A case study on Shifting Cultivation and its Sustainable development in Nagaland

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1. INTRODUCTION

Shifting cultivation commonly known as slash and burn agriculture is an age-old traditional agricultural practice in Nagaland. The system involves cultivation of crops on steep slopes by cutting of forests, bushes, etc., up to the stump level, leaving the cut-materials for drying and final burning to make the land ready for dibbling of seeds of different crops before the onset of rains and grow crops 2-3 years till yield become uneconomical. Once the land becomes inadequate for crop production, it is left to be reclaimed by natural vegetation for years to recuperate and a new piece of land is then selected to repeat the process. The periodicity after which cultivation is again taken up in the Jhum land is called Jhum cycle. The most remarkable feature of the shifting cultivation is that all essential crops, rice, maize,tapioca, colocasia , cucurbits , sweet potato, ginger, finger millet, cotton, tobacco and many others grown in the same field as mixed land use system. The fire ashes correct the soil acidity and make the soil more fertile.

The origin of shifting cultivation could be traced back to the Neolithic period around 7000 BC (Sharma 1976). This most primitive form of agriculture is still common amongst the tribal people in various pockets. According to the estimate made by the task force on shifting cultivation in India there were approximately 622.2 thousand families in India under shifting cultivation out of which 443.3 thousand families i.e. 71.25 percent were located in the North Eastern region alone. In North-East India over a 100 of tribal ethnic minorities are practicing shifting cultivation and in certain parts of this region it is practiced not only by the tribal minorities but also by the landless people and lowland migrants (Singh et.al.). According to the report of National Commission on Agriculture (1976), 49 ,2000 tribal families of this region are involved in Jhumming and the total area affected by this practice is 26,94,000 ha. The practice of shifting cultivation was not harmful or was considered rather useful during the time when it was started. Least disturbance to soil, natural fertility build up of soil, mixed cropping on slopes under purely rainy conditions and dependence slopes under purely rainy conditions and dependence of local resources, were some of its merits. When the system emerged there was no population pressure and the cycle of rotation was 10 to 20 years or above, thus leaving enough time for the soil to revive. Due to increase in population, and non-availability of land, the cultivation cycle nowadays has reduced to 3-6 years, thus resulting into a large scale damage to the forests which leads deforestation and denudation of hill slopes (Borthakur et al, 1978). The field after harvest is abandoned for sometime during which, the field regains its fertility (Lhungdim, 2010). In the north eastern region, however, secondary succession is quick to take place, but in most cases the area is occupied by weeds, useless shrubs, tall grasses and different species of bamboos. After the land is abandoned it is rarely occupied by the original vegetation. Jungle cutting, burning, clearing and dibbling of seeds accounted flora considerable amount of loose soil material, ashes and soil clods to roll down the foothills.

Shifting cultivation usually starts before December with the clearing of forest areas. By mid-February to mid March i.e. before onset of monsoon, drying and burning of debris takes place and followed by ploughing and cultivation of crops. For several years, farming of the plot continues, until the soil loses fertility. After harvest, land is left fallow and cultivators repeat the process in a new plot. First plot remains fallow and vegetative regeneration takes place till the plot is reused for same purpose in a cycle. People

involved in jhum cultivation are called Jhumia. The average size of jhum plot varies from 1.0 to 2.0 ha and the average family consists of 2 adults and 3 to 4 children (Borthakur, 1992).

The significance of this system of farming in the present day is more because of the maladies associated with it. Resource degradation, low productivity, little or practically no scope for application of improved agricultural production technology are some of the drawbacks in this system. Jhum cultivation causes serious land degradation and ecological problems. Different studies indicate that shifting cultivation leads to (a) lowering of organic content (b) decreasing the available phosphorus, potassium and magnesium (c) lowering the total quantity of sesquioxides, iron, aluminium, calcium, potassium, phosphorus etc. (d)affecting adversely the cation exchange capacity and physical properties i. e. water holding capacity and field capacity and increasing the pH and reducing microbial activity (FAO, 1982).

In North-East India about 7.6 lakhs ha area is affected by shifting cultivation. Amongst North Eastern states Nagaland is the worst affected state followed by Arunachal Pradesh, Mizoram, Meghalaya, Manipur Assam and Tripura(NRSC, 2011).

Keeping in view the problems associated with shifting cultivation the study is taken up in Nagaland with the following objectives.

1.1 Objectives

I. To study the trend of change in shifting cultivation.
II. To study the relationship between slope, aspect and abundance of shifting cultivation.
III. Action plan for sustainable development or alternate use for shifting cultivation.

1.2 Study Area

The study area covers entire Nagaland state with an area of 16579 sq km. Nagaland is a state in the far north-eastern part of India. The state lies between 98° to 96° E longitude and 26.6° to 27.4° N latitude (Fig 1). It borders the state of Assam to the west, Arunachal Pradesh and part of Assam to the north, Myanmar to the East and Manipur to the South. The state capital is Kohima and the largest city is Dimapur. It has an area of 16,579 km² with a population of 1,980,602 as per the 2011 census, making it one of the smallest states of India. The state is hilly interspersed with ridges and valleys. The altitude varies between 110 to 3840 meters above sea level. Mount Saramati is the highest peak with a height of 3,840 meters and its range forms a natural barrier between Nagaland and Burma. Rivers such as the Doyang and Diphu to the north, the Barak River in the southwest and the Chindwin river of Burma in the southeast, dissect the entire state. The climate of the state is bracing and healthy. Summer temperature ranges from 7 to 23 degree Celcius. The average annual rainfall ranges from 200 to 280cms. Soils of Nagaland are derived from Tertiary rocks belonging to the Barail and Disang series. The Barials consists of alternating layers of sandstones and shales with carboniferous intrusions or even coal seams. The underlying Desang series represent unfossiliferous shales, slates and phylites. Inceptisols is the most dominant soils that covers 66% area of the state. Ultisols (23.8 %) is the second dominant soil followed by Entisols (7.3 %) and Alfisols (2.9). Soils are acidic and very rich in organic carbon but poor in phosphate and potash content.

