Estimation of current fallow using remote sensing technology in Udham Singh Nagar District of Uttarakhand

N RAMU[1], MAHENDRA SINGH PAL[1] and AJEET SINGH NAIN[2]

[1]Department of Agronomy and [2]Department of Agrometeorology, College of Agriculture, G. B. Pant University of Agriculture and Technology, Pantnagar-263 145, (U.S. Nagar, Uttarakhand)

ABSTRACT : Land use and land cover mapping serve as a basic inventory of land resources throughout the world. Remote sensing offers a wide means of acquiring and presenting land cover data globally and timely. The present study aims to find out the land use/land cover features of Udham Singh Nagar district of Uttarakhand state, India through application of Remote sensing and GIS. At present the reported geographical area of Udham Singh Nagar is 2579 km^2 as compared to remotely sensed data of 2755.70 km^2. The study was made with the help of high resolution LANDSAT satellite imagery of 30th November, 2013 and ENVI and Arc view software to classify the land use/land cover features. The results indicated that the highest area was covered by crop land (55.08%) followed by forest area (20.86) and current fallow (15.08%). The area under water bodies, built up, orchards and weeds and shrubs were found at the tune of 4.88%, 4.02%, 0.04% and 0.03%, respectively. The remotely sensed data indicated that there was a little variation among the different land use covers. The current fallow land is supposed to be utilized during rabi season for the production of mainly wheat, legumes, oilseed crops etc.

Key words: Land use and Land cover, Remote Sensing, LANDSAT ETM+, Udham Singh Nagar

Remote sensing technique is the most efficient scientific tool in conjunction with ground truth and toposheet for collection of spatial information, identification, classification and mapping of the land use units (Nageshwara Rao and Vaidyanadhan, 1981). Allan (1990) also proposed that remote sensing and GIS will play significant role in mapping of agricultural resources and scientific land use planning. At present, there is increase in demand of land resources by different sectors due to urbanization causing serious loss of agricultural land, vegetation and water bodies (Soraj *et. al*, 2015). Therefore, it is urgent need to utilize our available resources including land and water efficiently and effectively to feed our ever increasing population. The present study aims to map land use and land cover features of Udham Singh Nagar district of Uttarakhand state for better management of our available land resources.

MATERIALS AND METHODS

General description of the study area

The study area lies in the district of Udham Singh Nagar, Uttarakhand with a latitude 28° 53' N and 29° 23' N and longitudes 78° 45' E and 80° 08' E, respectively. The geographical area of the district is 2579 km^2 and in aerially it ranks 9th in Uttarakhand state. The study area falls in 15-20 km wide *Tarai* region belt that separates the hills from the plains and mainly comprises of thick jungles, swamps and grasslands. Large tracts of this region now comprise of fertile farmlands. Soils are shallow with sandy to loamy texture, poorly sorted, comprising mainly of gravel, sand, silt, clay with pebbles etc. Climatically, the area falls in sub-tropical and sub-humid with three distinct seasons *i.e.* summer, monsoon (rainy season) and winter. There are two distinct rainy seasons, one in summer (*Kharif*) with a peak in July-August and the other in winter (*Rabi*) with a peak in late December–early January. The average annual rainfall is around 1400 mm. About 90% of the rainfall is received during the monsoon period and the remaining 10% of the rainfall is received during non-monsoon period. The temperature ranges from 1^0 to 42^0 C.

Software used

ENVI (Environment for Visualizing Images) software was developed in September 2000 to analyze the images captured with infrared cameras. ENVI-4.8 is the ideal software for the visualization, analysis and presentation of all types of digital imagery. ENVI is written entirely in IDL, the Interactive Data Language. IDL is a powerful, array-based, structured programming

language that provides integrated image processing and display capabilities and an ease to use tool kit. ENVI is the premier software solution for processing and analyzing geospatial imagery used by remote sensing professionals, scientists, researchers, image analysts and GIS professionals all around the world.

Remote sensing images

LANDSAT ETM+ image (Cloud free) of 30th November, 2013 of path 145 and Row 40 (Containing Udham Singh Nagar and adjoining region) was acquired which is being currently provided by U.S. Geological Survey (USGS) free of cost at their website (e (http://Edcsns17. cr.usgs.gov /Earth Explorer/ or http://glovis.usgs.gov/) LANDSAT ETM+ is a sun synchronous satellite, having a 16 days revisit proficiency or temporal resolution. A sample full image of 145 path and 40 row has been presented in (Fig. 1) and a subset covering U.S. Nagar has been shown in (Fig. 2). QUAC atmospheric correction was done to the image before image classification for better delineation of land use and land cover classes.

Image classification

Image classification is based on conversion of imagery data to thematic data. Image classification is the process of sorting pixels into finite number of individual classes or categories based on their digital number (DN) values. If a pixel satisfies set of certain criteria, the pixel is assigned to the class corresponding to those criteria.

