Change detection during 1959 to 1999 (40 yrs.) for Barkot forest range and its peripheral area, Dehradun, India

P.S. Chauhan, M.C. Porwal, J.D.S. Negi and R.K. Manhas

Abstract: Remote Sensing is the art and science of obtaining information about an object, area or phenomenon through the analysis of data acquired by a remote device. Remote sensing along with Geographical Information System (GIS) is an important tool for change detection over a period of time. The present study was conducted in the Barkot Range of Dehradun Forest Division, Dehradun, Uttarakhand, India. Results of the present study reveal that nearly 34% of the total area was under the inter classes change. The most prominent change was observed in Forest to Agriculture class and Sal/Sal Misc. (Dense) to Sal/Sal Misc./Misc. Sal (Medium) class contributed 11.40% and 10.10%, respectively.

Key words: Barkot Forest Range; Dehradun; GIS; Remote Sensing.

1. Introduction

Remote Sensing is the art and science of obtaining information about an object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation (Lillesend & Kiefer, 2000). Although, there are several definitions of remote sensing but fundamentally the major concept is the same.

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GIS is an information technology which stores, analyze and displays both spatial and non-spatial data. The main objectives of GIS are: maximise the efficiency of planning and decision making, provide efficient means for data distribution and handling, eliminate the redundant, data base, integrate information from many sources, perform the complex analysis on geographically referenced data and finally generate new information including spatial modeling.

RS and GIS together have potential to provide comprehensive information on various facts of forests management in India (Roy, 1999). It can be said that remote sensing and GIS are twins of advanced technologies. Thus, it is undisputed that GIS is complementary to remote sensing technology and as well as a tool for spatial representation of information obtained from remotely sensed data which are essential as management input. Hence, in the present study RS and GIS applications were used to find Change detection during 1959 to1999 (40 yrs.) for Barkot forest range and its peripheral area.

2. Material and Methods

2.1 Study Area

Dehradun Forest Division (Fig. 1) is a sub-tropical region with a little temperate climate than surrounding areas due to the altitudinal range of 600-800 m above mean sea level (amsl). The annual temperature of the study area ranges between 1.8 °C (January) to 40 °C (June) whereas annual rainfall is around 191.8 cm. The frost is quite common in winter nights. Severe frost occurs in January and February affecting the Sal regeneration. The area lies between 77° 52' E to 78° 20' E and 30° 02' N to 30° 21' N Longitude while average altitude of the Dehradun Forest Division is 600 m amsl.

Champion and Seth (1968) classified the Doon valley into three Sub-types on the basis of Sal forests, viz., Moist Shiwalik Sal forest, Moist Bhabhar Doon Sal forests and Dry Shiwalik Sal forests (Roy, 1999). The Sal of this region is typically of II/III quality and advance growth is generally adequate. However, the seeding regeneration is very poor (Bisht, 1989). Sal is the dominant plant species and its associates are *Mallotus phillippinensis, Ehretia laevis, Syzygium cumini, Terminalia alata, Litsea glutinosa, Ardisia solanacea, Flacourtia indica* (Salim and Ullsten, 1999).

2.2 Methodology

Standard mapping methodology using aerial and satellite images has been used in the present study. Aerial photographs of 1976 and satellite data of IRS 1C, LISS III False Colour Composite (FCC) of March 1999 on 1: 50,000 scale was used for mapping purpose. Ancillary information from Forest Department like Forest range map of Dehradun Forest Division and Rajaji National Park on 1: 50,000 scale was used. Besides, Working Plans of Dehradun Forest Division and Rajaji National Park proved to be an asset (Singh, 1986; Srivastava *et al*., 2002).

The reconnaissance survey of the study area was initially carried out to remain familiar with the study site. Ground truth observations were made to prepare the interpretation Key, which is essential in forest cover and forest canopy density classification. Garmin GPS (Global Positioning System) was used to locate the latitude, longitude and altitude of the study sites.

Remote sensing data such as IRS 1C LISS III images were visually interpreted using image elements for the forest type and density classification as well as other landuse types. The whole study area was classified in 4 (four) classes in terms of forest density viz., Dense, Medium, Open and Degraded and into 10 (ten) landuse classes on the basis of interpretation key viz., Sal, Sal Miscellaneous, Miscellaneous Sal, Miscellaneous, Riverine, Shrub, Scrub, Plantation, Agriculture/Fallow and *Rao* (seasonal streams)/ Water Body.

