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A Study of Landuse/ Landcover Pattern in Inducing Landslide Hazards in Parts of Almora and Nainital Districts of Uttarakhand

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Abstract:

Land degradation is a common phenomenon in mountainous region. Although the casual factors are mainly natural and man induced, inappropriate landuse enhances the degradation process. In some interior village areas of Nainital and Almora, many denuded and deforested slopes are found, which further accelerate the process of ecological degradation. In this paper many landuse/ landcover categories have been identified which is mainly responsible for having a landslide. In the present study most of the landslide has an association with open to degraded vegetation. Simultaneously some of the slides are occurring in the scrubby and barren lands. In the same way, hilly urban areas of Uttarakhand like Nainital and Almora towns which are popular for its tourism activity are facing the problem of land degradation. Due to continuous flow of tourists throughout the year many tourism based developmental activities have continued un-debated during the last few decades, leaving practically no space for further expansion. Despite such situation the towns continue to expand at the cost of local environment. Consequently with little scope for further expansion, these towns presently face a variety of problems.....those of landslides, destabilization of slopes, scarcity of water and sewage problem etc. Such type of land use process has direct effect on soil loss and mass movement. Here an attempt has been done to analyze what kind of landuse/ landcover is affecting the general topography of the area and become a notable factor for landslide hazards.

Keywords: Landuse, Landcover, Landslide, Land degradation, Nainital, Almora

1. Introduction

Land is among the most important natural resources. It covers only about 30% of the total area of the earth surface and all part of this small percentage are not habitable. It is the prime and a vital resource for man. Since the beginning of human existence man has directed his activities with reference to earth resources and he knows how to use these resources for his benefit. The uneven distribution of population in different parts of the world is mainly due to varied characteristics of land and climate. The rugged topography, steep slopes of the mountains, low lying areas susceptible to water logging, desert areas and thick forested areas are normally sparsely populated or uninhabited. Plains and river valleys offer suitable land for agriculture. Hence these are the densely populated areas of the world.

Land is used for different purposes such as agriculture, forestry, mining, building houses, roads and setting up of industries. This is commonly termed as land use. The use of land is determined by physical factors such as topography, soil, climate, minerals and availability of water. Human factor such as population and technology are also important determinants of land use pattern.

People and their demands are ever growing but the availability of land is limited. The quality of land is different from place to place. People started encroaching the common lands to build up commercial areas, housing complexes in the urban areas and to expand the agricultural land in the unsuitable areas.

Today the vast changes in the land use pattern also reflect the cultural changes in the society. Land degradation, desertification, soil erosion and landslides are the major threats to the environment because of the agricultural and constructional activities in rural and urban areas.

Mostly landslide hazards in mountainous terrain often occur during or after a heavy rainfall resulting in loss of life and damage to property. Land use and land cover mapping is thus very important for resource evaluation.

In all, for most of the application of Remote Sensing and GIS, knowledge of a landuse/ landcover is important and without this the planning and management activities are biased. The landuse/ landcover is considered as an essential element for modeling and understanding the earth as a system.

2. Objectives

The main objectives is to prepare thematic maps like landuse/ landcover from the remote sensing satellite data (IRS-1C/1D PAN/LISS-III) and from SOI topographical maps so that we can detect, identify the area of active landslides through the analysis of these maps and able to take some safe mitigation measures.

3. Study Area

Lying between latitude 29°15'N to 29°35'N and longitude 79°25'E to 79°40'E, the study area covers about 89000 ha (890 sq km) area of Nainital and Almora districts of Uttarakhand.

4. Methodology

Remote sensing data help in mapping land resources, especially in mountainous areas, where accessibility is limited. In such areas, land degradation is a main concern. In the present work, the landuse/landcover map have been prepared on 1: 12,500 scale through visual interpretation of IRS- 1C/ 1D, PAN data of May and March 1999 and LISS-III data of April, 2000. Survey of India topographical maps on 1:50,000 scales were enlarged upto 1:12,500 scale and were used as collateral information and for base map preparation. Ground truthing have also been done in the study area.

