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"Environmental Impact of Landform and Landuse/Landcover Changes In Upper Ijai Basin, Manipur, India"

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Abstract

Landform and landuse/landcover changes in upper Ijai Basin of Manipur have led notable environmental degradation driven primarily by current jhumming, expanding settlement, agricultural, infrastructural development and increase in population. These changes have increased soil erosion, sedimentation, surface runoff and risks of floods and landslide.The study area lies between 24^0 $37^/59.718^{//}$N to 25^0 $0^/46.4796^{//}$N latitudes and 93^0 $32^/20.126^{//}$E to 93^0 $47^/58.87^{//}$E longitudes. Present research is carried out using survey of India (SOI) topographic map on 1:50,000 scale and LANDSAT imagery (2006 and 2012) and field work, different types of landforms and landuse/landcover have been identified in Ijai basin. On the basis of magnitude, the landforms are broadly divided into two categories i.e., major and minor landforms that are utilised by man and nature for different purposes. Major landforms include structural hills, valley and flood plains and minor landforms like alluvial fans, terraces, point bars, channel bars, rapids and waterfalls etc. associated with these major landforms. Eight different categories of landuse /landcover i.e., Agricultural land, settlement, current jhumming, dense forest, medium forest, scrub land, barren land and water bodies have been identified in the Ijai river basin. Between 2006 and 2012 there have drastic changes in landuse/landcover patterns in the study area. The analysis revels that there is decrease in the forest areas (dense and scrub areas) while increases in agricultural, settlement, jhumming cultivation and medium forest areas. Increase in the settlement area, jhumming cultivation and changes of forest areas are mainly due to increase in population. First and foremost, requirement of river basin management in the study area under investigation is mass awareness amongst the local inhabitants about

demerits of environmental degradation due to large scale deforestation which would subsequently be affected to their socio-economic condition.

Keywords: Landform, landcover, flood plain, valley, alluvial fan, Landsat, deforestation

Introduction

Land is the only natural resource that needs dynamic management system for sustainable use. To study land as a keystone for all natural resources it is essential to understand the associated landform characters. Howard and Spock (1940) have defined landform as "any element of the landscape characterized by a distinctive surface expression or internal structure or both and sufficiently conspicuous to be included in a physiographic description". Land surface is constantly being modified by a number of exogenic and endogenic processes which lead to formation of different types of landforms. Thus, Landforms are the function of structure, lithology, process and time or in short, they are the product of normal cycle of erosion (Davis, 1894). Land cover refers to natural vegetation, wetlands and water bodies, rock/soil etc while landuse refers to human interferences with different activities.

Landcover is a basic resource and it has to be utilized in accordance with the suitability and ecological capabilities which depends on various geological, biological and climatic factors.Land is a non-renewable natural resource on which man depends for his food, fibre, fuel, shelter and recreation. Due to ever-growing population, there is enormous pressure on land's limited resources which are being over-exploited to meet human demands and as a result the ecological balance is being disturbed. For judicious use of the limited resources without disturbing ecology of the earth it is essential to have proper scientific landuse planning. The necessity, therefore, is to have upto-date data concerning the present and past landuse patterns and changes.

Study Area

Ijai is one of the important tributaries of river Irang and integral part of the Barak River System. Ijai River basin, the present area lies between24°37′59.718″N and 25°0′46.4796″N latitudes and 93°32′20.126″E and 93°47′58.87″E longitudes (Fig.-1.) and falls under Survey of India topographic sheet numbers83H/9, 83 H/13, 83 G/12 and 83 H/10 on 1:50000 scale. It originates from Makhan Khuman of Koubru Hill Ranges of Senapati District (Manipur), covering an area of about 510.8 km^2. From its origin to Tupul, river Ijai flows north-south and thereafter it takes an abrupt turn and flows toward west till the confluence with Leimatak River near Luangchum village.

Methodology

The IRS-ID LISS-III satellite data of 2006 and 2012 pertaining to the study area was collected and registered to SOI topographic sheets of 1:50,000 scale and analysed using GIS software (ERDAS, version-10.0). The surface lithological analysis of the study area has been carried out through visual interpretation of satellite data considering the geological map (GSI, 1978) as the base map. The slope map of the area was generated from the DEM data (Digital Elevation Model data). GIS visual

interpretation techniques have been followed in delineation of landform and landuse/landcover units/data based on tone, texture, slope, drainage pattern colour characteristic of the satellite imagery and identified the changes in the landform and landuse/landcover unitesand causes are calculated. Adequate field checks were conducted for deriving information on geomorphic units and verify the boundaries and properties of the delineated landform units and landuse/landcover classes

Results And Discussion

Slope

Slope is an important geomorphic factor and essential component of the complex landscape that forms a drainage basin (Chorley *et al.*, 1985. The study of slopes provides information not only about the variety of topographical features but makes available also the evidences needed for interpretation of complex forms of landscape. Slope map of the study area has been prepared from ASTER DEM data, having a resolution of 30m vertical elevation. Global Mapper 16.0 and ARC GIS 10.0 have beenused to generate the required slope classes.Slope values of the study area arebroadly categorized into three groups. i.e. moderate (45.03%), steep (52.95%)and very steep slope (2.03%) of the total area after Mukhopadhyay (1982). As the entire study area lies in the hilly terrain, gentle slope is absent.

