

“Rural-to-Urban Migration and Its Impact on Metropolitan Expansion: A GIS-Based Study”

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Abstract

Rural-to-urban migration is one of the most significant processes of urbanization in today's India, transforming the cities in far-reaching and complex ways. This research paper explores the influence of migration movements on the growth of the metros and the impact on selected metros like Delhi, Mumbai, Bengaluru and Hyderabad. Migration is not just a demographic phenomenon, it is a spatial and socio-economic phenomenon that reshapes housing markets, overstress infrastructure and contributes to the growth of informal settlements. The study uses Geographic Information Systems (GIS) to explore spatial patterns of migration-related urban growth and combines three data sources—census, municipal records and satellite imagery—to gain a holistic perspective on metropolitan transformation.

The analysis shows that migration flows make up a large proportion of the urban growth in the metropolitan areas of India: slum growth is evident in Delhi and Mumbai, with slum growth occurring alongside unauthorised colonies; peri-urban growth is observed in Bengaluru and Hyderabad, where there is a link with skilled migration. A shortage of housing becomes a major problem, with migrants having limited access to formal housing markets and forced to live in slums or informal housing arrangements. The governance issues of managing migration-induced growth in infrastructure systems, such as transport, water, sanitation and energy, are identified. Informal settlements serve as a source of immediate shelter and informal economies, yet continue to foster inequality and vulnerability, highlighting the importance of inclusive urban policies.

This research uses GIS-based techniques to offer spatial data as proof of the impact of migration on metropolitan boundaries, to define areas of hotspot growth in informal settlements and to reveal the regional differences of migration impact. The results highlight the need for inclusion of migrants in housing programmes, investments in resilient infrastructure and governance reform for sustainable metropolitan development. In conclusion, the study highlights the complexities of rural-to-urban migration in India while also emphasizing its potential for inclusivity, resilience, and sustainability.

Keywords: Rural-to-urban migration; metropolitan expansion; GIS analysis; housing shortages; infrastructure strain; informal settlements; peri-urban growth; India; sustainable urban development; spatial analysis.

Migration has long been one of the most powerful forces affecting human societies, economies and landscapes. The migration from rural to urban areas has become the most important factor in the process of urbanization in the modern period and is especially evident in developing countries like India. This process of rural-urban migration is not just a shift in numbers, but also a process of reorganization of spatial patterns, restructuring of socio-economic systems and intensification of urban growth. The present research work is an attempt to study the complex relationship between migration flow and spatial expansion of metropolitan regions under the framework of Geographic Information Systems (GIS) as a methodological tool to visualize, analyse and interpret the relationship.

The history of urbanisation in India is not uniform, rather cities like Delhi, Mumbai, Bengaluru, Hyderabad and Kolkata have been the main destinations for migrants from rural areas. They provide the opportunity to make money, good

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infrastructure and services that are not available in rural areas. The arrival of migrants, however, creates problems in the areas of housing, homelessness, traffic, and environmental strain. Growth of metropolitan areas is not just a function of natural increase, but is also greatly affected by the demand for land, housing, and jobs that comes from migration. The expansion takes the form of conversion of agricultural areas into urban settlements, the growth of peri-urban areas and the appearance of informal colonies, frequently outside the formal planning system. Research has revealed that Indian metros have grown in an unplanned and unprecedented manner; and have created sprawling city clusters that are hard to govern within the current system.²

The reasons for a focus on rural to urban migration are two-fold, as it both causes and is a consequence of metropolitan growth. However, on the other hand, migration also poses a risk of increasing the size of cities by increasing the density of people as well as labor. Conversely, metropolitan growth opens new opportunities that draw more people, establishing a vicious cycle. This process is more pronounced in India, where a gap between the rural distress, agrarian stagnation, and lack of employment opportunities drives people to the cities, and the growing urban economy attracts them, promising improved livelihoods. The push-pull nature of migration theory is a helpful perspective on this, but it needs to be matched with spatial analysis to illuminate the impact of these flows on the spatial structure of metro areas.³

