



Smart Planning for Urban Resilience

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ABSTRACT: Building Smart Cities is impossible without smart and intelligent planning. Master Plans are a way of giving a direction for ordered growth and development in urban India. With increasing urbanisation and more than 40% of country's population residing in urban areas by 2030, the need for smart master planning is imperative. Over the past decade and a half, the situation of the urban areas has been worsening during the monsoons. It is important to recognize that urban floods begin with an unanticipated high rainfall, disrupting movement and communications apart from playing havoc with the urban environment and economy. The multiplicity of administrative set-up of cities with competing jurisdiction and function does not make things any easier. The focus remains on disaster and relief operations; however, it is an urgent requirement to look into the root causes of the problem, to analyze the inter-related issues that the recent floods across Indian cities have demonstrated.

Rapid concentration of the population in Gurugram leading to real estate focused development has resulted in the encroachment of the low-lying area and natural water channels, which is not sustainable from any dimension – environmentally, economically and socially. This paper takes an in-depth look at the case of Gurugram, the approach adopted for planning and urbanisation and resultant worsening of urban condition in the city over the decades. The city's double edged problem of acute water scarcity in summers and flooding in monsoons has been analyzed using Remote Sensing and GIS technologies. The need is a shift in the planning approach to be in line with the Sustainable Development Goals of making Gurugram inclusive, safe, resilient and sustainable.

Key words: Smart Planning, Urban Flooding, GIS, Gurugram

I. INTRODUCTION

Development leads to urbanisation, which is a process of change from rural to urban way of life over space and time, based on naturally evolved or acquired specialization (Mabogunje, 1968). It is defined as a process of growth guided by socio-cultural, economic, political and physical factors and spatio-economic planning interventions (Kulshrestha, 2006). Human population has lived in rural areas historically. In 1800, only 3 percent of the world's population lived in urban areas, which increased to 14 percent by the turn of the century. In 1950, 30 percent of the world's population resided in urban centers. In 2008, for the first time, the world's population was evenly split between urban and rural areas (Population Reference Bureau, n.d). As of 2016 54.5 percent of the world's population was residing urban areas (United Nations, 2016), which by 2050 is projected to be 66 per cent of the world's population (United Nations, 2014). As the world

urbanizes, sustainable development will be a paramount issue, particularly in the lower-middle-income countries, India being amongst those, where the pace of urbanization is very fast, about 3,000 times faster than the urbanisation triggered by industrial revolution in United Kingdom (Paul, 2016).

II. STATE OF URBANISATION IN INDIA

The process of urbanisation has been taking place in India since historical times, the pace has quickened during the last century due to westernization, industrialization and modernization (Mishra et. al. 2016). Ramachandran (1989) perceives urbanisation to have begun during the industrial revolution, when workers migrated from agriculturally dominant areas to manufacturing hubs or when the agricultural areas began to be put into non-agricultural use, primarily manufacturing resulting in the increase in the proportion of urban population to the total population.

Urbanisation in India gained momentum due to population influx at the time of Independence, when there was cross border migration as well as rural to urban migration. The population residing in urban areas in India has increased from 25.8 million in 1901 to 377.1 million in 2011 (Census of India, 2011). During the years after Independence, industrialization resulted in urbanisation when people moved from agrarian activities to manufacturing jobs in cities, especially in

the decade 1971-81. With a slight decline in urbanisation in the next decade (1981-91), India, again has been experiencing an increase in urban population from 1991 till 2011. The increase can be attributed to liberalisation policies of the government in 1990s, IT boom and focus on urbanisation for economic development in the 11th and 12th national Five Year Plans (Government of India, 2012) (Refer Table 1.0).

Table 1: Urbanisation Trend in India, 1941 to 2011.

Census Year	1941	1951	1961	1971	1981	1991	2001	2011
Percentage of Urban Population	13.8	17.3	18.0	20.22	23.73	25.72	27.78	31.1
Percentage Change	1.8	3.5	0.7	2.22	3.51	1.99	2.06	3.32

Source: Dubey, 2010 & Census of India, 2011

Historically, urbanisation in the country has been more of an organic phenomenon than a planned initiative (Mahavir and Bedi, 2013). It is estimated that 40 percent of India's population will be living in urban areas by 2030 (New Climate Economy, 2014), which will further increase to 60 percent by 2050 (UN-Habitat, 2016). Urbanisation has been increasing the stress in urban areas on socio-cultural, environment and infrastructure as the pace of urbanisation has been faster than the coping capabilities of authorities that manage the urban areas. With urbanisation, not only have the existing urban settlements grow in demographic and spatial context but the number of settlements in the urban category too increased from 3060 in 1947 to 7935 in 2011 (Census of India, 2011). The settlements that were villages became small towns and eventually many of these have grown into large urban centers mainly due to growth inducement in form of economic activities and government policies. The process has led to physical, socio-cultural, economic and environmental changes in and around these settlements.

