

Application of Remote Sensing and GIS in Detecting Shifting Cultivation Areas of Garo Hills, Meghalaya

B. S. Mipun

Introduction:

Remote sensing provides a source of data for processing and analysis, monitoring and forecasting tasks. GIS provides the capacity for integration of remote sensing and other with geo-reference data from various sources, enables digital overlays of different data sets, their spatial analysis and generation of user required cartographic and statistical products from integrated data bases.

Shifting cultivation in North Eastern India as also in other parts of the world has been catastrophic for the land and the forests, the main component of the ecosystem (Ramakrishnan *et al.* 1981). With existing high population density, it is no way sustainable and no reduction in shifting cultivation cycle seems to be sufficient (Kushwaha, 1993). Majority of the forests in Meghalaya is owned privately and there exist no guidelines to control exploitation of these forests. Three major tribal groups inhabit in Meghalaya plateau, namely the Khasis, the Jaintias and the Garos. The area under shifting cultivation in a given year is estimated to be 760 sq. km and as many as 344000 (1993) persons are dependent on it. In this study, an effort has been made to acquire initial information about correct detection of shifting cultivation in a given period of time for effective planning.

Shifting cultivation in the North-East Region of India is associated with ecological, social and cultural factors including lack of communication leading to geographical remoteness and isolation. The essential features of shifting cultivation as practised in the region are:

- a) Selection of site on the hill slope is done before the month of December.
- b) Clearing of the site by cutting jungle is done during the months of December –January.
- c) Burning of jungles around February-March.
- d) Sowing of crops in an intimate mixture by dibbling follows immediately after burning of cut jungles.

- e) Abandoning the land after cultivation for a period of 3-6 years usually and shifted to another site.
- f) Return to the same abandoned site after a period of 3-6 years to repeat the process.

No scientific method or modern technology is employed for preparation of the land. The only implements used in the farming are chopping knife, dibbling stick and a small hoe for weeding. The only inputs used are seeds and human labour where a person participates in most of the works. The important crops grown are rice, maize, tapioca, colocasia, sesame, cucurbits, beans, yams, sweet potato and banana etc. Most of these crops are cultivated in an intimate mixture. Sometimes a single crop such as rice is grown in the second year in the same field where other mixed crops are grown. The land is left fallow for regeneration after 2-3 year cultivation. The shifting cultivation cycle in the same land that extended to 20-30 years in olden days has now been reduced to 3-6 years only. The causes for this reduction of shifting cultivation cycle are due to pressure on land, increasing population, decrease in productivity leading to utilisation of more areas under shifting cultivation. The various adverse effects of the practice of shifting cultivation are:

- (i) There has been large-scale deforestation resulting in denudation of hilltops and slopes, which lead to undesirable ecological change and elimination of the water source.
- (ii) There is large-scale soil erosion due to deforestation and cultivation on hill slopes where no soil conservation measures are undertaken.
- (iii) Continuance of primitive cultivation system does not encourage modern technology.
- (iv) Labour intensive cultivation with low technology results in low productivity.

There are 5100 villages in Meghalaya (in 1991) of which 418 are located in Jaintia Hills District, 1227 in East Khasi Hills Districts, 743 in West Khasi Hills, 677 in East Garo Hills and 1383 in West Garo Hills District. Nearly 61% of total village in East Garo Hills and 68% in West Garo Hills are involved in the practice of shifting cultivation. A total of 28352 (9.53%) households in Jaintia hills, 100313 (6.94%) in East Khasi hills, 29167 (11.89%) in West Khasi hills, 26406 (31.80%) in East Garo hills and 71697 (38.33%) in West Garo hills derive their sustenance primarily from shifting cultivation. Two categories land for shifting cultivation are "owned" and "rented". The village communities own majority of the Shifting cultivation lands. The individual family is assigned a piece of land for cultivation during the season. Thus, he has only right to use it. About 93% of shifting cultivation population are involved in owned land for cultivation and 10% are engaged in rented lands.

The Study Area:

Meghalaya plateau is an extension of the peninsular India. It is a fragment of the Upper-continent of Gondwana. The rocks of the pre-Cambrian age like-hard crystalline granites mainly constitute the plateau. Gneiss and granulates. The physiographic characteristics of the region is highly dissected and irregular terrain in the western and northern faces in contrast to the regular and steep fall of southern face, down to the Barak Surma plain through a faulted face.

Meghalaya extends from 25°05' - 26°41'N and 89°47' - 93°36'E comprising of the Garo, Khasi and Jaintia Hills. But the present study deals with Garo Hills only. The Garo Hills is an extensively dissected tract of 8,164 sq. km. with an average elevation of 600m. from the mean sea level. The study area comprises of three districts of Garo hills of Meghalaya. (Long. 89°52'30"E to 91°5'E and Lat. 25°21'26"N to 26°7'30" N). The districts are West Garo Hills, East Garo Hills and South Garo Hills. The area is hilly with lateritic soil. It receives annual rainfall of 1500 mm and has a typical sub-tropical climate. The forest that is predominantly secondary in origin is classified as sub-tropical moist deciduous (Champion and Seth 1968). The average cycle of crop-forest rotation is 5-6 years. The landscape is composed of highly, degraded secondary forest.