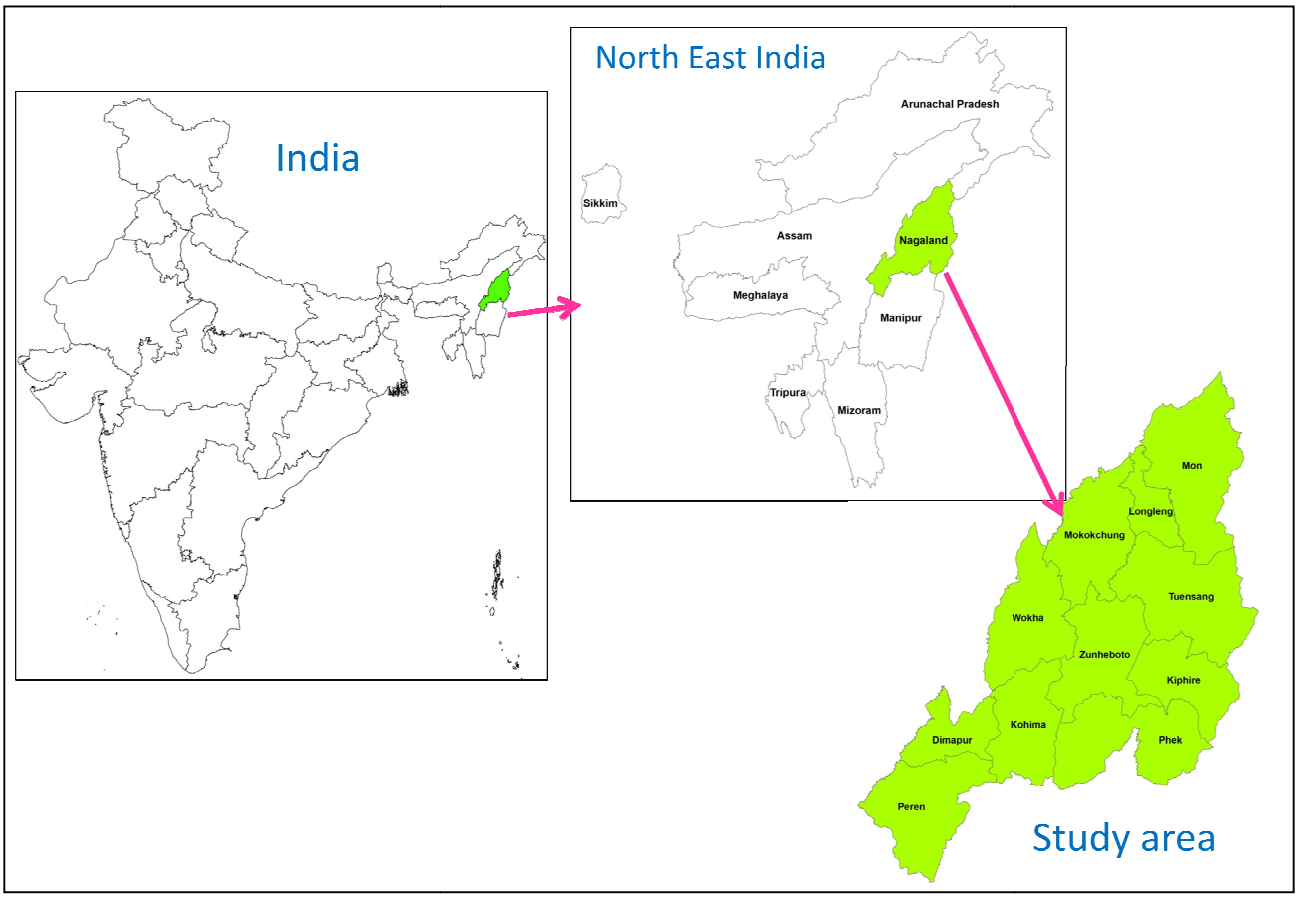

Fig 1: Location map

Nagaland has a predominant tribal population generically referred to as Nagas with several tribes and sub-tribes and clans etc. speaking diverse dialects specific to each tribe. The major tribes of Nagaland are Angami, Ao, Chang, Chakesang, Khiammungan, Konyak, Lotha, Phom, Rengma, Sangtam, Sumi, Zeliang and a fewmixed tribes such as Kacharis, Mikirs, and Gorkhas. Agriculture is the backbone of the economy of Nagaland and the source of employment for majority of its inhabitant. About 68% people are engaged in agriculture. An important features of Agriculture in the state is Jhumming or Shifting cultivation. The principal crops include rice, corn, millets, pulses, tobacco, oilseeds, sugarcane, potatoes and fibers. Other significant economic activity are forestry, tourism, insurance, real estate, and miscellaneous cottage industries. Forest is the most dominant land use of the state followed by wastelands, shifting cultivation and permanent agriculture (Table 1).

2. MATERIALS AND METHODOLOGY

2.1 Data used

i. Wasteland map at 1:50K of year 2002-03, 2005-06, 2008-09
ii. LULC map at 1:50K of year 2011-12
iii. SRTM DEM
iv. ERDAS IMAGINE 13
v. Arc GIS 10
vi. Collateral data

2.2 Methodology

The study is carried out by using wastelands map and LULC map Nagaland state at 1:50k of the year 2002-03, 2005-06, 2008-09, and 2011-12. The shifting cultivation areas were extracted from the wastelands map and LULC map. All shifting cultivation layers were overlaid in GIS environment and change analysis was done. Slope and aspect map is generated from SRTM DEM. Slope and aspect map was overlaid with shifting cultivation layers of all four years and studied the relationship between the slope and aspect. Land use action plan was prepared by considering slope and soil of the shifting cultivation areas. The soil depth map was prepared by using soil map prepared by NBSS & LUP (1:250K scale). Slope and soil map were integrated with shifting cultivation map of 2011-12 in GIS environment. All these GIS analysis were carried out by using ArcGIS 10 software. The brief methodology is presented in the flow chart (Fig.2).

Table 1: - Land use and Land cover type of Nagaland

Sl. No	Category	Area (Sq.km)	% to TGA
1	Built up	361.18	2.18
2	Agriculture land (permanent)	638.30	3.85
3	Forest	10107.98	60.97
4	Grass / Grazing lands	18.91	0.11
5	Wastelands	2231.39	13.46
6	Water bodies	211.08	1.27
7	Shifting Cultivation	3010.17	18.16
	Total	**16579.00**	**100.00**

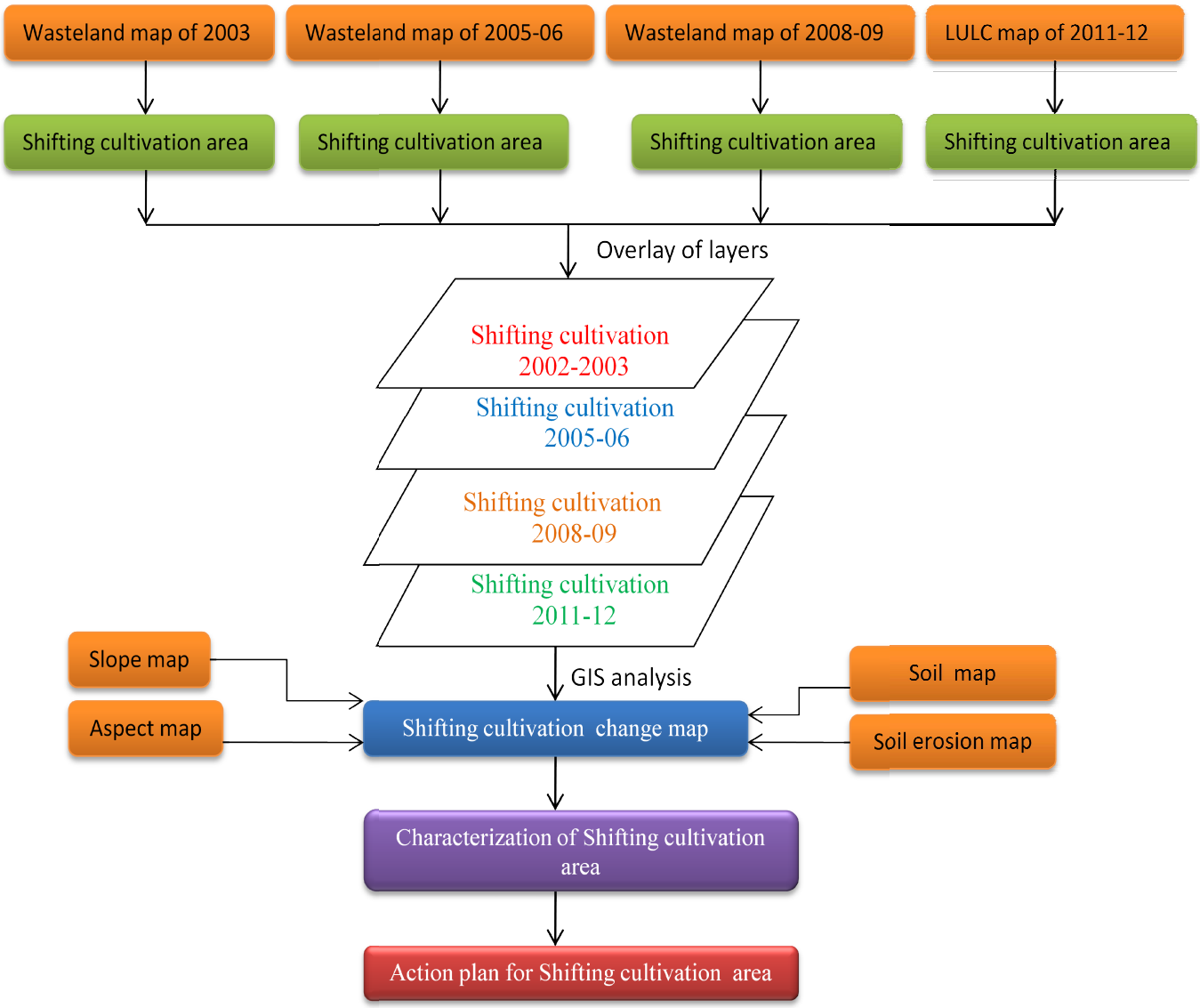

Fig.2: Flow chart of the methodology

3. RESULTS AND DISCUSSIONS

3.1 Study on trend of change in shifting cultivation areas

From the study it is observed that area under shifting cultivation increases over the year 2002-03 to 2008-09 (Fig.3 to Fig.7). The area covered during 2002-03 was 117 Sq. Km which increased to 1239 Sq.km to 1515 Sq.Km during 2005-06 and 2008-09 respectively (Table 2). The shifting cultivation area was decreased to 1286.57 Sq. km (Fig.7) during year 2011-12.