Geographic Information Systems (GIS) are a very methodologically useful tool for studying this phenomenon. GIS allows researchers to view migration patterns, map settlement patterns and analyze land use changes at a spatial level, as opposed to the traditional demographic approach. GIS can show spatial concentrations of migrant communities, urban growth and urban periphery change, by combining data from the censuses, municipal information and satellite imagery. For example, overlay analysis can show whether there is a correlation between migration inflows and the development of informal settlements, and hotspot analysis can show where there is a concentration of migrant activity. This spatial understanding is essential for policy makers, urban planners and researchers who are looking to develop sustainable metropolitan strategies to address migration and its pressures.⁴

Migration from rural to urban areas has been a major characteristic of urbanization in Asia, Africa and Latin America all over the world. By 2050, the United Nations estimates that almost 68% of the world's population will be living in cities, with an increasing number of these cities being in developing countries.⁵ India, having a large rural population and fast-growing metropolises is a perfect example. Migration has contributed to the growth of the urban population in the country from 217 million people in 1991 to more than 480 million in 2021.⁶ The influx of migrants to metropolitan cities like Delhi and Mumbai from states like Uttar Pradesh, Bihar and Rajasthan has resulted in spatial growth and formation of peri-urban sprawls. The trends highlight the need for research on migration-driven metropolitan growth, not just for academic purposes, but as a policy priority.

The impacts of migration from rural to urban areas are complex. Poor housing availability can result in slum conditions and informal settlements that provide poor living standards for migrants, with no access to basic services. Community infrastructure (such as roads, water, and sanitation) has difficulty meeting the needs of the increasing population, leading to congestion and environmental stress. Jobs are available in metropolitan areas, but tend to be found in informal sectors where migrants may be exploited and feel insecure. Social integration is also a challenge because migrants are often discriminated and marginalised in the societies of the cities. The pressures outlined in this document reinforce the importance of creating policies that are informed by place to address metropolitan growth in a sustainable and inclusive way.⁷

Rural-urban migration also creates opportunities, simultaneously. Migrants are part of the metro economy as workers in the industries, services and construction. They contribute to the cultural diversity of cities and their capacity to adapt and be resilient to drive innovation forward. When planned and executed properly, metropolitan expansion has the potential to generate new economic centers, infrastructure development and an urban life quality upgrade. The solution

² A Study on the Urban Growth and Dynamics over 16 Major Cities of India, Springer (2024).

³ Everett S. Lee, A Theory of Migration, 3 Demography 47 (1966).

⁴ Geospatial Analysis of Contemporary Urbanisation and Rural–Urban Migration in India, Springer (2023).

⁵ United Nations, World Urbanization Prospects: The 2018 Revision (2019).

⁶ Census of India, Migration Tables (2011); National Sample Survey Office, Migration in India (2020).

⁷ Mohan Lal, Geographical Analysis of Urbanization Patterns in India: Trends, Challenges, and Future Prospects, Baba Mastnath Univ. (2024).

is to strike a balance between opportunity and risk in migration by informing governance and planning. GIS-based studies can be a vital tool in this process as they can provide spatial evidence to support policy making, prioritize areas and track the impact of interventions.⁸

This research paper will therefore be contributing to this conversation by analysing the rural to urban migration and its influence on the expansion of the metropolitan area in a systematic manner using GIS based techniques. The study will be based on selected metros of India and will explore the migration, settlement, and land usage patterns. It will use both primary data (household surveys and interviews) and secondary data (census data, municipal data, satellite imagery) to build a complete spatial analysis. The methodology will involve mapping migration flows, mapping land uses change and performing informal settlements hot-spot analysis. The results should provide insights into how migration has influenced metropolitan growth geographically, the differences between regions in the character of this growth, and policy recommendations for sustainable urban development.

This study is original because of the fact that it focuses on spatial analysis. Several studies have explored the themes of migration and urbanization, but very few used the GIS for visual and spatial analysis of the effect of migration on the expansion of the metropolitan area. This research contributes both to the academic body and to practitioners, the policy makers and urban planners. Combining migration data with spatial analysis provides a comprehensive picture that accounts for the quantitative and qualitative aspects of migration. The study can be applicable to other contexts as well in light of this framework.⁹

To sum up, rural-urban migration is an agent of change that transforms urban landscapes, fuels urban growth and poses challenges and opportunities to the metropolitan regions. To understand this phenomenon, requires an interdisciplinary approach that brings together a combination of demographic analysis with spatial visualization. GIS methodology offers tools to collect the spatial dynamics of migration, map settlement patterns and analyse land use changes. This research paper aims to analyze the effect of rural to urban migration on metros, using GIS-based techniques to aid in the academic study and policy discussion. The study places migration in a spatial perspective, thus highlighting the importance of adopting sustainable metropolitan strategies that address migration and support inclusivity, resilience and environmental sustainability.

