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Urban Growth Dynamics in Gurugram Metropolitan Area: The Question of Sustainability

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Abstract: Gurugram, previously Gurgaon, a city situated south of New Delhi, the national capital of India and sharing its boundary with it, has experienced a tremendous growth trajectory from a Municipal Committee in 1961 to becoming Gurugram Metropolitan Area in 2017. Commensurately, the area expanded from 5.18 km² to 244.9 km², and its population went up from 38 thousand to nearly 2.4 million. The growth has been particularly phenomenal since the post-reform period. The built-up area of its constituent units in 2022 was 65.6 per cent in Municipal Corporation, Gurugram, 46.8 per cent in Municipal Corporation, Manesar and 16.9 per cent in rural areas. The metropolitan area includes approved and unapproved sectors/colonies/localities, outgrowths, census towns, several revenue villages with settlements within the Lal Dora, and large tracts of recently incorporated undeveloped land. What explains the urban dynamics? Is this growth sustainable to drive transformative change? This question is addressed in light of cities' physical and demographic growth being faster than the planning process, which poses a severe challenge for urban planners. Data sources are derived and mapped using Sentinel-2 and census data. The analysis reveals a mix-bag of centripetal and centrifugal forces linked with globalisation, industrialisation and economic development in bringing about this massive change within the city. Naturally enough, this explosive growth has brought concerns around sustainability in its wake.

Keywords: urban expansion, sustainability, Gurugram Metropolitan Area, Municipal Corporation, Sentinel-2 data

India experienced a new phase of enhanced urbanisation in the post-liberalisation, privatisation, and globalisation period initiated in 1991. Concomitant urban expansion brings substantial social, economic and environmental transformations. Equally significant is that the urban places are more sustainable and equitable, and for that, they must be planned to protect and sustain all, leaving

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no one behind. Only such places can be leveraged in the fight against poverty, inequality, unemployment, climate change and other pressing global challenges. Sustainable urbanisation drives transformative change (United Nations Human Settlements Programme, 2020; 2022).

Urban expansion, extensively studied in geography and urban planning, refers to the process of urban growth that frequently results in the extension of urban development into rural areas and the conversion of farms and natural land into urban areas. It has positive and negative impacts on the environment, economy, and society. Positive impact includes economic growth (Deng et al., 2010; Li et al., 2020; Mahtta et al., 2022; Xie et al., 2020) that can lead to an increase in investment, job opportunities, and overall economic growth, particularly in the service sector, construction of new roads (Zhao et al., 2017; Shi et al., 2019; Maity et al., 2021) that improve the access of essential services. The negative impact contains environmental degradation (Redman & Jones, 2005; Mundia & Aniya, 2006; Wei & Ye, 2014; Imbrenda et al., 2021), shortage of housing (Chadchan & Shankar, 2012; Abhay & Sharma, 2022), traffic congestion (Zhao et al., 2010; Amezquita et al., 2021; Lu et al., 2021), loss of agricultural land (Fazal, 2000; Shi et al., 2016; Sumari et al., 2017; Radwan et al., 2019), coastal ecosystems (Lu et al., 2015), work-travel distance (Zhang et al., 2009) etc. Urban expansion has also been correlated with different dimensions like rail transport (Kheyroddin & Ghaderi, 2022), urban sustainability (Soliman & Soliman, 2022), urban heat island (Haung et al., 2015 and Zhao et al., 2016), football games (Brown & Lanci, 2016), land tenure security (Agegnehu et al., 2016), flood risk (Kasim et al., 2021), cost-benefit analysis (Lichfield, 2007) etc.

The truism is that city expansion in a developing nation like India often does not conform with the city's master plan or planning authorities. Often, growth is outside a city's administrative boundary, resulting in a lack of efficient land use planning and infrastructure on its outskirts (Hall, 2020). At the same time, satellite towns surround large metropolitan areas in India, lessening the population burden on the central city and providing access to affordable property to the city inhabitants and in-migrants. Several cities have developed around Delhi, the national capital, following a policy of decentralising industry from the city centre to the periphery (Krishnan, 2021). The process has reduced crowdedness and congestion in the national capital. These cities require efficient characterisation of the urban environment to support urban planning and management. With the advancement of geospatial technologies, time-series imaging in conjunction with an Earth Observation (EO) big data cloud computing platform can efficiently and affordably monitor urban growth (Yan, 2021).

The present work is focused on the Gurugram Metropolitan Area, a conspicuous example of intense urban growth in the post-liberalisation period, particularly since the turn of the century, which has been visualised spatially and demographically over the last three decades.

Methodology

Gurugram Metropolitan Area, notified in 2017, has grown through the areal extension and accretion of municipal corporations, census towns, outgrowths, and *Abadi village or abadi deh*[2] *(inhabited area)*. This paper aims to understand the growth dynamics and raise issues of its sustainability. The Gurugram Metropolitan Area land use/land cover (LULC), 2022, was derived from ESA Sentinel-2 imagery at a 10m resolution (Figure 4). It is the best choice for LULC mapping because of its high spatial, spectral, and temporal resolution. Census is referred to for people-related information.