Data and Methodology:

The initial work was visual interpretation of the satellite data and PC based MGE GIS Environment software were used to integrate the thematic information for preparation of shifting cultivation and landuse/landcover map.

- i) IRS 1 B LISS - II (FCC) print products generated from bands 2,3 and 4 of December 1994 on 1:50,000 scale is used to prepare the landuse/landcover map and shifting cultivation area map.
- ii) Survey of Indian Topographical maps on 1:50,000 scale is used to prepare the base map.
- iii) Ancillary data collected to integrate the socio-economic information.
- iv) Intergraph (U.S.A.) MGE-PC GIS software that run integrally with Microstation-Oracic-6 was used to analyse the data and to prepare digital maps.

In the visual interpretation, basic image interpretation elements like tone, texture, size, pattern, location, association etc. were considered and suitable interpretation key was devised for different shifting cultivation areas and other landcover classes. The information obtained from IRS LISS II print products are transferred onto the base map prepared from SOI topographical maps using optical pantographs and final maps of the Garo hills were prepared by incorporating field observations by which doubtful areas were verified. The area under each category of landuse/landcover and

shifting cultivation areas are calculated by using digital area curvimeter (Digital Planimeter). The visual interpretation map is scanned and screen digitised for GIS analysis.

Result and Discussion:

Forest is a dynamic system. In the forest ecosystem vegetation composition is influenced by many factors. The shifting cultivation in the hill slope is an active agent in the vegetation cover of the study area. The area under shifting cultivation is mapped successfully by remote sensing technique and GIS.

Analysis of the remote sensing data shows that during the year 1994-95 area under shifting cultivation accounts for 328.69 sq. km. in the Garo Hills. In Garo Hills total area under forest cover accounts for 1655.11 sq. km. Using satellite data a land use/land cover map is also prepared. The area statistic as shown in table 1 and 2 observed that area under shifting cultivation in the hill ranges along the river Simsang in West Garo Hills district is predominant. The major portions of the hill slopes have been brought under rice cultivation along with other crops like plantation, yam, cucurbit and sesame etc.

Some parts of the West Garo Hills especially in the scene area covering sheet number 78/K/1 and 78/K/7 shows a great contrast, that forest cover is intake and grass and bush covers are not found. This is a clear indication of shifting cultivation practice in the area, which is degrading or eliminating the forest covers. Therefore, there is a positive relationship between agriculture practice and forest degradation. The forest area accounts for 377.81 sq.km. of the total area of 505.89 sq.km. in same sheet number 78/K/1 and 283.17 sq.km. out of the total area of 698-40 sq.km, in scene area of sheet no. 78/K/7.

There is no significant correlation between forest and agriculture. But it is established that increasing Shifting agriculture area means decrease in forest covers. Again there is an increase in grass and bush category. This is due to abandonment of cultivation areas for regeneration of forest cover. The details of the findings are shown in the Table-1 and Table-2.

Conclusion:

In Meghalaya to control Shifting cultivation there are two schemes in operation: -

- (i) Integrated Scheme. That 100 acres of land are terraced in a compact area and 50 families of farmers are settled allotting 2 acres of land for each family.
- (ii) Rehabilitation of the farmers through afforestation and cash crop plantations. This will be raised by the Soil Conservation Department and ultimately handed over to the farmers at the rate of one hectare per family.

Ultimately unless the attitude, traditional practice of the farmers are changed and they are convinced of the changes that takes place due to such schemes for the success of such scheme will take many more years. Yet, there is no proven Technology with the development departments to bring about the awareness amongst the farmers because there has not been systematic study of the problems faced by them particularly with regard to improvement of agriculture in the environment in which they live.

The present study will be of great help to the planners and govt. agencies to know the amount of deforestation that are taking place due to shifting cultivation for taking remedial and alternative measures. The accurate and recent data is available only from satellite imagery. Therefore, remote sensing is emerging as a great tool in mapping and creating databases for the shifting cultivation and other fields than any other conventional methods.

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Table-1: Area Under Different Landuse/ Landcover In Garo Hills (1995)

