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Spatial Pattern of Urban Sprawl of Class – 1 Towns in Non- NCR Sub-region of Haryana

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ABSTRACT

This study analyzed the spatial pattern of urban sprawl in Class-I towns of the non-NCR sub-region of Haryana over the past three decades. The primary objective was to examine the extent and growth patterns of urban expansion from 1991 to 2021 and to identify the driving forces behind this transformation, including industrialization, transportation networks, and demographic shifts. The research utilized secondary data sources, including topographical sheets from the Survey of India and satellite imagery obtained from GLOVIS/BHUVAN and USGS. Landsat 4, Landsat 7, and Landsat 8 satellite images from 1991, 2001, 2011, and 2021 were analyzed to assess urban growth trends. High-resolution imagery from Google Earth was further used to delineate built-up areas, which were digitized into vector layers for spatial analysis. Advanced Geographic Information System (GIS) techniques were applied to map and quantify urban sprawl across different time periods. The findings revealed a significant outward expansion of urban areas in the non-NCR Class-I towns of Haryana. Hisar, Karnal, Panipat, and other major towns exhibited consistent growth, with urban areas expanding by over 100% in some cases. The spatial pattern demonstrated a combination of concentric and corridor-based growth, influenced by infrastructural development and land availability. However, the rapid urbanization resulted in the loss of agricultural land, environmental degradation, and increasing pressure on urban infrastructure. The study underscored the urgent need for sustainable urban planning policies to balance economic growth with environmental conservation and efficient land use.

Keywords: Urban Sprawl, Non-NCR Towns, Haryana, GIS, Land Use Change

INTRODUCTION

Urban sprawl was a defining characteristic of urbanization in rapidly developing regions, driven by economic growth, migration, and infrastructural expansion (Bhatta, 2010). Over the past few decades, Haryana witnessed substantial urbanization, with Class-I towns in the non-NCR sub-region experiencing notable spatial expansion.

While much research focused on the National Capital Region (NCR), the non-NCR towns of Haryana underwent significant transformation due to increasing population density and economic activities (Prakash, 2018). These towns expanded outward, integrating peri-urban and rural areas into the urban framework, altering land use patterns and socio-economic dynamics (Verma & Kumar, 2019).The non-NCR sub-region of Haryana consisted of several Class-I towns that functioned as administrative, commercial, and industrial hubs (Singh, 2015). These towns played a vital role in regional development by attracting businesses, industries, and laborers from surrounding rural areas (Sharma, 2017). Over time, the built-up area increased, leading to the displacement of agricultural lands and green spaces (Mehta, 2020). As urban expansion progressed, the demand for housing, infrastructure, and public services intensified, further accelerating urban growth (Garg et al., 2016).

Various factors contributed to the urban sprawl observed in these towns. Industrialization and economic diversification acted as primary catalysts, drawing populations seeking employment opportunities (Kumar & Sharma, 2019). Improved transportation networks, such as national highways and railway corridors, facilitated the movement of goods and labor, enhancing regional connectivity (Chaudhary, 2021). Additionally, government policies influenced zoning regulations and land-use planning, often favoring rapid urban expansion over sustainable development (Rana & Verma, 2018).The spatial pattern of urban growth exhibited distinctive trends across different towns. Some towns experienced concentric outward growth, with older city centers forming the nucleus of expansion (Srivastava, 2020). Others expanded along major transportation corridors, leading to linear or fragmented urban structures (Yadav & Gupta, 2022). The nature of growth depended on various factors, including geographic location, economic activities, and infrastructural developments (Bhattacharya, 2010).

Rapid urbanization in non-NCR towns led to multiple socio-economic and environmental challenges. The conversion of fertile agricultural land into urban settlements raised concerns regarding food security and sustainable land use (Joshi, 2016). Expanding built-up areas resulted in environmental degradation, including deforestation, declining groundwater

levels, and increased pollution (Rani, 2021). Additionally, urban infrastructure faced growing pressure, with increasing demands for water supply, waste management, and efficient transportation systems (Khatri & Goel, 2019).Despite these challenges, urbanization generated economic opportunities and regional integration. Expanding trade, commercial activities, and industrial developments created employment and improved living standards for many residents (Sharma & Singh, 2018).