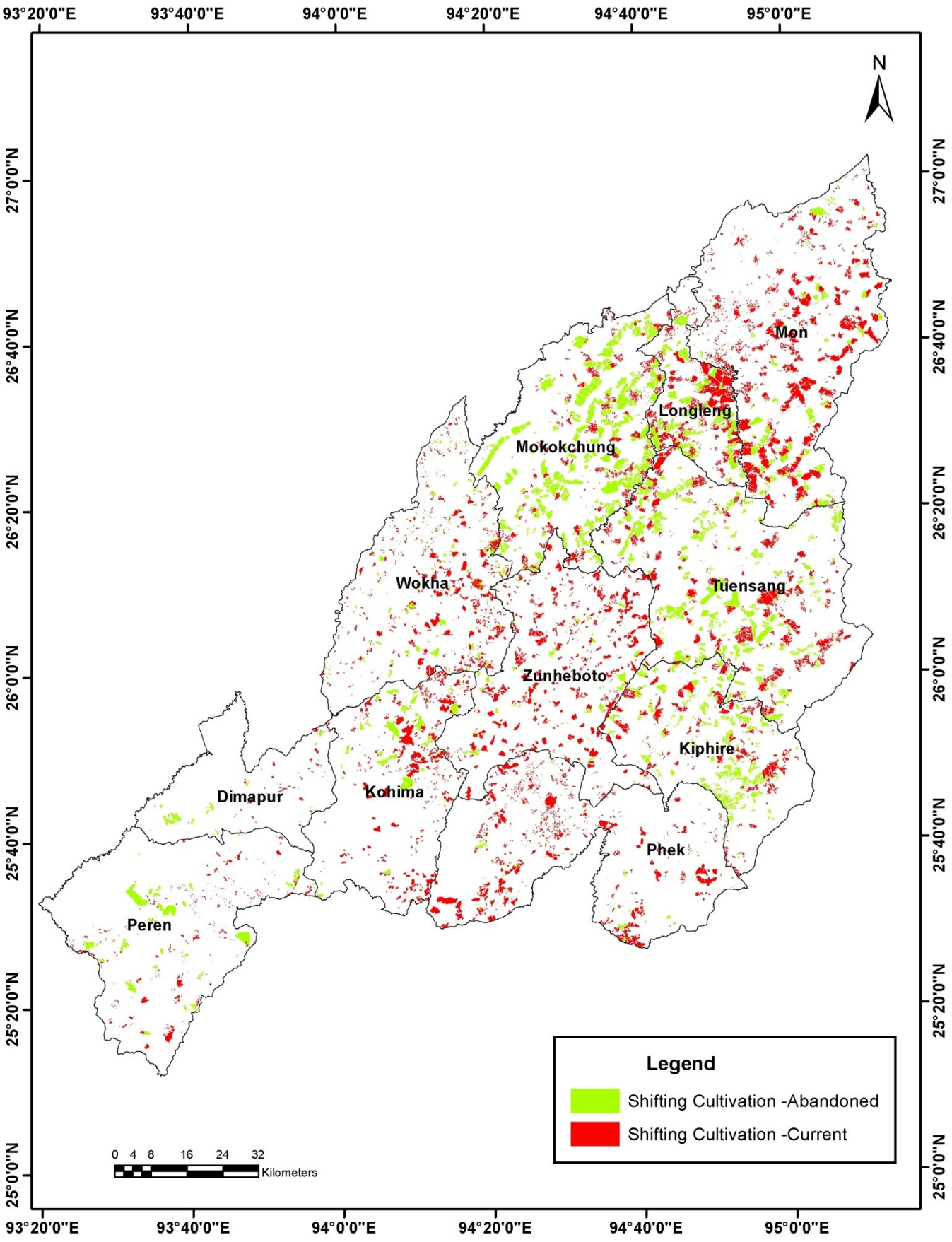

Fig.3: Shifting cultivation during 2002-03

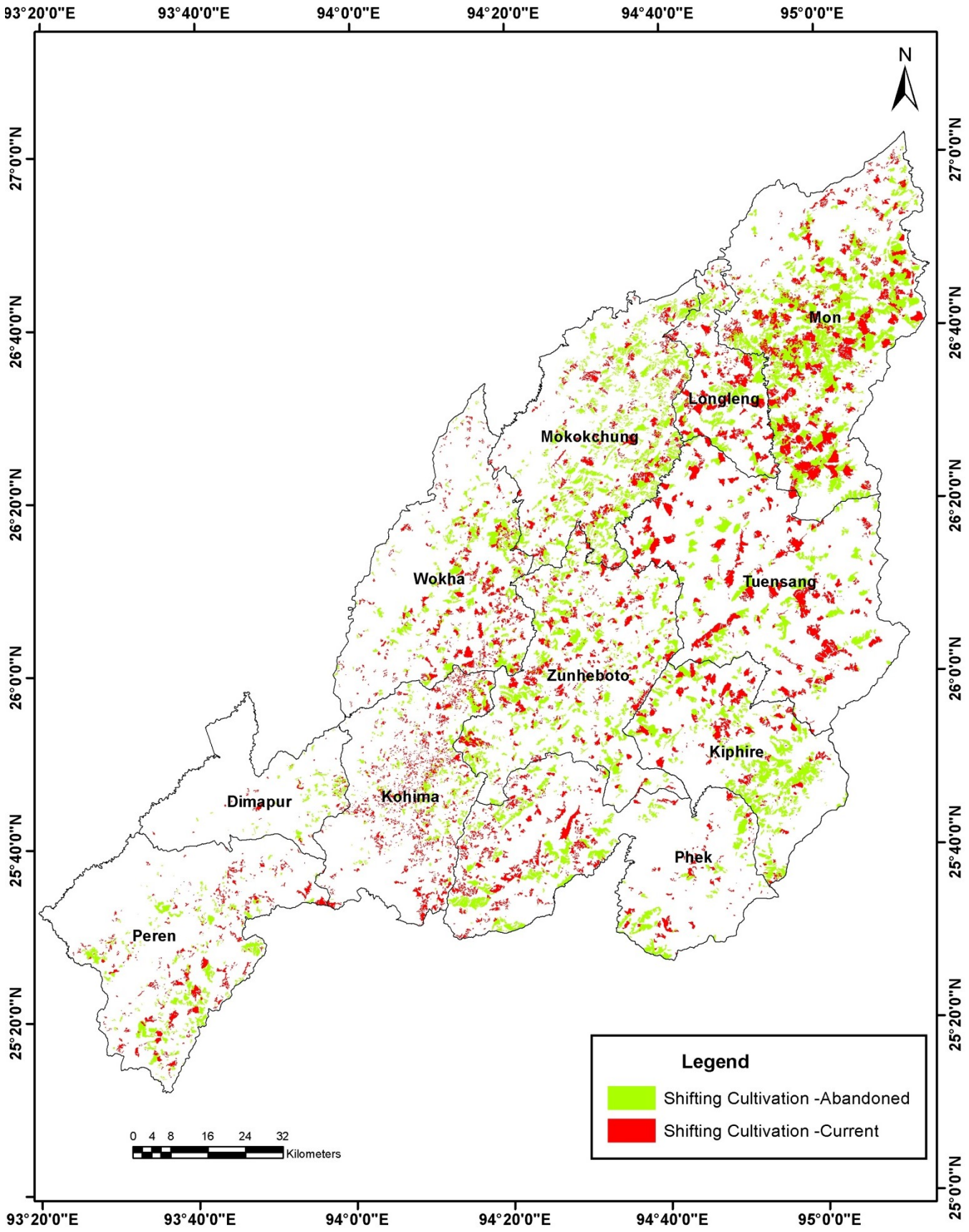

Fig.4: Shifting cultivation during 2005-06

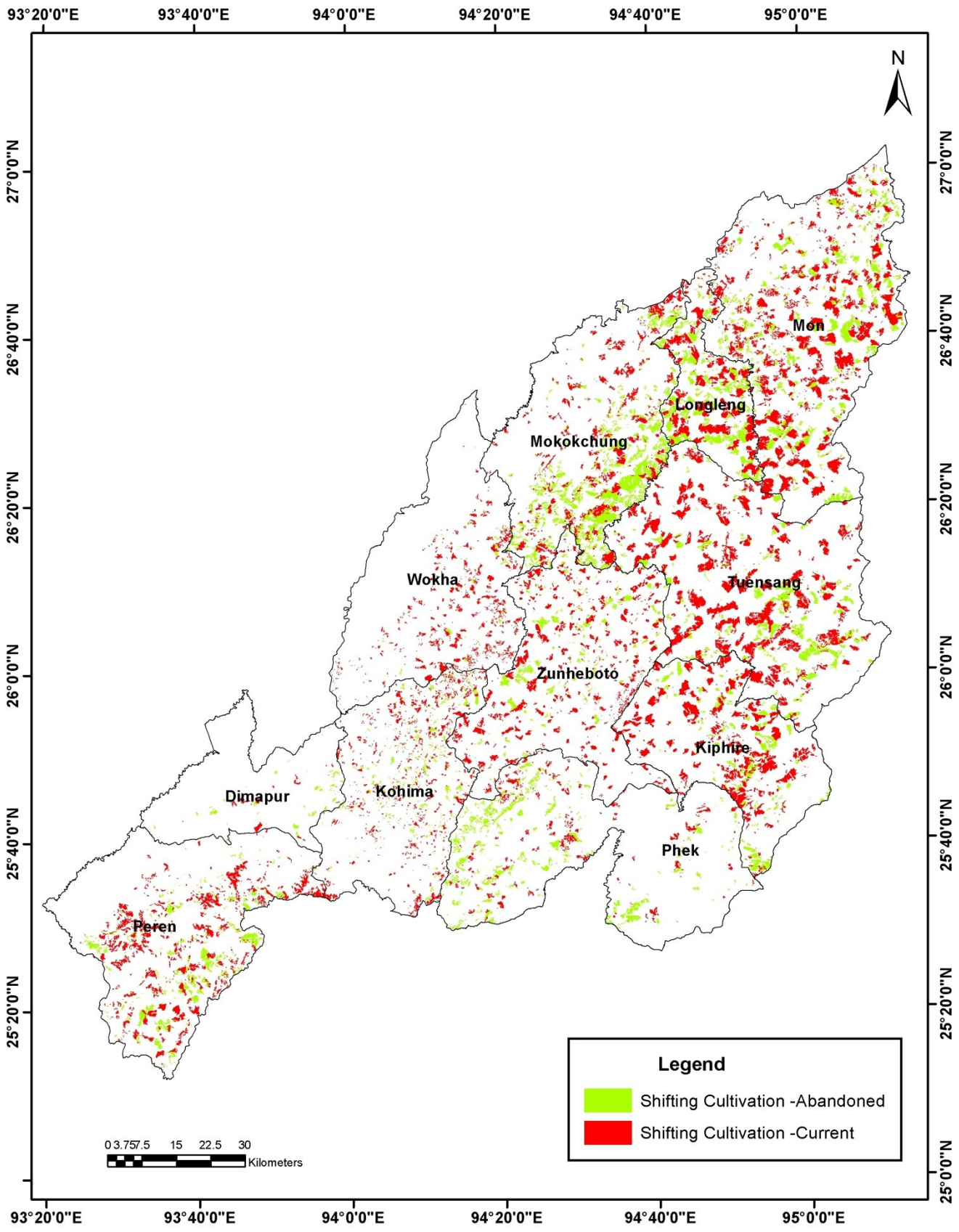

Fig.5: Shifting cultivation during 2008-09

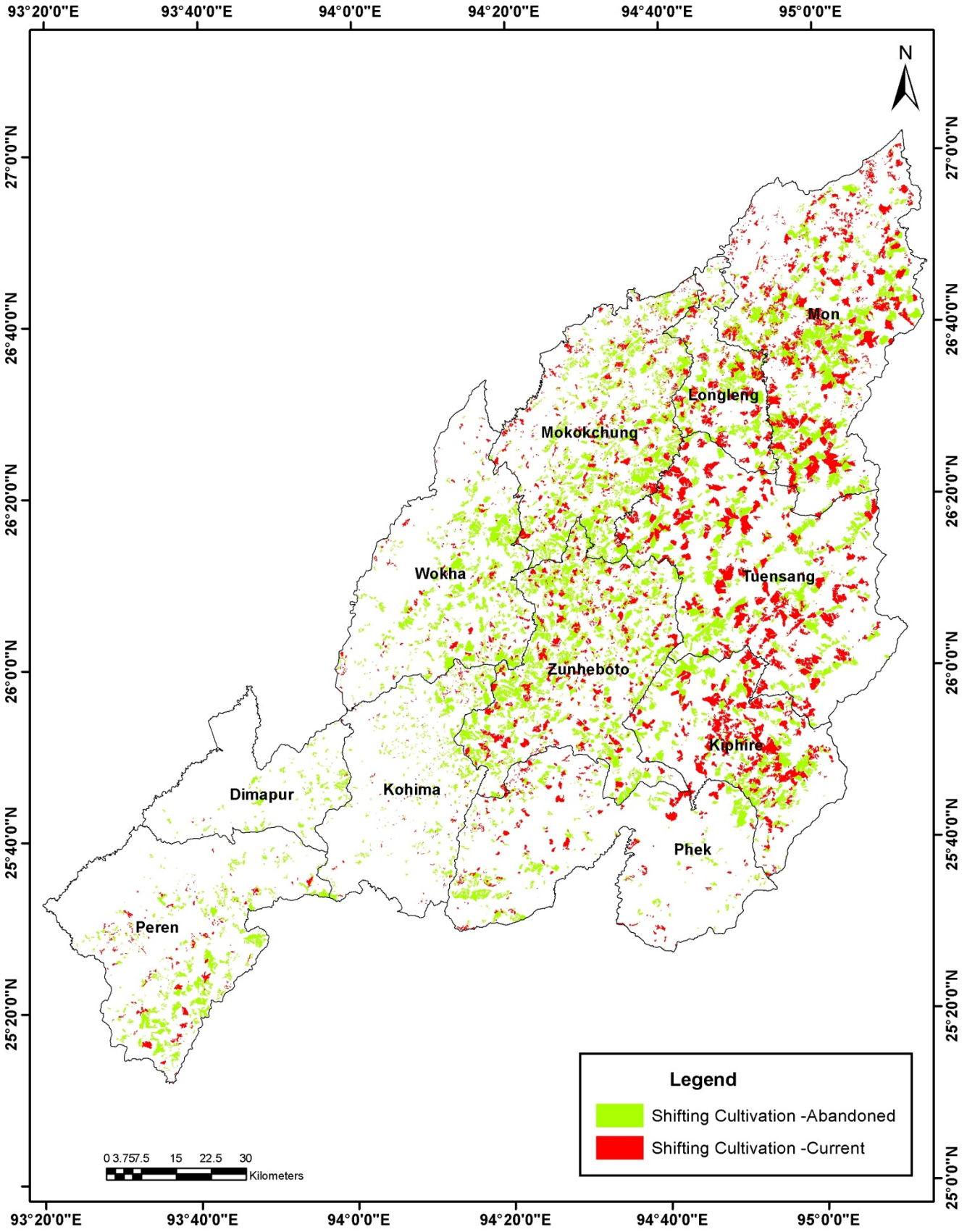

Fig.6: Shifting cultivation during 2011-12

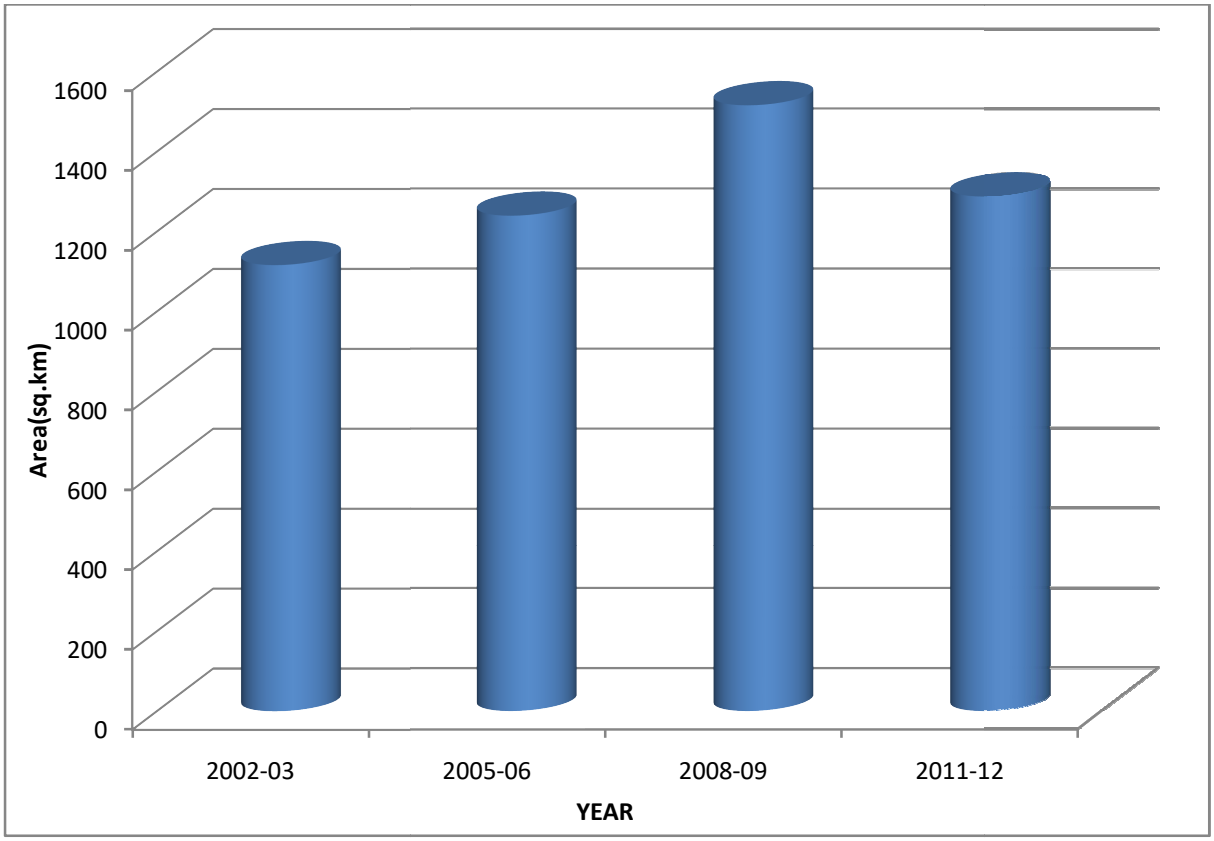

Fig:7 Changes in Shifting Cultivation Area

From the study it is also observed that the abandoned jhum area increased during 2005 -06 and 2011-12 and it is decreased during 2008-09. The current jhum cultivation area increased during 2002-03 to 2005-06, 2008-09 and decreased during the year 2011-12 (Fig.8).

Table 2: Shifting cultivation area in Nagaland

Year	Area (Sq. Km)	Change(Sq. Km)
2002-03	1117	
2005-06	1239	+122
2008-09	1515	+276
2011-12	1287	-228

