

## Forest Cover Change Detection Analysis of District Panchkula, Haryana

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**Abstract** The present study has analysis of various types of forest density cover of district Panchkula. This study based on primary and secondary data. Supervised classification and NDVI method have been used for detection of forest cover changes with the help of Landsat ETM + (2001) and Landsat-8 (2011) satellite data. Satellite data was digitally classified and various land use classes has identified. A supervised classification was performed on two multi-temporal satellite imageries and a total of eight major land use and land cover (LULC) classes were identified and mapped. Satellite images were classified based on the NDVI threshold values and the results show that the highest forest change found near the Panchkula city

due to the urbanization and population growth. By using post-classification techniques, from 2001 to 2011 the forest cover has decreased by an amount of 3,660.37 ha representing 4.17%. Total area under forest in the district is 38400 ha which is about 42.76% of the total geographical area (89,800 ha) of the district. Main trees found in the district are Eucalyptus, Kikar, Shisham, Neem. Decrease in vegetation has been as a result of anthropogenic activities in the study area.

**Keywords** Land use, Land cover, Forest cover, Change detection, Classification.

### Introduction

Forest provides goods and services including water, shelter, flood, fodder, nutrient cycling, cultural and recreation value. Forest also helps in providing habitat for wildlife and also improves land degradation and desertification [1]. According to FAO (2000) forests and natural plantation with canopy cover greater than 10% and a surface to 0.5 ha; determined by the presence of tree and the absence of other predominant land use, which trees should be able to reach a minimum height of 5 m. According to the United Nations Framework Convention on Climate Change (UNFCCC), the main cause of deforestation was agriculture. 32% of deforestation is due to commercial agriculture; 48% of deforestation is due to existed farming; 14% logging is responsible for deforestation and 5% of wood collection is responsible of deforestation [2]. Forested ecosystems are being rap-

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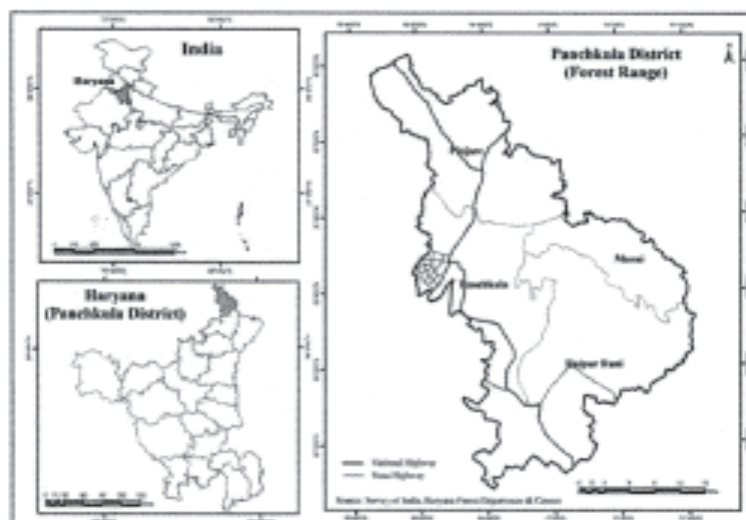


Fig. 1. Location map of Panchkula district.

idly and directly transformed by the land uses of our expanding human populations and economies [3]. Land conversion is the greatest cause of extinction of terrestrial species, of which particular concern is deforestation, where logging or burning is followed by the conversion of land to agriculture or other land uses and if forest is left standing, the resulting fragmented landscape typically fails to support many species that previously existed [4]. India is facing a serious problem of natural resource scarcity, especially that of water in view of population growth and economic development [5]. Remote sensing and GIS has unique potential in forest cover assessment and temporal data allows change detection of land cover