The emergence of educational institutions and healthcare facilities attracted skilled professionals, contributing to knowledge and service-based economic growth (Verma, 2020). Moreover, improved road and rail connectivity enhanced accessibility to economic centers, strengthening regional markets (Goswami et al., 2021).Understanding urban sprawl in non-NCR towns became essential for policymakers and urban planners. Examining spatial expansion helped identify challenges and formulate effective urban management strategies (Patel & Mehta, 2017). Research on urban growth patterns provided insights into how urbanization evolved and how planning interventions could have mitigated its adverse effects (Kumar, 2022).While extensive studies examined urban expansion in NCR towns, research on the non-NCR sub-region remained limited (Shukla & Prasad, 2019). This knowledge gap necessitated a detailed investigation of urban sprawl trends in these towns (Mishra, 2021). The present study addressed this gap by systematically analyzing urban expansion patterns from 1991 to 2021, using satellite imagery and GIS-based techniques (Gupta & Sharma, 2020).By employing Geographic Information System (GIS) tools, this research mapped urban sprawl across Class-I towns in Haryana's non-NCR sub-region. The study analyzed decadal growth trends, identified the key factors influencing expansion, and assessed the challenges of rapid urbanization (Das & Roy, 2018). The findings highlighted the urgent need for sustainable urban planning to balance economic growth with environmental conservation and infrastructural efficiency (Pandey, 2022).

Study Area

The study focuses on Class-I towns of the non-NCR sub-region of Haryana, including Hisar, Karnal, Panipat, and other prominent urban centers. These towns serve as economic and administrative hubs, attracting migration from rural areas. Geographically, the region is characterized by fertile plains, intersected by major highways and railway lines, facilitating urban expansion. The towns have witnessed rapid infrastructural growth, with increasing residential, commercial, and industrial developments. However, this growth has also led to challenges such as traffic congestion, pollution, and strain on public services, necessitating effective urban management policies.

Objectives

i. To analyze the spatial extent and growth patterns of Class-I towns in Haryana's Non- NCR from 1991 to 2021.
ii. To examine the major driving forces behind urban sprawl, including industrialization, transportation networks, and demographic shifts.

DATABASE & RESEARCH METHODOLOGY

The study was based on secondary data sources, including toposheets from the Survey of India and satellite images from 1991 to 2021, acquired from GLOVIS/BHUVAN & USGS. Open-source data provided by these organizations were utilized. Four scenes were selected periodically for each of the years 1991, 2001, 2011, and 2021. These satellite images were captured by Landsat 4, Landsat 7, and Landsat 8 satellites to analyze urban expansion trends over the study period.The spatial analysis of urban sprawl in Class-I towns of Haryana was conducted through a detailed examination of built-up extents over four distinct decadal intervals (1991, 2001, 2011, and 2021) using high-resolution satellite imagery sourced from Google Earth. By leveraging the "Data and Time" functionality, imagery from October or November was selectively retrieved to ensure optimal clarity and consistency across the temporal dataset. Each image was manually scrutinized, with the zoom level individually adjusted to accurately capture the spatial delineation of urban boundaries. The resulting imagery was then digitized into vector layers, encapsulating the urban extents for each respective period, which laid the foundation for a comprehensive spatial analysis using advanced Geographic Information System (GIS) techniques.

RESULT & ANALYSIS

Hisar, a prominent non-NCR Class-I town in the state of Haryana, has undergone a remarkable transformation over the past three decades. The provided map has vividly depicted the city's urban sprawl, which has been a consistent and substantial phenomenon. In 1991, the urban area of Hisar was recorded at 20.95 km², which has expanded to 43.04 km² by 2001, marking a growth of 105.4%. This trend has continued in the subsequent decades, with the urban area having reached 61.51 km² in 2011 and further expanding to 91.69 km² by 2021. The decadal growth rates of 42.9% (2001–2011) and 49.1% (2011–2021) have indicated a sustained and robust pattern of urban expansion.The spatial pattern of this urban sprawl has demonstrated a concentric outward growth, with the urban core of 1991 having formed the nucleus of development. The subsequent decades have witnessed the urban fabric extending radially, with significant

growth being observed in all directions, particularly towards the eastern and southeastern parts of the city. This pattern has likely been influenced by the availability of land and the development of transportation infrastructure, which has facilitated the integration of peripheral areas into the urban framework (Sharma, 2023).