III. IMPACT OF URBANISATION

Urbanisation has brought about many positives, but has not been free of negative impacts. It has increased the standard of living of the people and has given access to better facilities and amenities. It has provided education, health and transportation and communication facilities to a larger population. However, it has not been bereft of challenges that have been overriding the benefits provided by it.

The rapidness with which urbanisation has set in has deteriorated the environment. Issues have risen with respect to land, housing and basic services like water, sanitation, education and health. These problems exist not only in mega cities like Mumbai, Delhi, Kolkata and Chennai but in urban settlements of lower order as

well. Increasing migration to urban settlements from rural hinterland in pursuit of better economic conditions has gradually led to over occupancy of villages falling within the urban areas and to the growth of slum and squatter settlements where there is lack of basic facilities and amenities and the living condition is sub-standard. Such areas lack proper drainage and disposal system. Similar conditions exist in the periphery of the urban settlements as well.

The biggest challenge of urbanisation is environmental degradation. Degradation has set in all the three strata, namely, above, on and under the ground/surface. On ground/surface degradation includes, pollution of water bodies, drying up of ponds, river and lake pollution and surface contamination. Sub-surface pollution includes soil contamination, aquifer depletion and contamination and over/above ground pollution consists of air and noise pollution. The urban areas are faced with challenges of increasing slums, solid waste management and transportation, unregulated urban expansion, growth of congested urban villages, shortage of drinking water and sanitation and urban flooding, all leading to environmental degradation.

IV. URBAN FLOODING

Urban flooding, which is the focus of this paper, is inundation of land or property in an urban area caused by excessive rainfall, more than the capacity of the natural and man-made drainage system. Flooding in urban areas is not a recent phenomenon, though the reasons remain the same across most urban areas. As recorded by NIDM (n. d.), in Calcutta (no Kolkata) Lake Town has suffered heavy floods since 1970s due to mindless urbanisation, encroachment upon and filling-up natural drainage channels.

Innumerable illegal and planned colonies have emerged in the urban areas without due consideration to the drainage pattern and topography of the area, which remain the main cause of urban flooding

Urban flooding is significantly different from flooding in rural areas. Whereas in rural areas flooding is mainly due to breach of river or coastal flooding inundating the agricultural land and settlements, in urban areas impermeable surface cause flood. Urban flooding is due to a combination of factors that can be clubbed into three broad categories, namely, planning, meteorological and policy (Ahmed et. al., 2013) Encroachment of the low-lying areas, ponds and reservoirs and drainage channels mainly due to construction in these areas, increasing imperviousness leading to increased surface runoff and improper waste disposal leading to clogging of drains are the planning factors leading to flooding. As stated by (Ahmed et.al. 2013) urban heat island effect adds to the cause for extreme rainfall events and the lack of integrated flood control implementing agency magnifies the problem.

There has been a notable increase in urban flooding with major cities experiencing floods not once, but repeatedly over the years since the turn of the century. Instances vary from Hyderabad in 2000, Ahmedabad and Hyderabad in 2001, Delhi and Hyderabad in 2002 and 2003, Chennai and Bhabra in 2004, Mumbai and Bangalore in 2005, Surat, Vishakhapatnam and Hyderabad in 2006, Kolkata and Mumbai in 2007, Jamshedpur and Hyderabad in 2008, Delhi and Bangalore in 2009, Guwahati and Delhi in 2010, Guwahati in 2011, Ludhiana in 2012, Surat, Mumbai, Delhi, Bangalore and Kolkata in 2013, Srinagar in 2014, Chennai, Srinagar and Mumbai in 2015 and Gurgaon, Delhi, Bangalore and Ludhiana in 2016. Earlier excessive rainfall used to result in water logging in some low-lying areas; but in recent years roads become water channels during monsoons, with many areas of the cities either getting partially or completely submerged causing not only massive loss to life and property but brings all activities to a complete standstill.