From the interpretation it shows that highly irregular distribution of slope in the study area and may be attributed to the lithological and structural complexities, unsystematiclanduse patterns, eratic burning of forest for jhumming,etc. However, southern part of the basin is characterised by moderate slope. Western and southern part of the study area is characterized by steep slope with moderate slope at sporadic areas. South-eastern portion of the study area is predominated by steep slope. However, the eastern side of the south-eastern portion exhibit predominance of moderate slope. Eastern boundary of the study area is characterized by moderate slope which changes to steep slope towards west. North-eastern portion of the study area is predominated by moderate slope with steep slope at sporadic areas along with little patches of very steep slope. Extreme northern part of the study area is characterized by steep slope. The area between Ijai and Aleng rivers are characterised by steep slope but areas near river valleys are characterised by moderate slope. Superposition of slope and relief map reveals that higher slopes are generally found at higher altitude and vice versa.

Geology

In the study area only Barail Group of rocks belonging to Laisong, and Jenam formations are exposed. A geological map of the study area as been prepared on the basis of available literatures, interpretation of LANDSAT Imageries and field observations. Due to tectonic disturbances, geology of the study area has become highly complex. Most of the major river courses follow the faults, anticline and synclinal axes.

Landform and Landuse/Landcover

Different types of landforms and landuse/landcover in the study area have been worked out on the basis of visual interpretation of LANDSAT imageries of 2006 and 2012 using GIS software (ERDAS, Version-10.0) and field survey. On the basis of their dimensions these landforms are classified as major and minor. Major landforms include hills, valleys and flood plains. Hills are the product of folding and faulting characterized by conical and flat tops, which are modified into concave and convex nature by ongoing recent erosional processes. Valleys are developed along the weak zones like anticlinal and synclinal axes, fault plains, fractures and joints etc. While minor landforms are alluvial fans, terraces, point bars, channel bars, waterfalls rapids etc. These landforms are identified on the bases of changes in the contour patterns on the topographic maps and field observations.

Landuse/landcover pattern in the study area have been classified into eight categories as i) Agricultural Land, ii) Built-Up Land (Settlement), iii) Current Jhumming, iv) Dense Forest, v) Medium Forest, vi) Barren Land, vii) Scrub Land and viii) Water-bodies.Landuse/landcover map and table reveals that major part of the study area falls under the dense forest covers, followed by scrub land, medium forest, agriculture, settlement, water-body and barren land. Most of the villages are situated in the remote areas on the flat hill tops. Important villages are: Kharam, Noney, Nungtek, Awangkhul, Senam, Sekjang, Marangching, New Charoi, Chakotlang, etc. Most of the villages are connected with un-metalled roads or footpaths but the villages settled along NH-37 are well connected with metalled road. Agricultural land is confined along the course of Ijai river and hill slopes (jhum cultivation). The main crop grown in the area is mainly paddy. Superposition of landuse/landcover map over slope, relief and slope aspect maps suggests that there is no definite relationship among them.

