

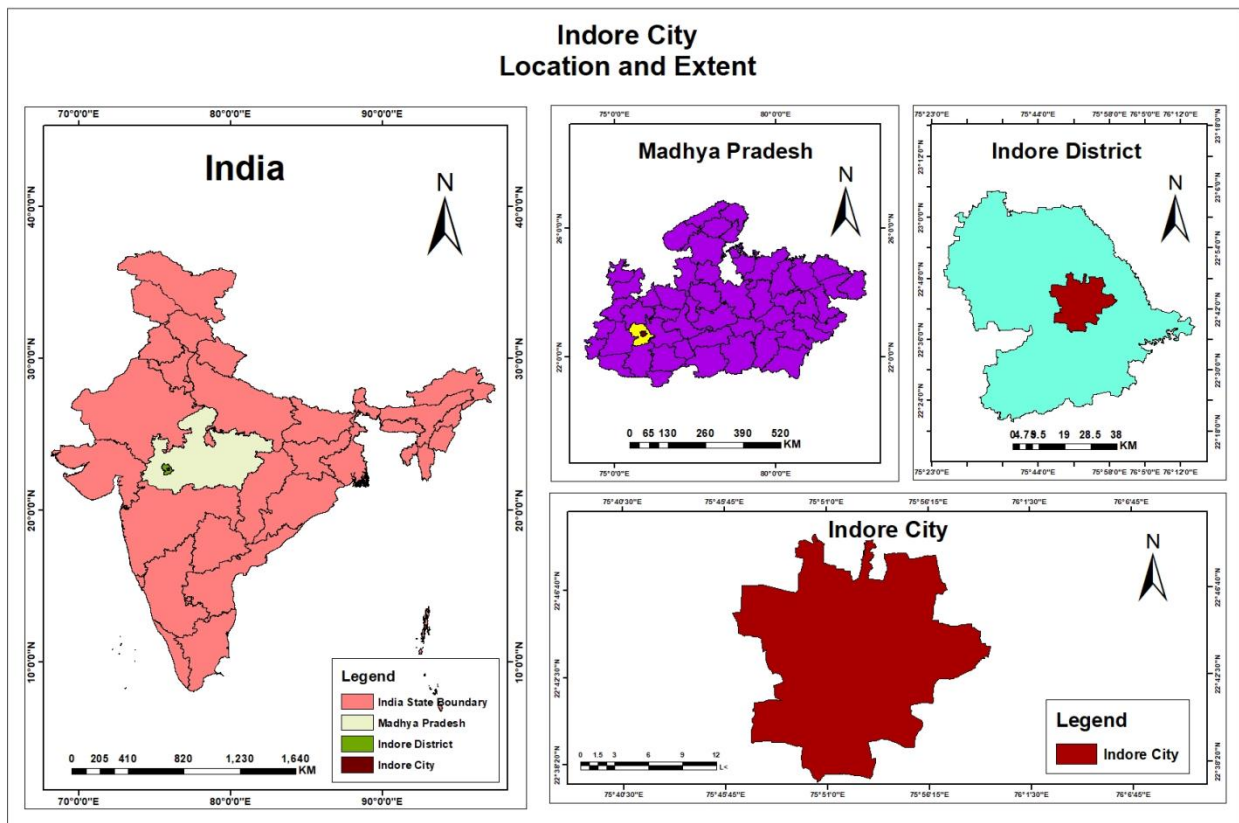


# Population Growth and Changing Land-use Patterns in Indore City

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**Introduction:** Land serves as the foundation for all kinds of human activities and is a very precious resource. We cannot increase the total availability of land, but we can optimize the use of the available land resources through sustainable practices. Land is internationally defined as the total area of Earth's territorial surface, encompassing all attributes of the biosphere just above or below the surface. Meanwhile, land use can be defined as the aggregate of arrangements, activities, and inputs that people employ in various land cover types (Casperson, O.H., et al, 2014). Land is an immensely important asset for humans. It forms the basis of human survival and all human activities, serving as a fundamental requirement for any form of production and development. (Kamp, I.V., et al, 2003) stated that land cannot be destroyed, but it can undergo changes or suffer damage. Understanding the changes in land use/land cover categories over time provides valuable insights for the improved utilization of land resources. The continuous growth of cities results in rapid changes in land use and the expansion of the city's area, typically including the surrounding regions. This phenomenon has various harmful impacts on the urban environment of the city. First of all, cities face problems generated by urban sprawl. A sprawling city consumes a wide range of surrounding agricultural areas and converts them into fragments (Gomes, et al., 2019). With the passage of time, these fragmented areas of agricultural land, vacant lands, and green spaces get reduced and converted into built-up areas of various uses. Likewise, the city becomes larger and larger in terms of built-up area and smaller in open/green spaces. Secondly, the growth of cities leads to an increase in vehicular emissions, industrial emissions, domestic emissions, and others. The combined emissions from all these sources result in high air pollution. This increased air pollution becomes the major source of poor urban environment, which deteriorates the quality of life for the residents of the city.

**Study Area:** Indore stands as one of the most renowned urban centers within the Indore District of Madhya Pradesh. It is well known for trade, commerce, education, and hospitality. It is also recognized as the commercial capital and educational center of the state. As per Section 4 of the Madhya Pradesh Town and Country Investment Act, 1973, it is the largest city in the "Agricultural Industrial Area." It is situated at 22°43' north latitude and 76°43' east longitude on the Malwa Plateau. The city is located at an altitude of 548.64 meters above sea level. It follows a mayor-council form of government. The city is encompassed by the Indore Municipal Corporation, spanning an area of 279 km<sup>2</sup>. This territory is divided into 19 distinct zones, each of which contains 85 wards.



**Figure 1: Indore City Location and Extent**

**Objectives of the Study:** The study aims to achieve the following objectives:

1. To know the distribution of population in 85 wards of the city.
2. To know the patterns of population growth in the city.
3. To know the Urban Sprawl in the city.
4. To know the changing land-use patterns in the city.
5. To know the present patterns of land-use in the city.

