

Impact of Urbanization on Demographic Shift and Growth Rate in a Holy City: A Case of Varanasi Municipal Corporation Area, India

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Abstract

Urban demographic transformation is one of the principal forces influencing spatial development, infrastructure demand, and socio-economic restructuring in rapidly urbanizing regions. In India, demographic changes occurring since the beginning of the twenty-first century have been accompanied by accelerated economic liberalization, improvements in transportation infrastructure, expansion of higher educational institutions, and increasing migration towards medium and large cities. These processes have significantly altered the demographic composition of historic cities, many of which are simultaneously attempting to preserve their cultural identity while accommodating rapid urban growth. Varanasi, located along the banks of the River Ganga in eastern Uttar Pradesh, represents one of India's most significant cultural and religious centres. The demographic dynamics of the holy city, have been increasingly reflected broader national urbanization trends while also exhibiting distinctive characteristics arising from its religious economy, heritage landscape, and expanding metropolitan influence. Improvements in transportation networks, expansion of educational institutions, growth of tourism related activities, and diversification of employment opportunities have collectively contributed to sustained population growth and increasing urban expansion. The rapid demographic change has also intensified pressure on housing, infrastructure, mobility, environmental resources, and heritage conservation. The paper argues that future planning strategies for Varanasi should integrate demographic forecasting with the present-day study and assessment of urban growth and trends keeping in consideration the past decades dataset of demographic variables and the impact of that in urban area within the municipal limit of Varanasi Municipal Corporation. The paper further examines the demographical pattern with regard to the geographical footprints of 90 wards of the urban area under the municipal limit from the dataset of Census 2011 respectively.

Key Words - Demographic Shift, Urban Growth, Urbanisation and Demographic Variables.

I. INTRODUCTION

Urbanization has emerged as one of the most influential drivers of demographic transformation in the twenty-first century, reshaping the spatial, economic, and social structure of cities across the developing world. In India, rapid urban growth has significantly altered settlement patterns, population distribution, workforce composition, and infrastructure demand, particularly in cities possessing historical and cultural significance. Unlike newly developed urban centres, heritage cities experience a dual challenge of accommodating increasing population pressures while preserving their cultural identity and historic urban fabric. Consequently, understanding the spatial dynamics of demographic change has become essential for developing sustainable and evidence-based urban planning strategies. Varanasi, one of the world's oldest continuously inhabited cities and an important religious, cultural, and tourism centre, represents a unique example of this urban transition. The expansion of municipal boundaries, increasing migration, changing occupational structures, and uneven distribution of urban services have collectively contributed to substantial demographic variations across its municipal wards. While the historic core situated along the River Ganga continues to exhibit high population concentration and intense land-use pressure, peripheral wards have experienced comparatively higher rates of population growth due to outward urban expansion. These contrasting development patterns have generated significant spatial disparities in population density, literacy, workforce participation, sex ratio, and demographic growth, all of which influence the city's future planning priorities. By integrating demographic statistics with spatial analysis, the research contributes to a more nuanced understanding of urban growth in heritage cities and provides an empirical foundation for culturally sensitive, inclusive, and sustainable urban development policies. The findings are intended to support planners and policymakers in formulating ward-specific strategies that balance population growth, infrastructure provision, and conservation of Varanasi's unique cultural landscape while promoting long-term urban resilience. The planning interventions at local area level of an urban area or fringe as articulated by (Mukhopadhyay & Chatterjee, 2026b) emphasizes on redevelopment strategies and envisioned F.A.R. incentivization as a proposal, but for an urban area intervention as a whole under the governance of a local government needs an initiation on understanding of demographic shifts and patterns which becomes a basis for policy framework with regard to urban development visions in the future drafts of Master Plans. Thus Local Area Plan and its impact (Mukhopadhyay & Chatterjee, 2026) as specified needs a clear distinction when the planning guidelines gets deciphered at urban and regional scale, thereby the primary data collection in cohorts as articulated by (Ghia & Mukhopadhyay, 2024) and (Reddy & Mukhopadhyay, 2024) gets substituted with secondary data from DCHB (District Census Handbook) and Census 2011 in the methodological approach and for the examination of demographic shift and growth rate study, dealt in this research for the urban area under Varanasi Municipal Corporation comprising of 90 administrative wards.

II. LITERATURE REVIEW

The search strategy adopted for the literature review of the concerned research, dealt with the implications of the urban growth and its correlation with the respective demographic variables in the limit of an urban area. The keywords, for searching literature, in the search engine / database notified with Scopus / Web of Science / UGC and other allied, has been used extensively with a given timeline of last 50 years, given the nature of the research are, “URBAN GROWTH RATE” AND “DEMOGRAPHIC SHIFT” OR “DEMOGRAPHIC STUDY” AND “URBANISATION” OR “IMPACT OF URBANISATION” OR “ENABLERS OF URBANIZATION”.

(Kumar et al., 2023) provide a significant contribution to the understanding of multidimensional urban poverty by examining the spatial distribution and determinants of deprivation across slums in Varanasi. Using a Multidimensional Poverty Index (MPI) based on primary household surveys, the authors establish that socio-religious affiliation, occupation, and geographical location are the principal correlates of multidimensional poverty, highlighting considerable spatial inequalities within the city. Their findings underscore that slum households located in the middle geographical zone, particularly Muslim migrant communities engaged in informal occupations, experience the highest levels of deprivation, thereby emphasizing the importance of socio-spatial differentiation in urban poverty analysis. Despite these important contributions, the study presents several research gaps that warrant further investigation. First, the analysis is confined exclusively to slum settlements, thereby limiting its applicability to the broader demographic and socio-economic transformations occurring across the entire urban agglomeration of Varanasi. The research primarily investigates poverty as a multidimensional phenomenon without adequately examining how demographic processes—including population growth, migration, fertility transition, household composition, age structure, literacy, and workforce characteristics—have influenced the city's spatial development since the early 2000s. Moreover, the study adopts a cross-sectional research design based on primary survey data, which restricts the assessment of temporal demographic changes and long-term urban transformation.

