Temporal Analysis of Land use Pattern Changes of Noida, NCR Using Geospatial Tools

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Abstract:

Land use and land cover changes due to fast growing cities over short time are very major environmental issues for developing countries. The change analysis of various land use pattern within the city are very important factor for proper management so decision makers and planners to take an effective measures. Satellite based earth observation and monitoring is very scientific and effective tool to detect and monitor land use changes.

In the present work an attempt has been made to analyze the temporal land use pattern changes for major land use classes of Noida, which is one the fast growing city of North Central Region (NCR) by using multi temporal satellite data of Landsat. Spatio-temporal assessment of land use pattern for the year 2010 and 2013 were analyzed using ARC GIS and ENVI software's. The results show the rates of changes are high in terms of conversion of open land into built-up land and increase of built-up area within four years. It is also observed that the surface water bodies are reduced quantitatively and qualitatively both. The results observed from the classification of low resolution satellite images are very important primary level quantification of land use pattern and changes in the area. It is also recommended that the area needed a detail land use planning based on very fine resolution satellite images for proper assessment of land use pattern for their sustainable utilization.

Key Words: Satellite Images, Land use pattern changes, ARC GIS, ENVI and Noida.

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Introduction

Urbanization can be portrayed as the rate at which the urban population of the district is expanding. In the course of the last few decades, there has been a critical change on utilization of Land use Land cover over the globe because of the over demand of the growing inhabitants. It is because of the fast change of human culture, modernization, industrialization and globalization. Relocation from rural areas to urban regions is dominating and pulls in immense masses because of the accessibility to various necessary facilities including educational institutions, transportation, shopping malls, parks and other recreational activities. Land use practices of a region are affected by various parameters specifically physical and chemical environments, socioeconomic factors and needs of the masses. Ever expanding demand because of fast development of populace has put huge pressure on natural resources of the country.

For sustainable development it is important to capture the magnitude of effects up on the environment in order make the right decisions and take measures and steps to minimize the negative effects of urbanization for both the urban population and ecosystems. The importance of preserving the functions of urban ecological spaces for the maintenance of a healthy environment cannot be stressed too much. Even though remote sensing cannot fully grasp the all intricate interrelations with the surrounding environment.

GIS and multi temporal remote sensing information has become very important in the investigation of such changes. LULC relates to the observable earth surface expressions, for example, vegetation, geography, water assets and anthropogenic features which depicts the Earth's physical condition in terms of the natural environment with man-made structures (Prafull Singh et al., 2012). Land use Land cover data are important components for observing, assessing, securing and planning for the earth's natural resources. Lately geo-spatial technologies are getting to be progressively vital in the improvement, management and observing of different earth resources. Remotely sensed multispectral data collected from satellites provide a systematic, synoptic ability to assess conditions over large areas and on a regular basis [1]. Within a concise time of time, the field of remote sensing will change significantly with the anticipated increment in number of satellites of numerous types (Glackin, 1998). However, the primary target of this paper is to investigate the role of geospatial technologies for land use mapping of one of the most populated and upcoming cities of India utilizing satellite information for sustainable usage of the earth's resources and their improvement. Therefore, serious problems associated with rapid development such as additional infrastructure, informal settlements, environmental pollution, destruction of ecological structure and scarcity of natural resources has been studied carefully using remote sensing and GIS technologies for a rapidly grown megacity(10) .

The present paper is one of the case study of Noida which is one of the fastest growing city of NCR Delhi, It can be seen that urbanization has occurred in such a fast rate in the city of Noida due to the different developmental activities. The rapid changes in the land use pattern and haphazard growth of city are major concern. In the present work an attempt has been made to analyze the temporal land use pattern changes for major land use classes of Noida, which is one the fast growing city of North Central Region (NCR) by using multi temporal satellite data of Landsat and their analysis.

