AN ECOLOGICAL ANALYSIS OF THE CORBETT NATIONAL PARK LANDSCAPE, U.P. – A REMOTE SENSING GIS APPROACH.

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ABSTRACT

Remote sensing offers newer ways to conceptualize patterns in a landscape as capabilities in GIS and remote sensing technology rapidly expand. The results of remote sensing landscape level ecological analysis can be synthesized for understanding and addressing habitat management for biodiversity management. The present study was aimed at characterization of the Corbett National Park landscape UP, India based on the landscape ecological principles. Vegetation mapping has been carried out using IRS 1B satellite data through visual interpretation. Patch characterization parameters like fragmentation, patch density, juxtaposition, interspersion etc have been studied and presented in this paper. It is hoped that the findings of this study would be useful in planning and management of the Park.

Keywords: Remote sensing, GIS, Landscape, ecological analysis, patch.

INTRODUCTION

An understanding of the background, rates and causes of change in forested landscapes can help to guide conservation efforts on many scales. Forested landscapes are dynamic- they are always in transition and have always been in a state of constant change. Though the rates of change vary temporally and spatially, change underlines the natural stand of forests. The spatial configuration of the landscape elements can be attributed to a combination of environmental correlates and human forces (Forman and Godron, 1986). In some cases, the disturbance regime is dominated by natural fires (Heinselman, 1981) while in others, anthropogenic activities predominate (Sharpe *et al*, 1987). Hence, temporal changes in landscape patterns are dictated by a combination of natural and human influences, each of which operates at different spatial and temporal scales. The interaction between these leads to specific landscape dynamics. Measurement of changes on a temporal scale can be done by comparing sequential maps of the landscape.

STUDY AREA

The Corbett National Park covers an area of 520.82 sq. km. and is located in the Northern part of Uttar Pradesh at the foothills of the Himalayas in the districts of Pauri Garhwal and Nainital. Altitude ranges between 280 to 1138 metres and temperatures range between 5 to 44^{o} C.

The flora of the area mainly consists of *Shorea robusta* or sal (75%) followed by *Anogeissus latifolia, Acacia catechu, Terminalia tomentosa, Butea monosperma, Salmalia malabaricum, Lannea coromandalica, Garuga pinnata, Mallotus phillipensis, Helicteris isora* and *Dendrocalamus strictus* (on slopes and disturbed areas). *Dalbergia sissoo* is confined to the banks of sots. Islands of the Ramganga river contain *Dalbergia sissoo* mixed with *Acacia catechu* and occasional occurrence of *Bombyx ceiba.*

The grasslands or ‘chaurs’ support short and tall palatable and unpalatable grasses and are important for herbivores. The fauna of Corbett National Park is rich and diverse due to the abundance of water, food and cover. Endangered fish like

Mahseer, crocodiles and gharials flourish in the Ramganga river. Chitals, sambars, hogdeer, barking deer, gorals and elephant are the main herbivores while amongst the carnivores are tiger, leopard, jungle cat, leopard cat, jackal *etc*. Other animals are the sloth bear, porcupine, varanus and a variety of snakes.

MATERIALS AND METHODS

Data used:

1. Satellite data: IRS 1B FCC Date of pass 16-4-94, corresponding to toposheet nos. 53 K/10, K/14, K/15, O/2 and O/3.
2. Survey of India toposheets, scale 1:50000, Nos. 53 K/10, K/14, K/15, O/2 and O/3.
3. Relevant published material.
4. Park boundary (source Park authority).

Computer system:

UNIX - based ARC/INFO and PC – Based Arcview Software

Methodology: The Survey of India topographical maps (scale 1:50000) were used to prepare base maps. The major details with respect to important natural and man-made features like study area boundaries, rivers, roads, habitations, contours etc were traced onto the tracing film. The permanent features appearing in the Survey of India toposheets were matched to those in the satellite imagery prior to interpretation. IRS-1B LISS II satellite data was used for visual interpretation. This interpreted map was then digitized using ARC/INFO software and various patch characteristics were calculated using ARC/INFO and Arcview.

RESULTS AND DISCUSSION

1. **Vegetation mapping:** The forests of Corbett National Park can be broadly designated as sal forests (Plate 1). In most of the places, sal forms the dominant cover and occupies extensive areas in the lower stretches. It is quite distinct because of its unique spectral signature. The core area carries a dense

forest of predominantly sal. With the change in slope and aspect, the vegetation changes from sal to sal-mixed and through mixed sal finally to miscellaneous which give their own characteristic spectral signature.