(Chetty, 2024) presents a comprehensive assessment of urban growth dynamics across eighty-eight mid-sized Indian cities by integrating decadal urban expansion rates (UER), population growth rates (PR), and the population-to-urban expansion (PU) ratio derived from Census of India data. The study effectively identifies cities exhibiting compact growth and urban sprawl while emphasizing the influence of economic growth, government policies, infrastructure development, and migration on urban expansion. However, despite its broad national perspective, the study provides only a macro-level comparison and does not investigate the city-specific demographic transformations that underpin urban growth. Although Varanasi is included among the selected cities, its demographic characteristics, migration patterns, age composition, literacy transition, workforce structure, and household dynamics are not examined in detail. Furthermore, the reliance on municipal boundary expansion and decadal census indicators limits the understanding of intra-city spatial variations and neighbourhood-level demographic changes. The study also gives limited attention to the interaction between demographic transitions, land-use change, and urban planning interventions in heritage cities. (Shukla et al., 2018) provide a comprehensive assessment of the interrelationship between population growth, land use and land cover (LULC) transformations, and water quality across the Upper Ganga River Basin using remote sensing, GIS, and statistical modelling. The study successfully demonstrates that increasing population and rapid urbanization have significantly contributed to the expansion of built-up areas and the deterioration of water quality within the basin. However, the analysis is conducted at a macro river basin and district scale, limiting the understanding of city-specific demographic transitions and their spatial implications. Although Varanasi is identified as one of the most densely populated districts experiencing rapid urban growth, the study does not examine demographic attributes such as migration, age composition, literacy, workforce participation, household characteristics, or intra-city population distribution. Furthermore, the research primarily emphasizes environmental consequences of population growth while giving limited attention to the implications of demographic transformation for urban planning, infrastructure provision, and sustainable city development. Future studies should integrate detailed demographic analysis with geospatial and planning approaches to better understand the evolving urban dynamics of Varanasi and support evidence-based planning interventions.

(Bhatta, 2009) presents a robust methodological framework for analysing urban growth patterns by integrating remote sensing, GIS, demographic indicators, and statistical models to evaluate urban sprawl in Kolkata. The study demonstrates that built-up area expansion can continue despite declining population growth rates, highlighting the complex relationship between demographic change and urban spatial development. Furthermore, the incorporation of variables such as household count, workforce participation, and Shannon's entropy provides a comprehensive understanding of urban growth dynamics and offers valuable planning insights. However, the study is primarily methodological and centred on Kolkata, limiting its applicability to heritage cities with distinct socio-cultural and demographic characteristics such as Varanasi. Although demographic variables are considered as determinants of urban growth, the analysis does not explicitly examine migration patterns, age structure, literacy transitions, household composition, or socio-economic disparities that shape demographic transformation over time. Moreover, the research focuses predominantly on the physical dimensions of urban expansion, with limited discussion on how demographic changes influence infrastructure demand, service provision, heritage conservation, and sustainable urban planning. Future research should adopt a city-specific and longitudinal approach by integrating demographic transition analysis with geospatial techniques and planning indicators to comprehensively assess the evolving demographic patterns and their implications for sustainable urban development in Varanasi. (Chadchan & Shankar, 2012) present a comprehensive review of urbanization trends and sustainable urban development in India by examining the impacts of post-liberalization economic reforms on land use, housing, transportation, infrastructure, and metropolitan growth. The study effectively highlights how dispersed urban expansion, low-density development, housing shortages, loss of agricultural land, and inadequate transport systems have emerged as major challenges to sustainable urbanization. It further proposes planning approaches such as compact city development, transit-oriented development (TOD), smart growth, and inclusive urban design to mitigate these issues. However, despite providing a valuable national-level perspective, the study exhibits several limitations with respect to city-specific demographic analysis. The discussion primarily focuses on metropolitan cities and generalized urban growth trends, without investigating the demographic transitions of individual heritage cities such as Varanasi. Although urban population growth and migration are recognized as key drivers of urban expansion, the study does not explicitly examine demographic attributes including age structure, literacy transition, household composition, workforce participation, or migration characteristics that shape urban transformation. Furthermore, the projections are largely based

on macro-level population estimates and land consumption scenarios, limiting the understanding of intra-city demographic variations and neighbourhood-level spatial dynamics.

(Bekturganova et al., 2022) provides valuable empirical evidence on the relationship between demographic transition factors and demographic dividend indicators by examining the influence of fertility, mortality, working-age population, and labour force participation through correlation and regression analyses. The findings indicate that urban fertility rates and rural mortality significantly influence the working-age population, while the rural male working-age population contributes positively to labour force growth. The authors further emphasize the importance of demographic policies in harnessing demographic dividends and improving economic development. Despite these contributions, several research gaps remain. The study is confined to the national context of Kazakhstan and therefore offers limited applicability to rapidly urbanizing Indian heritage cities such as Varanasi. Although demographic variables are analysed, the research primarily focuses on their relationship with labour force outcomes and economic growth, without examining their implications for urban spatial expansion, migration patterns, household characteristics, literacy transition, or intra-city demographic variations. (Yakubenko, 2020) investigates the relationship between public goods provision, population concentration, and the growth of primate cities using panel data from 88 countries between 1991 and 2014. The study demonstrates that improved access to public goods, particularly water and sanitation, significantly reduces disproportionate population concentration in primate cities, while inadequate infrastructure intensifies migration and reinforces urban primacy. Furthermore, the findings reveal that excessive growth of primate cities often occurs at the expense of smaller urban centres, thereby widening regional disparities and slowing hinterland development. Despite its significant theoretical and empirical contributions, the study exhibits several research gaps. The analysis is conducted at a cross-country level, emphasizing national urban systems rather than city-specific demographic transitions. Consequently, it does not explore how demographic attributes such as migration patterns, age structure, literacy, workforce composition, household characteristics, and population density influence the spatial evolution of individual heritage cities like Varanasi. Moreover, although the study acknowledges the role of public infrastructure in shaping migration and urban concentration, it provides limited insights into the interaction between demographic change, land-use transformation, and local urban planning policies. Future research should therefore adopt a city-level, longitudinal approach integrating demographic indicators, geospatial analysis, and planning frameworks to comprehensively examine demographic shifts and their implications for sustainable urban development in Varanasi.

