ORIGINAL ARTICLE

A city growth and land-use/land-cover change: a case study of Bhopal, India

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Abstract
Nowadays, the rate of urban expansion is quite alarming in developing countries, especially in India. This hasty rate of urban expansion has significantly transformed the natural landscape and creates negative impact on environment. For planned development, we need to understand the urbanization process clearly, and also need to understand the changes in land use/land cover (LULC). Currently, remote-sensing data and GIS technique have been used extensively to understand the urbanization processes and its impact on land use. The aim of the current study is to analyze the expansion of Bhopal city and its impact on land use, using remotely sensed data along with several statistical techniques such as Shannon's entropy and Chi square statistic. The analysis shows that the city has experienced a rapid rate of horizontal expansion; city area increased from 15.8 km^2 in 1991 to 184.5 km^2 in 2016 at an average change of 7 km^2 year^{-1} with spatial disparity. LULC classes of the city area were altered by this expansion process. Expansions of built-up area mainly come from the agricultural and forest land. These are the two primary classes which were affected badly by this expansion process. The present study suggests to make cities more compact, and the need to take proper land and housing policy by the local governing authority and policy makers.

Keywords Urban expansion · Developing countries · Urban sprawl · LULC · Remote sensing · GIS

Introduction

Urban growth is a spatial and demographic process and points to the increasing importance of towns and cities as a center of population within a given economy and society (Bhatta 2009). On the other hand, urbanization is "*a social process which refers to the changes of behavior and social relationships that occur in social dimensions as a result of people living in towns and cities*" (Wirth 1938). The urban population of the world is projected to exceed 60% by 2030, with 90% of the anticipated increase occurring in low-income countries, which have urban settlements that are progressing five times faster than in advanced countries (Jat et al. 2008; Haregeweyn et al. 2012; Thebpanya and Bhuyan 2015). Between 2000 and 2030, built-up areas in cities with 100,000 or more people will increase by 175% (Angel 2005). Rapid urbanization in the world is quite alarming,

especially in developing countries such as India (Kumar et al. 2007). The accelerated urban growth of developing countries leads to sprawl,[1] mainly because of the unauthorized and unplanned development at the fringe area of the city (Clarke et al. 1997; Richardson et al. 2000; Farooq and Ahmad 2008). Rapid expansion has also led to a dramatic change in landscape, creating enormous environmental problems (Grimm et al. 2000; Farooq and Ahmad 2008; Mundia and Murayama 2010). For the expansion of urban area, more land is required, which can be promoted by the conversion of different land uses into built-up environment. In a recent study of the capital of India, it was found that the built-up area has a total increase of 17% between 1997 and 2008, which comes mainly from agricultural land and waste land (Mohan et al. 2011). Another story from Ethiopia, where 151 ha (54%) of agricultural land in 1957 were converted to residential purpose in 1986 (Haregeweyn et al. 2012). Appropriate use of land is an extremely vital social decision, because land is a limited resource (Mather 1986). Nowadays urbanization has led to drastic change on land-cover pattern (Deng et al. 2009; Kumar et al. 2010). Large-scale

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[1] The term 'sprawl' refers here to unplanned and uncoordinated horizontal expansion of urban areas.

