

Urban Growth of Samastipur City (Samastipur District), Bihar, India: Challenges and Planning

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Abstract

The process of urbanization in India's smaller cities has gained momentum in recent decades, particularly in regions like Bihar where demographic pressure and infrastructural development are reshaping the urban landscape. Samastipur, a rapidly growing city in northern Bihar, has emerged as a key administrative, commercial, and transport hub in the Mithilanchal region. Despite its growing importance, the spatial configuration and functional dynamics of the city remain under-examined in academic and policy discourse. This study aims to investigate Land use Land cover changes over two decades from 2000 to 2024. The research employs high-resolution satellite imagery, topographical maps, and demographic data from Census 2011, integrated within a Geographic Information System (GIS) framework. Key methodologies include Land Use and Land Cover (LULC) classification. The study delineates various functional zones such as residential, commercial, administrative, Institutional, and transportation corridors. Findings reveal a semi-concentric and linear morphological pattern, with high-density development around the city centre and transportation nodes. The city is experiencing unplanned expansion at its peripheries, marked by land-use fragmentation and inadequate service distribution. Functional zones often overlap, leading to inefficiencies in land use and infrastructure allocation. The study highlights the need for comprehensive urban planning, emphasizing controlled growth, zoning regulations, and sustainable infrastructure development. The spatial insights derived from this research can serve as a foundation for future urban policy formulation and integrated development planning in Samastipur and similar emerging cities.

Keywords: Urban Growth, planning strategies, Samastipur City, Spatial Analysis, urban development

1. Introduction

Urbanization is one of the most transformative processes influencing the spatial and socio-economic fabric of 21st-century India. Although much attention has been paid to the expansion of mega-cities like Delhi, Mumbai, and Bengaluru, smaller urban centres are experiencing equally dynamic and complex growth patterns (Kundu, 2011). According to the Census of India (2011), urban areas account for 31.2% of the country's total population, with significant demographic shifts occurring in Tier II and Tier III cities. These smaller cities, such as Samastipur in Bihar, are evolving into important regional hubs for trade, administration, and services (Pradhan, 2013).

Land use Land cover changes analysis is the critical analytical process to understand how cities evolve over time. It involves the spatial analysis of built-up forms, street networks, land use, and patterns of settlement (Whitehand, 2001). Closely related to this is the concept of functional structure, which refers to the spatial distribution of different urban functions such as residential, commercial, institutional, and administrative zones (Pacione, 2005). Together, these concepts offer valuable insights into the way urban spaces operate and are shaped by socio-economic, political, and environmental forces (Moudon, 1997).

India's smaller cities often face unplanned urban growth, driven by rural-to-urban migration, land speculation, and infrastructure lags (Batra & Bhatia, 2014). In Bihar, urban development is challenged by low investment in urban infrastructure, limited town planning expertise, and fragmented land records (NITI Aayog, 2021). Consequently, urban sprawl, congestion, and haphazard land use patterns are common, especially in rapidly expanding districts like Samastipur. Samastipur City was a Municipal corporation, on 26 December 2020, Bihar cabinet approved Samastipur Municipality will be upgraded as Municipal Corporation to include 68 Villages from 16 Gram Panchayats of surrounding existing Municipality, it comes in existence on March 10, 2021. Samastipur Municipal Corporation is located in northern Bihar on the bank of Burhi Gandak River, functions as a district headquarters, transportation node, and economic hub. Its strategic location as a railway junction and agricultural trade centre has driven its urban growth (Goel & Sharma, 2019). However, this growth is largely organic and unplanned, resulting in spatial fragmentation, informal housing clusters, and uneven access to civic amenities (Singh & Kumari, 2022). The city now exhibits a polycentric urban structure with a high-density core and sprawling peripheries. Despite its regional significance, Samastipur remains underrepresented in academic research on urban form and planning. There is a pressing need to analyze its spatial evolution using scientific tools such as Geographic Information Systems (GIS) and satellite imagery.

This study aims to bridge this gap by conducting a detailed spatial analysis of Samastipur's urban growth by LULC and functional structure.