(Wang et al., 2020) examine the determinants of high-tech talent migration and industrial development in the Yangtze River Delta Urban Agglomeration (YRDU) using a dynamic system Generalized Method of Moments (sys-GMM) model. The study demonstrates that the expansion of high-tech manufacturing industries, foreign direct investment, and talent incentive policies significantly influence the attraction and retention of skilled labour, whereas traditional macroeconomic indicators such as GDP per capita and population density exhibit relatively weaker effects on migration decisions. The authors further highlight the importance of higher education institutions in attracting talent while noting the limited influence of healthcare, ICT infrastructure, and green spaces on migration behaviour. Despite these significant contributions, the study presents several research gaps. Its analysis is confined to the Yangtze River Delta and primarily focuses on high-skilled migration associated with advanced manufacturing, thereby limiting its applicability to culturally significant and service-oriented heritage cities such as Varanasi. Although demographic variables such as population density are incorporated, broader demographic dimensions, including age structure, household composition, literacy transition, socio-economic characteristics, and overall population dynamics remain unexplored. (Castells-quintana et al., 2020) articulated a comprehensive theoretical and empirical investigation into the phenomenon of "urbanisation without growth," demonstrating that rapid population growth, rural-urban migration, and inadequate investment in urban infrastructure can lead to urban expansion without corresponding economic development. Through cross-country analysis, a dynamic theoretical model, and regional evidence from Tanzania, the authors establish that high fertility, migration pressures, and insufficient urban capital contribute to declining productivity and the emergence of poorly serviced megacities. Its analysis is primarily centred on Sub-Saharan African countries, thereby limiting its applicability to rapidly urbanizing heritage cities in developing economies such as Varanasi. Although the study highlights population dynamics and migration as key determinants of urbanisation, it does not investigate city-specific demographic attributes including age structure, literacy transition, household composition, workforce characteristics, and intra-urban demographic redistribution. Furthermore, the authors acknowledge the need for future research to examine endogenous fertility, migration behaviour, differential birth and death rates, and other contextual factors such as urban planning, institutional development, and infrastructure investment that shape urban growth trajectories. These limitations indicate the necessity for city-level, longitudinal research integrating demographic indicators with geospatial and planning analyses to better understand demographic shifts and their implications for sustainable urban development in Varanasi.

(Geyer et al., 2013) critically examine the interrelationships between migration, urban marginality, and informality in African cities, arguing that rapid rural-urban migration, increasing urban primacy, and the expansion of the informal sector have contributed to socio-economic disparities and unsustainable urban growth. The authors emphasize that excessive concentration of population in major urban centres, coupled with inadequate investment in lower-order towns and rural economies, intensifies unemployment, informality, and spatial inequalities. They advocate strengthening intermediate cities, formalizing informal enterprises, and promoting balanced regional development as essential strategies for achieving sustainable urban systems. Although migration and urban concentration are identified as key drivers of urban transformation, the study does not explicitly investigate demographic characteristics such as age structure, literacy transition, household composition, workforce participation, or population density at the city level. Furthermore, the research provides limited empirical assessment of the interaction between demographic change, land-use transformation, infrastructure provision, and urban planning interventions. (Cohen, 2006) provides a comprehensive review of global urbanization trends, highlighting the demographic transformation of cities in developing countries and emphasizing the implications of rapid urban growth for sustainable development. The author identifies rural-urban migration, natural population increase, urban boundary expansion, and settlement reclassification as the principal drivers of urbanization, while stressing the increasing concentration of population in small and medium-sized cities. Cohen further argues that inadequate urban governance, insufficient infrastructure, unreliable demographic data, and weak urban population projections significantly constrain effective urban planning and policy formulation. The analysis is conducted at a global and regional scale, relying predominantly on United Nations urbanization datasets, thereby providing limited insights into the demographic transitions of individual cities. Although the study acknowledges the importance of migration, population growth, and urban expansion, it does not investigate city-specific demographic characteristics such as age structure, literacy transition, household composition, workforce participation, or neighbourhood-level spatial variations. Furthermore, the author highlights the absence of standardized

definitions of urban areas, inconsistencies in demographic data, and uncertainties in urban population projections, which hinder accurate assessment of urban dynamics.

(Cohen, 2004) critically examines the nature and trajectory of urban growth in developing countries by synthesizing global demographic trends, urbanization patterns, and the influence of globalization on city development. The author argues that urban growth is increasingly driven by a combination of natural population increase, rural–urban migration, annexation of peripheral settlements, and economic restructuring, while emphasizing the growing significance of small and intermediate cities alongside metropolitan centres. Cohen further highlights the challenges posed by inadequate urban infrastructure, unreliable demographic data, weak governance, and rapid urban expansion in developing countries. Although the author identifies migration, natural increase, and urban expansion as the principal drivers of urban growth, the analysis does not explicitly investigate demographic characteristics such as age structure, household composition, literacy transition, workforce participation, and neighbourhood-level population distribution. Furthermore, the paper acknowledges the limitations of inconsistent urban definitions, outdated census data, and under-enumeration of urban populations, which constrain accurate demographic assessment and urban forecasting. It also provides limited discussion on how demographic transitions interact with land-use change, heritage conservation, and local planning interventions in rapidly growing heritage cities. (Reeitsu, 1996.) presents a comparative analysis of urbanization patterns in developing countries by examining the relationship between economic growth, industrialization, and urban expansion. The author argues that urbanization follows diverse trajectories across regions, highlighting phenomena such as hyper-urbanization, urbanization without industrialization, and the growing importance of intermediate cities. The study further emphasizes that globalization, industrial restructuring, and regional economic integration have reshaped urban systems, while demographic transition, declining fertility, and changing age structures significantly influence future urban growth. The analysis is primarily macro-comparative, focusing on national and regional urbanization trends rather than city-specific demographic transformations. Although the author discusses demographic transition and urban growth, the research does not examine localized demographic characteristics such as migration streams, household composition, literacy transition, workforce participation, or intra-urban population distribution. Furthermore, the paper offers limited empirical evidence on how demographic changes interact with land-use transformation, infrastructure provision, governance, and planning interventions in individual heritage cities

III. METHODOLOGY

This study adopts a quantitative, descriptive, and spatial analytical research methodology to examine the impact of urbanization on demographic shifts and urban growth in Varanasi, India, with particular emphasis on the period between Census 2001 and Census 2011. The methodological framework is designed to investigate how changes in demographic characteristics have corresponded with the city's urban expansion, thereby providing empirical evidence for understanding the interrelationship between demographic transition and urbanization. Given that demographic change constitutes one of the fundamental determinants of urban transformation, the study integrates demographic indicators with spatial analysis to evaluate the evolving urban structure of Varanasi and its implications for sustainable urban planning. The study is primarily based on secondary data collected from authentic government sources, including the Census of India 2011, District Census Handbooks, Primary Census Abstracts, and few administrative records taken as a primary data. These datasets provide comprehensive demographic information at the city and ward levels, enabling a systematic comparison of demographic changes over the decadal period. To complement the demographic datasets, spatial information derived from Geographic Information Systems (GIS), satellite imagery, and administrative boundary maps is incorporated to examine the spatial distribution of population and urban expansion across Varanasi. The integration of demographic statistics with GIS facilitates the visualization of demographic variations and enables the identification of spatial patterns associated with urban growth. To capture these dynamics, the study considers a set of key demographic variables that collectively reflect the demographic profile of Varanasi. These include total population, population density, decadal population growth rate, sex ratio, child sex ratio, overall literacy rate, main workers, and marginal workers. These indicators have been selected because they represent both the quantitative and qualitative dimensions of demographic transition. Total population and population density indicate the magnitude and spatial concentration of urban growth, while the decadal growth rate reflects the pace of demographic expansion. Sex ratio and child sex ratio provide insights into gender balance and demographic sustainability, whereas literacy serves as an indicator of human capital development and socio-economic progress. Similarly, the distribution of main and marginal workers reflects changes in labour force participation and economic restructuring accompanying urbanization.

