Urban growth and patterns of Mahendragarh City 1991-2025

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Abstract

The phenomenon of urban growth is a complex one. It is the result of numerous social, economic, ecological, cultural, and even political situations. Rapid urbanization generally arises due to the disbursement of peripheral prime agricultural land, destroying the natural landscape in the process. The industrial and economic development has initiated the rapid growth of small and medium-sized towns in India. Mahendragarh city, a part of the National Capital Region of India, is undergoing rapid urban expansion. This study examines the process of urban expansion in Mahendragarh city. The methodology of the study is dependent on open-source Landsat satellite data, GIS-based unsupervised classification, and spatial metrics analysis. The city expansion has been analysed for a period of 34 years, from 1991 to 2025, and population growth has been studied since 1991. Within the study period, expansion rate of 15.30 %. Built-up land had a growth rate nearly 2 times higher than population, indicating urban sprawl. An assessment of different landscape metrics revealed that the landscape of Mahendragarh has lost land use diversity. The findings of this study offer information about the present state of urban growth. It also serves as a valuable resource for formulating comprehensive planning and development policies, ensuring the promotion of sustainable urban development.

Keywords: **Urban growth, ecological, disbursement, expansion, Urban sprawl.**

Introduction

India experienced a new phase of enhanced urbanization in the post-liberalisation, privatisation and globalization period initiated in 1991. Concomitant urban expansion brings substantial social, economic and environmental transformations. Equally significant is that the urban place is more sustainable and equitable and for that they must be planned to protect and sustain all, leaving no one behind (Binu and Kumar, 2023). Urban growth is a complex and dynamic process that reflects the interaction of demographic, economic, social, and spatial forces over time. Over time, demographic, economic, social, and spatial variables interact to create urban expansion, which is a complicated and dynamic process. In addition to population growth, cities also undergo land-use change, infrastructure development, and spatial expansion. Important insights into the internal organization and external growth of urban areas can be gained by studying urban growth patterns, especially with regard to distance and direction from the city centre.

By determining whether growth is concentrated in particular corridors or uniform in all directions, directional growth analysis contributes to a better understanding of urban expansion. Many cities see linear or sectoral patterns of development as a result of growth following important transportation lines like highways and railroads. The availability of land, economic opportunity, and natural features all have

a big impact on how expansion is directed. These trends are especially noticeable in small and medium-sized towns, where spatial expansion is city of Mahendragarh, which is situated in the southern region of Haryana, is a prime example of a tiny but expanding Indian metropolis. In the past, the city grew as a traditional hamlet with a small built-up area focused on regional markets and governmental buildings. It has gradually changed throughout time as a result of growing infrastructure, shifting socioeconomic situations, and population growth. Its regional significance and urban growth have been further enhanced by its proximity to neighbouring towns like Rewari and Narnaul (Census of India, 2011; Haryana Urban Development Authority, 2018).

Mahendragarh's physical structure and demographic composition have changed significantly in the last several decades. Due to strain on land resources brought on by both natural population growth and rural-to-urban migration, the city has expanded outside of its traditional core. New colonies and peri-urban developments emerge as a result of this expansion, which is frequently linked to the conversion of agricultural land into residential and commercial usage. These tendencies are indicative of larger urbanization trends seen in India's small towns (Bhagat, 2011; Kundu, 2011). heavily influenced by infrastructure development (Northam, 1975; Pacione, 2009).

Another crucial aspect of urban expansion is the alteration of land use. Converting open spaces, rural communities, and agricultural land into built-up regions is a common part of city expansion. In addition to changing the physical landscape, this process has serious environmental and socioeconomic repercussions, such as decreased agricultural output and increased demand on natural resources. According to Bryant et al. (1982) and Allen (2003), growing cities frequently experience the formation of a rural-urban periphery characterized by mixed land use and transitional land cover.

Therefore, the purpose of this study is to analyse the growth and pattern of Mahendragarh city by examining the relationship between population growth and spatial development as well as the city's expansion in terms of distance and direction from the city centre.