The town-centric causal factors behind Hisar's urban sprawl have been rooted in its strategic location and evolving socio-economic profile.

As a district headquarters and a regional center for trade, education, and administration, Hisar has attracted a steady influx of population, driving the demand for residential, commercial, and institutional spaces (Pawan, 2021). The city's connectivity to other parts of Haryana and neighboring states through major roads and railways has played a pivotal role in shaping its urban growth, facilitating trade and mobility. Additionally, the development of educational institutions, healthcare facilities, and agro-industrial activities has further contributed to Hisar's urbanization by attracting professionals, students, and associated services (Singh, 2015).

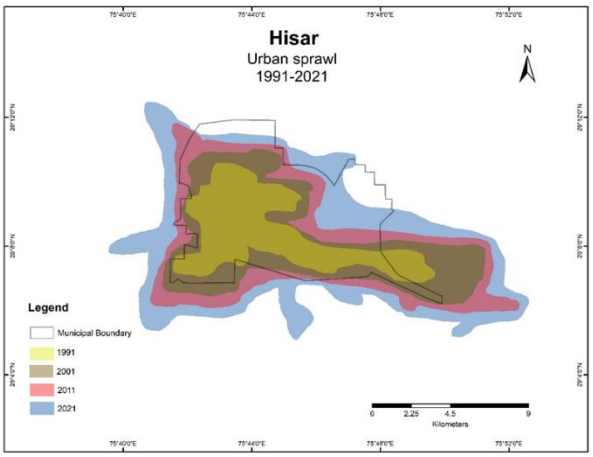
Despite its growth, Hisar's urbanization has also brought challenges, including the loss of fertile agricultural land, environmental degradation, and increased pressure on urban infrastructure and services. The city's expansion has underscored the need for sustainable urban planning to balance growth with the preservation of its socio-environmental fabric (Map 1).Yamunanagar and Jagadhiri, a prominent non-NCR Class-I town in Haryana, have exhibited steady urban sprawl over the past three decades, reflecting their transformation into a significant regional urban center. In 1991, the combined urban area of Yamunanagar and Jagadhiri was recorded at 13.02 km², which has expanded to 18.96 km² by 2001, marking a growth of 45.7% over the decade (Table 1). This trend has continued in the subsequent decades, with the urban area having reached 27.97 km² in 2011 and further expanding to 37.92 km² by 2021. The decadal growth rates of 47.5% (2001–2011) and 35.6% (2011–2021) have indicated a consistent yet slightly decelerating pattern of urban expansion (Map 2). The spatial pattern of urban sprawl in Yamunanagar and Jagadhiri has revealed a dual-core growth, with each town's center having acted as a nucleus for expansion.

Over the decades, development has radiated outward, with marked growth toward the southern and western sectors. This trend has been driven by several factors, including the availability of affordable land, proactive local policies that have encouraged decentralization, and enhanced transportation networks—particularly major roads and railways that have facilitated connectivity. Additionally, economic opportunities, industrial expansion, and an influx of population have progressively merged nearby rural areas into a contiguous urban zone (Kumar, 2025).Panchkula, a non-NCR Class-I town in Haryana, has experienced significant urban sprawl over the past three decades, as depicted in the provided map. The decadal analysis of its areal extent has revealed a consistent and substantial increase in urbanized land. In 1991, the urban area of Panchkula was recorded at 12.61 km², which has expanded to 22.62 km² by 2001, marking a growth of 79.4% over the decade (Table 1).