Along the Ramganga river, and on the river islands are the stands of *Dalbergia sissoo* and *Acacia catechu*, known as khair-sissoo islands giving their own characteristic signatures on the data.

The 'chaurs' or the grasslands constitute an important and characteristic part of the part of the park, providing most of the grazing land for herbivores. 'Chaurs' are grassy blanks covering considerable areas. The important chaurs are Dhikala (partly inundated), Paterpani, Khinanauli, Phulai, Mohanpani, Bhadai and Bejrani. These are reversions of abandoned cultivation to wilderness and carry many herbs and short and tall grasses which serve as food for herbivores right from hog deer, barking deer and chital to elephant and cover for predators. The chaurs near the tourism complexes, due to biotic disturbance have weed infestation predominantly, *Lantana camara* and *Cannabis sativa*. *Cannabis sativa* is also extracted illegally in highly suitable areas for the prey-base posing a potential threat to their habitat. A large part of these chaurs has been lost by inundation and some portions remain submerged for part of the year. Yet, it was seen that the tough herbaceous flora that comes up provides shelter for herbivores which are seen flocking in high numbers on such chaurs. Besides, a luxuriant growth of castor bushes (*Ricinus communis)* has been seen to come up on sandy banks which forms a good food for herbivores. The total area considered in the study is 662.62 sq. km while the area of the Park is 520.82 sq. km. The additional area of 42 sq. km which forms the southern buffer of the park is under different disturbance regimes and hence has been deliberately included.

2. **Landscape Ecological Analysis:** The vegetation map prepared from the satellite imageries has been used for the analysis of the landscape elements of the corbett National park. Foe interspersion and porosity fixed grids of 3*3

have been used and that 15*15 for porosity and patch density. Interspersion, juxtaposition and patchiness images were prepared for the study area porosity and patchiness images were also generated for the sal or *Shorea robusta* forest.

2.1 Patch size or area: A contiguous area on the same landuse class or a non-linear surface area differing in appearance from its surroundings is called a patch.. Patch size is one of the most significant properties of the patch. The energy, biomass and the nutrient content in a patch has a direct relationship with its area. The species composition, biomass and productivity of a patch vary depending on the interior to edge ratio. Patch size analysis shows that they are significantly different in each vegetation type. Sal, Sal mixed, mixed sal, miscellaneous and Mixed bamboo/Bamboo mixed show higher patch size while pure bamboo shows the minimum average patch size. Area and other characteristics of the vegetation/landuse classes are given as Table 2.

2.2 Patch shape: Comparison of interior to edge ratio determines the patch shape of a landscape (Forman and Godron, 1986). There is a correlation between the shape and the wildlife habitat conditions in a given area (Marcot and Meretsky, 1983). Patches with less interior and more perimeter will have a shape index more than 1 as (that for a circular patch is = 1). The patch shape was calculated according to the following formula:

$$\mathbf{D_i = \sqrt{P/2(A*\pi)}}$$

Where, D_i = shape index of patch I

P = perimeter of the patch

and A = area of the patch.

Analysis of the patch size indicates that patches of river sand grass and bamboo show a less average patch size as compared to other forest types. The dominant forest types viz. Sal, Sal mixed, mixed sal, miscellaneous and Mixed bamboo/Bamboo mixed show a very high

index of shape demonstrating a very high irregularity of the edges of these patches.

2.3 Interspersion: Interspersion is the measure of the spatial intermixing of habitats/landuse and is calculated in a non-specific manner. A count of cells of dissimilar grey values of the grid cells around that of the middle grid cell pixel). A moving grid of 3*3 was used to calculate the interspersion. Analysis of interspersion image shows a fairly uniform distributed variation throughout the study area. However central part of the patch shows the homogeneity status, which is mainly due to the presence of pure sal and sal mixed forests. About 80% of the total area is intact. Only 0.35% of the total area shows a high interspersion. High interspersion values towards the southern part can be attributed to the presence of varying forest types which are located on a highly varying physiography.

2.3 Juxtaposition: Juxtaposition refers to the adjacency or proximity of different habitat types. Juxtaposition of the central grid cell is calculated by comparing the class of central grid with an adjacent grid (or direction) with respect to the central grid carries a weightage. A moving grid of 3*3 was used for the analysis of juxtaposition.

In this analysis, vegetation/vegetation map was regrouped and reclassified into 8 classes viz. Sal, Miscellaneous, Grass, Bamboo, Riparian, Plantation, Water body and Non Forest. Highest weightage was assigned to sal*sal while minimum weightage was assigned to Non forest*non forest combination. Juxtaposition gives a perspective in ultimately deriving DI (Disturbance Index). As can be expected, the highest juxtaposition index was given by sal forest which account for nearly 57% of the total area followed by the non forest class representing about 26% of the area.