The present study employs a GIS-based spatial analytical approach to examine the demographic characteristics of the 90 municipal wards of Varanasi Municipal Corporation (VMC) using Census of India 2011 data. The maps prepared in GIS (ESRI ArcGIS) provide a spatial representation of key demographic variables, namely total population, population density, sex ratio, child sex ratio, male-female population composition, literacy rate, main workers, and marginal workers. The integration of demographic datasets with ward-level GIS mapping enables the identification of spatial heterogeneity, demographic concentration, and socio-economic disparities within the municipal area. Such an approach facilitates a comprehensive understanding of the relationship between demographic transformation and the process of urbanization, thereby providing an empirical basis for sustainable urban planning and policy formulation.

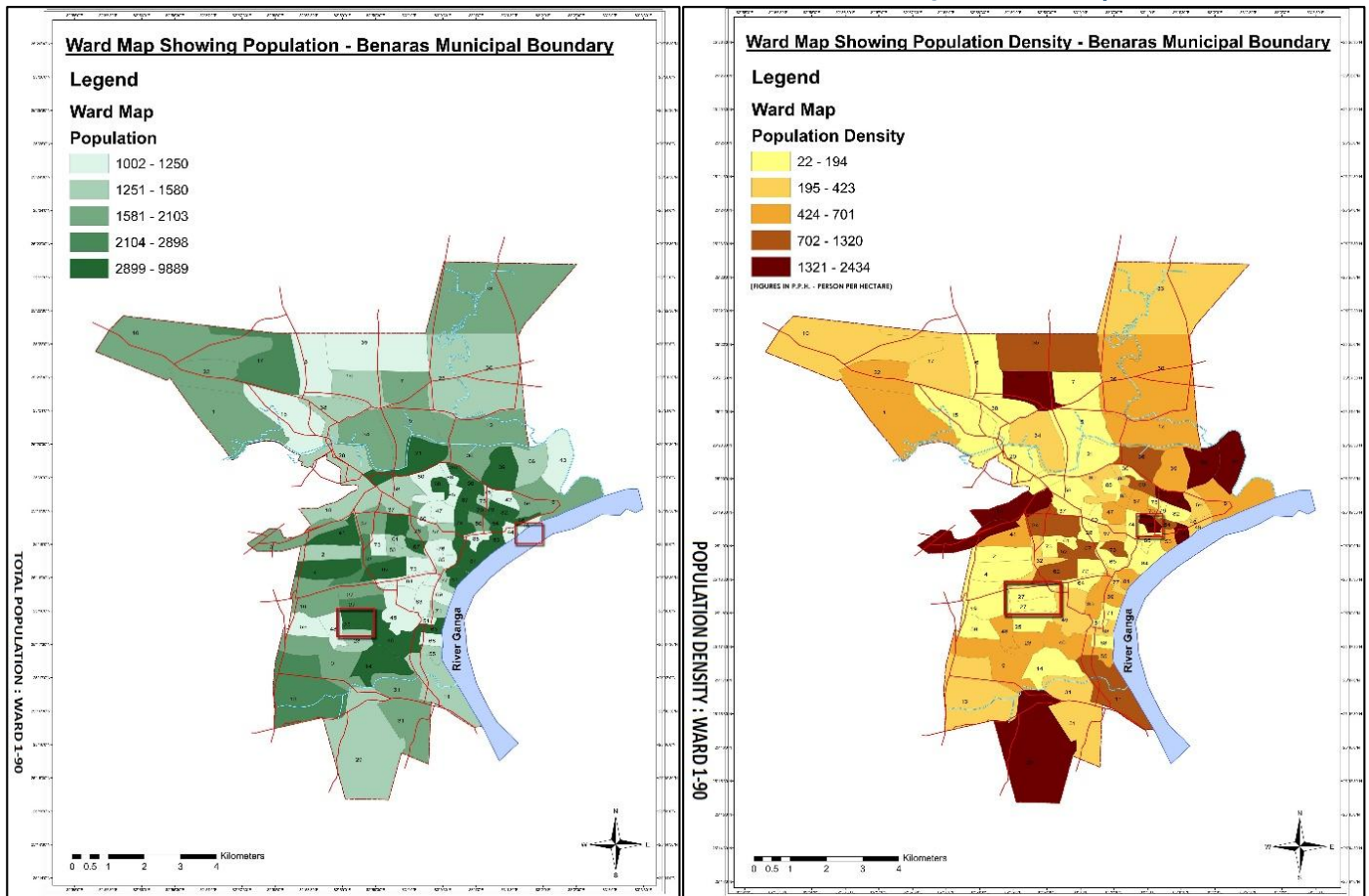


Fig. 1 – GIS Maps Showing Total Population and Population Density for 90 Wards, Varanasi Municipal Corporation (Source: Author)