Study Area

Gurugram Metropolitan Area covers 675 km² and is located near the Delhi-Haryana border on National Highway 48, just four kilometres from Indira Gandhi International Airport. It appears to be part of a big conurbation seen aerially. This metropolitan area includes the Municipal Corporations of Gurugram and Manesar and rural areas (Figure 1, on the following page)

Gurugram Municipal Corporation, a major constituent of the Gurugram Metropolitan Area, is one of the prominent cities of NCR besides Delhi, Faridabad, Ghaziabad, and Noida. Gurugram, also known as the country's cyber city, is a million city and one of the country's leading industrial and financial hubs. Business parks house the country's largest IT and Fortune 500 companies. Concomitant to this is growth in the real estate, automotive, and retail sectors.

Similarly, Manesar is one of India's fastest-growing industrial towns. Initially, it was developed as Industrial Model Township (IMT).

The Gurugram municipality is comprised of around 1119 localities/colonies. HSVP (Haryana Shehri Vikas Pradhikaran) sectors, group housing, builders' societies, the land around villages, and village settlements within Lal Dora, i.e., village *abadies* (Table 1).

Table 1

Approved and Unapproved Areas/Units in Gurugram Municipality

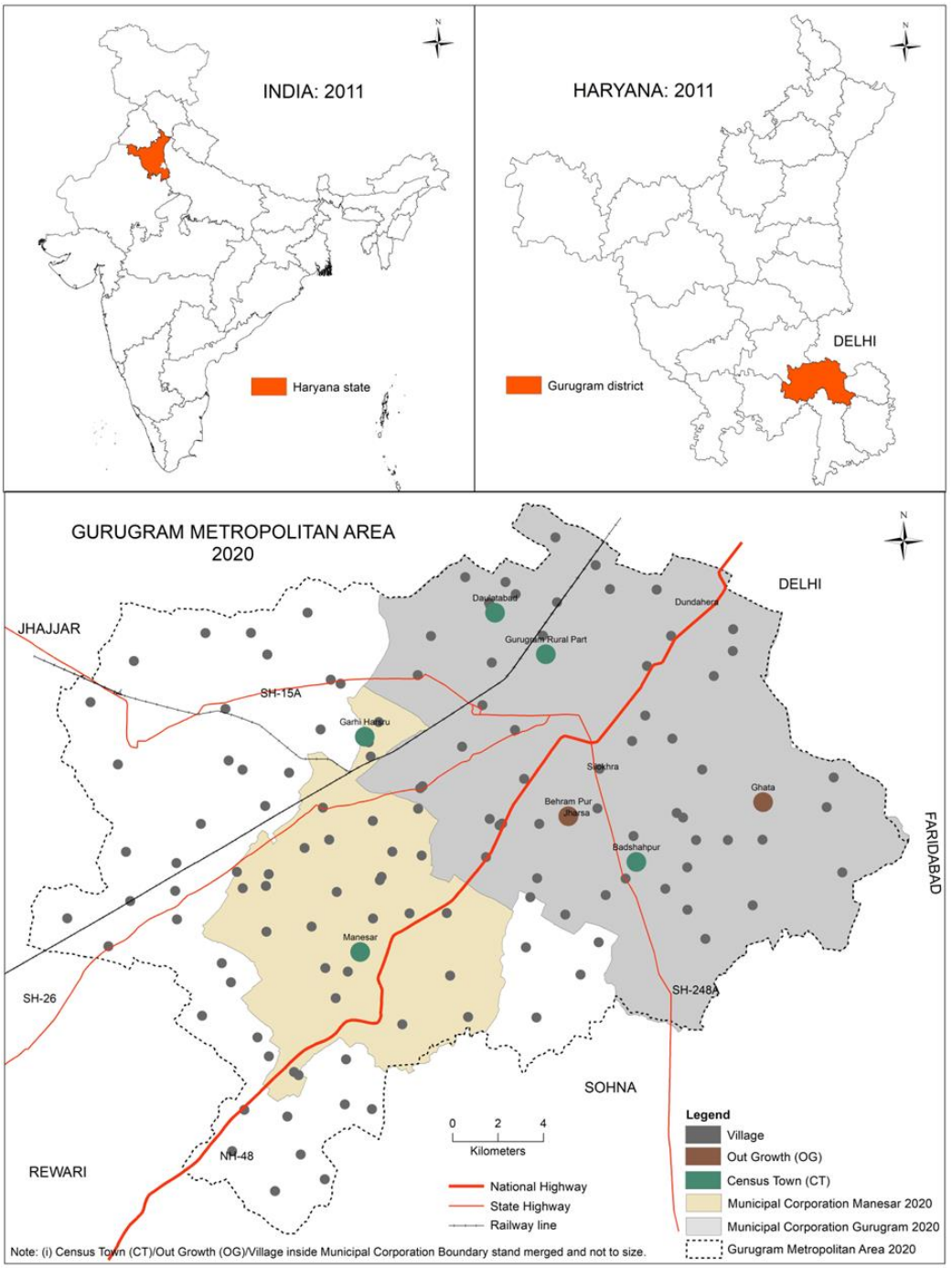
Locations			Units
Approved			804
Unapproved			315
	(i)	Unapproved sector	91
	(ii)	Unapproved villages/societies/colonies etc.	166
Lal Dora			58
Total			1119

Source: https://ulbhryndc.org

[2] 'Abadi Deh' or 'Abadi Village' is a term used in India to describe the areas within a village where houses and other buildings are located. These lands are mainly used for residential purposes and are usually considered outside agricultural or commercial land.

