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Urban Growth, Land Fragmentation, and Community Livelihoods in the Varanasi Rural-Urban Interface

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ABSTRACT

It can be seen that, over the last few decades, significant socio-spatial changes are observed in the rural-urban fringe of Varanasi, reflecting pressure from rapid urbanization invading traditionally rural spaces. Understanding these dynamics would therefore be crucial for sustainable development, especially in the case of Varanasi's future as a Smart City. According to the 2011 Indian Census, Varanasi had 1.2 million urban residents, with population growth in the rural-urban periphery rising by over 25% between 2001 and 2011, mainly driven by rural migration and urban sprawl. This paper examines the patterns of land use, infrastructure development, and demographic change within the rural-urban interface of Varanasi, focusing on challenges of resource allocation, displacement, and environmental degradation while focusing on opportunities for improved infrastructure and economic growth. It therefore requires strategic management of the growth of the Varanasi rural-urban fringe to protect the livelihoods, ecosystems, and cultural landscapes of rural communities. Sustainable development of Varanasi's edge would need integrated urban-rural planning and targeted policy interventions for inclusive growth for the city and the peri-urban population.

Keywords: *Smart City, Urbanization, Rural-Urban Fringe, Sustainable Development*

1. INTRODUCTION

Background of Varanasi: Varanasi, one of the oldest living cities in the world, has its seat on the hallowed banks of the Ganges River in Uttar Pradesh, India. It boasts profound historical, cultural, and religious heritage and attracts millions of pilgrims who come from every corner of the globe every year, drawn by it as the sacred city for Hindus, Jains, and Buddhists. Often termed as the spiritual capital of India, Varanasi is the centre of cultural practices, religious traditions, and academic learning. Rapid urbanization and expansion are, however, now creating unprecedented challenges to the city's unique identity as a centre of spirituality, traditional knowledge, and cultural richness that offer both opportunities and complexities for urban planners and policymakers (Bharati, 2013).**Rural-Urban Dynamics:** Rural-urban dynamics refer to the socio-economic, spatial, and cultural interactions occurring at the borders where urban growth encroaches upon rural spaces. These dynamics are important in urban planning, especially in areas that experience rapid urban expansion. In Varanasi, for example, at the rural-urban fringe, the sprawl of the city has transformed agricultural and undeveloped lands into residential, commercial, and industrial zones. Balancing rural areas' shifting towards more urban expansion must be known in relation to balanced development, considering resource distribution changes as well as aspects affecting social cohesion and preservation of the traditional livelihood and landscapes which remain within these rural settings. This would become notably challenging for Varanasi due to history and changes occurring at increased

rates toward the fringes. **Smart City Development:** A Smart City will enhance urban living and economic growth while managing issues such as resource management and service efficiency using technology, infrastructural development, and sustainable development. The India Smart Cities Mission, launched in 2015, identified 100 cities for large-scale urban renewal and modernization and has included Varanasi. Including Varanasi will make sure that importance at the cultural and economic level is provided with infrastructure enhancement, connectivity, and the availability of sustainable urban services. The Varanasi Smart City Proposal made available in 2016 presents a list of proposals with items such as the up-gradation of modernization systems in urban mobility systems, IT infrastructure enhancements, and iconic sites both alongside the Ganges ghats. Much of this growth, though, focuses on the core of the city, leaving even less attention placed on such challenges for the wider fringe to address. Hence, aligning periphery needs with a Smart City vision is, therefore, still an immediate priority toward realising inclusive growth.

2. LITERATURE REVIEW

Rural-Urban Dynamics in Developing Nations: Whereas rural-urban migration occurs among developing nations due to poor economic inequalities, inadequate infrastructure, and limited rural occupations, Harris and Todaro's (1970) dual economy model would state continuing migration in spite of urban unemployment, as rural folk tend to view cities as possessing better opportunities, albeit underemployment and congestion characterize such benefits (World Bank, 2020). Employment, education, and better quality of life remain the dominant aspirations for permanent or temporary migration for destinations like sub-Saharan Africa and South Asia. Conditions for integration remain very difficult by distance and costs, particularly to average members of marginalized groups. **Socio-economic Landscape of Varanasi:** The socio-economic profile of Varanasi mirrors its cultural heritage with handloom and tourism industries. Rural hinterlands, hence, connect with cities through trade and seasonal migration, resulting in a unique rural-urban nexus in the contemporary sense, according to Joshi, 2020. So, as far as integrated urban planning is concerned and where rural-urban interfaces come into play, regional economic development of Varanasi is crucial, points Chatterjee, 2019. Smart Cities Frame: The Smart Cities Mission seeks to create niches for enhancing sustainability, but Varanasi faces the stark challenge of balancing heritage with rural connectivity. Limited digital infrastructure, scarcity of data, and governance challenges complicate this further (World Bank, 2020). Growth strategies reveal connections between rural and urban areas as part of bridging socio-economic divides (Oxford Academic, 2021). **Knowledge Gaps:** The issues most pertinent to research in this context have generally shunned the rural-urban interactions, much more pertinent for ensuring equity in the cities such as Varanasi that are rich with culture. There is almost no data on the social and economic impact of such rural migration on such cities.

