Landuse / Landcover Detection Mapping and Identification of Shifting Cultivation Areas of Tirap district

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Introduction

Tucked away in the corner of North-East India, lies Arunachal Pradesh, the land of 'the Rising Sun', where shifting cultivation is widely practiced in the hilly rugged areas of the state. This form of agriculture is practiced i.e., ecologically unsustainable but suited to the primitive technology available in such areas where level land for settled cultivation is extremely scarce. As such the practice of shifting cultivation that has evolved over the years has become a traditional practice rooted in the culture of not only the tribal populace of Arunachal Pradesh but in various other hill areas of north-east India. In certain areas of Arunachal Pradesh shifting cultivation is the main source of livelihood of the people and this is hardly surprising considering the low level of socio-cultural, technology and the negligible proportion of level land available in the state. In the hill slopes, the tribal farmers has little other options than to resort to *Jhum* cultivation, as shifting cultivation is referred to in North-East India.

From the point of view of forest, however, *jhum* cultivation could not have been much more When the practice was adopted in societies with negligible population pressure, the *jhum* field/plot was allowed to lye fallow for long years long enough to allow vegetal cover to regenerate before the cultivators turn to cultivate that plot again and thus complete the *jhum* cycle. Such long cycles, which were ecologically healthy, soon gave way to reduced

cycles one the factor of population and land scarcity came into play. Current practices of *jhum* in the hills of north east India with short land in the face of growing population, the periodicity of such cycles is ever reducing cycles are not ecologically healthy practices and it is a practice that has, among other factors, taken a toll on the vegetal cover in the hills.

Methods and Data Base

A base map on a scale of 1:50,000 were prepared with SOI toposheets (1996) covering the study area. IRS IC FCC imageries on the same scale were interpreted monoscopically to delineate the shifting cultivation areas along with the preparation of LUCC maps for 1994 and 1996. Interviews of village elders, ground truth to verify certain doubtful features and necessary rectification were made to the pre field maps. Plainmetric measurements were carried out, accuracy estimation on select test sites and digitizing the maps into a GIS system were also carried out. Finally changes in shifting cultivation as well as temporal change in the various categories were identified.

High resolution multispectral remotely sensed data from the IRS satellite was used for visual interpretation of the shifting cultivation areas. Land use and land cover mapping would also be carried out to delineate shifting cultivation areas. Likewise land use and land cover changes and forest cover mapping was also to be carried out using the remotely sensed data. For the 1960's in the absence of access to aerial photographs, Survey of India topographical sheets on 1:50,000 scales were used to prepare broad categories of forest and non-forest areas. The area under forests would be compared to those in the 1990's data relating to 1996 and 1994 (IRS 1C and IRS 1B respectively) during the winter seasons were used and temporal variations would be ascertained. While preparation of the 1996 land use and land cove map was supported by intensive ground truthing, the same was not possible for the 1994 map. IRS-1C FCCs were used (1:50,000) for 1996 and IRS-1B (1:50, 000) for the 1994 land use and land cover maps. The forest areas were also delineated and temporal changes mapped and quantified.

Analysis

In 1996, as per SOI toposheets, the Tirap district had a forest area of 1948.719 km^2 out of the total area of 2362 km^2. This amount to 82.5 percent of total area coming under forest cover. The remaining area largely comprised of grasslands with a negligible area under settlements. In the study on the basis of SOI toposheets the area has been divided into two broad landuse categories of

1. forest area,
2. non forest area.

Identification of more detailed land use categories was not possible on the basis of SOI toposheets, and only from data sources such as aerial photographs and satellite imagery would give more precise land use/land cover categories. However for the present analysis where forest cover mapping and temporal variation is the objective, the categorization of 1996 land cover into two categories are useful for comparison purposes with area under forests at present. In 1966, 82.5 percent of Tirap's total areas were under forest cover. The remaining 17.5 percent of the district was largely under grasslands (Table-1).