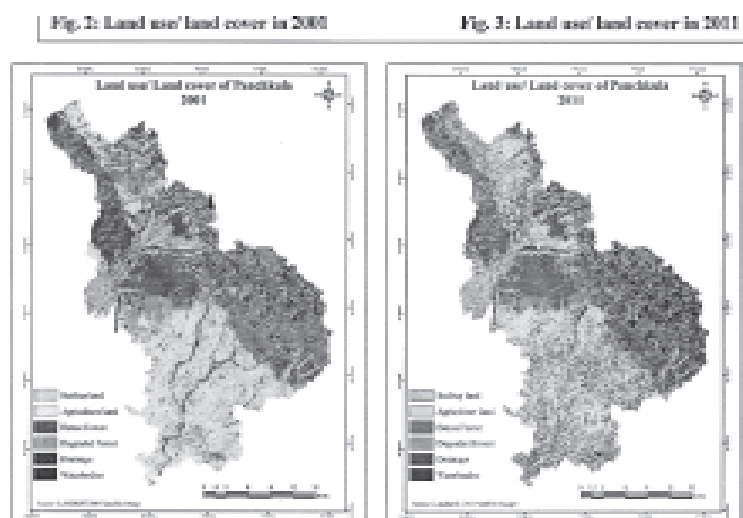
changes over a period of time [6]. The study presented here considers remote sensing data as a base for analysis the changes in forest cover of the Panchkula district.

#### Study area

Panchkula district of Haryana (India) located in the northern most part of Haryana state was selected for the case study. This is a very small and hilly district having a geographical area of 898 sq km. It lies between latitudes  $30^{\circ}26'$  to  $30^{\circ}56'$  north and longitudes  $76^{\circ}47'$  to  $77^{\circ}10'$  east (Fig. 1). The area is a highly undulating and eroded piedmont zone of the Shiwalik

Table 1. Land use/land cover change trend from 2001 to 2011.

Land use/Land cover classes	Area in hect 2001	Area in percentage	Area in hect 2011	Area in percentage	Change area in hect	Change in %
Built-up land	3350.1	3.82	4327.1	4.93	977	1.11
Agriculture land	35914.1	40.90	36546	41.62	631.9	0.72
Dense forest	21223.53	24.17	17563.16	20.00	-3660.37	-4.17
Degraded forest	20601.1	23.46	23403.2	26.66	2802.1	3.19
Drainage	6210.32	7.07	5528.04	6.30	-682.28	-0.78
Waterbodies	500.85	0.57	432.5	0.49	-68.35	-0.08
TGA	187800	100.00	87800	100.00		



**Fig. 2.** Land use/land cover in 2001. **Fig. 3.** Land use/land cover in 2011.

hills interspersed with a number of rivulets and channels falling into the Ghaggar river. Vegetation cover in the area is sparse due to steep slopes and high soil erosion. The soils of the area excessively drained, highly permeable and have low to medium productivity.

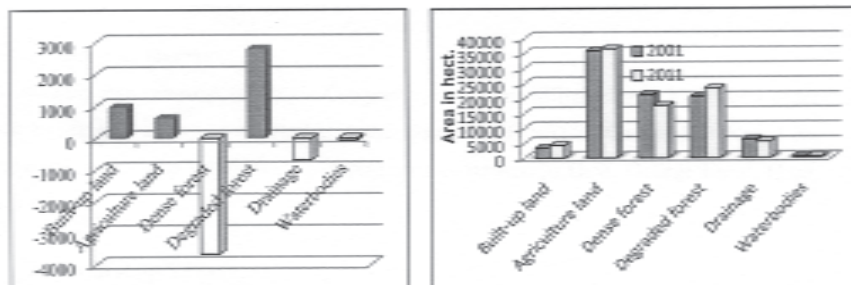
### Materials and Methods

Landsat ETM+ data in the form of false color composite (FCC) (bands 4, 3, and 2, scale 1 : 50,000, and Landsat-8 digital data for the year of 2011 were used for this study. In the present study supervised classification of the satellite imagery was used to produce land use/land cover classes. Digital classification (supervised classification) as well as on screen visual interpretation method was employed to delineate and map the intended forest and non-forest categories. The images of the study area were taken through three stages to generate land cover classes of the study area. These include (1) feature extraction; (2) selection of training data (signatures); and (3) selection of suitable classification approaches. The primary forest type and Landuse maps were prepared based on

field observation and image interpretation. The following six land cover and use classes were identified and mapped: Built-up land, agriculture land, dense forest, degraded forest, drainage and waterbodies. Normalized Difference Vegetation Index (NDVI) vegetation indices were used to distinguish healthy vegetation from others or from non-vegetated areas. Using red and near-infrared reflectance values and this was integrated in the post-classification analysis to discriminate between the green cover and barren land. The classification accuracy was assessed by an error matrix. Based on the ground truthing, the misclassified areas were corrected using recode option in ERDAS Imagine. The error matrix and Kappa Statistics methods were used to assess the mapping accuracy.