**Research Methodology:** The study aims to understand the distribution of population in the different wards of the city and to know the patterns of population growth in the city. The study focuses on the changing patterns of land-use in the city and on the present patterns of land-use in the city. The study is based on the secondary source of data. The ward wise population data was collected from the Indore Municipal Corporation and the ward map was collected from Indore Smart City Office. Data related to population growth, urban sprawl and land-use patterns was collected from Indore Master Plan 2014. Quartile method was used to describe the distribution of population density in the city. The city comprises of total 85 wards. Map of these wards is given below:

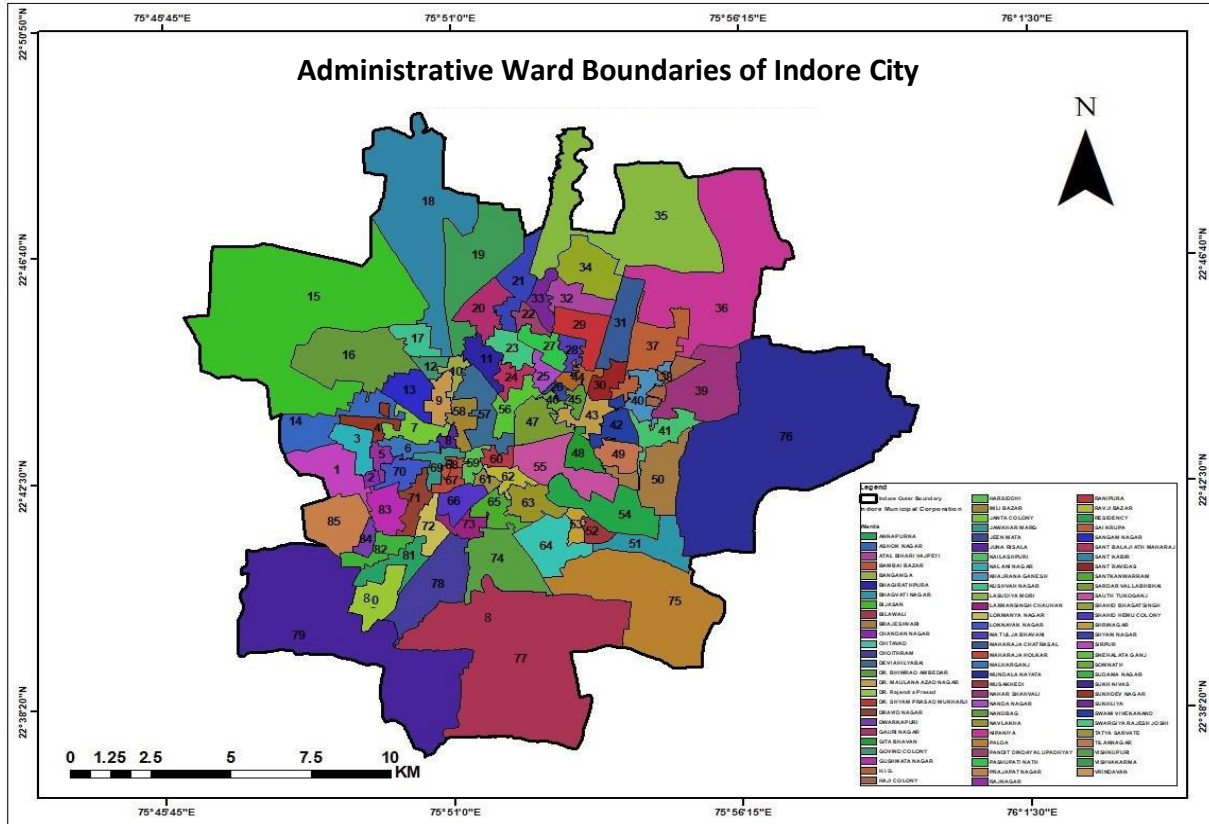


Figure 2: Administrative Ward Boundaries of Indore Metro City

## Results and Discussions

Topography and resource availability in a region have a direct impact on population distribution. Spatial population distribution varies based on the land's carrying capacity, which in turn is influenced by the economic activities conducted in an area. Well-developed socio-economic and commercial facilities attract a larger number of migrants, often resulting in higher density than the land's carrying capacity. The population distribution in Indore metro city is highly variable due to various socioeconomic and commercial factors.

**Population density** shows the distribution of population within the city. There is significant variation in population distribution among the different wards of Indore city in 2021. As a result, it is classified into four categories based on quartiles, as outlined below.

Table 1: Population Density of Indore City (2021)

Class	Quartile Value (Density/km <sup>2</sup> )	Total wards	Description of Wards (Ward No.)
Low	1121-13607 (Q1=13607)	22	76,15,77,79,35,36,18,75,19,16,39,78, 55, 74, 37, 34, 54, 50, 14, 85, 1, 31

Low-Medium	14103-27877 (Q2=27877)	21	21,64,51,57,29,47,63,80,32,41,20,13, 42, 40, 43, 81, 83, 71, 72, 7, 65
High-Medium	27997-47061 (Q3=47061)	21	66,23,48,49,11,33,3,27,56,58,70,82, 9, 17, 30, 62, 73, 69, 4, 38, 25
High	47205-178726	21	24,44,6,22,59,28,52,12,60,67,10,45, 53, 84, 5, 61, 46, 26, 68, 8, 2

