Urban Green Spaces: A Comparison of the Delhi NCR region and Kolkata Municipal Region

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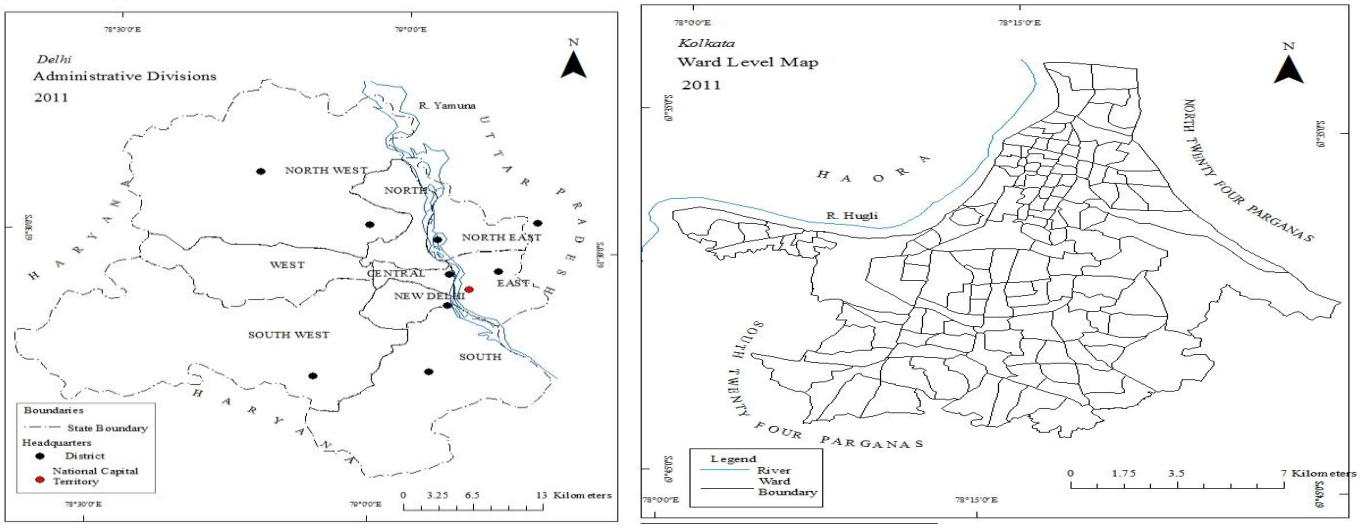
Abstract:
The process of urbanisation has led to fast-paced development in urban cities. The expansion of infrastructure hastaken a toll of the urban green spaces which are a source of life in these cities where problems like pollution have taken atollon the health of common man. Urban green spaces not only are life-giving but have anaesthetic importance which is pleasing to the eye and has a positive psychological impact. In light of the importance of urban green spaces, this paper illustrates the change in urban landscape and it impacts on urban green spaces in fast developing cities of Delhi and Kolkata. A comparative analysis using GIS methods has been made.

Keywords: *Delhi NCR, GIS, Kolkata. Urban green spaces*

1. Introduction

Delhi and Kolkata, emerging metropolitans of the country are rapidly developing themselves industrially in order meet the needs of their economy and to achieve prosperity. Delhi, NCT and Kolkata, being the



hub of economic functions in the North and the East respectively experience high migration of population from all parts of the country. As a result, the demographic pressure has increased to a great extent.

Fig 1: Administrative Divisions of Delhi and Kolkata (2011)

Therefore, it is not only the natural increase of population but also ahigh rate of migration that contributes to the population in the cities. The result has been rapid deforestation and removal of green covers. This section focuses on the vegetation cover in both the cities. Since, both the cities are almost on the same scale of development, therefore, both have been chosen for a comparative analysis. The analysis is based on two techniques – NDVI and Landuse Classification.

2. Study Area

Delhi is located in northern India between the latitudes of 28°-24'-17" and 28°-53'-00" North and longitudes of 76°-50'-24" and 77°-20'-37" East. It is located on the banks of the Yamuna in northern India and includes the Indian national capital city. It is the second most populous metropolis in India after Mumbai and the largest city in terms of area. The NCR includes the neighbouring cities of Baghpat, Gurgaon, Sonepat, Faridabad, Ghaziabad, Noida, Greater Noida and other nearby towns. The physiography of Delhi is dominated by the river Yamuna, and the Aravalli range, and the plains in between, formed by alluvium deposits of recent formation.

