

# Assessing the Environmental and Land Use Impacts of Urban Growth: A Case Study of Ajmer, Rajasthan

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## Abstract

The world is currently experiencing an unprecedented surge in urban expansion. Today, over half of the global population resides in urban areas, and this figure is expected to rise to nearly 5 billion by 2030. Urbanization holds the promise of promoting enhanced well-being, efficient resource use, and economic development. However, it also intensifies the demand for urban infrastructure due to the increasing population (Drakakis-Smith, 1996). A significant consequence of urban growth is the conversion of agricultural land for other purposes, a trend that is especially alarming in developing nations like India. This study evaluates the influence of urbanization on land use and land cover changes in Ajmer city. The city's growing population—driven by rural-to-urban migration and its religious importance attracting numerous visitors—has led to substantial shifts in land utilization. Rapid urban sprawl is contributing to a decline in both agricultural land and landholdings. With the accelerated pace of urbanization, vast tracts of farmland have been repurposed into residential and industrial zones (Retnaraj, 1994). Several factors are propelling this population growth, including Smart City initiatives, employment prospects, educational opportunities, quality housing, advanced healthcare, and improved living standards. This population boom not only escalates the demand for food but also reduces food production capacity through construction, environmental degradation, and reduced agricultural activity (Aldington, 1997). Additionally, urban growth in Ajmer is linked to several critical issues such as land degradation, pollution, poverty, slum development, and unaffordable housing. Other notable impacts include increased pollution, traffic congestion, environmental risks, land deterioration, and rising crime rates. The research incorporates land use mapping using temporal satellite imagery from the years 2000 and 2017. Change detection techniques are applied using Geographic Information System (GIS) tools such as ERDAS and ArcGIS. Supervised classification is conducted using ERDAS software to delineate and analyze transformations in land use patterns.

**Keywords:** Urbanization, Urban Sprawl, Land Degradation, Environmental Hazards, Crime

## I. INTRODUCTION

Urbanization refers to the progressive shift of population from rural to urban areas. In the year 1800, merely 2% of the global population resided in urban centers. However, this figure has surged dramatically over the last two centuries, reaching 50%, and is projected to climb to 66% by 2050. In India, the pace of urbanization gained momentum post-independence, largely due to the adoption of a

mixed economic model, which facilitated the expansion of the private sector. This development contributed significantly to urban growth. According to the 1901 Census, only 11.4% of India's population lived in urban areas. This proportion rose to 28.53% by the 2001 Census and surpassed 30% in 2011, reaching 31.16%.

## II. STUDY AREA

Ajmer, historically known as Ajayameru, serves as an administrative hub in the Indian state of Rajasthan. It is situated approximately 355 kilometers southwest of New Delhi, the national capital (Figure 1).