Objectives of the study

The present study is aims at the following objectives:

(i) To analysis the urban growth and expansion of Mahendragarh City from 1991 to 2025.

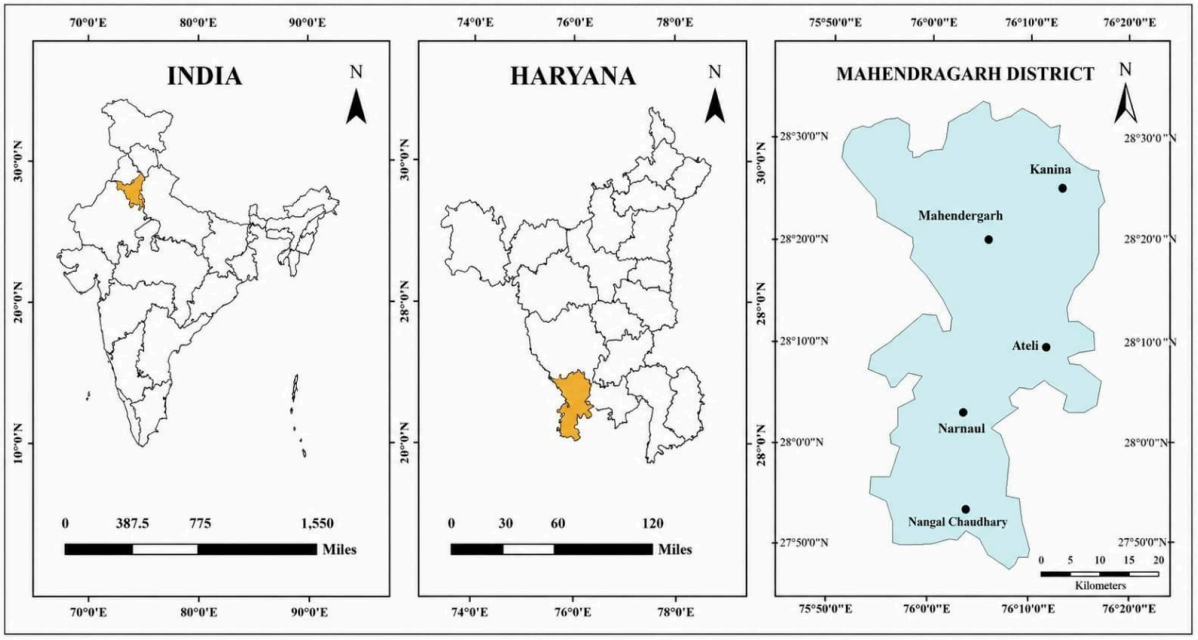
(ii) To present a comparative analysis of population growth and built-up area statistics.

Study Area

The present paper relates to Mahendragarh city situated in south western part of Haryana. It has a geographical area of 12 to 13 km^2 though it often extends to the broader Mahendragarh tehsil. It stretches between 28°14' 48"N latitude to 28°17'22" North latitude and76°07'42"E to 76°10'42" East longitude. The climatic condition in the district varies from arid to semi-arid, with annual rainfall of 592.5 mm. About 75 percent of annual rainfall is received during the south west monsoon during June to September. Dohan

and Krishnawati streams, which are ephemeral, make irregular flood plains in the district. The flood plain occurs in association with sandy terrain and dunes to variable morphology.

Map 1: Location of Study Area



Source: Prepared by research scholar using ArcGIS software

Data base and Methodology

The study depends on a combination of secondary data sources and geospatial analysis techniques. Population data have been obtained from official census records, while spatial data have been derived from satellite imagery and maps. The use of standardized datasets ensures consistency and reliability in the analysis of temporal changes (Census of India, 2011; Kothari, 2004). Geospatial analysis forms a central component of the methodology, with tools such as Geographic Information Systems (GIS) being used for mapping and spatial interpretation. GIS enables the integration of different types of data and facilitates the visualization of urban growth patterns. Through techniques such as digitization, layering, and thematic mapping, the study is able to represent complex spatial relationships in a simplified and interpretable.