Fig. 1 Location of the study area (Bhopal city)
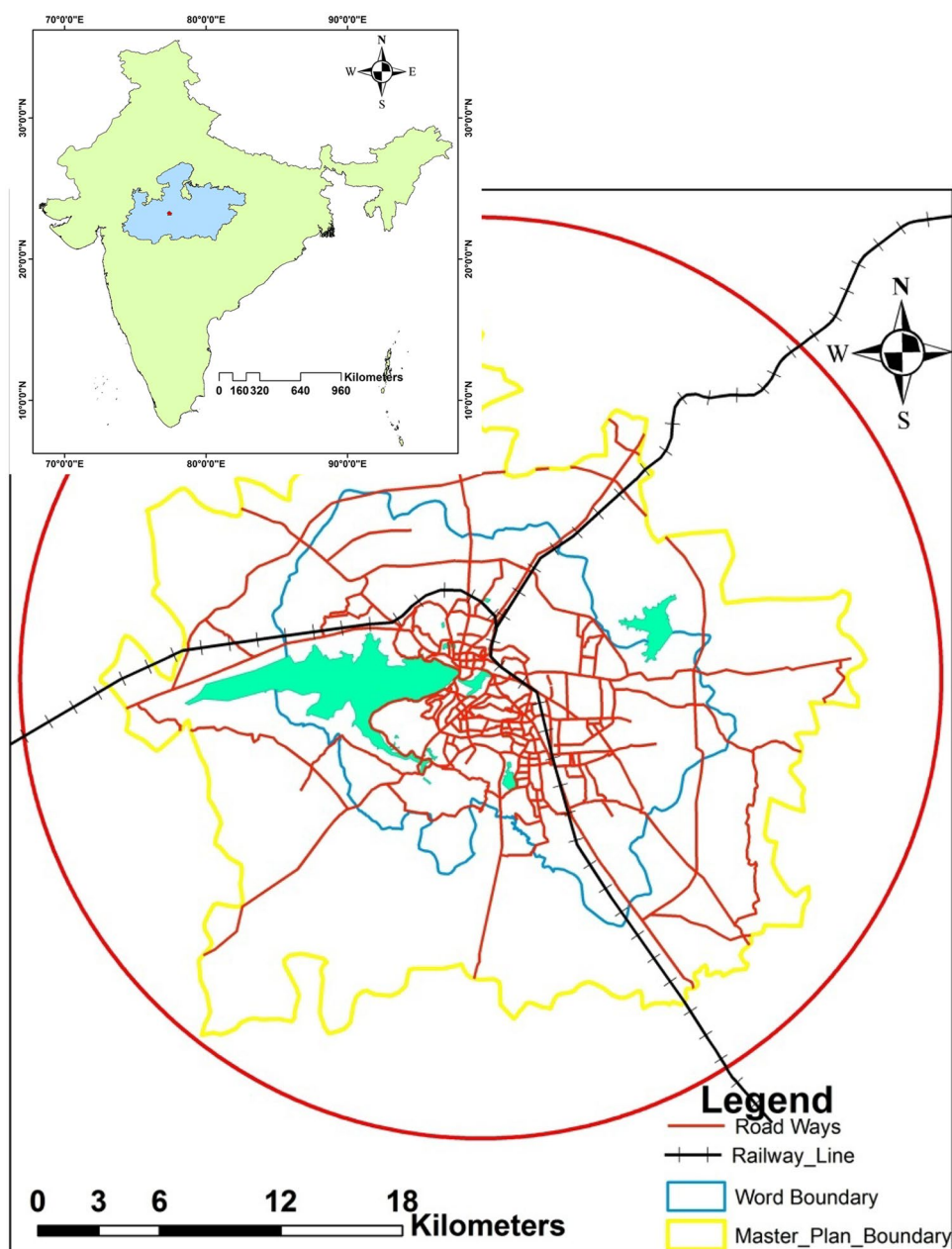
land-use and land-cover change are matter of global concern. Uncovering of such changes may help decision-makers and planners to understand the factors in land-use and land-cover changes, and take effective measures.

In this backdrop, current study tries to analyze the urban growth phenomenon of Bhopal city and the land-use changes related to growth phenomenon since 1991 using remote-sensing data along with the help of simple statistical model. Here, we try to answer the very pertinent questions
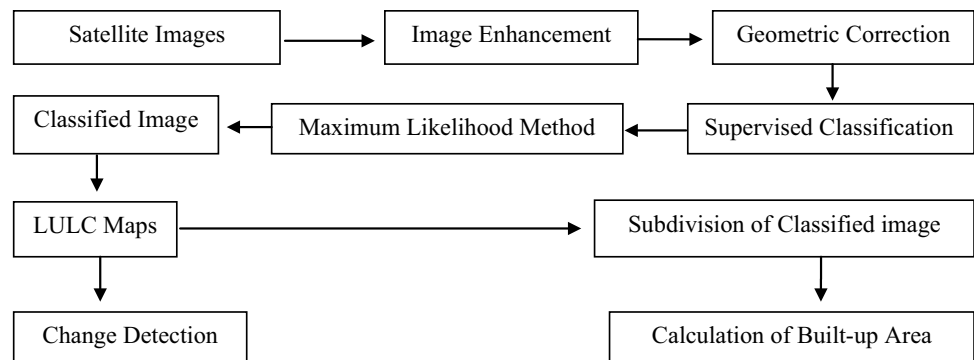
which are as follows—what is the status of urban growth[2] of Bhopal city since 1991? What is the land-use scenario of the city in last 3 decades? How growth phenomenon alters the land-use/land-cover classes?

Study area

Bhopal is the capital of India's state Madhya Pradesh and also the administrative headquarters of Bhopal district, where the present study has been conducted (Fig. 1). Bhopal was built in 11th century by the Parmara King Bhoj (1000–1055). At that time, the city was originally known

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[2] The concept of 'urban growth' discussed here is confined within the extent, rate, and direction of expansion of built-up environment.