The study on changes of shifting cultivation during year 2002-03 and 2005-06, it is observed that new shifting cultivation areas has come up that covers 54.9% of the study area. The maximum new shifting cultivation areas are found in non wastelands that covers 41.5% of total study area. It is also observed that other wastelands like land without scrub is converted to shifting cultivation (0.61% of study area). Abandoned shifting cultivation is changed to current shifting cultivation and covers 1.8 % of area, degraded forest changed into shifting cultivation and covers 0.1 % area, and land with scrub to shifting cultivation covers 10.9 % area. The study showed that continuous

shifting cultivation is observed in 27878 ha. In some places shifting cultivation (38.3%) areas has been converted to other wastelands classes and non wastelands (Fig.9).

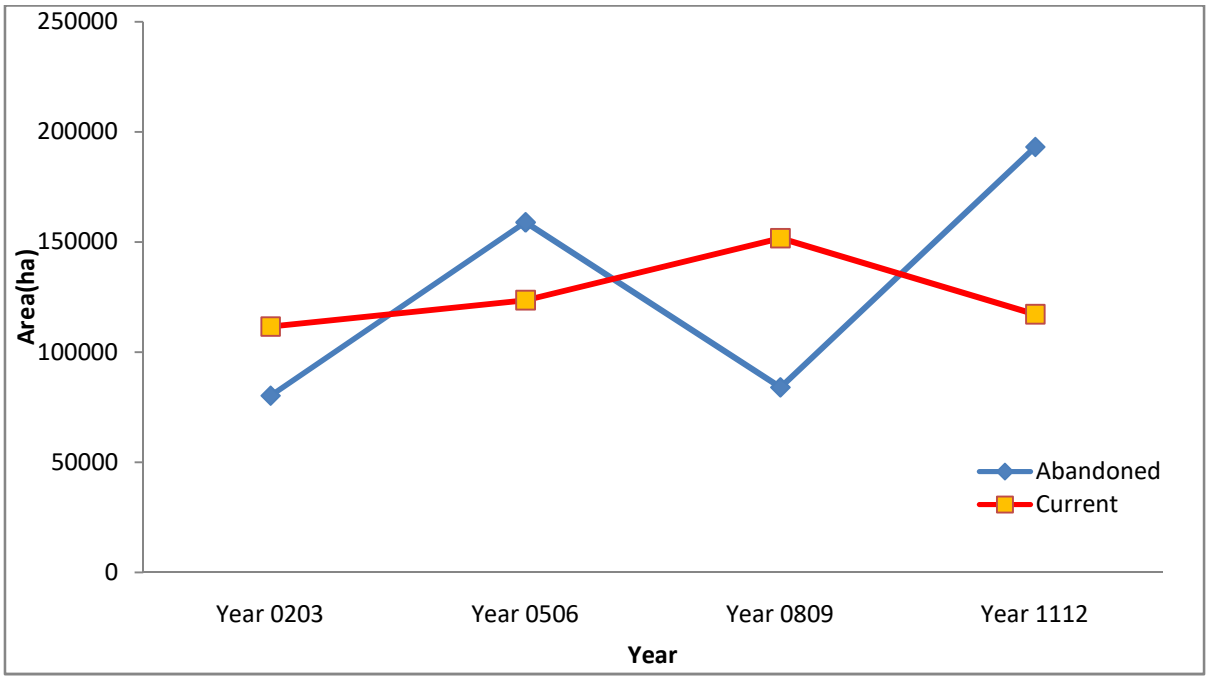

Fig:8 Trend in changes in Shifting Cultivation area

Study on changes on shifting cultivation during year 2005-06 to 2008-09, the maximum changes observed in shifting cultivation areas (36.6%) which become land with Scrub and in non wastelands (23.4% area) which become shifting cultivation during year 2005-06. It is also observed that other wasteland like land with scrub is changed (6.6% area) to shifting cultivation. The study showed that continuous shifting cultivation is observed in some areas that covers 13.5 % area (Fig.10).

During the year 2008-09 to 2011-12, the maximum changes observed in new shifting cultivation areas which has been converted from land with scrub, forest and non wastelands that covers 27.5% ,(3.1%) and 17.1% area respectively (Fig.11). It is also observed that in some places shifting cultivation areas has become non wastelands land like built up, forest plantation and agricultural plantations that covers 10497 ha area.

