

FACTORS AFFECTING LAND USE CHANGE AND ITS IMPACTS IN THE EASTERN HILLS OF NEPAL

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ABSTRACT. – **Factors Affecting Land Use Change and Its Impacts in the Eastern Hills of Nepal.** The objective of this paper is to explore factors causing change in land use and land cover categories in the Eastern Hills of Nepal's during the past 24 years between 1986 and 2010. The paper draws data and information from three different map sources —land resource mapping project 1986, toposheet 1996 and Landsat imagery 2010. In addition, the mapping data being generated were verified in the field through using observation, reality check approach and consultation workshops held at different places in the Eastern Hills of Nepal. The study area comprises four contiguous hill districts such as Bhojpur, Dhankuta, Sankhuwasabha, and Terhathum.

A significant change has occurred particularly in two major categories of land use and land cover in the Eastern Hills of Nepal over the past two and half decades. While forest land increased consistently over the past 24 years, cultivated land area increased during the years 1986-1996 but decreased between 1996 and 2010. In agriculture, patches of abandoned agricultural land have also been observed in areas away from road facility in the recent years due to out-migration of youths. Intensification of agriculture practice was found along and around roads, wherein traditional subsistence cereals crops have been replaced with commercial vegetables and high value crops such as large cardamom, ginger, seeds and fruits.

Three major factors comprising community forestry program, construction of roads, and introduction of improved agriculture development programs have contributed to internal trading between major land use and land cover categories. Further, these changes have offered benefits like nature conservation, internal and international trade of local products, and better living conditions of local communities. These development efforts should be kept in mind for policy measures in regard to conservation and development management of land use and land cover categories in other areas of Nepal.

Keywords: *land use change, Eastern Hills, Nepal, arable land, forest land, GIS.*

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INTRODUCTION

Land is a crucial natural resource in Nepal, where agriculture is the main economic base. However, Nepal is facing a major challenge with improper use of land resource. There is lacking of land use plan and acts in Nepal and as a result, no land use is being practiced to provide a vision for land based sustainable development, as well as to regulate land uses in an efficient way, thus to prevent land use conflicts and safeguard other natural resources in the country (FAO, 1993).

Investment in development projects has been increasing over time across Nepal, causing change in land use and land cover. In this regard, there is urgency of an integrated land use planning as a tool that combines interactive relations between the development activities and use of land resource. In 2002, National Land Use Project was set up and since then, efforts have been continued through research projects to generate databases necessary to the land use planning in Nepal. Only in 2013, the Government of Nepal promulgated National Land Use Policy.

Land use often changes due to human interventions and natural causes. Current land use patterns in any area are the result of human activities over the years, but they are strongly influenced by natural conditions. The heterogeneous landscapes with mosaic of arable land, patches of natural vegetation, grassland, agro-biodiversity, built-ups and others reflect the diverse land uses in the area. Lourenco et al. (1997) have found that external factors such as agricultural and forest conservation policies, transport development, hydro dam works, etc. are driving forces behind frequently changing in the use of land in rural areas. Axinn and Ghimire (2011) have found in their studies that social, economic, and demographic changes affect land use patterns over time.

Land use studies generally concern with the spatial and temporal patterns of land conversion at different geographic scales by human activities and understanding the causes and consequences of these changes. They also deal with explaining the economic process, viz. human behavioral component that underlies land use change, i.e. causal relationships between individual choices and land use change outcomes (Axinn and Ghimire, 2011). As human systems of production change, be they shifting cultivation, subsistence agriculture, or commercial production, patterns of consuming land change and these changes alter the use of the land and the nature of the resulting land cover. According to Gautam et al. (2002), Virgo and Subba (1994), Thapa (1996), Jackson et al. (1998), land use in an area represents an insightful reflection of human interaction with its environment and development interventions such as infrastructure, introduction of new technologies, changes to policies, etc. are likely to change in land use and socio-

economic development in response to these drivers of change. Provisions of schools, health services, markets, and transportation services may all change social life in consumption patterns of land. These changes in patterns of consuming land are likely to have important consequences for local land use and land cover.

Land use is a fundamental measure of how the environment is organized in a setting. Changes in land use are reflected in the relative magnitude of the land area being devoted to agricultural and non-agricultural activities. Over time, as the population changes, as the economy grows, and as the government infrastructure spreads, land use is likely to be transformed in many ways, for instance, the conversion of agricultural land to land for housing and other non-agricultural enterprises, the reduction of public forest and grazing lands, and the intensification of farm land.

This paper intends to explore factors responsible behind changing in land use and land cover and their impacts in the Eastern Hills of Nepal.

1. Data Sources and Methods of Analysis

1.1 Land use definitions and classifications

In this paper, land use is defined to refer to the proportion of total land area shared by different land use categories. Based on the 1996 topo sheet of Nepal (SD 1996), five broad categories of land use such as arable land, forest, shrubland, grassland and other lands can be ascertained. Arable land refers to the land being used for cultivation of cereal crops like rice, wheat, maize, and millet and other crops like vegetables, tea, fruits trees etc.; forest lands include all lands having permanent forests and trees with more than 10 percent crown cover (DFRS 1999). Shrub refers to bush, or degraded forest or secondary growth forest, where there are scattered trees standing or with less than 10 percent crown cover; grassland comprises meadows and pastures; and other lands include settlement built-ups, roads, barren or bare land, water bodies, snow land, rock and ice. This definition is broadly to include the social and economic purposes and contexts for and within which lands are managed or left unmanaged. Change in land use type refers to those occurred in three different map year points 1986 (KESL, 1986), 1996 (SD, 1996) and 2010 Landsat imagery. The factors of land use change may include human activities, including local culture, economics, and land policy and development and environmental change.

These works are to calculate and compare change in the land use categories by location in those three years. The rationale behind considering those broad land use types is that each of them has significant role to development and nature conservation in Nepal. For instance, forest contributes to rural development

by providing forest products such as firewood, fodder, timber and herbs to rural communities, and by regulating atmospheric conditions. In addition, the forests are also essential to sustain agriculture and livestock (buffaloes, cows and goats) rearing in the Eastern Hills. Arable land is a fundamental resource to support living of majority of the rural people. There is a close link between agriculture and forest resources. The former derives products from the latter such as fodder, leaf-litter, etc. to maintain the nutrient levels and soil structure. Grassland has an immense role to contribute not only to raising livestock such as cows, sheep, and yaks in the high mountains, but also to maintain the watershed.

Thus, the data for this paper has been acquired from both analogue and digital map sources of those three map years so far available in Nepal. The 1986 map data has been considered as the benchmark year for spatial database of land use and land use change. The topo sheet digital data sets have two scales such as 1: 50,000 and 1: 25,000. The mapping resolution of Landsat imagery is 30 m. The 1:25,000 has been set as the base map scale, with minimum mapping unit of 2.5 hectare. In so doing, a careful choice of appropriate GIS functions together with field verification of land use and land cover categories at the training sites particularly along the road access and towns, where change in land uses often assumed to have occurred, were used so that loss or uncertainty of land use and land cover information particularly from 1:50,000 to 1:25,000 was minimised at maximum possible level. Further, the Eastern Hills also lacked reliable baseline household data, which was needed to comprehensively capture the complex relationships between land use change and its impacts on the social and economic conditions.

1.2 GIS mapping procedure

The spatial data transformation process in GIS format being adopted in the study is as follows:

1. The analogue datasets of 1986 map sheets were scanned and processed into the compatible data form by adopting all steps such as geo-referencing, digitizing (missing features), topology building, editing, edge matching, appending, and map layouts in the ArcGIS format. Likewise the digital data features of topo sheet of 1996 including river levels, road types, and contours were defined and edited as to the need of this study. In case of Landsat imagery 2010, the digital data processing included all steps such as re-projecting to the modified Universal Transverse Mercator coordinate system (adopted by the Survey Department of Nepal) through re-sampling of <math><0.5</math> pixel (equivalent to approximately 10-15 m),

selection of training sites (based on in-situ assessment provided by ground truthing work), creation of multiple signatures, identification and classification of land use and land cover by maximum likelihood classifier, post reclassification assessment (based on existing land use, digital elevation model and field data), and refinement of classification by filtering. The classification accuracy as explained by the Kappa statistics was at 85.3 per cent.