2.5 Patch density (Porosity and patchiness): Porosity refers to the density of patches of all types (Slatkin, 1974). The interchange among plant species is influenced by low porosity. A disturbance in natural landscape increases the patch density and decreases matrix connectivity. In the present study porosity and patchiness were calculated using masks of 15*15 and 3*3 sizes respectively.

2.6 Patchiness: Patchiness refers to the density of patches of all types (Slatkin, 1974). Higher value for patchiness indicates a large number of patches or in other words a high fragmentation. Patch analysis shows a fairly uniform of patches over the entire area of the park. It was found that 92.5% of the area has low patch density. This can be attributed to the strict protection of the park and good management by the park authorities.

2.7 Porosity: Porosity refers to the density of the patches of a particular type. Porosity analysis of the sal forest type shows low porosity in the sal patches of the core or the central zone as compared to those at the boundary. This can be well correlated with the disturbance and terrain. High disturbance and rough terrain result in high porosity.

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Table 1. Interpretation key for the Corbett National Park landscape.

Forest

S.N	Type	Tone	Texture	Pattern
1	Sal (>70%)	Dark red	Smooth	Irregular
2	Sal-mixed	Medium red	Medium	Irregular
3	Mixed sal	Blackish red	Coarse	Irregular
4	Miscellaneous	Brownish red	Very coarse	Irregular
5	Grass	Yellowish white	Smooth	Irregular
6	Bamboo mixed/mixed bamboo	Pink	Medium-coarse	Irregular
7	Bamboo	Pale pink	Smooth	Irregular
8	Mixed grass/grass mixed	Greenish yellow	Smooth	Irregular
9	Scrub/blank	Blackish green	Coarse	Scattered
10	Riparian	Reddish brown	Smooth	Irregular
11	River sand with grasses	Yellowish white	Smooth	Irregular
12	Plantations	Dull red	Smooth	Irregular
13	Miscellaneous with bamboo and grass	Pinkish yellow	Coarse	Irregular
14	Agriculture	Pinkish red	Coarse	Regular to Irregular

Non-forest

S.N	Type	Tone	Texture	Pattern
1	Water body	Blue	Smooth	Linear to Irregular
2	Habitations	Bluish grey	Coarse	Irregular
3	Blank/Rocks	White/cyan/black	Smooth	Scattered
4	Abandoned villages	Pinkish red	Smooth	Irregular
5	Dry river bed	Whitish blue	Smooth	Irregular
6	Dam	Pale white	Smooth	Linear

Table 2. Patch characteristics of the Corbett National Park landscape.

S.N.	CATEGORY/CLASS	No of Patches	Area sq.km.	Average area	% area	Peri-meter	Avg patch shape
1	Sal	142	86.53	0.61	16.61	543.96	16.48
2	Sal mixed	82	104.07	1.27	19.98	696.16	19.24
3	Mixed sal	71	120.00	1.69	23.04	836.50	21.53
4	Miscellaneous	95	95.12	1.00	18.26	631.40	18.25
5	Grass	57	13.16	0.23	2.53	148.00	11.50
6	Mix grasses/grass mix	71	8.43	0.12	1.62	140.14	13.61
7	Bamboo	1	0.03	0.03	0.01	1.10	1.79
8	Misc with bamboo & grass	23	9.08	0.39	1.74	81.70	7.64
9	River sand grass	15	2.31	0.15	0.44	43.53	8.07
10	Bamboo mis/Mix bamboo	19	28.31	1.49	5.44	193.30	10.24
11	Scrub	13	1.72	0.13	0.33	26.11	5.61
12	Riparian	22	2.59	0.12	0.50	37.50	6.57
13	Plantations	4	3.80	0.95	0.73	17.97	2.60
14	Water body	14	37.43	2.67	7.19	261.14	12.03
15	Blank/rocks	9	0.62	0.07	0.12	12.37	4.43
16	Abandoned villages	2	0.21	0.11	0.04	3.87	2.38
17	Habitations	2	2.15	1.08	0.41	15.33	2.95
18	Agriculture	2	0.20	0.10	0.04	4.46	2.81
19	Dry river bed	14	8.99	0.64	1.73	191.55	18.01
20	Dam	2	0.24	0.12	0.05	3.55	2.21
	Total	660	524.99		100.00	3889.93	47.86

Plate 1. Vegetation/landuse map of Corbett National Park