2. Objectives:

- a. To examine the spatial growth and land use patterns of Samastipur city over the past two decades.
- b. To assess the challenges posed by unregulated urban growth.
- c. To recommend planning strategies for sustainable urban development.

3. Database and Methodology:

The study utilizes a combination of primary and secondary data sources to conduct an in-depth spatial analysis of the urban Growth and functional structure of Samastipur City. The major data sources include:

- a. **Satellite Imagery:** High-resolution satellite images from Landsat 8 OLI (2024) and Landsat-5 OLI (2000, 2010) were used for Land Use and Land Cover (LULC) classification and spatial mapping.
- b. **Census Data:** Demographic and socio-economic data were obtained from Census of India 2011, including population, density, literacy, and occupational structure.
- c. **Field Surveys and Ground Truthing:** Site visits and geo-tagged photos were used to validate land use types and update discrepancies in remote-sensing data interpretation.
- d. **Secondary Literature and Reports:** District census hand Book, Academic journals, and government reports.

4. Methodological Tools and Framework

To achieve the objectives of this study, a spatial-analytical framework was developed that integrates geospatial tools, quantitative indices, and ground verification techniques. The methodological workflow is outlined below:

a. GIS Mapping and Spatial Analysis

Geographic Information Systems (GIS), such as ArcGIS 10.8 were employed to Geo-reference base maps, digitize administrative boundary, and analyze spatial patterns.

b. Land Use and Land Cover (LULC) Classification

Supervised classification of satellite imagery was performed using Maximum Likelihood Classification (MLC) in ArcGIS.

c. Ground verification and Secondary Data Correlation

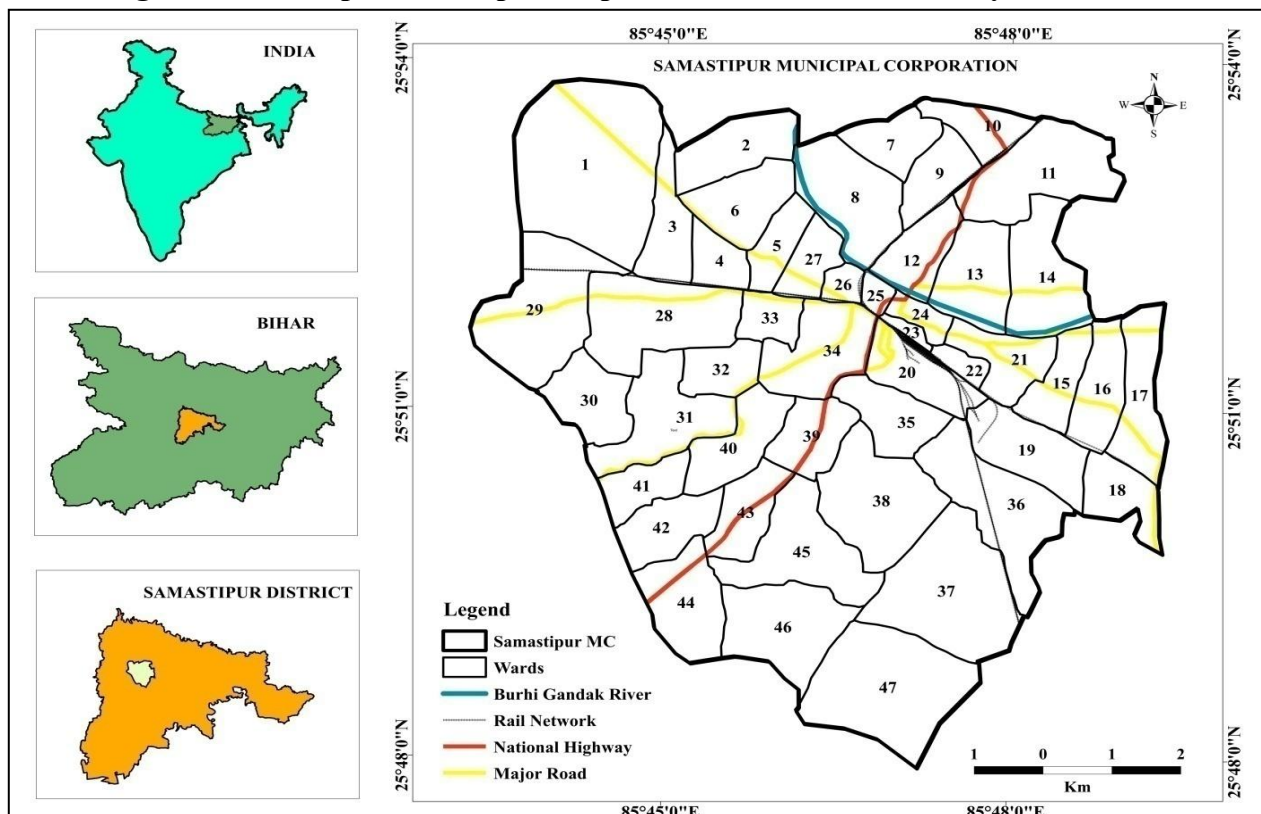
Field visits were conducted in selected wards to verify classified land uses and to update functional details. Data collected through field notes and GPS-enabled mobile mapping were cross-checked against remote sensing outputs. Secondary datasets such as urban policy documents and socio-economic profiles were correlated with spatial patterns for validation and contextual analysis.

