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Bio-Diversity Characterizations using Remote Sensing & GIS Techniques: A Case Study of Dalma Wild Life Sanctuary, East Singhbhum

V.S.S.Kiran[1,*] and Pankaj Kumar[2]

[1]Lead Faculty, IIC Academy at IIC technologies Ltd.

[2]Geospatial Application engineer, RSI Softech India PvtLtd.

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ABSTRACT

Tropical forests are more diverse than the other terrestrial ecosystems by possessing greater number of life forms. It is widely accepted that the identification and prioritization of important centers of biodiversity are necessary at both the national and the global scale for conservation action. Indian subcontinent, with diverse bio-climatic regions supports one of the richest flora and fauna. The increased human pressure and consequent effects on the landform and land use changes has a profound effect on the present vegetation and the biodiversity. The present study is one of the important parts of Gangetic plains whose flora is unique to India because of the tropical drier and occasionally humid climate, it provides the information on the present status of biodiversity of the forests of Dalma in Jharkhand state through analyses of phyto-sociology and remote sensing data, as to their structure and compositional variations correlated with topography, fragmentation and threats operating, which may be useful for planning and monitoring sustainable management of forests and conservation of biodiversity. The objective of the present study is to present initial information of vegetation through the application of RS and GIS techniques along with a phytosociological analysis of the forests for their diversity and it's based on three major approaches i.e. Remote Sensing, GIS and Ecology.

Introduction

The forest Dalma in Jharkhand is one of the important parts of Gangetic plains whose flora is unique to India because of the tropical drier and occasionally humid climate. India is rich in endemic flora and fauna. The endemism of Indian biodiversity is high. The central India and part of east Indian forest -like Dalma is very significant due to their rich mineral resource and luxurious growth of Shorearobusta, the pioneer species and associated species –like Adina cordifolia, Terminaliatomentosa etc, constituting the main timber source to most part of the northern India. More or less hilly topography covered by thick forests provides unique ecosystems for biological resources, which play active role in the sustenance of diversity of species. The ground with intensive grazing fire and inadequate vegetative cover lead to high degree of run off which often into flood disrupting the main communication between Chaibasa and Jamshedpur. The forests as well on these accounts, are derived of the benefit of rain water which otherwise would have increased the moisture status and aided significantly in maintaining a much better forest crop and luxuriant ground flora. The tract is gullied particularly along the banks of the rivers and sheet erosion is common throughout. The gully formation has been amply aided by the abuse of vegetative cover of the hills and undulating plains. Studies on inventorying and monitoring were scarce for Chotanagpur region. The only documentation that too, quantitative were found in forest department records of various forest divisions. Satellite remote sensing provides a means to obtain a synoptic view of forest cover and their condition on real time basis. It also saves both time and effort to discriminate spatial features. Phyto-sociology of the forest cover, understanding of spectral and temporal responses of vegetation, coupled with the digital image processing techniques and finally incorporation of GIS have brought about a profound benefits of the application of satellite remote sensing data in forest inventory and mapping (Roy *et al*, 1997). The increased human pressure and consequent effects on the landform and land use changes has a profound effect on the present vegetation and the biodiversity. The present study is a project work on preliminary basis. The objective of the present study is to present initial information of vegetation through the application of RS and GIS techniques together with a phytosociological analysis of the forests for their diversity. The study is basically based on three major approaches i.e. Remote Sensing, GIS and Ecology.

Study Area:

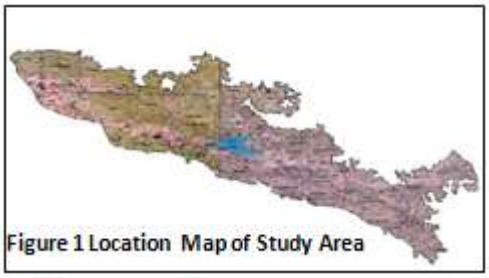
The study area has been taken is Dalma forest in the Dalma hills, Jharkhand state. It is located on 23˚01'00" North to 22˚42'00" North latitude and 86˚00'00" East to 86˚30'00" East longitudes. It has an average elevation of 3000 feet's. Study area falls within the Patamda and Saraikella Forest division and its dominated by a high point at 926 meters on Dalma peak form the northern limits of Chotanagpur plateau. The soil type of study area is covering is loamy and sandy loamy and clay loamy. Temperature of the study area is recorded is as high as 115° F and the diurnal range of temperature is between 20° F to 40° F. The annual average rainfall of the districts is 1433 mm.