3. RESEARCH OBJECTIVES AND SCOPE:

3.1 This paper discusses the socio-economic and environmental impacts of urbanization at the rural-urban fringe in Varanasi, paying special attention to land fragmentation and community livelihoods. It analyses land-use patterns, infrastructure development, and demographic shifts associated with the expansion of Varanasi under the Smart City

initiative. It also highlights the benefits of urban sprawl, which are educating one's self, better accessibility to medical facilities, and good job opportunities, by losing demolition, resource management, and sustainability. After all, this piece of research is meant to underscore the fact that balanced development and integrated planning in regards to both fringe and cities have to be pursued considering Varanasi.

3.2 Research Significance: An understanding of the dynamics between rural and urban systems in Varanasi will be an important step toward achieving sustainable urban growth and successful Smart City development. As Varanasi grows, the interface between rural and urban communities is under intense pressure concerning land fragmentation, degradation of environmental resources, and socio-economic disparities between the rural and urban populations. The study aims to explore these dynamics and present the integrated urban-rural planning process that focuses on environmental sustainability, resource equity, and cultural preservation. This, at its final analysis, will actually help policymakers and urban planners develop a balanced approach at development that would actually see the benefits being accorded to both the fringe populations and the populations living within an urban setting while maintaining Varanasi's heritage.

4. METHODOLOGY

The rural-urban context of Varanasi can be comprehended through the use of secondary data which has been obtained from reliable academic sources such as the reports of the Ministry of Rural Development, Ministry of Urban Development, and NSSO; Census data (2011, 2021) and the respective records of urban development from municipalities and planning bodies and the appropriate scholarly guides. Through a systematic approach through which new and strongly cited reports are provided as regarding population demography issues, migration issues, economic issues, and infrastructural development issues in the country. The analytical framework includes statistical examination focusing on estimating population and economic disparities; and comparative studies vis-à-vis rural and urban areas that depict the existing gaps in terms of living standards and infrastructure; and temporal trend studies in population, employment, and the process of decision making. This enhances comprehension of the development over the period of time and how it will help the case of Varanasi in push for development of in the smaller scale of local, national and global relevance.

5. ANALYSIS:

5.1 Integrated Urban Design Framework for Varanasi: From the analysed findings, this study constructs an Integrated Urban Design Framework that seeks to accommodate cultural factors whilst addressing the urban expansion dynamics of Varanasi owing to the Smart City Mission. Varanasi, famous for its old ghats, temples, and the cluttered neighborhoods, is now besieged with the problems caused by urbanization. The framework for such integration focuses on the following: **Sustainable Development of the Infrastructure.** Adequate functional infrastructure in Varanasi is required to sustain the urban needs of the cities residents. First of these improvements should include transport and housing as well as sanitation and waste disposal. Public transport should be scaled up to reduce traffic congestion and emissions which seeks to lessen environmental impact. Furthermore, construction should

be ‘green’ in many aspects to supplement environmental sustainability; sanitation infrastructure should be upgradable in such a way that unequal conditions between the core urban areas and the hinterlands no longer exist. Solutions Low Environmental impact for Long Term sustained Urban Development **Public Amenities and Green Spaces:** The introduction of greenery and public space in the city planning of Varanasi will enhance its attractiveness and that of the urban fabric. Improvement of parks, riverfront development, and other urban greening projects around the Ganges allow to preserve culture and history while sustaining ecological environments. Green spaces decrease pollution and pollution-caused threats through cleaner air and foster social cohesiveness- all resolving the objectives of an integrated and healthy urban environment. **Socio-Economic Equality:** The design of cities should address the imbalances in the provision of housing, health care or education services for instance to migrants from rural areas and the low-income populations in cities. An increase in affordable housing schemes, availability of healthcare services, and education in both rural and urban regions means that the residents of Varanasi have all the advantages of urbanization. This framework shall provide guidelines for policy makers on the appropriate strategies for rural-urban migration patterns and conservation of heritage sites within an economic growth that is progressive while preserving the culture of Varanasi.