Fig. 2 Methodological framework for the LULC maps and built-up area extraction

Data used

The following multi-temporal Landsat imageries were used to accomplish the study

1. Landsat Thematic Mapper (TM) image (path 145, row 44) from 21 August 1991
2. Landsat Enhanced Thematic Mapper Plus (ETM+) image (path 145, row 44) from 3 August 2000
3. The Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) Landsat 8 image (path 145, row 44) from 13 June 2016

All the Landsat satellite images of Bhopal were downloaded from the Geo Data Portal of United State Geological Survey (USGS). To overcome the seasonal vegetation differences, the images were acquired during the dry season for referenced years. All images contained less than 1% cloud cover and the thermal band is not considered for the current analysis due to its coarser spatial resolution (120 m). The vector map of Bhopal planning area provides a framework for clipping and sub-setting the satellite images. Other ancillary data such as land-use maps, municipal ward maps, and census data were also used either as references or for analytical purposes.

as *Bhojpal.* Bhopal is known as the *City of Lakes* for its various natural as well as artificial lakes. It is located in the central part of India, and lies between the latitude 23°07′–23°54′N, longitude 77°12′–77°40′E, just north of the upper limit of the Vindhya mountain ranges. The city has uneven elevation and small hills within its boundaries, having an average elevation of 500 m (1401 ft). It is the 16th largest city of India and 134th largest city in the world. Bhopal had 2,368,145 inhabitants according to the census of 2011.

Methodology

Understanding the dynamic phenomenon of urban growth, such as expansion of built-up area/sprawl, requires the study of LULC changes. ERDAS imagine and ArcGIS software have been used to generate various thematic layers. Complete methodology has been presented in Fig. 2. After collecting the images (1991, 2000, and 2016) of different years, standard image processing techniques have been used such as image extraction, correction (radiometric and geometric) for the further uses of the images. After the processing stages, all the images were subset using vector map of Bhopal planning area. Then, the subset images were classified into supervised classification using maximum-likelihood classifier (MLC) algorithm. ERDAS imagine software was used for image analysis. Finally, from the classified images, built-up area of the city has been calculated and also the LULC maps have been prepared to detect changes of LULC classes over the years.

To understand the dynamics of urban growth in a better way, a sequence of circles (number of circle is four) was drawn from the city center. Geographically, central location of the city is considered as the city center. The extended circle was drawn considering the latest built-up area of the city from 2016 image. All the circles were divided into four cardinal directions to help understand the rate of urban expansion in different directions.

Assessment of urban dynamics

Built-up land as an indicator of urban growth

The class 'built-up land' is a configuration of different types of artificial surfaces; for example, buildings, roads, markets, etc. This class is the most significant interior

Table 1 Urban expansion of Bhopal city (1991–2016). Source: Computed by author

Year	Built-up	% of built-up to total area	Change (%year^{-1})		
			1991–2000	2000–2016	1991–2016
1991	15.8	0.97	36	11	
2000	66.98	4.12			
2016	184.5	11.35			37
Change (km^2 year^{-1})			5.76	7.34	6.74

part of the city and also covers most of the city area. The percentage of built-up area is an indicator of development (Barnes et al. 2001). It can be taken into account that developed regions have larger proportions of built-up areas compared to less developed regions (Sudhira et al. 2004). It can also be used to measure urban sprawl. The percentage of built-up area has been gained from the classified satellite images. The built-up percentage of different zones of every image clearly shows the pattern of urban growth of the city. The annual rate of urban expansion for the time period of 1991–2000 and 2000–2016 has been calculated using the following relationship (modification after Mohan et al. 2011):

$$\text{RUE} = \frac{\text{UA}_{i+n} - \text{UA}_i}{n \times \text{UA}_i} \times 100,$$

Here, UA_{i+n} and UA_i are the urban areas in km^2 at time $i+n$ and i, respectively, and n is the interval of the calculation (in years). By interpreting these imageries, we can simply understand whether the city has become more centralized or multicenter over time. To understand how the city changes over time, or to illustrate urbanization statistically, we need to choose quantitative measures that summarize one or more

of their characteristics. For the built-up areas for each zone and for each time period is represented in Table 1, which shows the urban statistic of Bhopal city. A radical graph has been presented for the effective understanding of the built-up dynamics of Bhopal in spatio-temporal context (Fig. 3). Built-up area has increased as a result of horizontal expansion, from 15.8 km^2 in 1991 to 184.5 km^2 in 2106. Result displayed that the urban area was stretched annually by about 36 and 11% during the period of 1991–2000 and 2000–2016, respectively. In 1991, built-up class held 1% territorial unit of the city, and now, in 2016, it shares 12% area of the city.

The growth dynamics of Bhopal city has a spatial disparity. Though the city center acts as a locus of growth, having railway junction and major highways, but the city expansion is not limited within the central area. The greatest expansion of the city occurred towards the east, south–east, and south directions, because these are directions where major railway lines are radiating. The different national highways are passing in these directions like—NH 12 which connects Bhopal to Jabalpur in the East and Jaipur in the West, NH 86 connects Bhopal to Sagar in the East, and Dewas and Ujjain in the West (Fig. 4). In this way, Bhopal expands linearly along with major connectivity of the city. When we focused on the administrative limit of the city, it was observed that Bhopal gradually expanded 'beyond the municipal boundary' due to unauthorized and unplanned development and has a trend towards sprawl.

