

Remote Sensing Based Analysis of Land Use / Land Cover Dynamics in Takula Block, Almora District (Uttarakhand)

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ABSTRACT Present study is an attempt to analyse the dynamics of land use / land cover using modern geospatial techniques of Remote Sensing and GIS in Takula Block of District Almora, Uttarakhand, India. The Landsat TM (Thematic Mapper) satellite images for year 1990, Landsat ETM+ (Enhanced Thematic Mapper Plus) images for years 2005 and training data collected through field visit were used to analyse the dynamics of land use / land cover from 1990 to 2005 over a 15 year of period. Maximum Likelihood Algorithm was used for image classification in ERDAS 9.3. Mapping and analysis of land use / land cover classes were performed in ArcGIS 9.1 software. Five classes of land use / land cover (namely: forest, croplands, water bodies, built-up structures and fallow land) were mapped and analysed in the study area. The study reveals that the land use / land cover changes have occurred in forest (- 6.28%), croplands (+7.99%), built-up structures (1.22%) fallow land (-2.97%) and water body (0.04%). The study also highlights the importance of digital change detection techniques in sustainable land use planning and development for Takula Block.

INTRODUCTION

Land use/land cover is a very important aspect of central strategies for managing natural resources and monitoring environmental changes. The land use/ land cover pattern of any region is an outcome of various physico-cultural factors and their utilization by man in time and space. Hence, it is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to be able to simulate changes (Prakasam 2010). Land use and land cover are two separate terminologies which are often used interchangeably (Dimiyati et al. 1996). The land use describes the use to which the land is put, whilst land-cover describes the surface cover characteristics (Mc Cloy 1995). In other words,

the term land cover refers to the physical materials on the surface of a given parcel of land, while land use refers to the human activities that takes place on or make use of land, for example, residential, commercial, industrial etc. (Longley 2001). Land use is a way by which human beings utilise land while land cover exists as a natural environmental system (Jensen 2007). To make planning and decision process more realistic, effective and sustained for managing land resources and environment in a particular region requires reliable quantitative information primarily on existing land use/ land cover and their dynamics. Such types of information are also essential for developing eco-friendly packages for optimizing production. The modern Geo-spatial technology of Remote Sensing (RS) coupled with Geographic Information System provides a powerful mechanism, not only to monitor natural resources and environmental changes but also permits to analyze the information of other environment variables (Marble et al. 1983). One of the most important distinguishing characteristics of RS, relative to other data acquisition approaches, is that it can provide detailed, quantitative land surface information at large spatial coverage and at frequent temporal intervals

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(Prenzel 2004). The remote sensing data due to its perspective view, multi-spectral, multi-resolution and frequent monitoring capabilities make its well-suited for monitoring land use/land cover pattern and their dynamics over any large areas.

The recent advancement in digital image processing techniques have brought about a profound acceptance of the application of satellite remote sensing data in land use/land cover inventory, mapping and change detection (Kachhwaha 1985; Coppin and Bauer 1996; Star et al. 1997; Xiaomei and Ronqing 1999; Chilar 2000; Elmore et al. 2000; Mukul 2010; Manonmani and Suganya 2010; Abbas and Arigbede 2011; Singh and Khanduri 2011). Realizing the importance of land use/land cover monitoring in sustainable land resource management and planning present study is an attempt to map out and analyse the dynamics of land use / land cover pattern through processing Landsat satellite images of 1990 and 2005 in the core of GIS environment for the Takula Block, Almora district, Uttarakhand, India.

The area of study lies in, eastern part of the Almora District, between $29^{\circ}41' 5''$ N to $29^{\circ} 52' 27''$ N latitudes and $79^{\circ} 30' 31''$ E to $79^{\circ} 30' 42''$ E

longitudes, encompasses an area of 260.52 sq.km² (Fig.1). With the exception of small area, the whole of the study area falls within the Himalayas and drainage is carried off by the Kali or Sharda. Most of study area enjoys the cool temperate climatic conditions. As of 2001 Indian census, the block has a population of 43537. Recent population data of 2011 for the block is not available.

METHODOLOGY

In this study, Landsat- 5 TM (Thematic Mapper) data (Band-4, 3,2; Resolution-30m), Date:15th October, 1990 and Landsat -7 ETM + (Enhanced Thematic Mapper Plus) data (Band-4,3,2; Resolution-30m), Date: 16th November, 2005 were used. The satellite data covering study area were obtained from Global Land Cover Facility Site (GLCF).As reference and base map preparation, two Survey of India topographical sheets of the year 1975 on 1:50000 scale numbered 53 O/9 and 53 O/10 were used. These data sets were imported in ERDAS IMAGINE version 9.1 (Leica Geosystems, Atlanta, U.S.A.) satellite image processing software to create a False Colour Com-