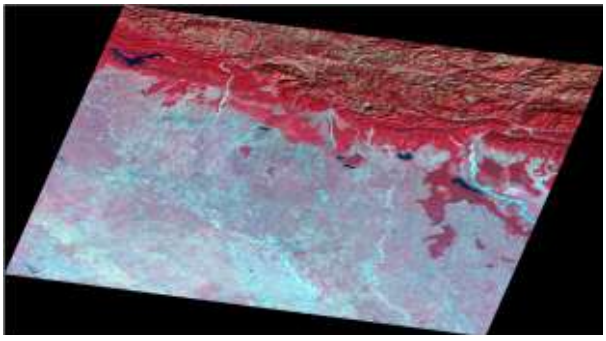

Fig. 1: A sample of remote sensing image used in the study

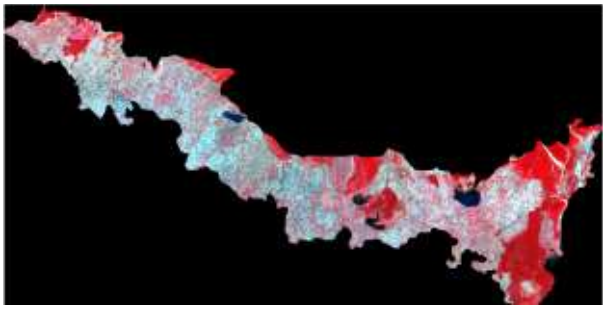

Fig. 2: A sample of subset image of Udham Singh Nagar

The present study used supervised classification technique to categorize the image in to different land use/ land cover categories. In this classification method, type and location of a set of land cover types *viz.* crop, fallow or water etc. are well known through fieldwork, maps, aerial photographs and personal experience. This set of land cover types is called the training classes or training sites. The spectral characteristics of these training sites are used to train the computerized classification technique to classify the whole image. Each pixel having similar spatial signature is assumed to a particular training class and left out pixels are grouped under unclassified or unknown training class and so the whole image is classified into different land cover classes.

Training of Software

Training of the image processing software is the process in which the software is used to recognize the spectral signatures of the various target objects. Region of Interest (ROI) over different objects such as built-up land, crop land, water bodies, weeds and shrubs, orchard, forest and current fallow land were created with the help of ground truth information.

In this study, supervised classification using maximum likelihood classifier embedded in ENVI-4.8 software was carried out by taking ROIs of different classes. Training classes/pixels are group of pixels (ROIs) or individual spectra from which homogenous ROIs were selected. Supervised classification was used to cluster pixels in a dataset into classes corresponding to user-defined training classes. Spectral signature of different classes was generated based on the information collected during ground truth and temporal information obtained from high resolution Google-Earth image (earth.google.com). In classification, entire image has been classified into separate classes and objects were discriminated based on ground truth data. Maximum likelihood classification assumes that the statistics for each class in each band are normally distributed and calculates the probability level of a given pixel belonging to a specific class.

RESULTS AND DISCUSSION

The land use pattern and its spatial distribution are the major rudiments for the foundation of a successful land use strategy required for appropriate sustainable

development of the area. The land use map prepared through remote sensing data and their spatial distribution is shown in Fig. 4, different land use categories in Fig. 3 and their area in Table 1. Land cover mapping serves as a basic inventory of land resources for all levels of organization, environmental agencies and private industry throughout the world. The various land use patterns were depicted in the study area using on screen visual interpretation of the satellite imagery of LANDSAT ETM+. A mixture of land use / land cover classes like built-up land, crop land, water bodies, weeds and shrubs, orchard, forest and current fallow land were identified and mapped using visual interpretation keys such as color, tone, texture, pattern, size and shape.

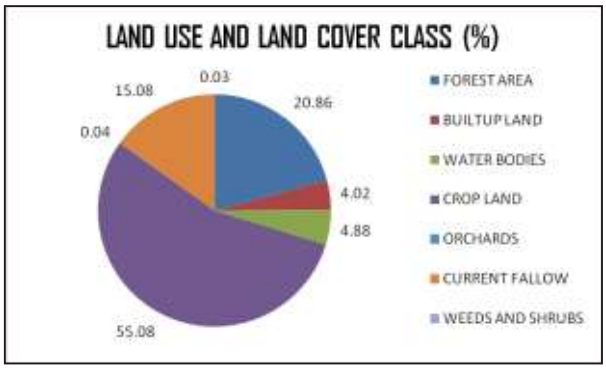

Fig. 3: Pie diagram of land use and land cover classes of U S Nagar

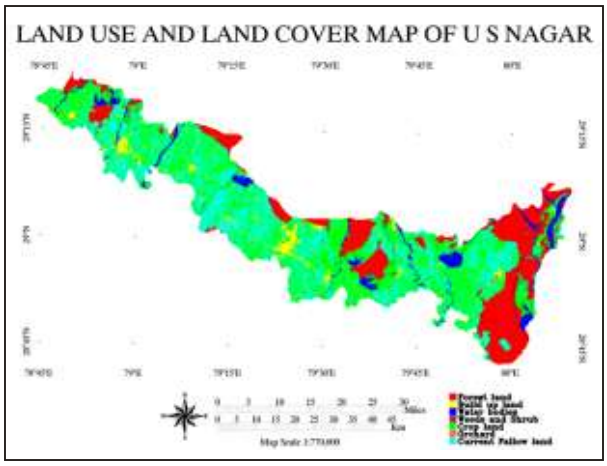

Fig. 4: Land use and Land cover map of Udham Singh Nagar

Crop land area

In the imagery, the crop land area was identified with red and pink colour with coarse to smooth texture on the date of the satellite imagery. The total area was estimated as 1517.80 km^2 (55.08%) of the gross area as compared to reported area 1291.95 km^2 sharing 50.09 % of total geographical area of Udham Singh Nagar.

