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Land use Land Cover Change Detection for Doon Valley using Arc-GIS & ERDAS Tool

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Abstract: The land use change has generally occurred locally, regionally and world wide over the last few decades and will carry on in the future as well the land use change has to be evaluated properly using conventional as well as latest techniques of Remaote sensing and Geographical Information System (GIS) . In order to obtain reliable and latest information on the temporal , spatial and structural change in forest cover and to appreciate the relationship between the current development and its likely impact on land cover / land use and total environment of the region. The variations in the attribution of total area into various specific land cover / use classes have been studied. Satellite images required for estimating land cover are being obtained from earth explorer. The conventional LULC (land use land cover) map of the study area are obtained by classifying the images of year 2000, 2005,2011 and 2017 using ERDAS IMAGIN 9.2 and Arc GIS. We have devided our area into five different classes i.e. urban, water, agriculture, forest and barren land. Results obtained by analyzing the images shows a drastic increase of built up area, agriculture area and barren land followed by decrease forest area and water area.

Keywords: Urban, Land use, Land cover, Change detection, Remote sensing, Geographical information system

INTRODUCTION

Urbanization is an essential part of modern world but it is also playing a sideways influence of economic growth of any country. India, being a developing country, urbanization makes a major contribution in its economic growth. In India, all the towns and cities have grown slowly in the nineteenth and the twentieth century's. The growth of urban population in the recent years has been resolute mainly near metropolitan and new cities. In earlier times, settlement of population was focused along the river banks, religious centers and agricultural hub. The main reason for such a settlement was due to easy approachability of water for drinking and domestic uses.

In order to obtain reliable and latest formation on the temporal, spatial and structural change in forest cover and to appreciate the relationship between the current development and its likely impact on land cover/land use and total environment of the region. The variations in the attribution of total area into various specific land cover/ use classes have been studied.

The rapid development of the concept of vegetation mapping has lead to increased studies of land use and land cover change worldwide. Although the terms 'Land Use' and 'Land Cover' are often used interchange ably, their actual meanings are quite distinct [1]. 'Land Use' refers to human activities that take place on the earth's surface (How the land is being used; such as residential housing or agricultural cropping.) 'Land Cover' refers to the natural or man-mad e physical properties of the land surface.

During the past millennium, humans have taken an increasingly large role in the modification of the global environment. With increase in numbers and developing technologies, man has emerged as the major, most powerful, and universal instrument of the environmental change in the biosphere today. Both globally and in India, land cover today is altered primarily by direct human use.

Urbanization is the increasing number of people that live in urban areas. It predominantly results in the physical growth of urban areas, be it horizontal or vertical [2]. The United Nations projected that half of the world's population

would live in urban areas at the end of 2008. By 2050 it is predicted that 64.1% and 85.9% of the developing and developed world respectively will be urbanized. Urbanization is closely linked to modernization, industrialization, and the sociological process of rationalization. Urbanization can describe a specific condition at a set time, i.e. the proportion of total population or area in cities or towns, or the term can describe the increase of this proportion over time. So the term urbanization can represent the level of urban development relative to overall population, or it can represent the rate at which the urban proportion is increasing.

STUDY AREA

The Doon District is a longitudinal topographic depression situated in the foothills of Lesser Himalaya of Uttarakhand. Doon valley covers 85.7% area of Dehradun Tehsil of Dehradun district as shown in Figure No. 1.

Considering the Comparison requirements whole tehsil has been mapped. The Valley is believed to have been formed due to folding of Shiwalik sediments of Upper Tertiary age. It is bounded in the north by the Main Boundary Fault or Krol Thrst. To the south the Shiwaliks abut against Gangetic alluvial plains.

The Doon valley, a unique micro- geomorphic unit, is a parallelogram shaped structural valley and is bounded in the North by lesser Himalaya and in the South by Shiwalik, in the NW by river Yamuna and in the SE by the river Ganga. Geographically, it lies between latitudes 29º55' and 38º30' N longitudes 77º 35' and 78º28' E covering an area of 222.95 sq.km. Its elevation range from 315 m. to 2500 m while the gradient varies between 7 & 10 m/km this synclinal trough receives 210cm.Rainfalls annually and the summer temperature ranges between 380C and 410C, while the winter temperature varies between 150C and 500C. The hydro geological and meteorological conditions (231.5 cm annual average rainfalls) of the valley are responsible for the condition for the different types of forest cover. Land use of the valley is dominated by forest and cultivated areas as they respectively cover about 66.13% and 17.12% of the total area. During past independence era, urbanization in the valley has become most powerful agent of transformation. As per census 2001, urban population of Dehradun Tehsil reached 58.1% of total population and this urban population account for 31% of the total urban population of Uttarakhand state. After creation of Uttarakhand state in 2002, Dehraun city became state capital which ushered the era of rapid expansion in Built up area beyond municipal limits. There has been massive expansion in construction activity for industries, institutional infrastructure and Residential colonies.