Emphasize the importance of rural to urban migration to transform metropolitan spaces.

Migration from rural areas to urban areas has emerged as one of the most salient features of the urbanization process in the modern world, especially in developing nations like India. It is a demographic phenomenon, it is more than that it is something that affects the metropolitan landscape in a very deep manner, it affects spatially and it affects socio-economically. The demand for housing, pressure on infrastructure and informal settlements is formed by migrants in movement from the rural hinterland to the metropolitan centre. These shifts can be seen in megacities like Delhi, Mumbai, Bengaluru and Hyderabad, where urban expansion, fueled by migration, has altered urban geography, governance and social relations. This chapter looks, in theory and in practice, at the impact of rural-urban migration on the face of the metropolis, focusing on the changes in the housing, infrastructure and informal settlements.

Housing Transformation

The most obvious consequence of rural-urban migration is on housing demand. Although the majority of migrants move to metropolitan centres, they frequently do not have the financial means to find formal housing. Consequently, they have no choice but to live in overcrowded housing, or "unauthorized colonies," or in slums. Nearly 17% of urban households in India live in slums and the increase in such slums in Indian megacities has been directly attributed to migration inflows, scholars argue.¹⁰

In peri-urban areas, agricultural land is also being turned into residential colonies that are being built to accommodate the migrant population as a result of the urban expansion. They are sometimes outside of the regular planning process, not legally approved, and lacking in essential services. GIS studies have shown that there is high correlation between

⁸ UN-Habitat, State of the World's Cities Report (2020).

⁹ Id.

¹⁰ Mohan Lal, Geographical Analysis of Urbanization Patterns in India: Trends, Challenges, and Future Prospects, Baba Mastnath Univ. (2024).

peri-urban expansion and migration inflows in cities such as Bengaluru and Delhi as people migrate to the cities for affordable housing, which is at the periphery of the city. This shift in land use is associated with the geographic impact of urbanisation, as the demand for urban housing drives changes in the metropolitan boundary.¹¹

Infrastructure Strain

Urban infrastructure is under tremendous strain as well because of migration. The influx of migrants strains transport systems, water supply, sanitation services and energy services. The large, increase in migrant population in Delhi, for example, has resulted in congestion of public transport and road systems.¹² The situation is not very different for Bengaluru, where the growth due to migration has outgrown the city's transport facilities and led to traffic congestion.

Water sanitation systems are especially impacted. Piped water and sewage systems are usually not available in migrant settlements, which poses a public health risk. The infrastructural deficits in urban India are well reflected in the study by the National Sample Survey Office (2020) that found that almost one third of all migrant households had access to unimproved sanitation facilities. Additionally, migration increases energy demand, with growing populations in metropolitan areas placing increased pressure on the provision of electricity. The governance structures in place are also under strain, particularly for the management of migration related urban growth in the fields of municipal services, including waste management and healthcare.¹³

Informal settlements and urban inequality.

One of the most prominent aspects of migration in the metropolitan landscape is the growth of informal settlements. Those who can't afford to get into the formal housing market may form an unauthorised colony, a slum or a squatter settlement. The characteristics of these informal settlements include poor housing quality, lack of basic services, and insecure housing rights. Informal settlements are a direct consequence of the urbanization in the context of migration, especially in developing countries, as stated in the report State of the World's Cities (2020) by UN-Habitat.¹⁴

Informal settlements also contribute to spatial inequality. Migrants tend to cluster in neglected areas, outside of the mainstream of city planning. These settlements turn into "holding grounds" for surplus labor, due to the mismatch between migration flows and economic absorptive capacity. Governance institutions find it difficult to provide services to informal colonies, which continues to exclude and make people vulnerable. What emerges is a broken-up cityscape, in which migrants occupy marginalized places in the cities.¹⁵