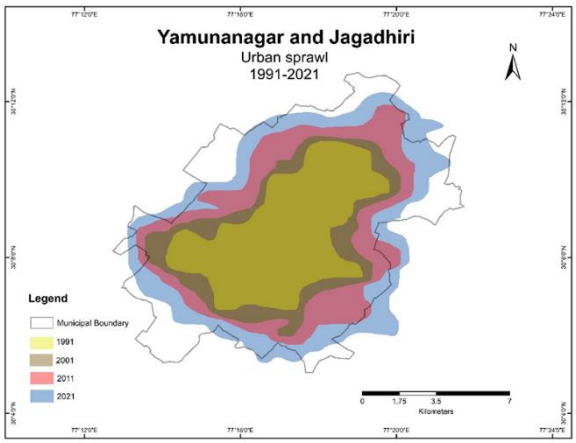
Table 1: Trend of Urban Sprawls in Non-NCR Class -I Towns of Harana, 1991-2021

Class - I Cities	1991	2001	2011	2021
	Area	Area	Area	Area
Faridabad	20.95	43.04	61.51	91.69
Gurgaon	13.02	18.96	27.97	37.92
Rohtak	12.61	22.62	35.68	78.63
Karnal	13.38	21.09	41.96	66.30
Panipat	12.26	18.78	28.22	40.30
Sonipat	16.50	29.74	43.17	56.50
Bhiwani	13.62	23.08	34.20	46.06
Bahadurgarh	1.25	3.22	6.13	9.13
Jind	20.95	43.04	61.51	91.69
Rewari	13.02	18.96	27.97	37.92
Palwal	12.61	22.62	35.68	78.63

Source: Calculated by Researcher



Map 1



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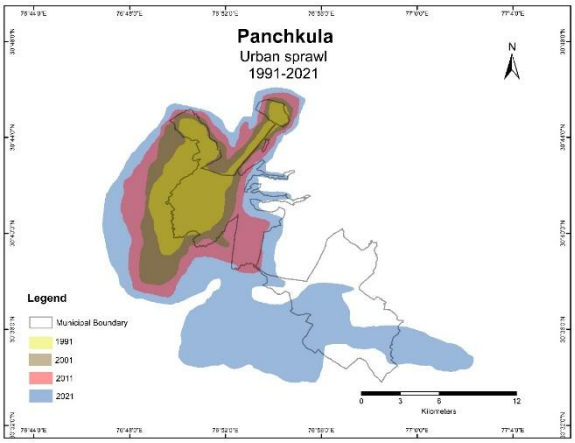

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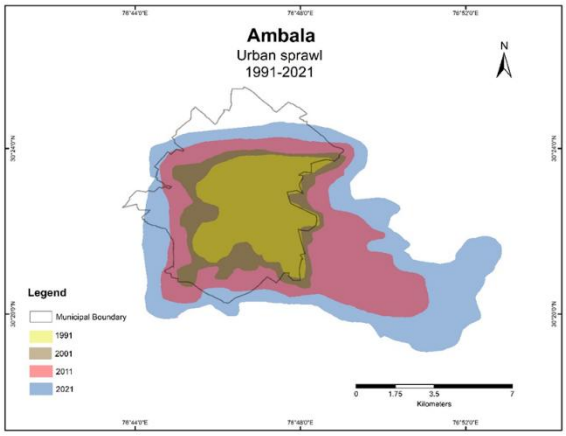

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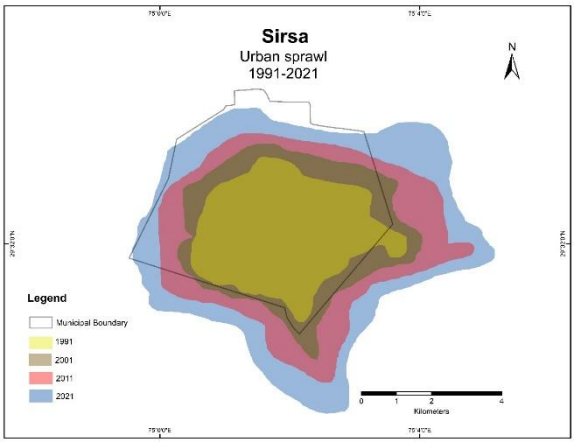