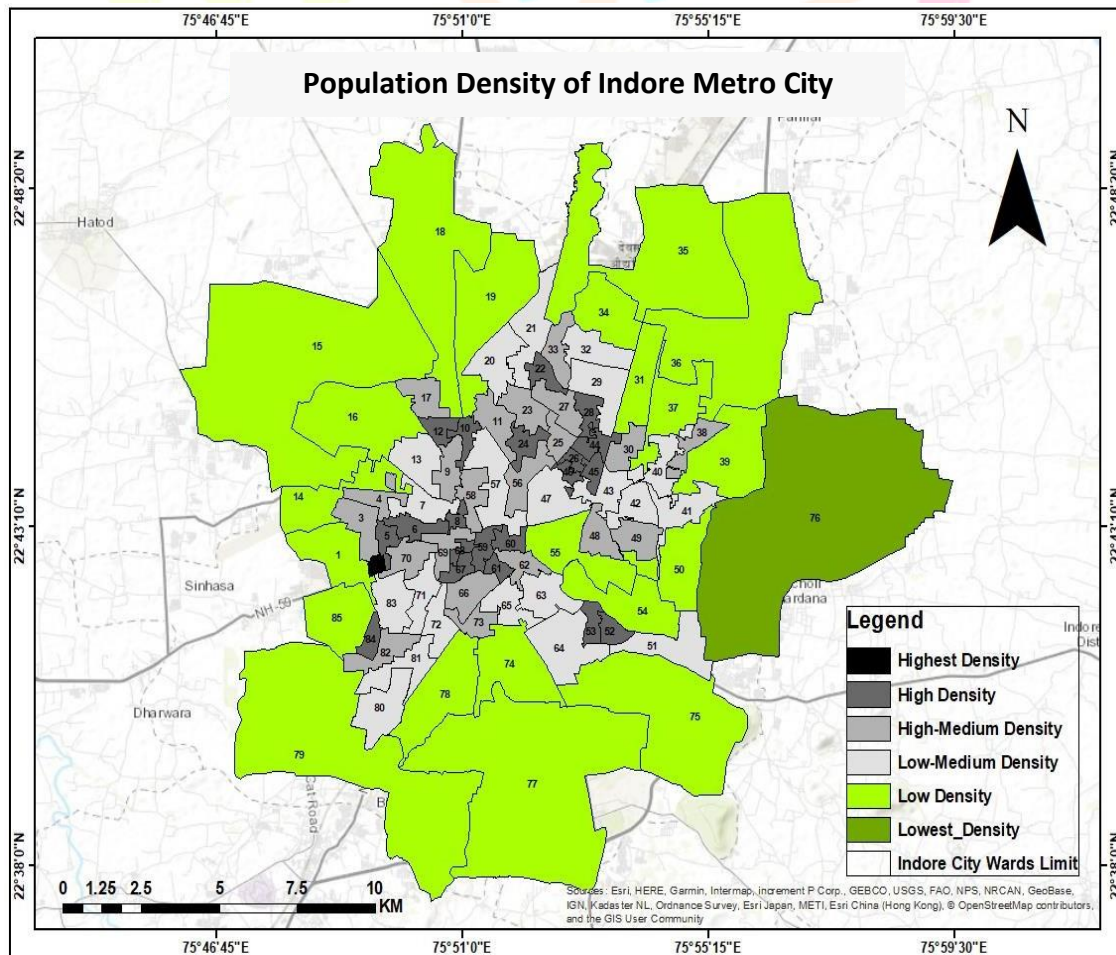


Figure 3: Population Density of Indore Metro City

The total population of Indore metro city in 2021 is 30,62,657 and the total municipal corporation area is 279 km<sup>2</sup>. Based on this, the population density of Indore metro city in 2021 is calculated as 10,977 persons per km<sup>2</sup>. The distribution of population density across the various wards of the city is provided below:

1. **High Density:** The ward with the highest density is 'Chandan Nagar' which has 1,78,726 people living per square kilometer. The major reason behind the highest density in this ward is its size; it has the smallest area among all the wards of the city. Other wards with high density include Juna Risala (1,34,177 persons/km<sup>2</sup>), Bambai Bajar (1,18,362 persons/km<sup>2</sup>), Jeen Mata (1,09,868 persons/km<sup>2</sup>), Somnath (95,939 persons/km<sup>2</sup>), Taty Sarwate (82,827 persons/km<sup>2</sup>), Raj Nagar (76,347 persons/km<sup>2</sup>), Dwarkapuri (72,160 persons/km<sup>2</sup>), Dr. Maulana Azad (70,016 persons/km<sup>2</sup>), Bhim Rao Ambedkar (67,890 persons/km<sup>2</sup>), Banganga (66,338 persons/km<sup>2</sup>), Maharaja Holkar (62,634 persons/km<sup>2</sup>), Ranipura (62,069 persons/km<sup>2</sup>), Govind Colony (61,669 persons/km<sup>2</sup>), Musakhedi (58,191 persons/km<sup>2</sup>), Ma Tuleja Bhavani (50,531 persons/km<sup>2</sup>), Harsiddhi (50,503 persons/km<sup>2</sup>), Pandit Dindayal Upadhyay (48,625 persons/km<sup>2</sup>), Malharganj (48,183 persons/km<sup>2</sup>), H.I.G. (47,466 persons/km<sup>2</sup>), and Sant Balajinath Maharaj (47,205 persons/km<sup>2</sup>).

These wards are located in the CBD, its surroundings, and are also scattered across the central part of the city. These areas are commercially well-developed parts of the city and are home to famous places such as Rajwada Bajar, Kothari Bajar, and Khajuri Bajar.

2. **High-Medium Density:** The wards included in this category are Nanda Nagar (47,061 persons/km<sup>2</sup>), Haji Colony (41,487 persons/km<sup>2</sup>), Sukhdev Nagar (41,094 persons/km<sup>2</sup>), Jawahar Marg (40,125 persons/km<sup>2</sup>), Laxman Singh Chauhan (39,832 persons/km<sup>2</sup>), Ravji Bajar (38,023 persons/km<sup>2</sup>), Sant Ravidas (36,945 persons/km<sup>2</sup>), Kushvah Nagar (35,856 persons/km<sup>2</sup>), Vrindavan (35,040 persons/km<sup>2</sup>), Sudama Nagar (33,389 persons/km<sup>2</sup>), Loknayak Nagar (31,860 persons/km<sup>2</sup>), Imli Bajar (31,662 persons/km<sup>2</sup>), Snehalata Ganj (30,905 persons/km<sup>2</sup>), Pashupati Nath (30,430 persons/km<sup>2</sup>), Sukhliya (30,058 persons/km<sup>2</sup>), Bhagirathpura (28,693 persons/km<sup>2</sup>), Tilak Nagar (28,336 persons/km<sup>2</sup>), Gita Bhavan (28,158 persons/km<sup>2</sup>), Swargiya Rajesh Joshi (28,074 persons/km<sup>2</sup>), and Shahid Hemu Colony (27,997 persons/km<sup>2</sup>). These wards are located adjacent to the wards with high density in the CBD and other parts of the city that are well-developed in terms of markets, hospitals, and educational institutes.
3. **Low-Medium Density:** The wards falling into this category are Sant Kanwarram (27,877 persons/km<sup>2</sup>), Janta Colony (27,774 persons/km<sup>2</sup>), Lokmanya Nagar (27,334 persons/km<sup>2</sup>), Dravid Nagar (26,975 persons/km<sup>2</sup>), Gumashta Nagar (26,338 persons/km<sup>2</sup>), Annapurna (25,754 persons/km<sup>2</sup>), Shri Nagar (25,607 persons/km<sup>2</sup>), Khajrana Ganesh (23,553 persons/km<sup>2</sup>), Swami Vivekanand (22,794 persons/km<sup>2</sup>), Sangam Nagar (22,305 persons/km<sup>2</sup>), Gauri Nagar (21,317 persons/km<sup>2</sup>), Kailashpuri (21,026 persons/km<sup>2</sup>), Atal Bihari Vajpeyi (19,763 persons/km<sup>2</sup>), Dr. Rajendra Prasad (19,669 persons/km<sup>2</sup>), Navlakha (19,494 persons/km<sup>2</sup>), Sardar Vallabhbai Patel (19,313 persons/km<sup>2</sup>), Dr. S.P. Mukherjee (16,542 persons/km<sup>2</sup>), Devi Ahilya Bai (16,150 persons/km<sup>2</sup>), Bhagvati Nagar (15,746 persons/km<sup>2</sup>), Chitavad (14,361 persons/km<sup>2</sup>), and Shyam Nagar (14,103 persons/km<sup>2</sup>).

These wards are situated between the central and middle parts of the city. Notable city landmarks such as the city Museum, Mahatma Gandhi Medical Hospital, and CHL CARE Hospital are found in this category. Despite this, many wards are positioned alongside National Highway 47, leading to a lower-medium population density in these wards.