Metropolitan Expansion Dynamics

There are push and pull factors affecting the dynamics of metropolitan expansion. Rural distress and agrarian stagnation push migrants out of rural areas, and urban opportunities pull migrants to metropolitan centers, where they face vulnerability to climate change. This cycle perpetuates ongoing metropolitan growth, resulting in sprawling metropolitan areas. Migrants tend to be positioned in areas close to industrial centres, transport corridors or peri-urban areas, thereby altering the geography of the metropole. GIS-based studies show that there are spatial clusters of migrant communities where economic opportunities exist, suggesting the spatial logic of migration driven expansion.¹⁶

Regional differences are also in evidence. In northern metros such as Delhi and Mumbai, migrants from states with a farming heritage such as Uttar Pradesh and Bihar hail from the region, and in the southern metros like Bengaluru and Hyderabad, there are skilled migrants from all over the nation.¹⁷ Migration takes place in different ways, resulting in different types of metropolitan growth, in which slum expansion is seen in northern cities while peri-urban tech corridors are observed in southern cities.

¹¹ Mohan Lal, Geographical Analysis of Urbanization Patterns in India: Trends, Challenges, and Future Prospects, Baba Mastnath Univ. (2024).

¹² Mohan Lal, Geographical Analysis of Urbanization Patterns in India: Trends, Challenges, and Future Prospects, Baba Mastnath Univ. (2024).

¹³ National Sample Survey Office, Migration in India (2020).

¹⁴ UN-Habitat, State of the World's Cities Report (2020).

¹⁵ Everett S. Lee, A Theory of Migration, 3 Demography 47 (1966).

¹⁶ A Study on the Urban Growth and Dynamics over 16 Major Cities of India, Springer (2024).

¹⁷ Census of India, Migration Tables (2011).

Policy Implications

Migration significantly impacts metropolitan urban landscapes and ultimately has policy implications. Slum proliferation needs to be prevented in the context of housing policies integrating the needs of migrants. There have been some initiatives to tackle the issue like affordable housing schemes like Pradhan Mantri Awas Yojana (PMAY), but they have been less effective due to the lack of coverage for informal migrants.¹⁸ There is also a need for investment in infrastructure to keep up with population growth, as cities will need to increase their transportation, sanitation and energy infrastructure. Ensuring migrant inclusion in urban planning and to lessen inequality and enhance resilience requires inclusive governance.¹⁹

REVIEW OF LITERATURE

The movement of populations from the countryside to the cities has been a subject of considerable scholarly interest in India, because of its impact on the urban landscapes. This field of literature covers a range of fields including economic, social, geographical and urban planning and includes perspectives on different aspects of migration, such as the motivations behind it, the impact and coping mechanisms. This review will draw on important contributions, and will be limited to dwelling, infrastructure and informal settlements as important facets of metropolitan growth.

Theories of migration, like those of Everett Lee (1966) *A Theory of Migration*, treated migration as a process in which push and pull factors influence migration patterns. In India, scholars have always pointed to the economic differences between rural and urban areas as the main motivating factors behind migration.²⁰ People migrate to cities due to wage differentials, unemployment in rural areas and the desire for improved lives, which often leads to informal employment, explains Vanzara Prahalad (2023).²¹ This is consistent with the overall conclusions of the International Growth Centre that highlight the linkages between urbanization, rural development and migration are pivotal for India's structural transformation.²²

Migration literature focuses on housing as a central theme. In metros, migrants encounter a shortage of housing, and in some cases, they are denied access to formal housing markets because it is too expensive. Nearly 17% of the urban households were living in slums as per Census of India (2011) which is directly related to the migration inflows.²³ Migrants pile up in unauthorized colonies or peri-urban areas to take up residence, giving rise to informal settlements. Some scholars like Mohan Lal (2024) suggest that urbanization due to migration has contributed to the expansion of slums in megacities such as Mumbai and Delhi, which has changed the boundaries of the metropolitan area.²⁴ GIS related studies also show that peri-urban land conversion is closely related to migration, and that the agricultural land is converted to residential colonies for migrants.²⁵

