Land Use and Land Cover Change Detection For Dehradun City (2004-2009)

Dr. Asha Sharma

Asstt. Prof. In Geography

Mata Sundri Khalsa Girls College, Nissing

Introduction

According to the UDPFI guide lines , an urban area is characterized by population sizes greater thatn 5,000 and at least 75% of the resident population dependent on non-agricultural/primary activities for income generation. Supporting populatons and economic activites requires the occupancy of land or the utilization of resources linked to land . Hence , growth in population or tis redistribution and growth/shifts in economic activity manifests as changes in land use and / or land cover. Studying land use / land cover changes can therefore help understand the trends and predict settlement development patterns in any region which in turn can guide spatial planning and policy making.

Study Area

Dehradun city is situated in the southern part of Dehradun District within the newly formed Uttarakhand state . Dehradun is the interim capital of Uttarakand , situated in the Dun Vally at 300 19' N latitude and 78 o 02'E longitude . The city is sorrounded by river Song in the east , river Tons on the west , Himalayan Shivalik ranges on the North and Sal forests in the south . It is the largest city in the hill state and well connected by rail and road transport . Dehradun city alongwith its contiguous outgrowths from an "Urban Agglomeration" consisting of Dehradun municipal area , Forest Research

Institue, Dehradun Cantonment , Clement town Cantonment , Adhoiwala outgrowth and Raipur town.

Physiography

Dehradun City is located on a gentle undulating plateau at an average altitude

of 640 m above mean sea level. The lowest altitude is 600 m. in the southern

part , whereas highest altitude is 1000 m on the northern part. The northern slope

(south facing) has a gentle gradient of about 8 o which mostle comprises of coarse boulders, pebbles, gravels derived mailnly from Pre-Tertiary and

Shiwalik rocks with top soil and silt/snad. The north facing southern slops is steeped in gradient of about 10 o formed mainly of reworked Upper Shiwalik boulders and gravels with sand and silt.The drainage of the city is borne by two rivers namely:Bindal and Rispana River . The direction of flow of these

I seasonal streams and nalas in the eastern part is north to south and western part it is north to southwest .The whole area is heavily dissected by a number of seasonal streams and nalas , which are locally known as " Khalas". Dense patches of forests exist along the north and in the outer limit of regulated areas.

Project Objectives

1. To detect urban land use-land cover change for Dehradun city during the period 2004-2009

Methodology

Data Procurement

Image of Map Rectification

Image to Image Rectification

Normalisation of Image

Extraction of Study Area

Classification

Change detection

The softwares that were employed for the project were ERDAS Imagine and Arc GIS 9.3

Data Procurement

The details of data used on the project are as follows

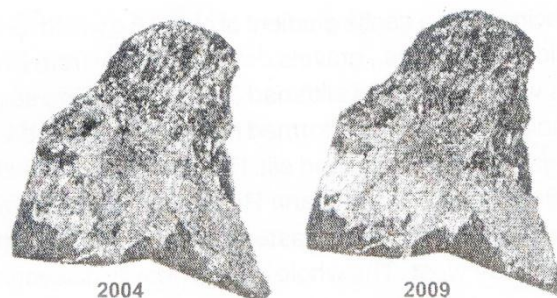| SI No.	Data Type	Source
1.	Toposheet 531/3	Survey of India
2.	Setellite image-LISS 4 ,2004 for Dehradun , resolution : 5.8m	HRS , Dehradun
3.	Setellite image-LISS 4 ,2009 for Dehradun , resolution : 5.8m	HRS, Dehradun
4.	Guide Map-Dehradun	HRS , Dehradun

2004   2009

Image Rectification and Registration

The toposheet data was stored as an image file in TIFF format . Using ArcGIS, the toposheet image was ractified to the user defined co-ordiantes UTMWGS84 using 16 equi spaced control points as input .The rectified toposheet was imported to ERDAS Imagine. One of the satellite images was tehn rectified to the same user defined co-ordinate system using the rectified toposheet as reference. In order to ensure good alignment of satellite images during the overlay operations for change detection, image to image registration was done between the un-rectified and the rectified satellite images.