The maps generated by using remote sensing data were digitised by using SPANS and exported in Dxf format, which was imported in ILWIS (Integrated Land & Water Information System) as a segment map (Vector form). The segment map was subsequently converted into polygon by using point map and finally in raster layer. The raster layers were used for crossing of themes through map calculation function. The output layers generated after crossing thematic layers were used to find out the change in forest type and density classes.

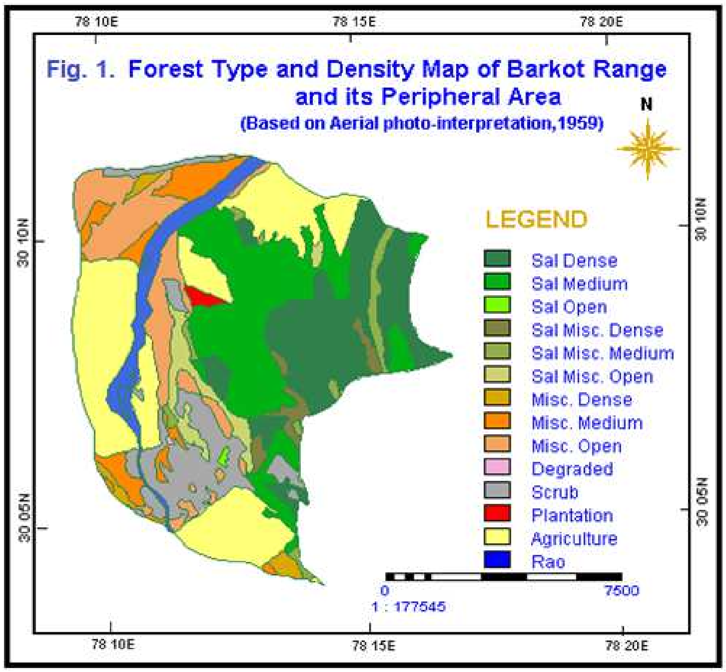
3. Results

Forest type and density map of Barkot and its peripheral area for the year 1959 based on Aerial Photographs on 1:50,000 scale prepared by Forest Survey of India, (Fig. 1, Table 1) revealed that out of total area of 10582.63 ha the contribution of Sal Medium was max. (19.20%) followed by Sal Dense (17.20%).

Other major classes were Misc. Open and Scrub contributing 10.60% and 9.02% respectively. In the non-forest category maximum contribution was of Agriculture i.e. 24.40% followed by Rao i.e. 5.14%. The minimum value (0.05%) was observed under degraded category.

Forest type and density map of the same area (1999) based on interpretation of IRS-IC LISS-III, FCC, on 1:50,000 scale (Fig. 2, Table

1) revealed that Sal Medium contributed the maximum (21.30%) area followed by Sal Misc. Medium (12.50%). Other major class was Sal Dense (10.70%) while Sal Open, Sal Dead, Sal Misc. Dense, Misc. Sal Dense Misc. Sal Medium contributed approximately equal area ranging only between 0.50-0.60%. On the other hand 3 classes i.e. Misc. Dense, Misc. Sal Dense and Orchard contributed to 0.21%, 0.22% and 0.33% respectively. In the non-forest area maximum contribution was observed in Agriculture (36.10%) followed by Plantation (7.25%). Rao contributed 4.91% and the minimum value (0.04%) was observed in the case of shrub class while comparing the 1959 and 1999 information it is evident that there is a significant decrease of area under Sal Dense. It had reduced to 10.70 % in 1999 from 17.20 % in the year 1959. The detailed analysis of changes is explained further in this chapter.