Study Area

Noida, also known as New Okhla Industrial Development Authority (NOIDA) is spread over an area of 203 sq. kilometers, and has a populace of around 0.64 million is located at 28.57°N 77.32°E, lies in northern India in Gautam Buddha Nagar District of Uttar Pradesh state. It is bound on the west and south-west by the Yamuna River, on the north and north-west by the city of Delhi, on the north-east by the cities of Delhi and Ghaziabad, India and on the north-east, east and south-east by the Hindon River. Noida has hot and moist climate for the vast majority of the year. The climate stays hot during summers, i.e. from March to June, and temperature ranges from most extreme of 48°c to least of 28°c. Rainstorm season occurs during mid-June to mid-September with a rainfall of 93.2 cm (36.7 inches), but sometimes heavy rainfall causes flood. Temperatures tumble down to as low as 3 to 4°c at the crest of winters. Noida additionally has haze and cloud in winters. Because of a quick industrialization and urbanization and expanding foundation necessities in Delhi and Noida, biological irregularity is made in light because of overuse and exploitation of ecological assets. The urban communities are subjected to congestion and high
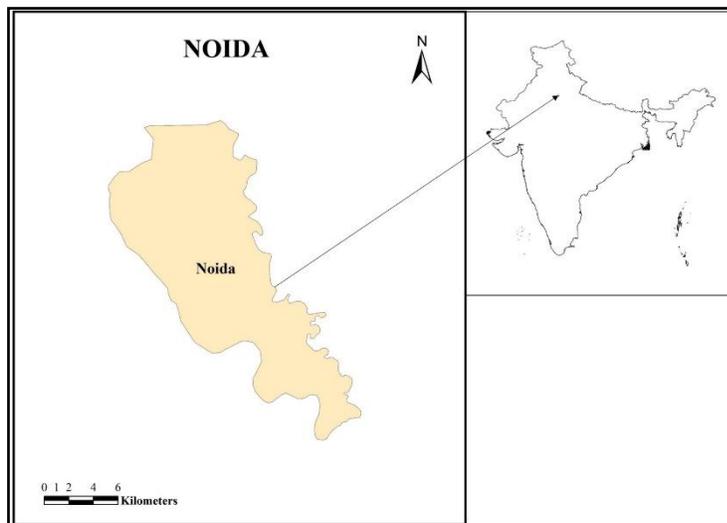
population density. Migration of large population is also having an impact in air and water pollution.

Figure 1: Location Map of the Study Area.

Data used and Methodology

Landsat TM images of 5th May 2010 and Landsat 8 image of 10th May 2013 downloaded from http://glovis.usgs.gov/ has been used for this study based on the obtainability of good quality images (acquired under clear sky conditions).They have a spatial resolution of 30 meter per pixel. The image classification process has been carried using ENVI 4.1 and Arc GIS 10.2.1 software using the following methods as shown on (Figure 2).

Table 1: Table for Data used

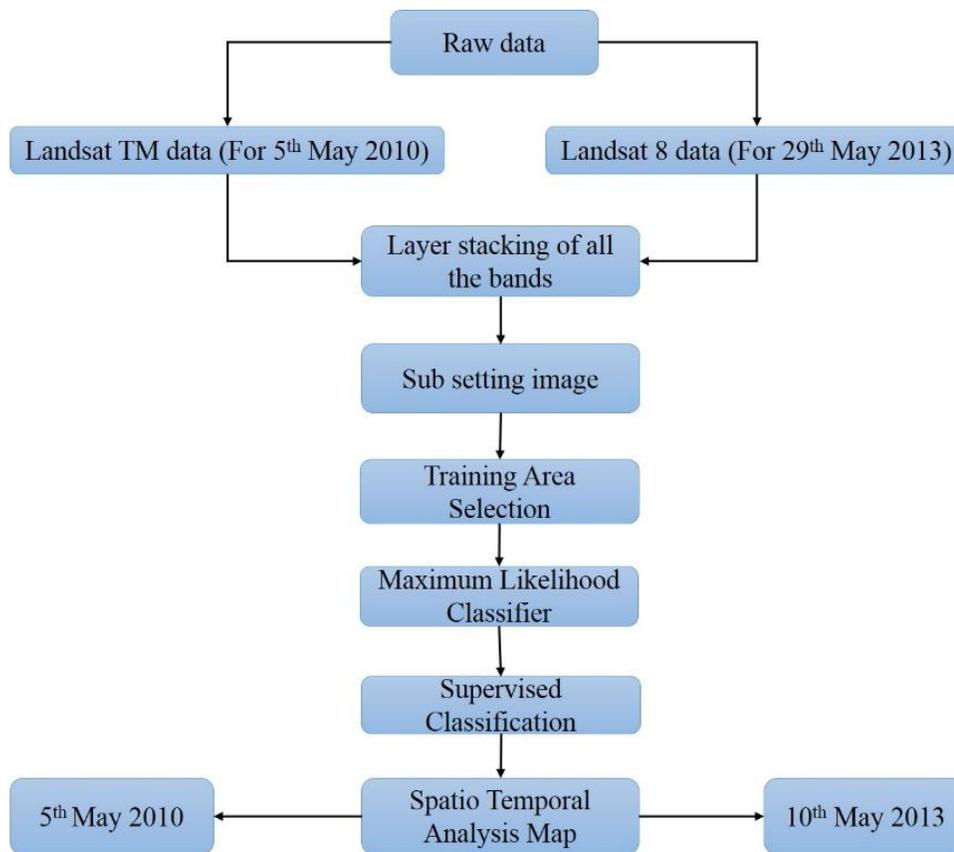|	
Raster data	• **Landsat TM (5th May 2010)** • **Landsat 8 (10th May 2013)** Data Source: http://earthexplorer.usgs.gov/
Vector data	• **DIVA GIS** Data Source: http://www.diva-gis.org/Data
Software's used	• **ENVI 4.1** • **Arc GIS 10.2.1**