4. **Low Density:** The city has 22 wards characterized by low population density. These wards are Maharaja Chatrasal (13,607 persons/km<sup>2</sup>), Sirpur (13,552 persons/km<sup>2</sup>), Prajapat Nagar (13,139 persons/km<sup>2</sup>), Ashok Nagar (12,272 persons/km<sup>2</sup>), Brajeshwari (11,640 persons/km<sup>2</sup>), Residency (11,034 persons/km<sup>2</sup>), Shahid Bhagat Singh (10,723 persons/km<sup>2</sup>), Sai Krupa (10,550 persons/km<sup>2</sup>), Vishnupuri (10,140 persons/km<sup>2</sup>), South Tukoganj (9,231 persons/km<sup>2</sup>), Choithram (9,148 persons/km<sup>2</sup>), Nahar Shahvali (8,811 persons/km<sup>2</sup>), Nand Bagh (6,589 persons/km<sup>2</sup>), Vishvakarma

(5,615 persons/km<sup>2</sup>), Palda (3,332 persons/km<sup>2</sup>), Sant Kabir (3,167 persons/km<sup>2</sup>), Nipaniya (2,588 persons/km<sup>2</sup>), Lasudiya Mori (2,123 persons/km<sup>2</sup>), Sukh Niwas (1,941 persons/km<sup>2</sup>), Bilawali (1,590 persons/km<sup>2</sup>), Bijasan (1,575 persons/km<sup>2</sup>), and the lowest density is found in Mundala Nayata (1,121 persons/km<sup>2</sup>).

These wards have low population density primarily because they are situated in the outermost areas of the city. These regions still have significant potential for growth and development, making them ongoing development zones.

**Population Growth Patterns:** The development of a city depends on its population growth. A low population underutilizes resources, while a high population results in resource scarcity due to increased population pressure. Therefore, the optimum population is the one that can make the most efficient use of required resources in a city. The table provided below shows the population growth patterns of Indore city.

**Table 2: Population Growth Patterns of Indore City (1901-2021)**

YEAR	POPULATION	GROWTH (%)
1901	97,804	-
1911	54,112	-44.65%
1921	1,05,317	94.52 %
1931	1,42,524	35.33 %
1941	2,03,695	42.92 %
1951	3,10,859	52.61 %
1961	3,94,941	27.05 %
1971	5,60,937	42.03 %
1981	8,29,327	47.8 %
1991	11,09,056	33.78 %
2001	15,06,062	35.80 %
2011	19,94,397	32.4 %
2021	30,62,657	53.5 %

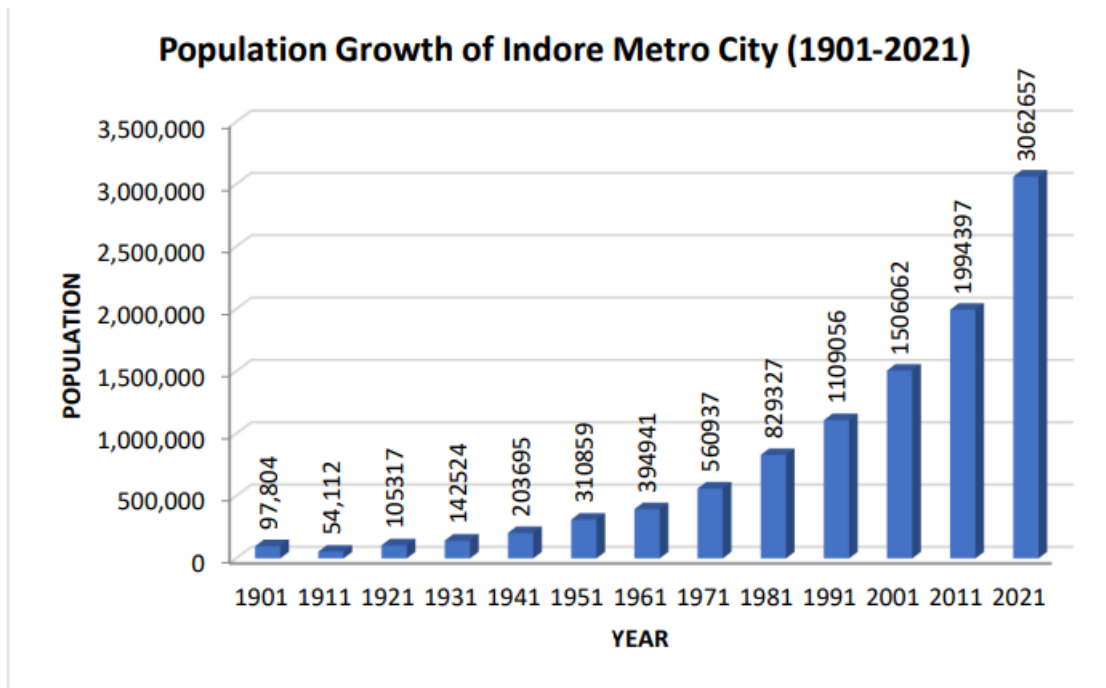


Figure 4: Population Growth of Indore City (1901-2021)

The table illustrates the decadal growth of Indore city since 1901. There was a period of negative growth between 1901 and 1911. However, in the subsequent decade, there was a substantial increase of 94.5% in 1921, marking the highest growth rate observed until 2021. The growth rate decreased to 35% in 1931 compared to the previous record. In 1941, it increased by 42.9 %, and in 1951, by 52.6 %. The lowest growth rate was observed in 1961 when it was reduced to 27 %. The second-highest increase in its growth was observed in 2021 at 53.5 %. The population of Indore metro city has increased by 31-fold since 1901.

**Urban Sprawl in City:** Urban landscapes are dynamic, continually evolving due to the bustling commercial and industrial activity that generates substantial employment opportunities and enhanced wages. Such prospects entice individuals to settle within these urban cores. The presence of a sizable workforce and improved wages fosters the growth of other essential amenities, including education, healthcare, and improved transportation connectivity. These advancements draw more individuals towards these urban nuclei, causing the urban boundaries to expand into the neighboring regions.

In many instances, these adjacent regions are villages where the majority of land is allocated for agriculture or forestry. However, as major urban centers extend their reach towards these villages, the previously allocated land for agricultural purposes becomes encroached upon and is transformed from rural to urban land use. This transformation often results in the construction of compact built-up structures, encompassing both residential and commercial land use. Unfortunately, this phenomenon obliterates the once-available open spaces on these lands.

Urban sprawl occurs when the population of a city expands beyond its existing boundaries into the surrounding areas, resulting in high population growth. The area under Indore metro city has undergone changes over time. In order to accommodate the needs of the growing population, the Municipal Corporation of the city has had to incorporate the surrounding areas that are in demand, thereby expanding the city's limits.