To better understand the expansion pattern, we introduced here two maps which clearly reflects the major roads and railway lines of the city.

Quantifying degree-of-freedom of urban growth

Urban growth is a dynamic phenomenon with fluctuation and spatial variation. To calculate the
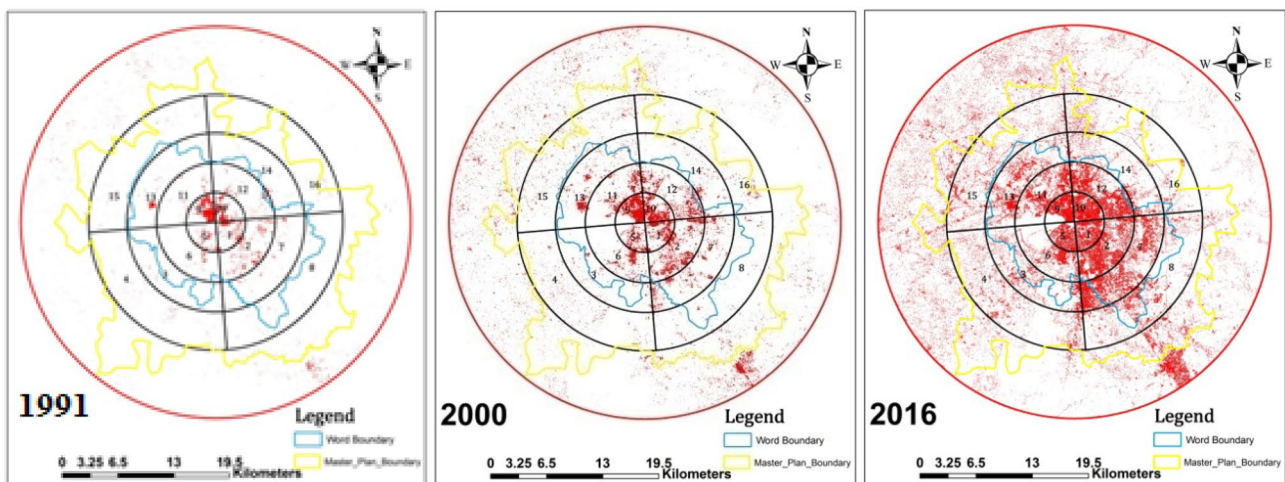
Fig. 3 Classified images of different time point, showing urban expansions
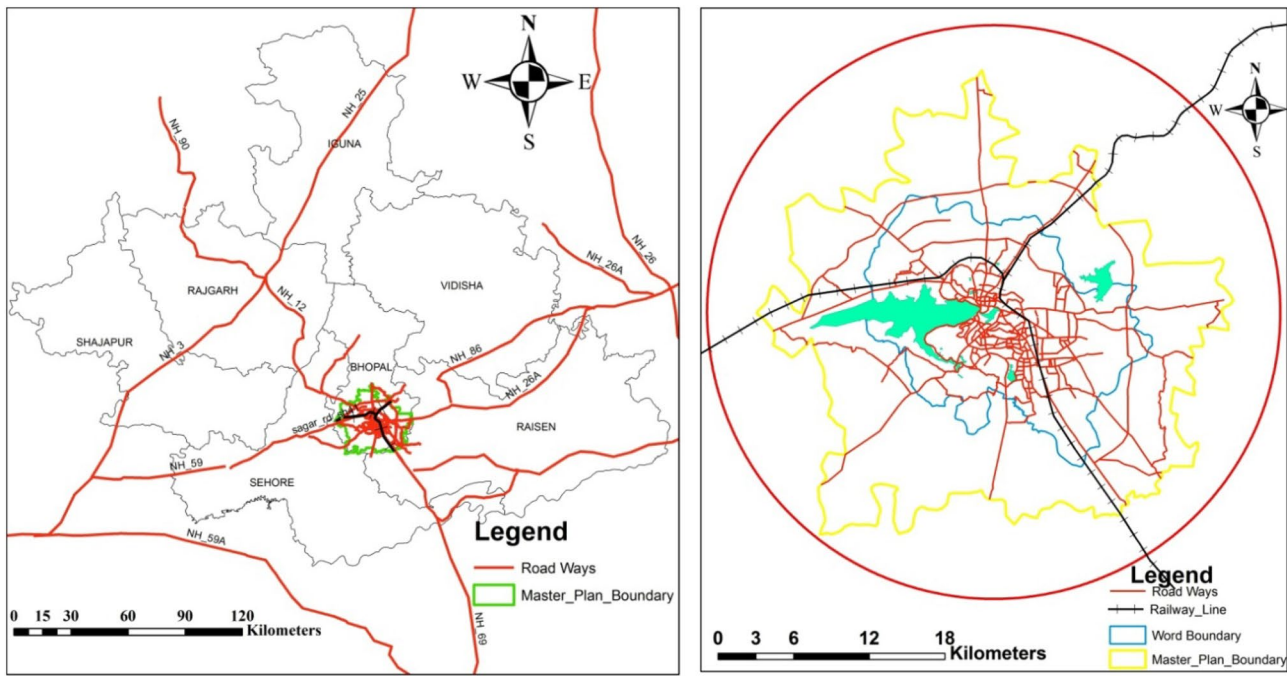
Fig. 4 Internal and external connectivity map