5.2 Evolution of Urban Planning: A Phased Approach: Varanasi city has gone through three periods which were the essential pieces of its urban transformation. The first phase was the main of the three phases completing the city's development, land use, and the need to preserve heritage areas due to urbanization issues that are mounting. **Master Plan 1961-1991**: These are mainly the infrastructures of the zoned structure for Varanasi. The boundaries between residential, commercial, and industrial areas are clearly drawn. However, it didn't have the needed mechanisms to control the informal growth in the core of the historic city, which instead developed the unrestricted and uncontrolled growth. At this stage, the need for more control is evident over the haphazard construction as there are more informal settlements in places and lack of infrastructure in overcrowded places. **The 1991–2011 Master Plan:** This was the time when the zoning laws were stretch zones to the periphery thus Varanasi moved out to less developed ones thus decongesting the urban core which was bolstered by rural-to-urban migration. Regrettably for this, the implementation of this was hard; hence a lot of places were urbanized informally in such areas. Nevertheless, this phase should be more governance and polices should be adopted for effective policy and urban-rural relations. **2011–2031 Master Plan:** At present, the master plan is at a stage where the heritage conservation measures will be the one together with sustainable urbanization. More policies are to be introduced which include stronger land use regulation to limit informal settlements, preserve cultural heritage, and guarantee ecological balance. The master plan of preserving historical monuments throughout the city, integrating urban vegetation along with most of the green infrastructure, Varanasi into its spatial structure, and finally to the achievement of its historical and cultural goals.

5.3 Historic Profile of Urban Expansion: Varanasi, due to its previous historical importance as a site of religiosity, culture, and commerce, had developed an urban sprawl pattern. On gaining independence, this process of growth continued at a rapid rate with the ingestion of the rural adjacent bases of land and changed demography and economy. The form this has taken has been Smart City Mission from 2015, a mission designed to address such historical problems with enhanced structures strategically through a more complete digital connectivity system and optimal utilization of resources. Indeed, uncontrolled growth in the rural-urban fringe persists in dislodging its rural inhabitants and stressing up the environmental elements of land use. The

issue still remains, thus there's a pressing need to incorporate a model of development with the requirements of today's urban system and history or past usage and social economies of land.

5.4 Administrative Boundaries and Urban Governance: Varanasi Urban Governance has more than one administrative unit, each overlapping the other, explaining roles and facilitating the rationing of resources: **Varanasi Municipal Corporation (VMC)**: It has control over the core urban area of the city that is 82.1 square kilometres in area, and it has been targeting essential services like water, sanitation, and waste management. However, the population density is quite high in the managed area, and the services are inadequate to fulfil the needs. **Varanasi Urban Agglomeration (VUA)**: It covers approximately 112.26 square kilometers and includes areas beyond the core that comprise other urbanized regions in the periphery. VUA's role thus underscores the expansion of the city boundaries and facilitates the distribution of services in the denser peripheral zones. **Varanasi Development Region (VDR)**: The VDR is an area of 793 square kilometers as defined in Draft Master Plan 2031 that should serve as a basis for sustainable development along with balanced growth at the rural-urban interface. A more expansive boundary gives an opportunity to do strategic zoning targeting both expansion at the edge of the city and core rural preservation for development. This will really require a coherent and integrated urban governance structure for the fast growth of the city, to better serve the societies and to make sure that all developments in the urban area correspond to sustainability goals.

5.5 Connectivity and Location Analysis: Connectivity has been the most important factor in terms of economic activities and connectivity in the region, thereby making Varanasi the high ranked city. Since the city is on all major national highways NH-2, NH-56 and NH-29, it is well connected to other key regions in North India for growth of trade, tourism, and logistics. The Master Plan 2011 emphasized enhancing transport infrastructure. Inner and Outer Ring Roads were to be developed in order to decongest the city core. They are useful instruments in restructuring traffic circulation patterns through dense areas and facilitating smooth movement, and these require constant infrastructure management as the pattern of urban extension continues.