Kolkata is located in the eastern part of India between the geographical coordinates of 88º 30'E - 22º 33' N longitude. The city has been divided into different topographical regions. There are mainly five geographical units including east, west, north, south and central Kolkata. The adjoining regions include Howrah, Hooghly, North 24 Parganas, South 24 Parganas and Nadia. Kolkata is situated on the outskirts of the Sundarban Delta (145 km to the south of Kolkata). It's on the eastern bank of the river Hooghly. The topography of Sundarban is also typical as it the largest mangrove delta in the world.

3. Objective

The objective of the study is to understand the nature of green spaces in Delhi and Kolkata. An attempt to compare the status of green cover in both cities has been made. An investigation to understand the underlying causes impacting land-use/cover has also been attempted.

4. Database and Methodology

The study is based on theuse of satellite data. The details are given in the table below.

Table 1: Source of Data

Sr.	Satellite	Sensor	Date	Place	Resolution	Path-Row
1.	IRS-P6 Resourcesat 2	L4 fmx	24-01-2012	NCT Delhi	5 m	96/51, A
2.	IRS-P6 Resourcesat 2	L4 fmx	29-02-2012	Kolkata	5 m	108/56,C
3.	IRS-1D	L3	15-02-2002	NCT Delhi	23.5 m	96/51
4.	LANDSAT 7	ETM+	17-11-2000	Kolkata	28.5 m	138/44

The study is based on theuse of GIS-based methods. For the study satellite imagery for the year 2002 and 2012 has been used. The satellite imagery for 2000 is an ETM^{+} (Landsat 7) image and 2012 is a LISS (Resourcesat 2) image. Two methods have been used. The first method is the Normalised Difference Vegetation Index used to assess the vigour of vegetation cover to estimate the percentage change in area and the second methods are the Land-use/cover analysis based on which a change detection analysis has been conducted. The second method is a tool to identify theunderlying causes of change in the green cover of Delhi.

5. NDVI

The NDVI is an indicator of the quality of vegetation and extent of green cover. It is an important method to distinguish the green cover from anarea other than vegetation. File pixel value for vegetation in urban areas is almost close to 0 and usually, the value nears to 1 for built up and other features. The NDVI is

based on the principle of spectral reflectance of vegetation in the Infrared band. In the present study, 50 samples of vegetation were taken to calculate the NDVI. It is important to note that denser the vegetation higher is the NDVI. Also, the health of the vegetation is an important factor affecting NDVI values. Greener the vegetation, high is the NDVI value. In 2012 according to the analysis of imagery the NDVI value for Kolkata was 0.124 and for Delhi, the value was 0.1721. It has already been explained before that NDVI values for Delhi have declined as compared to 2002 while it has increased for Kolkata since 2000. File pixel values were significantly high in areas of city forests of Ridge in Delhi particularly in the Central Delhi while in thecase of Kolkata it was the Maidan and South Kolkata where pixel values were high. Though values for Kolkata have increased yet, the NDVI value remains low as compared to Delhi. This means the density of vegetation in Delhi is much higher as compared to Kolkata. However, it is important to note that area has a bearing on density as well since Delhi has an area much larger as compared to Kolkata. Moreover, the health of vegetation is much better in Delhi as compared to Kolkata. The greening initiatives in Delhi have been much more active due to the massive impact of pollution and industrial development as compared to Kolkata as a result of which afforest action and reforestation are highly promoted. Maintenance of parks, public spaces and greenery on the roads is much more taken care of as a part of the development of recreation in the city.