Table 2 Degree-of-freedom of urban growth. Source: Calculated by author

Year and zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	χ^2
1991–2000	0.18	0.41	0.67	0.23	0.02	0.23	0.37	1.28	2.21	0.65	0.12	0.16	0.01	0.01	0.02	0.03	6.59
2000–2016	0.07	0.16	0.27	0.09	0.01	0.09	0.15	0.51	0.88	0.26	0.05	0.06	0.00	0.00	0.01	0.01	2.63
χ^2	0.25	0.57	0.94	0.32	0.03	0.32	0.51	1.79	3.09	0.90	0.17	0.23	0.01	0.02	0.02	0.04	9.21

'degree-of-freedom' of urban growth of the city, Chi square test has been used with the Pearson's Chi square expression: (observed–expected)^2/expected. It exposes the degree of deviation of observed urban growth over the expected. According to Almedia (2005), "*Pearson's Chi square statistics takes into account the checking of freedom amongst pairs of variables chosen to explain the same category of land-cover change*". The Chi square test for each temporal span (x_i^2) was calculated as follows (Table 2):

$$\chi_i^2 = \sum_{j=1}^{m} \frac{\left(M_j - M_J^E\right)^2}{M_J^E}$$

where χ_i^2 = degree-of-freedom for ith temporal span, M_j = observed built-up area in jth column for a specific row, and M_J^E = expected built-up area in jth column for a specific row.

The expected built-up area for each zone was computed from the observed built-up growth table of the zones. Here, the table consider as matrix M (see the appendix for the calculation of M matrix), with the element M_{ij}, where i denotes the specific time span and j denotes specific zone. The expected growth is computed by taking the ratio of the product of the marginal totals and grand totals (Almeida et al. 2005). Therefore, the expected growth for this study was calculated by the following equations:

$$M_{ij}^E = \frac{M_i^s \times M_j^S}{M_g},$$

where M_i^s = row total; M_j^S = column total; M_g = grand total.

The Chi square has a lower limit of 0, when there is no difference between the observed and expected growth, both have equal values. Table 2 clearly shows the degree-of-freedom for each zone of different images. The degree-of-freedom is very high (6.59) for the time

Table 3 Shannon's entropy for different zone. Source: Calculated by author

Year and zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Hi
1991	0.29	0.20	0.02	0.02	0.22	0.06	0.05	0.01	0.37	0.33	0.08	0.10	0.06	0.02	0.02	0.01	1.869
2000	0.27	0.22	0.04	0.04	0.22	0.11	0.12	0.03	0.33	0.31	0.18	0.19	0.10	0.06	0.05	0.03	2.288
2016	0.25	0.22	0.10	0.07	0.23	0.12	0.19	0.08	0.25	0.27	0.21	0.22	0.13	0.08	0.07	0.05	2.544

period of 1991–2000, and in 2000–2016, the value (2.62) was reduced. From the above analysis, we can clearly say that Bhopal has a zonal variation of degree-of-freedom. Freedom is pretty high in the zone of 8 and 9. In addition, the overall degree-of-freedom is too large 9.2. From the above discussion, it can be stated that, in some portion of the city, there is a huge gap between expected growth and the growth observed. Higher Chi square value indicates that the region have not achieved the level of growth that was expected. Though the zones 1, 5, 9, 10 are lie in core of the city but also unable to fulfill the expected growth from these zones.

It is true that the urban space has a spatial variation in terms of growth impetus. But here, the average freedom value (9.2) indicates that the city has a lack of equal weightage and dearth of uniformity in planning. However, it should be noted that higher degree-of-freedom cannot be considered as sprawl; instead, it should be considered a variation in growth process.

This method of analysis is useful to find out the lag zone in terms of built-up growth and also provides a conceptual framework to the city planner that which part of the city need to more focus on future growth.

