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Land Cover Change of Indian Cities:

A case Study of Noida and Bengaluru.

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Abstract - *Ever increasing populations have led to increased demand for urban land and thus high rate of urbanization is observed in the last decade. This comes at the cost of environmental degradation in terms of reducing green cover in Indian cities. The paper deals with spatial land cover analysis of Bangalore and Noida, immensely urbanized cities of India, through the technique of Normalized Difference Vegetative Index (NDVI), comparing the data for 2000 and 2016. The factors accounting for land cover change in these two metropolitan cities, in the past few years, are also discussed in the paper.*

Key Words: NDVI, Urbanization,, Grassland, Land Cover, Built-up

1. INTRODUCTION

Urbanization doesn't symbolizes growth only. Being a multi-directional term, growth can portray both a positivity in the trends as well as a decline in the respected condition.

Two cities which we have considered, have seen an immense upraise in the population growth pattern. Noida being a satellite city to the capital of India saw an inflow of migrants from every walk of lives, seeking to uplift their standard of living while, Bengaluru boasts of a robust IT sector which even emulates the scale of some of the developed nations.

It becomes imperative to regulate population spurt so as it doesn't affect the environment negatively. However, rarely it is seen that development efforts are put in to provide a sustainable environment for the people without deteriorating the environment. Land cover change and degeneration is what follows post establishment of settlements. This needs to be kept in check. This paper outlines the challenges in planning to ensure better delivery of basic services across the city.

1.1 NOIDA

NOIDA (New Okhla Industrial Development Authority) was formed under the U.P. Industrial Area Development Act, 1976, NOIDA has now established itself as one of the few planned, integrated, modern Industrial Cities in India. Well connect to Delhi through a well laid network of roads, this city is spread over an area of 20,316 hectares. NOIDA offers a pollution free high standard of living and highly supportive industrial environment with its unique infrastructure providing numerous, matchless facilities. As per provisional reports of Census India, the population of Noida in 2011 is 642,381; of which male and female are 352,577 and 289,804 respectively.

In 2015, Noida was ranked the Best City in Housing sector in India as per a leaning news channel. Noida dethroned Mumbai as the second-best realty destination. Noida has emerged as a hot spot for IT and IT-enabled services industry with many large companies setting up their businesses here. Moreover, as per Noida authority CEO, Noida is considered to be India's greenest city with about 50% green cover, the highest of any city in India.
Even after all these incessant "Green Noida, Clean Noida" drives, the land cover has immensely changed over the last decade due to the proliferation of the city because of urbanisation.

1.2 Bengaluru

Bengaluru is one of the fastest growing Indian cities and has attained a name of 'Silicon Valley of India' for harbingering and taking the lead in the growth of Information Technology (IT) based industries in the country. With the advent and growth of IT and allied sectors and the onset of economic liberalization in 1991, Bengaluru has spearheaded in service-based industries fueling substantial growth of the city both economically and spatially.
Bengaluru has become a cosmopolitan city attracting people and business both from within as well as across the nations. With an estimated population of 8.5 million in 2011, Bengaluru is the fifth most populous city in India and ranks 18th most populous city in the world. Bengaluru was the fastest-growing metropolitan city after New Delhi between the years 1991 and 2001, with a growth rate of 38% during the mentioned time-frame.

2 LITERATURE STUDY

2.1 Normalized Difference Vegetation Index

The NDVI, in the range of -1 to 1, is derived from red and near-infrared bands of images:

(NIR-Red)/ (NIR+Red)

The concept behind NDVI is that plants' chlorophyll absorbs sunlight, which is captured by the red band of the electromagnetic spectrum, whereas a plants spongy mesophyll leaf structure has a reflectance in the near-infrared band of the spectrum. (Lv, 2013)
The NDVI is the quantification of the energy received and energy emitted by plant communities. This index gives a value of how green a particular region is, i.e., the quantity of vegetation present in that area and its state of health of the growth. (C.L Meneses-Tovar)