2. The likelihood changes of land use and land use categories in the Eastern Hills of Nepal were verified in the field, particularly at training sites accessed by roads. The attribute data available over time from the record or base data at the district level were limited and inconsistent. So data verification in the field was carried out in two steps. First, consultation with representatives of various district line agencies at the headquarters of four Eastern Hill districts of Nepal was carried out to determine whether there was any change in land use types on 2010 based enlarged land use color maps generated by GIS. In the meantime, all gray reports and data available at the districts were also acquired. Secondly, key features such as newly built roads, commercial vegetables patches, cardamom and *Amreso* (broom grass), abandoned arable land patches, hāt bazaars, health service, and place names were verified by visiting the locations. GPS equipment (3m-resolution) and color topo sheets (1996) as reference maps were used for verification in the field. Updating of the land use features incorporating field verification information and final layouts in GIS environment were prepared.

3. The attribute data including population, production of major agriculture crops such as off-season vegetables, cardamom, ginger, non-timber forest products (e.g. herbs) and woods were gathered from different sources (publications, documents, reports, statistical and digital data and maps) by visiting all related organizations. Integration of the attribute data related to land use at the district level has been made based on standard coding system of the Central Bureau of Statistics (CBS). These were made to see change in the land use pattern and identify gaps to help explain the key factors responsible behind land use change, as well as change in the social and economic conditions of the people of the study region.

4. Change in the land use categories has been computed by the overlay function between a pair of two consecutive years, such as: (i) 1986 and 1996 and (ii) 1996 and 2010. Magnitude of change (in percent) in land use categories has been determined at four levels, such as: <25, 26–50, 51–75, and >75, based on the mappable polygon size. The map layouts of land use categories have been prepared following the standard colors, and other GIS functions such as buffer and overlay were employed wherever feasible.

2. Results and Analysis

2.1 *The study area - an introduction*

For this paper, the Eastern Hill region of Nepal comprises four districts such as Bhojpur, Dhankuta, Sankhuwasabha and Terhathum (Figure 1). The study area extends over 6,557 km², sharing 4.4 per cent of the country's total land area (147,181 km²). The neighboring districts of the study area are Khotang (Hill) to the west, Ilam (Hill) to the east and Morang and Sunsari in the south Tarai (plain), which borders with India. In the north lies Tibet of China. These surrounding areas have linkages to land use change in the study area.

The physical settings of the Eastern Hills are characterised by rugged topography that presents a maze of spurs and valleys; the elevation of which ranges from 300 to over 8,000 masl (Figure 2). The hills traverse from east through west and there are a number of narrow longitudinal river valleys, which are extensively brought under cultivation through terrace farming. The Himalayas confine in the northern part, extending up to the Tibetan border. This belt also consists of rolling pastureland, where sheep and yaks graze. There are historically important trading routes leading to Tibet through the passes. The Koshi River together with its principal tributaries such as the Arun, the Sunkoshi, and the Tamor drain the study region (figure 3). The Koshi is also the largest river of Nepal. The Monsoon is the main system to affect climate of the study region. Over 80 per cent of the annual precipitation of 1,500 mm occurs during June-September months, which generally decreases from east to west whereas the mean temperature increases from north to south. While the moist sub-tropical climate prevails in the southern half, the temperate climate and tundra types of climate are found in the northern part of the Eastern Hill region.

The total population of the study region was 609,407 in 2011 census, mainly occupying the lower hill slopes and river valleys in the Eastern Hill region (figure 4) and giving an average density is 93 persons per square kilometer. The study region saw overall a negative growth rate of -0.52 per cent during 2001-2011 decade, unlike the national population growth rate of 1.4 per cent during the same decade. The region consists of diverse ethnic groups. The Rais and the Limbus are the indigenous inhabitants. There has been a tendency of flow of people from the hills to the Tarai in the Eastern region from the very beginning. In 1991, for example, the population migrating out in the Eastern Hill region has grown drastically by 3.1 per cent as compared to 8.4 per cent in 2001.

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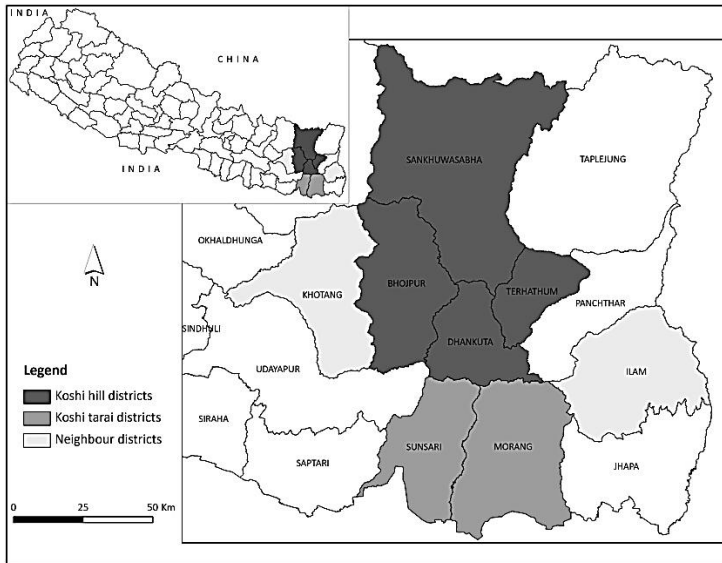


Figure 1. Location of Eastern Hill Region, Nepal

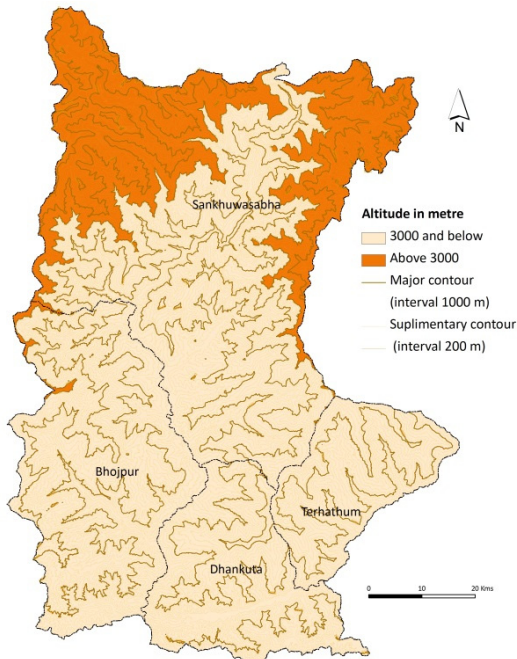


Figure 2. Relief features by elevation, the Eastern Hills of Nepal

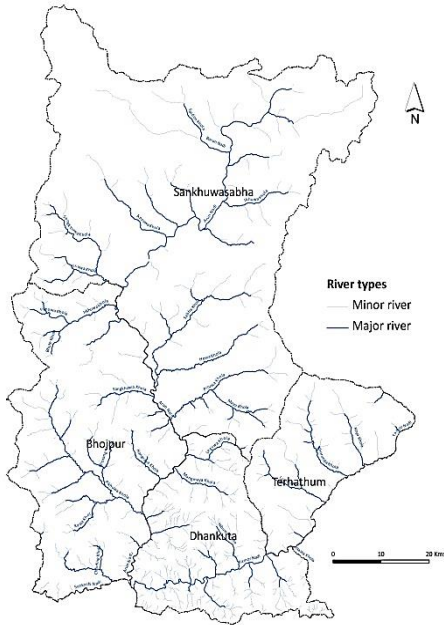


Figure 3. Drainage systems, the Eastern Hills of Nepal

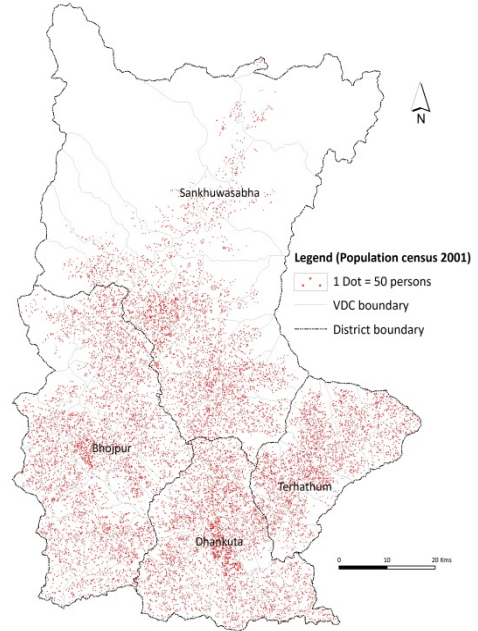


Figure 4. Distribution of population in Eastern Hills of Nepal, 2001

In the Eastern Hills, agriculture is the principal economic activity, with 67 percent working population engaged in this sector. But the agriculture is predominantly of subsistence nature, except in few areas accessed by roads where intensive cultivation of vegetables is being practiced. One of the main sources of income is remittance, with about 56 percent households receiving remittances from foreign labour. The manufacturing sector is primarily based upon local raw materials and products. Each of the four districts of the study area is characterised by their unique products such as tea estates in Dhankuta, Dhaka (cotton cloth) in Terhathum, Allo (a kind of NTFP) in Sankhuwasabha and paper in Bhojpur. In 2011, a total of 1,774 were registered mostly based on the indigenous products such as textiles (Dhaka, Allo cloths) and handicrafts (bamboo products, embroidery products). The Dhankuta and Terhathum districts were included under ‘Tea Zones’ by the government in 1982. In addition, various users’ groups and associations related to milk, vegetables, live animals, retail outlets, wholesale, etc. have been emerged in recent decades for promoting internal marketing systems. However, market integration has been the main hurdle due to limited market places and very limited access roads (figure 5).