Improperly planned transformation of these urban areas has altered the drainage characteristics of natural catchments by increasing the volume and rate of surface runoff. The areas that were seasonal water flow channels have been inadvertently converted into built-up, which causes obstruction in the water flow during monsoons resulting in the fury of floods. As the towns, have grown into cities and large urban areas, there has been expansion into agricultural lands and have eventually taken over any available space for building urban structures. The long existing ponds of the villages

too have been engulfed by built-up, even though these are known to be low-lying areas prone to flooding.

V. CASE OF GURUGRAM

Gurgaon city is located 20 KMs southwest of New Delhi, India's capital. Lying in the state of Haryana, Gurgaon falls within the National Capital Region. It has grown to be the financial and technical hub of North India. The demographic parameters as well as the spatial spread that is urban expansion in terms of space has been studied to understand urbanisation of the city.

A. Growth of Gurugram

Gurgaon is among the few Indian cities to have experienced unprecedented growth. The settlement of Gurgaon has been in existence since the times of Mahabharat (Government of Haryana, 1983). It has been under the rule of various rulers and became the East India Company's territory through a treaty of Surji Arjunaon in 1803 (Government of Haryana, 1983). The town of Gurgaon became the headquarters of the administration in 1816. By the mid-19th century, Gurgaon was part of the princely protectorate of Pataudi which is part of Gurgaon district today. The British rulers played their own part in adding to the layers of Gurgaon's past. All throughout, Gurgaon developed as a commodities and grain market of importance. The British integrated Gurgaon into the Punjab Province where it served as district and tehsil headquarters. At the time of independence, owing to mass-migration from newly created Pakistan, refugee camps like Bhim Nagar and Arjun Nagar were established (Government of Haryana, 1983).

After India's independence, Gurgaon continued to be a part of the state of Punjab until 1966 when Haryana formed a separate state. After the bifurcation of the state of Punjab, Gurgaon became an important market hub of Haryana within the old economic setup. By 1965, the authorities saw the potential evolutionary prospect of Gurgaon in relation to the power centre of Delhi, and developed the first master plan. Throughout these slow but major economic and administrative changes Gurgaon remained an agro-based feudal society, which depended heavily on the land for economic sustenance (Times of India, 2003). 1970s mark the beginning of the city's growth and development journey. But it has been since 1990s onwards that the huge population has moved into the city and giving it a growth spurt. This growth spurt has been an outcome of the new liberal system in the 1990s. As the city exists today, its anatomy can be divided into three parts, Old Gurgaon, lying on the left (when facing north) of the National Highway number 8 (NH-8).

The areas to the right (when facing north) of NH-8 have been built, 1990s onwards and are termed as New Gurgaon or DLF area, by private developers under the aegis of Haryana Urban Development Authority (HUDA). There exist villages that became urbanized as the city grew, which are pockets of very high population density.

Demographic Growth. The population of 2016 was 23,76,324 (Indiaonlinepages, 2016). The population has increased from 1,00,877 in 1981 to 9,01,968 in 2011 which is a 769.34 percent increase in 3 decades. In the Census years, 1991, 2001 and 2011 the population was 1,35,884, and 2,29,243 which further increased by 293 percent to 9,01,968 in 2011. Nearly doubling of population in two consecutive decades between 1941-51 and 1951-61 can be attributed to mass-migration of people from newly formed Pakistan due to the partition

of the country at the time of independence. Continued high growth rate of 50 percent (1961-71) in the following decade can be due to bifurcation of erstwhile Punjab and emergence of state of Haryana and in 1971-81 due to planned development of Gurgaon as per the first Master Plan of the city. The decade of 1981-91 experienced decline in the growth rate which again soared (refer Table 2). The increase in the population has been triggered due to setting up of Maruti factory in late 1970's. The astronomical increase in population in late 1990's and 2000's is due to liberation policy of government of India which resulted in foreign investments and coming up of IT Industry. The increasing population resulted in increased density. The population density in 2001 and 2011 was 716 and 1204 respectively which is an increase of 68.16% (Source).

Table 2: Decadal Population, Growth Rate and Projected Population- Gurgaon.

Year	Total Population	Growth Rate
1941	9,935	
1951	18,613	87.35
1961	37,868	103.45
1971	57,151	50.92
1981	1,00,877	76.51
1991	1,35,884	34.70
2001	2,29,243	68.70
2011	9,01,968	293.45
2021	30,00,000	232.61
2031	57,00,000	90.00

Source: District Gazette, 1910 and 1983, Census of India, 2011 and Government of Haryana, 2012

Spatial Growth. As stated above, historically, Gurgaon has been a commodities and grain market town. After Bifurcation of Punjab and birth of Haryana state, Gurgaon town started gaining importance with planned development beginning as an outcome of city's first master plan.