Forest area

The forest is an area bearing an association predominantly of trees and other vegetation types capable of producing timber and other forest products and is discriminated by their red to dark red tone and varying in sizes. They show irregular shape and smooth texture. It covered an area of 574.86 km^2 which was 20.86 % of the geographical area of study and it was in line with reported area 581.99 km^2 of 22.57 % .

Current fallow land

These fallow lands refer to all land which was taken up for cultivation but is temporarily out of cultivation for a particular period and was identified by their greenish grey to greenish tone and medium texture and occupied area was 415.67 km² which was about 15.08 % of the geographical area as compared to reported area of 300 km² sharing 11.63 %.

Water bodies

Water bodies are an area of impounded water of natural or man made enclosed water body with regulated flow of water and identified by blue or black colour. Number of surface water bodies *viz.* ponds, reservoir and dam with seasonal rivers were delineated from the satellite image (Fig. 2) and covered 134.61 km²

Table 1: Land use and land cover classification of U S Nagar

LU/LC Category	Area in sq. Km	Percentage	Secondary Data in sq. Km (NRSC and Statastical data of US nagar)	Percentage
Forest land	574.86	20.86	581.99	22.57
Built up land	110.76	4.02	135.65	5.26
Water bodies	134.61	4.88	160.59	6.23
Crop land	1,527.80	55.08	1291.95	50.09
Orchards	1.22	0.04	---	---
Current Fallow land	415.67	15.08	300.00	11.63
Weeds and shrubs	0.78	0.03	---	---
Total	2755.70		2579.00	

accounting to 4.88% of the gross area as compared to area of 160.59 km² sharing 6.23 %..

Built up area

Built up land is composed of areas of intensive with much of the land covered by structures like cities, towns, villages, industrial and commercial complexes and institutions. It was estimated that the covered under built up land was 110. 76 km² with 4.02 % of geographical area and it was reported in NRSC as 135.65 km^2 sharing 5.26 %. This land cover class was represented by white and grey colour in satellite imagery (Fig 2).

Orchard

Orchards were appeared as somewhat dark red colour and resembled as forest and was spread to about 1.22 km² (0.04%) of the study area.

Weeds and Shrubs

The spectral signature of weeds and shrubs was viewed by faded brown colour in satellite imagery. It was found by ground truthing that the class was dominated near by water bodies and the total area covered was estimated 0.78 km² *i.e.* 0.03% of the geographical area.

On the basis of comprehensive study between remotely sensed and reported area under different land use classes revealed that application of remote sensing and GIS was effective tool to estimate area under different land use and land cover classes effectively and efficiently. Niranjana *et al.* (2009) also generated the information on land use/land cover from geo-coded false color composite (FCC) print of Indian Remote Sensing Satellite (IRS-IC LISS 111) data at 1:12500 scale of Itagi subwatershed, Ranebennur taluk, Haveri district of Karnataka.

CONCLUSION

The above study indicated that district of Udham Singh Nagar had 15.08% of current fallow land and 0.03% of weeds and shrubs making together nearly 15.1% of total geographical area. It draws special attention and be utilized for agricultural production. Hence government and scientific interventions are required for proper planning and its execution for sustainable development of available unutilized land resources for sustaining food and nutritional security of district Udham Singh Nagar of Uttarakhand state in years to come.

REFERENCES

Allan, J.A. (1990) Sensors, platforms and applications; acquiring and managing remotely sensed data. In: Steven, M.D, Clark, J.A. (Eds.), Applications of remote sensing in agriculture. Butterworths, The University of Nottingham, Great Britain University Press Cambridge, Pp. 3–18.

Nageshwara, R. and Vaidyanadhan, R. (1981) Land Use Capability Studies from Aerial PhotoInterpretation-A case study from Krishna delta, India, *Geographical Review of India* 3, 226-236.

Niranjana, K.V., Chandrakantha, G., Srinivas, S., Gowda, K.G.A. and Basavaraju, N.G. (2009) Natural resource inventory of Itagi subwatershed by using remote sensing and GIS techniques. *Mysore Journal of Agricultural Sci*ences 43(1), 1-7.

NRSC. (2014) Land Use / Land Cover database on 1:50,000 scale, Natural Resources Census Project, LUCMD, LRUMG, RSAA, National Remote Sensing Centre, ISRO, Hyderabad.

Soraj, Savita, Goirola, S. (2015) Role of geospatial techniques for land use/land cover change detection mapping: A case study of Rudrapur block of Uttarakhand. *International Journal of Science, Engineering and Technology Research* 4(1), 1-3.

Received: April 28, 2016
Accepted: December 16, 2016