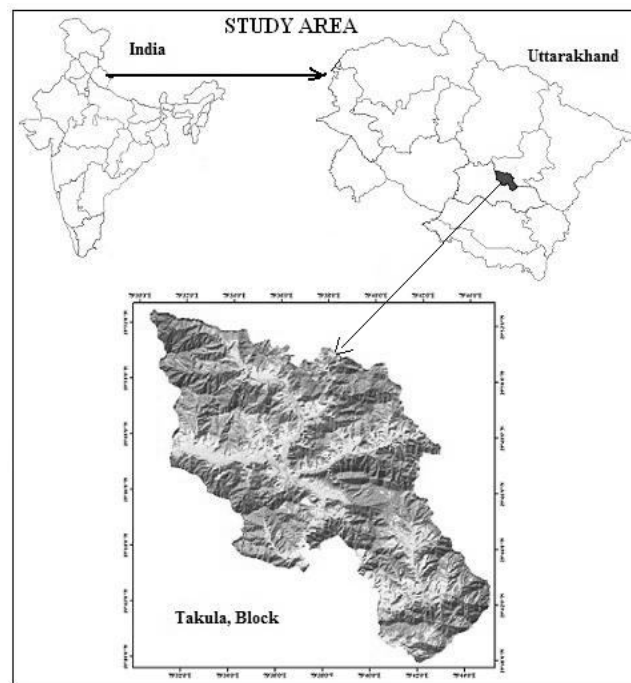


Fig. 1. Location of study area

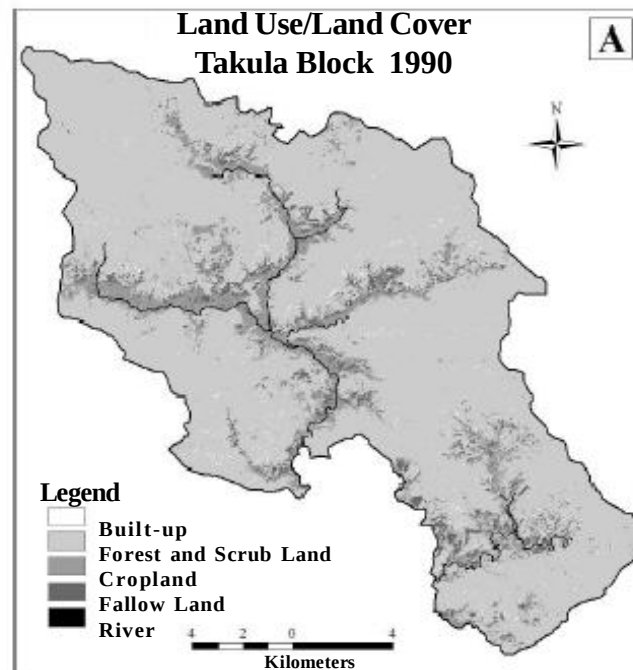


Fig. 2. Land use/land cover Takula Block 1990

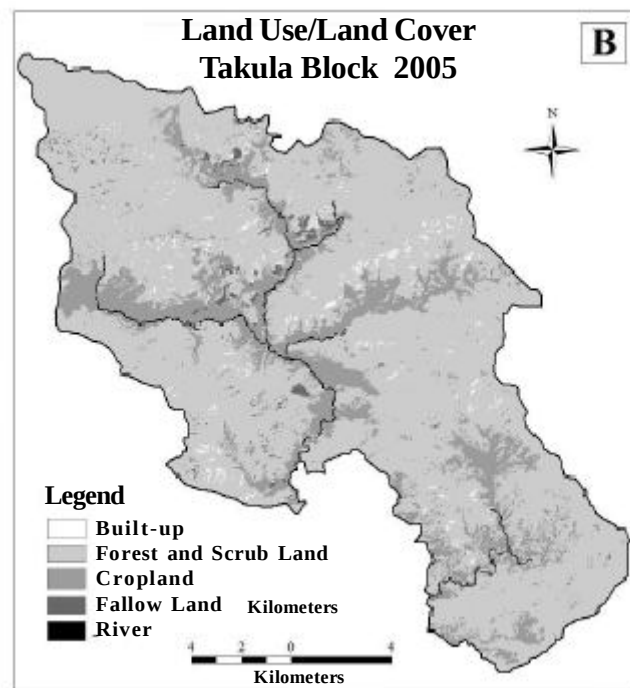


Fig. 3. Land use/land cover Takula Block 2005

posite (FCCs). The layer stock option in image interpreter tool box was used to generate FCCs for the study areas. The sub-setting of satellite images were performed for extracting study area from both images by taking geo-referenced out line boundary of Takula block map as AOI (Area of Interest). The FCC images of the study area (Landsat 5 TM, MSS, 1990 and Landsat 7 ETM+, 2005) were then digitally processed for land use/land cover identification and mapping. Image classification procedure is used to classify multi-spectral pixels into different land cover classes. The maximum likelihood algorithm of supervised classification was used for pixel clustering. The training sites on the remotely sensed data that represent homogenous examples of known land cover types were identified on basis of experience and these sites were visited for training data collection. The GPS map 70 Cx (Garmin Tiwan) handset was used to find latitude and longitude of training sites on the ground. To evaluate the accuracy of classified image files (thematic raster layer, randomly sampled 250 points on reference image were analyzed in ERDAS IMAGINE software using Accuracy Assessment option in the Classification dialog. The classified layers were compared with ground truth data and Google earth high resolution images and error matrix was prepared. Digitally generated land use/land cover maps and statistics for the years of 1990 and 2005 were analyzed for change detection during the period of above 15 years.