Dehradun district is a district of Uttarakhand state in northern India. The district headquarters is Dehradun, which has also served as the provisional capital of Uttaranchal since its founding in 2000. The district has 6 tehsils, 6 community development blocks, 17 towns and 764 inhabited villages, and 18 unpopulated villages. As of 2011 it is the second most populous district of Uttarakhand (out of 13), after Haridwar.

The region was seized as a war spoil from the Maharaja of Tehri-Garhwal as a consequence of the Gurkha War of 1814 – 16, and attached administratively to Saharanpur District to its immediate south, which was already in British hands. Dehradun district also includes the prominent towns of Rishikesh, Mussoorie, Landour and Chakrata. The district stretches from the Ganges River in the east to the Yamuna river in the west, and from the Terai and Shivaliks in the south and southeast to the Great Himalaya in the northwest.

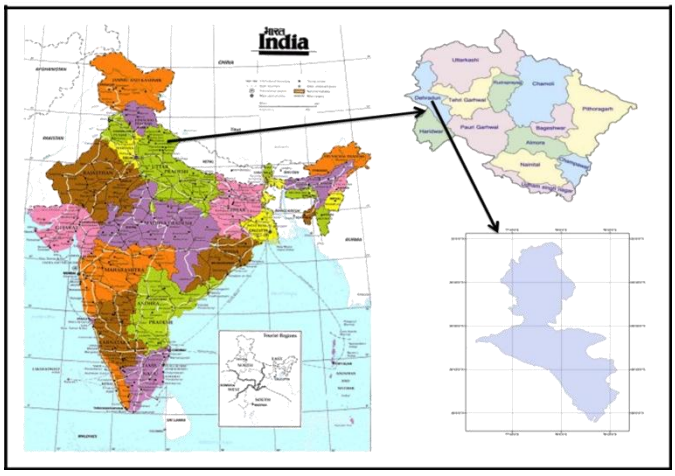

Fig-1: Study Area Map of Doon Valley

Dehradun has many beautiful old buildings. After Dehradun was made the capital of Uttarakhand, there was a construction boom, especially in residential property. Modern buildings have gradually supplanted older architectural styles including those related to the British colonial rule of India. Important older buildings include Clock Tower, Forest Research Institute, CNI College, Morrison Memorial Church, Inamullah Building, Jama Masjid, Osho Meditation Center, Indian Military Academy and Darbar Sahib.

METHODOLOGY USED

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals.

There are two main types of remote sensing: passive remote sensing and active remote sensing. Passive sensors detect natural radiation that is emitted or reflected by the object or surrounding areas. Reflected sunlight is the most common source of radiation measured by passive sensors. Examples of passive remote sensors include film photography, infrared, charge-coupled devices, and radiometers. Active collection, on the other hand, emits energy in order to scan objects and areas whereupon a sensor then detects and measures the radiation that is reflected or backscattered from the target. RADAR and LIDAR are examples of active remote sensing where the time delay between emission and return is measured, establishing the location, speed and direction of an object.

ERDAS IMAGINE 9.2 is a remote sensing application with raster graphics editor abilities designated by ERDAS for geospatial applications. ERDAS IMAGINE 9.2 is aimed primarily at geospatial raster data processing and allows the user to prepare, display and enhance digital images for mapping use in geographic information system (GIS) or in computer-aided design (CAD) software. It is a toolbox allowing the user to perform numerous operations on an image and generate an answer to specific geographical questions.

By manipulating imagery data values and positions, it is possible to see features that would not normally be visible and to locate geo-positions of features that would otherwise be graphical. The level of brightness or reflectance of light from the surfaces in the image can be helpful with vegetation analysis, prospecting for minerals etc. Other usage examples include linear feature extraction, generation of processing work flows ("spatial models" in ERDAS IMAGINE 9.2), import/export of data for a wide variety of formats, orthorectification, mosaicking of imagery, stereo and automatic feature extraction of map data from imagery.