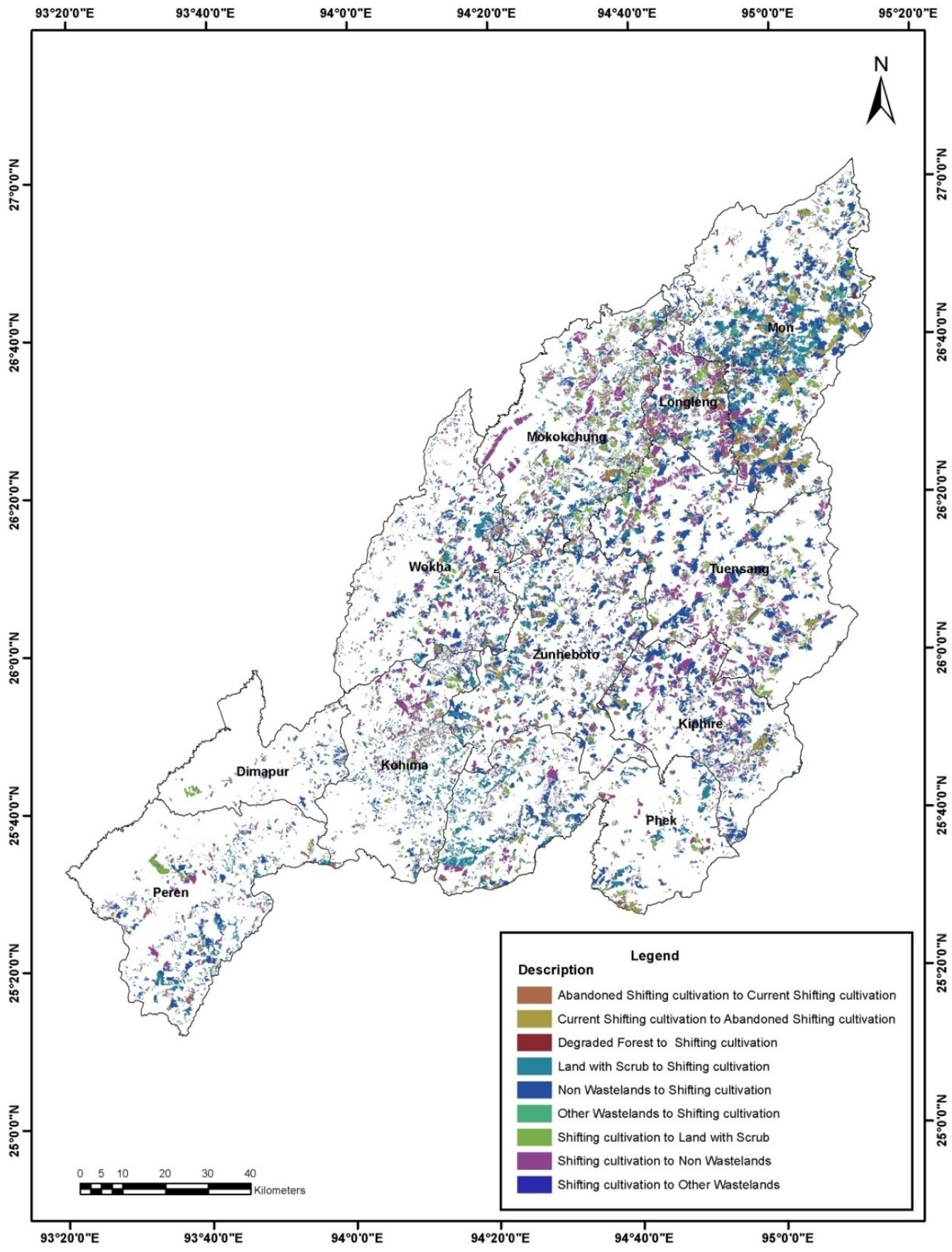

Fig: 9 Changes during 0203-0506

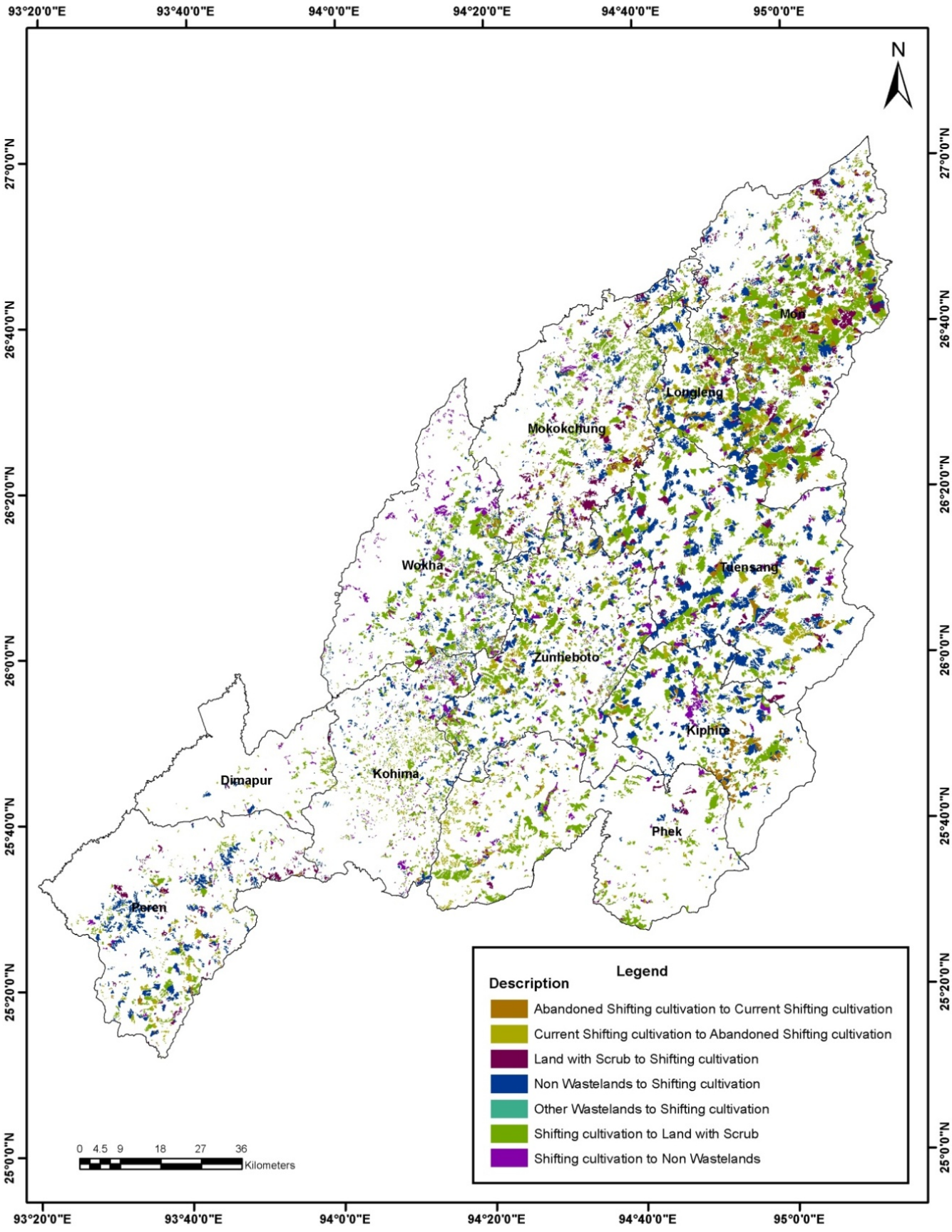

Fig: 10 Changes during 0506-0809

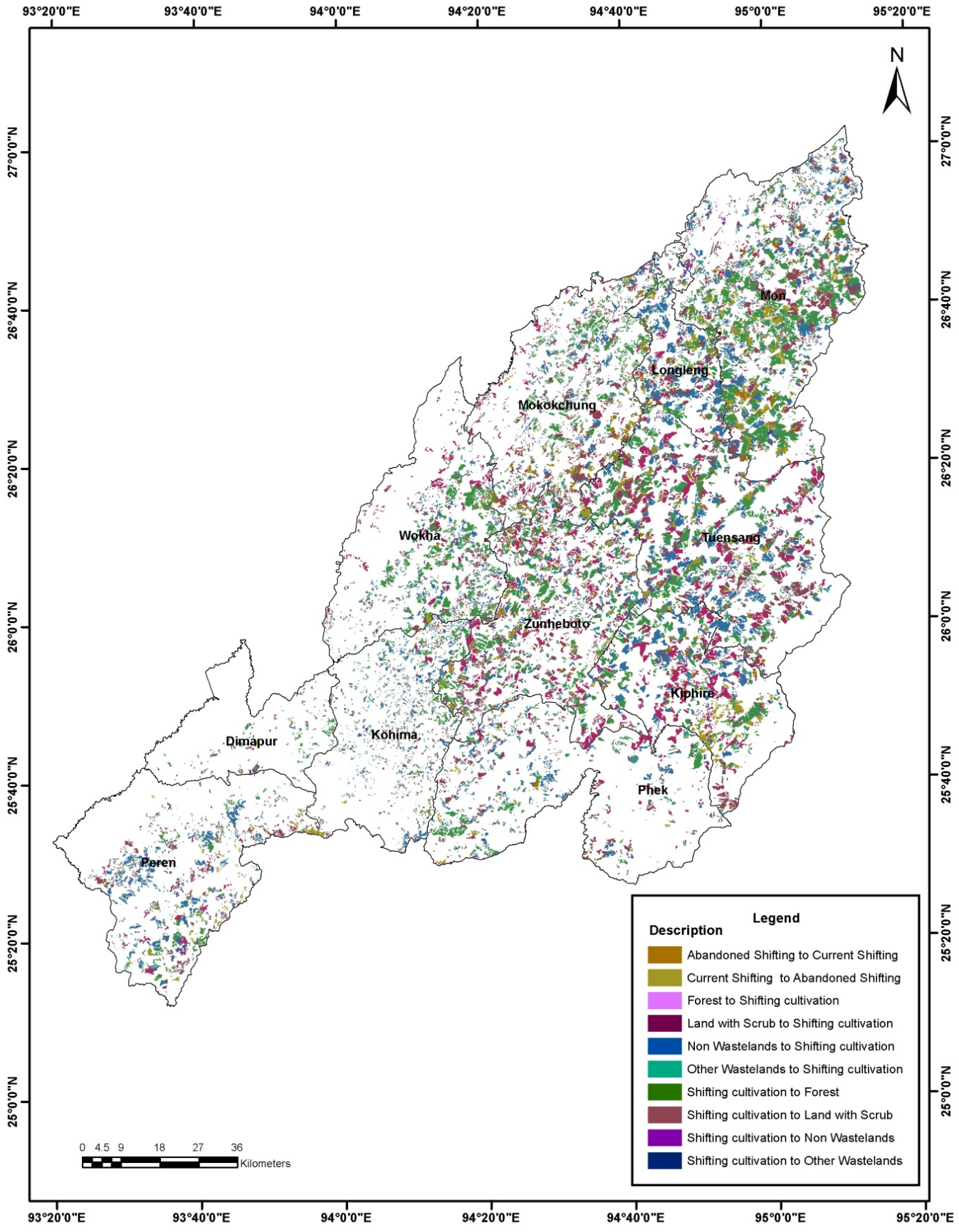

Fig: 11 Changes during 0809-1112

3.2 Study the relationship between slope and aspect with abundance of shifting cultivation areas

From the study it is observed that shifting cultivation areas are found in gently sloping land to very steep slopes. But it is also observed that shifting cultivation area