Figure 1

Gurugram Metropolitan Area Geographic Location in India and Haryana State



Source: Based on Census Data of 2001-2011 and Haryana Government Town and Country Planning Department Notification No. T&CP/GMDA/PF-89-III/2017/19918 dated 12 August, 2017.

Urban Growth Dynamics: Analysis and Discussion

Areal Expansion and Population Increase

The urban growth in Gurugram Metropolitan Area results from the growth pattern of its constituent units: The Municipal Corporations of Gurugram (the major constituent), Manesar, and the incorporated village *abadis*. The growth is the outcome of natural increase, jurisdictional change, and, in large measure, migration.

Gurugram, a Municipal Committee since 1961, transited to the Municipal Council in 2001 and Municipal Corporation in 2011, as per the Census.

> "The Haryana Municipal (Amendment) Act, 1994 (http://secharyana.gov.in/html/act5.htm) identifies "Municipality" as an institution of self-government constituted under section 2A, which may be a Municipal Committee, Municipal Council, or Municipal Corporation.
> 1) Municipal Committee is a transitional area with a population not exceeding fifty thousand;
> 2) Municipal Council is a smaller urban area with a population exceeding fifty thousand but not exceeding three lakhs, and
> 3) A Municipal Corporation is a larger urban area with a population exceeding three lakhs that is to be governed by a separate Act."

The change in its administrative status, coupled with the merger of Outgrowths– Silokhra, Jharsa; Census towns–- Gurgaon Rural, Dundahera, Sukhrali; and villages led it to expand physically (Table 2). Some Census Towns grew in situ while others were part of urban agglomeration. The addition of these lateral spreads (peri-urban areas and outgrowths) to the urban population has been sizeable and significant since 1991. Some village settlements within the jurisdiction of the municipal corporations have grown too large (Figure 2). Offering affordable housing finds favour with migrants, which supports the city's economy in formal and informal ways.

Table 2

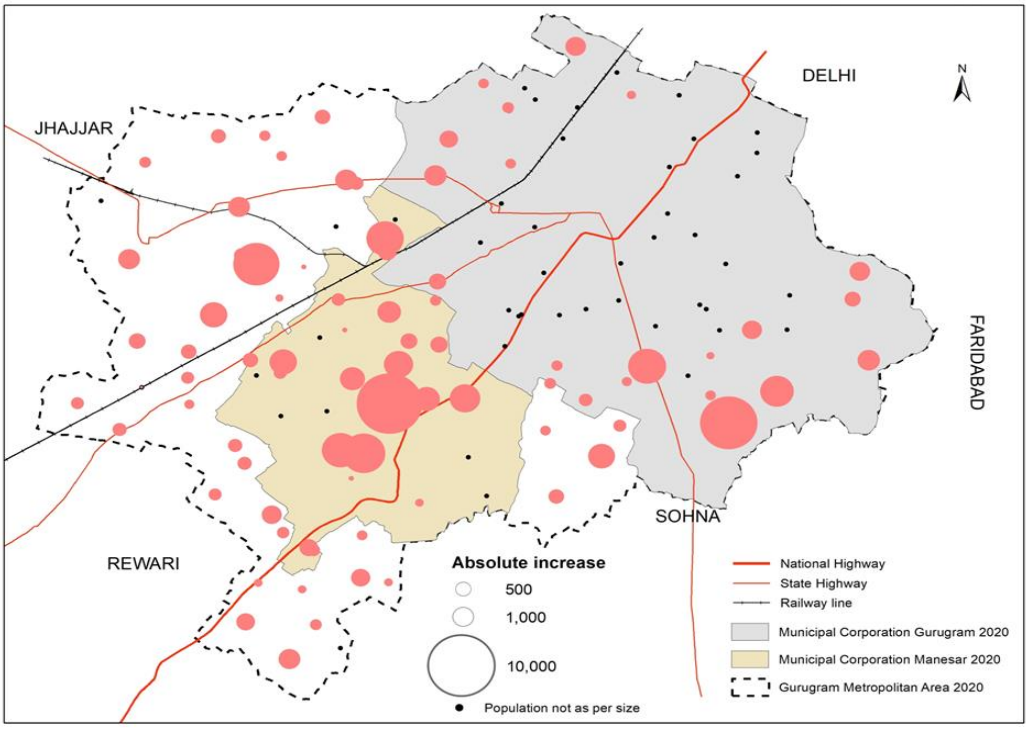
Villages/Census Town Merged Into Gurugram Metropolitan Area

Year	Villages/Census Town	Area in sq. km	Population	Gurugram MC
1971				15.33
1981	Gurugram Rural (CT) part	8.80	11762	24.13
1991	Dundahera (CT) Gurugram Rural (CT) part	5.75	21165	29.88
2001	Silokhra (OG), Jharsa (OG) Sukhrali (CT) Gurugram Rural (CT) part Dundahera (CT)	17.51	66491	47.39
2011	(i) (a) Daultabad (OG) Part, Ghata (OG) Part, Naya Behram Pur (OG) Part, (b) Badshahpur Part (CT).	(a) 31.25 (b) 13.79	25142 15593	Gurugram UA =198.39 sq. km.