5.7 Demographic and Socio-Economic Profile:

Heading	**Details**
Location & Area	Latitude extension: 25°16'01" N to 25°22'01" N Longitude extension: 82°58'23" E to 83°01'48" E
Population (2011)	3,676,841 (Male: 1,921,857; Female: 1,754,984)
Rural/Urban Distribution	Rural: 2,079,790; Urban: 1,597,051
Literacy Rates	Overall: 75.60% (Male: 83.77%; Female: 66.69%)
Administrative Structure	3 Tehsils, 8 Blocks, 108 Nyaya Panchayats, 760 Gram Panchayats
Density	1,535 persons/sq.km

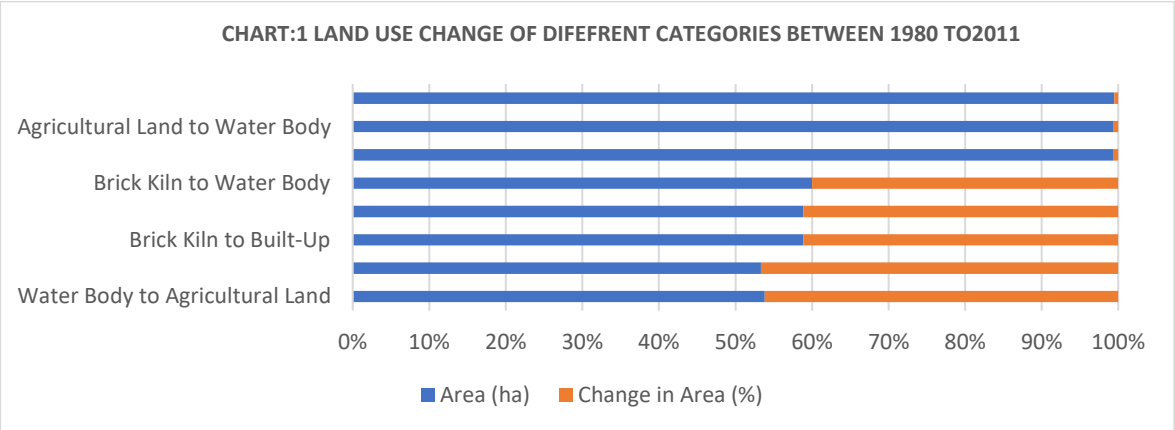
Table 1: Demographic and Socio-Economic Profile

The demographic and socio-economic profile of Varanasi, therefore, reveals an important chasm between the rural and the urban groups with broad ramifications for the distribution of resources and the formulation of policies. Varanasi, according to the 2011 census, had a total

population of 3,676,841; more residing in the rural regions (2,079,790) than in the urban one (1,597,051). 1. The total city population remaining predominantly urbanized amounts to 1,535 persons per square kilometre and places a tremendous burden on the already stretched infrastructure and public services like overcrowding, traffic congestion, and strain on health, education, and shelter. In the rural areas, the number of persons per square kilometre is significantly lesser, but their issues are that of the scarcity of infrastructure and limited public resources. Literacy rate further highlights the disparity among two genders with a general rate of 75.60%. There is an evident difference between the male and female literacy rates, which stands at 83.77% and 66.69%, respectively. Generally, literate rates are higher for urban dwellers than their rural counterparts, which reflects a better access to educational facilities and resources in comparison to that of their rural counterparts with limited educational opportunities. This lack of access still perpetuates socio-economic gaps because again, rural people-more the women than men-get fewer opportunities and chances to obtain education with an indication of a narrow scope for better-paid career options. Another form is the economic gap that depicts dependency of rural populations in the country on farming, which is usually an industry constantly oscillating due to the variability of seasons with non-reliable incomes while, on the other hand, the urban populations tend to enjoy diverse economic activities whose incomes are stable. Administratively, it is divided into 3 Tehsils, 8 Blocks, 108 Nyaya Panchayats, and 760 Gram Panchayats, an arrangement gearing toward the unique needs of both urban and rural. Still, such a convoluted system sometimes delays proper delivery of resources and policies, especially to the rural areas, which are often neglected in the course of development policies targeting the urban areas. In short, the demographic and socio-economic profile of Varanasi underlines an urgent need for governance structures that would concentrate on balanced development in rural and urban areas so that a package of balanced population growth can be taken forward and inclusiveness in socio-economic opportunities ensured for all.

