

## Spatial Pattern of Brownfield-Greenfield development across Urban-Rural Transition: A case study of Kolkata Metropolitan Area

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### ABSTRACT

The rapid pace of urbanization has given rise to a new form of spatial development with cities that extend beyond the administrative and physical boundaries. This type of urban growth needs constant balance and augmentation of Urban core and the outward expansion toward the periphery. So a balance is to be maintained between Brownfield development to maximize the use of existing resources and Greenfield development to balance the diseconomies of congestion. But urban transformation is a continuum and the transition from rural to the urban area forms a fuzzy boundary. The place-based perception of urban-rural transition thus has ie urban, peri-urban and rural zones. Whereas the process based perception of urban-rural transition lies in the dynamics between Brownfield development and Greenfield development. The paper compares the place-based definition with that of a process-based approach to understand the urban-rural transition characteristics

**Keywords** – Brownfield, Greenfield, Urbanization, Spatial pattern, Kolkata Metropolitan Area

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### I. INTRODUCTION

#### I.I Background

The dynamics of urbanization is on the rise which is evident by the fact that around 55% of the world population now resides in urban areas and the percentage is projected to go up to 68% by 2050[1]. The interesting aspect of this world urban population is that 35% of it's projected growth between 2018 to 2050 is to be concentrated in India, China and Nigeria alone[1]. Considering only the absolute numbers of population growth we may observe some major urban transformations in India. Indian cities bring opportunities for growth and also challenges of accelerated demands for infrastructure, affordable housing, basic services, jobs etc.

The aspects that shape a city are its urban form, its constantly shifting population[2] and the interactions between them (both intra and inter). Urbanization is a multifaceted process and it is transforming the economic and socio-cultural fabric of large urban areas and remodelling their spatial structure. Understanding these urban transformations through assessment of the spatial dynamics of the city is, therefore, a preliminary step towards a better understanding of its economic drivers, social patterns and consumption requirements.

#### I.II Need for Study

Urban transformation is a gradual process that includes expansion of existing cities vertically and spatially through densification or growing outwards, the renewal of existing dead urban areas and a gradual shift of rural areas into urban areas. With the rising population, the city experiences a dual force of pull towards the urban core and a push towards an expansion outwards engaging the adjoining areas. The inward pull of the urban core drives the city towards a development that is characterized by Brownfield developments, Infill, Densification and more intense land use and the outward push lead to expansion of the city towards hinterlands creating new suburbs and Greenfield developments.

The spatial transformation of the urban area from a rural area is a continuum and is influenced by several factors[3]. Physical growth of the urban area, migrating population from the rural area, locating a new service node or manufacturing facility can be few of them. Understanding the spatial transformation of an urban area based on its current situation helps us to assess its probable direction of growth, the factors that are influencing it and the policies or strategic decisions that might help it to evolve.

To sum up, the growth of the urban areas cannot be stopped, but the nature of this growth always remains the question as in how much of the growth will go to infill development (both inner-city & suburban context) or Brownfield and how much will go to new Greenfield development (the new suburbs)[4]. The objective therefore of this paper is to study this fuzzy transition across the urban area, peri-urban area and rural area in the form of the Brownfield –Greenfield dynamics.

## II. LITERATURE REVIEW

### II.I Brownfield and Greenfield Development

Urbanisation scenario in India can be summed up under broad themes:

- Issues of urban agglomeration versus congestion within a metropolis:

Cities display very strongly the agglomeration of economies, as firms, skilled labour, institutions and other facilities locate themselves in close proximities. Subsequently, it also forms congestion diseconomies under the absence of resilient urban infrastructure, which may result in the form of deterioration in civil services, traffic congestion, pollution, etc. Under this circumstance, the urban cores might degrade drastically, so the challenge is to augment the advantages of agglomeration of economies and minimizing the congestion diseconomies. So there is a need for constant adaptation and augmentation in the form of Brownfield and Greenfield development.