Thus all images , toposheet and setellite images of 2004 & 2009 were brought to the same co-ordinate system. The images were checked for alignment using swipe function in the utility tool in the viewer window of ERDAS Imagine.

Classification of Image

With the intent of understanding the limitations and possibilities in application, the images were classified by the both the supervised and unsupervised classification techniques.

Visual interpretation of the images helped indentify the following major land use categories for the study subsets.

1. Dense Forest
2. Open Forest
3. Agriculture Cropland •
4. Agriculture Fallow
5. Plantation
6. Land with or without scrub
7. Built UP
8. Water Body
9. Open/vacant land

Unsupervised Classification

The subset images of 2004 and 2009 were classified separately using ERDAS Imagine.

In the classifier Tab of the Erdas Imagine window , select Unsupervised Classification .

A window opens for Unsupervised Classification (isodata). The subset image to be classified is given as input. Output files are defined for cluster layer and signature set. These are stored as image and signature files respectively. In color scheme options, choose approximate true color. The number of categories to be recognized is defined. The greater the number of categories generated , the more accurate the

classification will be . However the cases where the class variations per unit area are high , greater number of categories may reduce the interpretation clarity . Also define the number of iterations and the convergence threhol limits . The process output is generated when either of these criteria is met . The specified maximum number of iterations was 30 and the convergence threshold was specified at 0.98.The generated outpur resembles the reference satellite image subset since the colour scheme option chosedn was approximate tru colour. In case the colour scheme option chosen was preudo colour , the generated outpur layer would appear in shades of grey . Image interpreation is easier with the approximate true colour option. Geo linking the satellite image subset with the generated output layer helps identify classes more accurately. For the software generated classes , type and colour definition is done using the keyboard after clicking on well defined land use class samples on the generated output layer.

Supervised Classification

In supervised classification, training samples of reflectance ranges / DN values associated to different land use categories are defined by the user before the classification is performed by the software.

The subset images of 2004 and 2009 were classified separately using ERDAS Imagine.

Samples of signatures denoting the various land use categories are fed into the' Signature Editor in the Classifier tab of the ERDAS Imagine window. Samples of the same land use category are merged to form a representative signature class. Each of such representative signature classes are named appropriately. In cases where ground verifications are required , ground truthing is done by collecting Ground Control Points (GCPs) to ensure accurate representation of land use .

Once the signatures are fed into the signature editor for all classes, the signature editor file was saved. This signature editor file was given as input to generate the supervised classification layer
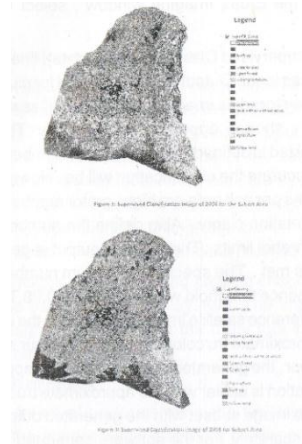
Accuracy Assessment

The following procedure was followed to perform the accuracy assessment of each classified image.

In the Classifier Tab of the ERDAS Imagine windows , Accuracy Assessment option was chosen . In the Accuracy Assessment window that opened , the file to be opened in the viewer was selected . The Viewer was selected using Select Viewer option in View tab. In the Edit tab , the option to Create / Add Random Points was opened . A value equal to ten times the land use classes to be indentified was input as the number of random points. Geo linking the classified image with the reference subset image helped to improve accuracy of the fed reference class values in the Accuracy Assessment Viewer. After generating the Reference Values for the generated random points, the display of the class values was turned on in the Accuracy Assessment Viewer. In cases of considerable mismatch between the class value and the reference value, the reference value code was revised to an appropriate value after checking with the reference value , the reference value code was revised to an appropriate value after checking with the reference subset image and classified image. The Accuracy Assessment Report was then generated . Classification accuracy of the range 80% and above is considered acceptable.

The accuracy assessment reports generated for supervised classification of 2004 and 2009 subsets were 64% and 68% respectively.