Methodology: Dalma forest region is thick, evergreen and with deciduous trees, for this the satellite images of both Landsat-7 Etm+ and PAN Image are carefully observed in the image processing software to understand the relative tonal variation, texture, tone and associated feature of image elements. Various Remote Sensing enhancement techniques and band

Tele:

E-mail addresses: sambasivakiran@yahoo.com

combinations techniques are applied for the visual interpretation. Landset-7 Etm+ data has 9 band including PAN, of which green (0.52-0.60µm), red (0.63-0.69µm) near-infrared (0.76-0.90µm) and mid-infrared (1.55-1.75µm) are utilized here in analysis. The false colour composite imageries have been prepared by combining three different bands in blue, green and red color. Two parameters have been selected to prepare FCCs. The Combination of (band 2, 3&4) green, red and near-infrared band has been done in three ways. In the first case bands have been fused as BGR (Standard FCC). In the second case, bands have been fused as GRB and in the third case as RBG. The Combination of (band 3, 4 &5) red, near-infrared and mid-infrared band has been done in three ways also. In the first case bands have been fused as BGR. In the second case bands have been fused as BRG and in the third case bands have been fused as RGB. FCC image is showing in Figure 2.



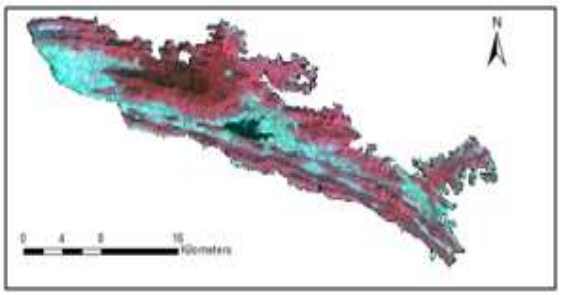


Figure 1: FCC Composed Image

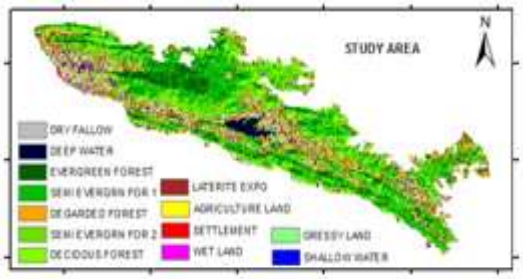


Figure 3. Unsupervised Classification of LULC

Interpretation keys for visual interpretation: Visual interpretation of the image has been done on the basis of tone, texture, and pattern of the picture elements or pixels (Table: 1). Distributions of same tonal and brightness of pixels, *viz.* red for the vegetation on the image are observed thoroughly. The association and extent of tone criteria are also taken into consideration. The size of the same kind of pixel distribution and their location has been determined. Tonal variations of pixels on the image are verified or determined by ground verification with the help of GPS and corresponding land cover features have been established.

Unsupervised Classification: Unsupervised Classification of the image was done using ERDAS Imagine. Twenty classes tentatively determined to understand the ground feature spectrally. The range of digital numbers (DNs) of respective tone on the classified image is obtained and the tonal distribution, position, and extent are correlated with spectral property of spatial feature tentatively.

Supervised Classification: Supervised classification of multispectral image is performed by the selection of proper number of training sites, which were determined during ground verification through GPS and by the understanding of spectral property of the ground feature concerned. In the standard false colour composite image the variation of colour tone was correlated with ground and the degrees of hue variation and type of tone is treated as respective class and is given an attribute by incorporating a colour code. After mentioning the training site Maximum Likelihood Classifier algorithm was used to classify the image. About thirteen broad classes/categories have been assigned for the classification.

Reconnaissance & Survey: During reconnaissance survey major vegetation types and a few prime localities of characteristic types are taken into consideration. Generally survey was performed along the roads, major drainage, hilltops and settlements. Interaction has been done with forest department and workers of Wild Life Sanctuary and people of the respective area for the information on drainage, plant resources and location and extent of people's movement along the forest area. GPS survey is mainly to collect the sample points of study area. Sampling of GPS points for quadrate plots were laid randomly in different region of semi evergreen and deciduous forest mainly. There are 10 to 12 plots were laid in different regions of the forests. The data obtain in the samplings is to some extant reflection of actual scenario of the ground. At each sample point the circumference at breast height (cbh) of all tree species were recorded. The individuals with cbh> 30 cm. is considered as tree and with > 17 cm. and < 30 cm. cbh as saplings of tree species.