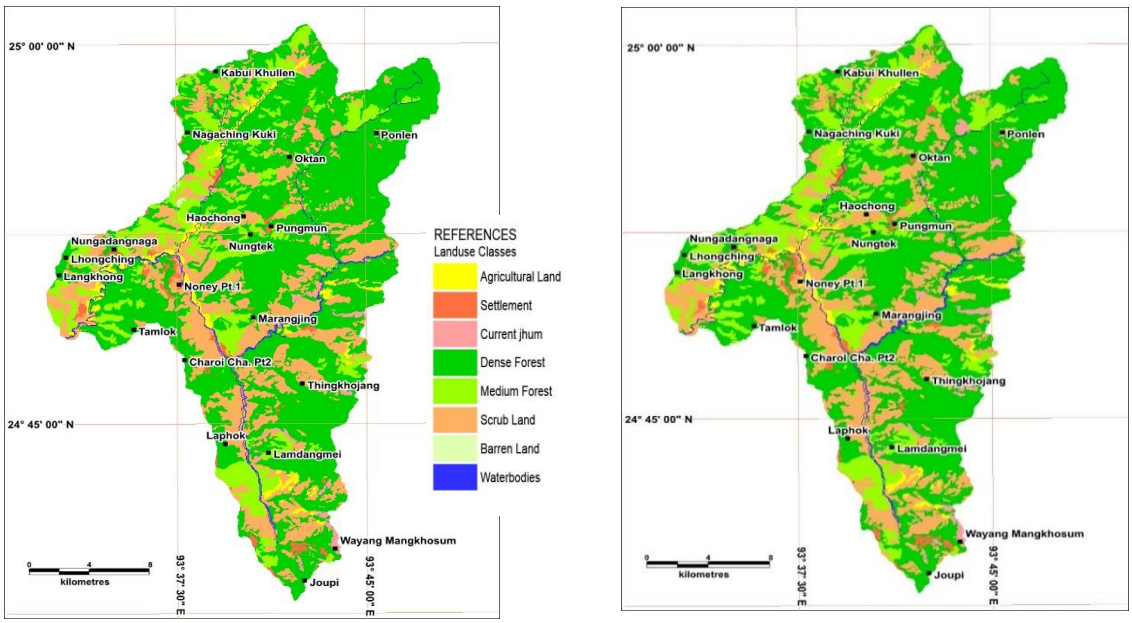

Fig. 1: Landuse Map of the study area for the year2006 and 2012

Photograph showing:

A) Different types of landforms and Landusei) pointbar, ii) channel bar, iii) medium forest and iv) dense forest

B) Agricultural land (terrace used for paddy cultivation)

C) Alluvial Fan (I) and (II) jhum cultivation

D) Alluvial Fan (I) and (II) jhum cultivation
E) Deep and narrow valley
F) Wide and straight valley

Changes of Landuse/Landcover Patttern

In order to meet the demand of ever-growing population there is enormous pressure on the limited land resources which causes changes in the landuse patterns in time and space. Landuse pattern is a spatial arrangement of different types land at a particular period of time. According to Anderson (1971), landuse data is required for the analysis of environmental processes and problems that must be understood properly if living condition and standards are to be improved or maintained at current level. Landuse/landcover analysis is one of the aspects which have been dealt with great emphasis in the recent past (Kam, 1995; King, 2002; Chauhan and Nayak, 2005; Mahajan and Panwar, 2005; Shamsudhin*et al.*, 2005, Arveti*et al.*, 2016 etc.). Remote sensing is found to be a very useful tool for the investigation of changes in landuse/landcover pattern because of its synoptic view capability and receptive coverage (Lugue, 2000). In order to work out the changes in landuse/landcover pattern inthe study area mapping has been carried out by visual interpretation of LANDSAT data for the year 2006 and 2012 and the result obtained shown in table 1 and presented graphically in figure 2.

Table-1: Landuse changes during 2006-2012

Sl. No.	Landuse Classification	Area in the Year 2006 (km^2)	Area in the Year 2012 (km^2)	Total change (km^2)	% of Change
1	Agricultural Land	12.96	13.020	0.059	0.012
2	Settlement (Built Up land)	8.527	8.536	0.009	0.002
3	Current Jhumming	5.683	6.674	0.991	0.194
4	Dense Forest	289.932	288.233	-1.699	-0.333
5	Medium Forest	71.459	75.729	4.27	0.836
6	Scrub Land	118.263	114.990	-3.273	-0.641
7	Barren land	0.388	0.003	-0.385	-0.075
8	Water-bodies	3.615	3.643	0.028	0.005
	TOTAL	**510.828**	**510.828**		