Figure 1: Flowchart for Methodology

Land use land cover classification has been carried out by using the multi-spectral satellite image of Landsat TM and Landsat 8 data. After acquiring the raw data, all the bands have been layer stacked and then the Image interpretation can be performed in two most widely used methods e.g. digital analysis and visual elucidation. In the digital classification step, training areas for distinctive classes are characterized on the satellite image based on the different band combinations of the spectral bands and their response pattern.The features of training sites were digitized and statistical characterizations of the data were made. known as signatures and taking into accountthese training areas satellite imagery is classified into distinctive classes utilizing parametric or non-parametric classifiers (Lu et al., 2007).Finally, the image classification has been carried out by the method of Supervised Classification utilizing the Maximum Likelihood Classifier, a statistical decision in which the pixels were allotted focused around the class of most elevated likelihood. Land use Land cover was classified into four classes i.e., Built Up, Vegetation, Water body and Cultivation and others.

Results and Discussion

Land is one of the most important natural resources. The landuse pattern and its spatial distribution are the prime requisites for the preparation of an effective landuse policy needed for the proper planning and management of any area. The classified land use / land cover map of the area shown in Fig. 3 and their spatial distributions are given in Table 2. The different Land use Land cover classes extracted from the satellite imagery includes Built up, vegetation, water bodies and cultivated land and others.The classified map of the study area of Noida showed that majority of the lands were occupied by built up over the years. In statistical terms the percentage of Built Up in Noida area was 29.52% during 2010 which was increased to 40.03% in 2013.It is also showing some positive land use analysis in which the wastelands are getting reduced and is getting replaced by vegetative area which is showing an increasing trend over the years. With the increase in urbanization, the urban vegetation is also increasing with decrease in the Open Land. It can also be seen through the graph in Fig. 4 that built up has increased rapidly during 2013. The built up area was found to be 63.17km2 during the year 2010 which further expanded to 86.35 km2 in 2013. Simultaneously, the cultivated lands were found to be 94.76 km2in 2010 which had shrunk to 62.29km2in 2013.There is a minor change in the area of water body also with the area declining from 3.64 km2 in 2010to 3.06km2during 2013.However the vegetative regions are seen to be expanding through the years. Overall, it can be seen that built up is the most prominent conversion. On the basis of mapping of different land use group within the study region better planning of land use can be arranged through appropriate analysis of different land use categories for a particular development and preparation of better land resources management plans.
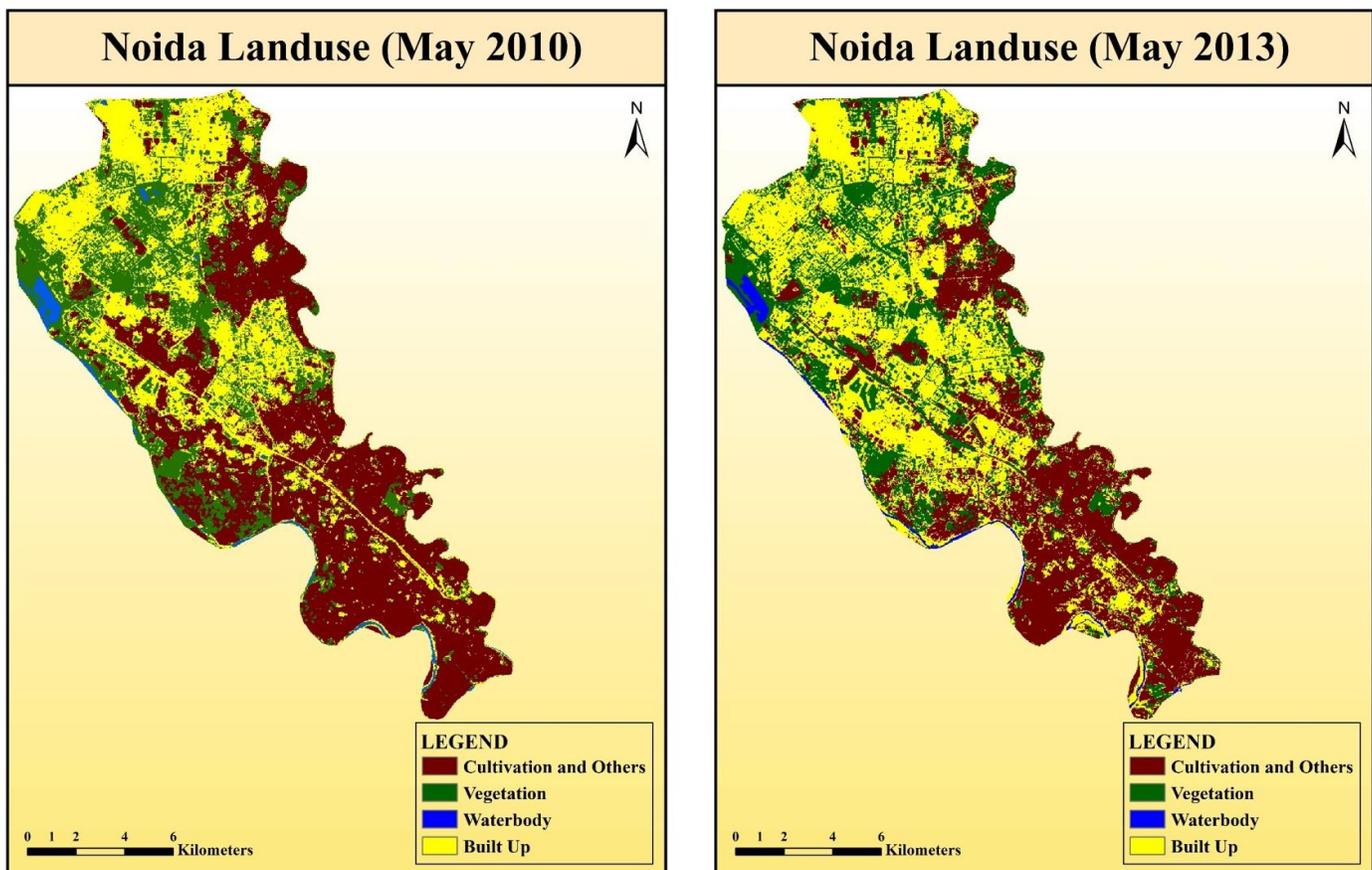