Urban Density and Growth Rate

The Urban per unit area considered as Urban density. This research evaluates the urban density and growth rate using following formulae:

Urban Density = Urban Area / Zone Total Zonal Area

Where, urban density conducted for every arc of ring viz., radial zones on each ring to compare and assess the differentiation of urban settlement and urban sprawl in cases of comparatively higher differences.

Growth Rate = TFUA - TIUA / TIUA x 100

Where,

TFUA= total final urban area (km^2)

TIUA total initial urban area (km^2)

Urban Density

The series of urban density of any area gives us brief account on geographical extension of city in particular period in addition to urban sprawl, topography, civilization, human settlement, magnitude of development and directional increase of city in specific way due to distribution of market area, industrial infrastructure, educational facility, transportation network, water availability, medical services and so on. Here the urban density has been analysed on two basis viz. directional analysis and multiple ring buffer analysis.

Growth Rate

The growth rate is the percentage change in a specific variable over a defined period of time. It is used to measure how quickly something in expanding or contracting- such a population and is essential for evaluating performance and forecasting trends.

RESULTS AND DISCUSSION

Some results and observation of the study are being discussed below:

Population Growth Trends of Mahendragarh City

Since population growth directly affects both spatial expansion and infrastructure demand, it is a crucial indicator of urban sprawl. Mahendragarh city population growth over time is displayed in the table below.

Table 1: Population Growth of Mahendragarh City

Census Year	Population	Decadal Growth (%)
1991	18500	……
2001	23000	24.3
2011	29128	26.66
2021	35000	20.2 (Estimated)

Source: Census of India 1991,2001,2011.

The population has been steadily growing over the years, according to the table 1. Between 2001 and 2011, the growth rate was at its highest, which might be explained by increased migration and economic

prospects. Urbanization has been mostly fueled by population growth, which has raised demand for housing and services (Census of India, 2011; UN-Habitat, 2016).

Spatial Expansion of Mahendragarh City

The growth of population is closely linked with the expansion of built-up area. As population increases, the city expands outward to accommodate new residential and commercial developments.

The table 2 and figure 1 shows the temporal growth of built-up area in Mahendragarh city from 1991 to 2025. The analysis clearly indicates a continuous increase in urban built-up land during the entire study period. The growth of built-up area reflects rapid urbanization, population increase, infrastructural development, and expansion of residential and commercial activities within the municipal boundary.