Year	Villages/Census Town	Area in sq. km	Population	Gurugram MC
	(ii) Allawardi, Basai, Begampur Khatola, Behrampur, Cartarpuri Alias Daulatpur Nasirabad, Chakarpur, Choma, Dhanwanpur, Fazilpur Jharsa, Garoli Kalan, Garoli Khurd, Ghata, Islampur, Kadipur (Part), Kanahi, Khandsa, Kharki Dola, Mohammadpur Jharsa, Molahera, Nathupur, Pawala Khasrupur, Sarhol, Shamshpur, Sihi, Sikanderpur Ghosi, Tikri and Wazirabad.	106.49	118888	

Source: (i) Computed from A-04: Towns and urban agglomerations classified by population size class in 2011 with variation between 1901 and 2011 - Class I. https://censusindia.gov.in/census.website/data/census-tables#
*Note: The projected population of 2021 is based on the Compound Annual Growth Rate (CAGR)

Figure 2
Absolute Population Increase Between 2001-2011 in Gurugram Metropolitan Area Villages Notified by Haryana Government Town and Country Planning Department on 12.08.2017



Source: Based on Primary Census Abstract Total, Haryana, District - Gurgaon – 2001 and 2011. https://censusindia.gov.in/nada/index.php/catalog/20695
https://censusindia.gov.in/nada/index.php/catalog/6277

Manesar, with a 14.7 sq. km area and 23448 people, emerged as a census town in 2011 with a state-of-the-art industrial model town (IMT). It was upgraded to a municipal corporation comprising 161 sq. km in 2020.

Similarly, a discernible change in population size happened. Gurugram Metropolitan Area's population figures were used to analyse growth trends and decadal variations from 1991 to 2021. The population has grown extraordinarily over the last three decades, from 0.36 million in 1991 to 1.17 million in 2011 and 2.42 million (projected, as the Census has not been held) in 2021 (Table 3). The decadal growth, recorded and estimated, was 67.9 per cent, 286.5 per cent, and 107.3 per cent commencing 1991. The population is expected to grow to 4.25 million by 2031, as per Gurugram Master Plan 2031.

Tracing Gurugram Metropolitan Area's population based on its area jurisdiction in 2020 shows a considerable change. The rural-urban components' configuration has shifted in favour of urban in terms of population and area (Table 3; Table 4).

Table 3

Population Trends in the Gurugram Metropolitan Area From 1991-2021

Gurugram Metropolitan Area	Total population				Per cent share			
	1991	2001	2011	2021*	1991	2001	2011	2021
Rural	226995	323392	241351	114842	61.41	57.46	20.68	4.75
Urban	142651	239446	925560	2303656	38.59	42.54	79.32	95.25
Total	369646	562838	1166911	2418498	100.0	100.0	100.0	100.0

Source: (i) Computed from A-04: Towns and urban agglomerations classified by population size class in 2011 with variation between 1901 and 2011 - Class I.
https://censusindia.gov.in/census.website/data/census-tables# and
(ii) Primary Census Abstract Total, Haryana, District - Gurgaon – 2001 and 2011.
https://censusindia.gov.in/nada/index.php/catalog/20695
https://censusindia.gov.in/nada/index.php/catalog/6277
*Note: The projected population of 2021 is based on the Compound Annual Growth Rate (CAGR)

Table 4

Gurugram Metropolitan Area (sq. km.), 2020

	Name	Administrative status	1991	2001	2011	2020
1: 1A+1B+1C	Gurugram Metropolitan Area	Gurugram Metropolitan Development Authority	675.0	675.0	675.0	675.0
1A	Gurugram	M. Corp	29.9	47.4	198.4	310.3
1B	Manesar	M. Corp	-----	-----	14.7	123.8

	Name	Administrative status	1991	2001	2011	2020
IA+IB	**Gurugram + Manesar**		**29.9**	**47.4**	**213.1**	**434.1**
	Per cent share of the urban area		4.4	7.0	31.6	64.3
1C	**Rural Areas comprising villages**		**645.1**	**627.6**	**461.9**	**240.9**
	Per cent share of the rural area		95.6	93.0	68.4	35.7

Source: Computed from Gurugram Metropolitan Area Map 2020 and Census of India Data 1991-2011.

A note on migration status would be appropriate since many people are migrants.

In-Migration in Gurugram City

In Gurugram City, as per Census 2011, 71.6 per cent (6.45 lakh) people are migrants. Over 62.5 per cent (4.04 lakh) came in the nine years before 2011. An important aspect of interest is the volume of international migration. About 15456 or 2.4 per cent of persons were lifetime immigrants, mostly from Asian countries. Over 57.4 per cent (8875) of international migration was recorded in the nine years before 2011 (Table 5).