Compared with the 1966 forest/non-forest situation substantial land use/land cover changes developed three decades later in 1996. Only a partial reduction in total area under forests resulted, from 82.5 percent in 1996 to 74.58 percent in 1996 showing a reduction of 187.14 km^2. However from the area of 1761.579 km^2 in 1996 the proportion of dense forest, with crown density of over 40 percent was rather low at 29.93 percent of the total geographical area of the district of 706.94 km² area under open forests and degraded forests were 582.23 km² and 472.4 km² respectively amounting to 24.65 percent and 20 percent of the total geographical area of the district respectively (Fig.-1). When buffer zones of 1,2,3 4 and 5 kilometers were created around the polygons representing degraded forests it was found that 64 percent of these polygons existed within a kilometer of human settlement areas. Since settlements have proximity to roads there is an implicit relationship between accessibility (by roads) and forests degradation. A certain amount of timber logging was permitted (prior to December 1996 when Supreme Court order banned logging) and these had proximity to roads. Moreover, forest degraded areas have a linkage with shifting cultivation areas due to the proximity of *jhum* areas to degraded forests and because shifting cultivation involves clear felling/burning of forests, upon abandonment nominal re-growth may take place depending upon the duration of being left fallow.

Table-1: Distribution of Degraded Forests vis-à-vis Settlements in Tirap District.

Distance	Number of Degraded Forest Polygons	Percentage to Total
Within 1 km	92	64.78
1 to 2 km	28	19.72
2 to 3 km	14	9.86
3 to 4 km	3	2.11
4 to 5 km	4	2.82
Beyond 5 km	1	0.70
Total	142	

From Table-1 it is clear that in the first two categories (degraded forest polygons occurring with 1 km and 2 km) 84.5 percent of the total polygons representing degraded forest seem to indicate the impact of human activity in forest degradation. Additionally, areas with relatively better accessibility are also the area with more degraded forests.

Conversely areas with relative inaccessibility have larger proportions of area under dense forests. Thus the polygons representing dense forests exist in (among other areas) a belt along the Tirap – Myanmar border; incidentally this is also a stretch where higher elevations are found relative to the average elevation of the district. However, the inaccessibility dense forest relationship does not hold well in case of the intra-district boundary between Tirap and Changlang. This could be due to a variety of factors such as grazing, extraction of fuel wood, shifting cultivation and logging. Discussions with village elders pointed to the importance of the latter two agents in forest degradation. In fact several of these patches degraded forests were under *jhum*

