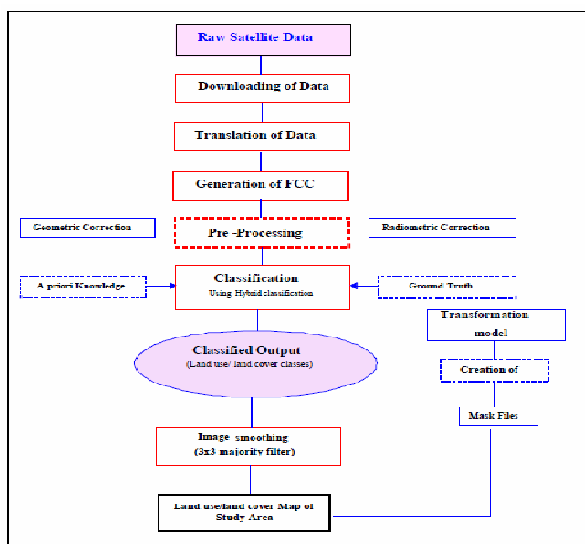


Fig 2 Flow chart for land use/ land covers map classification

**Table 1** Satellite data used for the study area

| Year | Path / Row | Satellite | Sensor     | Date & Time of acquisition             | No. of Bands |
|------|------------|-----------|------------|--|--------------|
| 1990 | 146-40     | Landsat   | Landsat TM | 18 <sup>th</sup> March 1990 & 06:00:25 | 3            |
| 2000 | 146-40     | Landsat   | Landsat TM | 29 <sup>th</sup> Aug 2000 & 01:21:10   | 3            |
| 2010 | 146-40     | Landsat   | Landsat TM | 25 <sup>th</sup> Feb 2010 & 09:15:33   | 3            |

The procedure adopted in the study forms the basis for deriving statistics of land use/ Land cover and subsequently the change. Land use land cover of entire Bhopal Region was carried out from three sets of satellite imageries retrieved for three different time

periods (1990, 2000 & 2010). Hybrid land use land cover classification technique was used for image processing. The methodology followed was on-screen visual interpretation using visual image interpretation keys like tone, texture, size, pattern, association etc. Methodology flow chart in fig. 2 indicate different steps followed in the updation of land use land cover map and also the Land use/Land Cover (LU/LC) change map generation.

**RESULT AND DISCUSSION**

One of the objectives of the study was to generate a spatial GIS database for the study area and to understand the urbanization process in the past 2-3 decades. Secondly and most importantly the main objective of this study is to quantify the sprawl of urbanization. Therefore the built-up area was extracted and used to assess the urbanization. The results and outcomes are presented in the form of maps, charts and statistical graphs. A simple superimposing technique was used to assess the spatial growth of built-up area for the given period of 20 years. All the three LULC maps of Bhopal Region are predominantly covered with built-up area. The built-up area is predominantly covered with 15% of the total area of Bhopal Region. During 1990 built-up area had increased to 38%, with a sharp decrease with forest, and agricultural land areas. Between the year 2000 and 2010 there was a slight increase in builtup class with only 3% increase i.e., 47% of the total area of Bhopal Region comprised built up space. Over the period of 20 years built-up area had increased to 26% in Bhopal.

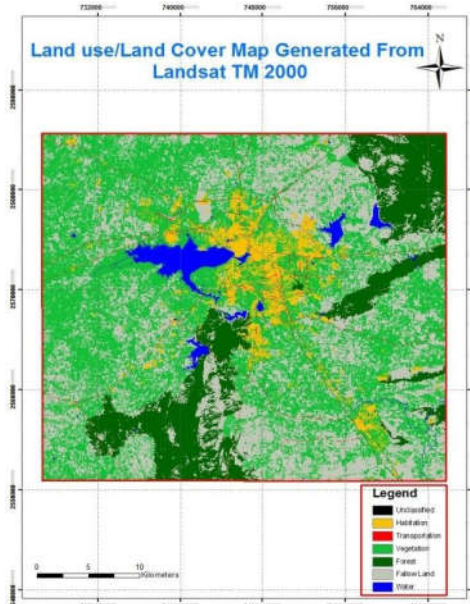


Fig 3 Land use/ land cover map generated from Landsat TM scene, 1990 of the study area.