Measuring the compactness of urban growth

Shannon's entropy is a very useful method for the measurement of compactness or dispersion of urban growth (Yeh et al. 2001; Lata et al. 2001; Sudhira et al. 2004; Kumar et al. 2007; Bhatta et al. 2010). However, a recent study by Nazarnia et al. (2019) raises the question about the suitability of using the 'entropy' as a measure of urban sprawl as it is not susceptible to crucial difference between spatial patterns of built-up areas, which represents the various level of urban sprawl. Although the entropy measure is criticized in a recent the literature, yet among the several metrics of urban sprawl measurement, Shannon's entropy is the most often and widely used metrics for the measurement of urban sprawl (Yeh et al. 2001; Lata et al. 2001; Sudhira et al. 2004; Kumar et al. 2007; Bhatta et al. 2010). The degree of sprawl can be identified by the magnitude of entropy value. The entropy value ranges from 0 to $\log_e(n)$. Value '0' indicates that the distribution of built-up area is very compact, while values closer to $\log_e(n)$ reveal that the distribution is much dispersed. The higher value indicates the higher level of dispersion, which indicates occurrence of

urban sprawl. If the distribution is very compact and vertical development of built-up then the entropy value would be closer to 0. In this study, Shannon's entropy was computed to quantify the compactness or dispersion of built-up growth in different spatial and temporal context. The Shannon's entropy for each zone has been calculated using the following formula:

$$H_j = -\sum_{i=1}^{n} p_i \log_e (p_i),$$

where p_i = proportion of built-up area in the ith zone is calculated by obtaining the ratio of built-up area (in %) of ith zone and the sum of built-up area (in %) of all zones. n = total number of zones = 16.

Now, we computed the relative entropy (H_j), to scale entropy to a value between 0 and 1 by dividing H_j by $\log(n)$:

$$H_j = -\sum_{i=1}^{n} p_i \log_e (p_i) / \log(n).$$

If the value of relative entropy is zero (0), which indicate that the nature of urban growth is compact and the magnitude of sprawl is zero. The upper end of the relative entropy value (1) indicates higher level of urban sprawl (Yeh et al. 2001).

Both the Tables 3 and 4 show that the overall entropy value of the city is not very close to 0 and also increasing with the passage of time (1991–2016). Therefore, the city has a gradual trend of sprawl development. In 2016, the relative entropy value of the city is very close to 1, which indicates that the level of sprawl of the city is very high. After that, zone-wise analysis shows that, except the zones 1, 9, and 10, rest of them have a trend to increase entropy value (see Fig. 5). Therefore, it can be said that the city has witnessed dispersed built-up growth across different spatial zone within specific time span. Therefore, it can be concluded that the general tendency of growth of the city is sprawl development.

Table 4 Relative entropy for different years. Source: Calculated by author

	1991	2000	2016
Relative entropy	0.674	0.825	0.918
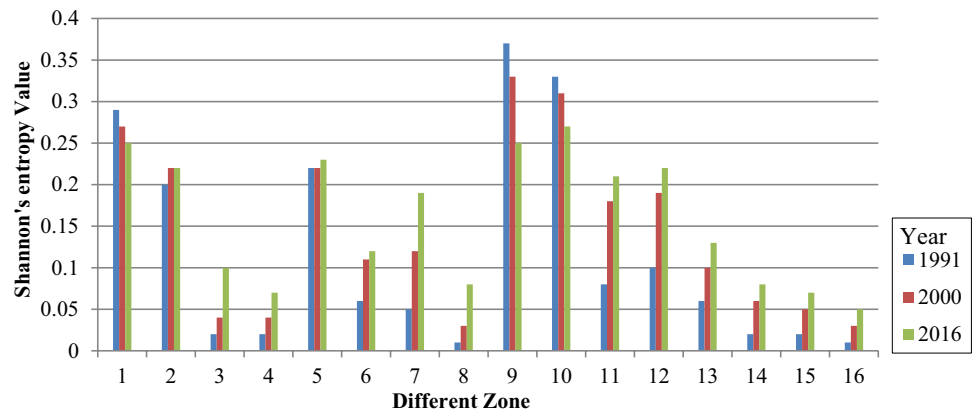
Analysis

Therefore, after the analysis of built-up expansion, degree-of-freedom of urban growth, and Shannon's entropy; we got a clear picture about the nature of urban expansion of Bhopal city. The result of degree-of-freedom of urban growth indicates that Bhopal has a spatial variation of degree-of-freedom; even at the core area, the city is unable to achieve the expectation level of growth. Whereas, the assessment of built-up-area expansion indicates that the city expands beyond the limit of municipal boundary. Finally, when we focused on Shannon's entropy value, the study reveals that the city has a gradual trend towards sprawl development. Though it is true that we do not have any exact value by which we can say that this particular value indicates sprawl. However, if we focus on subjective definition of urban sprawl, it is an undesirable pattern and process of urban growth which extends to the outside of the core urban area in a dispersed manner. Then, we can say that the concept of Sprawl emerged in *Lake Town,* due to unauthorized and unplanned development at the fringe area of the city, as we noticed along the major line of communication (NH-12, 86, Railway Line). Though the core city area has space for further development, but the present development nature has a trend towards peri-urban development. This is the clear indication of sprawl development in Bhopal.