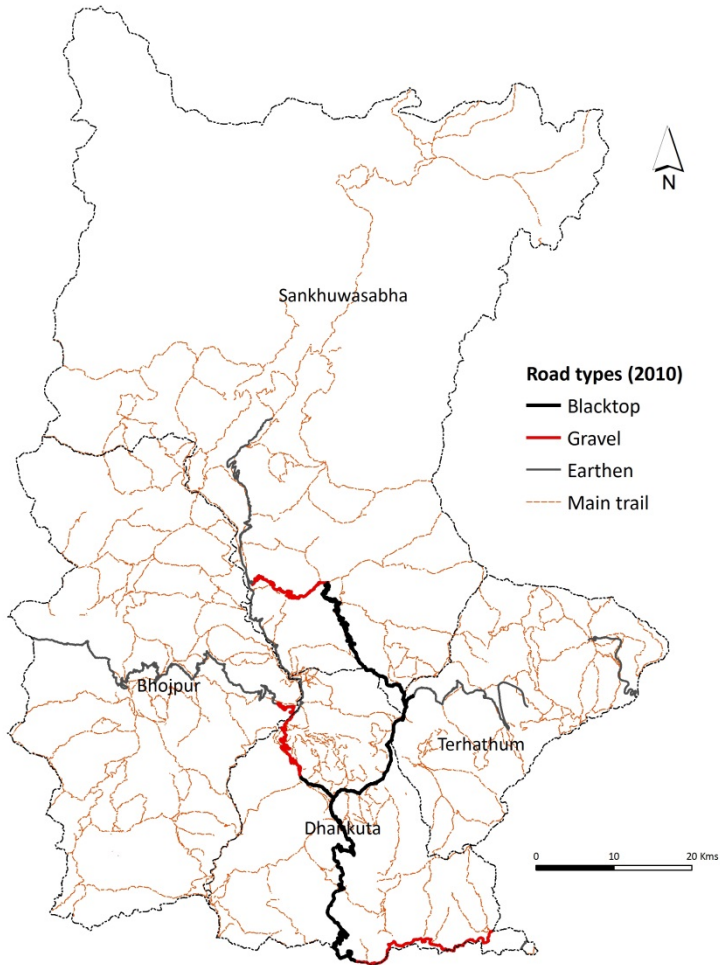


Figure 5. Distribution of roads and major trails in the Eastern Hills of Nepal, 2010

Road for the first time came in the Eastern Hills in 1982. Now the highways have opened up extending forward linkages and other links of the local produce with large cities of Dharan and Biratnagar in the Tarai and then other places across the country, as well as with India. There is also air service between the study region and Kathmandu, the national capital city and Biratnagar, the regional city of Eastern Nepal. Here, fuel wood is the major source for cooking and kerosene is next important fuel basically for lighting purpose. The literacy is over 52 percent.

2.2 Change in Land Use

(a) Distribution of land use by mapping years

Of five major land use categories in the Eastern Hills, forest is by far the largest coverage, making up of 47 percent. Next is the arable land, sharing nearly 30 percent. So in 2010, they combining together occupied dominant position in all land use categories, accounting for over three-fourths of total area of the Eastern Hills. They also had predominated in the previous two mapping point years – 1996 and 1986 (table 1).

Table 1. Distribution of land use categories by year, the Eastern Hills

Land use Categories	1986		1996		2010	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Arable	199,404	30.4	219,688	33.5	196,400	29.9
Forest	259,366	39.5	245,918	37.5	307,154	46.8
Shrub	60,541	9.2	61,946	9.4	11,544	1.8
Grassland	59,254	9.0	20,718	3.2	36,216	5.5
Others	77,551	11.8	107,846	16.4	104,802	16.0

Sources: LRMP 1986, Toposheet 1996, and Landsat imagery 2010

However, the spatial distribution of two major land use categories – forest and arable land– varies remarkably that seems to be related to relief features in the study region. In all three mapping years: 1986, 1996 and 2010 (figures 6, 7, and 8), the arable land generally appears to be confined to the river basins and the lower and middle slopes of the hills, whilst the forest has occupied the areas around the riverbanks characterized by hot summer climate, as well as the high and steep slopes of the mountains and hills. At the individual district level too, the forest is the largest natural resource in terms of area coverage of Bhojpur and Sankhuwasabha, whereas the arable land is the most important resource in terms of area coverage of Dhankuta and Terhathum. In 2010, the districts of Bhojpur and Sankhuwasabha had forest coverage with 46 and 51 percent respectively, while in the same year Dhankuta and Terhathum districts had over 46 percent arable land coverage (see table 3). These juxtaposing distribution patterns of forest and arable land among the districts are mainly due to variation in terrain across the study region.

(b) Change in land use and land cover (1986-2010)

Over the past 24 years, there has been a remarkable change in land use and land cover in the Eastern Hills of Nepal. Of all land use categories in the study region, arable land and forestland show remarkable changes. There was an increase by 10.2 percent in arable land between 1986 and 1996, while a decrease by 5.2 percent in forest between the same two years (Table 2). Contrary to these changes, arable land decreased by 10.6 percent, while forest saw an increase of 25 percent in 2010 as compared to 1996. By 1996, forest coverage decreased to 37.5 percent while arable land increased to 33.5 percent, but however forest coverage sharply increased to 46.8 percent in 2010 while arable land coverage reduced to 29.9 percent in the same year. The coverage of shrubland remained at around 9 percent in 1986 and not so changed in its area in 1996 but declined sharply to 1.8 percent in 2010. Grassland experienced a decrease from 9 percent in 1986 to 5.5 percent in 2010. Other land uses comprising water bodies, snow land, bare land, rock and ice, built-ups, and roads shared 11.8 percent in 1986 and rose to around 16 percent in the following two mapping point years.

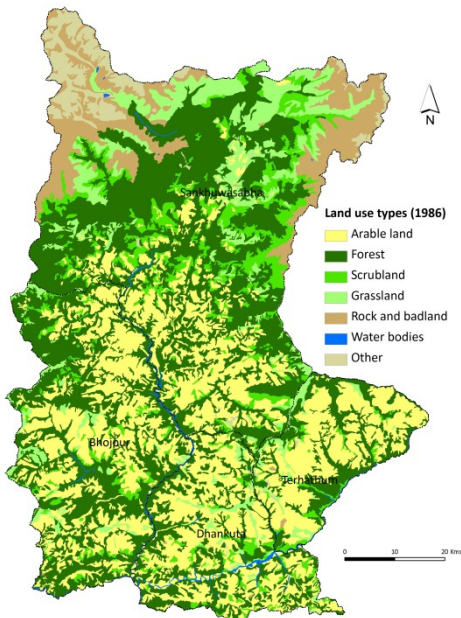


Figure 6. Distribution of land use and land cover in Eastern Hills of Nepal 1986

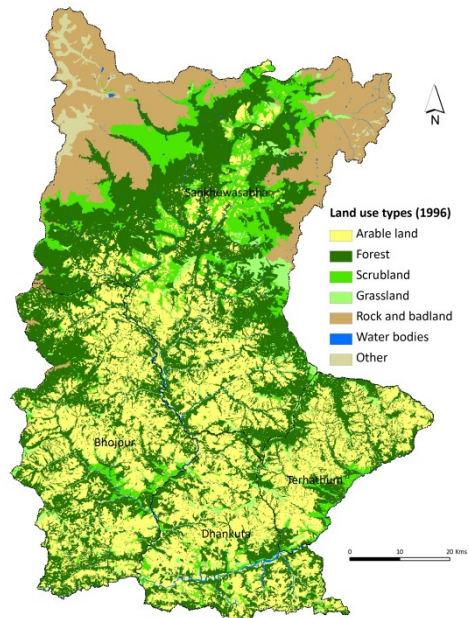


Figure 7. Distribution of land use and land cover in Eastern Hills of Nepal, 1996

