Range Mgmt. & Agroforestry 30 (1) : 72-77, 2009
ISSN 0971-2070

Forest landuse planning for Thano range, Dehradun forest division, Uttaranchal

Ramesh Kumar Jha , H. C. Karnataka* and D. N. Pant**
Department of Forestry, Rajendra Agricultural University, Bihar, Pusa, Samastipur, India.
Corresponding author e-mail : rkjha23@yahoo.com; rkjha23@hotmail.com
Received : 25th July, 2008 Accepted: 25th May, 2009

Abstract

Remote Sensing and Geographical Information System (GIS) are essential tools for regional planning and ecological studies. Remote sensing promises to bridge the gap between intensive ecological research and better planning and management of landscapes. In the present study, by combining spatial and non spatial database using remote sensing and GIS techniques, it has been quite possible to categorize the forested land into different forestry landuse and subsequent planning for the better sustainable management of these forest land for good return and fulfilling the day to day needs of society. The study highlights maximum area under community forestry followed by protection forestry, homestead forestry, agroforestry, commercial forestry I, commercial forestry II and silvipasture. However, the farm forestry shows lowest area extent. These results indicate the maximum interference by human within the surrounding forest areas. The study highlights that Remote sensing and GIS techniques as the effective tools for suitability analysis of the different forestry land use and their respective land utilization planning.

Keywords : Remote sensing, Geographical Information System, Spatial, data, Landuse, Thano range

Introduction

Land use planning is the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land use options. Its purpose is to select and put into practice those land uses that will best meet the needs of the people while safeguarding resources for the future (Jha *et al.,* 2006). The driving force in planning is the need for change, the need for improved management or the need for quite different pattern of land use dictated by changing circumstances (FAO, 1993). Our basic needs for food, water, fuel, energy, clothing and shelter must be met from the land, which is in limited supply. As population and aspirations increase, land becomes an increasingly scarce resource.

The study area is facing much biotic pressure from the surrounding villages (Tiwari, 2000). These villages are situated amidst in between degraded forest areas. The poor people are mostly dependent on forests to meet their urgent requirement of fuel wood, fodder and small timber. The limited resources, its use by the people and the importance of protection/conservation for maintaining the ecological balance call for forestry land use planning.

Land use planning for forestry requires division for different natural forest land uses, the up to date information about the qualitative and quantitative aspects of forestry attributes, forest types, biophysical characteristics, slope, aspects, drainage, village extent and quantification of biotic pressure within forest land and the change over the period.

Remote sensing and GIS techniques are well documented for evaluation of land and its optimum utilization (Pant and Naig, 2007). These techniques are playing the vital role for planning and decision making process in the field of forestry and other natural resources. Remote sensing data of appropriate scale holds the promise to generate most of the required spatial database and is also amenable to computerization for developing information system for long term monitoring.

The database creation and their processing can be achieved in computerized environment through Geographical Information System. This technology can be effectively used for forestry land use planning. The aims of the present study are to prepare the digital database for finding the potential forest land use categories for efficient planning and management.

The study area

Thano Forest Range of Dehra Dun Forest Division lies between the 30° 11'38" to 30° 15'0" North and 78°08'11" to

* National Remote Sensing Agency, Hyderabad, India.
** Indian Institute of Remote Sensing, (NRSA), Department of Space, 4 Kalidas Road, Dehra Dun. Uttaranchal, India.

78°14'22" East. It is bounded by part of Dehra Dun district in the north, Haridwar district in the south, Shiwalik ridge in the west and Pauri Garhwal and Tehri Garhwal in the east (Figure 1).

The study area consists of both hilly and plain terrain and provide the drainage pattern of the study area by dividing into a number of runs and stream, especially in the western and central part of the study area. Geologically, Doon Valley is formed due to the coalescence of numerous fans produced due to upliftment of the pre-tertiary rocks. The soils in the study area exhibit wide variation due to their texture, depth, stoniness, colour, drainage, moisture, organic matter, cation exchange capacity *etc*. The forest soils are mature and belong to mollisol and alfisol order.