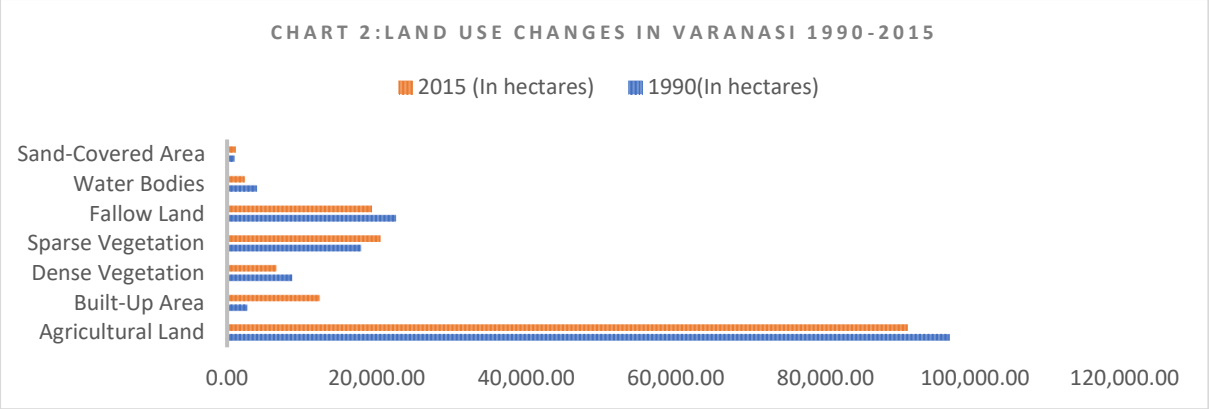
5.8 Physical Planning in Historical Areas: The historical core of Varanasi poses special problems, including narrow streets and high-density neighbourhoods with scant space for the upgradation of infrastructure. This overall radial-linear growth pattern aligned with major roads suggests influence from the Master Plan 2011-2031. Environmental concerns, while protecting the Ganges along with sustainable stormwater management, point out the imperatives of heritage conservation-friendly design yet new growth in a manner that is supportive to this rich history landscape an integral part of the development plan for Varanasi.

5.9 Comparative Analysis of Spatial Growth Patterns:



From a comparative analysis of the pattern of spatial growth in Varanasi from 1980 to 2011, it is evident that such land-use changes highlight significant impacts of urban expansion on the environment and agricultural resources of the city. Through the master plans between 1961 and 2031, it is observed that there is a trend to convert agricultural land into built-up areas. In the region, around 7,180.9 hectares, that is, 49.9% of agricultural land have been converted for urban uses, mainly in fringe regions. This growth also affected water bodies as 18.5 hectares (16.2%) of water body areas were converted to built-up zones and 2.1 hectares (1.8%) to agricultural land, which means that natural resources are increasingly being repurposed to accommodate urban infrastructure. Brick kiln areas have also undergone major changes as 110.3 hectares (77%) were converted to built-up spaces and 31.5 hectares (22%) reallocated to agricultural use. While these changes were being wrought, more or less 11,710 hectares were found to have no change in use, which therefore means parts are still preserved although limited in the context of the surroundings. The land conversion pattern observed finds that built-up areas are favoured over green and agricultural land spaces at the expense of the crucial balance between environmental and agricultural productivity. Therefore, there is the need for urgent and sustainable zoning practices that can manage such urbanization pressures without compromising the environment or agricultural productivity in this regard.

5.10 Land Use and Infrastructure in the Rural-Urban Fringe:



The changes in land use within the rural-urban fringe of Varanasi, between 1990 and 2015, were dramatic as an indication of growing pressures from urban development. A total of 96,586.41 hectares of **agricultural land** was decreased to 90,982.62 hectares during 2015, and 6.47% was decreased within the period of 2000–2020 mainly for conversion into urban purposes. This is reflected in the **built-up area,** which increased dramatically from 2,670.51 to 12,348.18 hectares, thus reflecting rapid urbanization that has transformed the landscape to respond to increasing residential and commercial needs. The cover of vegetation also went through some observable changes. The dense vegetations decreased from 8,663.60 to 6,594.08 hectares which appears to be the loss of forest and green areas possibly by the pressures of development. Open forests, however rose from 17,882.37 to 20,473.82 hectares indicating thinning canopy spreads and maybe the effects of devastated lands or forests fragmentation. **Fallow area** dropped from 22,568.04 to 19,385.75 hectares, demonstrating agricultural land diversion, but **water bodies** were reduced by 3,968.30 to 2,347.67 hectares; the areas show stress from development on environmental resources in those areas owing to expansion into urban development. Comparatively, with respect to **sand-covered land**, land expanded by around 207.12 hectares, possibly due to effects along rivers or urbanization effects, thus the fringe region of Varanasi is still susceptible to both changes in urban development and

environmental practices. Built up areas increased while agricultural and natural resources areas decreased, indicating clearly the necessity of protecting the integrity of the ecosystem and the preservation of agricultural resource use in infrastructure development.