- The synergy of metropolitan outgrowth with rural development

62% of the total GDP of India was contributed by cities and towns in the year 2009-2010. 2/3 rd of the economic output is contributed by the Indian cities though it houses a minor part of the country's population[5]. Firstly as the urban economy is expanding very rapidly, it affects rapidly increasing the rural-urban migration in search of jobs and better services creating a huge pressure on the existing urban area. Secondly, urban areas are expanding into rural hinterlands and many urban pockets are becoming dilapidated unable to adapt to the changing dynamics. So the urban development should be in synergy with rural development and provision of an optimal level of services is necessary.

An inclusive approach in this context is the need of the hour to minimise the rural-urban disparity.

- Disparities in small cities and towns:

42.3% of the urban population is concentrated in 50 cities with a population of more than 1 million. So India's urban growth has largely concentrated in big cities. Hence up-gradation at different is required to prepare to realise the potential challenges and

capacities of smaller towns adjoin the larger cities so the growth is inclusive.

Hence both Brownfield development and Greenfield development forms an inevitable tool to accommodate the growing population and urbanization pressures. If used as separate measures both have limitations and will not be able to cope with the rapid urbanisation phenomenon. Maximum utilization of urban core in the form of Brownfield development and augmenting it with much needed Greenfield development would help to benefit from the relative advantage and minimize the risks of both the approaches[6].

In favour of sustainable development, one may advocate brownfield development as it minimizes the consumption of land and eases pressure on the fringe area. It has been estimated that every hectare of land developed in a Brownfield project may save up to 4.5 hectares of Greenfield land in an outlying area from development. Brownfield development with closely-knit neighbourhood makes the best use of existing infrastructure and reduces sprawl. Whereas Greenfield development needs to spend on new infrastructure set up but it provides more space for expansion, less congestion and a pleasant environment. Greenfield development may be attractive to housing, retail developers or for locating light industries or amusement parks as it is easier to built-in terms of available space. Some Brownfield may have issues of contamination which might add to the expenses which do not occur in case of a Greenfield development[6][7]. The term Brownfield came to use around the 1960s in the UK where it was used to describe land so damaged by previous industrial or other development that it is incapable of beneficial use without treatment[8].

By the 1990s Brownfield in the UK meant any previously developed land, whether contaminated or not which may also be vacant, derelict or contaminated.

Around the 1980s the term Brownfield came to be used in Scotland, Canada and the USA. One of the major difference in perception of Brownfield in the USA is the fact that it is usually associated with known or suspected contamination from pollutant or hazardous material, hence not reusable unless properly treated. Summarizing all the categories of land that are included as the Brownfield in the different terminology or models.

- Previously developed land
- Lands that are being used currently due to actual or suspected contamination.
- A contaminated land that is currently being used wholly is not to be included as Brownfield

- Brownfield land can exist in both urban and rural setup and may also be located within a Green-belt.
- Some Brownfield site or a part of such site may be vacant land, derelict land or contaminated land.

It may be noted that the definitions of Brownfield can reflect the approaches utilised by different countries. Countries with low population densities consider Brownfield land as contaminated land, particularly land affected by previous industrial activities. Countries with high population densities, like developing countries definitions of Brownfield cover different spectra. Initially, it only included previously developed but now it also includes vacant land and currently used land with further development potential.

In most of the countries, the term Greenfield as a semantic counterpart of Brownfield. A Greenfield is defined as any parcel of land not previously developed, ie never previously built on or despoiled by mineral extraction or waste disposal. Some characteristics of a Greenfield site include[7]:

- rural or extremely low-density lands;
- significant natural, cultural, or agricultural resources;
- Locations outside recognized urban limits.

Urban sprawl and Greenfield development both occur at the fringes but unlike the former Greenfield development includes proper urban planning.

The success of creating Greenfield without sprawl depends upon how the developments are in symbiotic and contiguous with each other making it greater than the sum of its parts.

Three conditions are prerequisites for a Greenfield development minus the sprawl[7]:

- **Green Infrastructure:** Where should we build and, more importantly, where should we not build? Green infrastructure guiding the “hard infrastructure”.
- **Mobility and Access:** For residents, traffic may be the worst thing about sprawl. An integrated, multimodal transportation network should reduce automobile dependence by as much as 25 percent.”
- **Liveability and Lifestyle choices:** A third, more complex priority is providing a range of life and lifestyle choices a mix of housing types, sizes, and prices within regions and communities. Lifestyle options should include local or regional access to employment.