**Table 3: Changes in Municipal Corporation Area of Indore City (1901- 2014)**

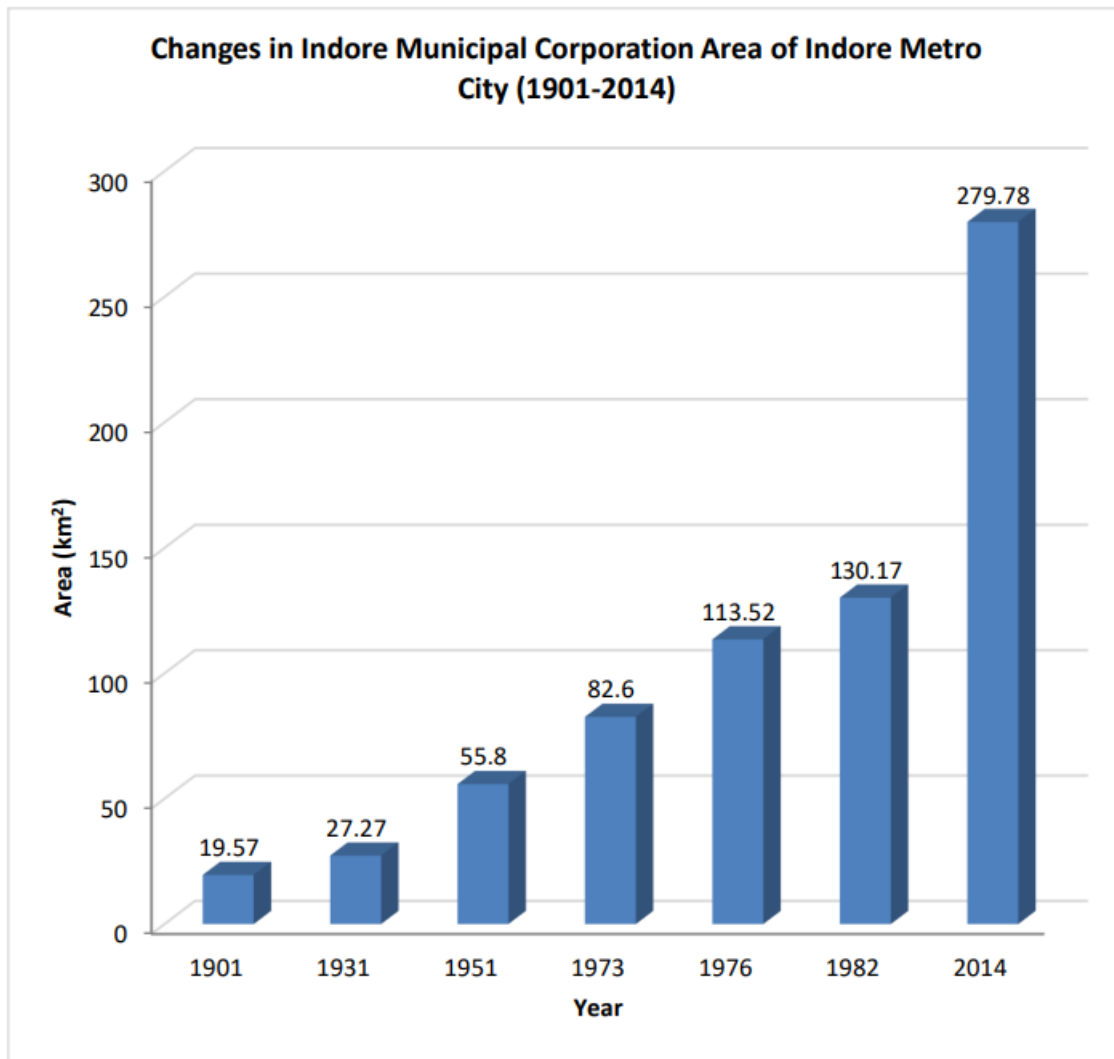
Year	Municipal Corporation Area (km <sup>2</sup> )	Area Increased (km <sup>2</sup> )	Percent Variation (%)
1901	19.57	-	-
1931	27.27	7.7	39.34%
1951	55.80	28.53	104.62%
1973	82.60	26.80	48.02%
1976	113.52	30.92	37.43%
1982	130.17	16.67	14.68%
2014	279.78	149.61	114.93%



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**Figure 5: Changes in Indore Municipal Corporation Area of Indore City (1901-2014)**

The provided table illustrates the changes in the city limits of Indore over various time periods. The lowest change was observed in 1931, with an increase of 7.7 km<sup>2</sup>, resulting in a percentage variation of 39.3%. In 1951, the city's area expanded to 55.8 km<sup>2</sup>, with the addition of 28.5 km<sup>2</sup>, representing a percentage change of 104.6%. Two decades later, in 1973, the city's existing area had expanded to 82.6 km<sup>2</sup>, including approximately 37 villages, with an additional 26.8 km<sup>2</sup> being incorporated. Within a short span of three years (1976), the city's area was extended by 30.9 km<sup>2</sup>, resulting in a total area of 113.5 km<sup>2</sup>, with a percentage change of 37.43%. In 1982, due to a growing population, the Indore Municipal Corporation expanded the city's area to 130.11 km<sup>2</sup> by including an additional 16.6 km<sup>2</sup> of surrounding area.

The most significant change occurred in 2014 when an area of 143.61 km<sup>2</sup> was added to the city. The Municipal Corporation extended the city's area again due to the population growth and infrastructure requirements. This extension included 29 surrounding villages, such as Nipaniya, Piplyakumar, Kanadiya, Tigriyarao, Bicholi Hapsi, Bicholi Mardana, Nayata Mundala, Palda, Limbodi, Bilawali, Fatan Khedi, Kailud Kartal, Nihalpur Mundi, Hukumakhedi, Sukh Niwas, Ahirkhedi, Chhota Bangarda, Tigriya Badshah, Rawati, Bedari, Bhurasala, Kumedi, Bhangarh, Shakkarkhedi, Tilawali Chanda, Aranya, Lasudiya Mori, Mayakhedi, and Bada Bangarda. This expansion increased the city's total area to 279.78 km<sup>2</sup>, including 149.61 km<sup>2</sup> of newly added village areas. This represents the highest percentage increase (114.93%) in area upto 2021. No further additions have been made since then, and the city's current (2021) area remains as 279.78 km<sup>2</sup>.

Rural settlements have continuously merged with urban areas as a result of urban expansion. Controlled development is necessary within and around urban centers to align with the city's development pattern. Proper

development of villages on the Panchayat level is essential for improved facilities, quality of life, and enhanced interaction between rural and urban centers in close proximity. The inclusion of surrounding villages effectively contributes to the controlled development of the city.