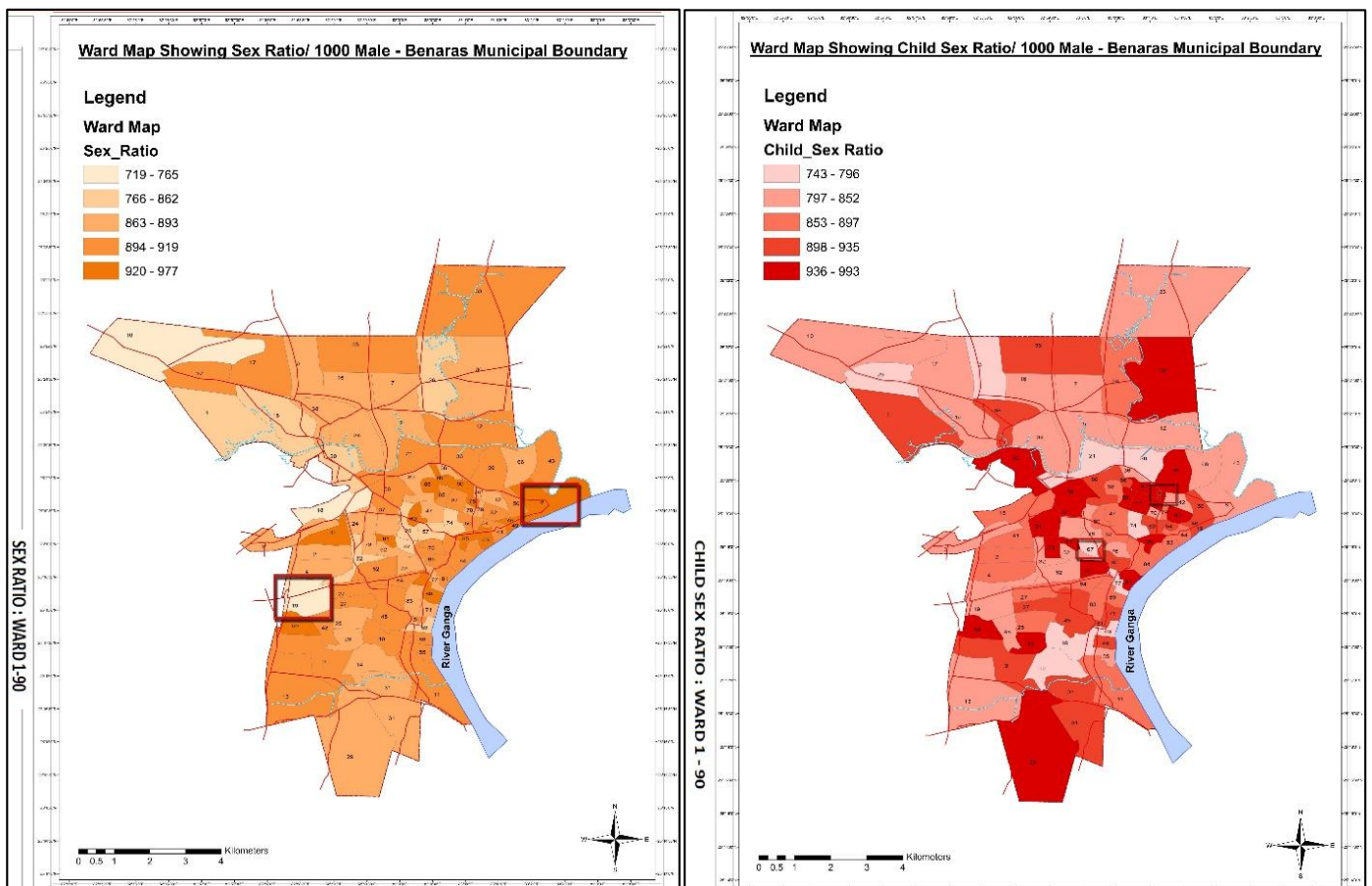


Fig. 2 – GIS Maps Showing Sex Ratio and Child Sex Ratio for 90 Wards, Varanasi Municipal Corporation Area (Source: Author)

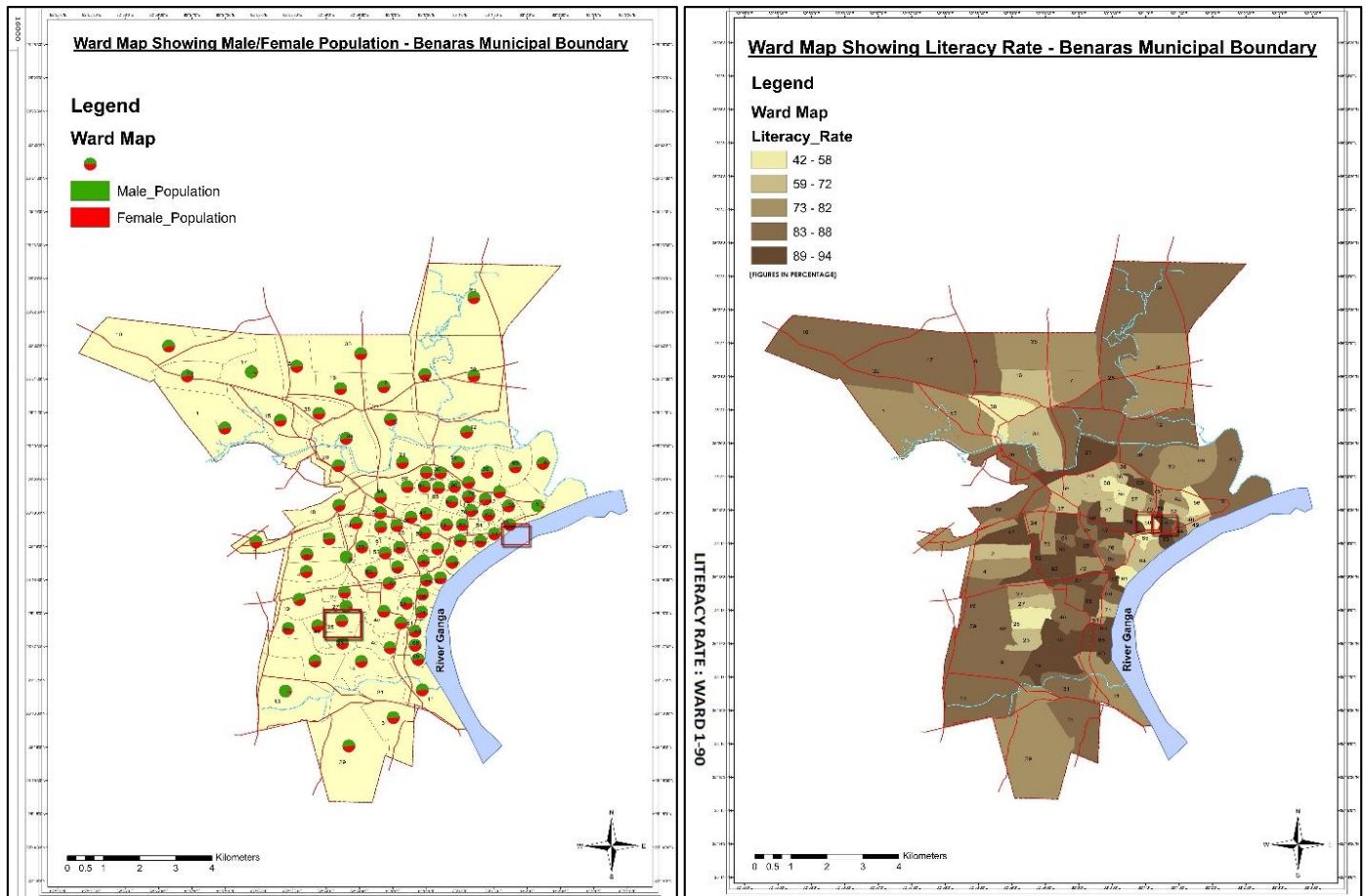


Fig. 3 – GIS Maps Showing Male Female Population and Literacy Rate for 90 Wards, Varanasi Municipal Corporation Area (Source: Author)