## II.II Urban, peri-urban and rural

The growth in urban areas can be attributed to three conditions: the natural increase, rural-urban migration and reclassification along with changes in municipal boundaries and outgrowths. It can be observed that natural increase in population in the urban area plays a dominant role in the growth of urban areas as compared to rural-urban migration. Another important observation is the fact that post-2000, a major proportion of the urbanization is attributed to changes in municipal boundaries, the inclusion of outgrowths and transition of rural areas to the urban areas. This aligns with the fact that most of the large metropolitan area has expanded spatially outward forming an urban agglomeration. These urban agglomerations comprise of the continuous urban area with its outgrowths. Along with the growth of the urban area, its interaction with the surrounding rural hinterland becomes a complex function of economic and social interdependency[9]. The interaction of urban area with its rural hinterland influences gradual change in land uses, livelihood pattern and a population density which leads to the rural to urban transition. Urban-rural transition is a continuum which occurs gradually. In between absolute demarcation of urban or rural lies the peri-urban or the rural-urban fringe.

TABLE 1:Percentage distribution of Urban Growth components[10]

Components	Percentage distribution			
	1971-1981	1981-1991	1991-2001	2001-2011
Natural increase	50	62.3	57.6	43.8
Rural-urban migration	18.6	18.7	20.8	20.6
Reclassification	31.4	19	21.5	35.6

The place-based perception of urban-rural transition thus has ie urban, peri-urban and rural zones. Whereas the process based perception of urban-rural transition lies in the dynamics between Brownfield development and Greenfield development. The paper compares the place-based definition with that of a process-based approach to understand the urban-rural transition characteristics

## III. METHODOLOGY

Urbanization is not limited to incremental growth of existing metropolis or addition of newly planned cities but also coalescing of settlements around various nodes and corridors of new opportunities. This has led to the formation of urban agglomerations and megacities. A megacity has a minimum of 10 million population and it’s spread is

beyond the defined administrative limits. The area selected for the study is Kolkata Metropolitan Area (KMA) that is amongst the five megacities in India along with Mumbai, New Delhi, Chennai and Bangalore[11]. KMA with three Municipal Corporations (including Kolkata Municipal Corporation), thirty-nine Municipalities and twenty-four Panchayat Samitis and extending over 1886.67 sq. Km is the largest urban agglomeration of eastern India. [12]Kolkata has significant importance in the development of eastern and the north-eastern part of India as there is no other major urban centre within 100 km unlike other parts of the country. From table 2 we can observe that the core of KMA has a sharp increase in growth rate in the decade 1991-2001 whereas the peripheral towns have a steady growth of around 2.7 per decade from the 1980s to 2001.

Post-2001 KMA experienced an overall negative growth rate especially the core city compared to the adjoining towns[13]. The socio-economic development and internal structure of the metropolis are inter-related and KMA provides an interesting study opportunity.

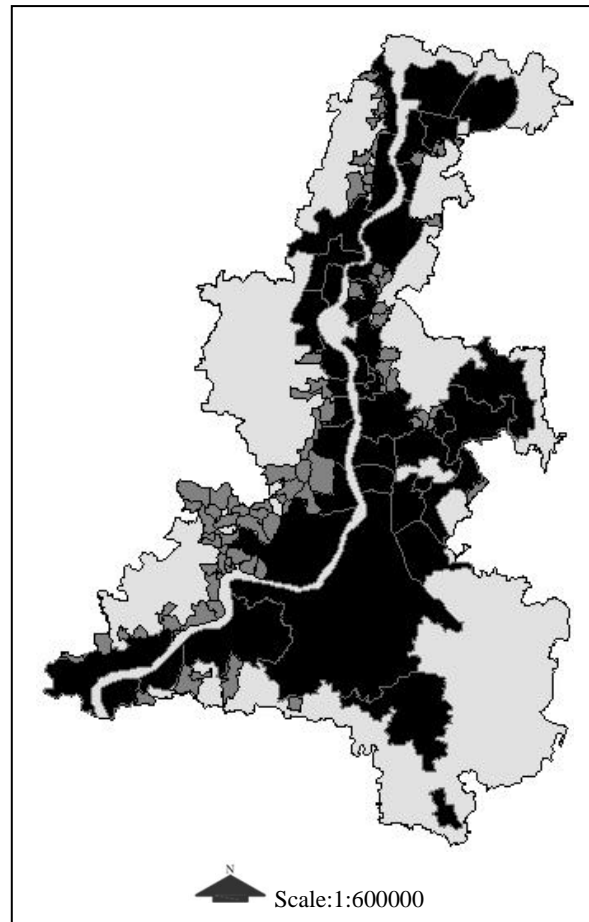
**TABLE 2:** Growth rates of Core and Periphery of Kolkata Metropolitan Area[14]