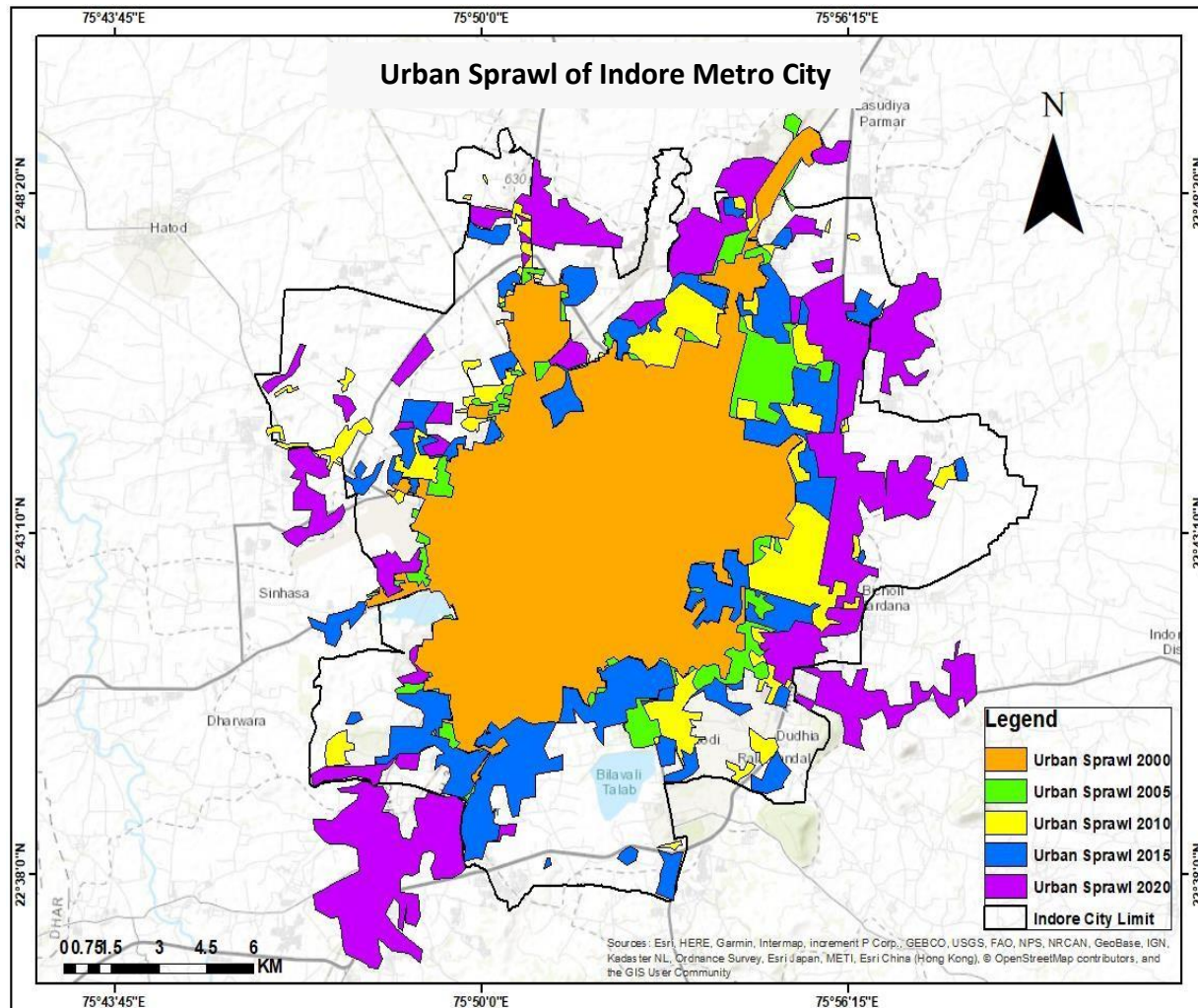
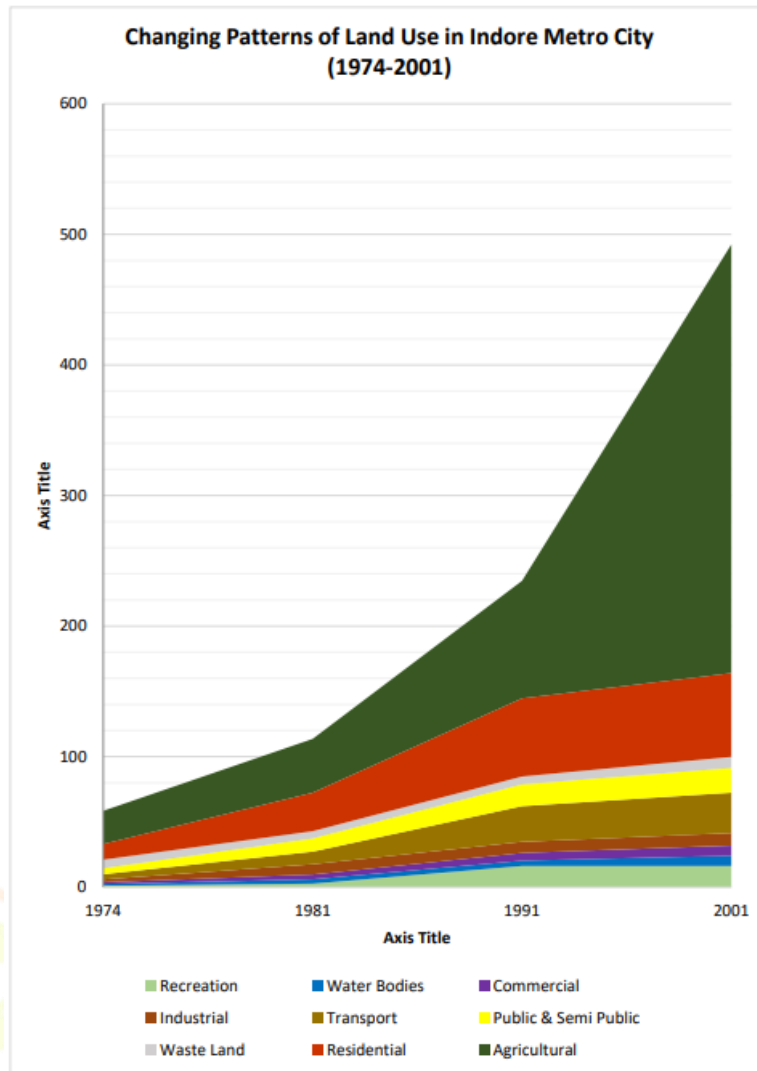


Figure 6: Urban Sprawl of Indore Metro City

**Changing Patterns of Land-Use:** Urban growth transforms the patterns and processes of land into various land uses. The alteration of urban land use patterns is a dynamic process, particularly in rapidly developing cities like Indore. Due to natural population increase and migration, there is a swift growth of population in Indore metro city, leading to complex issues associated with the provision and maintenance of basic amenities and infrastructure. Over the past decades, Indore metro city has undergone alarming changes in its dynamic land use system, natural environment, and industrialization. The table below presents various findings concerning changes in land use categories within the Indore metro city during different time spans, from 1974 to 2001.