Table 3: Spatial Growth of Gurgaon City.

Timelines	Areas that developed
1970s	Maruti factory Area-Udyog Vihar phase 1 industrial area
1980s	Sec 31-38
1990s	Sec- 24,25,25A,26A,27,28,29,39,40-49, DLF phase 1, Sushant Lok 1
2000s	Sec 50-57 (Golf course road)
2010s	Sohna road and golf course road extension areas.

Source: Census of India 2001, 2011, and indiaonlinepages.com

The liberation policy of Government, setting up of Maruti Factory and GE-BPO led to spurt in city's growth. The area wise growth of Gurgaon can be traced through the table below (refer Table 3 and Map 1 below). There has been marginal increase in area from 1981 to 2001 but between 2001 and 2011 the increase has been from less than 50 sq km to more than 200 sq km due to the jobs generated in the city clubbed with private housing development which has been steered by government's development plans. The area is expected to be 332.72 by 2031 as per the Gurgaon Manesar Urban Complex Development Plan.

B. Impact of Urbanisation

Urbanisation has brought about many positives, but has not been free of negative impacts. It has increased the standard of living of the people and has given access to better facilities and amenities. It has enabled access to amenities like education and health and facilities like transportation and communication to a larger population.

However, it has not been bereft of challenges that have been overriding the benefits provided by it. The biggest challenge of urbanisation in Gurgaon is environmental degradation, in terms of slums, poor sanitation and solid waste management and pollution caused due to traffic and mis-management of water and waste and flooding of the city.

Urbanisation of Gurgaon has seen the change in the land use in the areas adjoining the town. As the town grew, the villages in the vicinity of the municipal area were converted from primarily agriculture and pasture lands to predominantly built-up consisting of housing colonies, roads and commercial spaces. As the land use of the area changed from having about 9 percent of area under built-up (Gupta and Nangia, n.d.) to more than 66 percent built-up in 2008, the fact drainage pattern of the area has not been taken into consideration is evident. While the master plan prior to 2001 indicated the preservation of major water channels (nallahs/drains) for rainwater harvesting and providing drainage in the city, the subsequent master plans have negated this aspect. During the period of real-estate boom between 2002 until 2012, construction activities were not controlled and blocked the drainage channels and ponds (Ramani, 2016).

The drains, bunds and ponds around the villages like Ghata, Jharsa, Chakkarpur, Nathupur exist partially as these were zoned as protected forests. Among these, specially, the pond of Chakkarpur has completely dried up, with the pond area being filled up with construction and other waste. The storm water drain built in the area is either clogged or of insufficient capacity to carry the heavy surface runoff during monsoons leading to submergence of the roads. The main nallah, Badshah Kost has been abandoned between Sectors 66 to 62 under the new master plans and channel of the drain exists in disjointed state between the sectors 55, 56, 61 and 62. An artificial linear storm water drain has been constructed along the southern peripheral highway to cater to the rain water drainage.

Ghata, the deepest bandh in the south-eastern part of the city that had a submergence area to collect the rain water as large as 100 hectares and functioned as the natural flood water storage site, has been converted to primarily residential area of sector-58. Many sectors along the Dwarka Expressway fall in the high flood level of the Najafgarh drain which may get submerged during extreme rainfall events in the future.

Ponds of varying sizes, have been an integral part of the village settlement, generally in the periphery of the settlement, act as recharge zones and help sponge flood water. All these natural low lying areas should be left vacant and not filled up with sewer, construction and

solid waste. In Gurgaon master plan area (Gurgaon-Manesar Urban Complex Development Plan 2031), there are 120 villages and each village has had at least one such pond. However, as of date, with rampant land use conversion, there remain only 56 such water bodies (refer Map 2).

Over the last 15 years the natural channels have been blocked and the ponds have been filled up for real estate development. Major drains like Badshahpur, Kadarapur and Nathupur have been reduced in their water carrying capacity due to construction activity or dumping of garbage and construction material. The impact of this is being experienced almost every year since 2011 in the form of flooding by the residents. The intensity and frequency of these events is increasing year on year.