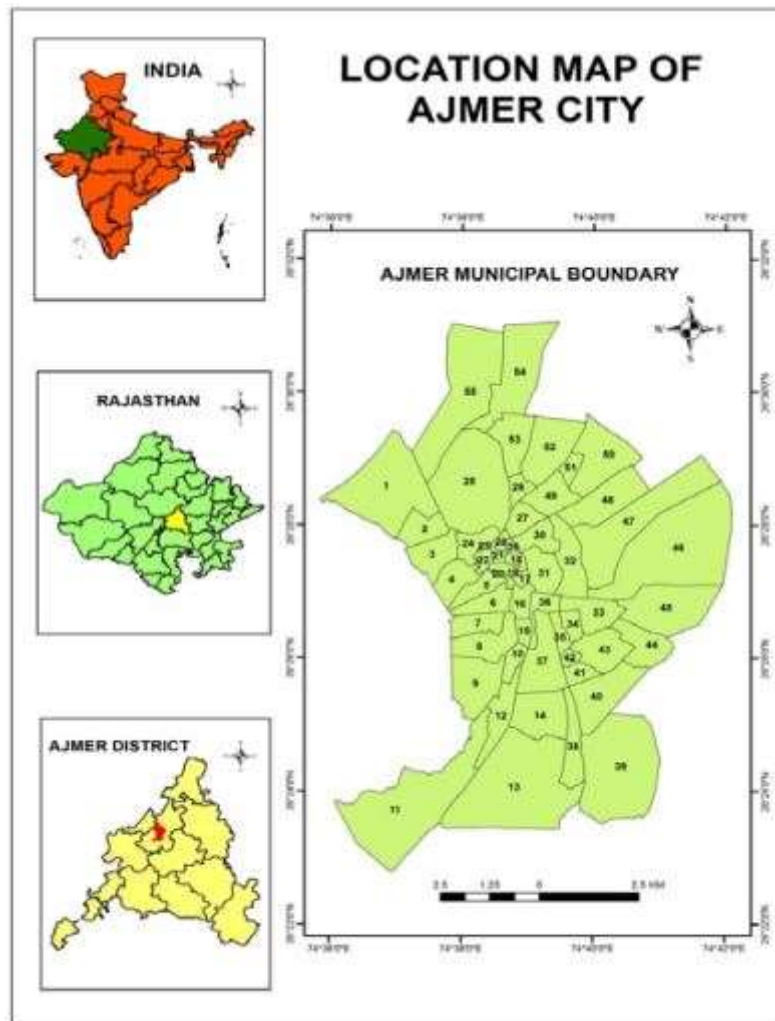


Fig 1 Location of Ajmer City

The eastern part of Ajmer district features a predominantly flat terrain with minor undulations, while the western region—from the northwest to the southwest—is traversed by the Aravalli mountain range. This part of the district includes sandy desert valleys that form part of the Thar Desert, occasionally interspersed with cultivated oases. Despite the arid conditions, certain areas, such as the plain where the city of Ajmer is located, are fertile. This valley hosts the man-made Anasagar Lake and is enclosed by the Nagpathar range (also called Serpent Rock), which acts as a natural barrier, shielding the area from desert sand intrusion.

### III. OBJECTIVES OF THE STUDY

As urbanization progresses, there has been a significant decline in cultivable land, posing serious challenges to the sustainability of agriculture. In Ajmer, existing urban planning frameworks often neglect or exclude agricultural considerations from urban land use planning. Consequently, this study aims to raise awareness regarding the need to safeguard agricultural land amidst urban expansion. The primary objectives of the study are:

1. To evaluate the effects of urbanization and urban sprawl on the spatial growth of Ajmer city in Rajasthan.
2. To perform land use change detection in Ajmer city from 2000 to 2017.
3. To analyze the rising environmental challenges and hazards associated with rapid urban development in the city.

### IV. DATA AND METHODS

This research adopts a case study approach to examine land use transformations influenced by urbanization in Ajmer city, which includes 60 administrative wards. The case study method allows for an in-depth empirical analysis of real-world changes beyond the researcher's control, utilizing geospatial tools such as ArcGIS and ERDAS (Bhatta, 2010).

The study maps the spatial and temporal dynamics of urban expansion and land use transitions between 2000 and 2017 using Landsat satellite imagery. A supervised classification method, based on the maximum likelihood technique, was applied in ArcGIS 10.2 to classify five key land use categories: built-up area, agricultural land, forest, wasteland, and water bodies. The extent of each category was measured and compared for both time periods to identify significant shifts.

#### • Data Collection

1. Satellite images for the years 2000 and 2017 were acquired from the USGS portal.
2. The city's Master Plans were reviewed for land use planning insights.
3. Ward-wise maps and demographic data were collected from the Ajmer Development Authority and Ajmer Nagar Nigam.

### V. RESULTS AND DISCUSSION

Ajmer city, with deep historical and religious roots, is centrally positioned in Rajasthan and holds administrative, academic, and cultural significance. As per the 2011 Census by the Government of India, Ajmer qualifies as a Class I Urban Agglomeration governed by a Municipal Corporation. The total urban population was recorded at 551,101, comprising 283,072 males and 268,029 females.

This research incorporates satellite imagery from 2000 and 2017, current land use maps, ward-level population density data, and urbanization impacts to assess land cover change. Ajmer city comprises 60 municipal wards. Wards with the highest population densities include 20, 21, 22, 23, 28, 29, and 42—areas covering recently developed neighborhoods such as Chandravardai Nagar, Subhash Nagar, Adarsh Nagar, and Madar Gate.