Urban theory and dynamic expansion

Urban center is a narrow geographical space, where we can notice the concentration of capital and economic activities and a greater degree of specialized production (Lefebvre et al. 1991). Because of these facilities, urban center acts as an engine of growth to their surrounding hinterland (Hoselitz 1955). In a growing city, concentrations of all those facilities are supposed to increase with time. In 1991, urban expansion of Bhopal does not cross the municipal limit. However, in 2000, it is expanded beyond the administrative limit of the city and now the magnitudes of crossing are too high,

it looks like a sprawl. Since the 1970s, spatial characteristics of India's metro cities started to change (Shaw 2007). However, at that time frame (1970s–1990s), Bhopal went beyond the impact of globalization forces, as Bhopal's demographic and economic weightage did not attract the global investors. However, in 1992, when economic, social, and political order changed, the nature and characteristics of industries also changed by the process of de-industrialization, re-industrialization, and nationalization. In case of Bhopal, changes have occurred in a similar pattern. These changes happened due to the fact that neoliberal phenomenon changed the urban space little faster and also resulted in uneven urban geography (Harvey 2007). After economic reform, the accelerated intercity movement was observed due to the minimization of the rigidness of state boundary. In the case of Bhopal, we saw that intercity network was developed; boundary is also open for economic activity. At that time, industries and commercial houses developed along with major transportation network beyond the municipal limit of the city, which was clearly reflected in built-up map for the year of 2000. By this process, industries are concentrated apart from the city center on a feasible location without considering administrative limit of the city; after that, numbers of industries are also increasing gradually through the impact of agglomeration economies.

Detection of land-use/land-cover changes

Land use and the pattern of land cover in an area are the result of natural, social, and economic factors and their consumption by men in time and space (De and Jana 1997). The uncovering of such changes may help decision-makers and planners to understand the causes of land-use and land-cover changes and take effective measures (Mohan et al. 2011). Therefore, first of all, here, we focused on land-use classification scheme after that we focused on changes.

Table 5 LULC classification schemes. Source: (modification after Thebpanya and Bhuyan 2015)

LULC classes	Description
Built-up area	It includes all types of artificial surfaces such as residential, commercial, and industrial areas as well as transportation infrastructure
Forest land	Includes areas with dense vegetation, such as those covered with shrubs that from closed curtains and trees
Water bodies	It Includes lakes, rivers, ponds, and marshlands
Agricultural land	"Characterized by high percentage of grasses, other herbaceous vegetation, and crops, including lands that are regularly mowed for hay or grazed by livestock, regularly tilled, and planted cropland."
Stony waste	It indicates outcrop area, basically mountain outcrop
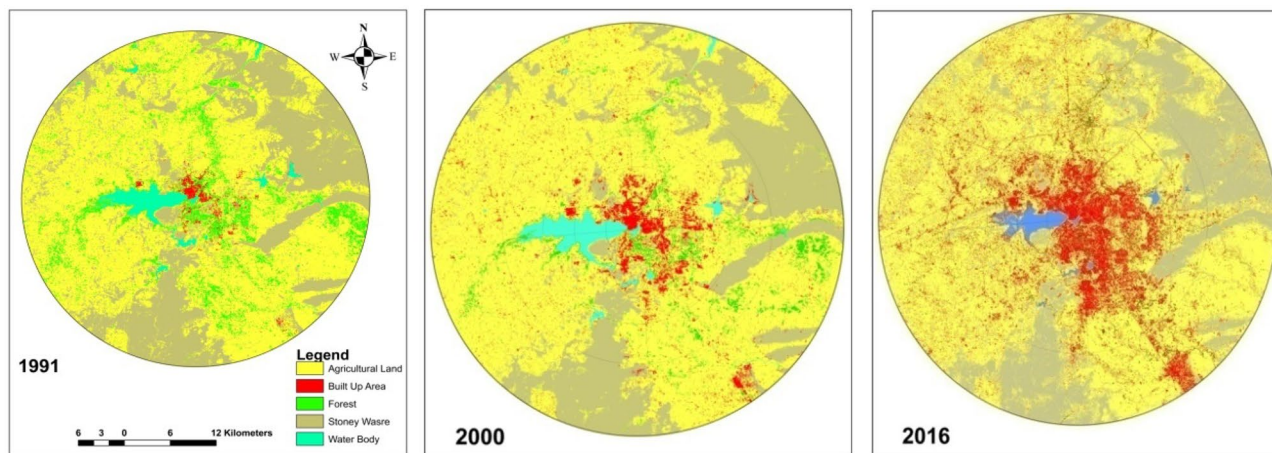
Fig. 6 Land-use/land-cover map of Bhopal city

Classification scheme

National Remote Sensing Centre (NRSC) of India classified the entire land cover of the country into six broad classes such as built-up, agricultural land, forest, grass/grazing, barren/waste lands, and wetlands/water bodies. For the present analysis, the entire study area has been classified into five classes, considering the standard classes defined by the United State Geological Survey (USGS) and also the objectives of the study. Though, there is no universally accepted classification system that can be used by all users everywhere, that is why to avoid the LULC class 'grazing' and to fulfill the study objectives, the study has taken USGS framework. The following land-use and land-cover (LULC) classification schemes have been used for the current study, which is mentioned below (Table 5).