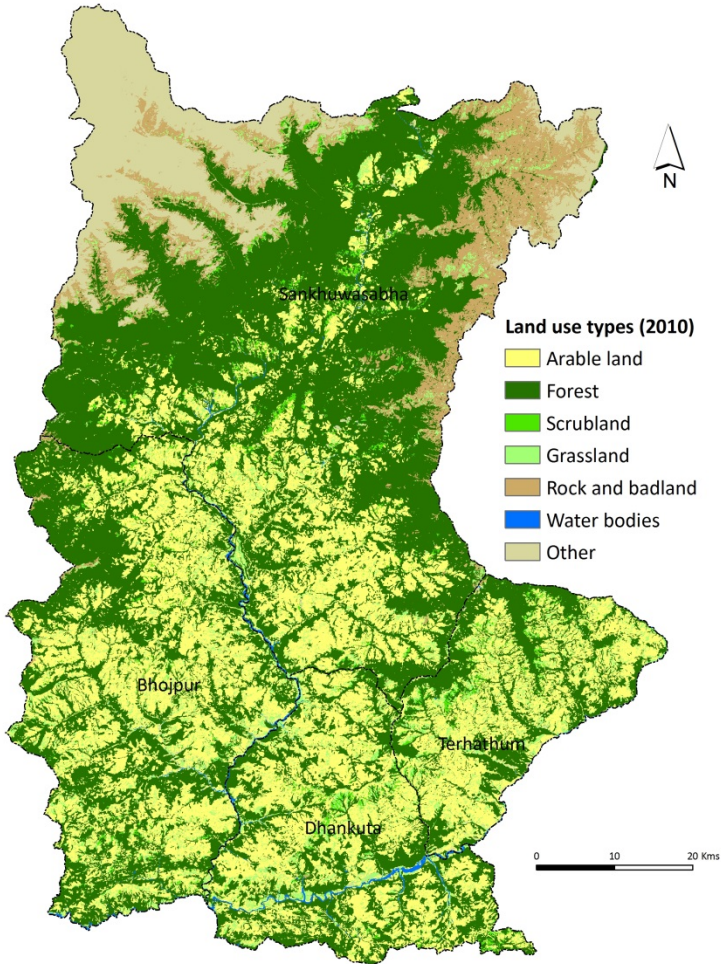


Figure 8. Distribution of land use and land cover in Eastern Hills of Nepal, 2010

Table 2. Magnitude in change (%) in land use categories by year, Eastern Hills of Nepal

Land use Categories	1986-96		1996-2010		1986-2010	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Arable	20,284	10.2	23,288	-10.6	3,004	-1.5
Forest	13,449	-5.2	61,236	24.9	47,788	18.4
Shrub	1,405	2.3	50,402	-81.4	48,997	-80.9
Grassland	38,536	-65.0	15,498	74.8	23,038	-38.9
Others	30,295	39.1	3,044	2.8	27,251	35.1

Sources: LRMP 1986, Topo sheet 1996, and Landsat imagery 2010

Firstly, the arable land area has decreased by 1.5 percent while that of forest has increased by 18.4 percent in the Eastern Hills over the past 24 years. But a remarkable change has occurred in shrubland and grassland during the same duration of years. Table 3 depicts that the grassland declined by 65 percent during the decade of 1986-96, but increased to 75 percent between 1996 and 2010, while during the 1996-2010 decades, the shrubland declined by 81.4 percent. Thus during 1986-2010, the shrubland and the grassland declined by 81 and 39 percent respectively.

Table 3. Magnitude in change (%) by land use category in the Eastern Hills, 1986-2010

Land use Type	Year	Bhojpur	Dhankuta	Sankhuwasabha	Terhathum	Relative share %
Arable	1986	42.7	52.0	14.5	55.7	30.4
	1996	49.0	52.6	17.0	53.0	33.5
	2010	44.5	48.4	15.6	46.3	29.9
Forest	1986	46.0	33.9	39.6	31.8	39.5
	1996	42.5	30.6	36.8	36.2	37.5
	2010	45.8	38.6	50.8	39.5	46.8
Shrub	1986	5.3	7.0	12.4	4.9	9.2
	1996	3.9	4.9	13.9	4.9	9.4
	2010	1.6	2.2	1.5	3.0	1.8
Grassland	1986	4.8	4.4	12.7	5.7	9.0
	1996	2.3	3.0	3.2	4.7	3.2
	2010	6.7	8.7	3.3	10.1	5.5
Others	1986	1.1	2.6	20.8	1.9	11.8
	1996	2.3	2.6	29.1	1.2	16.4
	2010	1.4	2.2	28.8	1.1	16.0
Total area (ha)		152,325	89,854	346,896	67,040	656,115

Note:

- The values were derived from land use GIS map
- The summation of the values of the five land use categories along the column of each district of a single year gives 100 per cent, e.g. $(42.7+46.0+5.3+4.8+1.1 = 100)$

Secondly, land use change at district level presents different features from those in the whole study region. In 1986, arable land shared 52 percent in Dhankuta but that decreased to 48.4 percent in 2010. But the arable land in

Terhathum decreased continuously over the past 24 years. Changes have occurred in arable land coverage in Bhojpur and Sankhuwasabha with similar pattern: first it increased and then decreased. For instance, the arable land in both districts: Bhojpur and Sankhuwasabha occupied the largest area with 49 and 17 percent respectively in 1996, while it declined in 1986, as well as in 2010. The pattern of change in the forest land in Bhojpur and Sankhuwasabha appears to be the same; first decreased and then increased (see Table 3). In 1996, forest occupied the lowest coverage at 42.5 and 36.8 percent respectively in both districts. By 2010, it rose substantially to around 51 percent in Sankhuwasabha and 46 percent in Bhojpur. Terhathum has shown continually increased in the forest coverage in all three-mapping point years. On the whole, there was an increase in the forest coverage in all three districts except in Bhojpur during the past 24 years.

Thirdly, the overall patterns of change in the land use categories appear to be in differential manner in the Eastern Hills. Three distinct patterns of change are discernible (table 3). The year 1996 seemed to be crucial in the coverage of arable, forest, grassland, and 'other land'. First, the relative share of arable land and 'other land' in that year was highest in the Eastern Hills and then declined before (1986) and after (2010). Secondly, forestland and grassland had relatively lowest share in 1996 and then increased in both years: after (2010) and before (1986). Thirdly, the relative share of shrubland has constantly decreased over the past 24 years in the Eastern Hills.

Fourthly, there also exists distinctive differential manner of change in the land use categories at individual district level during the past 24 years. In Terhathum, for instance, arable land has continually declined, while the forest land has continually increased. Conversely, there is different pattern of change in land use categories in other three districts: Bhojpur, Dhankuta and Sankhuwasabha. In these three districts, the year 1996 seemed to be crucial. The arable land and 'other land' occupied the highest relative share in 1986 and then declined before and after that year, while the coverage of forest and grassland was the lowest in 1996, but increased in both years - 1986 and 2010. In regard to shrubland, there was a declining trend during the past 24 years in Bhojpur, Dhankuta and Terhathum, but its coverage was highest in Sankhuwasabha in 1996 and then declined in both years.