Conversely, wards like 10, 15, 17, 18, and 51 exhibit relatively lower population densities. These include historically congested localities such as Dargah area, Kesarganj, and neighborhoods near Taragarh Hill, including Ajayanagar, Bhagwanganj, and UIT quarters. Due to space constraints, vertical building expansion is common in these zones.

Ajmer's latest Master Plan indicates that the core city has expanded beyond its original municipal boundaries. The newly developed peripheral zones are better structured and planned, offering improved infrastructure and housing facilities.

## Land Use in Ajmer City

The analysis of land use change in relation to population growth demonstrates a clear correlation—urban land development often reflects population pressure (Bernstein, 1993). Satellite imagery from 2000 and 2017 reveals significant transformations in Ajmer's land use. According to the study, the city's total area spans 81.70 sq.km. Residential development dominates the current land use configuration. The Master Plan initially earmarked approximately 7,250 acres for residential use; however, around 6,000 acres have already been developed. The rapid growth in residential areas has outpaced the development of other land uses, often encroaching upon zones reserved for alternate purposes.

TABLE I LAND USE OF AJMER CITY

| S. No. | Land Use           | Proposed in Master Plan 1971-2001 |                     | Actual In Master Plan 2001-2023 |                     |
|--------|--------------------|-----------------------------------|---------------------|---------------------------------|---------------------|
|        |                    | Area in acres                     | %age of development | Area in acres                   | %age of Development |
| 1      | Residential        | 7250                              | 50.8                | 6000                            | 52.26               |
| 2      | Commercial         | 500                               | 3.4                 | 564                             | 4.96                |
| 3      | Industrial         | 1560                              | 10.8                | 586                             | 5.10                |
| 4      | Government         | 120                               | 0.9                 | 140                             | 1.22                |
| 5      | Public/Semi-Public | 1750                              | 12.2                | 1571                            | 13.68               |
| 6      | Recreational       | 840                               | 6.0                 | 138                             | 1.20                |
| 7      | Transport          | 2260                              | 15.8                | 2483                            | 21.60               |
|        | TOTAL              | 14,280                            | 100%                | 11,482                          | 100%                |

Source: Master Plan 1971-2001 and 2001-2023

## Urban Development and Land Use Change in Ajmer City

During the period from 1970 to 1980, several residential areas such as Shastri Nagar, Shastri Nagar Extension, Bhagwan Ganj, Vaishali Nagar, Anasagar Circular Road, and Dhola Bhata were developed. The next decade (1980–1990) saw the planning of Jwala Prasad Nagar, Arjunlal Sethi Nagar, and M.D. Nagar. From 1990 to 2005, further expansion included H.B.U Nagar, B.K. Kaul Nagar, Chandravaradai Nagar, and Maharana Pratap Nagar. Later, between 2005 and 2015, residential projects like Panchsheel Blocks A–E, Prithviraj Nagar Yojana, Pragati Nagar Kotra, Patrakar Colony, Kotra, and Kayad were initiated.

Spatial analysis reveals that residential development has expanded into areas initially designated for other uses, such as commercial zones and open spaces. This is largely attributed to the proliferation of cooperative housing societies that have often undertaken development in contradiction to the city's master plan (Yadav, 2017).

## Land Use and Land Cover (LULC) Change – Year 2000

Interpretation of satellite imagery from the year 2000 indicates a significant transformation of agricultural land into built-up areas. Encroachments were particularly noticeable around prominent city attractions like Ana Sagar Lake and nearby hill regions. During this year:

1. Agricultural land declined by 57.94%, reducing to 47.34 sq. km.
2. Built-up areas expanded to 16.12 sq. km, accounting for 19.73% of the city's land area.
3. Some wastelands were repurposed for urban and mining activities, especially near hilly terrains.

### Land Use and Land Cover – Year 2017

By 2017, built-up areas had further replaced agricultural lands across the city, forming dense settlement clusters in the central urban zones. Specific observations include:

1. Agricultural land further declined to 33.60 sq. km, comprising 41.12% of the total city area.
2. Built-up areas increased to 30.15 sq. km, now making up 36.0% of the total urban area.
3. Wasteland continued to diminish, reducing to just 1.36 sq. km.