5. Theme analysis

In the present study most of the landslides have an association with open to degraded vegetation. Simultaneously, some of the slides are occurring in scrubby and barren lands. Amiyam landslides on the left bank of Gola river has occurred in scrubby area due to less vegetation cover and thin weathered band of sandstone. Balia nala landslides near Harinagar in the vicinity of Nainital are occurring in degraded forest areas due to toe removal, dolomite and limestone rocks and some landslides are occurring in barren land rocky/ non rocky, agricultural land and in forest blanks also.

In the study area the major landuse/ landcover categories identified and mapped are built up area, vegetation cover (dense, medium, degraded), forest blank, scrub/grassland, agricultural land, barren land (rocky), barren land (non rocky), river sand, water bodies etc (Fig.1 & 2). The vertical distribution of vegetation cover in the study area shows the following three broad zones of vegetation which are depicted in Table 1.

FOREST TYPE	SUB TYPE	ALTITUDE	VEGETATION
Sub tropical	Low altitude mountain forest	500-1000	Mixed broad leaved species and shrubs
Temperate Forest	Warm temperate forest	1000-1300	Hill Sal, Chir Pine And Mixed species
	Temperate forest conifers	1300-1800	Chir pine
	Cold temperate forest broad- leaved	1800-2000	Banj-oak, Rhododendrom
Sub Alpine Forest	Sub Alpine- moist deciduous	2000-2500	Moru, Blue pine, Silver fir, Spruce, Deodar, Cypress
	Sub Alpine- high altitude conifers	2500-3500	Krarsu, Blue pine, Birch, Juniper

Table 1: Vegetation zones

These forest vegetations has been further categorized into three sub categories:

- **Dense vegetation:** In the present framework of landuse/ landcover classification system, this category includes dense type of vegetation having more than 40% canopy. The total area under this category comes 42495.95 ha which is 47.75% of total geographical area.
- **Medium Vegetation:** The total area comes under the medium vegetation cover is 3487.85 ha, which is 3.92% of the total geographical area.

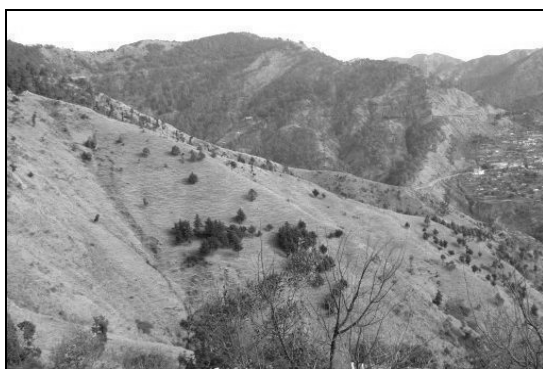


Plate 1: Degraded vegetation patch of Alukhet *Plate 2: Forest Blank in Bhowali Nainital Road*

- **Degraded vegetation:** Due to many anthropogenic activities and some other natural processes land become degraded. In the study area 2811.96 ha comes under degraded land which is 3.16% of total geographical area.
- **Forest Blank:** Areas in the forest that are completely devoid of trees are Forest blanks. Total area under is category is 101.22 ha which is 0.11% of the total area.



Plate 3: Grassland in Garampani *Plate 4: Scrubland in Bhujan Road*

- **Scrub/Grassland:** These are areas where natural or climax type of vegetation is dominated by grasses or grass like plants and non grass like herbs. The total area comes under scrubby grassland vegetation cover is 7840.63 ha which is 8.80% of total geographical area.
- **Barren rocky land:** The barren rocky lands are unsuitable for any production which is characterized by exposed massive rocks and excessive accumulation of surface stones. The total area of this category is 3514.52 ha, which is 3.95% of the total study area.



Plate 5: Barren Rocky in Janglia road *Plate 6: Barren rocky*

- **Barren Non-Rocky land:** Barren Non rocky areas are those areas which have no rocks and grass cover and have been stabilized as wasteland in the hilly region. The total area coverage is 162.89 ha, which is 0.18% of total geographical area.