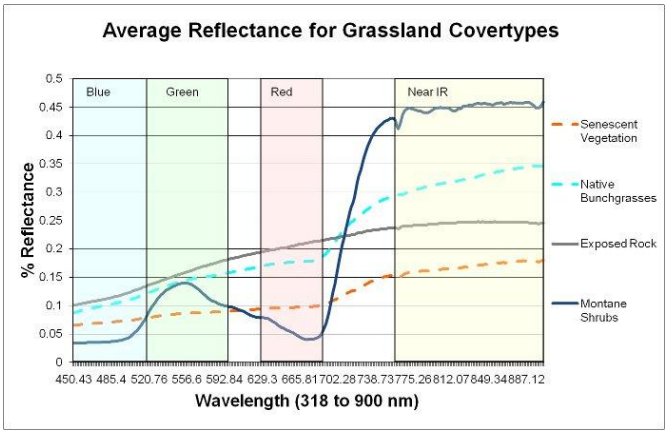


Figure 1: Reflectance of Grassland

Courtesy:
(http://wiki.landscapetoolbox.org/doku.php/remote_sensing_methods:normalized_difference_vegetation_index)

2.2 Urbanization

Urbanization is an index of transformation from traditional rural economies to modern industrial one. It is progressive concentration of population in urban unit (Kingsley Davis, 1965). Urbanisation is an increase in population and economic activities in the urban areas which leads to further development of towns and agglomerates to contain this rising population. It is a cause and effect of heightened economic progress in a region (Census of India, 2011). Population of India is expected to increase from in 1.2 billion (2011) to 1.3 billion (2021), increasing the degree of urbanization from 31% (2011) to 42% (2021). Since 1981 population of the country has increased 1.7 times while urban population has increased 2.4 times. This shows that urban populations will be increasing tremendously in the coming decades. (India, 2011)
Determinants of urbanization can be social, economic or demographic. Public policies and governance, stage of technological advancement, degree of socio-economic awakening; all these factors are social determinants of degree of urbanization. The economic determinants are; the type of economy, degree of development, degree of commercialization and extent of diversification of economy. And rate of population growth, magnitude of migration and population density are the demographic determinants of urbanization.
Migration plays a key role in urbanization. Migration as defined as movement of people from one place to another. (Geographic, 2005) According to United Nations, migration is the crossing of the boundary of a political or administrative unit for a certain period of time. Migration can be temporary as well as permanent. (Castle, 2000) Migration to urban areas from rural areas depends on many factors like lack of basic facilities and amenities in rural areas, high employment opportunities in urban areas, low and uncertain wages in rural areas and better living conditions in urban areas. (J. Corbett, 1885)
To provide the basis needs of the people such as housing and infrastructure, land is cleared off. This not only changes the land cover but has severe repercussion in the longer run. To provide a sustainable living, planning is imperative.

3 Methodology

Land use is the function of land, i.e., what a particular parcel of land is used for. Land varies in utility from area to area. In rural area, land use majorly includes forestry and agricultural land while, in urban areas land use could be housing or industry. Humans take the natural environment and change it for their own purposes. This paper will be highlighting how the land use and land cover of Noida and Bengaluru has been changed in the course of 16 years. Two imageries which have been used are that of April 2000 and April 2016.

Two separate images have been used to find the overall change in land cover. These includes multispectral satellite satellite imageries from Landsat-4 and Landsat-8 OLI/TIRS satellites respectively. Land cover has been shown using both the techniques of supervised as well as unsupervised thematic classification.
Classification of the Built up, Grassland and Dense Forest, has been carried out by using ERDAS imagine (v 15).