5. Study area:

a. Geographical Location

Samastipur City is located in the northern part of Bihar, India, and lies between 25°47'55"N to 25°53'49"N latitude and 85°43'17"E to 85°49'19"E longitude. Total area of the city is 71 km², situated on the banks of the Burhi Gandak River, a tributary of the Ganga. The city serves as the headquarters of the Samastipur district which falls under the Tirhut division and is part of the Gangetic alluvial plain, making it agriculturally productive and prone to seasonal flooding.

Figure1: Samastipur Municipal Corporation with ward boundary and Labels



Note: Map prepared by the Author using Arcgis

b. Demographics

As per the 2011 Census of India, the urban population of Samastipur City (Municipal Corporation) is 2,53,136, that was 67,925 when it was municipality. City had a population density of 3,565 persons per square kilometre. The literacy rate stands at 84.9%, with male literacy at 88.9% and female literacy at 80.4%, showing a moderate gender disparity. Samastipur is linguistically diverse, with Hindi, Maithili, and Urdu being widely spoken (District Census Handbook: Samastipur, 2011).

b. Urban Growth Trends

Samastipur City is not a planned City, over the past two decades; Samastipur has experienced rapid urbanization, largely influenced by its strategic location along the Delhi-Howrah and Delhi Mumbai railway corridor and national highways NH-122 and NH-322. Expansion has been mainly towards the south and southeast, characterized by residential sprawl, informal settlements, and land-use conversion from agricultural to urban purposes. The city's core is a dense mix of commercial and residential activity, while peripheral areas reflect unplanned and linear growth along transport corridors. The absence of a formal master plan has contributed to haphazard development and growing pressure on infrastructure.