Table 2: Growth of Built-up Area in Mahendragarh City

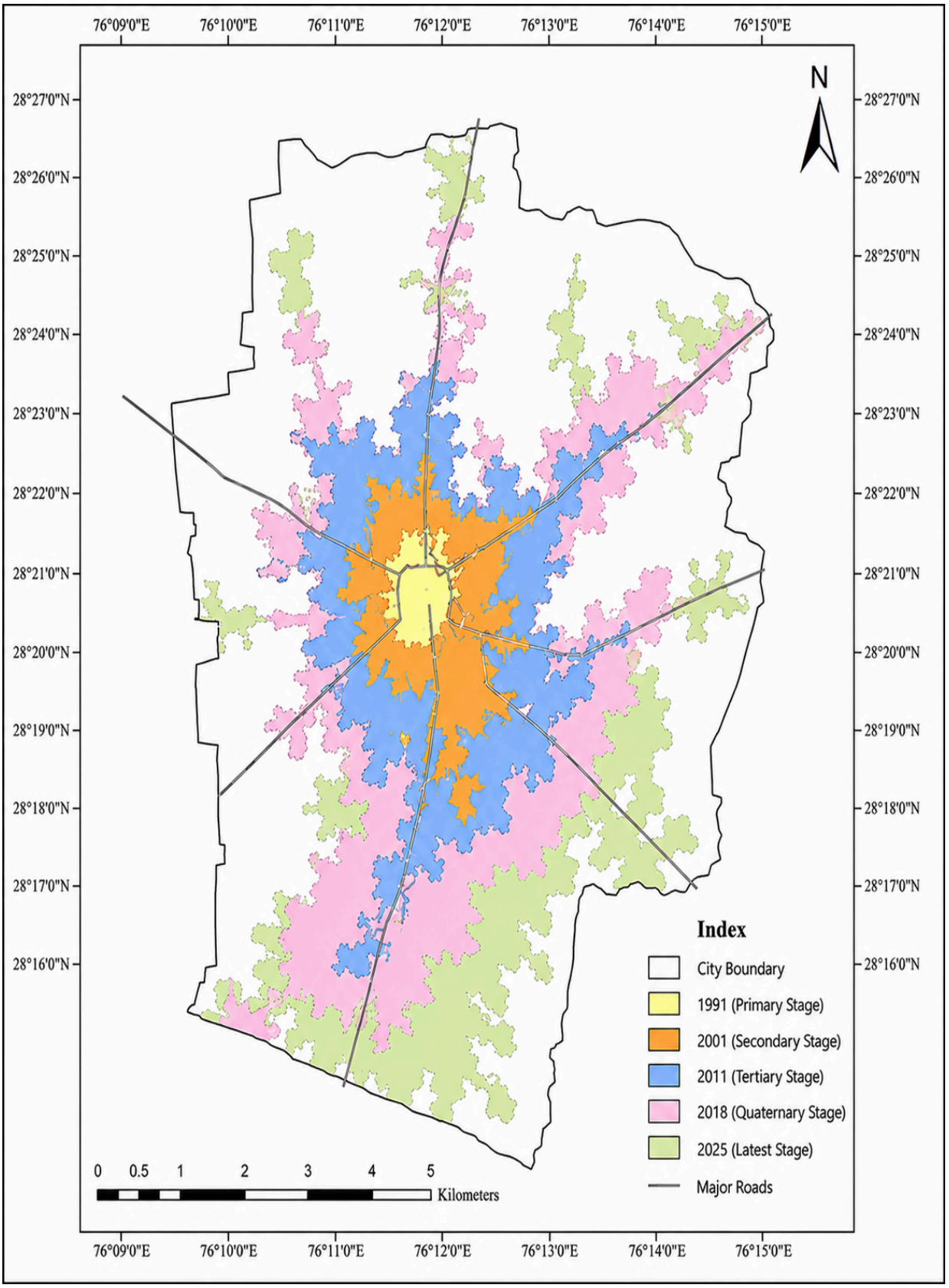
Years	Built-up Area (sq. km)	Growth (%)
1991	4.20	……..
2001	7.10	69.05
2011	11.20	57.75
2025	15.30	36.61

Source: Prepared by research scholar from LULC Map.

In 1991, the built-up area of Mahendragarh city was approximately 4.20 sq. km., indicating that the city had a relatively compact urban structure with limited spatial expansion. Most of the municipal area during this period consisted of vegetation and open land, while urban development remained concentrated around the traditional city core.

By 2001, the built-up area increased to 7.10 sq. km., registering a growth of approximately 69.05 percent over the previous decade. This period witnessed significant expansion of residential colonies, commercial establishments, and transportation infrastructure. Urban development began spreading outward from the central core toward peripheral regions, particularly along major roads and transportation corridors. During 2011, the built-up area further increased to 11.20 sq. km. with a growth rate of about 57.75 percent. By 2025, the built-up area reached approximately 15.30 sq. km., accounting for a growth of 36.61 percent over 2011. The comparatively lower percentage growth during this period does not indicate slower urbanization; rather, it reflects the fact that a large proportion of available land had already been urbanized during earlier decades.

Figure 2: Urban Growth and Expansion of Mahendragarh City



Source: Prepared by Research scholar using Arc GIS.

Population Growth and Physical Expansion of Mahendragarh City

The relationship between population growth and physical expansion is a fundamental aspect of urban development, as increases in population directly influence the spatial growth of a city. In Mahendragarh,

this relationship is clearly evident, where rising population has led to increased demand for housing, infrastructure, and services, ultimately resulting in the outward expansion of the urban area. The interaction between demographic and spatial processes reflects a dynamic pattern in which population pressure acts as a driving force behind land-use transformation and urban growth (Pacione, 2009; Bhatta, 2010).