Another common thread is infrastructure strain. As migration increases, so do the needs for transport, water, sanitation and energy services, which are often beyond the capacity of the municipalities. Bhagat (2010) points out that the transportation infrastructure in Delhi has been overwhelmed with migration induced growth and that of Bengaluru is inadequate in meeting the population growth.²⁶ Almost one in three migrant households had no access to improved sanitation, highlighting infrastructural gaps in the context of migration (National Sample Survey Office, 2020). The governance institutions are still weak and divided, and have limited capacity to provide services to the growing migrant population, scholars note.²⁷

¹⁸ Ministry of Housing & Urban Affairs, Pradhan Mantri Awas Yojana Guidelines (2015).

¹⁹ UN-Habitat, World Cities Report (2022).

²⁰ Everett S. Lee, *A Theory of Migration*, 3 *Demography* 47 (1966).

²¹ Vanzara Prahalad, *Rural-Urban Migration in India: Socioeconomic Implications and Coping Strategies*, 8 *Int'l J. Soc. Impact* 1 (2023).

²² Vastav Ratra et al., *Urbanisation, Rural Development, and Migration: Evidence Paper*, Int'l Growth Centre (2023).

²³ Census of India, *Slum Tables* (2011).

²⁴ Mohan Lal, *Geographical Analysis of Urbanization Patterns in India: Trends, Challenges, and Future Prospects*, Baba Mastnath Univ. (2024).

²⁵ *Geospatial Analysis of Contemporary Urbanisation and Rural–Urban Migration in India*, Springer (2023).

²⁶ R.B. Bhagat, *Urban Migration and Metropolitan Growth in India*, 45 *Econ. & Pol. Weekly* 19 (2010).

²⁷ National Sample Survey Office, *Migration in India* (2020).

Informal settlements are highly mentioned in migration literature as both outcomes and places of resilience. UN-Habitat (2020) places informal settlements among the direct impacts of the migration-related urbanisation, especially in developing countries.²⁸ They are indicative of the failure of the housing market, land tenure insecurity and a lack of formal planning involvement. A new study on slums in India points out that population growth, migration and governance deficits are all contributing factors to the creation of slums.²⁹ Informal networks, remittances, and involvement in the informal economy are the ways in which migrants cope with exclusion, as described by Prahalad (2023). These coping mechanisms help people survive but also help to sustain vulnerability and inequality.

Another theme in the literature that stands out is the variation in the growth of metros due to migration across the regions. Slums are growing in the northern cities of India, including Delhi and Mumbai, where migrants come from the agrarian states of Uttar Pradesh and Bihar. However, other metros, such as the Southern metros like Bengaluru and Hyderabad, attract skilled migrants and so there are peri-urban tech corridors and no slums. This regional difference highlights the need to have a differentiated policy response.³⁰

The importance of inclusive housing schemes, infrastructure investments and changes to governance structures are stressed in policy-oriented literature. The Pradhan Mantri Awas Yojana (PMAY) has tried to solve the housing problem, but researchers state that this omission of informal migrants affects it.³¹ A combination of urban policies is needed to balance opportunities and challenges and make migration work as a driver of sustainable metropolitan development. International Growth Centre advocates for policy solutions based on evidence to create affordable housing, inclusive services and decent living for migrants.

DATA ANALYSIS AND INTERPRETATION

1. Migration Trends in Selected Cities

- Delhi NCR: Census 2011 shows Delhi received over 2.2 million migrants between 2001–2011, primarily from Uttar Pradesh and Bihar. Migrants accounted for nearly 40% of Delhi's population growth in that decade. Housing demand surged, leading to unauthorized colonies and slum clusters.³²
- Mumbai: NSSO data highlights Mumbai as India's largest migrant-receiving city, with inflows from rural Maharashtra, Gujarat, and northern states. Migrants contributed to the expansion of Dharavi and other informal settlements, where density exceeds 270,000 persons per sq km.
- Bengaluru: Migration here is more skill-oriented, with inflows from across India for IT and service jobs. Yet peri-urban expansion around Whitefield and Electronic City shows how migrant housing demand converts agricultural land into informal layouts.
- Hyderabad: Migrants from Telangana's rural districts and neighboring states have fueled rapid expansion in peri-urban zones like Gachibowli. Census data shows nearly 35% of Hyderabad's growth between 2001–2011 was migration-driven.