### Results and Discussion

The results of the supervised land use/land cover classifications using Landsat and Landsat-8 images show that Panchkula district is having the dominance of forest cover, where Pinjore, Morni and Raipur Rani forest range having major portion of forest cover in the district. The supervised classification of the im-



**Fig. 4.** LU/LC Negative and positive change. **Fig. 5.** LU/LC change patterns (2001-2011).

ages yielded two land cover maps of the study area (as shown in Figs 2 and 3). As already mentioned the following six land use/land cover classes were distinguished after classification; Built-up land, agriculture land, dense forest, degraded forest, drainage and waterbodies. These classes were calculated (based on the count of pixels) in hectares (ha) and also in percentages (Table 1). The trend analyses of the study area reveals a change in size of the six land use/land cover over the 10 year period of the study (Table 1). Built-up and degraded forest experienced the most positive change while high density forest experienced the most negative change. Built-up and agriculture land covers land area of 3,350.1 ha and 35,914.1 in 2001 while 4,327.1 ha and 36,546 area in 2011 respectively, which is increased 977 ha and 631.9 respectively during the study period. Dense forest made the highest conversion of 3,660.37 ha to built-up and degraded forest and agriculture land due to anthropogenic activities in forest area. Other land use/land cover categories i.e. Drainage (682.28 ha) and waterbodies (68.35 ha) shrinking from 2001 to 2011 (Figs. 4, 5).

As previously mentioned, accuracy assessment of the classified image is an important step in image classification. The quality of a thematic map from a satellite image is determined by its accuracy. A classification accuracy assessment was performed on the 2011 Landsat-8 image and an assessment report was obtained having an error matrix, accuracy totals (Table 2). Accuracy assessment was not performed on the 2001 Landsat image due to unavailability of ground

validation data and reference points. This has been one of the major problems of remote sensing. Another measure of map accuracy is the kappa coefficient, which is a measure of the proportional (or percentage) improvement by the classifier over a purely random assignment to classes. Kappa values have been characterized into three categories: A value greater than 0.80 (80%) represents strong agreement, a value between 0.40 and 0.80 (40 to 80%) represents moderate agreement, and a value below 0.40 (40%) represents poor agreement. In this study Overall Kappa Statistics is 0.55 which is range between 0.40–0.80 (40 to 80%) represents moderate agreement. Kappa can be used as a measure of agreement between model predictions and reality or to determine if the values contained in an error matrix represent a result significantly better than random.

#### NDVI (Normalized Difference Vegetation Index)

The NDVI gave very good results in identifying forest areas for subsequent investigation and data collection during field work. Although, it was not tested statistically, but there seems to be no significant difference between the results obtained from NDVI classification and those obtained from the supervised classification. NDVI of the study area were generated from the Landsat ETM+ (2001) and Landsat-8 (2011) imagery. The digital numbers (DN's) of the pixels for the resultant map ranged from 0 to 255. Applying Groten and Ocatre [7] rule (as in Section II.E), Pixels with DN greater than 135 appear red in color which

**Table 2.** Summary of accuracy in percent.

LU/LC	Producer accuracy	User accuracy
Build-up land	97.52	49.70
Agriculture land	61.47	76.79
Dense forest	73.34	79.21
Degraded forest	50.00	28.25
Drainage	49.49	63.41
Waterbodies	56.50	84.05
Overall Classification Accuracy=66.31%		
Overall Kappa Statistics=0.55406		

could dense forest or a cultivated land. DN values less than 135 indicate water bodies, built-up land and degraded forest. Forest areas turn to have higher NDVI values due to their greater green biomass. From the period 2001 to 2011, the remarkable change in vegetation has been found due to anthropogenic activities in the study area.

### Conclusion

This study amply demonstrates the use of remote sensing and GIS to analyze the forest cover change in the study area. The relationship between the forest covers and its associated LULC classes were investigated and various thematic maps were developed. It was observed that vegetation has changed remarkably from the period 2001–2011. This decrease in vegetation has been as a result of anthropogenic activities in the study area but these were not investigated.

Therefore, further analysis of these factors is needed to better explain the impact of these factors on forest cover change. Also, by taken more factors such as rainfall, soil moisture into consideration, the study could reach a higher accuracy for forest cover change detection.

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