The climate is comparatively sub tropical to temperate and humid, having three distinct seasons of monsoon, winter and summer period. The temperature varies between 3°C in December to 38°C in May (Rawat, 2006). The hottest months are May and June and the coolest months are December and January. The monsoon season start in by the end of June and covers most part during July to October. The month of July and August are the period of heavy rainfall. However rains continue upto December and there is little rain in January and February too. Based on the average annual rainfall data of ten-year duration of 1979 to 1989 (Rawat, 2006), the total annual rainfall range between 1570 mm to 2200 mm (Rawat and Bist, 2002). The floods cause considerable damage to forest by uprooting of trees nearby the runs. The flow of wind is mostly from western side and is of moderate velocity.

Forest vegetation

The heterogeneous land use of the study area is supporting the variety of forest vegetation types occurring in different altitudinal zones. The most common gregarious formation under tropical to subtropical climate are Sal (*Shorea robusta*), Dhaura (*Anogeissus latifolia*), Shisam (*Dalbergia sisoo*), Khair (*Acacia catachu*) and Kanju (*Holoptlea integrifolia*). The subtropical to temperate climate is mostly supporting minor patches of pine (*Pinus roxburghii*) and Ban Oak (*Quercus leucotrichofora*) and their associates.

Materials and Methods

Satellite image interpretation

Creation of database and analysis

IRS-IC LISS III false colour composite geo-coded image (FCC of spectral bands NIR, R and G) on 1 : 50,000 scale for the year April 1999 was visually interpreted on the basis of its spectral variability supported by ground truth information. Identification and delineation of all forest vegetation type and other land use/ land cover feature was done using the standard visual interpretation techniques (Browden and Pruitt, 1983). Slope and drainage maps were generated from the existing topographical map. The data base of all these maps was created in the Arc View.

The slope categories were determined on the basis of ground realities associated with forest types and associated changes. A 100 m buffer on both the sides of stream/nala/rivulets was generated for demarcating the area under protection forestry scheme. The decision for keeping a 100 m buffer was used to assess the forest conservation areas against soil erosion and forest damages due to flood during high rainfall period. Based on observation 500 m and 1000 m village buffer were created.

Rapid rural appraisal for sample data collection

The interviews under RRA were conducted on 1 per cent of total number of households of all the villages situated between song and Jakhan rivers under 18 forest blocks. These rivers and their tributaries are forming the complete drainage pattern of the study area and creating a natural barrier for carrying fuel wood, fodder and other woody products from the forests occurring across of them. The data were collected using a structured performa containing all the direct and indirect questions attempting to assess an individual's dependency on the forests. In order to ensure the correct answers from the interviewers, rapport building process was kept in mind and the questions which seemed to be adverse for that current environment, were avoided. It was tried to explore and diagnose the most important problems, which has caused the dependency of villagers on the forest by establishing the RRA characteristics of interactive, innovative and informal communication in the field.

Data integration and analysis

The primary digital maps of forest type and land use, drainage map, drainage buffer map, village point map and village buffer map were integrated, analysed and modeled under GIS environment for creating the potential forestry land use map. The modeling was done from the matrix developed on the basis of responses received from RRA techniques of surveying.

Results and Discussion

The heterogeneous landscape of Thano forest range is supporting a variety of forest vegetation covers, comprising