Population Growth and Housing Demand

An increase in population leads to a corresponding rise in housing demand, which is one of the primary drivers of physical expansion.

Table 3: Population vs Housing Growth

Year	Population	Households	Built-up Area (sq. km)
1991	20000	3500	4.20
2001	26000	5200	7.10
2011	34000	7500	11.20

Source: Census of India 1991, 2001, 2011

The table 3 clearly shows that as population increases, the number of households and built-up area also increase. This indicates a strong relationship between demographic growth and spatial expansion. The rising demand for housing has led to the development of new residential areas, particularly in the intermediate and peripheral zones, resulting in the expansion of the city's physical boundaries (UN-Habitat, 2016).

Land Conversion and Urban Expansion

Population growth also leads to the conversion of land from rural to urban use, particularly agricultural land. The table 4 highlights a clear trend of increasing built-up area and declining agricultural land. As population grows, the demand for land increases, resulting in the conversion of agricultural land into residential and commercial uses. This transformation reflects the process of urbanization and spatial expansion (Bhatta, 2010; Singh, 2014).

Table 4: Land Use Change with Population Growth

Year	Population	Built-up Land (%)	Agricultural Land (%)
1991	20000	18%	36%
2001	26000	30%	28%
2011	34000	48%	22%

Source: Prepared by research scholar.

Direction and Distance Analysis of Mahendragarh City

The analysis of urban growth in terms of direction and distance provides a deeper understanding of how a city expands spatially under the influence of physical, economic, and infrastructural factors. While population growth explains why cities expand, directional and distance-based analysis explains how and where this expansion takes place. Such analysis is widely used in urban geography to identify spatial patterns and growth trends (Pacione, 2009; Knox & McCarthy, 2012).

Concept of Distance - based Urban Growth of Mahendragarh City

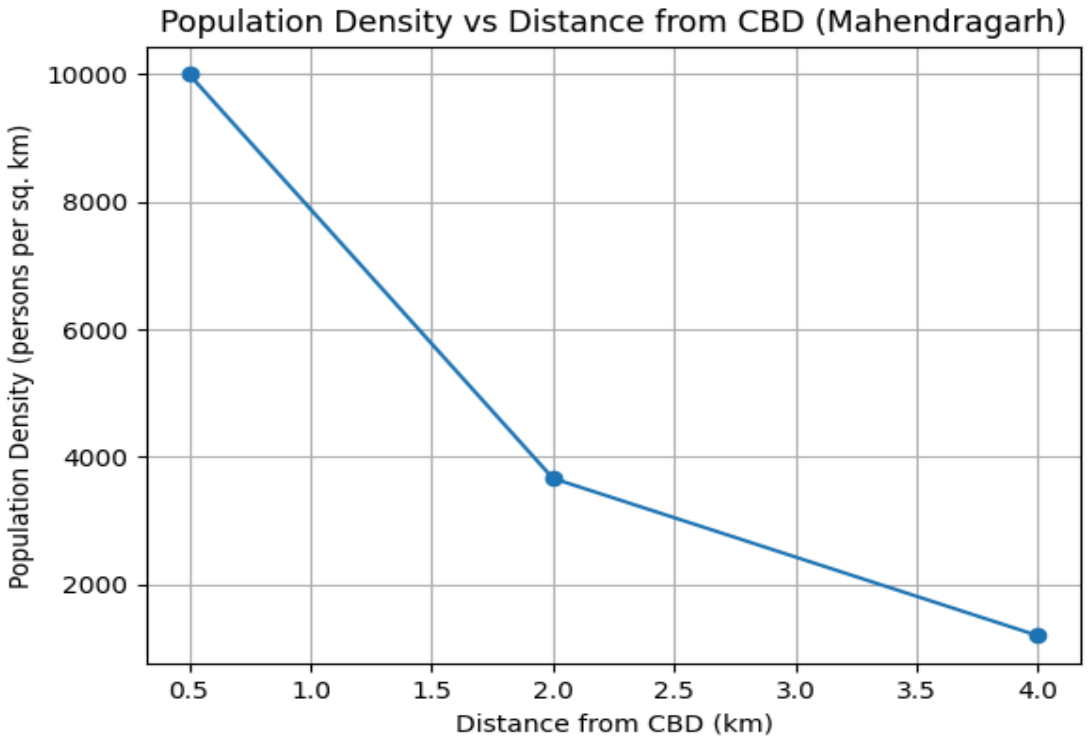
The focus of distance-based analysis is on how urban features change as one gets farther from the city centre. The majority of cities show a distance-decay pattern, in which the degree of growth diminishes as one gets farther away from the Central Business District (CBD). As a result, a zonal structure with core, intermediate, and peripheral regions is produced (Clark, 1951; Richardson, 1977).