Distribution	1981-1991	1991-2001	2001-2011
Core(Kolkata and Howrah)	0.94	10.03	-9.64
Periphery (All other towns)	2.69	2.74	-0.65

The chosen study area is divided into three areas as (i) urban area (municipalities and municipal corporations), (ii) peri-urban area( Census Towns), and(iii) rural area. Census classifies an area as urban, based on two approaches[3]: an administrative one, in which statutory towns urban are declared urban and includes urban local bodies, municipalities, cantonment board.

The second approach considers demographic and economic criteria of(i) a minimum population of 5,000;( ii) At least 75 per cent of the male main working population engaged in non-agricultural pursuits; and (iii) density of population of at least 400 persons per sq. km[15] In the second approach rural area into classifies Census towns when the criteria are met. Census Towns are governed by rural local bodies or Gram Panchayats and not by any municipal bodies. So Census Town is a unit that has some characteristics of both urban and rural, rather it is in the transition from rural to urban, hence we consider them as the peri-urban area in this study[16] [17].

**Figure 1:** Study area of KMA



#### IV. RESULTS AND DISCUSSION

As the underlying theme of the paper is to assess Brownfield-Greenfield dynamics across urban-rural transition the findings are discussed under the following subsections:

(a) Temporal assessment of the development of the urban fabric. (b) Approaches of the development authorities towards the metropolis (c) Brownfield-Greenfield development in Urban-Rural transition zones

IV. I Temporal assessment of the development of the urban fabric.

- **Pre 1920s-** Agro-based economy, industries limited to the core of Kolkata and Howrah and few centres along the bank of the river.
- **1920s-1951-** Colonial industrialization on the rise. Chain of riverside industrial centres with rural hinterland leading to urban-rural imbalance. Huge refugee influx from 1947 partition of India leading to stress on infrastructure and slum breeding.
- **1952-1990s-** The problem of core congestion, housing shortage, rising demand for infrastructure, rapid urbanization escalated due to rise in population. This problem was aggravated by the second influx of refugees in 70s from Bangladesh

partition. Satellite towns like Salt Lake and Rajarhat started to develop.

• **1990s-till date-** Revival attempts followed by trade liberalization. Housing initiative, industrial belts and added agricultural land in east bank sub-regions. Kolkata Metropolitan Area's growth trend is primarily towards the east engulfing the wetlands. Though previous attempts have been made to promote the growth toward the west with the townships of Durgapur and Asansol as important hubs for the secondary sector yet Brownfield transformation has a trend of shifting toward the east.

IV.II Approaches of the development authorities towards the metropolis

• Pre-1700s -The major attention of the civic bodies was to collect taxes.

As markets in Kolkata grew at a steady rate so did the revenue collected. Other economic activities started around the Tank Square area which remains a major area for economic activities to date. No attention or investments were made for public health and public services.

• The 1700s to 1800s - The commercial activities shaped the city. Funds were raised to construct roads, streets, tanks, health and sanitation.

• The 1800s to 1900s- Commercial and industrial activities rose which attracted more inhabitants and attempts of planned development were made.

• Post-independence- Huge refugee influx contributed to the service sector and other commercial –industrial activities. But the civic bodies failed to meet the basic needs of the residents.

• The 1970s to 1980s- Physical infrastructures failed to attract new industrial activities and administrative boundaries were increased for better public health service management. For the fringe area majority of the population depends on urban centre for their primary source of income. Trade and commerce facilities are confined to Kolkata city. On an average land dedicated to public and semi-public uses is comparatively less in Kolkata indicating inadequacies in areas of educational, health and other facilities. The facilities available are mostly confined to Kolkata, with the near absence of facilities in the rest of the KMA.