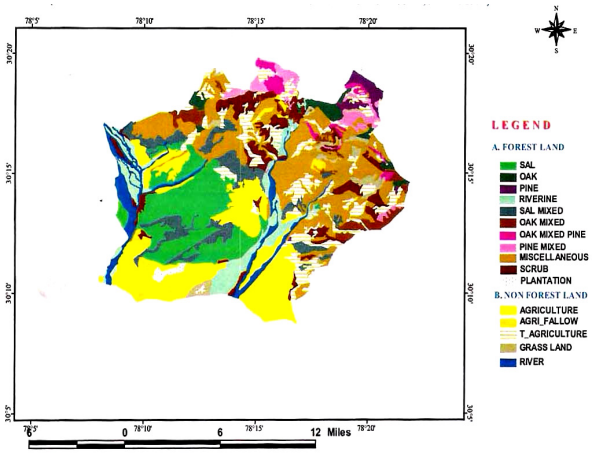
Table. 1: Visual interpretation key

S. No.	Type of forest	Tone	Texture	Shape	Location
1.	Sal high density	Dark red	Medium	Irregular	Plain and slightly
2.	Sal medium density	Blackish dark red	Medium coarse	Irregular	Plain and slightly undulating area
3.	Sal low density forest	Light reddish	Medium to coarse	Irregular	Medium-steep slope area
4.	Sal mixed with miscellaneous forest	Dark blackish and spotted reddish	Medium coarse and rough	Irregular	Undulating to medium slope area
5.	Miscellaneous and mixed forest	Dull green, medium green, light reddish	Medium and coarse	Irregular	Medium to steep slope area
6.	Riverine forest	Dark/medium blackish light red	Medium to coarse	Irregular	Near the river course.
7.	Plantation	Light dark red	Fine and medium	Regular and definite pattern	Almost in flat area and road side
8.	Degraded forest	Light whitish brown	Rough	Irregular	Plain to medium slope
9.	Oak forest (dense)	Dark maroon colour and tar red	Medium	Irregular	Mountain area, mostly on the depression/ Nala sides
10.	Pine forest (dense)	Medium to light maroon	Medium	Irregular	Mountain areas steep sloppy mostly on spurs and ridge, gentle slope.
11.	Agriculture	Patchy red	Fine to medium texture	Irregular	Plain to gentle slope
12.	Terraced agriculture	Pinkish red	Medium to coarse texture	Irregular	Specific area
13.	River course	Whitish blue	Smooth to medium texture	Linear	Specific area
14.	Scrub/shrubs	Dull medium blue	Medium	Irregular	Steep sloppy areas and near settlement
15.	Grassland	Pure dull white/dull white with light blackish	Smooth	Irregular	Specific

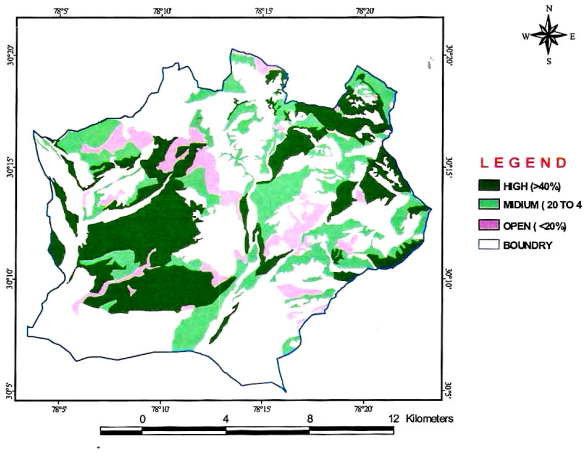
Table 2 : Forest type classification of Thano range of DehraDun forest division

S.No.	Value	Forest type	Forest area	Area in Sq. Km.	% age
1.	14	Miscellaneous	F	31.25	19.59
2.	15	Oak	F	3.13	1.96
3.	16	Oak mixed	F	4.90	3.07
4.	17	Oak mixed pine	F	2.77	1.73
5.	18	Pine	F	2.17	1.36
6.	19	Pine mixed	F	4.57	2.86
7.	20	Plantation	F	0.97	0.61
8.	22	Riverine	F	9.46	5.93
9.	23	Sal	F	23.05	14.45
10.	24	Sal mixed	F	11.55	7.24
11.	25	Scrub	F	10.60	6.65
			Forest area total	104.42	65.47
12.	11	Agriculture	NF	24.66	15.46
13.	12	Agri-fallow	NF	3.55	2.22
14.	13	Grassland	NF	3.59	2.25
15.	21	River	NF	8.39	5.26
16.	26	T_agriculture	NF	14.89	9.33
			Non-Forest area total	55.07	34.53
			Total area	159.50	

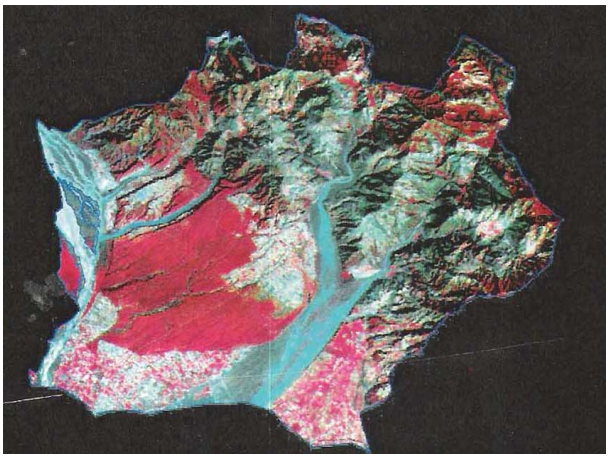
of Sal forest on the alluvial plain and lower foot hill slopes, Oak forest on the depression and side slope of ridgelines and the dry deciduous forest, mostly on the poor sites from lowest to the highest one. The scrub formation has been found mostly on either very poor sites or heavy biotic pressure, patches of Chir pine are also found amidst dry deciduous forest located below Oak zone. *Anogeissus latifolia, Dalbergia sissoo, Acacia catechu* and *Holoptlea*