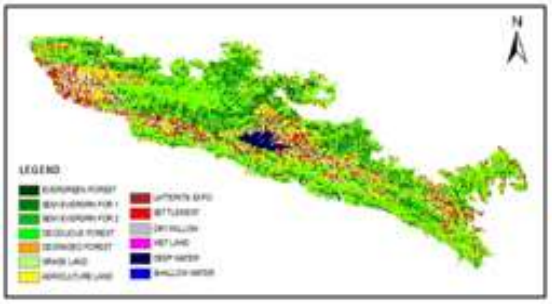


Figure 3: Supervised Classification of LULC

Phytosociological Work: Number of individual species were recorded to determine their frequency, density, abundance, basal area etc. Finally, the data were analysed for the determination of Importance Value Index (IVI), which is the sum of the relatives of frequency, density and dominance (Mueller-Dombois and Ellenberg, 1974). Frequency is the degree of dispersion of an individual species in a community. It expresses the percentage and represents the chance of occurrence of species in a given habitat.

$$\text{Frequency} = \frac{\text{Total no. of quadrates in which species occur} \times 100}{\text{Total number of quadrate studie}}$$

Relative frequency is the percentage frequency of a particular species in comparison to total frequency of all other species.

$$\text{Relative Frequency} = \frac{\text{Frequency of Species X 100}}{\text{Sum of Frequency of all Species}}$$

Density indicates the abundance of a species in a unit area. Density of a species expresses the numerical strength in a community. This parameter gives an idea about the dominance and rarity of a species and is also an indicator of the standing biomass and productivity of the region (Ambasht*et al.*, 1995).

$$\text{Density (Per quadrate)} = \frac{\text{Total no. of individuals of the species} \times 100}{\text{Total number of quadrate studied}}$$

Table 1: Visual interpretation of the standard false color composite satellite image

Sl	CoverType	Tone/Color	Texture	Pattern	Size	Location
1	Evergreen Forest	Medium To Bright Red	Course	Non Contiguous Patches	Small To Large	Distributed Along The Slopes, Gullies And Hilltop.
2	Semi-Evergreen Forest-1	Dark Red To Light Blackish Red	Rough	Noncontiguous Throughout	Small To Large	Distributed Throughout The Island
3	Semi-Evergreen Forest-2	Moderately Blackish Red	Rough	Noncontiguous Patches Throughout	Small To Large	Distributed Throughout The Island
4	Deciduous Forest	Blackish Red	Rough	Non Contiguous	Small To Large	Distributed In Flat Topography
5	Open/Degraded Forest	Light Pinkish/ Blackish Red	Rough	More Or Less Contiguous Narrow Strip	Small	Distributed Along The Sides Of Roads And Settlements
6	Grass Land	Light Green, Cyan And Pinkish	Rough	Non Contiguous	Small	Situated In More Or Less Flat Topography And Adjacent To Roads And Creeks
7	Agriculture Land	Light Pink To Dark Pink	Rough	Non Contiguous	Medium	Distributed Adjacent To Settlement
8	Settlement	Cyan And Blackish Red	Moderate Rough	More Or Less Contiguous	Small	Situated In Flat Topography
9	Dry Fallow Land	Whitish To Light Gray	Fine	Non Contiguous	Small	
10	Laterite Exposure	Greenish Brown	More Or Less Smooth	Non Contiguous	Small	Distributed In Patches Along The
11	Wet Land	Light Cyan	Less Smooth	Contiguous	Small	
12	Shallow Water	Bright Blue	More Or Less Smooth	Contiguous	Small	
13	Deep Water	Blackish Blue	Moderate	Contiguous	Large	