| Toposheet Number | Code 1 | Code 2 | Code 2i | Code 3 | Code 4 | Code 5 | Code 6 | Code 7 | Total |
|------------------|--------|--------|---------|---------|---------|--------|--------|--------|---------|
| 78k/1 | 13.90 | 90.87 | 9.46 | 0.00 | 377.81 | 7.20 | 0.00 | 6.65 | 505.89 |
| 78k/2 | 72.82 | 22.10 | 16.95 | 533.50 | 35.29 | 9.57 | 0.00 | 1.77 | 694.00 |
| 78k/3 | 74.02 | 57.41 | 43.10 | 352.80 | 149.55 | 5.92 | 0.00 | 15.60 | 698.40 |
| 78k/4 | 7.64 | 24.53 | 1.66 | 31.65 | 5.17 | 2.49 | 0.00 | 0.00 | 73.14 |
| 78k/5 | 9.86 | 67.92 | 21.81 | 458.17 | 100.80 | 4.96 | 0.00 | 0.00 | 663.52 |
| 78k/6 | 86.77 | 35.00 | 36.87 | 442.88 | 87.59 | 2.34 | 0.00 | 4.95 | 698.40 |
| 78k/7 | 34.61 | 18.17 | 19.40 | 332.11 | 283.17 | 10.94 | 0.00 | 0.00 | 699.40 |
| 78k/8 | 3.76 | 9.92 | 16.45 | 124.41 | 43.06 | 0.96 | 0.00 | 0.00 | 198.56 |
| 78k/9 | 45.17 | 30.50 | 6.47 | 374.47 | 60.68 | 3.89 | 11.96 | 1.33 | 534.47 |
| 76k/10 | 58.90 | 5.98 | 61.17 | 278.98 | 133.89 | 4.01 | 152.64 | 2.83 | 698.40 |
| 78k/11 | 83.63 | 14.59 | 49.09 | 444.66 | 92.85 | 13.58 | 0.00 | 0.00 | 698.40 |
| 78k/12 | 3.53 | 15.04 | 12.26 | 125.87 | 66.65 | 3.51 | 1.73 | 0.36 | 230.95 |
| 78k/13 | 24.72 | 51.20 | 13.73 | 206.89 | 158.49 | 2.52 | 0.19 | 0.00 | 457.74 |
| 78k/14 | 33.06 | 66.88 | 2.08 | 224.47 | 20.17 | 3.80 | 0.00 | 0.00 | 350.46 |
| 78k/15 | 8.34 | 24.91 | 14.19 | 106.32 | 37.94 | 3.33 | 0.00 | 0.00 | 195.03 |
| | 560.73 | 535.02 | 328.69 | 4037.18 | 1655.11 | 79.02 | 166.52 | 33.49 | 7395.76 |

Based on 1995 IRS IB Satellite data (area in km)

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|-----------|---------------------------|
| Code 1.00 | Built-up Area/Settlement |
| Code 2.00 | Settled Agriculture |
| Code 2i | Jhum |
| Code 3.00 | Grass & Bush Cover |
| Code 4.00 | Forest |
| Code 5.00 | Water bodies/River |
| Code 6.00 | Barren/Rocky/Sandy |
| Code 7.00 | Marshy/Water logged areas |

Table-2: Landuse/Landcover Areas of Garo Hills (Area in Percentage)

| Toposheet | | | | | | | | | |
|-----------|--------|--------|---------|--------|--------|--------|--------|--------|--------|
| Number | code 1 | code 2 | code 2i | code 3 | code 4 | code 5 | code 6 | code 7 | Total |
| 78k/1 | 2.48 | 16.96 | 2.88 | 0.00 | 22.83 | 9.11 | 0.00 | 19.86 | 6.84 |
| 78k/2 | 12.99 | 4.13 | 5.77 | 13.21 | 2.13 | 12.11 | 0.00 | 5.29 | 9.38 |
| 78k/3 | 13 | 10.73 | 13.11 | 8.74 | 9.04 | 7.49 | 0.00 | 46.58 | 9.44 |
| 78k/4 | 1.36 | 4.58 | 0.51 | 0.78 | 0.31 | 3.15 | 0.00 | 0.00 | 0.99 |
| 78k/5 | 1.76 | 12.69 | 6.64 | 11.35 | 6.09 | 6.28 | 0.00 | 0.00 | 8.97 |
| 78k/6 | 15.47 | 6.54 | 11.83 | 10.97 | 5.29 | 2.96 | 0.00 | 14.78 | 9.44 |
| 78k/7 | 6.17 | 3.40 | 5.90 | 8.23 | 17.11 | 13.84 | 0.00 | 0.00 | 9.44 |
| 78k/8 | 0.67 | 1.85 | 5.00 | 3.08 | 2.60 | 1.21 | 0.00 | 0.00 | 2.60 |
| 78k/9 | 8.06 | 5.79 | 1.97 | 9.28 | 3.67 | 4.92 | 7.18 | 3.97 | 7.23 |
| 78k/10 | 10.50 | 1.12 | 18.61 | 6.91 | 8.09 | 5.07 | 91.66 | 8.45 | 9.44 |
| 78k/11 | 14.91 | 2.73 | 14.94 | 11.01 | 5.61 | 17.19 | 0.00 | 0.00 | 9.44 |
| 78k/12 | 0.63 | 2.81 | 3.73 | 3.12 | 4.15 | 4.44 | 1.04 | 1.07 | 3.12 |
| 78k/13 | 4.41 | 9.57 | 4.18 | 5.12 | 9.58 | 3.19 | 0.11 | 0.00 | 6.19 |
| 78k/14 | 5.90 | 12.50 | 0.63 | 5.56 | 1.22 | 4.81 | 0.00 | 0.00 | 4.74 |
| 78k/15 | 1.49 | 4.66 | 4.32 | 2.63 | 2.29 | 4.21 | 0.00 | 0.00 | 2.64 |
| | 7.58 | 7.23 | 4.44 | 54.59 | 22.38 | 1.07 | 2.25 | 0.45 | 100.00 |