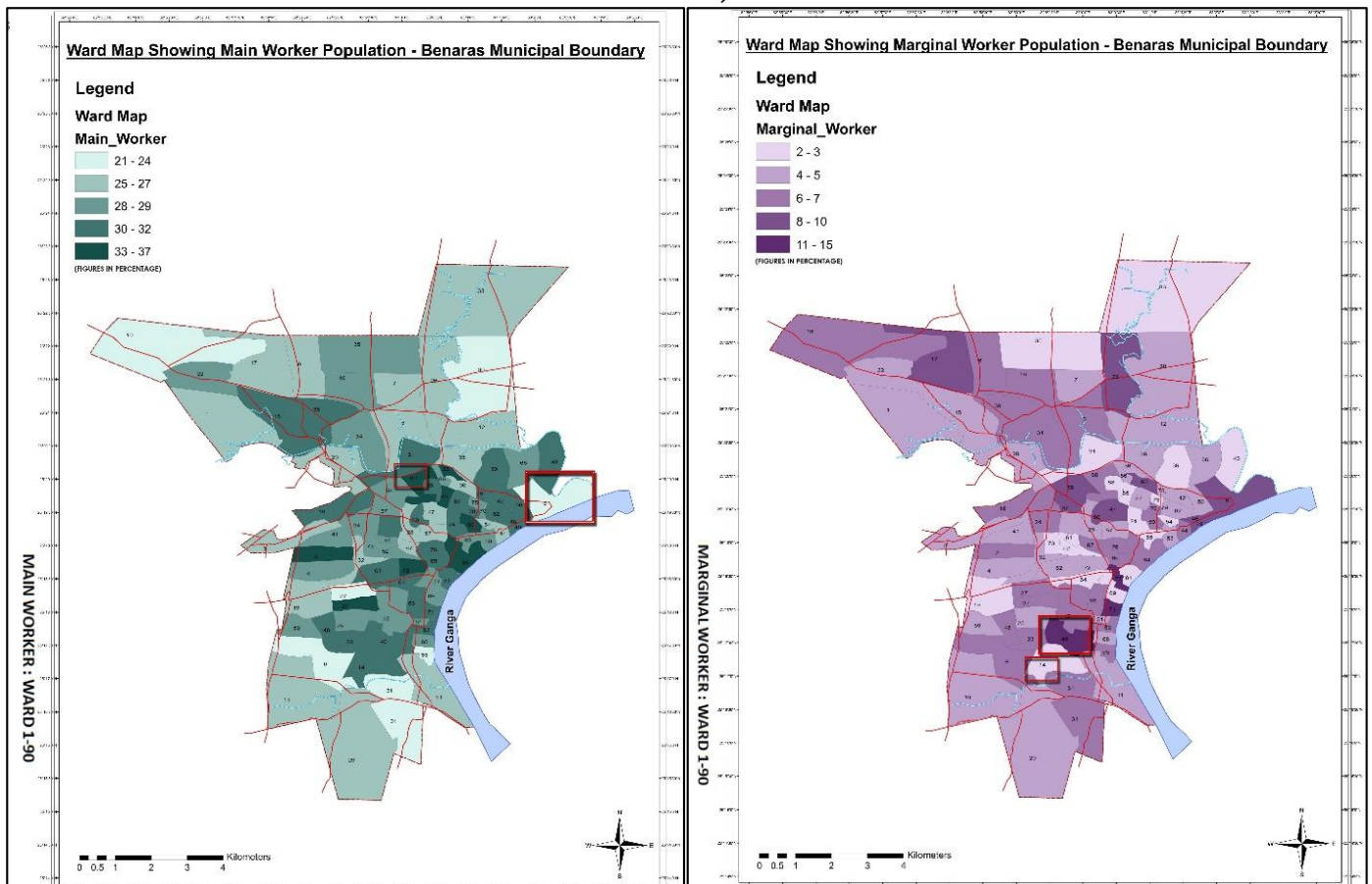


Fig. 4 – GIS Maps Showing Main Workers and Marginal Workers Population for 90 Wards, Varanasi Municipal Corporation Area (Source: Author)

Total Population and Population Density

The spatial distribution of total population indicates considerable variation among the municipal wards. The GIS map reveals that the highest population concentration is observed in Ward 39, followed by several centrally located wards such as 36, 41, 84, 87, and 90, which exhibit relatively higher population classes. In contrast, Ward 35, Ward 6, and a few peripheral wards fall within the lowest population category, indicating comparatively sparse settlement patterns. The concentration of population within the central municipal area reflects the historical evolution of Varanasi as a commercial, religious, and institutional centre where economic opportunities, educational facilities, and transport accessibility continue to attract population inflow. A similar spatial trend is evident in the population density map. The highest density values are observed in Ward 16, Ward 43, Ward 18, Ward 29, and parts of the historic inner-city wards adjoining the Ganga River, whereas comparatively lower densities occur in the expanding peripheral wards such as 27, 25, 31, and 59. The coincidence of high total population and high population density demonstrates that urban growth in Varanasi has largely occurred through intensification of existing urban areas rather than horizontal expansion, thereby increasing pressure on infrastructure, transportation networks, housing stock, and public utilities. These findings indicate that population density acts as one of the principal indicators of urbanization intensity and reflects the spatial concentration of economic and social activities within the city.

Sex Ratio, Child Sex Ratio and Male–Female Population

The GIS analysis of the sex ratio indicates moderate spatial variation across municipal wards. The highest sex ratio values are observed in Ward 8 and several eastern wards adjacent to the Ganga River, whereas the lowest ratios occur in Ward 19 and neighbouring western peripheral wards. The male-female population map further demonstrates that, despite variations in sex ratio, male and female populations remain relatively balanced throughout most wards. However, densely populated commercial and institutional wards exhibit comparatively higher male populations, reflecting migration associated with employment, education, trade, and service-sector activities. The child sex ratio map presents a somewhat different spatial pattern. Higher child sex ratios are concentrated in Ward 30, Ward 29, Ward 20, and several central wards, whereas relatively lower ratios are evident in Ward 22, Ward 14, Ward 25, and neighbouring localities. These spatial disparities may indicate differences in socio-economic conditions, educational attainment, healthcare accessibility, and gender-related social practices across different parts of the city. From an urban planning perspective, the child sex ratio serves as an important indicator of demographic sustainability and future population composition. The relatively balanced sex ratio across most wards suggests that urbanization in Varanasi has not produced extreme gender imbalances, although localized disparities warrant targeted policy interventions.