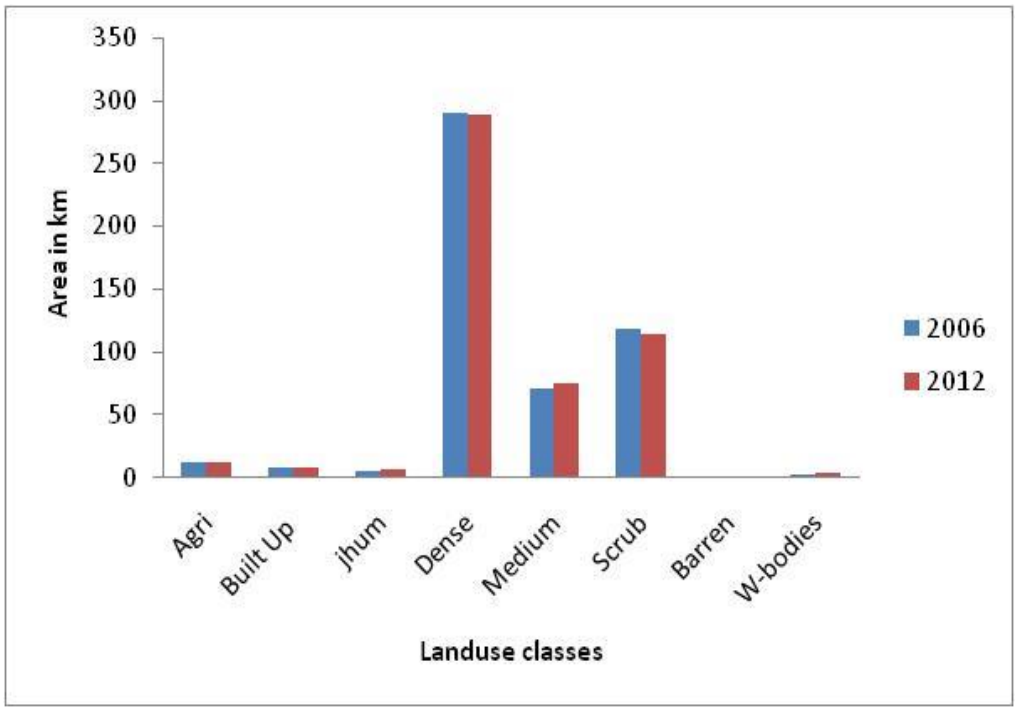

Fig. 2: Landuse changes graph during 2006- 2012

Analysis of figure 2 reveals that there is decreasing in area of dense forest and scrub land while increase in the areas of settlement, agriculture and medium forest in the basin area. Nearly two third of the basin area is covered with forest. In the year 2006 the dense forest covers in the Ijai basin was 289.932km^{2}which has been reduced to 288.233km^2 in 2012. There is an increase in the medium forest areas from 71.46km^{2}during 2006 to 75.73km^2 during 2012. There is a decrease in scrub land, from 118.26km^2 in 2006 to 114.9905km^2 in 2012. Barren land is decreased from 0.39km^2 to 0.003km^2 during 2006 to 2012. From the analysis, it is found that area of forest (dense and scrub) decreases while agricultural, settlement and medium forest areas have increased. Scrub and barren lands have been either converted to agricultural or jhum lands

Conclusion

Landuse/landcover maps have been prepared using LANGSAT data for the years 2006 to 2012. Within a span of six years, areal extent of several landuse patterns has been modified. This may be due to erratic burning of forest, widespread practice of jhumming and ill-planned landuse in the study area. Analysis of data reveals that there is dense forest and scrub land whereas; agriculture and medium forest have increased in the area. Degradation of forest in the study area is mainly caused due to prevalent jhumming, growth of settlement, rampant use of timber and forest products for firewood and ongoing railway projects (plate-5A). The shifting/jhumming cultivation is being practiced due to lack of irrigation, communication, transport facilities and infrastructural facilities and other means of livelihood. Landuse/landcover changes also related to population growth. Due to the increase of population lead increase in

settlement area and change the forest area also. So erratic burning of forests for jhumming and indiscriminate cutting of trees for domestic, widening/making road and others are also related to population growth. These changes have increased soil erosion, sedimentation, surface runoff and risks of floods and landslide also.

Watershed management and landuse planning in the study area can be integrated through programmes generating mass awareness of the local people towards environmental degradation due to deforestation and its ill effects on the socio-economic conditions in the long run. There is need of rehabilitation of forest in the area through programmes such as:

i) Massive afforestation,
ii) Ban on indiscriminate cutting down of trees for commercial purposes,
iii) Ban on burning of forest for jhum cultivation.

The state Agriculture Department has set up a number of orchards-cum nursery to grow fruit trees like orange, lemon, plum, walnut, guava, banana, pineapple etc. and plantation of cash crops like tea, rubber, coffee etc. Various structures like bench terraces, contour bands, and ridge terraces and grasses waterways can be constructed to conserve water and soil. Where ever the terracing is not possible improved jhumming can be done with application of manures and fertilizers. As far as possible, jhumming should be avoided in the area. Scientific landuse planning will be helpful to check soil erosion from the hill slopes and permanent water to percolate underground. In addition, retention dam may be constructed in the areas prone to intensive erosion. To make the afforestation programme effective and to minimize jhumming cultivation in the area, it is essential to introduce some other alternative subsidiary occupations on commercial scale by giving incentives and financial aids, such as: piggery, poultry, mushroom cultivation, beekeeping, cane and bamboo works etc. Besides these, fuel efficiency resources such as biogas, solar energy and wind energy etc. may be introduces which would greatly reduce pressure on the forest.

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