Within India, migrants are recorded as intra-state (intra-district, inter-district) and inter-state. 69.2 per cent of migration was inter-state, and the remaining was intra-state. The major source of interstate migration was from Delhi (1.32 lakh), followed by the three most backward states of India, namely Uttar Pradesh (1.1 lakh), Bihar (0.6 lakh) and Rajasthan (0.3 lakh) (Figure 3). Better work/employment and educational prospects, development of new industrial complexes, transport and communication and diversity of functions provided an impetus to facilitating migration in Gurugram.

Table 5

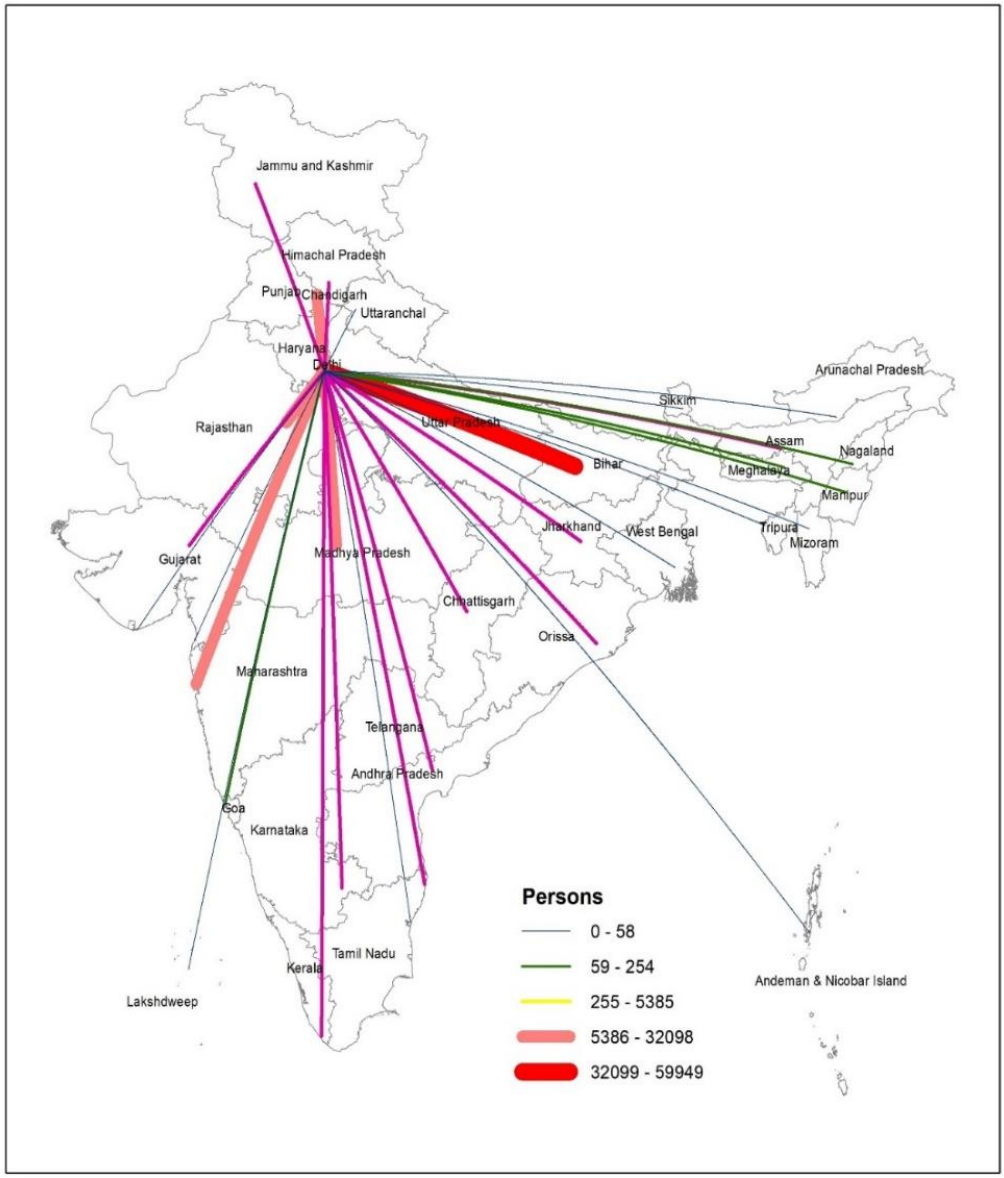
In-Migration in Gurugram City, 2011

Type of Migration	Total migrants	Work/ employment	Business	Education	Marriage	Moved after birth	Moved with household	Total Others
Nomenclature	Numbers	Per cent migrants						
Total	**6,45,568**	**30.05**	**0.98**	**0.56**	**13.50**	**2.37**	**41.67**	**10.88**
India	6,29,885	30.09	0.98	0.56	13.71	2.39	41.66	10.60
International	15,456	28.24	1.15	0.56	4.68	1.24	42.01	22.12
Unclassifiable	227	32.16	0.88	1.32	5.73	2.20	45.81	11.89
Within India								
A) Intra State	1,82,906	19.78	0.93	0.70	21.63	3.44	37.27	16.26
(i) Intra District	78,312	14.23	0.83	0.62	15.86	5.76	35.37	27.33
(ii) Inter-District	1,04,594	23.93	1.00	0.75	25.94	1.71	38.70	7.96
B) Inter-State	4,46,979	34.32	1.00	0.51	10.48	1.96	43.45	8.29