July 2016 heavy rainfall impacted nearly all of Gurgaon. The main effected areas were sectors 14, 15, 17, 21, 38, 44, 46, Sushant Lok and DLF areas, Sohna Road, Gold Course Road, IFFCO Chowk, Sheetla Mata Mandir area, Civil Lines and Old Delhi Road. The NH-8 and Delhi – Gurgaon Expressway was too submerged under water at many places. Gurgaon falls among the top 5 cities in the country that are prone to flooding. (Geospatial World, 2016).

Gurgaon city lies in a low-lying region and receives water that flows down both from the Aravalli hills and Delhi's Chhatarpur area. Encroachments along the main Badshahpur drain and patchy concretization of drains has intensified the problem of flooding over the last decade and a half. Real estate driven urbanisation has led to drying up of the natural drains and ponds which have acted as sponge during the monsoons in absorbing the rain water and recharged the ground water. Rampant construction has led to total loss of the natural drainage channels and reservoirs.

The floods have every time caused traffic jams, damage to public and private property, mixing of solid waste in flood waters causing further choking of drains and mixing of fecal matter in the flood water due to open defecation resulting in vector and water borne disease. There has been long hours of disruption of power supply and telecommunication. The loss due to floods caused by heavy rainfall was estimated to be 500 crores (Kumar, 2016), with hours of overnight traffic jam on NH-8 (Ahuja and Behl, 2016). Measures need to be adopted by the authorities to take corrective actions to prevent loss and damage to life and property. The approach needs to be holistic and not piecemeal.

VI. SMART PLANING

Smart planning needs to regards water as collective public resource and manage it in a sustainable manner.

There is a paramount need to change the approach of making development plans. A shift in approach from making a prospective land use plan is required to make an environmentally integrated development plan wherein water resources are in ways that do not impair their present and future value, with policies that address both the current and long-term needs of humans and the environment. An integrated approach combining watershed and land use management with development planning, engineering measures, flood preparedness, and emergency management should be adopted for controlling urban floods (Gupta, 2012)

With the Smart Cities initiative of Government of India, it is imperative that the plans for the cities be wholesome and well-integrated with physical, environmental, social, cultural and economic milieu of not only the urban limits of the city but the region as well using geospatial technology. The approach to the urban flooding problem of the cities like Gurgaon needs to be two pronged, one corrective (as much as possible) and secondly proactive, which will be for long-term.

The corrective approach is to revive the natural flood protection systems consisting of natural drainage channels and ponds. In Gurgaon, where the channels have been disconnected due to construction of roads, the need is for building these connections so as to make the flow channels continuous and unobstructed. These areas can be further developed as green areas of the city, which shall eventually function as recharge zones and recreational area and be the lungs to the city. Where the revival of the channels and ponds is not possible due to the building having being constructed upon, attempt should be made to increase the porosity of the area by reducing the concrete surface like mixed pavements (grass/soil and concrete). Attempts should be made to increase the vegetation cover of varying types and height so that the surface run-off reduces to some extent.

The long-term approach is to integrate the existing water bodies and drains into the development plan in such a manner that these are not treated as sore and defunct areas that can be filled up to build upon. Even if, the existing ponds are not in a healthy state, attempts need to be made to revive these areas and made a part of green open spaces, which are mandatory in any city plan.

As much there is a need for a regional perspective in urban plans, it is imperative to create a national urbanisation policy as well at the national level, which essentially needs to define the direction in which urbanisation in the country should take place. This approach may control the over-crowding in the urban areas, which in recent years has created a demand of

rampant urbanisation of the productive agricultural lands.

VII. CONCLUSIONS

Urbanisation is imperative for the growth and development of the city. The process has been experienced by many cities in India, Gurgaon being among these. Though the changes brought about by urbanisation has provided access to amenities and facilities to a larger population, rampant development has not been bereft of degradation of the environment, specially disappearance of natural drainage channels and ponds that have acted as sponges soaking water and recharging the ground water. With these natural flood sinks disappearing, there has been frequent flood of the city and its intensity has increased over the years.

Corrective actions are required in preventive and proactive manner by ways of adopting integrated environmental approach to planning which is smart. Efforts are needed at city, regional as well as national levels to address the issue of urban flooding. While at the city level, corrective actions like revival of the drains and ponds is required, a regional approach is essential in planning for the future and steps are needed for a sound urbanisation policy that may intend to curtail migration to urban centers. It is required to make not only Gurgaon but other cities safe, resilient and sustainable.

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