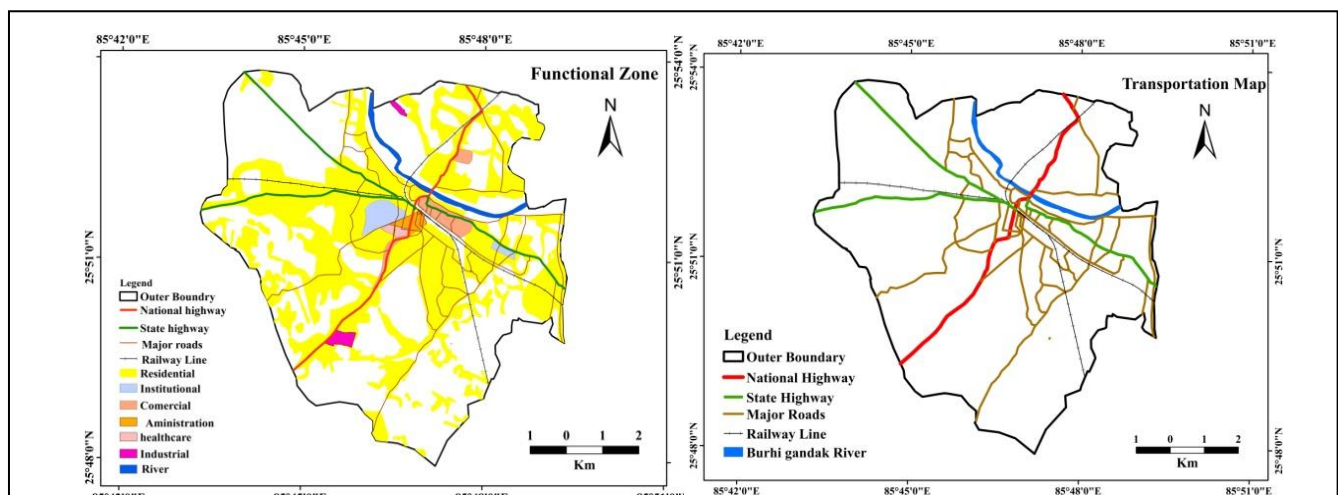
c. Historical Background of the City Structure

Historically, Samastipur emerged as a regional trading post and transport junction during the British colonial period. Its significance grew with the development of the East Indian Railway in the late 19th century. Post-independence, the city evolved into a municipal town with expanding administrative functions and a steady rise in population. The historical core, particularly around the railway station and municipal offices, forms the nucleus of the city's morphology. Over time, new residential colonies, educational institutions, and commercial areas have developed along key roads and transport axes, giving the city a semi-concentric and linear spatial pattern.

5. Morphological Structure of the City:

Samastipur exhibits a semi-compact urban form with a dense central core, primarily surrounding the Samastipur Junction Railway Station, and gradually diffused peripheral growth towards the northeast and southwest. Historically, the city grew as a transportation-led nucleated settlement, with commercial, institutional, and administrative functions concentrated near the central node.

Figure2: Functional area and Transportation Map of the Samastipur City



Note: Map prepared by the Author using Arcgis

However, recent decades have witnessed a fragmented and dispersed expansion pattern, particularly along arterial roads and toward Tajpur, Warisnagari, Musrigharari and Rosera. Urban growth has extended along the NH-122 and other local connectors, leading to the emergence of linear corridors and peri-urban sprawl. This pattern reflects a transition from compact to semi-linear and dispersed morphology, typical of small Indian cities experiencing unplanned growth due to population pressure and infrastructural constraints.

- **Road Network and Connectivity:**

The road network of Samastipur exhibits a radial-linear structure centred near the railway junction, acting as the city's transportation spine. Key features of the road morphology include:

a. High Connectivity Zone: The central city area has dense intersections and short road segments, improving local mobility and access.

b. Peripheral Discontinuity: Outer zones exhibit irregular layouts with sparse connectivity, leading to longer travel times and unequal access to services.

c. Hierarchical Roads: The road system includes arterial roads (NH-122), sub-arterial connectors, and narrow residential lanes.

- **Settlement Patterns and Spatial Organization**

The spatial arrangement of settlements in Samastipur follows a multi-nodal structure:

a. Central Zone: Mixed-use high-density core with administrative buildings, markets, educational institutions and transport hubs.

b. North and South Clusters: Residential colonies, Agriculture base Commercial and Industrial area.

c. Linear Extensions: Settlements aligned along NH-322 leading to Mushrigharari (To connect NH-122) and Samastipur to Rosera road (SH-55). Informal settlements have grown along the fringes, lacking adequate infrastructure and planning oversight. These areas present challenges in terms of drainage, sanitation, and public service delivery.