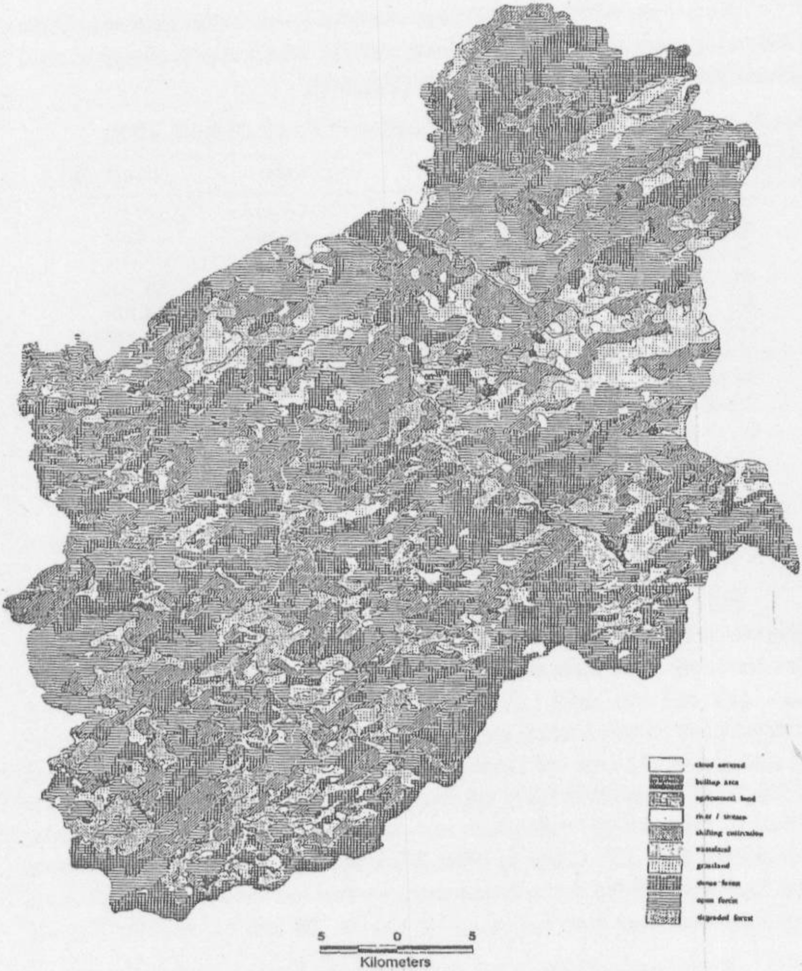

Fig.-1: Tirap District – Land use / Land cover (1994)

cultivation in the recent past ascertained from interviews with village elders. Thus several degraded forest patches are previously abandoned shifting cultivation area that have rejuvenated over the years.

As per the NRSA (1989) land use/land cover classification scheme the following categories of LULC along with the area and percentage to total are identified based on 1996 IRS IC data (Table-2).

Table-2: Land use/Land cover Classification of Tirap District, 1996.

Land use/Land Cover Category		Area	Area in %
1.	Build up land **	33.942	1.437
2.	Agricultural Land (including plantation area)	43.389	1.837
3.	Forest		
	(i) Dense	706.946	29.93
	(ii) Open	582.23	24.65
	(iii) Degraded	472.40	20.00
4.	Wasteland (including barren land/stony waste)	209.037	8.85
5.	Water bodies: River/Stream	33.54	1.42
6.	Others:		
	(i) Shifting Cultivation	56.995	2.413
	(ii) Grassland (including scrub)	216.43	9.163
	(iii) Cloud/Cloud shadow	7.086	0.30

N.B. ** Build up land barring Khonsa (Class V Town in 1991, 7097 persons) all others were in the rural category.

Built up land has recorded a nominal loss. This is because most of the settlements in this category are rural settlements. During the period, a few rural settlements may have been abandoned, and this could explain the slight decrease. Agricultural land (all agriculture, plantations barring Shifting cultivation) has shown a small increase, which could be due to limited/negligible changes in the area cultivated from one year to another. In the case of wastelands and grasslands fairly substantial losses are recorded. It is possible that part of these LULC categories may have changed to degraded forests, which in 1994 were 553.42 km² in 1996. While open forests have remained more or less the same it is the dense forest category that has shown a good proportion of positive change from 518.46 km² in 1994 to 706.946 km² in 1996 (Fig.-2).

For the period 1994-1996 changes in the various landuse/landcover categories delineated using IRS-1B and IRS 1C data could be quantified. However forest degradation could not be specified spatially or quantified due to the lack of data for 1966. The linkages between degraded forests and their proximity to settlements (and therefore indirectly the linkage between degraded forests and accessibility) were observed. In general shifting cultivation and timber logging were the chief reasons behind forest degradation. However, as far as forests as a whole were concerned and in particular dense forests, there