Change Detection

In the ERDAS Imagine window , the Change Detection operation is selected from the Utilities tab in the Image Interpreter . The supervised classification image of 2004 was fed in as the Before Image and the

supervised classification image of 2011 fed in as the After Image. Image Difference File and Highlight File were created. Highlight criteria was defined as all land use changes that increased more than 10% and those that decreased more than 10%. From the analysis of the supervised classification images, it is found that changes in land use classes upto Level II of the NUIS Urban Land Use / Land Cover Classification scheme can be comfortable identified. Given the spatial resolution of the satellite images used is 5.8 m , further classification may lack precision and accuracy.

Land Use / Land Cover Change : 2004-2009

From the attribute tables, the area distribution across categories has been analysed for 2004 and 2009, and the land use change expressed in hectares using Microsoft Excel. Change detection output in ERDAS Imagine suggests that most of the land use within the subset area has undergone change during the period of interest 2004-2009. The land use conversions indicate urbanization process within the Municipality Limits since 2004.

Across the nine land use categories studied, the indentified changes are as described below :-

Built-Up : From the classified images, it is understood that land use change to high density built up has been most pronounced along select corridors. These most identifieable corridors are the Saharanpur Road (SH55), Rajpur Road (SH55), Haridwar Road (SH49), the Kaulagarh Road , Chakrata Road Kaonli branch of the Bijapur canel and the Eastern canal of the Rajpur canal. Saharanpur , Ballupur and Kishanpur have evolved as urban sub centres. Total built up has increased in spread and density along the Rispana Rao and Nalapani ki Rao , and in the Birpur - Ghangoba belt near the Galjwari Reserved Forest area . Ribbon and radial types of urban sprawl development are evident .

Agriculture : The classified images show major shift in landuse from agriculture in the subset area for the period 2004-2009. Conversion of cultivate agriculture lands to fallow and fallow lands to open/vacant is most visible. Most of the agriculture land conversion has happened in the fringe areas towards the south of the city . The change is most pronounced in the

area surrounding the Haridwar Road segment of SH 49, and east of the Risikesh segment of the SH 55, extending up to the Lacchiwala Forest Area.

Forest : Two categories of forest land use were studied for change during the period 2004-2009, they being the open / degraded forests and the dense forests. It is found that the area under open forests have considerable decreased , whereas the area under dense forests have increased. The open forests have mostly been converted to plantations or open / vacant lands. Given that the satellite images are of two different months in 2004 and 2009, we may suggest further degradation of forets, than any

accurae assessment of forest land to plantation conversions . In the case of dense forests, it is noticed that the forest areas within the urban area have been degraded. The recorded increase in land area under dense forests, even with the degrading dense forests within the urban area, could suggest rejuvenated reserve forest areas towards the south of the city.

Water Bodies : The area under water bodies has shown an increases. The increase could be attributed to signature overlaps between the dense built up and sand bed area of the water bodies.

Open Land : The area under open land has almost doubled during 2004-2009 studying the trends in land use conversion.