Age 01-09 years								
Total	**4,03,636**	**34.50**	**1.03**	**0.69**	**9.45**	**2.01**	**45.37**	**6.95**
India	3,94,575	34.43	1.02	0.69	9.58	2.03	45.35	6.90
International	8,875	37.42	1.26	0.81	3.84	1.25	46.22	9.19
Unclassifiable	186	33.87	0.54	1.08	4.30	2.69	46.77	10.75
Within India								
A) Intra State	84,933	23.72	1.13	1.07	15.93	3.53	46.38	8.23
(i) Intra district	34,116	18.96	1.07	0.96	12.43	6.47	48.14	11.98
(ii) Inter-District	50,817	26.91	1.17	1.15	18.28	1.56	45.21	5.72
B) Inter-State	3,09,642	37.37	0.99	0.58	7.84	1.62	45.06	6.54

Source: Computed from D-03 City: Migrants within the State/UT by place of last residence, duration of residence and reason of migration – 2011. https://censusindia.gov.in/census.website/data/census-tables#

Figure 3

Lifetime Migrants in Gurugram City, 2011



Source: Based on D-03 City: Migrants within the State/UT by place of last residence, duration of residence and reason of migration – 2011.
https://censusindia.gov.in/census.website/data/census-tables#

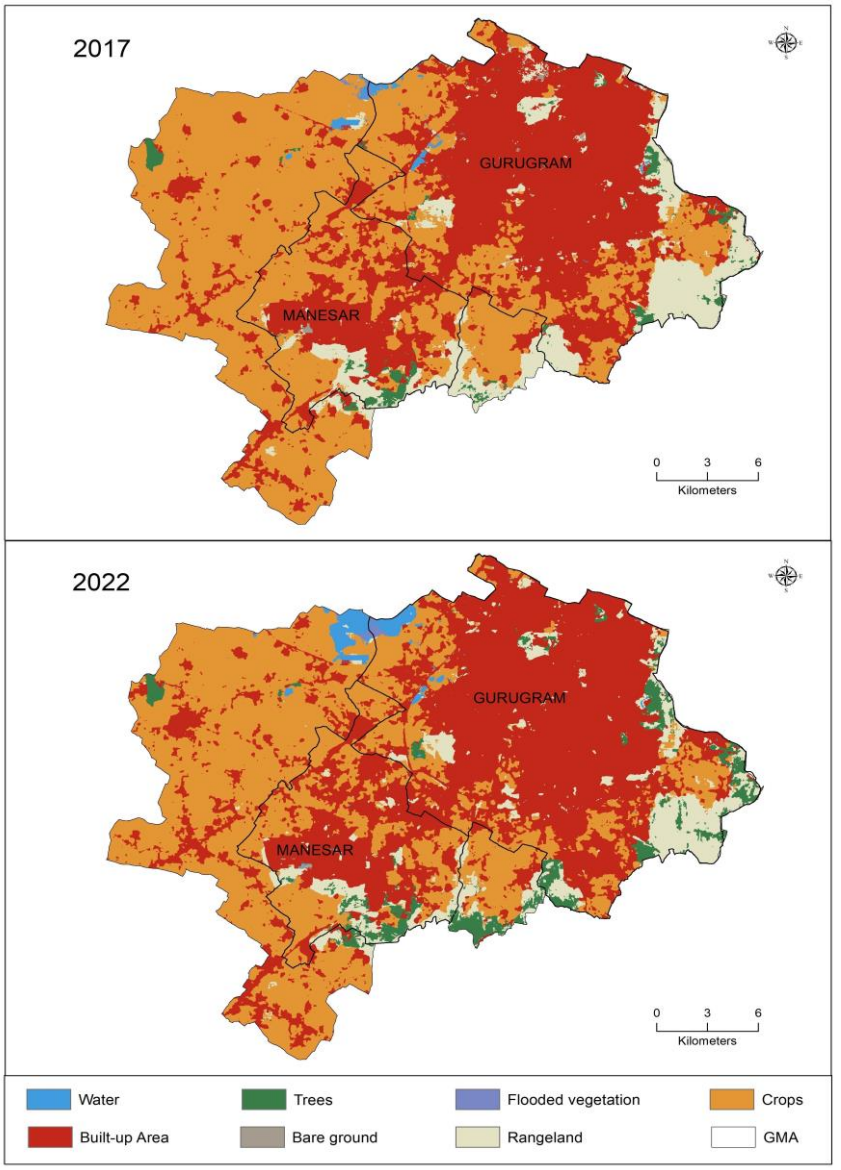
Consequently, upon peopling of the place, the built-up area increased.

Land-Use/Land-Cover of Gurugram Metropolitan Area

Two-thirds of the MCG area and nearly fifty per cent of MCM fall under the built-up category in 2022; the change has been appreciable since 2017. All this has been at the cost of loss of cropland (Figure 4; Table 6).