6. Urban growth and LULC analysis:

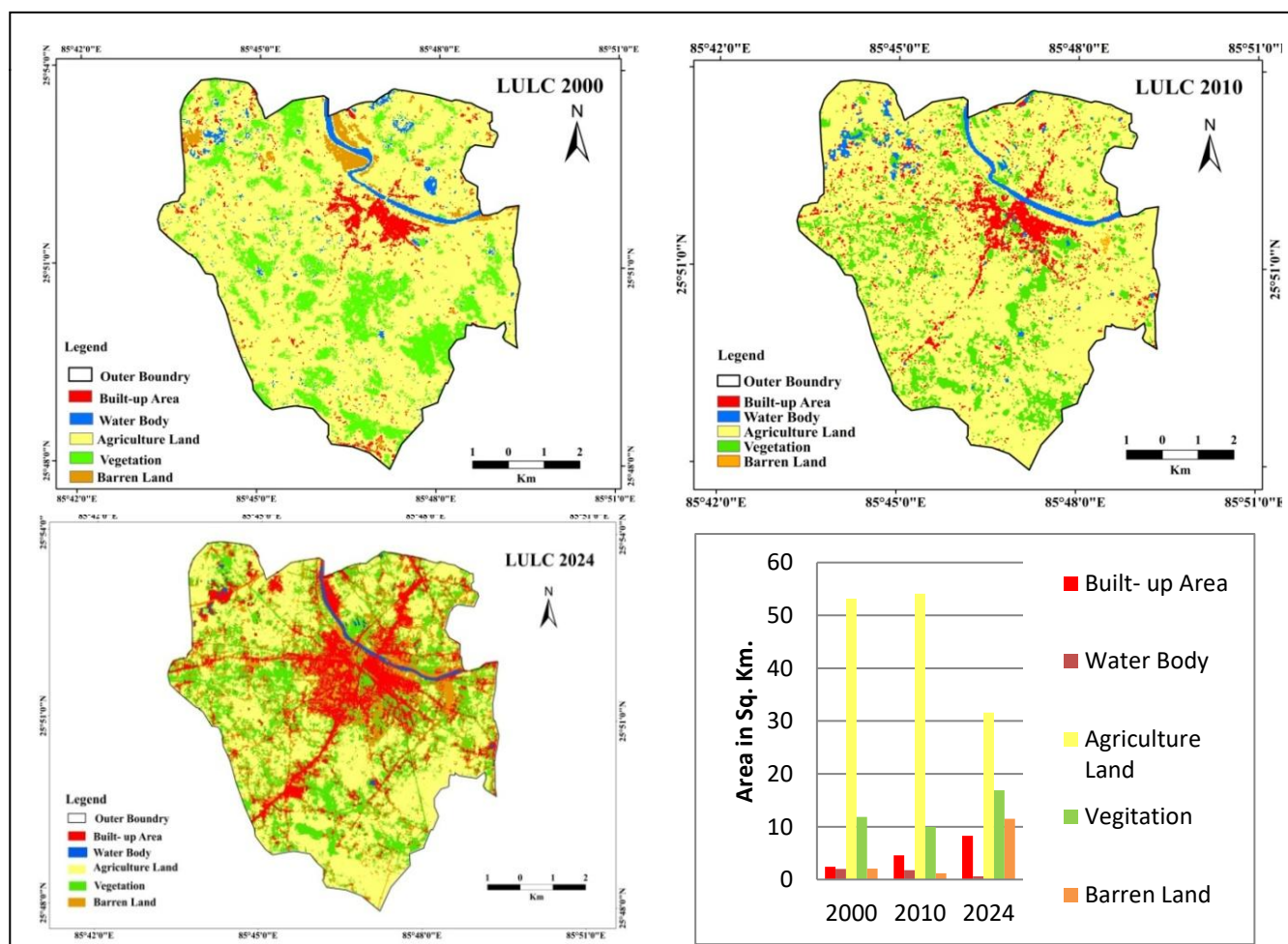
The spatial analysis of Samastipur reveals a transition from a compact urban core near the railway junction to a more dispersed and fragmented structure. Land Use and Land Cover (LULC) classification over two decades (2000–2024), evident that the built-up area has expanded by over 350 %, with significant outward growth towards northeast (Muktapur) and southwest (Mushrigharari). It is evident because Samastipur City was a Municipality, in 2021 its status upgraded from Municipality to Municipal Corporation by the State government to include 66 villages from 16 Panchayats of surrounding areas including four Census town under Samastipur Municipal Corporation, namely- Bhagirathpur, Bhuindhara, Dharampur and Mathurapur. Before that total area of Municipality was only 3.5 sq. km., after up-gradation to Municipal Corporation its area expended to 71 sq. Km.(Jagran, March 10, 2021). This outward spread reflects a corridor development pattern, replacing the earlier radial morphology. The city has undergone notable changes:

- Built-up area expanding toward the fringes to replacing agriculture land
- Agricultural Lands and Water body are gradually decreasing.
- Significant changes in Vegetation and Barren land

After analysis of LULC maps of present area of Samastipur Municipal Corporation, we find that agriculture land gradually decreasing from 53.24 sq. Km in 2000 to 31.58 sq. Km. In 2024 but slight Increase in 2010 (55.09 sq. Km.), It is because pace of Urbanization increased after 2010. Built-up area

Increased from 2.44 sq. Km. in 2000 to 4.59 sq. Km. in 2010 and 10.99 sq.km in 2024. Water body badly affected due to Urbanization, it reduced from 1.99 sq. Km. in 2000 to 0.68 sq. Km. in 2024. Vast ups and down may be seen in Vegetation cover and Barren Land, it first decreased in 2010 and Increased in 2024 with respect to 2000. Main reason behind that boom in urbanization started from 2010, Agricultural land converted into Non agricultural land, People from rural area come to urban area for built their own house or invest in land property for future plan, but they leave that land without any construction and not doing agricultural activity, in this vacant land Garbage and other waste material dumped by residents from surrounding area, therefore that land became Barren, in some cases they planted tree on that land for future investment, so that area under Vegetation and barren land has increased.

Figure3. LULC Map of Samastipur City from 2000 to 2024



Note: Map prepared by the Author using Arcgis using Landsat 5& 8.

Table1: Land use land cover Changes over Time (2000–2024) in Squire Kilometre

Year	Built-up Area	Water Body	Agriculture Land	Vegetation	Barren Land
2000	2.44	1.99	53.24	11.86	2.06
2010	4.59	1.77	54.09	9.96	1.18
2024	10.99	0.63	31.58	16.87	11.52

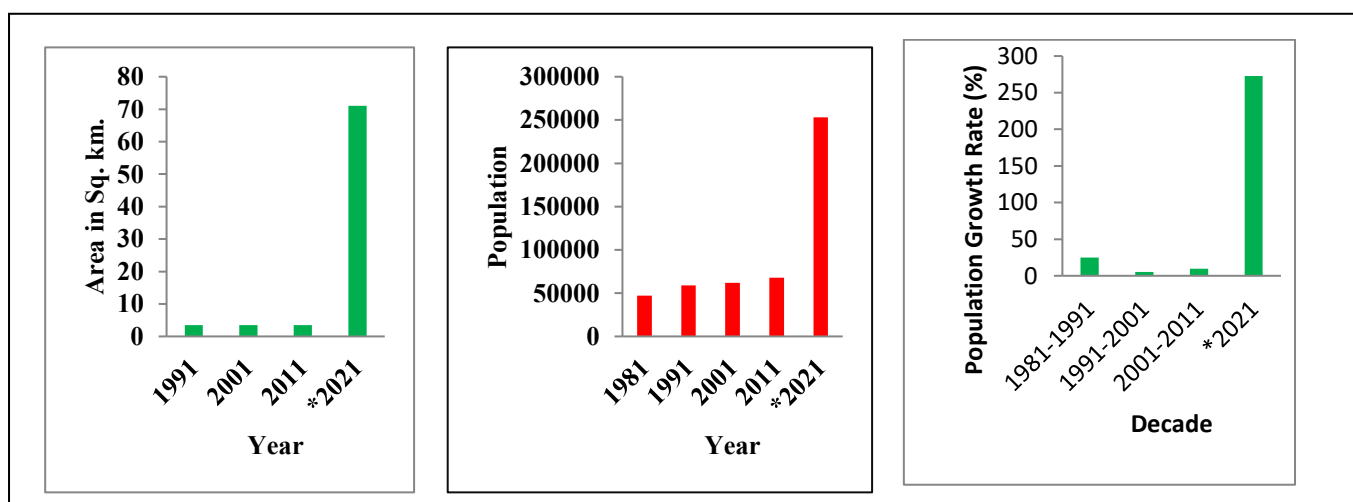
8. Historical Growth of Samastipur City:

Table2: Area Expansion and Change of Administrative status of Samastipur City (1991-2021)

Year	Urban Administrative Status	Administrative Area (sq. km)	Notes
1991	Municipality + OG (Railway Colony)	3.5	Small expansion, limited infrastructure
2001	Municipality + OG (Railway Colony)	3.5	Urban sprawl begins along transport corridors, 28 wards notified
2011	Municipality + OG(Railway Colony)	3.5	Built-up area growing faster than ULB limits
2021	Municipal Corporation	71.0	Major administrative expansion; 47 wards notified

Source- Census of India (1991, 2001, 2011) and Bihar Govt. Gazette 2021

Table 3: Change in Administrative are, total population and Population Growth of the Samastipur City



Note- Data compiled by the Author from Census of India

**2021 reflect high growth of City's administrative area, total population and decadal growth in population, because in 2021 status of Samastipur City changed from Municipality to Municipal Corporation to include 66 Villages from 16 Panchayats and 4 Census towns (Data included as per Census 2011)*

Samastipur City was established as Municipality in 1897 A.D. by British administration, it was a part of Darbhanga district, in 1972 Samastipur separated from Darbhanga district as a new district and its Headquarter established in Samastipur Municipality, In December 2020 Bihar state Govt. decided to upgrade its status from Municipality to Municipal Corporation and it enforced in early 2021. The area of Municipality was only 3.5 Sq. km, after conversion to Municipal Corporation its area increased to 71 Sq.km; it shows 1,928.57 % of growth. On other hand population growth also takes a big jump, according to 2011 Census, population of Municipality was 67,925, after conversion of Municipal

Corporation, with extended area it increased to 2,53,163, it shows 272.66% of population growth. Formula used to calculate decadal Spatial Urban growth and population growth are as:

$$\bullet \text{ Spatial Urban Growth (\%)} = \frac{\text{Built-up Area (t2)} - \text{Built-up Area (t1)}}{\text{Built-up Area (t1)}} \times 100$$

Where, t_1 = Present Built-up Area and t_2 = Previous Built-up Area

$$\bullet \text{ Population Growth (\%)} = \frac{\text{Population (P2)} - \text{Population (P1)}}{\text{Population (P1)}} \times 100$$

Where, P_1 = Present Decade Population and P_2 = Previous Decade Population

9. Urban Challenges

Despite moderate growth, Samastipur faces several urban planning and infrastructural challenges:

a. Traffic Congestion: Due to unregulated vehicular movement and a highly centralized commercial and administrative zone, daily congestion occurs along Station Road, Kachahri Road, Gudari Bazaar and near the Railway Junction.

b. Urban Sprawl: The lack of Municipal master plan or zoning enforcement has led to haphazard expansion, especially along the peripheries such as Tajpur Road and Musrigharari Road.

c. Informal Settlements: Low-income groups occupying flood-prone or encroached areas along the bank of Burhi Gandak River and railway tracks. These settlements are facing high vulnerability to both environmental hazards and socio-economic exclusion.

d. Fragmented Land Use: Functional zones are often not well-differentiated. Mixed-use developments exist without formal planning, leading to noise, waste, and infrastructural stress in residential neighbourhoods.