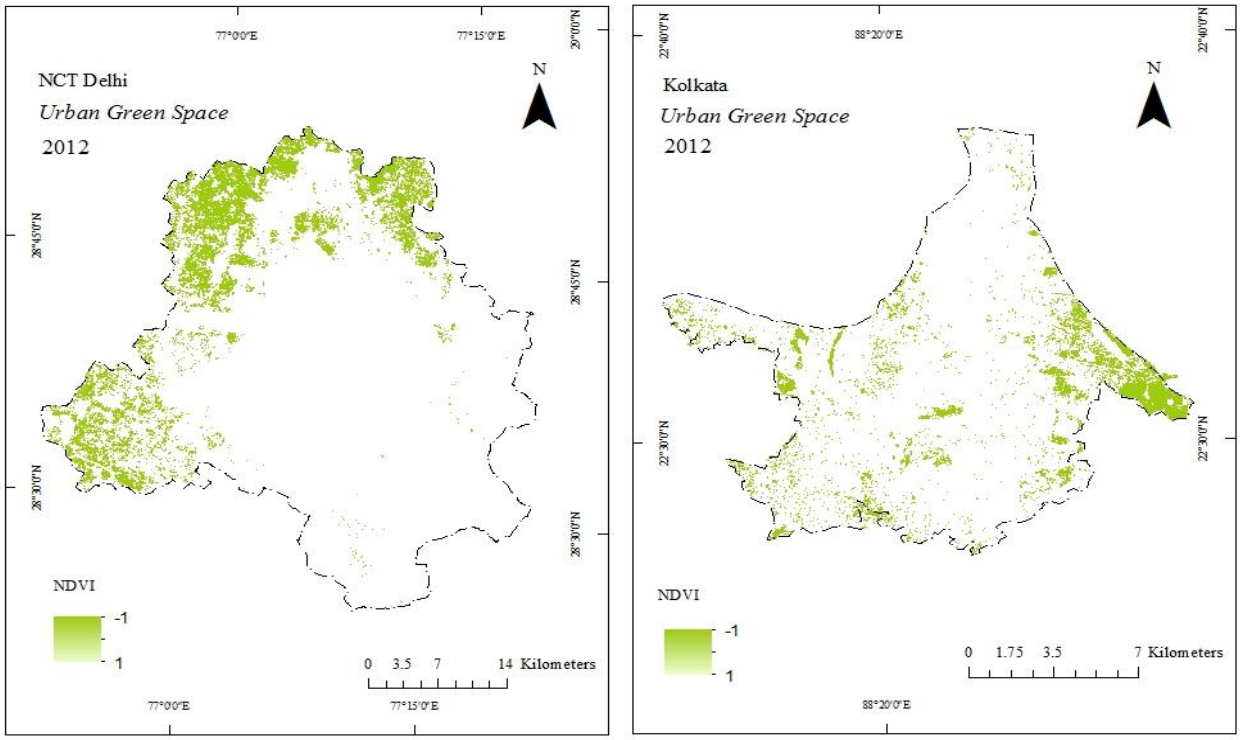


Fig 2: Demarcation of Green Spaces in Delhi and Kolkata (2012)

6. Land use Classification

This section deals with landuse classification in Delhi and Kolkata. In Delhi the landuse has been classified into four categories – vegetation, open spaces, water bodies and built up while in Kolkata the landuse has been classified into three categories – vegetation, waterbodies and built up. Kolkata is a congested city and almost all open areas have been now encroached upon and converted to built up, whereas in Delhi open spaces exist in the form of un-acquired land which has not been put to use, wasteland or may be barren lands.

7. Delhi

1. **Vegetation**: This category includes the public greens places, like parks, playgrounds, roadside greens and tree cover meant for the purpose of recreation. This also includes the city forests – The Ridge which acts as the lungs of the city. The ridge is a reserved forest which is divided into four parts –

Northern, Central, South-Central and Southern Ridge. Protected Forests also comprise of a small section of the city.

2. **Water bodies**: The major water body in Delhi is The River Yamuna which flows through for about a stretch of 22 km in the city. Other water bodies include water ponds, lakes, and step wells which are also referred to as baolis.
3. **Open Spaces**: Open Spaces comprise of the unacquired lands in Delhi which have not been put into use. It also includes wastelands and other barren land. Agricultural land left for reclamation also belong to this category. Besides this, the portions of Aravalis in the Southern part of Delhi which hardly has any vegetal cover also belongs to this category.
4. Built up: Built up comprises of all the concrete forms- settlements, commercial establishments as well as roads.