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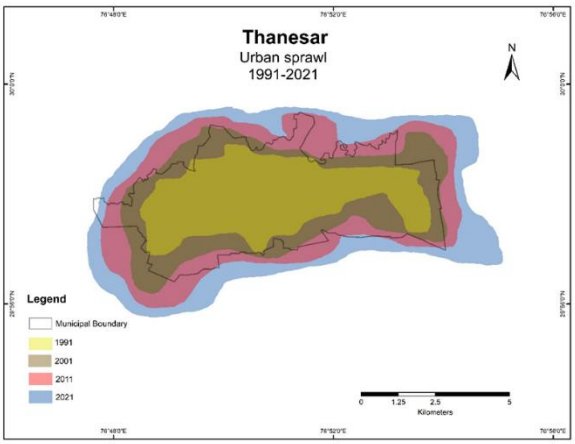


Map 6

This trend has continued in the subsequent decades, with the urban area having reached 35.68 km² in 2011 and further expanding to 78.63 km² by 2021.The decadal growth rates of 57.8% (2001–2011) and 120.4% (2011–2021) have indicated a rapid and accelerating pattern of urban expansion, particularly in the most recent decade.Panchkula's urban sprawl has shown concentric growth, with 1991's core serving as the nucleus (Map 3).

Growth has been radial, driven by affordable land, population growth, and enhanced transportation connectivity, particularly along key corridors (Singla, 2017). Moreover, local economic development and relaxed zoning regulations

have encouraged decentralized growth, integrating previously peripheral rural areas into a contiguous urban framework. Panchkula's urban sprawl has been fueled by its strategic location and socio-economic evolution, attracting residents and boosting demand for housing, commercial facilities, and services, along with its proximity to Chandigarh (Singh et al., 2021).

In 1991, Ambala's urban area was recorded at 13.38 km², which has expanded to 21.09 km² by 2001, reflecting a growth of 57.6% over the decade. This trend has continued, with the urban area having reached 41.96 km² in 2011 and further expanding to 66.3 km² by 2021. The decadal growth rates of 98.9% (2001–2011) and 58% (2011–2021) have highlighted a sustained and robust pattern of urban expansion (Map 4). The town's role as a district headquarters and a regional center for trade, education, and administration has attracted a steady influx of population, driving demand for housing, businesses, and public services (Joshi, 2008).Rapid urbanization has led to the loss of fertile farmland, raising concerns about food security and environmental sustainability (Sharma, 1979).

The spatial analysis of Sirsa's urban sprawl has highlighted a steady expansion. In 1991, the urban area was recorded at 12.26 km², which has grown to 18.78 km² by 2001, marking a 53.2% increase over the decade. This growth has continued, with the urban area having reached 28.22 km² in 2011 and further expanding to 40.3 km² by 2021. The decadal growth rates of 50.3% (2001–2011) and 42.8% (2011–2021) have reflected a sustained pattern of urban expansion (Map 5).Sirsa's urban sprawl has been driven by its strategic location and evolving economic role. As a district headquarters and a regional hub for agriculture and trade, Sirsa has attracted a steady influx of people seeking better opportunities (Rani, 2023). The town's proximity to fertile agricultural regions has supported agro-industrial activities, while its administrative importance has spurred demand for residential and commercial spaces (Gummagolmath, 2023).

In 1991, the urban area was recorded at 16.5 km², which has expanded to 29.74 km² by 2001, reflecting a growth of 80.3% over the decade. This trend has continued, with the urban area having reached 43.17 km² in 2011 and further expanding to 56.5 km² by 2021. The decadal growth rates of 45.1% (2001–2011) and 30.9% (2011–2021) have indicated a sustained, though slightly decelerating, pattern of urban expansion (Map 6).

The spatial pattern of urban growth has revealed a concentric outward expansion, with the 1991 urban core serving as the nucleus. Over the years, development has radiated outward, with significant growth being observed towards the northern and eastern parts of the town. This expansion has been shaped by the availability of land and the development of transportation infrastructure, including highways and railways that have connected Thanesar to other parts of Haryana and neighboring states (Anees, 2019).