Fifthly, land use change appears to be associated with elevation zones in the Eastern Hills. The distribution of arable land is confined to below 3,000 m, whereas all other categories of land use and land cover are distributed across all elevation zones at varying magnitudes (table 4). A preponderant proportion of arable land with over three-fifths appear to be concentrated in the elevation zone of 1,000-2,000 m and this together with the proportion of the arable land

lying in below 1,000 m zone represents over 92 percent of the total arable land area. Only a small proportion of arable land is available between 2,000-3000 m zone and above this zone no arable land exists due to unsuitable climate. Forest is found at relatively greater proportion in the 2000-3000 m zone; shrubland in the 1000-2000m; grassland within range of 1000-3000m, and 'other land uses' in the zone above 4000 m where land features like snow land, bare land, and rock and ice dominant. On the other hand, changes in the land use categories by elevation zones show minimal over time. This is true in case of arable land and forest coverage. For instance arable land has decreased at a differential percent of 4 points in the zone of 1000-2000 between 1986 and 2010, while forest has decreased at 5 points per cent in the below 1000 zone between the same two years. There has been a substantial increase in the shrubland in the 1000-2000 m zone, with 70 percent in 2010 up from 36 percent in 1986, but a large decrease in two zones: 2000-3000 and 3000-4000 during the same years. A pronounced change has occurred in the grassland in all elevation zones; its substantial sharing increased in 2010 compared to that in 1986 in two zones: <1000 and 1000-2000, while its substantial sharing decreased in 2010 compared to that in 1986 in all remaining three zones above 3000 m. There has been decreased in sharing of 'other land uses' in 2010 than in 1986 in the zone of >4000 m, as opposed to the sharing in the zone of 3000-4000, where it increased between the two years. It appears that there exists internal trading between land-use categories over time. As no adequate evidence exists, it should be therefore of future investigation.

Table 4. Share of land use categories according to elevation zones, Eastern Hills of Nepal

Elevation Class (m)	Per centile share of total land by land use category by year														
	Arable			Forest			Shrubland			Grassland			Others		
	'86	'96	'10	'86	'96	'10	'86	'96	'10	'86	'96	'10	'86	'96	'10
< 1000	30	30	31	28	25	23	15	19	13	4	10	34	7	6	4
1000-2000	65	63	61	28	31	30	36	27	70	20	29	41	1	1	1
2000-3000	5	7	7	32	35	33	20	19	8	31	44	11	1	1	2
3000-4000	0	0	0	11	9	13	25	27	8	18	15	6	4	15	15
> 4000	0	0	0	1	0	1	4	7	1	27	3	8	87	76	77

Lastly, there exists internal trade-off between land use categories, which is analyzed through the matrix table. Table 5a shows that an increase of the arable land at 10.2 per cent between 1986 and 1996 appears to be largely by encroaching upon the forestland (7.8%) and with small proportions on other three land use categories. Likewise increase in the shrubland during the decade of 1986-96 was assumed mostly due to consuming relatively greater proportion of forestland. Table 5a also shows that the arable and shrubland are the two major land use categories to consume most of the forestland during 1986-1996. The decreased in these two land uses – shrubland and grassland – could be linked to the increase in the forest coverage in Sankhuwasabha. This increase in “other lands” might be due to decrease in arable land, shrubland, and grassland. Table 5b exhibits that the decrease in the arable land between 1996 and 2010 was due to conversion of this land to grassland (7.2%) and to forest and shrubland. During that decade, increase in the forest land appears to be contributed largely by shrubland, followed by grassland and arable land, because all the latter three land use categories were found as largely declining. Thus, during the past two and half decades (1986-2010), the forest land appears to have increased at the cost of encroaching upon shrubland, grassland, and arable land. Increase in “others” land use mainly encroaching upon the forest, arable and grassland might be due to the construction of roads, expansion of settlement clusters and institution buildings, and others (table 5c). Further, the arable land increase at the cost of decreased forest land during 1986-1996 might be due to the expansion of cultivated land over the forest area by the practice of slash and burn farming of the local tribal communities, expansion of commercial farming on the land pockets lying along the road sides (figure 9) and establishment of tea estates. Patches of arable land have been turned into shrubland and grassland, which might be due to abandonment of cultivated land. The locations of abandoned cultivated land patches were found to be scattered across the Eastern Hills (figure 10), most likely due to an increase in outmigration of the labour force. This can be verified by the fact that there was absent population at 8.4 percent on average of the total population in the Eastern Hills in 2011 (CBS 2012). Thus, during the past two and half decades, only forest land has increased relatively at larger rates while the other three land use categories –arable land, shrubland and grassland– have decreased at different rates. It is evident from table 5c that the forest land increased consuming mostly the shrubland, grassland and arable land.

FACTORS AFFECTING LAND USE CHANGE AND ITS IMPACTS IN THE EASTERN HILLS OF NEPAL

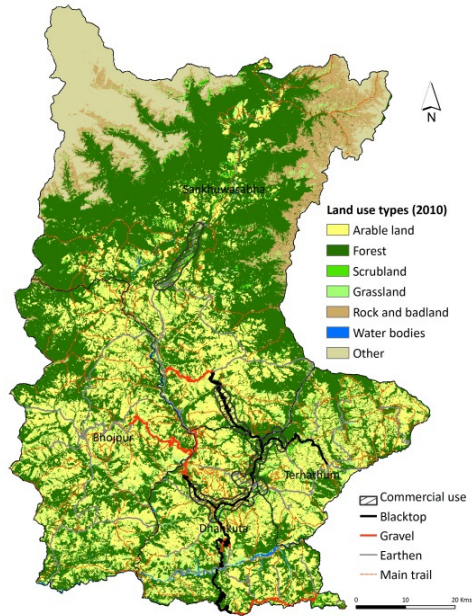


Figure 9. Location of commercialized agriculture patches in Eastern Hills of Nepal 2013

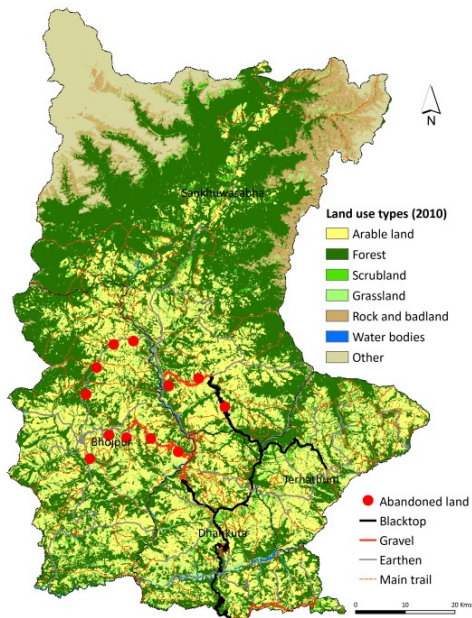


Figure 10. Location of abandoned lands in Eastern Hills of Nepal, 2013

Table 5. Matrix of relative changes (in per cent) of land use categories, Eastern Hills*(a) 1986 - 1996*

Land use Categories	Change (%) in LU categories					Total	
	Arable	Forest	Shrub	Grassland	Others	Area (ha)	%
Arable	0.0	-2.7	0.5	-11.2	7.1	20,276	10.2
Forest	7.8	0.0	1.0	-11.9	8.2	-13,439	-5.2
Scrub	1.4	-1.6	0.0	-16.4	21.0	1,403	2.3
Grassland	0.7	-0.3	0.3	0.0	2.8	-38,536	-65.0
Others	0.3	-0.6	0.4	-25.4	0.0	30,295	39.1

(b) 1996 - 2010

Land use Categories	Change (%) in LU categories					Total	
	Arable	Forest	Shrub	Grassland	Others	Area (ha)	%
Arable	0.0	20.5	-7.6	13.4	-0.2	-23,288	-10.6
Forest	-1.6	0.0	-53.1	41.0	-1.9	61,236	24.9
Scrub	-1.8	1.6	0.0	4.8	-0.1	-50,402	-81.4
Grassland	-7.2	1.8	-4.5	0.0	-0.7	15,498	74.8
Others	0.0	1.0	16.2	15.6	0.0	-3,044	-2.8

(c) 1986 - 2010

Land use Categories	Change (%) in LU categories					Total	
	Arable	Forest	Shrub	Grassland	Others	Area (ha)	%
Arable	0.0	13.2	14.7	6.8	6.4	-3,004	-1.5
Forest	0.9	0.0	51.2	16.7	18.3	47,788	18.4
Scrub	0.1	1.0	0.0	1.0	1.0	-48,997	-80.9
Grassland	0.5	2.0	3.9	0.0	9.3	-23,038	-38.9
Others	0.0	2.3	11.1	14.5	0.0	27,251	35.1

2.3 Factors of Land Use Change

Change in land use is a function of multiple factors. So it is difficult to explain the 'change' due to a single factor. In the study region, the factors behind land use and land cover change are as follows.