**Table 4: Changing Patterns of Land Use in Indore Metro City (1974-2001)**

Land-Use category	Area (km <sup>2</sup> ) 1974	Area (km <sup>2</sup> ) 1974%	Area (km <sup>2</sup> ) 1981	Area (km <sup>2</sup> ) 1981%	Area (km <sup>2</sup> ) 1991	Area (km <sup>2</sup> ) 1991%	Area (km <sup>2</sup> ) 2001	Area (km <sup>2</sup> ) 2001%	Percent Variation (%) 1974-2001
Residential	11.95	20.41%	29.50	25.4%	59.80	25.49%	64.15	13.03%	436.8%
Commercial	1.47	2.51%	3.60	3.14%	5.90	2.51%	7.73	1.59%	425.8%
Industrial	2.16	3.69%	7.80	6.87%	8.60	3.67%	9.56	1.94%	842.5%
Public and SemiPublic	4.52	7.72%	10.16	8.94%	16.65	7.09%	18.95	3.85%	319.2%
Recreational	1.14	1.95%	2.80	2.46%	16.27	6.93%	16.30	3.31%	1052.7%
Transport	3.95	6.75%	9.74	8.57%	27.26	11.62%	30.95	6.29%	683.5%
Waste Land	6.67	11.39%	5.43	4.78%	6.14	2.62%	8.44	1.72%	26.5%
Agriculture	25.43	43.43%	41.20	36.26%	89.92	38.32%	328.27	66.69%	1190.8%
Water Bodies	1.26	2.15%	3.39	2.98%	4.10	1.75%	7.91	1.60%	527.7%
Total	58.55	100%	113.62	100%	234.64	100%	492.26	100%	-



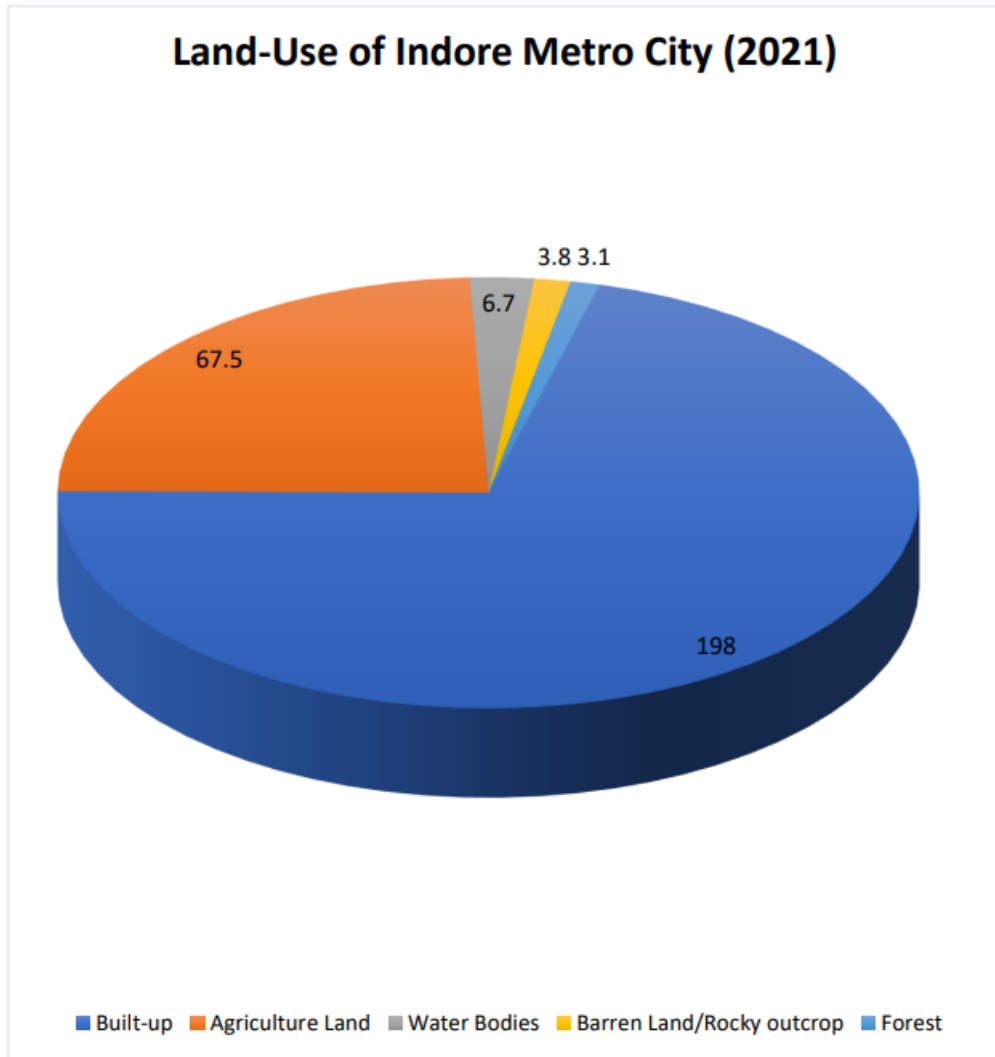
**Figure 7: Changing Patterns of Land Use in Indore Metro City (1974-2001)**

Indore is undergoing drastic changes in terms of urban expansion and land use patterns. The table reveals that since 1974, the maximum land use in the Indore metro city is designated as built-up area, which aggregates residential, commercial, industrial, public & semi-public, and transportation areas. Among these the highest positive percentage variation is observed in recreational (1052%) following by industrial (842.5%), transportation (683.5%), and residential (436.8%). The proportion of recreational land was at its peak in 1991 (6.9%) and reached its lowest in 1974 (1.95%). In the industrial sector, the highest growth rates were recorded only in 1974 and 1981 (3.6% and 6.87%), while it reduced to merely 1.94% in 2001. The transportation sector exhibited consistent growth over the first three decades, expanding from 6.7% to 8.5% and 11.6% in 1974, 1981, and 1991, respectively. It experienced a further increase to 6.2% in 2001.