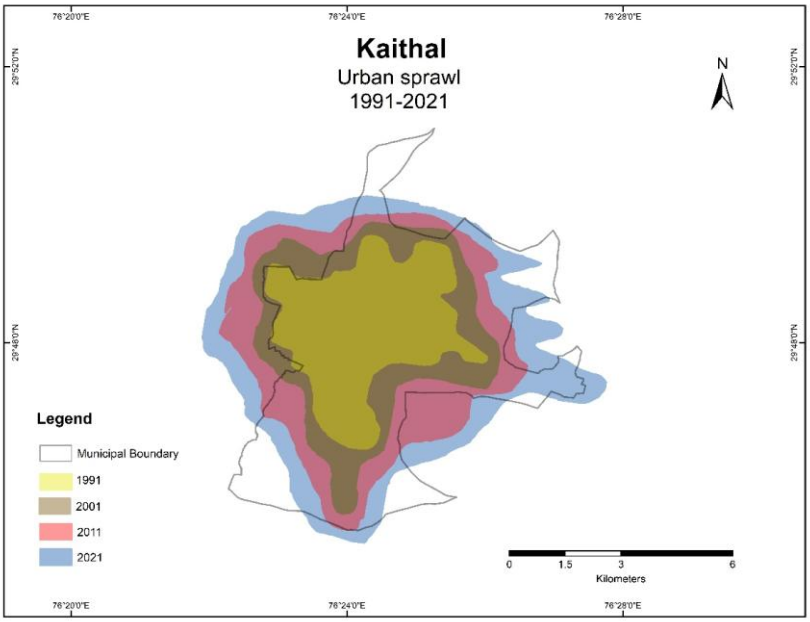
The urban sprawl has been driven by its unique historical and cultural significance. As a prominent pilgrimage destination, the town has attracted a steady influx of visitors, which has spurred the development of tourism-related infrastructure (Sharma, 2015).However, this rapid urbanization has brought challenges. The conversion of agricultural land into urban zones has raised concerns about food security and environmental sustainability. Increased pressure on infrastructure, such as water supply, waste management, and transportation, has highlighted the need for comprehensive urban planning.To ensure balanced growth, the town must adopt sustainable development strategies, including efficient land use, investment in public infrastructure, and preservation of its cultural heritage.

Kaithal, a non-NCR Class-I town in the heart of Haryana, has undergone a remarkable transformation over the past three decades. The town's urban sprawl, as depicted in the provided map, has been a testament to the dynamic interplay of regional factors and local realities. Situated in the fertile Yamuna-Ghaggar plains, Kaithal has long been a hub of agricultural activity (Goel, 2011).However, the town's strategic location, midway between the state capital Chandigarh and the industrial powerhouse of Panipat, has played a pivotal role in its urban expansion.

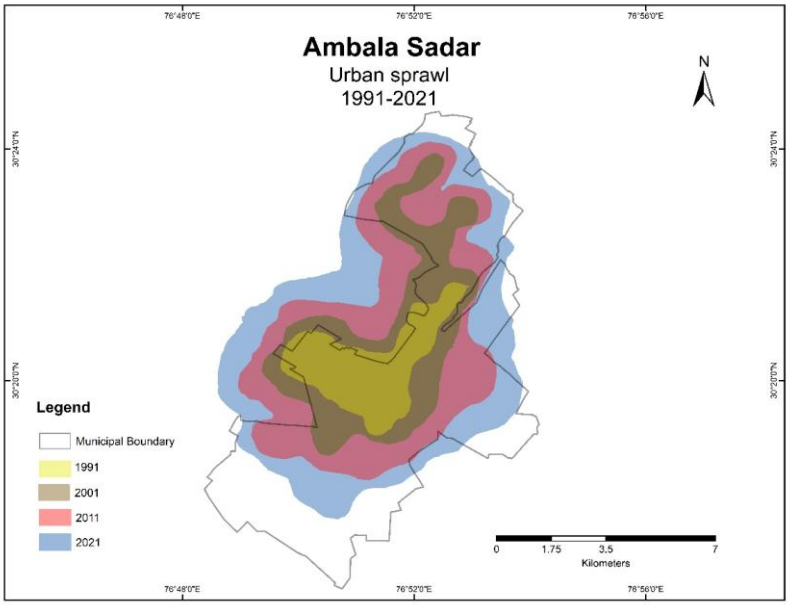
The development of major transportation corridors, such as the Kaithal-Patiala and Kaithal-Kurukshetra highways, has facilitated the integration of Kaithal with the broader regional economy, attracting both people and investments (Bhattacharya, 2010).The town's administrative significance as the district headquarters has been a key driver of its urbanization.