5.11 Housing and Urban Development Pressures:

Period	Population Growth Rate (%)	Factors Influencing Growth
1821–1831	3.81	**Gradual growth** due to steady economic and social stability.
1931–1941	28.10	**Pre-WWII economic expansion** fostering urban growth.
1941–1951	~30.00 (estimated)	Influx of rural migrants and refugees for employment
1951–1961	-2.00	Post-independence stabilization
1971–1981	-1.50	Continued rural retention
1981–1991	15.00	Rural-to-urban migration for better livelihood
1991–2001	19.44	**Accelerated urbanization** driven by industrial growth and economic reforms.
2001–2011	23.30	High growth due to economic expansion
2020	Not applicable	Population of 2.7 million driven by overall urban and economic growth

Table 2 : Population Growth Trends in Varanasi

Pressure on housing and urban development in Varanasi has increased with major population growth trends, primarily in the form of massive demographic shifts from the early 19th century up to the present. Population growth between 1821 and 1831 averaged at 3.81%, then a big jump occurred between 1931 and 1941 at 28.10% during pre-WWII economic development. This trend continued with a 30% growth during the period 1941-1951, encouraged by an increasing number of rural migrants and refugees seeking job opportunities in the city. Post-independence stabilization had some short-run reduction in the growth rate as noted from -2.00% over the period 1951-1961, and then another short-term reduction at -1.50% during 1971-1981, mainly because policies taken in the rural sector sought to stabilize migration. This latter, however, picked up a spurt of rural-urban migration and took the count up from 1981 to 1991 with an increment of 15.00%, followed by the hectic urbanization of 1990s with the rise of 19.44%, and further economical increase with the growth of 23.30% took the population from 2001 to 2011. Varanasi witnessed approximately 2.7 million people in the census of 2020 which increases the demand of its urban housing. These trends put enormous pressure on the core of Varanasi where house demands force strain on services mainly in slum areas. Though programs like Sarv Jan Hitay Gareeb Avas attempt to fulfil affordable housing requirements, informal settlements continue to dominate the landscape, testifying to what is generally insufficient in current schemes. It needs an increase in the infrastructure of affordable housing along with more effective implementations of housing programs to reduce the rates of urban poverty and allow space for the accommodation of migrants from rural backgrounds so that the overall living condition improves within the framework of Smart City, keeping in view the rapid increase of the population in Varanasi.

5.12 Shifts in Employment and Demographic Patterns:

Sector	Total Employment (%)	Notable Industries	Key Demographics
Manufacturing	32.48%	Textile mills (12.21% of total employment)	Primarily male-dominated, urban-focused
Trade and Transportation	30.06%	Merchant wholesalers of nondurable goods (14.27%)	Mixed rural-urban migration
Agriculture	18.33%	Small-scale farms, local markets	Predominantly rural, aging workforce
Services	13.21%	Tourism, hospitality, healthcare	Urban centres, young demographic
Construction	5.92%	Infrastructure, urban development projects	Rural migrant workforce, temporary jobs

Table 3 : Employment Distribution by Sector in Varanasi

The changes in employment and demographic trends in Varanasi are characterized by extensive migration from rural to urban sectors, with a substantial number of rural workers joining the urban-based manufacturing and trade sectors. Manufacturing engages 32.48 percent of the total employment with textile mills accounting for 12.21 percent that largely employ males of the urban sector. Trade and transportation account for 30.06 percent of employment, with merchant wholesalers of nondurable goods and drawing workers from both the rural and urban background especially those transitioning from agricultural employment. Agriculture, which used to be the largest source of employment, accounts for 18.33 percent of total employment and is made up of an aging workforce in the rural background suffering from declining returns on diminished agricultural land and resources. Tourism, hospitality, and healthcare are some of the sectors of the service industry that produce 13.21% of employment, which typically remains dominated by the younger generations and in urban regions because education and job training have increased. Construction employed 5.92% of the workforce, mostly rural migrants seeking temporary or seasonal work in urban development projects but having fewer economic mobilities because such employment is unstable. These demographic changes inform how growth in cities impacts the job profiles and how Varanasi needs to develop targeted social infrastructure to absorb this transition in the workforce. When the city expands its education, health and vocational facilities particularly in the case of rural migrants in cities, Varanasi is going to be better placed for evolving population dynamics to include all of them toward holistic economic development.