10. Planning strategies:

Land Use Planning and Zoning

Samastipur City is a newly formed Municipal corporation, and it is 10th largest urban body in Bihar and 177th largest urban body of India. So it is essential to develop this city according to a defined urban plan, for this it is required a well prepared City development plan for sustainable development of the city, which includes Land Use Map (Residential, Commercial, Industrial, and Green & Open Spaces) and strictly enforce zoning regulations to control unplanned and haphazard growth, especially along NH-322 and expanding peripheral areas.

Green Infrastructure and Environmental Conservation

Samastipur city has plenty of vacant land along the Burhi Gandak River and Jamuari River, Jamuari River is a Seasonal river, which is carrying all sewage and drainage water of Samastipur City, it is in its ruins stage, it is required to clean its stream and plant trees on the bank of it. It is also required to develop and conserve urban green belts.

Affordable Housing and up-gradation of Slums

Samastipur is an old and unplanned city; many Slums and landless population are residing in the city, for

them it is required to implement low-cost housing schemes under PMAY (Urban) and ensure proper basic services (water, sanitation, waste management). It is also required to upgrade existing informal settlements with security, improved sanitation, and better road access.

Well Connected Transport system and Mobility

After up-gradation of Samastipur City from municipality to Municipal Corporation, its area is expanded, Residents from rural area is migrating and settling in fringe areas of the City, to fulfill their requirements, it is essential to improve public transport facility (e-rickshaws, buses) with last-mile connectivity. It is also required to develop pedestrian pathways and cycle lanes, especially around core areas and educational hubs (Kasipur).

Solid Waste Management

It is required to Implement door-to-door Waste collection, source segregation (biodegradable/non-biodegradable), and composting units at community level, Plan for a scientific landfill site outside the functional area as per environmental norms and promote plastic-free zones, especially in markets and institutional areas.

Water Supply and Sanitation

It is required to introduce modernize piped water supply networks to cover all 47 wards with 24/7 access, construct decentralized sewage treatment plants and encourage reuse of treated wastewater for landscaping, it is also require to ensure 100% toilet coverage (under SBM-U).

Renewable Energy Adoption

Renewable energy is the basic requirement to become a sustainable and pollution free environment, to achieve this goal it is require to promote roof top solar panel on government buildings, schools, and households. Recently State government has announced 125-unit free electricity to all households, further it is planned that every household will be provided subsidized solar panel.

Resilient Infrastructure for Disaster Management

Samastipur City is lowland area and situated on the bank of the Rive Burhi Gandak and Januari, during monsoon it become flood prone area, to mitigate flood risk it is require preparing flood mitigation plans with early warning systems. Require to ensure Flood-resilient road, drainage, and public infrastructure, especially in low-lying area. It is also require conducting urban risk assessments for fire and earthquakes (Samastipur comes under seismic zone IV).

Inclusive Urban Governance

For Inclusive Urban Governance it is require to strengthening Urban Local Bodies (ULBs) by capacity building, GIS-based planning tools, and e-governance. To achieve the goal require to promoting citizen participation through regular public hearings and grievance redressed mechanisms.

Economic Development & Livelihood Generation

Samastipur district is agriculture dominated area, population density in this area is very high, and to fulfill their requirement employment generation other than agriculture is must required. People from surrounding of the Samastipur City comes to reside and commute in the city to fulfill their Medical, Educational and all other requirements, but job opportunity in the City is limited, so it is required to develop urban industrial clusters for agro-processing, small-scale industries, and handicrafts. Promote skill development centers linked with local employment demand and Create urban marketplaces and vending zones to support the informal economy.

Conclusion:

This study presents a comprehensive spatial analysis of the Land use and land cover analysis over two decade of Samastipur City, using geospatial tools and historical land use patterns. The findings reveal that Samastipur has undergone a gradual shift from a compact, monocentric form to a more dispersed, corridor-based urban structure, largely shaped by unplanned growth and transportation corridors. The central business district (CBD) near the railway junction continues to dominate commercial and administrative activities, while peripheral regions are increasingly accommodating residential and mixed-use development. The Land Use and Land Cover (LULC) maps from 2000 to 2004 highlight increasing spatial dispersion and declining urban compactness. Built-up area regularly increasing and Agricultural land and Water body are decreasing.

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