RESULTS AND DISCUSSION

Remote sensing techniques using satellite imageries coupled with field survey for training data collection were followed for digital change detection in land use/land cover during the past fifteen years (1990 to 2005). Maximum likelihood Algorithm based image classification techniques gave good results for digital change detection in land use/land cover classes. The overall digital classification of study area was found to be satisfactory. The accuracy assessment results were obtained about 89.22 percent of overall and 0.7783 Kappa accuracy for the year 1990 while the accuracy for the year 2005 image was found about 87.72 percent overall and 0.7633 Kappa. The land use/land cover maps obtained from image classification shown in Figure 2 and Figure 3 for the year 1990 and 2005 respectively. Five land use/land cover classes were mapped in the study area, that is, i. Forest, ii. Water bodies, iii. Cropland, iv. Built-up structure and v. Fallow lands.

The statistical analysis and graphical representation of comparative land use/land cover changes from TM image, 1990 to ETM+ image, 2005 of the study area are given in Table 1 and Figure 4.

During the past fifteen years, the dominant change which occurred in the study area is the croplands which were 13.48 per cent in 1990 and increased to 21.47 per cent in 2005. The total change of 7.99 per cent in croplands is a sign of

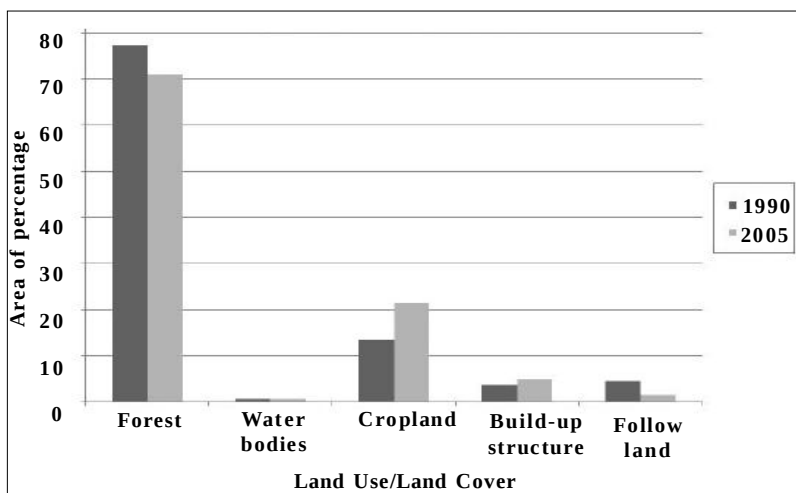


Fig. 4. Distribution of land use/land cover

Table 1: Takula block: Land use/land cover, 1990-2005

Land use/land cover categories	1990		2005		Change 1990-2005	
	Area in hectare	Area in percent	Area in hectare	Area in percent	Percentage change	Change in hectare
Forest	20119.55	77.36	18488.68	71.08	-6.28	-1630.87
Water bodies	205.29	0.78	213.36	0.82	0.04	8.07
Cropland	3506.58	13.48	5583.93	21.47	7.99	2077.35
Built-up structure	985.98	3.79	1304.76	5.01	1.22	318.78
Fallow land	1188.1	4.59	417.26	1.62	-2.97	-770.84

increasing demand of cropland to fulfil the increasing need of foods in the study area. During the same period, positive changes were observed in built-up area and water bodies. The area under built-up class is found to be 985.98 ha (3.79 per cent) in 1990 and 1304.76 ha (5.01 per cent) in 2005. The water bodies were identified in 205.29 ha (0.78 per cent) in 1990 and 213.36 ha in 2005. Total increase in built-up and water bodies were observed 318.78 ha (1.22 per cent) and 8.07 ha (0.04 per cent) during this period respectively. It is an established fact that any increase in built-up areas like settlement can increase pressure on existing resources. The changes in water bodies may be due to fluctuation in rain fall. Forest is predominantly covered in the study area where human activities are relatively less intense. It occupying 77.36% and 71.08% of the area in 1990 and 2005 respectively. Table 1 and Figure 4 depict that there seems to be a declining trend in forest area during 1990 to 2005 (-6.28%). It has decreased from 20119.55 hectares in 1990 to 18488.68 hectares in 2005. About 1630.87 ha of forest lands were converted into the cropland, built-up, and fallow land during this period. Other class where negative change has been observed was fallow land (-2.97%). Fallow land has decreased from 1188.1 hectares in 1990 to 417.26 hectares in 2005. This is a good trend and more effort should be given to convert fallow land into cropland.

CONCLUSION

In the present study, mapping of different types of land use/land cover and their change detection were carried out using digital image processing techniques. The spatial pattern and change detection in land use/ land cover could serve as guiding tool, in biodiversity conservation and environmental development. The study

may also prove a better input in sustainable land use /land cover planning in the study area. Land use/land cover change detection through processing of multi-temporal Landsat imageries has provided an accurate account of the situation of the study area during the period of 1990-2005.

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