Table 5: Population Density in Different Zones of Mahendragarh City

Zone	Distance from CBD	Area (sq. km)	Population	Density (persons/sq.km)
Core	0-1 km	1.2	12000	10000
Intermediate	1-3 km	3.0	11000	3667
Peripheral	3-5 km	5.0	6000	1200

Source: M.C. Mahendragarh and based on spatial distribution

Figure 1: Population Density and Distance from CBD of Mahendragarh City



Source: Prepared by Research Scholar

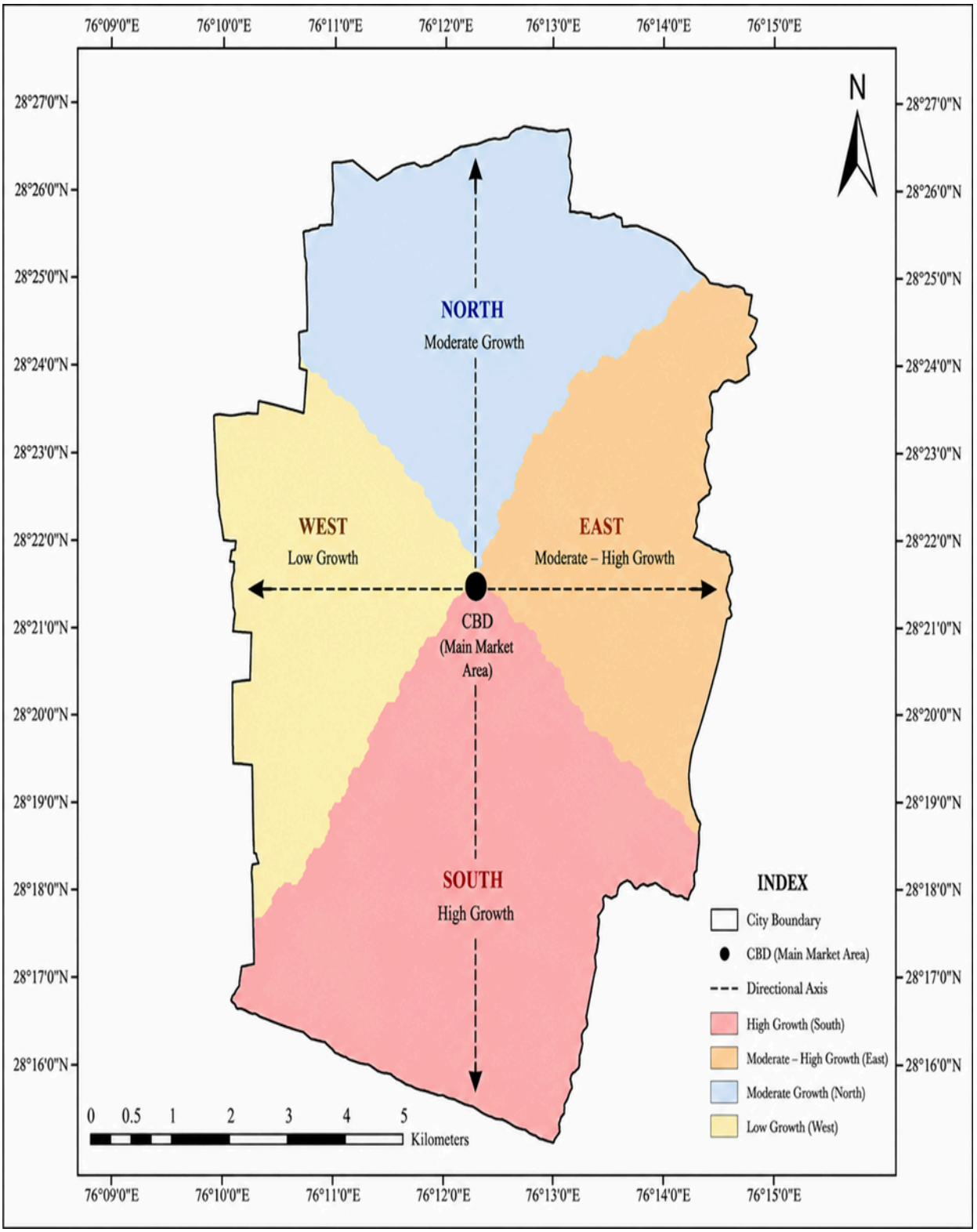
Table 5 and figure 3 clearly shows that the core zone has the highest population density, which is significantly greater than that of the intermediate and peripheral zones. This sharp decline in density with increasing distance from the city centre confirms the distance-decay principle. The high density in the core zone is a result of intense land use, concentration of economic activities, and limited space availability. In contrast, the peripheral areas exhibit lower density due to recent development and the presence of open land.