8. Kolkata

1. **Vegetation**: The green cover in Kolkata comprises of Public parks and spaces meant for the purpose of recreation. Also, natural greens include the Maidan which is the property of the Indian Army where the Eastern High Command of the Indian Army in Fort William is located. Maidan comprises of many of the city's playgrounds as well. South Kolkata is a prominent green area in Kolkata. It is mainly around the region of Rabindra Sarobar Lake where the city greens are located.

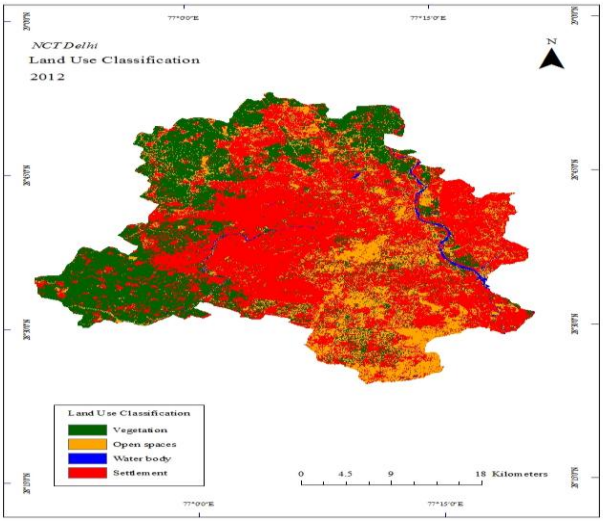


Fig 3: Land-use/cover Classification of Delhi and Kolkata

2. **Water bodies**: Kolkata has a large number of water bodies in the form of ponds and wells. Sincepisiculture is common in the region therefore many fisheries can also becited. Besides this, marshy areas in the Eastern Calcutta Wetlands which are marshy and an important fishing location are also significant water bodies.
3. **Built up**: The built up mainly comprises of all the concrete forms – roads, settlements, as well as commercial establishments.

9. Analysis

The comparative study of urban greening in Kolkata and Delhi is based on the analysis of pixel count belonging to a particular class. In Delhi categorization was done in four classes while in Kolkata it was only three classes. However, our primary aim is to analyse the ratio of vegetation to built up in both areas, therefore a difference in the number of classes is not bothering at all.

Table: 3.3.1 Land use Classification in Kolkata (in terms of pixel count)

S. No.	Classes	Pixel Count Delhi	% of total area Delhi	Pixel Count Kolkata	% of total area Kolkata
1.	**Vegetation**	17397242	29.27	1659488	22.98
2.	**Built up**	30444736	51.23	5066077	70.16
3.	**Water bodies**	541728	0.911	494292	16.84
4.	**Open Spaces**	11037766	18.57	N.A.	N.A.
	Total	59421472	100	719857	100

Table 3.3.2 Land use Classification (in terms of absolute area)

S. No.	Class	Area in Delhi (in sq kms)	Area in Kolkata (in sq kms)
1.	Vegetation	434.188	195.372
2.	Built up	759.818	596.433
3.	Water bodies	13.520	58.1934
4.	Open Spaces	275.472	N.A.
	Total	1482.99	849.99

From the above two tables we can infer:

1. The percentage of green cover in Delhi and Kolkata is nearly the same in terms of pixel count. However, in terms of absolute area, the extent of green cover is much higher in Delhi as compared to Kolkata.
2. The encroachment of built up in Delhi and Kolkata is well explained by the very high figures of 51 % area and 70% area under built up respectively. The figures are much higher in Kolkata and keeping in mind the areal extent of the city, it is well understood that Kolkata is ahighly congested city with high levels of urban encroachment. In terms of absolute area, the value of Delhi is high since the total area of Delhi is more than that of Kolkata.