Plate 7: Non- Rocky Barren Land

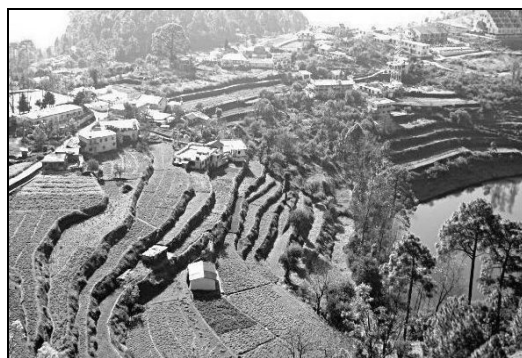


Plate 8: Agricultural terraces of Khurpatal

- **Agricultural land:** Despite limited land available for crops, agriculture remains the main activity for the people of Uttarakhand. In the mountainous part of the region topography greatly restricts the cultivation of crops as level land is scarce and is available only in wider river valleys which are few and far between. Agriculture however also extends to the ridges and mid-crest zones in the lesser Himalaya where nature of slopes, structure of soil, availability of water and sunshine are the determining factor for growing crops. On an average the largest proportion of cultivated land falls between the elevation range of 750-1500m. These extensions of agricultural land have created changes in highest order, particularly in the upland areas, where large patches are facing severe erosion problems, showing an adverse biotic impact and the land is subject to degradation due to slope failures and ill maintained terraces. The total area comes under agricultural land is 21290.31 ha, which is 23.93% of the total study area.
- **Built up area:** All manmade constructions covering the land surface are included under this category. These are human settlements comprising residential areas, transportation networks, utilities and services etc. Nainital and Kathgodam are the major town or city like settlement in the study area. Total area under this category is about 366.96 ha, which is 0.42% of the total geographical area.
- **River Sand:** Sandy areas are those areas, which have stabilized accumulation of sand in riverine or inland areas. Total area under this category is 535.42 ha, which is 0.60% of the total geographical area.



Plate 9: Nainital Lake



Plate 10 Khurpatal Lake

- **River/Water bodies:** Major surface water bodies and rivers have been mapped in the study area. Nainital, Bhimtal, Naucuchia tal, Sat tal, Sukha tal, Malwatal are the major lakes/ponds in the study area. Tal word attached with these names is derived from Kumauni dialect which means “Lake”. Naina lake is situated at the elevation of about 1938 meters above mean sea level. It lies between 29°24’ North latitude and 79° 23’ East longitude. It is the second largest lake of the Lesser Himalaya.



Plate 11: Puna tal Lake

Plate 12: Bhimtal Lake

Its geographical location is in between Bajun in the west and Nainital town in the North. The entire region extends across a major N-S slope. Bhimtal Lake is the largest lake in the study area. Gola, Kosi, Kalsa, Balia, Khairma are the major rivers of the study area. Total area under this category is 6392.62 ha, which is 7.18% of the total geographical area. A tabulated form of the total land use pattern of the study area:

Major landuse cover	Area in hacter	Area in percentage
Dense Forest	42495.95	47.75%
Medium Forest	3487.85	3.92%
Degraded Forest	2811.96	3.16%
Forest Blank	101.22	0.11%
Scrub/Grass land	7840.63	8.80%
Barren rocky land	3514.52	3.95%
Barren Non rocky land	162.89	0.18%
Agricultural land	21290.31	23.93%
Built up area	366.96	0.42%
River sand	535.42	0.60%
Water bodies	6392.62	7.18%