Arc GIS 9.3 is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database.

LAND USE CLASSIFICATION

A numbers of methods have been invented for land use classifications which are generally known as unsupervised and supervised classification. Land Use classification may be either by an unsupervised method in groups cases, by their relative spectral similarity or by a supervised method based on similarity of cases to asset of predefined classes that have been characterized spectrally here supervised method of classification is done so as to get the accuracy in classification. The Land use/cover Map was generated by using satellite image of 2000, 2005 and 2011 through ERDAS IMAGINE (version 9.2), which is powerful image processing software [3].

Land use practices have a major impact on natural resources including water, soil, nutrients, plants and animals. Land use information can be used to develop solutions for natural resource management issues such as salinity and water quality. For instance, water bodies in a region that has been deforested or having erosion will have different water quality than those in areas that are forested. Forest gardening, a plant-based food production system is believed to be the oldest form of land use in the world. The major effect of land use on land cover since 1750 has been deforestation of temperate regions. More recent significant effects of land use include soil erosion, soil degradation, salinization, and desertification [4]. Land use change, together with use of fossil fuels, are the major anthropogenic sources of carbon dioxide, a dominant greenhouse gas.

Land use is a description of how people utilize the land and socio-economic activity - urban and agricultural land uses are two of the most commonly known land use classes [5]. At any one point or place, there may be multiple and alternate land uses, the specification of which may have a political dimension.

RESULTS AND DISCUSSIONS

Images of path and row 146/39 for different years are used as listed in Table No. 1 with their data of acquisition and resolution for study.

Table-1: Detail of Data Required

S.No.	Date of Acquision	Resolution (m)
1	25th November 2000	30
2	25th November 2005	30
3	25th November 2011	30
4	23rd January 2017	30

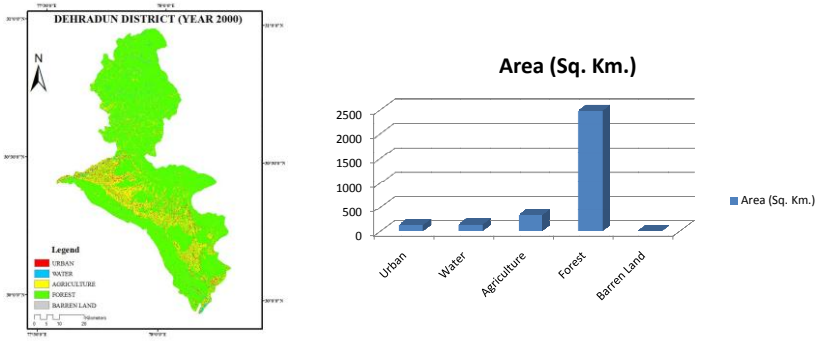

Fig-2: Land Use / Land Cover Map and Histogram of Study Area (2000)

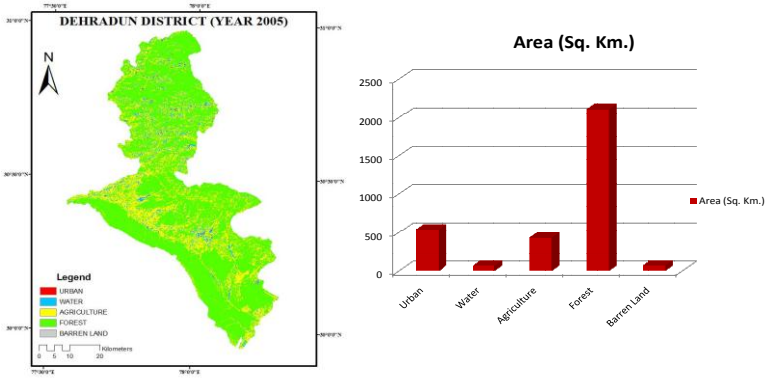

Fig 3: Land Use / Land Cover Map and Histogram of Study Area (2005)