Land-use/land-cover changes

In this section, the study focuses on how growth phenomenon, basically the horizontal expansion of built-up area,

alters the LULC classes. The city has witnessed rapid built-up expansion as a result of unplanned, uncontrolled development of different artificial surfaces, which leads to drastic change of previous land-use system (Fig. 6). From the following table (Table 6), it can be stated that, in 1991, most of the portions (around 60%) of the study area have categorized as agricultural land, whereas built-up areas, water bodies, and forest land account for 1, 2, and 7%, respectively. However, in 2000, agricultural areas have covered 57% of the study area, whereas built-up areas, water bodies, and forest land accounted for 4, 2, and 6%, respectively. In the year 2016, built-up areas accounted for 12% of the study area, whereas agricultural land, forest water bodies accounted for 53, 1.6, and 4%, respectively.

From the reference table (Table 6), it was also stated that different land-use/land-cover classes gained as well as lost their territory in different time periods. In the time period of 1991–2000, it was seen that agricultural land reduced by 30 km^2 areas, whereas forest land reduced by 17.29 km^2 areas. However, in the same time span, built-up class gained 51.18 km^2 areas by the maximum cost of agricultural land. Within the reference time span (1991–2016),

Table 6 Temporal changes of area of different LULC classes. Source: Computed by author

Land-use class	1991		2000		2016		1991–2000		2000–2016	
	km^2	(%)	km^2	(%)	km^2	(%)	Gain (km^2)	Loss (km^2)	Gain (km^2)	Loss (km^2)
Built-up area	15.8	0.97	66.98	4.12	184.5	11.35	51.18		117.5	
Agricultural land	963.88	59.31	934.27	57.49	866.27	53.30		− 29.6		68
Forest land	117.83	7.25	100.54	6.19	61.6	3.79		17.29		38.94
Water bodies	35.28	2.17	33.16	2.04	26.14	1.61		2.12		7.02
Stony waste	492.35	30.30	490.19	30.16	486.63	29.94		2.16		3.56
Total	1625.14	100	1625.14	100	1625.14	100.00				

built-up class holds the top position in terms of encroaching land from other classes. In terms of losing the amount of land, agricultural land tops the chart. Finally, we can say that overall 168.2 km^2 (10.34%) land area is converted into built-up class from other classes. This is the clear indication of alteration of LULC classes due to rapid rate of urban growth.

Conclusion

The study was aimed to analyze the expansion of Bhopal city and its impact on land use from remote-sensing data along with modern statistical techniques. The analysis shows that the city has experienced rapid horizontal expansion. The city area has increased from 15.8 km^2 in 1991 to 184.5 km^2 in 2016, at an average rate of change of 7 km^2 year^{-1} with spatial disparity. The city expansion altered the previous land-use system, and has a negative impact on the environment of the city. As it was previously mentioned, the nature of urban growth of the city is like sprawl. Intensification of built-up areas (built-up area has increased almost ten times from 1991 to 2016) altering the other land-use classes; the agricultural and forest land is most affected by this process, and forest land and water bodies also decreased between 1991 and 2016.

Therefore, optimum use of land is needed in this city to control haphazard urban growth, which is possible by introducing new regulation, allowing higher density in built-up area and to create constrains on the use of new areas building. It was also noted that each zone has a different level of compactness, leading to different growth patterns. Therefore, one policy for the whole city never works, to make the city more compact which we need to equally address all the issues.

Appendix

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	M_i	Grand total (M_g)
Observed growth in built-up area																		
1991–2000	1.7	4.4	0.7	1.4	1.3	2.0	3.6	0.8	1.8	2.2	2.9	4.2	2.4	1.3	2.1	1.1	33.8	118.5
2000–2016	2.6	7.0	5.8	6.0	2.6	2.9	13.6	8.6	0.4	2.3	5.4	7.9	6.5	3.7	6.0	3.5	84.7	
M_j	4.3	11.4	6.5	7.4	3.9	4.9	17.2	9.4	2.1	4.5	8.2	12.0	8.9	5.0	8.2	4.6		
Expected built-up growth																		
1991–2000	1.2	3.3	1.9	2.1	1.1	1.4	4.9	2.7	0.6	1.3	2.3	3.4	2.5	1.4	2.3	1.3		
2000–2016	3.1	8.2	4.7	5.3	2.8	3.5	12.3	6.7	1.5	3.2	5.9	8.6	6.4	3.6	5.8	3.3		

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