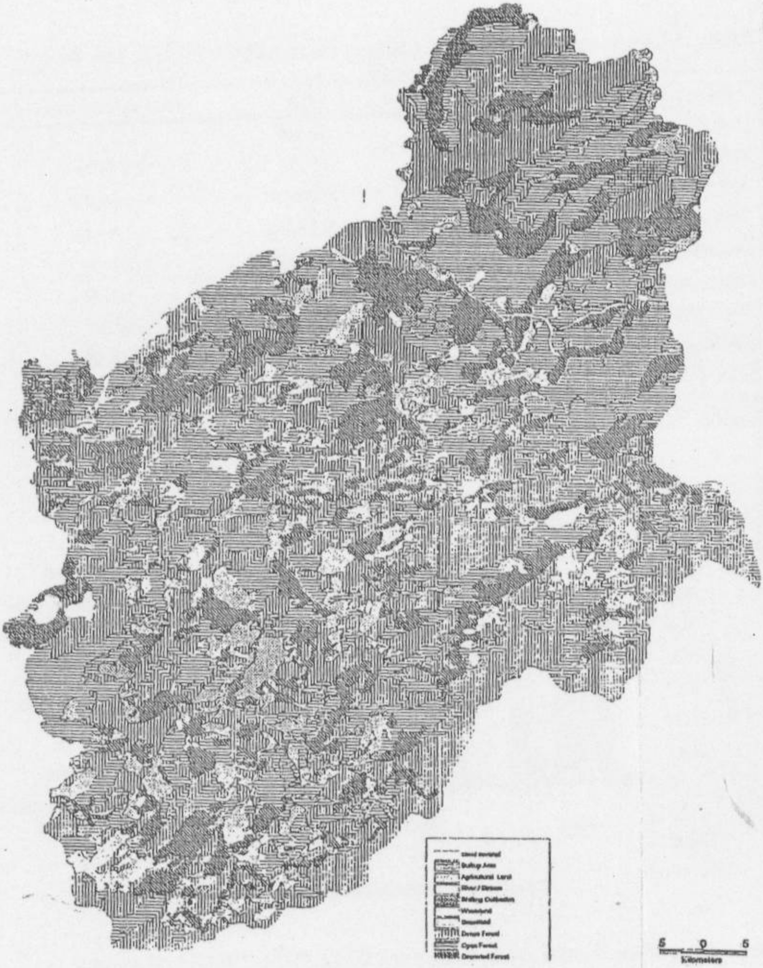

Fig.-2: Tirap District – Land use / Land cover (1996)

are clear signs of improvements and encouraging gains made during the period 1994-1996.

Table: 3 Landuse/Land cover Changes from 1994-1996 (in Per cent)

LU/LC Category	1994	1996	Increase/decrease km2
Builtup land	35.66	33.94	-1.72
Agricultural land	37.79	43.39	+5.59
Dense forest	518.46	706.95	+188.49
Open forest	566.88	582.23	+15.35
Degraded forest	553.42	472.40	- 81.02
Waste land	273.28	209.03	- 64.24
Water bodies	33.77	33.54	- 0.23
Shifting cultivation	95.19	56.99	- 38.19
Grass land	247.06	216.43	- 30.63

Source: IRS 1C LISS III Imagery, 1994 and1996

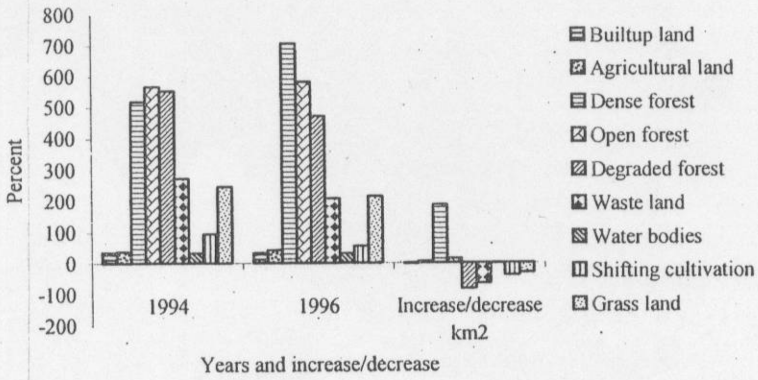

Fig.-3: Landuse/Land cover Changes from 1994-1996 (in Per cent)

Spatio-temporal dimensions of *jhum* cultivation areas

During the years 1994 and 1996 there were 4.03 percent and 2.41 percent of the district's area under *jhum* cultivation. This amounted to 95.19 km^2 area under *jhum* in 1994 and 36.99 km^2 area under *jhum* in 1996 showing a decline of roughly 50 percent of the 1994 *jhum* extent.