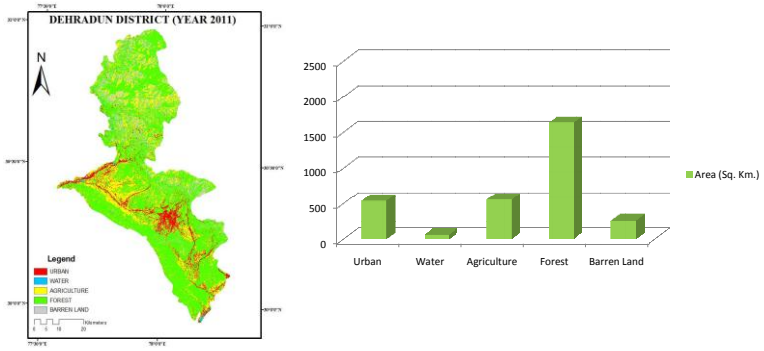

Fig 4: Land Use / Land Cover Map and Histogram of Study Area (2011)

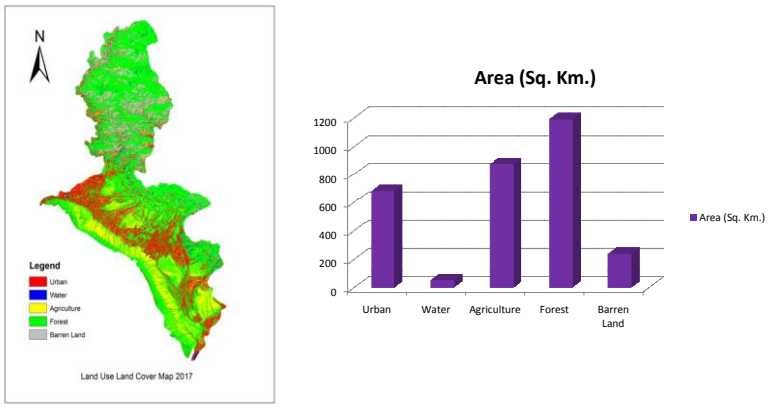

Fig-5: Land Use / Land Cover Map and Histogram of Study Area (2017)

Table-2: Land-use and land-cover for Doon Valley (in sq. km) [6].

S. NO	CLASSES	Year 2000		Year 2005		Year 2011		Year 2017	
		AREA (sq.km)	% AREA	AREA (Sq.km)	% AREA	AREA (Sq.km)	% AREA	AREA (Sq.km)	% AREA
1	Urban	126.172	4.1	541.053	12.8	541.053	17.61	680.84	22.17
2	Water	133.84	4.35	65.4111	3.12	65.4111	2.12	51.26	1.67
3	Agriculture	324.648	10.57	432.2637	13.78	556.7859	18.13	872.47	28.41
4	Forest	2481.58	80.8	2112.0606	68.77	1637.0244	53.3	1192.52	38.83
5	Barren Land	4.7529	0.15	68.7357	2.24	270.7182	8.81	237.93	8.92

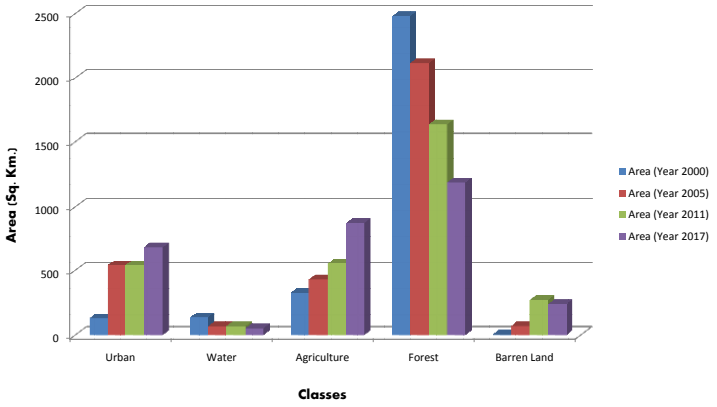

Fig-6: Land Use / Land Cover Histogram of Study Area

CONCLUSION

The change in land use and land cover has rapidly changed as the study shows a drastic increase of the built up area or urban area from 4.1% to 22.17%, an increase in agriculture area from 10.57% to 1.67%, an increase in barren land area from 0.15% to 28.41%, a reduced green cover (forest cover) from 80.8% to 53.3% and a decrease in water area from 4.35% to 8.92%. From the year 2000 to 2017. The analysis of the results shows the drastic increase of built up, barren land and agricultural area and reduced green cover and water area within the study area boundary limit.

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