is highest in steep slopes followed by moderately steep slope and very steep sloping. Lowest shifting cultivation areas are observed in gentle slopes followed by moderately sloping land (Fig.12).

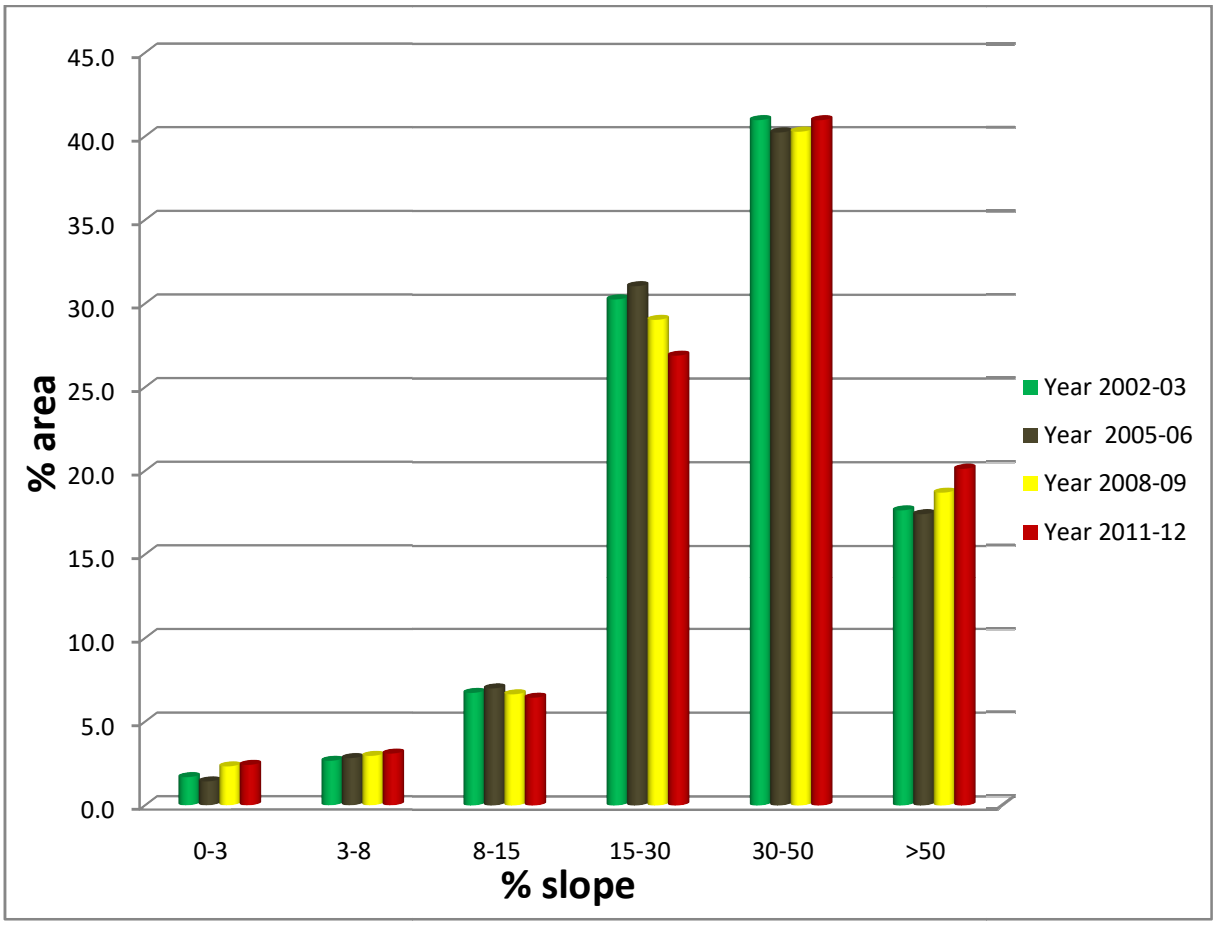

Fig.12: Abundance of shifting cultivation in respect to slope percent

Maximum percentage of shifting cultivated areas i.e. 37 to 38% are facing towards northern aspect and 36 to 37 % is in southern aspect, 13 to 14% is in West and 13 % is in East (Fig.13).