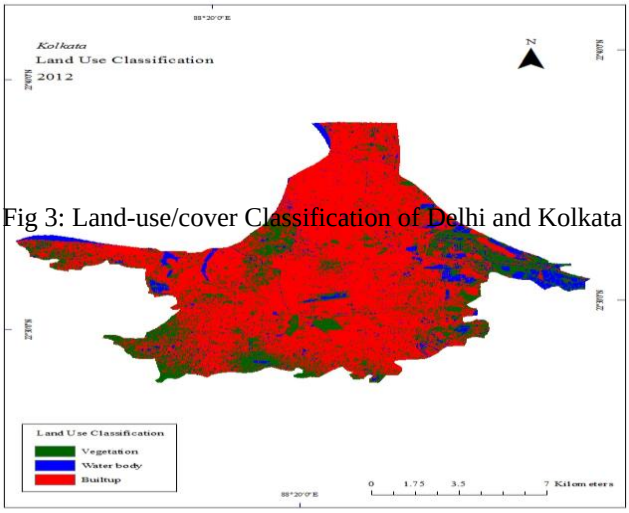


Fig 3: Land-use/cover Classification of Delhi and Kolkata

Fig 3: Land-use/cover Classification of Delhi and Kolkata (2012)

3. Open Spaces are lacking in Kolkata. This also explains the extent of urban encroachment in Kolkata since open spaces are occupied about 20% of the total area in Delhi.
4. Green ratio: The ratio of built up to green cover in Delhi is 1: 0.571 whereas in Kolkata it is 1: 0.32. This ratio is significantly low in Kolkata as compared to Delhi. This means that in any plot of the same size in Delhi and Kolkata, depending upon the ratio calculated the availability would be 57.1 % in Delhi and 32 % in Kolkata. The condition is much better off in Delhi as compared to Kolkata.
5. On the basis of the calculation of green area in Delhi and Kolkata, green space available per person can also be calculated given the population of both cities.

The Delhi Population (2012) = 20438946 and the Area under green cover = 434.188 km^2. Therefore, the available green space per thousand persons is 0.2124 km^2.

(Lang, 2008)Similarly Kolkata Population (2012) = 4324723 and the area under green cover = 195.372 km^2. Therefore, the available green space per thousand persons is 0.4517 km^2. Now, despite the fact that area under green cover is much larger in Delhi as compared to Kolkata and also the extent of urban encroachment is also high, yet the amount of green space per person available in Kolkata is higher than that of Kolkata. This brings us to the conclusion that population has a bearing on the green cover. Larger the population, larger the demographic pressure on resources, lesser is the availability.

10. Conclusion

Delhi is comparatively at a much better position as compared to Kolkata as far as sustainability is concerned. One of the probable reasons can be that Delhi is the National Capital territory and hence, caught more attraction in terms of being a model city that is able to strike a chord between its economic and environmental sustainability. Moreover, Delhi is at a much better level of development as compared

to Kolkata. Kolkata is the hub of commercial, financial and industrial activities of the Eastern region but is at a much lower scale of development in comparison to Delhi. In striving to become a world-class city with much better infrastructure and services, industrialization has become rapid in the city which has put a question to its sustainability. The decline of the green cover has been much more rapid in Kolkata as compared to Delhi over the decade. Moreover, the increase in built up has also been much massive in Kolkata as compared to Delhi. The percentage of built up in Kolkata was already high and a small percentage of increase was a very high contribution to the built up.

1. The comparison of urban green spaces on a recent note in Delhi and Kolkata was based on the results derived from NDVI and Landuse Classification. NDVI value in 2012 for Delhi was 0.1721 and for Kolkata, the value was 0.124. This indicated the amount of green cover is much more in Delhi as compared to Kolkata. With reference to landuse classification, Delhi has nearly 30% of the area in terms of pixel count and Kolkata has 23% of the area in terms of pixel count under green cover. With regard to build up, in the year 2012 Delhi has comparatively much less area as compared to Kolkata. Also, open spaces are lacking in Kolkata which makes it a congested city.
2. The Green Space Ratio with respect to built up in Delhi declined from 1:0.732 to 1:0.57 whereas in Kolkata it declined from 1:0.55 to 1:0.32
3. The Green space availability per thousand person is larger in Kolkata (0.47 km^2 per thousand population) as compared to Delhi (0.21 km^2 per thousand population). The role of thepopulation is important here since Delhi has a much larger population as compared to Kolkata.

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Weblinks

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