Figure 3: (a) Noida Land use Map (5th May 2010) & (b) Noida Land use Map (10th May 2013)

Table 2: Table showing change in Land use land cover categories between 2010 and 2013 for Noida

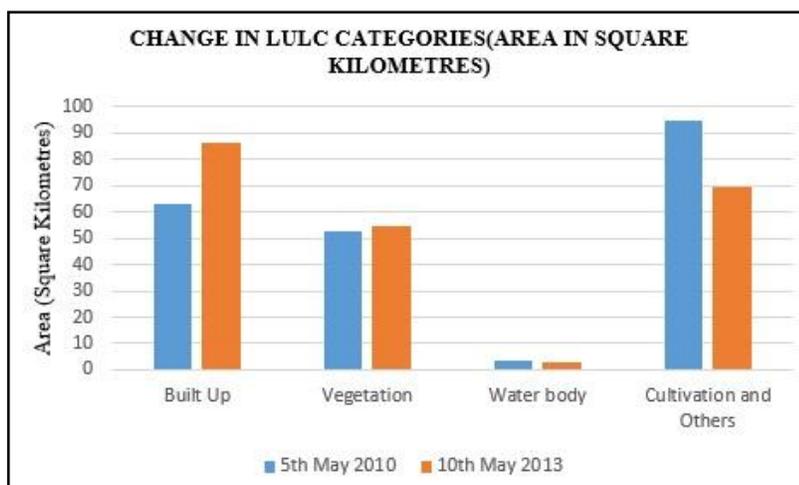| CHANGE IN LAND USE CATEGORY OF NOIDA BETWEEN 2010 TO 2013 FOR NOIDA				
	(Area in %)		(Area in Square Kilometers)	
	5th May 2010	10th May 2013	5th May 2010	10th May 2013
Built Up	29.52	41.03	63.17	86.35
Vegetation	24.47	25.34	52.37	54.56
Water body	1.70	1.42	3.64	3.06
Cultivation and others	44.29	32.18	94.76	69.29

Figure 4: Graph of change in LULC categories for Noida between May 2010 and May 2013

Conclusion

Satellite borne technologies are very helpful for dynamical monitoring of the process of urbanization. Land-cover / land-use data can be extracted from the satellite imagery by using a computer-assisted image-processing approach. The remotely sensed data with the aid of a GIS can provide valuable data for both quantitative and qualitative studies on land-cover changes.

The present work revealed that urban land use/land cover increase from 2010-2013 which is major environmental concern of the area. Spatio-temporal changes in the water bodies are also observed in the area. The results observed from this case study can be the baseline information on land use/land cover pattern of the area which is very useful for formulation of policies and programmes required for developmental planning of the area.

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