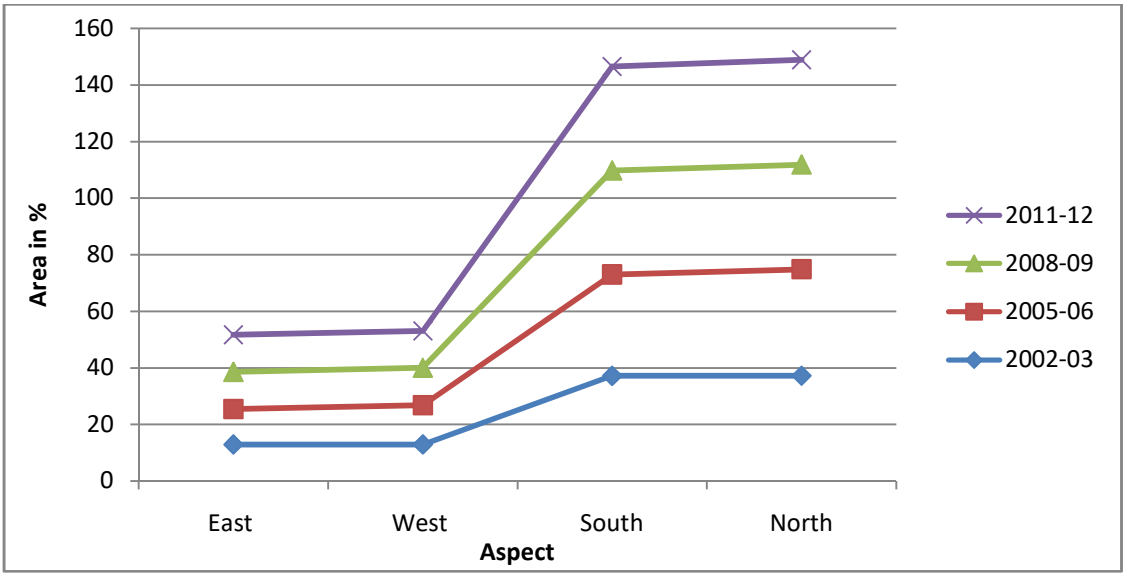

Fig.13: Relationship of shifting cultivation with aspect

3.3 Action plan for sustainable development or alternate use for shifting cultivation

Land use action plan was prepared by considering slope and soil of the shifting cultivation areas. Slope and soil map were integrated with shifting cultivation map of 2011-12 in GIS environment. The composite map were classified for alternate land use by considering the criteria given in the Table 3.

From the study it is observed that the shifting cultivation areas are mostly abundant in moderately slope to steep slope on north and south aspect. The soils of the study area are extremely shallow to deep. By considering the soil depth and slope the shifting cultivation areas are suggested for alternate land use like plantation of fruit trees, grasses, cultivation in terraces or on contour and afforestation (Table4). Fruit trees plantation with grass cover in the inter spaces are suggested in steep slope areas with deep soil and it covers maximum 37.9 % area. Cultivation in bench terraces are suggested in moderately steep slope with deep soils and covers 29.4 % area. Fruit tree plantation is suggested in very steep slope with moderately deep to deep soil and it covers area of 14 % area. Contour cultivation and strip cropping is suggested in 9.6 % areas in moderate slopes with slightly deep to deep soils. Afforestation (5.2% area) is suggested in very steep slopes with shallow to slightly deep soils. Grass plantation is suggested in steep to very steep slopes with extremely shallow soils.

Table 3: Criteria for alternate land use plan

Slope	Soil depth	Action plan
Very step	Extremely shallow to Slightly deep	Afforestation
Moderate slope	Slightly deep to Deep	Contour cultivation & strip cropping
Moderately steep slope	Slightly deep to Deep	Cultivation in bench terraces
Very steep	Moderately deep to Deep	Fruit tree plantation
Steep slope	Slightly deep to Deep	Fruit trees plantation with grass cover in the inter spaces
Moderately steep slope to very steep slope	Extremely shallow to shallow	Grass plantation

Table 4: Action plan for sustainable development

Description	% Area
Fruit trees plantation with grass cover in the inter spaces	3.9
Afforestation	5.2
Contour cultivation & strip cropping	9.6
Fruit tree plantation	14
Cultivation in bench terraces	29.4
Fruit trees plantation with grass cover in the inter spaces	37.9

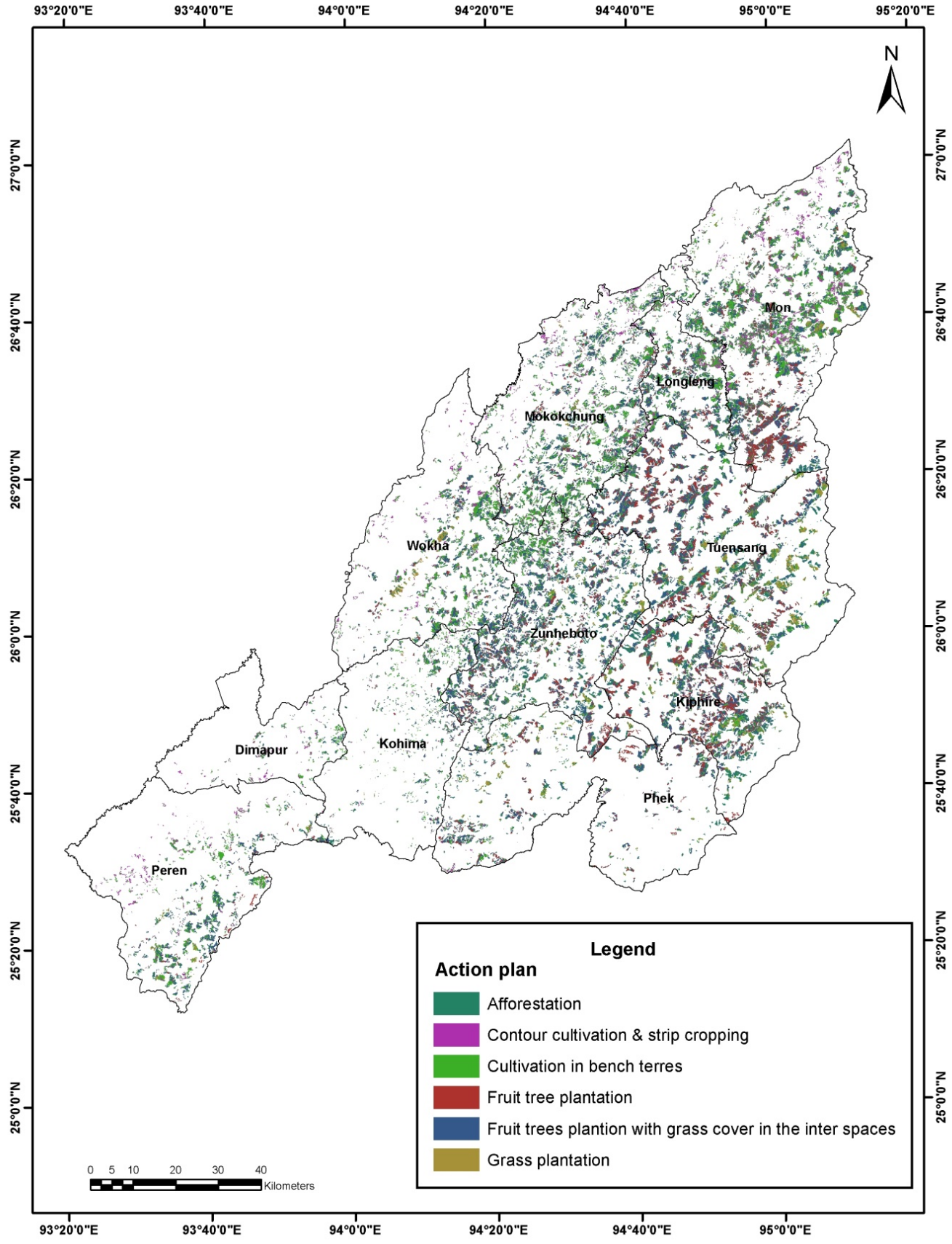

Fig 14: Action plan for sustainable development for Shifting Cultivation

4. CONCLUSION AND FINDINGS

From the study it is observed that the shifting cultivation area is increased during the study period 2002-03 to 2008-09 which may due to increase in population growth that leads to more demand for food. It is also observed that 228 Sq. Km area under shifting cultivation has been decreased during the year 2011-12 which may be replaced by the forest and agricultural plantations. From the change analysis study it is found that the shifting cultivation areas are dynamic in nature. Maximum changes observed in Non Wastelands that become shifting cultivation during 2005-06 and 2008-09. Maximum percentage of shifting cultivated areas facing towards northern aspect and southern aspect. Highest areas are found in steep slopes followed by moderately steep slope and very steep sloping. The soils of the study area are extremely shallow to deep. By considering the soil depth and slope the shifting cultivation areas are suggested for alternate land use like plantation of fruit trees, grasses, cultivation in terraces or on contour and afforestation. Fruit trees plantation with grass cover in the inter spaces are suggested in steep slope areas with deep soil that covers maximum area (37.9%). Cultivation in bench terraces and fruit tree plantation is suggested in 29.4 % and 14% area respectively.

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