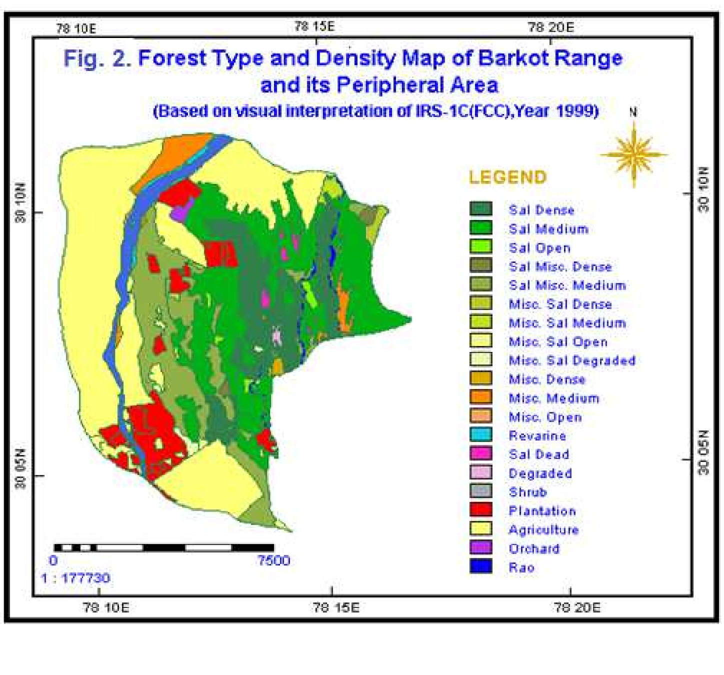


Table 1: Distribution of forest/landuse classes between 1959 and 1999 of the Barkot & its peripheral Area.

S. No.	Forest / landuse classes	1959		1999	
		Area (ha.)	Area (%)	Area (ha.)	Area (%)
1.	Sal Dense	1818.01	17.20	1128.03	10.70
2.	Sal Medium	2026.81	19.20	2257.21	21.30
3.	Sal Open	14.80	0.14	52.3	0.49
4.	Sal Dead	-	-	48.93	0.46
5.	Sal Misc. Dense	209.52	1.98	57.43	0.54
6.	Sal Misc. Medium	244.09	2.31	1325.62	12.50
7.	Sal Misc. Open	342.89	3.24	-	-
8.	Misc. Dense	138.61	1.31	22.7	0.21
9.	Misc. Medium	523.2	4.94	298.77	2.82
10.	Misc. Open	1126.81	10.60	4.92	0.05
11.	Misc. Sal Dense	-	-	47.71	0.45
12.	Misc. Sal Medium	-	-	64.61	0.61
13.	Misc. Sal Open	-	-	23.25	0.22
14.	Misc. Sal Degraded	-	-	29.99	0.28
15.	Riverine	-	-	52.74	0.50
16.	Degraded	4.80	0.05	16.68	0.16
17.	Scrub	954.18	9.02	-	-
18.	Shrub	-	-	4.58	0.04
19.	Plantation	50.25	0.47	767.57	7.25
20.	Agriculture	2584.97	24.40	3825.30	36.10
21.	Orchard	-	-	34.79	0.33
22.	Rao	543.69	5.14	519.50	4.91

Source: Based on Remote Sensing & GIS

Fig. 3 and Table 2 show that nearly 34% of the total area was under the inter classes change. The most prominent change was observed in Forest to Agriculture class and Sal/Sal Misc. (Dense) to Sal/Sal Misc./Misc. Sal (Medium) class contributed 11.40% and 10.10% respectively. Other major class under the change was Forest to Plantation, which constituted 6.70%.

The minor changes were observed in case of Sal (open) to (0.10%) Sal Misc. (Medium) class (0.41%) Agriculture to Rao (0.12%) and Rao to Riverine (0.10%) classes.