• To ease the high concentration of KMA different strategies are proposed by authorities throughout. In the **1960s** it was expansion, planning for the region as the hinterlands. In **1966s** Binodal, Kalyani-Bansberia as counter-magnets of Kolkata-Howrah metropolitan core was developed followed by Multi nodal strategy of the 1970s. In **2001** 'Polynucleated Multicentre Infrastructure' and outer

ring road linking new centres. There is a probability that the KMA's physical boundary will be pushed further eastward, absorbing non-KMA areas along the road[19].

IV.III Brownfield-Greenfield development in Urban-Rural transition zone

The initial step is to download Landsat images for the year 1991, 2001, 2011, 2017 and extracting the study area which is Kolkata Metropolitan Area

Followed by geo-referencing it using the ground control points from the topographic maps of the survey of India.

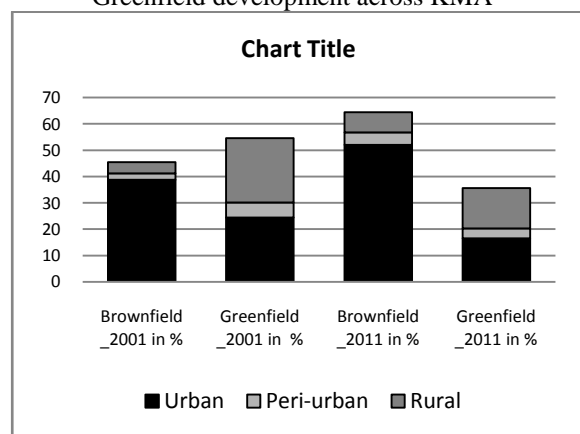
The next part is to analyse the land cover, for which following steps are needed to be done (i) False Colour Composite is to be generated, to locate heterogeneous patches in the landscape (ii) selecting the training patches that correspond to the FCC (iii) these training polygon coordinates are to be loaded in pre-calibrated GPS (iv) collecting the type of land cover of the selected polygon from the field and supplementing it with information from Google Earth. Land use pattern was classified using pattern classifier; in this case, the Maximum Likelihood Classification was used.

The image is reclassified into Brownfield and Greenfield's developments based on proposed measurement as[20]:

• Greenfield Development: Built-up pixels existing in the land cover for time T2 but not T1 and on the urban green area of time T1. This reclassifies new development that formed on the rural, low-density lands

• Brownfield development: Built-up pixels existing in the land cover for time T2 and T1.

Figure 2: The percentage share of Brownfield-Greenfield development across KMA



The sharp growth of the urban fabric is observed from the 1990s for the KMA area due to

growth in the urban core but from 2001 the growth slowed down

Greenfield development in 2001 shows new growth in both core area and also the peripheral rural area and peri-urban area. Whereas the existing Brownfield area is mostly concentrated at the core compared to the peri-urban and rural areas. Which means the urban core area is already densely built and growth is saturated.

For the year 2011, the majority of the growth in the urban fabric has slowed down. The rural area comprised the largest share of the Greenfield development showing some growth. The core area is saturated with brownfield development and the growth in the periurban area has also slowed down.

## V. CONCLUSION

For a growing metropolis, the initial phase is usually growth and further compaction of the urban core area which can be observed in the case of KMA. For the decade 1991 to 2001 we see a large share of Greenfield both in the urban core and in the rural and peri-urban area, which means rapid growth of the urban area and its spatial expansion outside the urban limits. As the urban area grows the growth in urban core gets saturated and the peripheral area continues to expand. KMA differs from this trend as the growth of both the urban core and peripheral area have slowed down sharply. For the decade 2001-2011 greenfield development of urban core has been very low whereas the growth in peri-urban and rural area continues the sluggish pace. As already mentioned that the basic services, healthcare and education facilities are low compared to the urban core in case of KMA. The study can be carried forward on the direction: does the availability of basic services has slowed down the overall growth of the Kolkata Metropolitan Area since the urban core is saturated

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