Literacy Rate

The thematic map depicting literacy rate demonstrates considerable intra-urban variation. Higher literacy levels are concentrated within the central municipal wards, particularly around educational institutions, administrative centres, and established residential neighbourhoods, where literacy exceeds approximately 89–94%. In contrast, comparatively lower literacy rates are observed in Ward 38, Ward 25, Ward 56, and a few peripheral wards falling within the lowest literacy class. The spatial relationship between literacy and total population indicates that many highly populated wards also record relatively high literacy levels. This pattern reflects the concentration of educational infrastructure, universities, schools, commercial establishments, and service-sector employment within the urban core. Higher literacy enhances labour productivity, improves employability, and accelerates economic diversification, thereby reinforcing the process of urbanization. Consequently, literacy emerges as a significant demographic variable influencing both urban growth and socio-economic development in Varanasi.

Main Workers and Marginal Workers

The distribution of main workers reveals that the highest proportions are concentrated in Ward 2, Ward 43, Ward 80, and several commercial wards located within the municipal core. Lower percentages of main workers occur primarily in peripheral residential wards characterized by comparatively lower economic activity. The concentration of main workers closely corresponds with areas exhibiting higher population density and commercial development, indicating that employment opportunities remain concentrated within the central urban economy. Conversely, the marginal worker map exhibits a different spatial pattern. Higher proportions of marginal workers are concentrated in Ward 40, Ward 14, and selected southern wards, whereas relatively lower proportions occur in Ward 31, Ward 25, and parts of the eastern municipal area. The spatial distribution suggests that marginal employment is more prevalent in transitional and peripheral neighborhoods where informal economic activities, seasonal employment, and lower-income occupations dominate. The coexistence of high main-worker concentration in the urban core and higher marginal-worker proportions in peripheral areas reflects the socio-economic differentiation associated with rapid urbanization.

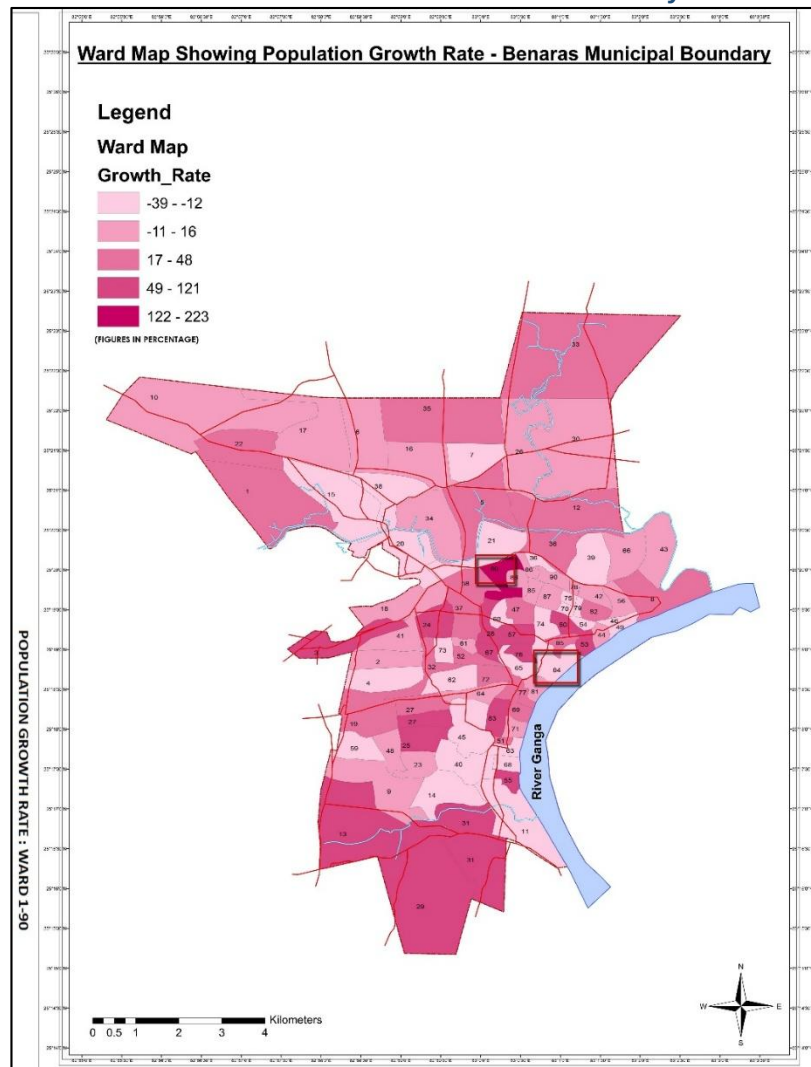


Fig. 5 – GIS Maps Showing Decadal Growth Rate of Population for 90 Wards, Varanasi Municipal Corporation Area (Source: Author)

The GIS based spatial analysis of the decadal population growth rate (2001 - 2011) across the 90 wards of Varanasi Municipal Corporation (VMC) reveals significant spatial disparities in demographic expansion, reflecting the uneven nature of urbanization within the city. The thematic map indicates that the highest growth rates (122–223%) are concentrated in Ward 80, with several adjoining central wards also exhibiting rapid population growth. In contrast, a number of peripheral and mature residential wards fall within the negative to low growth category (-39% to 16%), indicating either population stagnation or redistribution. These spatial differences suggest that population growth has not been uniform but has been strongly influenced by the availability of residential land, commercial development, institutional expansion, and accessibility to transportation networks. The observed growth pattern demonstrates a strong positive correlation between demographic growth rate and urbanization. Wards experiencing higher population growth generally coincide with areas undergoing intensified urban development, increased housing construction, expansion of commercial activities, and improved civic infrastructure. Such wards have become major destinations for rural-to-urban migration and intra-city population redistribution, thereby accelerating the pace of urban growth. Conversely, wards exhibiting lower or negative growth rates are largely characterized by saturated land use, limited development potential, ageing residential neighborhoods, or outward migration towards newly developing urban fringes.