(a) Planned development activities

Planned development efforts in Nepal concerning with the better livings of the people by providing different facilities and services were initiated through national periodic plans since 1956. The development approaches in the plans

focused on fulfilling 'basic needs', 'sustainability' and 'poverty alleviation'. Until now, all national plans have identified broad development sectors such as social services (education and health), agriculture, irrigation, land reform and forestry, transport, communication and industry, commerce, and power for budget allocation. In saying so, the development activities being executed under the government programs and policies in the Eastern Hills region like other regions include the Pakhribas Agricultural Research Centre, Integrated Rural Development Programmes, Dharan-Dhankuta highway, Landscape Conservation and Planning Environmental Resources, etc. These programs involving activities like national park and ecological conservation, agriculture, tourism, climate, rural trade, etc. deal directly and indirectly with the change in land use and its impacts in the Eastern Hills.

(b) Agriculture development activities

Agricultural activities in the Eastern Hills involves complex interactions among the various agents of change in land use including availability and quality of arable land, micro-climatic condition, human resource and social structure, and formal and informal institutions. Particularly the Pakhribas Agriculture Centre since its establishment in the 1970 has worked on introducing improved varieties of wheat and maize crops, and cows and goat species suited to the specific agro-climatic conditions of the Eastern Hills. Since the early 1980s, introduction of improved agriculture development programs through Centre for Environmental and Agricultural Policy Research, Extension and Development (CEPREAD) and Eastern Seeds and Vegetables (KOSEVEG) that initiated growing of off-season vegetables, seeds, large cardamom, ginger, fruits and livestock rearing has brought significant change in agriculture systems from subsistence to commercial farming in areas around the road access (CEAPRED, 2001). The vegetable farming in particular has grown dramatically after the provision of transport linkages and market access in the late 1990s. By assessing potential risks and benefits by the farmers through adapting various higher yielding varieties of cereal crops and turning towards cash crop cultivation has also been significant in the agricultural land use.

(c) Roads and transport

Roads seem to be a crucial infrastructure for overall development in the Eastern Hills. Increase in arable land during the 1986-1996 decade could be attributed to the building of 66 km Dharan-Dhankuta road in 1985 and thereafter began modern transport service in the Eastern Hills. The construction of roads continued that reached to a total of 934 km roads by 2010. Use of land for agricultural purposes increased by 10 percent during the 1986-1996 decade,

but decreased from 1996 onwards. However, the traditional subsistence cereals crops have been replaced not only with the commercial vegetable crops, but their cultivated areas have also increased substantially, particularly along the sides of roads. For instance, the farmers in the areas linked by roads have also practiced the inter-culture of 'Amreso' (broom from grass plant) and large cardamom in the shrubland and private forests. According to the studies of Sugden (2004) and CEAPRED (2001), the coming of the roads together with the intervention of agriculture innovations has encouraged local farmers to intensify vegetables cultivation particularly along the roadsides. Patches of commercial vegetable farming mostly located along the roadsides are considered to be an impact of roads on land use patterns. Further, the road impacts are found to have declined according to increase in distance from the road-head and disappear beyond a certain threshold distance. Other studies show that differential impacts on the intensity of agricultural production and income of the farmers due to different types of road facilities such as fair weather or seasonal road and all weather road, for instance the households living along the all-weather roads got more benefits from improved agriculture than the those belonged to the fair weather roads. Furthermore, while the commercial importance and role of the roadsides market towns such as Hile, Sidhuwa, Basantapur, Leguwa, etc. has been enlarged, the role and importance of some of the traditional towns have declined sharply due to bypassing them by new roads or emergence of intervening centres, or link with larger towns, such as Taksar in the case of Bhojpur, Chainpur in Sankhuwasabha. More importantly, the local handicraft and traditional artesian products have been disappeared due to penetration of cheaper manufactured goods in the local markets. There were extremely smaller volume of goods going out from the Eastern Hills than those entering into the region and the vehicles run over the RAP roads only during the fair weather season. There has been changed or shifted in the existing transport system. *Dhākar* or *Bhariya* (porter) that had served portering of goods between market towns and villages for long has been either disappeared or replaced by motors and coolies. The mules and donkeys as local and traditional transport means have been replaced and moved to areas where there is no motor road. On social front, different kinds of people from the surrounding areas have moved to the roadside for building new settlements, or establishing business enterprises.

(d) Community Forestry Program

In the Eastern Hill region of Nepal, the conservation of forests and the expansion of forests by the initiation of community forestry, leasehold forestry and private forestry programmes, as well as the conversion of some of the

shrublands into the mature forest trees assumed to be the reasons to increase in the forest land during 1996-2010. Studies indicate that community forestry, leasehold forestry and private forestry programs have been expanded over the bare lands, conversion of shrubland to mature tree canopies, plantation of tree species such as *Utis*, *Chiraito*, *Lokta*, *Salla*, bamboo, and growing of *Amreso* and large cardamom within the forest lands (DFID, 2013). By 2011 over 115,000 ha of forests have been handed over to a total of 1,449 Community Forests User Group (CFUGs) in the Eastern Hills. They comprised memberships of almost 142,000 households. A 1998 follow-up study on the physical resources in 288 sample sites of the Eastern Hills indicated that forest degradation had been reversed and the forests were widely regenerating. Compared to the national forest plots, there was less grazing in the CF plots, and there was an increase in numbers of species. An impact study in 2008 found that the CFs were supplying more than twice the amount of timber, poles and grasses needed by the households compared to the 2003 baseline. The study further identified that CF and the Livelihoods Forestry Project (LFP) income generating activities accounted for 25 percent of changes in household income from the 2003 baseline. Further, a 2006 mid-term review of LFP found that 71 percent of the beneficiaries of the income generation activities in the districts of Eastern Hills were women and 53 percent of the total beneficiaries were from disadvantaged ethnic groups.

(e) Makalu-Barun National Park

The Makalu-Barun National Park (MBCNP) covering an area of 2,330 km² was set up in 1992 and the local communities have been managing it in a participatory manner. There were 88 forest user groups and 12 communities with 6,000 households getting benefits from its buffer zone. Since 1996, the development and conservation of MBCNP has focused on the park development, community support, tourism facilities, and buffer zone. Tourism is another development impact in MBCNP. According to NTB records, 1,000-1,500 tourists visited the park and generated an estimated of US\$ 275,000 annually (Branney and Yadav, 1998). At the same time, however the increased number of visitors over the decades has also resulted in increased environmental degradation (tree harvesting, burning, grazing) along the main trails in MBCNP. More importantly, the Arun III hydroelectric project, which was designed in 1994 and its site and other associated infrastructure such as road to be constructed within the MBCNP, did not take place due to criticism on economic viability and environmental sustainability. The project however began in 2008 under the BOOT system (Built, Own, Operate, Transfer system) has caused both change in land use and then in the livelihood of the communities around the project area.

(f) Climate change

The Himalayan region of Nepal is one of the most sensitive hotspots to global climate change impacts. Evidence is that there is an increasing trend in temperature in the Eastern Basin with more than 0.3°C per decade at elevations over 4000 m. Over 30 years (1970 – 2000), the glacier area was lost by 0.2 per cent per year in the upper Tamor River basin. Such widespread glacial retreat can have two direct consequences: changes in the hydrological regime and glacial lake outburst floods. The upper Eastern drainage basin alone has 13 out of 14 GLOFs recorded in the Nepal Himalaya (Bajracharya et al., 2007). Several GLOF events recorded in the Eastern basin – the first event occurred in the Dudhkoshi basin in 1977, then in the Bhotekoshi and the Sunkoshi basins in 1981 and with the most significant one in 1985 that caused a damage of equivalent to US\$ 3 million. These events caused damages in hydropower plant, roads and bridges, main trails, cultivatable land and forest, and houses in both the headwater and down water areas. The Eastern Hill districts according to climate change vulnerability index lie in moderate to low ranges.

2.4 Impacts of Land Use Change

Land use change is a proxy indicator of development activities, which in turn has impacts on different phenomena directly and indirectly. Like factors of land use change, the impacts due to land use change also are difficult to explain, as impacts are the result of a combination of varieties of factors.