Figure 4

Land-Use/Land-Cover of Gurugram Metropolitan Area



Source: Based on Sentinel-2 data downloaded from https://livingatlas.arcgis.com/landcoverexplorer/#mapCenter=-3.286%2C31.34%2C3&mode=step&timeExtent=2017%2C2021&year=2022&downloadMode=true

Table 6

Land-Use/Land Cover of Gurugram Metropolitan Area and its Constituent Units, 2022

Land use/land cover category	GMA		MCG		MCM		Rural Area	
	Area in sq. km							
	2017	2022	2017	2022	2017	2022	2017	2022
Water	3.2 (0.5)	8.7 (1.3)	1.8 (0.6)	3.4 (1.1)	0.0 (0.0)	0.1 (0.1)	1.3 (0.6)	5.2 (2.1)
Trees	11.0 (1.6)	25.9 (3.8)	4.9 (1.6)	13.5 (4.4)	3.3 (2.7)	5.0 (4.0)	2.8 (1.2)	7.4 (3.1)
Flooded vegetation	0.6 (0.1)	0.9 (0.1)	0.2 (0.1)	0.6 (0.2)	0.0 (0.0)	0.0 (0.0)	0.4 (0.2)	0.4 (0.2)
Crops	333.7 (49.4)	283.9 (42.1)	77.4 (25.0)	55.4 (17.8)	58.5 (47.2)	48.9 (39.5)	197.8 (82.1)	179.7 (74.6)
Built Area	260.5 (38.6)	302.0 (44.7)	183.4 (59.1)	203.5 (65.6)	49.8 (40.2)	57.9 (46.8)	27.3 (11.3)	40.6 (16.9)
Bare ground	0.8 (0.1)	0.4 (0.1)	0.6 (0.2)	0.2 (0.1)	0.3 (0.2)	0.2 (0.1)	0.0 (0.0)	0.0 (0.0)
Rangeland	65.2 (9.7)	53.0 (7.9)	42.0 (13.5)	33.7 (10.9)	12.0 (9.7)	11.7 (9.5)	11.3 (4.7)	7.6 (3.2)
Total	675.0 (100)	675.0 (100)	310.3	310.3 (100)	123.8 (100)	123.8 (100)	240.9 (100)	240.9 (100)

Source: Computed from Sentinel-2 data of 2017 and 2022.
Note: Figs. in parentheses indicate % area.
GMA: Gurugram Metropolitan Area
MCG: Municipal Corporation Gurugram
MCM: Manesar Corporation Gurugram

Globally, it has been observed that as the urban population increased, the land area occupied by cities increased at an even higher rate. Between 1990 and 2000, a global sample of 120 cities showed that while the population increased by 17%, the built-up area increased by 28%. By 2030, the urban population of developing countries is expected to double while the city area triples (World Cities Report, 2016).

Gurugram Metropolitan Area, comprising the Municipal Corporations of Gurugram and Manesar, covers 675.0 km^2. Growing as a satellite town of the National Capital, Gurugram has urbanised phenomenally since 1991 and more so since 2001. It is essentially a post-economic reform occurrence as it grew industrially, becoming a hub of multinational companies, industry giants, call centres, software companies, shopping malls and skyscrapers. Besides being home to one of India's largest medical tourism industries, it is also known for its thriving finance and real estate. The Gurgaon-Manesar-Dharuhera-Bawal belt offers plenty of opportunities for entrepreneurs.

The expanding number of people has exponentially increased the demand for housing, infrastructure, office, industrial, commercial, and residential space in the Gurugram Metropolitan Area. The fast urban growth has been the result of the policy to decongest the national capital industrially, the creation of the National Capital Region Planning Board in 1985 to plan the shift of economic activities from Delhi to neighbouring states and to develop regional centres' infrastructure, the New

Economic Policy introduced in 1991 which opened the country's economy to the world through liberalisation, privatisation, and globalisation and creation of infrastructure and institutional functions. Gurugram Metropolitan Area grew due to its proximity to the NCT of Delhi. It is also well-connected to other states via highways and expressways.

The Question of Sustainability

The city's expansion has significantly altered the land use/land cover patterns and brought about social, cultural and economic changes that are continually changing. The rapid and extensive land-use changes, coupled with explosive growth, have raised sustainability concerns. The Sustainable Development Goals (SDGs) for sustainable cities include aspects of urban planning, design, and management, as well as clean air, water, and soil. They also address affordable, inclusive, and accessible transport, climate mitigation, building resilience, and integrating the needs of the impoverished. The challenge lies in achieving economic and social development without compromising the environment while enhancing urban residents' overall quality of life and well-being.

The unprecedented growth of this magnitude has placed tremendous demands on resources such as housing, water, sewage, energy, mobility, and biodiversity, leading to the generation of substantial waste. People are experiencing highly polluted air, mobility crisis, high road accident risk, and providing liveable conditions for migrants. The continual increase in built-up areas demands commensurate upgrading of physical infrastructure and strengthening institutions with an eye on sustainability. After all, transformative change will only come with sustainable urbanisation.