Table 2: Total Landuse cover of the Study area

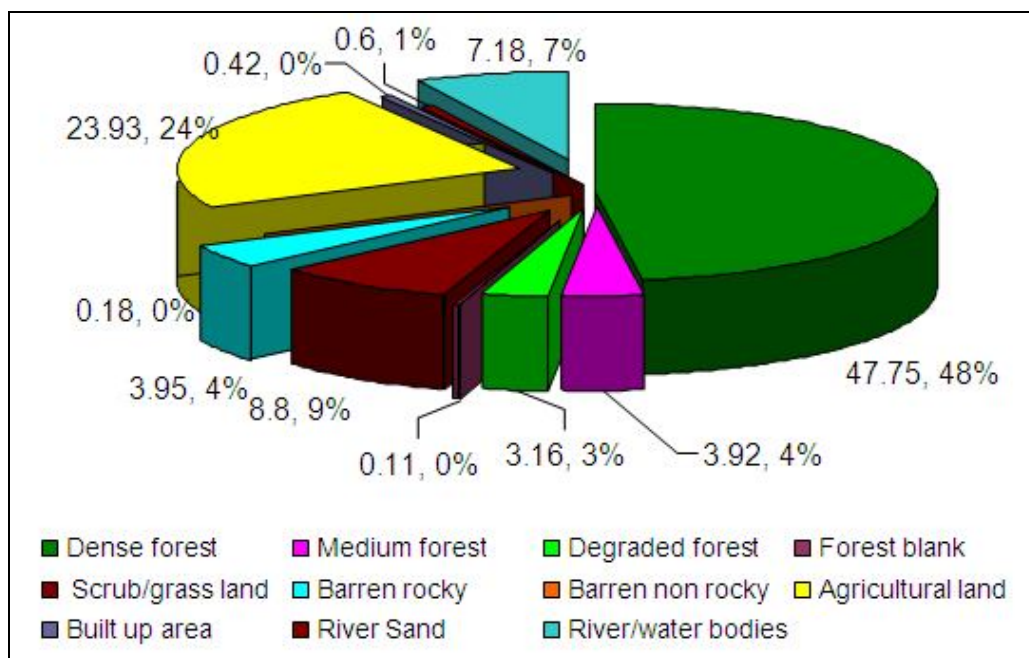


Figure 1: Area under different landuse/landcover

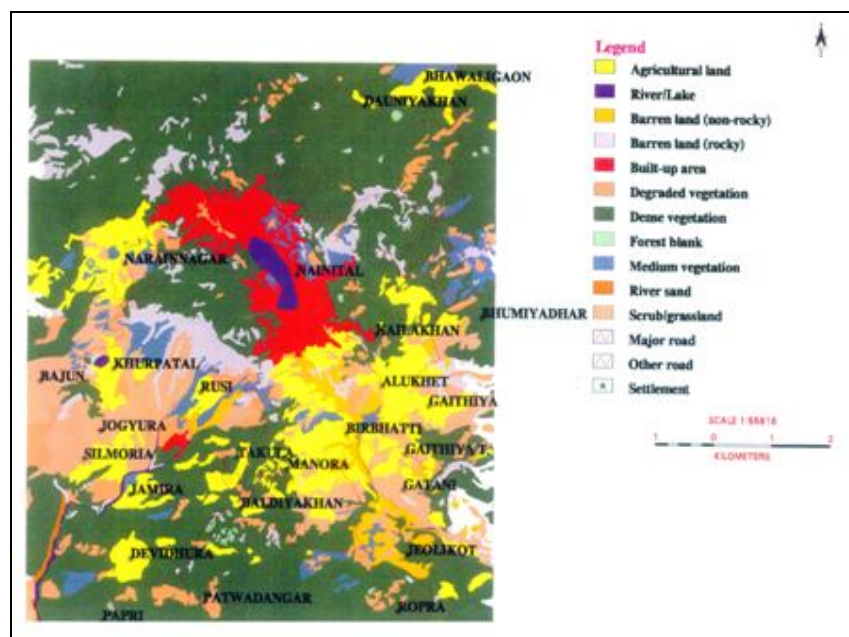


Figure 2: Landuse Map

6. Concluding Remarks

It is clear from the present study that there are different types of landuse cover are found in the areas of Nainital and Almora districts. This study helps us to know the landuse characteristics of the area. These landuse has an important bearing on Landslide hazard, zonal and mitigation measures. Through this study we are able to hold a clear picture on the proneness of area to landslides and find a way to apply some possible measures to cope with such hazards in this tectonically active & fragile terrain of Nainital and Almora districts of Uttarakhand.

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