(a) Improved agriculture production systems and flows

One of the impacts of land use change seen vividly in the study region is on intensification of the agriculture systems particularly the vegetable farming that has taken place along the motor able roads. Intensification has also been observed due to inter-culture practice of two or more crops, for instance, maize with beans and/or potato, and double cropping of staple crops such as rice and wheat, or maize in areas where such farming systems are feasible and applicable due to irrigation waters, road and market access, and other associated facilities. The facts are that imports of dung (chicken and goats) loaded in trucks from the Tarai have been observed in the study region and in turn export of high value crops to the adjoining Tarai towns. Vegetables, large cardamom, ginger, tea and fruits constitute the main cash and high value crops within the study area. Studies show that the traditional subsistence cereals crops have been replaced not only with commercial vegetables, but their cultivated areas have also increased

substantially (Pant, 2002; Sugden, 2004; Shrestha, 2006). Further, reliance on subsistence farming has declined as opportunities were increasing in off-farm income (Virgo and Subba, 1994). The vegetables, which were produced only for own consumption in the 1970s, increased to over 70,000 MT in 2004 due to commercial cultivation. For instance, the large cardamom area in the study region grew from 1,564 ha in 1991 to 3,224 ha in 2008 and ginger area rose by 3 folds and fruits area by 28 percent in holdings during 1971-2007. It was observed that the rise in production of vegetables and spices has been due to development of markets (near district headquarters), linking with demand centers in the Tarai lowlands (and further access to markets border towns of India) and the increased access to technical inputs and credit. Another impact is on renting of cultivated land for sharecropping, which was increased from 9 percent in 1981 to 23 percent in 2001. Investment in the acquisition of land in the Eastern Hills has also risen due to increasing remittance from ex-Gurkhas, as well as from the local workers in abroad (middle east countries, Malaysia, Korea, etc.). There is growing pressure on arable land in the headquarters towns, as well as in and around areas accessed by roads due to internal shifts of population.

Impact also found on adopting improved breeds or varieties of pigs, cows and buffalos due to the Pakhribas Agriculture Centre. The number of livestock holdings increased by 22 percent between 1981 and 2001. Though livestock rearing has traditionally been an essential component of farming systems in the Eastern Hills in terms of providing manure, drought power, as well as acting as a coping mechanism in times of food insecurity, the adaption of new breeds livestock since the past few years to improve productivity of milk and meat has been high amongst the local farmers and has been a source of income from selling milk and milk products and live animals. The number of modern livestock raising including milk processing through chilling facility, vehicles with refrigerators for transporting milk, milk collection and chilling centers for small dairy farmers is on the rise.

Further, the outflows of local products being traded through the towns and the district headquarters of the Eastern Hills include vegetables such as cabbage, cauliflower, tomato, radish, etc. and other high value products like species (*Akabare*, cardamom, ginger), fruits (orange, lemons), potato, and tea (table 6). Vegetables share the largest with about 56 percent of the total volume of outflows, followed by potato and orange. However, the exported products particularly vegetables differ in volume and types among the Eastern Hills districts. Overall, Dhankuta sharing about 41 percent of the total traded volume of the Eastern Hills became the largest district, while Sankhuwasabha with 10 percent being the smallest. Other two districts each shared about one-fourth.

Table 6. Outflows volume (m tons) of local products from the Eastern Hills districts

Export goods	Bhojpur	Dhankuta	Solukhumbu	Terhathum	Total	%
Akabare chilly	70	122	-	-	192	0.1
Cardamom	222	177	959	3,000	4,358	2.9
Ginger	4,010	2,261	572	2,000	8,843	5.8
Lemons	665	-	-	-	665	0.4
Orange	4,701	2,688	1,672	2,000	11,061	7.3
Potato	21,335	2,860	6,051	12,050	42,296	27.8
Tea	-	-	6	-	6	0.0
Vegetables	6,460	53,485	5,505	5,505	5,505	5,505
Total	37,463	61,593	14,765	38,340	152,161	100

Source: District Consultation Workshops and Record files of the Eastern Hill districts, June 2012.

Major local products, mainly high value crops entered into trade since the last few years included cardamom, ginger, vegetables, potato, fruits, tea, dairy products, herbs etc. In terms of volume of trade and value of money, ginger is by far the largest local commodity. Next exported items include cabbage, orange and so on. *Chiraito* comprised around 75 percent of the total cash value and 60 percent of the total volume of trade from the study region. An estimated of 140 tons of *Chiraito* passed through the Hile-Basantapur road during the 1992-93 trading season, while that of cardamom and herbs through the same route was 424 tons/year in 1991-1992. Terhathum alone exported cardamom of 290 metric tons in 2011 to India, Pakistan and the Gulf. Potato was also an important export agricultural product, accounting for 18.4 per cent followed by vegetables (14%), ginger and cardamom (11.3%) and fruits (3.3%). Fluid milk is the next important export product of Terhathum.

There are two types of flows of the local products in the study region. First, flows of local products have taken place through already existing network of market centres, including the hāt bazaars across each district, and then with major trading centres of other districts where there are road links. These outflows of the products have taken place through hierarchical levels of market places, for instance, trade flows of the local goods from small centers to the higher collection centers and then to other places-cities outside of the Eastern Hills within the country as well as of India.

2.5 Change in spatial location and structure of human settlements

Change in land use occurs by elevation zones over time and human intervention is crucial to this change in the study region. These processes affect to determine the location of settlements that directly concern with changing

surrounding land use. Change in land use together with the change in population (increased during 1991-2001 and decreased during 2001-2011) in the Eastern Hills is assumed to cause change in spatial distribution of settlements according to elevation over time.

While the GIS overlay function being performed between the layers of location of population clusters in the form of dots and the elevation zones in the Eastern Hills, the result exhibits the elevation zone 1000-2000m being the most favorable. This zone inhabited over 70 percent of the total population (table 7). Next to it is the elevation zone below 1000m, where shared about 23 percent of the total population. Only in Sankhuwasabha, some settlements are found in the zones above 3000m, while in other three districts all settlements are within the elevation zones below 3000m.

As compared the distribution of population clusters between 1991 and 2001 with elevation zones, there was no significant variation (Table 7). Two reasons to explain it are: first only little population increase at 8.8 percent (51,868 people) between 1991 and 2001 across the 6,557 km² of the Eastern region and the other, internal shift of settlements/population within the same zone.

Table 7. Distribution of settlements (values in per cent) by elevation zone and by year

Elevation Classes	Bhojpur		Dhankuta		Sankhuwasabha		Terhathum		Total	
	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001
< 1000	20.6	21.2	32.6	32.3	31.1	31.0	8.4	8.2	24.0	24.2
1000 - 2000	73.7	73.1	65.3	65.2	59.6	59.7	83.6	83.7	69.9	69.6
2000 - 3000	5.7	5.6	2.2	2.5	9.1	9.0	7.9	8.1	6.0	6.1
3000 - 4000	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
> 4000	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0

The distribution of population appears to be closely associated with the distribution of arable land in the Eastern Hills. Over 90 percent of the population clusters are concentrated in two elevation zones: 1000-2000 and <1000 where over 90 per cent of the total arable land is found. On average about 6 per cent population clusters found to be in the elevation zone of 2000-3000, due to dominant of grassland where major occupations of the people are animal husbandry and tourism. Administrative headquarters, major market towns, road alignments, basic facilities such as schools and health, religious monuments and other amenities are generally having major population clusters. It appears that people tend to have moved to places for permanent settlement where there are roads and other facilities, but those still living in the remote areas are devoid of

basic facilities. This process of development and migration of people nexus has created disparity in the level of development, as well as differentials in the impacts of development interventions.

3. Discussions

The two main natural resources of the Eastern Hills in terms of coverage are forest and arable land. The forest is the largest, as it covers around 40 percent of the total study area, followed by arable land with 33 percent. They are significant for the products for use by rural communities, valuable biodiversity, and regulation of hydrological and atmospheric conditions. They are also an important part of the cultural heritage and a valuable asset for the tourist industry.

The forest occupying dominant position in the land use categories appears obvious in the Eastern Hills, where high hills and mountains are preponderant. Since the late 1980s a growing recognition of the role of 'sustainable environmental management' led to focusing on the forest conservation and management by involving local communities as 'user groups', as integral element of improving livelihoods in terms of social and economic well-beings. Since then the community forestry program is being carried out under the policies and acts under the government system across the country. There is evidence that community forestry has been able to provide improved access of the poor to its resources. The revenue contributed by the forest products in the Eastern Hills has been largely from the private forests, followed by the community forests and non-timber forest products (NTFPs) including herbs. This means that the private forests are a likely source of good income for the households owning them. Apart from the forest products such as timber, fuel wood and animal fodder, the NTFPs are also an important source of revenue for communities in the rural areas. Government policy in Nepal has recognised the importance of NTFP based enterprises as a potential means to contribute to poverty reduction and an important source for government revenue. There are forest products based enterprises in the involving in making essential oils, handmade paper, fruit squash, briquettes, ginger, spices and vegetables, and *Chiraito*.