This is indicative of the variable nature of the practice. On a particular year a slightly larger area may be brought under *jhum* cultivation than on another year, depending on the requirements of the *Jhumia* family and the community, a slightly lesser area may be cleared and brought under jhum. Thus from the point of view of impact or degrading impact on forest cover, *jhum* can have a variable impact. However it is important to note here that over time when more and more areas are brought under the *jhum* cultivation practice, the deleterious effects on forest cover, soil loss and soil erosion get compounded. This is true as population pressure and land scarcity combine to bring on reduced *jhum* cycles and hence the *jhum* plot does not get enough time lying fallow to regenerate its soil/vegetal richness and becomes increasingly susceptible to degradation.

While over time, *jhum* can have a cumulatively deleterious effect on soil and the vegetal cover, the impact of forest degradation is not all that apparent in a given year. On the basis of the present study, 4 percent in one instance and 2.4 percent in the other is hardly enough evidence to 'blame' the entire forest degradation scenario on *jhum* cultivation. As noted in here that both *jhum* and timber logging are seen as agents of forest degradation.

According to official sources about 44 lakh tones of fertile soil is lost every year from areas where *jhum* cultivation is practiced in Nagaland. It has been estimated that 70 percent of the total top soil degradation and water resource degradation in Nagaland was due to *Jhum* cultivation (The Hindu 1998). This reference to Nagaland, Tirap's neighbour to its immediate south is relevant not least due to the similarity in practice in *jhum* and the close cultural affinity of the Wanchos and Noctes with the tribal population of Nagaland.

Let alone Tirap and Nagaland in the entire north-eastern region (NER) of India, shifting cultivation with deforestation, faulty methods of cultivation on hill slopes and in some cases construction of roads are the major cause of soil degradation (Patriram 1995). However, in the case of Tirap, the position of shifting cultivation with only 4 percent area under *jhum* the effect on forest cover, at a given point of time is not all that significant. At the same time, it has to be kept in mind that over time the cumulative impact of such a practice (*jhum* in Tirap has been carried out since time immemorial) becomes considerable. This is also linked with the periodicity of the *jhum* cycle, and the frequency with which the *jhumia* returns to a plot to re-cultivate the plot. It is well known that longer cycles (20-30 years) with long fallow periods were not harmful to the environments. Since there is no way to increase the length of the *jhum* cycle some sort of alternative livelihood for *jhumia* farmers must be explored. These could include activities like horticulture/pisciculture or even cultivation of commercially valuable species and selectively harvesting them on a profit sharing basis.

Of these integrated rural development is by any means the least important since it is though increased public participation that socially adaptable/adoptable and economically attractive employment or income generating awareness may be arrived at.

In rare cases *jhum* plots are 4-5 kms or even more than 5 km from the nearest settlements. The distance in the case of few such instances would possibly change and reduce considerably if the settlements in the district border, i.e. with Changlang were considered since there could be inhabitants in such fringe areas who cross the district to reach *jhum* lands in Tirap. A similar situation of shifting cultivation plots located in proximity to settlements exists in 1996 (Table-4).

Table- 4: Distribution of *jhum* plots in relation to settlements, 1996.

Distance from settlement in km	No. of *jhum* plots	% of plots to total no. of *jhum* plots
Within 1km	50	43.48
1-2	34	29.56
2-3	21	18.26
3-4	5	4.35
4-5	5	4.35
Beyond 5	-	-
Total	115	1000

Source: IRS 1C LISS III Imagery, 1996.

Given table shows that degraded forest exists close proximity to settlements, as seen in the earlier analysis the linkages between jhum areas and degraded forests becomes obvious and there is a tendency for degradation of forests areas to occur to close proximity to settlement areas, pointing to the impact of jhum on forest degradation.