As a regional center for trade, commerce, and public services, Kaithal has witnessed a steady influx of population seeking employment, education, and access to healthcare. This influx has fueled the demand for residential, commercial, and institutional spaces, leading to the outward expansion of the urban fabric (Map 7).

Ambala Sadar, a non-NCR Class-I town in Haryana, has experienced steady urban growth over the past three decades, reflecting its transformation into a growing urban center. The town's urban sprawl, as depicted in the provided map, has highlighted a consistent expansion driven by its strategic location and evolving socio-economic profile.



Map: 7



Map: 8

In 1991, Ambala Sadar's urban area was recorded at 1.25 km², which has expanded to 3.22 km² by 2001, marking a remarkable growth of 157.6% over the decade. This trend has continued, with the urban area having reached 6.13 km² in 2011 and further expanding to 9.13 km² by 2021. The decadal growth rates of 90.4% (2001–2011) and 48.9% (2011–2021) have indicated a consistent yet slightly decelerating pattern of urban expansion.The spatial pattern has demonstrated concentric outward growth, with the 1991 urban core forming the nucleus. Over the decades, significant development has been observed towards the northern and western parts of the town, influenced by the availability of land and the development of transportation infrastructure (Map 8). Ambala Sadar's urban sprawl has been rooted in its strategic location and administrative importance.

Its connectivity to other parts of Haryana and neighboring states through major transportation routes has facilitated trade and mobility, integrating surrounding rural areas into the urban framework. Additionally, the development of small-scale industries, educational institutions, and healthcare facilities has further contributed to urbanization by attracting professionals, students, and associated services. While Ambala Sadar's growth has brought economic

opportunities and improved connectivity, it has also presented challenges. The conversion of agricultural land into urban zones has raised concerns about food security and environmental sustainability.

CONCLUSION

This study examined the spatial patterns of urban sprawl in Class-I towns of Haryana's non-NCR sub-region over the past three decades. Using satellite imagery and Geographic Information System (GIS) techniques, it analyzed urban expansion trends from 1991 to 2021. The findings revealed that non-NCR towns experienced substantial outward growth, driven by economic opportunities, improved infrastructure, and demographic shifts. Hisar, Karnal, Panipat, and other key urban centers expanded significantly, incorporating peri-urban and rural areas into their urban fabric. The study found that urban expansion in non-NCR towns followed diverse spatial patterns. In several towns, concentric outward growth dominated, with the older city core acting as the nucleus of development. Other towns exhibited linear or corridor-based growth, particularly those located along major highways and railway routes. The development of transportation networks played a crucial role in shaping urban expansion, facilitating trade, mobility, and industrialization. Additionally, the availability of land at lower costs in peripheral areas encouraged rapid construction and urbanization.

One of the major findings of this study highlighted the consequences of unplanned urban growth. The conversion of fertile agricultural land into urban zones raised concerns about food security and environmental sustainability. The loss of green spaces contributed to rising temperatures, declining groundwater levels, and increased pollution. Additionally, the growing urban footprint put immense pressure on essential infrastructure, including water supply, waste management, and transportation systems. Without proper planning, these issues could have worsened, leading to long-term socio-economic and environmental challenges. Despite these challenges, the study recognized the economic benefits of urban expansion in non-NCR towns. The increasing urban population created demand for housing, commercial activities, and public services, stimulating local economies. The rise of small-scale industries, educational institutions, and healthcare facilities enhanced the socio-economic profile of these towns. Improved connectivity with larger economic hubs strengthened trade networks, making non-NCR towns more competitive and attractive for investment. To ensure sustainable urbanization, the study emphasized the need for well-planned development strategies. Policies focusing on efficient land use, improved public transportation, and smart urban growth could have helped balance economic expansion with environmental conservation. Implementing zoning regulations, promoting green infrastructure, and enhancing urban governance were crucial steps toward managing future growth effectively.

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