4 Case Study

4.1 Noida

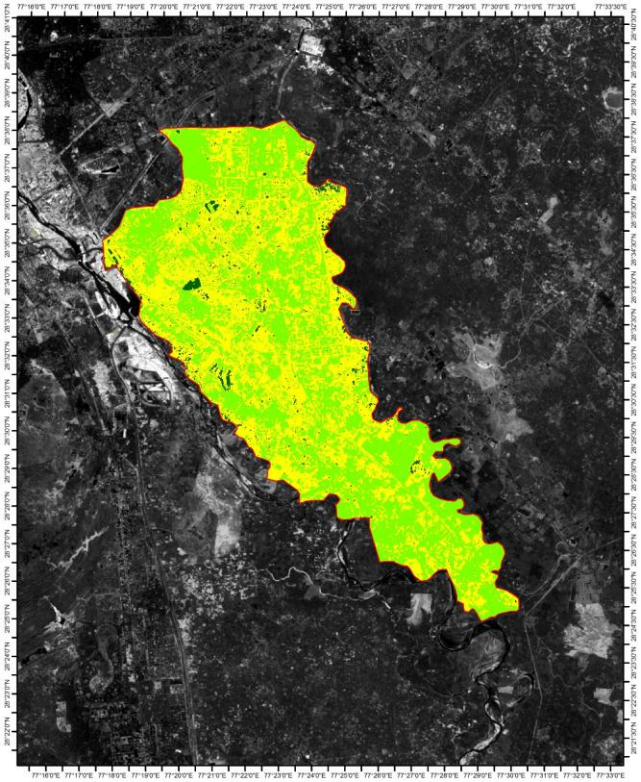


Figure 2: NDVI (Supervised classification), 2000

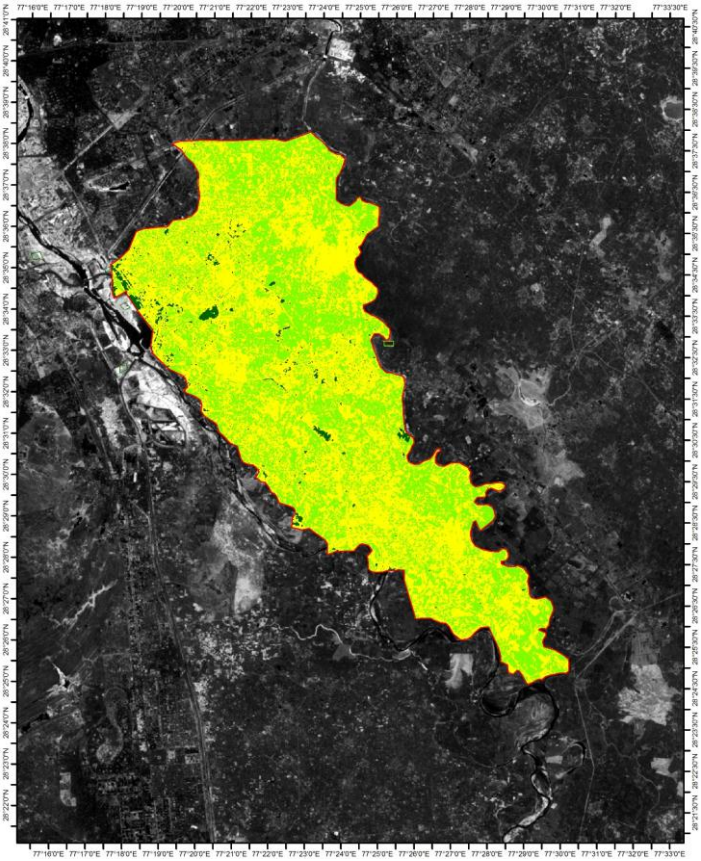


Figure 3: NDVI (Supervised Classification), 2016

According to the results achieved through this exercise, it can be seen that overall vegetation of Noida has reduced distinctively. (See fig 18 and 19)

Land Type	2000	2016
Forest	430.53	337.41
Grassland	10211.8	8377.56
No Vegetation	8532.9	10542.24

Table i: Area under different land cover

Table (i), gives an exact detail of how much the change is in terms of area under vegetation. From 430.53 Ha in 2000, forest reduced to 337.41 Ha. In 2016. While, grassland reduced from 10211.8 Ha. to 8377.56 Ha.

4.1.1 Major Changes

From the above images, it can be seen that the city doesn't have a definite pattern of growth overall but have spread across in every direction. In the recent years, due to intense land acquisition from the farmers at cheap rate and selling it to the builders for constructing huge projects, large amount of agriculture land has been converted in non-vegetation land. Major changes have happened around the expressway area where land was acquired from the farmers at very cheap rate and was sold to builders for high cost and with high FSI. This region has the highest number of high rise structures in NOIDA.