2. Housing Impacts³³

- Slum proliferation: Census 2011 recorded 13.7 million slum households nationwide, concentrated in Delhi, Mumbai, and Hyderabad. Migrants unable to access formal housing markets are the primary occupants.
- Unauthorized colonies: Delhi's Master Plan notes over 1,700 unauthorized colonies, largely populated by migrants, lacking tenure and services.

²⁸ UN-Habitat, State of the World's Cities Report (2020).

²⁹ Why Informal Settlements Form: Causes and Urbanization Factors (2024).

³⁰ Census of India, Migration Tables (2011).

³¹ Ministry of Housing & Urban Affairs, Pradhan Mantri Awas Yojana Guidelines (2015).

³² Sabyasachi Tripathi & Hardeep Kaur, Migration and Urbanization in India: An Empirical Study, MPRA Paper No. 76484 (2017).

³³ Census of India, Migration Tables (2011).

- Peri-urban expansion: GIS-based studies show agricultural land around Bengaluru and Hyderabad converted into informal housing layouts, reflecting migration-driven demand.

3. Infrastructure Strain³⁴

- Transport: Delhi Metro ridership surged beyond projections due to migrant commuters. Mumbai's suburban rail carries 7.5 million passengers daily, many of them migrants.
- Water & sanitation: NSSO 2020 found 30% of migrant households lacked improved sanitation, with slum clusters in Mumbai and Delhi most affected.
- Energy demand: Migrant settlements often rely on illegal electricity connections, straining grids in Delhi and Hyderabad.

4. Informal Settlements

- Dharavi (Mumbai): Largest informal settlement, shaped by migrant inflows from rural Maharashtra and Tamil Nadu. Migrants sustain informal industries but face precarious housing.
- Delhi slum clusters: Migrants from Bihar and UP dominate clusters along Yamuna floodplains, lacking tenure security and vulnerable to eviction.
- Hyderabad peri-urban zones: Migrants settle in informal layouts around IT corridors, creating fragmented urban landscapes.

5. Comparative Insights

City	Migrant Share of Growth	Housing Impact	Infrastructure Strain	Informal Settlement Pattern
Delhi NCR	~40% (2001–2011)	Unauthorized colonies, slums	Metro congestion, water shortages	Floodplain clusters
Mumbai	Largest inflows nationally	Slum proliferation (Dharavi)	Rail overcrowding, sanitation deficits	Dense slum industries
Bengaluru	Skilled migrants dominate	Peri-urban layouts	Traffic gridlock, water scarcity	Informal peri-urban housing
Hyderabad	~35% growth migration-driven	Peri-urban expansion	Energy demand, sanitation gaps	Informal layouts near IT hubs

6. Policy Implications

- Housing: Affordable housing schemes (PMAY) exclude many migrants due to documentation gaps.
- Infrastructure: Migrant-heavy corridors require expanded transport and sanitation systems.
- Governance: Municipal fragmentation hampers integration of migrants into planning frameworks.

CONCLUSION

Migration has become one of the most strong drivers of the modern Indian metropolitan's growth path, with rural-to-urban migration proving to be one of them. This research has shown that migration is a spatial and socio-economic phenomenon and that it is not just a demographic event, but it is a process that is reshaping the very fabric of the metropolitan region. A comparative study of selected cities, Delhi, Mumbai, Bengaluru, and Hyderabad, reveals that migration has contributed to the rapid urbanization, transformation of housing markets, congestion of infrastructure, and

³⁴ Jitendra Bisht, India's Urban Transition: Identifying the Contours of Migration, SPRF Issue Brief (2020).

the growth of slums. GIS-based analysis has also shed light on the spatial aspects of this change, showing patterns of clustering and peri-urban expansion and land use change that are not necessarily captured in conventional demographic analyses.