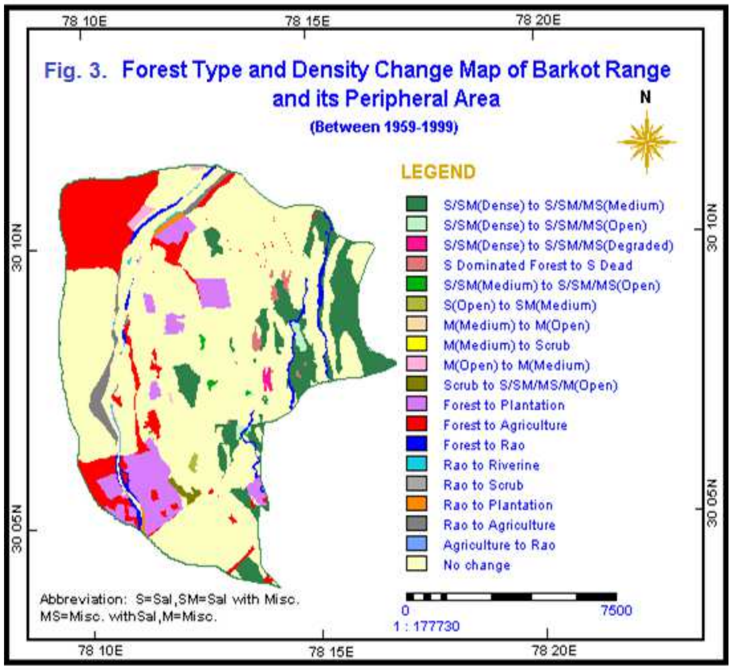


Fig. 3. Forest Type and Density Change Map of Barkot Range and its Peripheral Area

(Between 1959-1999)

Table 2: Change distribution of forest/ landuse classes during 1959 and 1999 of the Barkot and its Peripheral Area.

S. No.	Forest/landuse change classes during (1959-1999)	Area (ha.)	Area (%)
1.	S/SM (Dense) to S/ SM/ MS (Medium)	1065.24	10.10
2.	S/SM (Dense) to S/ SM/ MS (Open)	41.92	0.40
3.	S/SM (Dense) to S/ SM/ MS (Degraded)	19.60	0.19
4.	S Dominated to Forest to S Dead	48.93	0.46
5.	S/SM (Medium) to S/SM/MS (Open)	18.78	0.18
6.	S (Open) to SM (Medium)	13.03	0.12
7.	M (Medium) to M (Open)	4.53	0.04
8.	M (Medium) to Scrub	0.06	0.00
9.	M (Open) to M (Medium)	43.63	0.41
10.	Scrub to S/SM/MS/M (Open)	31.98	0.30
11.	Forest to Plantation	712.40	6.73
12.	Forest to Agriculture	1205.62	11.40
13.	Forest to Rao	179.59	1.70
14.	Rao to Riverine	10.99	0.10
15.	Rao to Scrub	0.39	0.00
16.	Rao to Plantation	31.53	0.30
17.	Rao to Agriculture	151.59	1.43
18.	Agriculture to Rao	12.76	0.12
19.	No Change	6990.03	66.10

Source: Based on Remote Sensing & GIS

Three classes namely Misc. (Medium) to Misc. (Open), Sal (Medium) to scrub and Rao to Scrub showed very minor changes in the values i.e. 4.53 ha, 0.06 ha and 0.39 ha respectively. Because of this minimum values these classes are showing as the negligible percentage i.e. 0.00%.

4. Discussion

The change analysis during 1959-1999 (40 yrs) showed heavy destruction of Forest to Plantation and Sal/SM (Dense) to Sal/SM/MS (Open) classes contributing 11.40% and 10.10%, respectively. The above figures are in conformity that mixed deciduous forest, which acts as corridor for Sal, vanished. The forest cover decline was also worked out by Sedha & Dutt (1982) and Sharma & Sharma (1982).

Sal mortality area have also been delineated from the remote sensing data of the year 1999 and the area was 100.18 ha, while using spatial analysis or modelling revealed that four factors played important role regarding Sal mortality i.e. Elevated zone, Southern aspect, Slope (3-5%) and Eroded soil. Extraction through spatial analysis or modelling showed that Sal mortality prone area was nearly 32%, which is alarming.

Reduction of mixed deciduous forest encircling moist Sal especially in Barkot has ultimately affected the microclimate by way of increasing air temperature. This increase in air temperature since 1960 onward has created a stressful environment for Sal community in general and Sal in particular. Consequently as a result of stressful environment the drying of Sal has come into appearance since 1990 in the form of patch mortality.

There is an urgent need of the immediate action. So that suitable measurements can be taken in time. Planting some suitable broad leaved species including some soil binder grasses can reduce this very problem. Other major prescription is to reduce biotic interference.

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