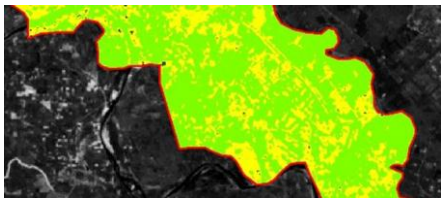


Figure 4: (a) 2000, Towards Greater Noida

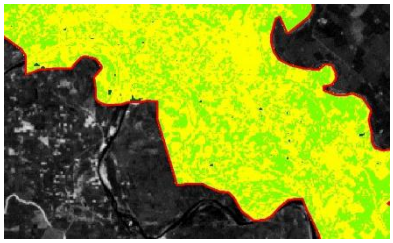


Figure 5: (b) 2016, Towards Greater Noida

It can be seen that though change in forest remains negligible in terms percentage (though, a reduction of 430.53 Ha. to 337.4 Ha), the grassland has reduced by dramatically by 10%. In 2000, area which came under grassland was 10211.8 Ha and in 2016, it reduced to 8377.56 Ha.

Reason to this is the development taking place throughout the city. It is one of the most promising real estate market and have a latent potential to become an IT hub. Hence, large scale residential townships are spawning throughout the city.

4.2 Bengaluru

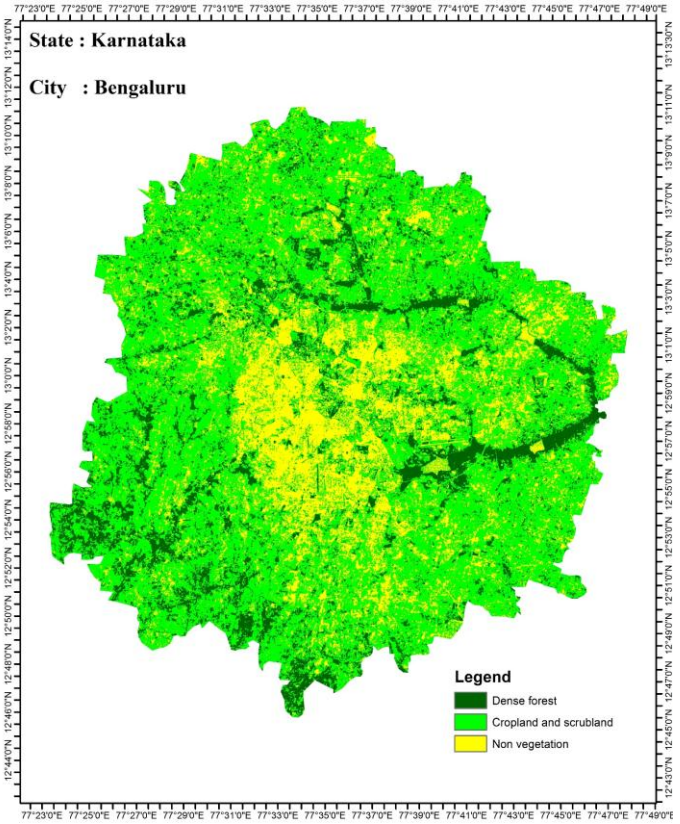
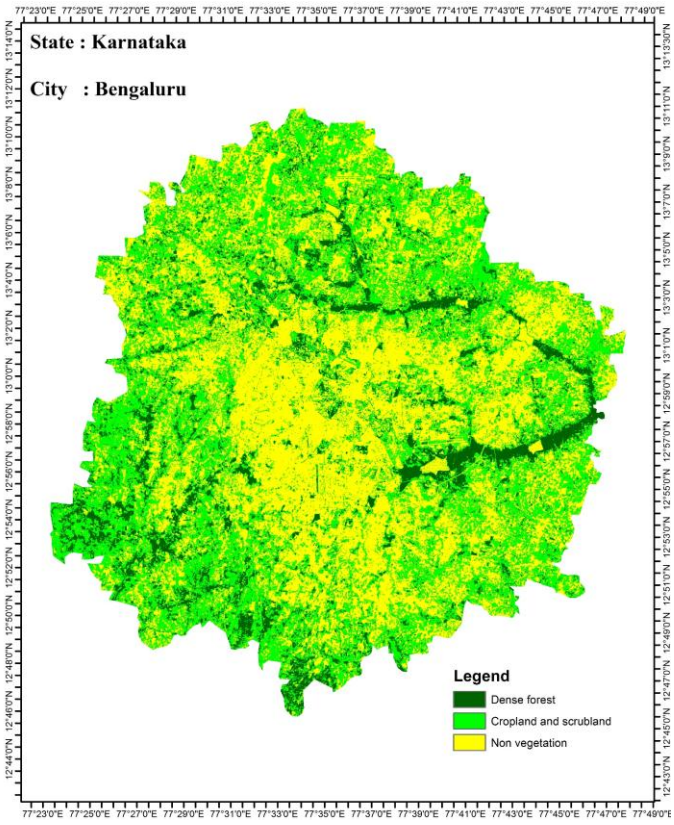