5.13 Environmental Pressures and Resource Management: Mass development in Varanasi cities has accelerated environmental pressures enormously, which have resulted in considerable resource depletion and huge ecosystem strain. Between the years 1990-2015, more than 5,600 hectares, or 6.47% of the area in agricultural land, was occupied for urban purposes, greatly disturbed local food production and expelled rural livelihoods. Increasing pollution levels have also experienced, especially near industrial locations, where factories and

not so efficient waste management triggered air and water quality declines dramatically. Several areas in the city have exceeded the safety levels of the Air Quality Index (AQI) readings. The level of PM2.5 is at two to three times the threshold set by WHO, seriously threatening the health of the public. The Ganges River is an important natural and cultural asset and has been very adversely affected by the daily discharge of around 200 million litres of untreated wastewater from the industrial processes like leather tanning and textile production. It brings down the levels of aquatic biodiversity and endangers the communities relying on the river to fetch supplies, including water, and irrigate their agriculture. It produces 600 tons of solid wastes every day but only collects 65%. This means that most of the public spaces, as well as the waters, are littered with waste, which is posing a risk to increased cases of flooding and a deteriorating environment. These barriers can be overcome if the management of resources for cities' planning goes hand in hand with facility upgradation of waste processing, industrial policy, and green infrastructure through installation of bio-filtration zones all along the Ganges River. This step will allow the city of Varanasi to strike the perfect equilibrium between the growth of a city and environmental conservation into a healthier ecosystem and into an environmentally sustainable future for residents.

5.14 Evaluation of Public Services and Infrastructure: Public services in Varanasi, which are handled by different departments of administration, continue to be under the challenges of growth in population demand. Some of the crucial services provided include water supply, sanitation, and shelter. VMC and District Urban Development Authority (DUDA) take care of them. Yet service gaps continue in the urbanizing areas indicating a need for an integrated allocation of resources in order to augment coverage, meet growing demands, and utilize the infrastructure appropriately in urban settings.

5.15 Water Supply, Sewerage, and Sanitation: Varanasi has very old water and sewerage systems that were not designed to meet the current demands. The coverage of sewerage is still low in Trans-Varuna as well as other areas, posing health and sanitation issues to the residents. Expansion of water supply infrastructure and sewerage facilities is required so that expansion does not pose public health concerns through unsafe water and sanitary facilities. **Water Supply:** The water supply system of Varanasi was built in 1892 to serve a population of 200,000. The systems have since been expanded in several rounds to serve and accommodate more than 1.2 million within the core urban centre, but the distribution system is underbuilt for current demand (Census of India, 2011). Plans by the **Ministry of Urban Development Water supply** distribution has increased, but there is still a need in many areas, particularly distant from the city and slums. Aging infrastructure means that there are often frequent leakages and losses that put a strain on supply. **Sewerage and Sanitation:** The sewerage system of Varanasi is divided into cis-Varuna and trans-Varuna. It is a combination of both overground and underground network at present, but only 30% of the city's population is covered. Partial coverage is there in the core urban areas, and 18% of the households do not have independent, shared, or community toilets and are dependent on unhygienic facilities. The area of Trans-Varuna is especially lacking in formal sewerage, causing severe sanitation problems. Raw sewage is commonly discharged into the Ganges and Varuna rivers, which also contributes to pollution. **Solid Waste Management (SWM):** Varanasi generates approximately 600 TPD of solid waste, of which biodegradable waste comprises religious offerings and vegetable waste and non-biodegradable waste: plastic. The city's principal landfill site is located at Karsada, approximated 20 km from the city centre and covers 40 acres. The city has not been able to collect and transport the waste properly, no proper recycling facility in the city, and source segregation is very minimal. This has caused improper wastes, and thus large percentages of

wastes dumped into Ganges and other public areas, all increasing the environment degradation pace.

5.16 Cultural Resources and Heritage Preservation: The ghats and kunds are perhaps the most essential elements of the identity of Varanasi and must, therefore, be conserved with proper direction. Challenges such as pollution, lack of tourism infrastructure, and overlapping interests between different agencies make preservation a challenge. Strategic planning is the need of the hour for preserving this significant tourist destination, achieving sustainable tourism, and keeping such heritage sites vibrant components of urban landscapes in Varanasi for posterity.