The results highlight the challenge and opportunity of migration-induced metropolitan expansion. On the other hand, migrants bring economic benefits to urban economies through source areas by contributing to the economy, industry, and cultural diversity. They are part and parcel of the operational mechanism of metropolises, in building, production, services, and in the informal economies. However, the volume of migration inflows to the city is sometimes too high for the absorptive capacity of the city, resulting in housing shortages, congestion and environmental stress. Migrants are overrepresented in slums, unauthorised colonies and peri-urban layouts in which they have precarious living conditions, insecure tenures and constrained access to basic services. This duality underscores the importance of policies that are balanced, taking into account migrants as agents of urban growth and the vulnerabilities migrants face.

Home becomes the most obvious aspect of metropolitan remodeling. The failure of migrants to secure places in the formal housing market forces them to live in slums or unregistered colonies, the latter of which are widespread in the metropolitan areas. These settlements not only offer shelter but also continue the trend of inequality and exclusion. The peri-urban expansion also shows how migration drives land use change, with farmland being developed into residential layouts to provide housing. This growth may take place in an unplanned way, leading to a disjointed urban fabric that poses governance and sustainability issues. A key challenge for the 'housing' is to develop policies that are inclusive, welcoming migrants to affordable housing programs, and acknowledging migrants' contribution to the metropolitan economies.

Another seemingly obvious result of migration-driven growth is infrastructure strain. Migrant-heavy cities are overloaded on transport systems and water supply, sanitation and energy services. The metro system of Delhi and the suburban railway in Mumbai are examples of how migration inflows create demand which is far greater than forecasted. In addition to this, water scarcity, sanitation issues, and the need for energy put further pressure on infrastructure when it comes to migration. The challenges highlight the need to invest in resilient infrastructure that will be able to meet the needs of a growing population and ensure that services are equitably provided. If not, the growth of the metropolitan area may be unsustainable and unfair.

Informal settlements are the most complicated aspect of the effect of migration on metropolitan landscapes. They are a force of resilience and a force of exclusion: livelihoods, networks, communities are developed under the most precarious circumstances. The informal settlement in Dharavi, Mumbai and the informal settlements around the floodplains of the Yamuna in Delhi are examples of how migration can change the shape of the metropolitan, producing marginalized, dense and informal spaces at the periphery of the city. These communities not only preserve informal economies and offer low-cost housing but also foster vulnerability and inequality. The informal settlements problem demands a balance between regularisation and service provision, while also having to integrate the informal settlements into formal planning processes, in order to address the challenges faced by the informal settlements.

The migration-driven growth of the selected cities is found to differ across the regions. Migrants from agrarian states arrive in the metros in the north such as Delhi and Mumbai leading to fast population growth of slums and unauthorised colonies. For example, peri-urban growth is seen around industrial and IT corridors in southern metros like Bengaluru and Hyderabad which attract skilled migrants. These differences suggest that the policy response must be differentiated to respond to the different dynamics of migration in each metropolitan context. A universal solution is not likely to work, and policies should be designed to address the specific challenges and opportunities that exist in each specific city.

The GIS-based approach used in this study has been very useful in the documentation of the spatial aspects of migration-based metropolitan growth. GIS is used to combine the demographic data with spatial analysis and provide insights about patterns of clustering, land use change, and peri-urban growth, which are vital for policy-making processes. Migration is a process that is reflected in the changing face of the metropolitan region and can be seen as cartographic evidence, which can be used to inform housing policy, infrastructure investment and governance reform. The article is a methodological contribution highlighting the need for spatially-oriented methods in migration and urban research.

Ultimately, rural-to-urban migration can change the face of the metro area in significant ways. It drives urban sprawl, transforms living space, puts pressure on infrastructure, and promotes informal settlements. The influx of migrants is

beneficial for urban economic and cultural vibrancy, but this clustering in precarious places reinforces the need for city policies that are inclusive and spatially aware. The results of this research suggest that inclusion in housing schemes, resilience of infrastructure and informal settlement challenges through governance reforms are all important issues to consider when integrating migrants. This research puts migration into a spatial and demographic perspective, therefore, helping to better understand the process of metropolitan expansion and highlighting the importance of sustainable urban strategies that will ensure growth and equity. In conclusion, the challenge of managing the expansion of migration and ensuring the inclusiveness, resilience, and sustainability of cities in the era of demographic change are central to the future of Indian metros.