Jhum Cultivation and forest Degradation

While shifting cultivation is viewed in some quarters as a major cause of tropical deforestation, recent research suggest that the reality is often more complex, and that explanations for deforestation must be sought in a variety of factors, many of which should be placed at the door of governments and international capital rather than of shifting cultivators (Brown and Schreckenberg, 1998). There are many causes of deforestation other than shifting cultivation. These vary in different parts of the globe and range from resource privatization, land speculation, fiscal incentives for land conversion, tenurial policies to ' development projects'. In the case of Tirap district while shifting cultivation is one agent of forest degradation, other factors underlying forest degradation/forest loss include timber logging and of course the land tenure system in which legal rights over land are closely defined. While the impact of forest degradation is not all that apparent in a given year, over time as more and more areas are brought under the jhum cultivation practice, the deleterious effects on forest cover, soil loss and soil erosion get compounded. Growing population and reducing periodicities of jhum cycle have aggravated the adverse impact of jhum on forest. In addition to forest cover additional effects of an increasing population pressure, declining land availability through degradation and a consequent shortening of the agricultural cycle, cause: (a) a drastic reduction in yield (b) reduce agro ecosystem and landscape stability in the face of the population, leading to social disruption (c) a decline in bio diversity due to weed take over, biological invasion and eventual site desertification and (d) substantial CO2 emitted into the atmosphere because of more frequent and extensive burns (Ramakrishnan, 1995).

Conclusion

Considering that 'information on existing land use/land cover and the pattern of their spatial distribution forms the basis for any development planning and that the current land use has to be assesses for its suitably in the light of land potential before suggesting alternative land use practices' (NRSA 1995). Land use pattern and changes therein were taken up for analysis. Satellite data gave an accuracy of 82 percent when the interpretation was tested in 120 test sites. Interpretation errors in delineated between degraded forests and grasslands had to be corrected following field checks. For the period 1994 to 1996 changes in the various LULC categories delineated using IRS-1B and IRS-1C data could be quantified. However forest degradation could not be specified spatially or quantified due to the lack of data for 1966. The linkages between degraded forests and their proximity to settlements (and therefore indirectly the linkage between degraded forests and accessibility) were observed. In general shifting cultivation and timber logging were chief reasons behind forest degradation. However, as far as forests as a whole were concerned and in particular dense forests, there are clear signs of improvements and encouraging gains made during the period 1994 to 1996.

The present analysis using IRS-1B and IRS-1C has shown the distribution and temporal changes in select land use categories. The forest cover has declined since 1966, but in the 1994-1996 periods there is a perceptible improvement. Fieldwork suggests that shifting cultivation and timber logging are chief agents of forest degradation/forest loss.

What alternative land use can be adopted in Tirap to ameliorate the situation must be considered in the light of:

a) The primitive technology available to the tribal *jhumia* cultivator/ *jhumia* family.
b) *Jhum* cultivation is virtually a way of life, rooted in the tribal ethos, and

c) The prevailing land tenure system which involves community ownership of forests in the overwhelming majority of the forest areas.

As regards control of forest degradation/forest loss there is an urgent need to go in for reforestation. At the same time on a pilot basis, timber plantation areas with specific commercially valuable species (Hollong for instance) need to be grown. Under the forest departments supervision along with community management/participation may be on a profit sharing basis, akin to the Joint Forest Management model prevailing in states like West Bengal – such plantation areas can be 'formed'.

This may be a solution to the logging aspect. Although the latter has been curtailed since December 1996, a complete ban may not be remain as a solution for very long and if some sort of logging was to be permitted in the near future, the issue of over harvesting of forests could re-emerge.

It may not be an inappropriate time to institutionalize a participatory forest management that focuses on:

a) property rights review (and where possible reform),
b) public participation on a profit sharing basis, and
c) Integrated rural development.

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