5.17 Implications of Urban Growth and Land Fragmentation for Community Livelihoods: The city of Varanasi has resulted in extreme land fragmentation from the processes of urban expansion affecting both agricultural areas and changing the means of livelihoods for different communities at the rural-urban interface. Through expansion, the boundaries of the town extended into the peripheral zones where agricultural lands were increasingly converted for residential or commercial use, thereby disrupting the existing traditional livelihoods based on agriculture. Key implications include:

5.18 Economic Shifts in Livelihoods: Land fragmentation leads to a reduced amount of existing farmland that is available for the population, causing most of the households within the rural area to seek employment from within the urban employment sectors. It eventually becomes a shifting of previous agricultural practice since most of the people who live within the city are obliged to embrace a non-agricultural type of employment within the economy of the urban sector. They often lead to less security on income and also decrease the strength of community resilience.

5.19 Increased Land Value and Displacement: Rising pressures in fringe areas for land serves to drive property values sky-high, largely out of the range of many long-time rural residents. It serves to displace people as families are forced off their land and are forced to abandon traditional ways of living. Land fragmentation also threatens food security because the local agricultural production declines, and the residents increasingly depend upon sources of food emanating from the urban centres. Urban growth in Varanasi's rural-urban fringe thus threatens the sustainability of community livelihoods. However, this requires that plans be made for urban development plans to incorporate measures of protective agricultural zones or provide other livelihood support programs to compensate for the displaced communities.

6. CHALLENGES IN INTEGRATING RURAL-URBAN COMMUNITIES AMIDST LAND FRAGMENTATION

Urban expansion in Varanasi has fragmented land, posing significant barriers to rural-urban integration within the Smart City framework. **Loss of agricultural land and community heritage** undermines traditional farming practices, erodes cultural values tied to agriculture, and diminishes community pride and cohesion. Fragmented development has also led to **limited access to urban services**, isolating rural pockets from critical amenities like healthcare, education, and utilities, thereby restricting economic opportunities for these communities. **Administrative and regulatory challenges** further exacerbate inequalities, with overlapping jurisdictions causing inconsistent application of zoning and land-use

policies, resulting in overdeveloped and underdeveloped areas. To address these issues, **land-use and zoning policies** must prioritize agricultural land protection through designated zones and incentivized farming, alongside **mixed-use development** to balance residential, commercial, and agricultural activities. **Economic development programs** should focus on livelihood diversification by supporting agricultural modernization and developing local micro-enterprises that utilize rural skills in crafts and local products, reducing dependence on traditional agriculture. Enhanced **infrastructure and service integration**, including improved rural connectivity and extension of utilities and digital access, can bridge gaps, enabling economic participation and access to Smart City services. Finally, **community-led environmental and cultural conservation**, through participatory land-use planning and ecological preservation programs, is vital for protecting natural resources, conserving biodiversity, and maintaining cultural heritage while ensuring sustainable urban growth. These integrated measures can foster inclusive development, balance rural-urban dynamics, and align with Varanasi's cultural and environmental identity.

6.5 CASE STUDIES OF RURAL-URBAN INTEGRATION AND LAND MANAGEMENT

The study of successful rural-urban integration models is a valuable input for Varanasi's Smart City development, especially in dealing with land fragmentation. **Mexico City's** peri-urban agriculture projects, which supported local farmers, formed food cooperatives, and safeguarded agricultural land, reveal the potential of integrating agriculture into metropolitan frameworks as a buffer against urban sprawl. **Kathmandu's** land pooling method, by consolidating small holdings to distribute residential and agricultural space equitably, is a replicable way to manage fragmentation while preserving rural livelihoods**. Hangzhou's** integrated rural-urban planning through transportation, natural conservation, and agricultural preservation show how balanced growth can be sustained in livelihoods and urban expansion. If Varanasi adopts such strategies, it can achieve harmonious development that respects its socio-economic and environmental dimensions.

7. CONCLUSION

The examination of successful rural-urban integration examples offers key outtakes for Varanasi's Smart City enhancement, which is especially important in the case of land fragmentation. Mexico City 's peri-urban agriculture initiatives that linked with local farmers, created food cooperatives, as well as protected the agricultural land, are examples of the fact that agriculture can be integrated into metropolitan areas and thus counter the urban sprawl. Kathmandu's pooling of land approach, which collected the small holdings for the equitable distribution of residential and agricultural space, gives a way to copy for the management of land fragmentation, and at the same time, rural livelihoods are preserved. Hangzhou's inclusive rural-urban design, mainly in the transport plane, conservation of nature, and agriculture preservation, shows how equilibrium in the growth process can be achieved and ensures a decent living for the inhabitants along with urban development. Varanasi, with the adoption of the same strategies, can find a way of well coordinated development that is both socially and environmentally sensitive inasmuch as it embraces the community and the natural environment.

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