A comparative land use assessment illustrates a consistent decline in agricultural land and a corresponding rise in urban infrastructure between 2000 and 2017. The conversion of wastelands to industrial uses is evident, while forest cover and water bodies experienced minimal change during this period.

### Demographic Growth and Its Implications

Between 2001 and 2011, the population of Ajmer grew from 485,197 to 542,321. Notably, the decade between 1991 and 2001 saw a surge in growth at 20.5%, a sharp rise from the previous decade's 7.6%. However, this trend slowed to 11.8% in the following decade. These fluctuations may be attributed to rural-to-urban migration patterns in the region.

### Environmental Impacts of Urbanization in Ajmer

The rapid pace of urban expansion has placed immense pressure on land resources, resulting in several environmental challenges:

- **Conversion of Fertile Lands:** Productive agricultural lands with rich groundwater reserves have been converted into urban infrastructure, reducing food production capacity.
- **Encroachments:** Inadequate urban planning has forced the urban poor to settle on ecologically sensitive zones such as hill slopes (e.g., Taragarh Hill) and near water bodies, leading to environmental degradation, blocked natural drainage, and altered water flow patterns into lakes.
- **Marble Industry Effects:** The Kishangarh region, known for its marble industry, has seen environmental degradation from marble slurry and industrial dumping, which damages vegetation and pollutes groundwater (Lall, 2017).
- **Mining Activities:** Mining has severely altered landscapes, degraded soil quality, and disrupted both agricultural and forest ecosystems.
- **Urban Congestion:** Population growth has led to shortages in housing, congestion, poor sanitation, and lack of urban infrastructure.
- **Rising Living Costs and Slums:** The high cost of urban living and unemployment have contributed to the rise of informal settlements. The 2011 Census recorded 59 slum areas in Ajmer.
- **Water Pollution:** The Anasagar Lake, a central feature of Ajmer, is heavily polluted due to untreated wastewater and solid waste discharge from the city. Poor sewage systems contribute significantly to the degradation of water quality.
- **Soil Erosion and Runoff:** The steep, deforested hills around Ajmer result in heavy runoff and erosion, causing sedimentation in natural drains and lakes.
- **Traffic Challenges:** Narrow and uneven roads, particularly in densely populated zones, create severe traffic congestion. Key commercial zones like Parao and Kesarganj double as grain markets, attracting heavy vehicles and exacerbating traffic flow issues. Inadequate parking facilities and the central location of the Ajmer Bus Stand add to the problem (Yadav, 2017).

## VII. Conclusion

The process of urbanization gained momentum following the Industrial Revolution in Europe and has con

tinued to expand ever since. Urban growth is largely driven by the development of the secondary and tertiary sectors, while primary activities such as agriculture have become less prevalent in urban settings. Industrialization has significantly reduced the extent of agricultural land, leading to declining agricultural productivity (Sherry, Mitra A. S. & Dutta B., 1981).

India, despite ranking second globally in terms of agricultural output and having around 50% of its population engaged directly or indirectly in agriculture, is experiencing one of the fastest rates of urbanization in Asia. This raises serious concerns about the nation's capacity to maintain food security in the future, as the encroachment of urban development on agricultural land continues to hamper agricultural growth.

Interestingly, after achieving peak levels of industrialization, many European countries have begun to reinvest in agricultural practices, recognizing the need for long-term sustainability and self-sufficiency—not just industrially, but also environmentally. India, with its strong agrarian potential, is currently witnessing rapid and widespread transformation in land use due to population pressure and expanding urbanization.

While urbanization offers numerous benefits, including job creation, technological advancement, improved infrastructure, enhanced transportation and communication, and better access to education and healthcare, it also brings several challenges. Without proper planning, urban expansion often leads to environmental degradation, resource depletion, pollution, land misuse, and overexploitation of natural assets. The growing urban population exacerbates issues like unemployment, housing shortages, and the lack of essential services such as sanitation, water supply, healthcare, and education. These deficiencies frequently result in the proliferation of slums and increased levels of urban poverty.

Therefore, it is imperative to adopt comprehensive urban planning strategies to ensure the efficient functioning of urban centers. The present era demands the creation of sustainable, environmentally conscious cities that not only cater to the needs of their residents but also preserve ecological integrity for future generations.

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