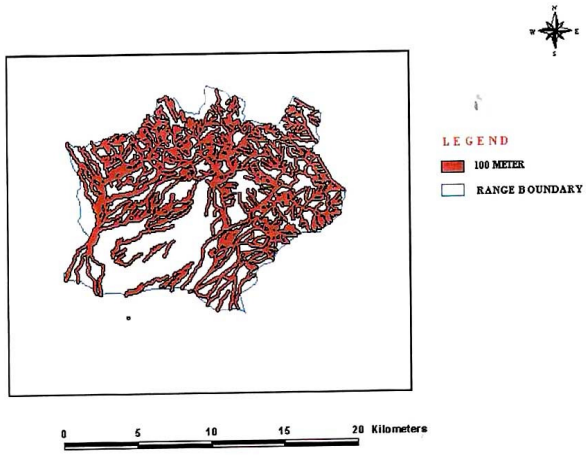
FOREST TYPE AND LAND USE MAP, THANO RANGE, DEHRADUN FOREST DIVISION (BASED – ON SCREEN VISUAL INTERPRETATION OF IRS – 1C LISS III, APRIL 1999)



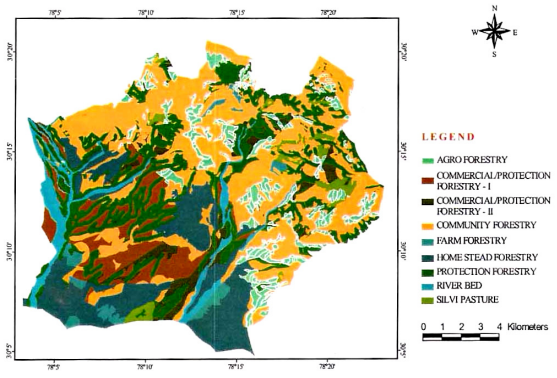
FOREST DENSITY MAP, THANO RANGE, DEHRADUN FOREST DIVISION (BASED ON SBREEN VISUAL INTERPRETATION OF IRS – 1C LISS III APRIL 1999)



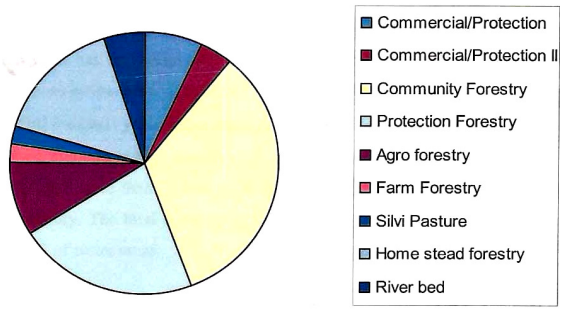
IRS-1C LISS III FALSE COLOUR COMPOSITE (SPECTRAL BANDS 3,2 &1), APRIL 1999



DRAINAGE BUFFER MAP, OF THANO RANGE, DEHRADUN FOREST DIVISION



MAP SHOWING POTENTIAL FOREST AND OTHER LAND USES OF THANO FOREST RANGE, DEHRADUN FOREST DIVISION



POTENTIAL FOREST AND OTHER LAND USES

Fig. 1 : GS & RIS images

Table 3 : Forest density classification of Thano range of Dehra Dun Forest Division

S. No.	Density	Area Sq. Km	Percentage density
1.	Open (< 20%)	11,683401	11,18802718
2.	Medium (20-40%)	37,173052	35,59692218
3.	High (> 40%)	41,46237775	39,7043814

integrifolia Kanju are the main gregarious formation within the community of the dry deciduous forest vegetation. Except *Anogeissus latifolia,* all are mostly confined along and near the river/rivulet sides (Figure 1).

Based on the matrix developed (Table 4) and subsequent data base the following potential land use classes were ascertained (Table 5).

Commercial forestry I : The areas supported high density Sal, riverine forest with more than half kilometre distance from village center and hundred meters distance from nala stream has been classified under the category. The total area under this category has been estimated as 11.17 Km^2 or 7.008% of entire area.