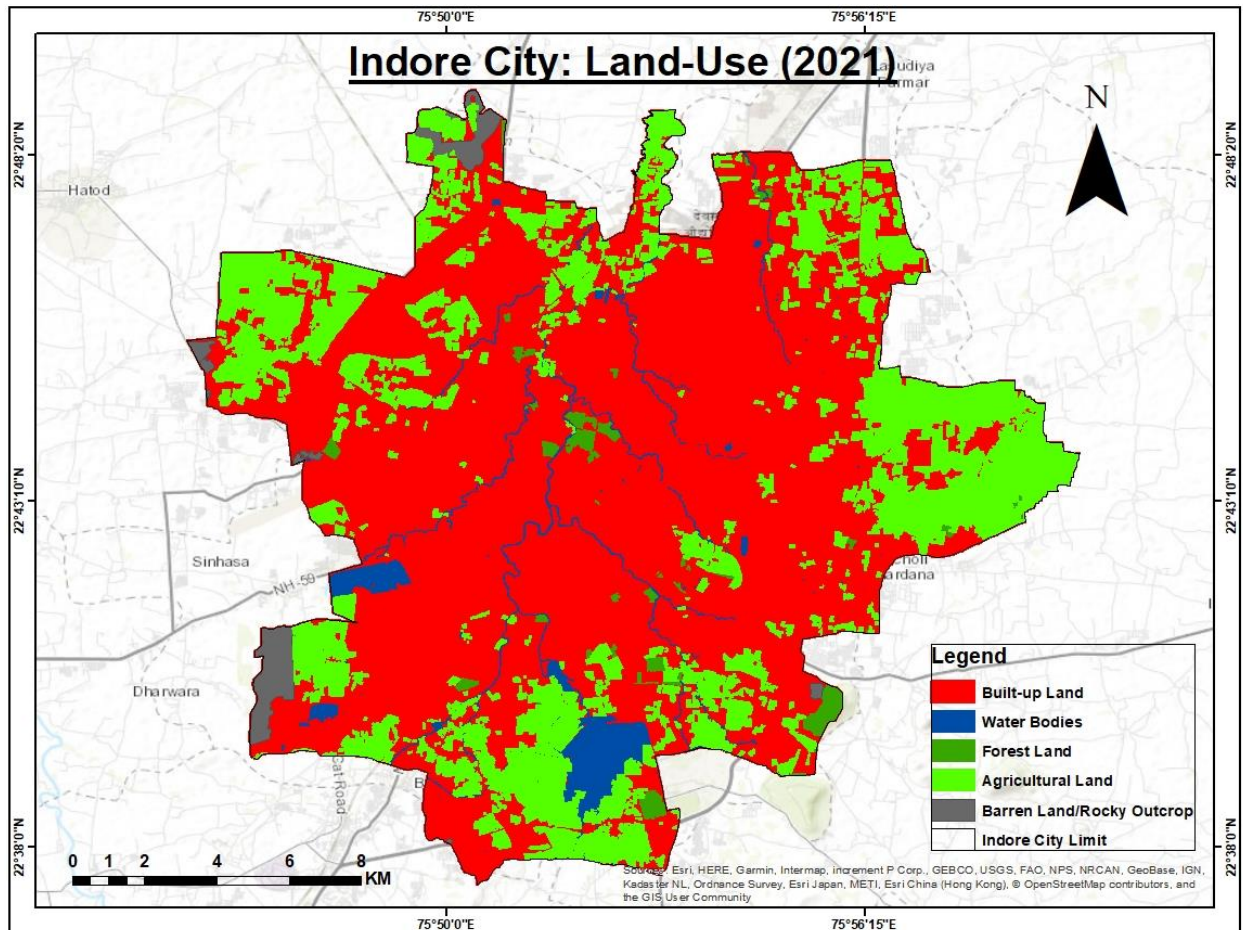
The percentage change in wasteland is evident. There has been a consistent decrease in the percentage of wasteland since 1972. It was notably high between 1972 (11.39%) and 1981 (4.78%). A slower decline rate is observed between 1991 (2.62%) and 2001 (1.72%). The trend of wasteland change indicates its conversion into other land use categories.

**Table 5: Land-Use of Indore City (2021)**

S.No.	Category	Area (km <sup>2</sup> )	Area in Percentage (%)
1	Built-up	198	71%
2	AgricultureLand	67.5	24%
3	WaterBodies	6.7	2.4%
4	BarrenLand/Rocky outcrop	3.8	1.3%
5	Forest	3.1	1.1%
	Total	279	100%



**Figure 8: Land-Use of Indore City (2021)**



**Figure 9: Land-Use of Indore City (2021)**

The total area of Indore city spans 279.7 km<sup>2</sup> and has been categorized into five distinct land-use types: Built-up Land, Agricultural Land, Water bodies, Barren Land/Rocky Outcrop, and Forest land. Built-up Land constitutes over half of the entire city area, accounting for 71% of the total. The second-largest category is agricultural land, encompassing 24% of the city's area, predominantly located in the outer wards of the city. The remaining three categories comprise a relatively smaller portion of the total city area. Water bodies cover 2.4% of the city's area, making it the third-largest category. Subsequently, barren land/rocky outcrop occupied 1.3%, and forest land constitutes only 1.1% of the total city area.

If we exclude the agricultural area from the city's total area 279.7 km<sup>2</sup>, then the remaining city's area is 211.6 km<sup>2</sup>. According to a total of 211 km<sup>2</sup>, 94% of the city's area is built-up, and a minimum of 6% is open space. While 'The Urban Greening Guidelines, 2014' have suggested that a minimum of 20% of the total city's area should be open/green space. Following this guideline, Indore metro city should have 42.3 km<sup>2</sup> of open/green space, but it has only 12.6 km<sup>2</sup>, which is a shortfall of 29.7 km<sup>2</sup>.

**Summary:** The total population of Indore metro city was 30 lakhs in 2021, with an area of 279.7 km<sup>2</sup>. Accordingly, the population density of the city is 10 thousand persons per km<sup>2</sup>. The city's population has increased 30-fold in the last 10 decades (1921-2021). The continuous growth of the city has made the central and middle parts of the city very dense, and later on, it started expanding into the outer and surrounding areas of the city. These surrounding areas need to be incorporated into the city's area. The Municipal Corporation of Indore has expanded the city's area six times since 1901 (19.5 km<sup>2</sup>), roughly increasing it by 15 times (279 km<sup>2</sup>) in the past 12 decades (1901-2021). The unplanned growth of cities badly affects their land use patterns. The main changes occurred in the vast increase in built-up areas, including residential (+436%), commercial

(+425%), industrial (+342%), public and semi-public (+319%), and transportation (+683%). The increasing demands of the growing population for land under different categories of built-up areas have engulfed a large amount of available open spaces in the central and middle parts of the city.

Continuous population growth results in the expansion of urban areas, perpetually requiring more space for habitation. Increasing population is leading to change in the land use patterns in the city. These changes occur in various forms of built-up, such as, residential, commercial, industrial, transportation, etc. The pressure of increasing urbanization is encroaching upon open spaces in the center and middle parts of the city, resulting in the expansion of city towards outer regions. Consequently, adjacent villages (agriculture lands) are being incorporated into the city to fulfill the needs of growing population. Over time, these agricultural lands will also undergo transformation into urbanized areas and will never revert to their original state.

**Conclusion:** The population of Indore metro city is continuously growing. There has been a 30-fold increase in its growth in the last 10 decades (1921-2021). Due to this, the land use patterns are changing. In these changes, the built-up areas in and around the city are continuously increasing. Residential areas have increased by 5 times, commercial areas by 6 times, industrial areas by 7 times, public and semi-public areas by 14 times, recreational areas by 15 times, and transportation areas by 30 times (1974-2021). To meet the demand for additional land, the city's area has increased 15-fold in the past 12 decades (1901-2021). The high demand for built-up areas has reduced the open spaces by 4 times in the city (1976-2021). There is strict need to focus on the types of land use patterns for the categories like recreation, parks, water bodies, and agricultural lands. It is required to preserve and increase the area under these categories to reduce the population pressure on the city's land use and to increase the quality of life in the city.

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