The prime agricultural lands are confined to the major river valleys such as the Arun, the Sunkoshi and the Tamor that lie below 3000 m. The arable land is mostly used for subsistence production by the terrace-fields method. However, the LRMP (1986) has found that about 30 percent of the total cultivated land together with the dispersed rural settlements located in areas above 15° slope in the hills and mountains across the country, including the study region was

technically vulnerable to disasters such as landslides and soil erosion. Such sloppy lands are rather better feasible for home gardening, fruits farming and pasture growing for animal rearing, according to the APROSC (1996).

Over the past 24 years, significant changes have occurred in overall land use, indicating the dynamics of land use. During the years 1986-2000, forest land grew with a little ratio, arable land at over 2 percent increase, and the increase in shrub was by over 6 percent. An increase in the forest coverage during 1996-2000 can be attributed to the initiation of forest conservation programs such as community forestry and leasehold forestry in the late 1970s and 1980s, while a decrease in the forest coverage during 1986-1996 coincided with an increase in arable land; the latter can be attributed to the building of Dharan-Dhankuta road in the early 1980s and the introduction of intensive agriculture system (off season vegetables) that demanded much arable land. Further, use of land for agricultural purpose appears to have decreased slightly during the years 1996-2010, but during the 1986-1996 decade, there was an increase in cultivated land, which coincided with a decrease in the forest coverage. On the other hand, there was a decline in population at an average of 38.3 percent in the Eastern Hills during the years 1991-2011 due mainly to out-migration (absent population). Further, a considerable internal trading appears to have occurred between land use categories, such as "forest" and "shrub" or "grassland," demonstrating a fluidity of land use. Shrubland and grassland are converted to more productive categories of forest land, reflecting the care of communities in managing and conserving their own forest resources. The private forest areas and shrubland are also being used for growing *Utis cum Amreso* (broom grass) and large cardamom. Change in the two land use categories – arable and forest of the Eastern Hills can be compared with that of neighboring districts including two Tarai districts - Morang and Sunsari and two hill districts - Ilam and Khotang. In the Eastern Hills, the forest coverage declined from 39.5 in 1986 to 37.5 per cent in 1996, but the arable land increased from 30.4 to 33.5 per cent during the same two years. Available sources indicate that arable land coverage of the Tarai two districts was 65 per cent in 1986 (LRMP 1986) that continued to increase to 74 per cent in 2000 (JFTA, 2001). But the forest coverage of these Tarai districts was only 24 per cent in 1986 and it further declined to 17 per cent in 2000. Over the past 14 years (1986-2000), there was virtually no change in arable land coverage in the neighboring two hill districts, but the forest coverage declined from 53 per cent in 1986 to 40 per cent in 2000.

Climate change impacts seem to have occurred on land use in the Eastern Hills. Studies on agriculture in the six case villages of the Dudhkoshi basin depict that the effects of a much weaker monsoon were evident, particularly in relation to crop production in 2009. As a result, many rice terraces were left unplanted

due to lack of sufficient water, and many rice crops that were planted dried out and left unusable due to the delay in consistent rainfall. Further, the study in Terhathum district carried out in 2011 found that the Monsoon rainfall with its erratic behavior got to be delayed the onset of the monsoon over the last 10 years and increasing cases of dry spells during the monsoon period. There has been changes in behavior in rainfall pattern, for instance, winter rain has been highly variable with almost none falling in the past 2 years. Cash crops such as cardamom, ginger and broom grass, which were proliferated in Terhathum, reduced in harvests and thus income due to decrease in water availability. In addition, the study also predicts that there is likely to be an increasingly positive correlation between urban migration and impacts of climate change, with more and more “climate refugees” moving to urban areas. Furthermore, farming land abandonments across different parts of the Eastern Hills have been observed due to decreases in manure supplies from livestock, as well as in agricultural labor forces, the latter is a recent phenomenon whereby youth migrants have a tendency to leave their areas in abroad for employment.

Change also has occurred in the trading pattern through the traditional trade centers such as Chainpur, Dhankuta and Olangchung of the Eastern Hills. These towns have evolved through historic time from the traditional role of long distance trading posts or centres of entrepôt trade for facilitating complementary goods between Tibet and India now to the market integration of local products. Some of the major development events occurred in the Eastern Hills in the early 1970s and 1980s that brought about changes in the existing marketing pattern and extended market integration with the Tarai and other parts of the Hills included: Dhankuta as a regional headquarters centre of the Eastern region, shift of district headquarters from Chainpur to Khandbari in Sankhuwasabha, development of Hile town by the families from Olangchung who established trade outlets there, construction of the Dharan-Dhankuta highway, and agriculture improvement programme. Those families at Hile town continued to live entirely on trade in cloth and other consumer goods, but since the last few years, the trading pattern has been changed and included *Chiraito* and cardamom of local produce as the most important trading commodities. A number of enterprises based on the non-timber forest products appear to have existed to produce essential oils, handmade paper, fruit squash, briquettes, herbs and *Chiraito*, and *Allo* based handicraft production (Kunwar et al., 2009).

Improvement in some of the social indicators such as education and health can be attributed to land use change and development impacts. In 2001, literacy rates for males and females in the Eastern Hill were 65 per cent and 42 per cent respectively which increased from 1971, showing also relatively better as compared to those of other regions in the country. The increase in adult

literacy and in the levels of education among both males and females has had likely impact on economic profile of the population, which has been changing with an increase in non-farm (services, clerical jobs and sales) and off-farm employment opportunities. The Eastern Hills saw a decrease in the fertility rate and increased knowledge about health care, which can be correlated with the rising educational status. The proportion of malnourished children below 3 years of age declined from around 30 per cent in 1994 to below seven per cent for three districts except Dhankuta. The Safe Motherhood Innovation Project (SMIP) found that there was an increase in awareness and utilization of maternal health services from 22 percent in 2004 to 66 percent in 2007. The GIS analysis shows that preponderant proportions of population found to have lived within 3 km buffer zone of the health facility location in the years of 1996 and 2010, which were either due to moving of people closer to facility location or improved in the number of health facilities, or both. This is very significant, since roads are available connecting only few places across the region. In case of road accessibility, there are still largest proportions of population living within 'above 5 km' buffer zone, indicating enormous travelling time required to reach the road-head point, though there was a significant decline of the population living in this buffer zone in 2010 compared to 1986.

CONCLUSIONS

A significant change has occurred in all land use categories in the Eastern Hills of Nepal over the past 24 years. Forest land and arable land have increased, while shrubland and grassland decreased. There exists a considerable internal trading between land use categories, especially forest and shrub or grassland, demonstrating a fluidity of land use across the Eastern Hills. These changes have several implications in land use policy measure and planning.

The distribution of population appears to be closely associated with the arable land in the Eastern Hills. Over 90 percent of the population clusters are concentrated in two elevation zones: 1000-2000m and over 1000m, where over 90 percent of the total arable land is found. Two reasons to explain it are: (i) increase of population between 1991 and 2001 across the entire Eastern Hills and (ii) internal shift of population within the same zone, as well as in areas having facilities of roads and other facilities such as schools, health and markets. Yet, no improvement has taken place significantly in the long existing traditional pattern of scattered settlements over the hills that are extremely lagging behind in the basic facilities and development indicators.

Government's development initiatives appear to be crucial towards impacting on land use change. For instance, the Community Forestry Programme and the Makalu-Barun National Park have contributed to increase and conserve

the forest coverage in the Eastern Hills. Further, the Community forestry activities have possibly contributed to a significant improvement in availability of fodder, fuel wood, and fruit tree resources, providing a beneficial effect on the balance of land use. Shrubland and grassland are being converted to more productive categories of forest land, reflecting the care of communities in managing and conserving their own forest resources. Similarly, intensification in agriculture production systems including growing of off-season vegetables, seeds, large cardamom, ginger, fruits and livestock rearing has occurred due to improved agriculture development programmes and building of roads linking producing areas and demand centers for export of local products.

The GIS digital database being created provides benchmark of land use and change in the Eastern Hills for the three map point-years: 1986, 1996 and 2010. However, the GIS mapping tool should also be used to look into further spatial analysis such as factors of remarkable changes in land use, social and economic impacts on land use, facility accessibility, flows of goods and people between places over time, etc. Such spatial database on land use requires updating in the future to see the impacts of human intervention on changing land uses vis-à-vis cultural landscape change.

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