Figure 7 LAND USE CHANGE IN HECTARES
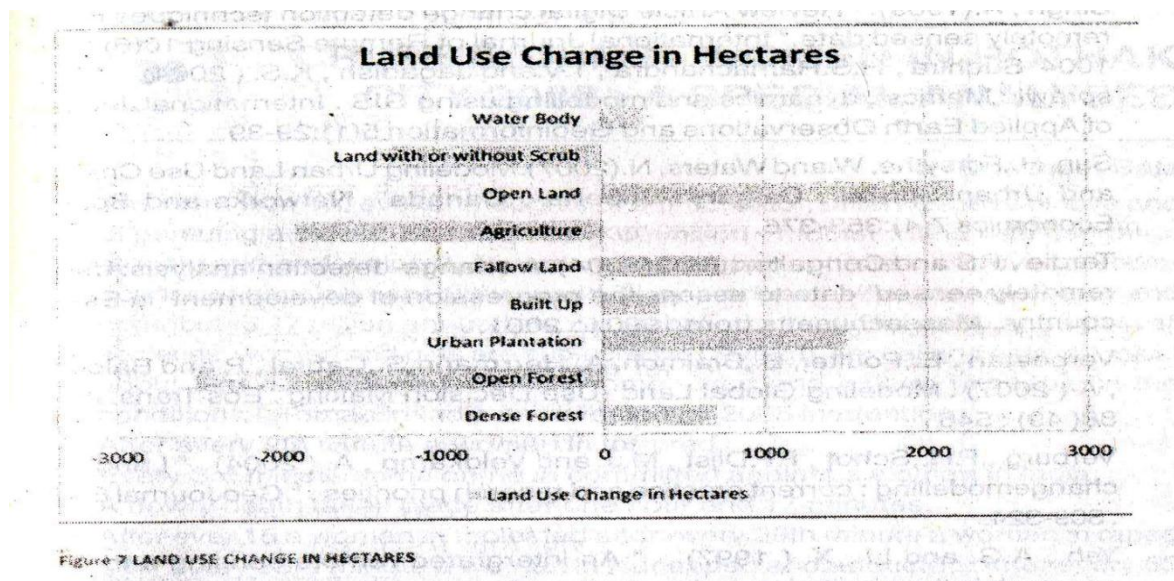
References :

Muzein, B.S (2006). Remote Sensing & GIS for Land Cover / Land Usae

Change Detection and Analysis in the Semi-Natural Ecosystems and Agriculture Landspaces of the Central Ethiopian Rift Valley.

N RSA (2003). India Remote Sensing (IRS) -P6, National Remote Sensing Agency

[online]

http://www.euromap.de/download/P6_data_user_handbook.pdf. [accessed Oct. 2008]

Pinto, N.N.and Antunes, A.P.(2007). Cellular Automata and urban studies : aliterature survey. ACE 1(3) Pontius, G.R. (2000). Quantification error versus location error in comparison of categorical maps. Photogrammetric Engineering and Remote sensing 66:1011-1016 Pontius, G.R. and Malanson, J.(2005). Comparison of the structure and accuracy of two land change models. International Journal of Geographical Inofrmation Science 19(2) 243-254.

Singh, A.(1989). " Review Article Digital change detection techniques using remotely sensed date." International Journal of Remote Sensing 10(6):9891004. Sudhira, H.S.Ramachandra, T.V. and Jagadish, K.S. (2004). Urban sprawl : Metrics , dynamics and modelling using GIS. International Journal of Applied Earth

Observations and Geoinformation 5(1):29-39.

Sun H.,Forsythe, W.and Waters, N.(2007).Modeling Urban Land Use Change and Urban Sprawl : Calgary, Alberta, Canada. Networks and Spatial Economics 7(4):353-376.

Tardie, P.S and Congalton, R.G(2004). A change-detection analysis: Using remotely sensed data to assess the progression of development in Essex country, Massachusetts from 1990 to 2001.

Verbeetan, E.,Poulter, B.,Braimoh, A, Herrmann,S.,Cabral, P. and Balogun, A (2007). Modeling Global Land -Use Decision Making. Eos Trans. AGU 88(49) : 546 .

Verburg, P.H.,Schot, P.P.Dijst, M.J. and Veldkamp, A.(2004). "Land use changemodelling : current practice and reserch priorities. "GeoJournal 61(4):309-324.

Yeh, A.G. and Li, X. (1997). "An intergrated remote sensing and GIS appraoch in the monitoring and evaluation of rapid urban growth for sustainable development in the Pearl River Delta, China. " International Planning Studies 2(2):193-210.

Yeh, A. and Li, X (2001). " Measurement and monitioring of urban sprawl in a rapidly growing region

using entropy." Photogrammetric engineering and remote sensing 67(1):83-90.

Yuan, F.,Sawaya, K.,Loeffelholz , B. and Bauer, M. (2005). Land coverclassification and change alaysis of the Twin cities (Minnesota) Metropolitan Areabz Multitemporal Landsat remote sensing of Environment. Remote sensing of Envirronment 98:317-328

Dr. Asha Sharma

Assistant Professor in Geography

Mata Sundri Khalsa Girls College

Nissing (Karnal)