Directional Growth of Mahendragarh City

The analysis of directional growth is essential for understanding the spatial dynamics of urban expansion, as cities rarely grow uniformly in all directions. Instead, growth tends to concentrate along specific axes influenced by transportation networks, land availability, economic activities, and physical constraints. A map-based approach provides a visual and analytical framework to identify such directional trends and their underlying causes (Pacione, 2009; Rodrigue et al., 2020).

The directional growth pattern map (figure 4) of Mahendragarh city reveals that urban expansion is uneven and directionally biased, with certain sectors experiencing more rapid growth than others. The pattern of development clearly indicates the influence of road connectivity and accessibility in shaping the spatial structure of the city.

Map 4: Directional Growth Pattern of Mahendragarh City



Source: Prepared by research scholar using Arc GIS

Government Policies and Planning: -

Government policies and planning initiatives play a crucial role in shaping urban growth by regulating land use, infrastructure development, and housing. In Mahendragarh, urban planning schemes and development policies have influenced the spatial organization of the city. Planned housing projects and

regulated land development help in accommodating the growing population and reducing unplanned expansion.

However, in many cases, the implementation of planning policies may be limited, leading to irregular growth patterns and urban sprawl. Government initiatives related to housing, infrastructure development, and urban governance directly affect the pace and direction of urban expansion. Effective planning and policy implementation are therefore essential for ensuring balanced and sustainable urban growth (UN-Habitat, 2016; Bhatta, 2010).

Conclusion

This study establishes that the growth and pattern of Mahendragarh city is a dynamic process shaped by the interaction of population growth, spatial expansion, and infrastructural development, resulting in significant transformation of land use over time. The study reveals that urban expansion in Mahendragarh has progressed through different phases, evolving from a compact and centralized settlement to a more dispersed and directionally influenced urban form.

The distance-based analysis confirms the presence of a clear density gradient, with high population concentration in the core area and a gradual decline toward the peripheral zones, indicating a typical core–periphery structure. The directional analysis highlights that urban growth is uneven and strongly influenced by transportation networks, with maximum expansion observed in the southern and eastern directions, while the western sector remains relatively underdeveloped.

The study further demonstrates a strong relationship between population growth and physical expansion, where increasing population has led to rising housing demand, land conversion, and outward expansion of urban boundaries. Overall, the study concludes that the growth pattern of Mahendragarh city is characterized by a transition from compact to dispersed development, highlighting the need for effective planning strategies to ensure balanced and sustainable urban growth.

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