Figure 6: NDVI (Supervised classification), 2000



Land Type	2000	2016
Forest	20528.5	12721.7
Grassland	82120.8	56678.2
No vegetation	29765.9	60015.4

Table ii: Area under different land cover

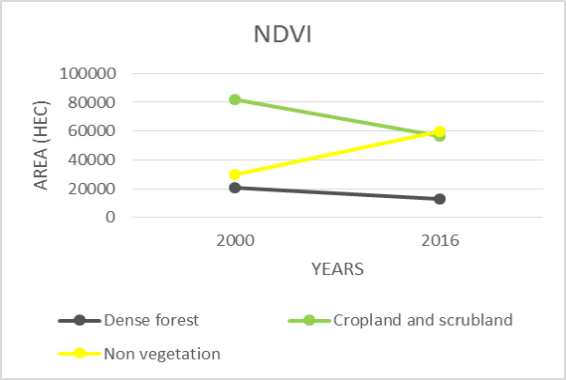


Figure 8: Graphical representation the change in land cover

When we draw a comparison between the two imageries in terms of dense forest and cropland, we can notice that, there is a drastic decrease in the area under the grassland and also the land under the dense forest. The other main reason is also being that, the grassland being converted to various other land uses in order to cater the growth. There is also another field which is the non-vegetation which actually shows the way the city is expanding

The images gives a clear picture of how the city has sprawled post the dotcom boom. Bangalore's IT industry boomed during this period itself with the advent of local and foreign IT companies.

Bengaluru is now in a league of its own, housing almost all the major IT firms like Microsoft, Google, Oracle, etc and as per permanent secretary for e-governance in the Indian state of Karnataka, Mr. Srivatsa Krishna, based on a recent McKinsey study, it will become the largest IT hub on the planet overtaking the Silicon Valley. Still the detrimental effects of urbanization can be see clearly in the above images.

5. Conclusion

NOIDA has been ranked as the second best city for real estate development and has undergone a drastic urbanization in the past 7-8 years. Not only the real estate, even other infrastructure facilities are getting an upgrade from time to time and this is beneficial for the city itself. Several other projects such as IT parks, International cricket stadium and even the country's first Formula 1 race track have graced the city in the last 5 years which has completely changed the face of the city. However, several steps have also been taken to preserve the green cover and the environment as a whole such as "preservation of Okhla bird sanctuary", "Night safari", Golf courses, Gardens and even terrace garden are being promoted to secure a sustainable development for the future.

Delhi, being the capital, attracts a large number of migrants every year. A study shows that nearly 4.58 lakhs people migrated to Delhi from 2001-2011. Hence, to cater the needs of the ever growing population in Delhi, cities like Gurgaon and Noida changed their policies regarding acquisition of land and other development regulations. A large portion of the work force in Delhi resides in these satellite cities like Noida, Gurgaon, Ghaziabad and Faridabad with Noida's share being the highest.

Bengaluru being one of the fastest growing metropolitan cities. The extent of urbanization is very high. Because of which we can observe a drastic change in the imageries especially in terms of the urban development. Due to this Land use change, many of the crop lands and also agricultural land and forests are getting converted to other land uses in order to cater this development. It is also observed that the water bodies are also getting less in number. This is also because of the Illegal encroachments and also development of those land parcels. This has caused diverse effect on the environment. Well known to be the green city, the vegetation in this area is a prime concern. But the prevailing conditions of urbanization has led to a lot destruction which a matter of concern. It is also observed that the development is largely taking place at the outskirts of the city where we can observe that a lot IT hubs and around which we can observe a lot of development. Another factor that can be noticed is that, in the year 2000 we can notice a lot green cover and dense forest in the outskirts which is diminishing rapidly. The chain or the system of lakes that is one of the important environmental factor is reducing day to day which has to be conserved to protect the environment.

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