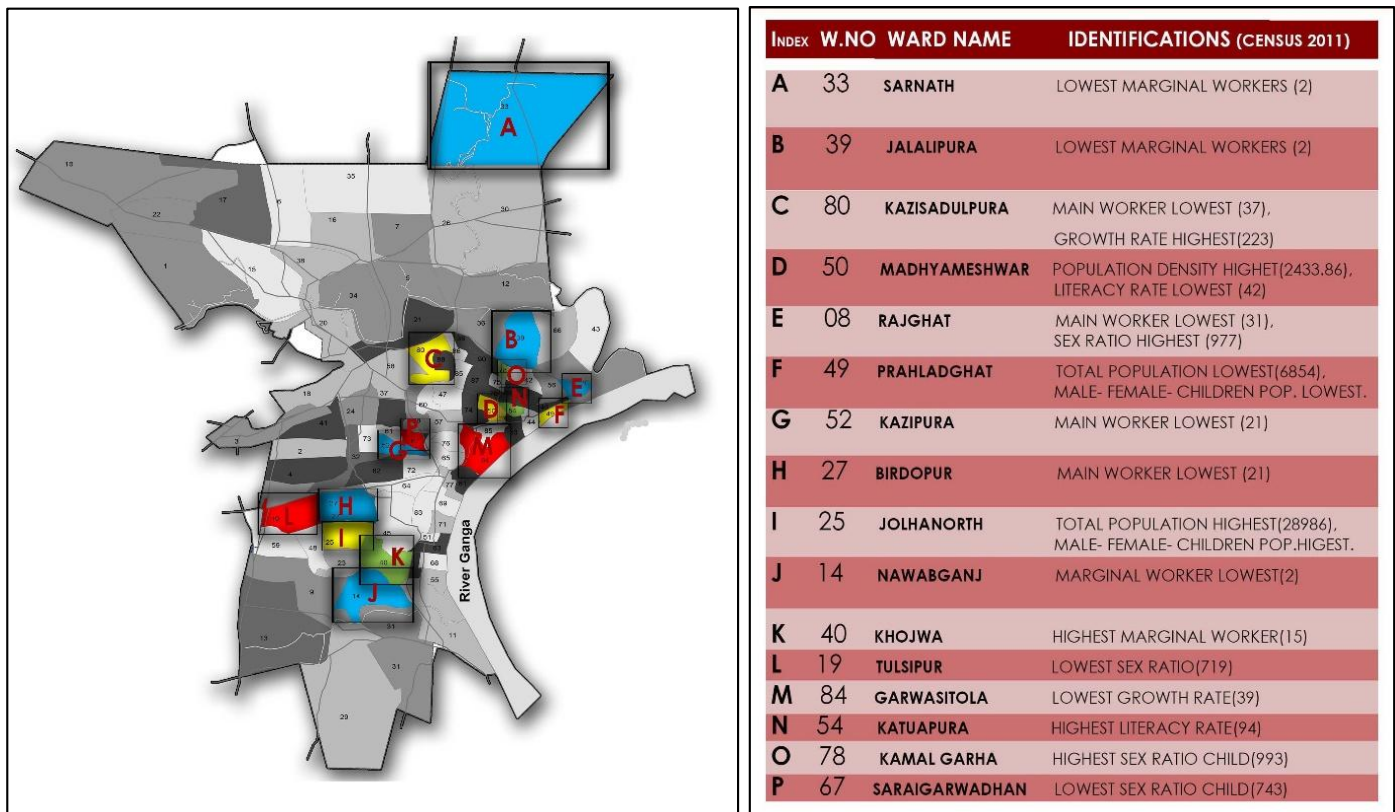


Fig. 6 – GIS Maps Showing Demarcation and Listing of Wards with Highest and Lowest Demographic Variable, Varanasi Municipal Corporation Area (Source: Author)

The integrated GIS-based demographic assessment of the 90 wards of Varanasi Municipal Corporation (VMC), based on the Census of India 2011, provides a comprehensive understanding of the spatial variations in population and socio-economic characteristics that influence urban development and heritage conservation. The synthesis of all thematic maps reveals that demographic variables are highly heterogeneous across the city and exhibit distinct spatial clustering rather than a uniform distribution. Core heritage precincts along the River Ganga are characterized by high population density, lower literacy levels, comparatively lower workforce participation, and relatively slower demographic growth, indicating mature urban neighbourhoods experiencing spatial saturation. In contrast, peripheral wards demonstrate higher population growth rates, reflecting rapid urban expansion and the outward shift of residential development. The spatial identification of extreme demographic conditions further strengthens this interpretation. Ward 25 (Jolhan North) records the highest total population, while Ward 49 (Prahladghat) exhibits the lowest population. Ward 50 (Madhyameshwar) possesses the highest population density but the lowest literacy rate, highlighting the challenges associated with dense urban settlements. Ward 80 (Kazisadulpura) records the highest decadal growth rate coupled with the lowest proportion of main workers, indicating emerging urbanisation with limited employment opportunities. Conversely, Rajghat demonstrates the highest sex ratio, Katuapura records the highest literacy rate, and Khojwa exhibits the highest marginal workforce participation, reflecting varying socio-economic conditions across the municipal area. Collectively, these demographic indicators reveal a strong relationship between population concentration, urbanisation intensity, employment structure, literacy, and social composition. The GIS-based spatial analysis therefore provides a robust evidence base for ward-specific planning interventions instead of adopting a uniform planning approach.

Conclusion

Correlation among Demographic Variables and Urbanization

The GIS-based analysis indicates a strong positive relationship between total population and population density, confirming that the most populated wards also experience greater spatial concentration of residents. A positive association is similarly observed between population density and main-worker participation, suggesting that economically active wards attract higher residential concentrations because of employment opportunities and commercial functions. The relationship between literacy rate and population concentration is also moderately positive. Highly urbanized wards generally exhibit better literacy outcomes owing to greater accessibility to educational institutions and public services. Furthermore, the male-female population composition corresponds closely with total population distribution, although commercial wards display a relatively higher proportion of males because of labor-related migration. The sex ratio exhibits comparatively weaker correlation with population density, indicating that gender composition is influenced by broader socio-cultural factors rather than urban concentration alone. Likewise, the distribution of marginal workers demonstrates a moderate inverse relationship with literacy and main-worker participation, reflecting disparities in employment quality across different wards. The spatial analysis collectively demonstrates that demographic characteristics are unevenly distributed across the municipal wards of Varanasi and exhibit a strong association with the city's pattern of urban growth. High population concentration, elevated population density, greater literacy levels, and higher proportions of main workers are predominantly concentrated within the historical urban core and major commercial corridors, reflecting the cumulative effects of economic development, institutional growth, and migration. Peripheral wards, in contrast, generally display lower population densities, lower literacy levels, and relatively higher proportions of marginal workers, indicating areas undergoing transitional urbanization. Overall, the GIS based demographic assessment confirms that urbanization in Varanasi has been accompanied by significant demographic restructuring characterized by spatial concentration of population, workforce redistribution, improvements

in literacy, and moderate changes in gender composition. These demographic transformations have directly influenced the city's urban growth trajectory by increasing demand for housing, transportation infrastructure, educational facilities, employment opportunities, and public services. The ward-level spatial analysis therefore provides a robust empirical foundation for understanding the relationship between demographic change and urban expansion and highlights the necessity for spatially differentiated planning strategies to promote balanced, inclusive, and sustainable urban development within Varanasi Municipal Corporation.

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