Commercial forestry II : These areas supported medium density Sal, Sal Mixed, miscellaneous, medium to high density class. More than half kilometers distance from village center and more than 100m distance from nala stream has been classified under this category. The total areas under this category have been estimated as 6.006 Km^2 and 3.7% of entire areas.

Community forestry : The areas supported by Sal and riverine, medium to open degraded, miscellaneous, all mixed Pine, Oak, Oak mixed pine and scrubs. Areas within one kilometre from villages or more than 100m ranges, from river, nala and rivulets has been classified under this category.

The tree species *Terminalia tomontosa, Acacia catechu, Dalbergia sissoo, Dalbergia melanoxylon, Tectona grandis, Leucaena leucocephala, Melia azaderach, Robinia pseudoacacia, Populus deltoides* and other miscellaneous species having fuel wood, fodder and small timber values which can fullfill the urgent requirement of the villagers are recommended for cultivation. The total area under this category has been estimated as 52.69 km^2 and 33.04% of the entire area.

Protection forestry :

The area where the all forest type, all density class scrub/ shrub, grassland, agriculture fallow with more than 100 m away from Nala stream or rivulets has been classified under this category. The total area under this category has been estimated as 34.47 km^2 and 21.61% of the entire area.

Agro forestry : The area with terraced agriculture within 100m has been classified under this category. The total area under this category has been estimated as 14.43 km^2 and 9.04% of entire area.

Farm forestry : The area within the range of 100m has been classified under this category. The total area under this category has been estimated as 3.51 km^2 and 2.2% of entire area.

Silvipasture : The areas 100m from village have been classified under this category. The total area under this

Table 4 : Matrix for potential forest Land uses, Thano range, Dehra Dun Division

Sl. No.	Type of potential Forest land uses	Existing Forestry cover Forest Type & land use	Forest Density	Slope Categories	Distance from village Centre	Distance from Nala stream (meter)
1.	Commercial/ production forestry I	Sal riverine	High density (>40%)	> 8%	>1/2 kms	>100m
2.	Commercial/ production forestry II	Sal riverine	Medium density (20-40%)	0-8% 8-30%	>1/2 kms	>100m
		Sal mixed & Misc.	High density	0-8% 8- <30%	>1/2 kms	>100m
3.	Community forestry	Sal Riverain	Open degraded	< 30%	< 1 kms	> 100m
		Miscellaneous	Medium density & open degraded	< 55 %	< 1 kms	> 100m
4	Protection forestry	All forest type grasslands agriculture & agriculture fallow	All density class & Scrub/shrub	>55%	-	>100m
5	Agroforestry	Terraced agriculture	-	30-55%	-	-
6.	Farm forestry	Agriculture fallow	-	< 55%	-	-
7.	Silvi-pasture	Grassland	-	< 55%	-	-
8.	Permanent agriculture & habitation	Agriculture & habitation	-	< 30%	-	-

category was estimated as 3.54 km^2 and 2.22% of the entire area. The preference need to be given to local grass species with introduction of legume *i.e. Stylosanthes hamata*.

Table 5 : Potential forest and other land use of Thano range of DehraDun forest division

Sl. No.	Forestry	Area in Sq. Km.	Percentage
1.	Commercial/protection	11.178	7.008
2.	Commercial/protection II	6.004	3.764
3.	Community forestry	52.699	33.041
4.	Protection forestry	34.478	21.616
5.	Agro forestry	14.433	9.049
6.	Farm Forestry	3.515	2.204
7.	Homestead forestry	3.548	2.224
8.	Homestead forestry	24.655	15.458
9.	River bed	8.142	5.105
	Total :	159.496	

Homestead forestry : The area within the range of 100m, agriculture land has been classified under this category. The total area under this has been estimated as 24.65 km^2 and 15.4% of the entire area.

Conclusion

The study highlights maximum area under community forestry followed by protection, homestead forestry, Agro forestry, commercial forestry I, commercial forestry II and silvipasture. However the farm forestry showed lowest area extent. These results indicate the maximum interference by human body within the surrounding forest areas.

The study highlights that Remote sensing and GIS techniques are acting as the most effective tools for suitability analysis of the different forestry land use and their respective land utilization planning.

In the present study, by combining spatial and non spatial database using remote sensing and GIS techniques, it has been possible to categorize the forested land into different forestry land use and subsequent planning for the better sustainable management of the forest land for good return and fullfilling the day to day needs of society.

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