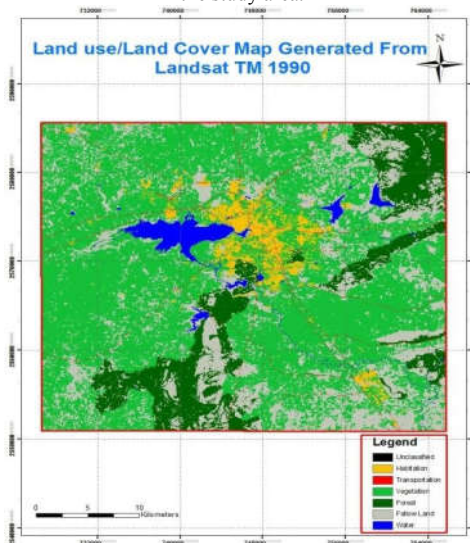


Fig 4 L and use/ land cover map generated from Landsat TM scene, 2000 of the study area.

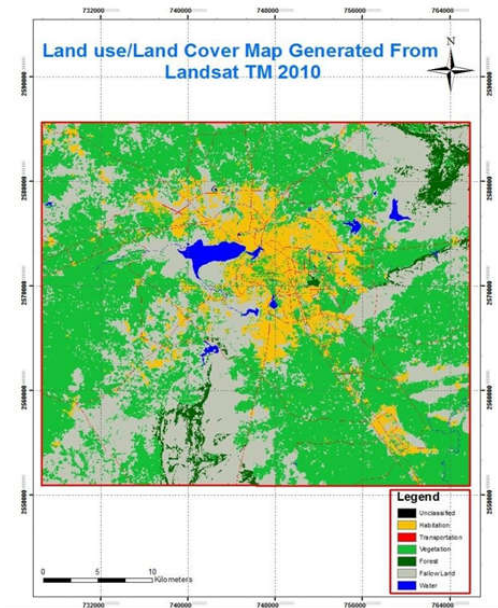


Fig 5 Land use/ land cover map generated from LandsatTM scene, 2010 of the study area