To start, the urban development approach adopted by the Haryana government is characterised by a random nature of growth in the city. In 1975, the state government enacted the Haryana Development and Regulation of Urban Areas Act, amplifying the involvement of the private sector in real estate development.

This resulted in the private sector acquiring a vast expanse of agricultural land. The city sprang up randomly and rapidly with rampant flouting of planning and construction norms. Numerous water bodies within the city were reportedly filled to facilitate construction, resulting in the blatant degradation of the ecology. This can be discerned from the fact that Gurugram was a relatively small urban area that acquired the status of a city in 2001. It became a Municipal Corporation in 2008 and MCG in 2017. Gurugram Metropolitan area comprises planned and unplanned areas, village *abadis*, and sectors built by HSVPN and private builders.

The economic dynamism in the area has also brought in many migrants working in the formal and informal sectors. This surge has heightened the need for housing and other essential civic amenities, including water supply. Migrants working in the informal sectors and low-paid jobs abound in scores of village settlements and unauthorised areas for want of living space, tremendously increasing

pressure on resources in these unplanned areas. Supplying water connections to the expanding population in slums may challenge the authorities, as it adds to the strain on water resources that are already under pressure, along with the broader urban infrastructure. What strategies can be employed to attain economic and social development without causing harm to the environment, all the while enhancing the overall quality of life and well-being of urban residents? Need to be worked out.

Another Achilles' heel is the intricate web of multiple urban governance bodies in the city, operating amidst overlapping jurisdictions and inadequate coordination. This results in a lack of robust accountability and prolonged delays in identifying and implementing solutions. The governance structure in Gurugram has consistently been fragmented, with entities like HSVPN (Haryana Shehri Vikas Pradhikaran), the PWD of the Haryana State government, MCG, GMDA (Gurugram Metropolitan Development Authority), and private developers shouldering responsibilities for service provision in various parts of the city based on their respective jurisdictions. Consequently, this situation has given rise to infrastructure challenges in specific city areas.

The Water Sustainability Assessment of Gurugram City by TERI (2020, p.14) found that unregulated and chaotic expansion in and around Gurugram City has destroyed wetlands, vegetation, and drainage channels. Due to land topography changes to maximise real estate development in Gurugram, water bodies have declined rapidly. Lowlands, once home to *johads* (traditional names for ponds and lakes), now have structures. In the future, extensive development may strain land and water resources, altering resource availability and ecology. Encroachments, unauthorised construction, and improper municipal waste and construction debris disposal threaten ponds and lakes.

Groundwater extraction has increased drastically in Gurugram as real estate development has outpaced city planning and public infrastructure related to water supply. Additionally, rapid city population growth has created an imbalance between annual groundwater extraction and recharge levels, which will worsen if not controlled. An unknown number of illegal bore wells makes monitoring and controlling illegal extraction difficult. The increase in built-up area and population has depleted its groundwater resource, which was rated as overexploited at 100 per cent in 2022 (Government of India, October 2022, p.157). The stage of groundwater extraction was 213.14 per cent in 2022.

The city's residential housing market, along with commercial and institutional establishments, is expected to be the main consumer of water in the coming years as the built-up areas continue to grow. The Pataudi, Farrukh Nagar, and Sohna tehsils currently contain most of the area's agricultural land.

The intensity of flooding during monsoons is expected to escalate in Gurugram city, attributed to a diminished catchment area, reduction in water bodies and green cover, and the expansion of built-up land.

The Centre for Science and Environment (CSE) has published a report indicating that the rapid urbanisation in Gurugram leads to significant environmental and sustainability issues. Failure to address this issue during the initial phases of development may result in significant depletion of resources, which can have detrimental effects on the environment and public health.

To achieve the sustainable development goals, the Guidance Framework lays out a plan for Gurugram to more efficiently use its resources, conserve water, energy, materials, and biodiversity, recycle and reduce pollution and waste, and ensure that all residents have equal access to these resources. These goals aim to realise what the New Urban Agenda and the Sustainable Development Goals (SDGs) have set out to accomplish. They are based on best practices and reflect the vital tenets of resource efficiency and savings policies at the state and national levels.

Conclusion

The present study has traced and analysed the urban growth dynamics in the Gurugram Metropolitan Area, focussed on post-reform changes based mainly on sentinel-2 satellite data and Census data. Benefitting from its location bordering the national capital, the policy to decongest Delhi, and the policy of the state government to create infrastructure to boost industrial development with the adoption of the policy of liberalisation, privatisation, and globalisation in India, it experienced tremendous dynamism in urban growth and land transformation attributed to industrialisation and its 'embeddedness' in a global network as a hub of multinational companies' offices and the centre of economic vitality worldwide. The large-scale change is essentially a post-2001 phenomenon. The built-up areas are expected to increase continually to three-fifths of the total area. A shrink in vegetation cover to less than the norm and depletion of water bodies raise concerns in the wake of pressing global problems arising from climate change and pose a challenge to policymakers. The scenario calls for the timely intervention of the political dispensation, policymakers, administrators, environmentalists, and all stakeholders to adopt sustainable practices for better land use management, such as ‘green investment for sustainable patterns of consumption and production, responsive and inclusive urban planning, the prioritisation of public health, and innovation and technology for all’.

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