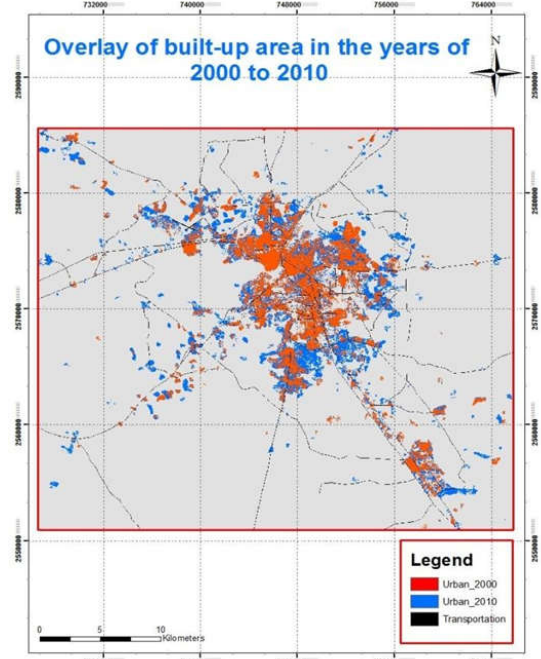


Fig 9 Overlay of Urban area in the years 2000 to 2010

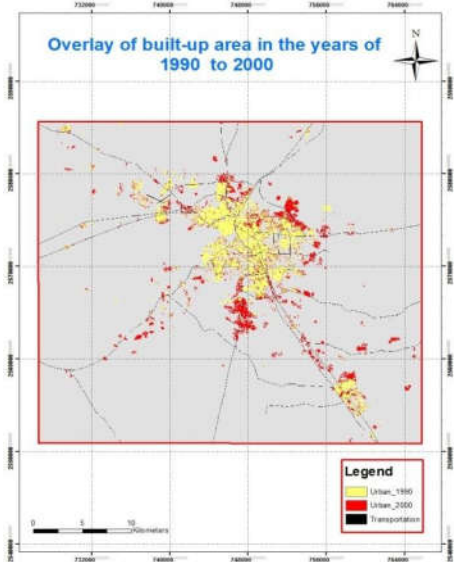


Fig 7 The spread of Urban area during different year 1999 – 2000

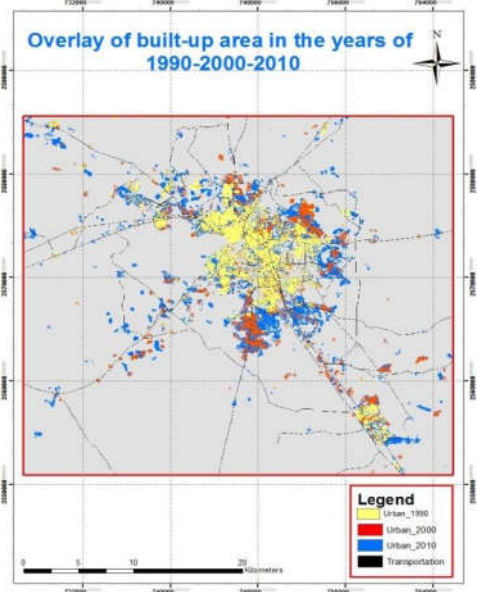
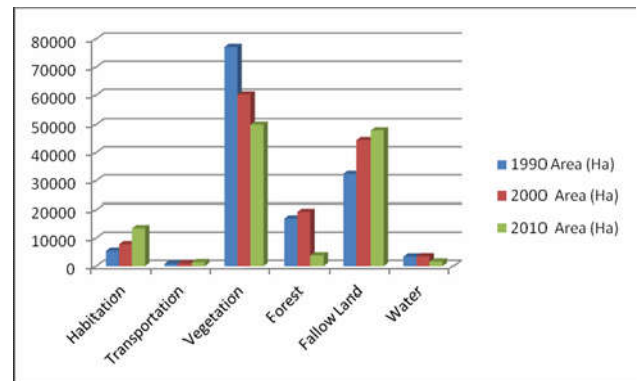


Fig 8 The spread of Urban area during different year 1990 2000-2010

Table 2 Area (ha) and percentage of the land use/ land cover categories of different years (1990, 2000 & 2010) of the study area

| Lu/Lc Categories | 1990 Area (Ha) | 2000 Area (Ha) | 2010 Area (Ha) |
|------------------|----------------|----------------|----------------|
| Habitation       | 5421.51        | 7784.28        | 13449.24       |
| Transportation   | 887.49         | 977.13         | 1416.42        |
| Vegetation       | 77124.69       | 60186.06       | 49933.35       |
| Forest           | 16905.96       | 11275.48       | 3810.87        |
| Fallow Land      | 32400.54       | 44416.98       | 47876.76       |
| Water            | 3371.13        | 3471.39        | 1624.68        |

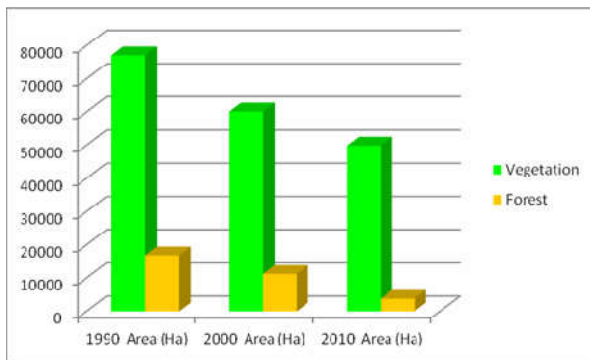


During the course of 20 years, an area of around 7,500 ha of agricultural lands was lost to built-up areas and road infrastructure. These agricultural and forest lands were spread the around Bhopal Region up to 1990. Forest land losses were also accounted in the course of urbanization. Approximately 13,000 ha of forest lands (open forest & dense forest) were lost during the study period. Moreover, Bhopal Region is covered with Agriculture Land rather than agriculture, therefore, conversion of Fallow land to other land uses was more prevalent.

Table 3 Area (ha) and percentage of the land use/ land cover categories of different Years (1990, 2000 & 2010) of the study area

| Lu/Lc Categories | 1990 Area (Ha) | 2000 Area (Ha) | 2010 Area (Ha) |
|------------------|----------------|----------------|----------------|
| Vegetation       | 77124.69       | 60186.06       | 49933.35       |

Forest 16905.96 11275.48 3810.87



**Fig 10** Area (ha) of Forest and Vegetation (Cultivated Land) area in different years Conclusion

The driving forces of land use and land cover change and urban expansion were explored and highlighted. As discussed earlier that this study has managed to develop a comprehensive LULC database for three time periods. Furthermore, it has enabled to assess spatio-temporal growth. Spatio-temporal growth can be quantified by a built-up area for different periods. At last the population growth vs built-up area shows a positive correlation i.e., higher the population growth large r the built-up area. The major impact of built-up area and urban expansion of Bhopal Region.

With the growth of urbanization and its associated infrastructure including roads and motor vehicles the environmental conditions will turn for the worse. Remote sensing and GIS studies can play an important role in warning us of these changes in spatial and temporal context. These studies can also help in identifying areas that can be set aside for protection as green areas and preserve existing green areas for future generations and for Bhopal Region.

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