Table 2: Philological Classes

Sl.	Species	Frequency	Density	Rel.Density	Rel.Freq	Rel.Dom	IVI
1	Acacia auriculiformis	11.1	11.1	0.29	1.32	0.005	1.62
2	Alangiumlamarckii	5.5	5.5	0.14	0.65	0.102	0.9
3	Albizzia stipulate	5.5	5.5	0.14	0.65	0.625	1.42
4	Anogeissuslatifolia	22.2	61.1	1.59	2.65	4.672	8.92
5	Antidesmaghaesembilla	5.5	5.5	0.14	0.65	0.025	0.82
6	Bassialatifolia	38.8	105.5	2.75	4.63	2.81	10.2
7	Bauhinia vahalii	11.1	27.7	0.72	1.32	0.659	2.7
8	Brideliaretusa	11.1	11.1	0.29	1.32	0.154	1.77
9	Buchananialatifolia	44.4	88.8	2.32	5.3	2.637	10.2
10	Casearіagraveeolens	22.2	27.7	0.72	2.65	0.584	3.96
11	Casеariatomentosa	11.1	50	1.3	1.32	0.924	3.55
12	Cassia siamia	5.5	5.5	0.14	0.65	0.071	0.87
13	Cedrelatoona	5.5	11.1	0.29	0.65	0.402	1.34
14	Cochlospermumgossypium	33.3	44.4	1.16	3.97	1.89	7.02
15	Cleistanthuscollinus	16.6	38.8	1.01	1.98	0.441	3.43
16	Cleistanthuspatulus	11.1	11.1	0.29	1.32	0.12	1.73
17	Dilleniapentagyna	5.5	5.5	0.14	0.65	0.182	0.98
18	Diospyrosmelanoxylon	50	105.5	2.75	5.97	2.507	11.23
19	Emblicaofficinalis	22.2	50	1.3	2.65	0.924	4.88
20	Eugenia jambolana	11.1	16.6	0.43	1.32	0.663	2.42
21	Ferroniaelephanta	22.2	27.7	0.72	2.65	0.12	3.49
22	Ficushispida	5.5	5.5	0.14	0.65	0.032	0.83
23	Flacourtiacranulatum	11.1	11.1	0.29	1.32	0.062	1.67
24	Flacourtiaramontchii	11.1	38.8	1.01	1.32	0.369	2.7
25	Gardenia gammifera	11.1	111.1	2.9	1.32	0.356	4.58
26	Grewiatiliaefolia	5.5	5.5	0.14	0.65	0.045	0.84
27	Helicteresisora	27.7	66.6	1.74	3.3	1.402	6.45
28	Holarrhenaantidysenterica	33.3	116.6	3.04	3.97	1.268	8.29
29	Lagerstroemia parviflora	16.6	16.6	0.43	1.98	0.708	3.12
30	Morindacitrifolia	5.5	44.4	1.16	0.65	0.178	1.99
31	Odinawodier	38.8	88.8	2.32	4.63	1.989	8.94
32	Oroxylonindicum	5.5	22.2	0.58	0.65	0.642	1.87
33	Pterocarpusmarsspium	22.2	38.8	1.01	2.65	1.618	5.28
34	Randiadumetorum	16.6	100	2.61	1.98	0.205	4.8
35	Semicarpusanacardium	22.2	77.7	2.03	2.65	1.793	6.47
36	Shorearobusta	94.4	1955.5	51.11	11.27	61.11	123.5
37	Soymidafebrifuga	22.2	72.2	1.88	2.65	1.042	5.58
38	Ptereospermumptetragonum	16.6	111.1	2.9	1.98	2.054	6.94
39	Terminaliabelarica	11.1	16.6	0.43	1.32	0.648	2.4
40	Terminaliachebula	22.2	38.8	1.01	2.65	1.278	4.94
41	Terminaliatomentosa	33.3	88.8	2.32	3.97	2.433	8.73
42	Xyliadolabriformis	5.5	11.1	0.29	0.65	0.205	1.15
43	Zizyphus jujube	11.1	33.3	0.87	1.32	0.008	2.2
44	Zizyphusoenoplia	11.1	27.7	0.72	1.32	0.007	2.05

Table 3: Philological Classes

Sl.	Species	Frequency	Density
1	Holarrhenaantidysenterica	33.3	116.6
2	Gardenia gammifera	11.1	111.1
3	Ptereospermumptetragonum	16.6	111.1
4	Bassialatifolia	38.8	105.5
5	Diospyrosmelanoxylon	50	105.5
6	Randiadumetorum	16.6	100
7	Buchananialatifolia	44.4	88.8
8	Odinawodier	38.8	88.8
9	Terminaliatomentosa	33.3	88.8
10	Semicarpusanacardium	22.2	77.7
11	Soymidafebrifuga	22.2	72.2
12	Helicteresisora	27.7	66.6
13	Anogeissuslatifolia	22.2	61.1
14	Casearіatomentosa	11.1	50
15	Emblicaofficinalis	22.2	50

Relative density shows the percentage of representation of the species in terms of a number of individuals in comparison to all other species in a community. They are calculated as follows.

$$\text{Relative Density} = \frac{\text{Density of a species x100}}{\text{Sum of density of all the species}}$$

It is the number of individuals of a species occurring in all the sampled area of a particular vegetation type. This parameter fairly gives an idea about the commonality of a species in a habitat under consideration.

$$\text{Abundance} = \frac{\text{Total no. of individuals of species occuring x100}}{\text{Total number of quadrates in which species occur}}$$

Relative abundance is the ratio of the species to number of quadrate studied for a given vegetation type. It is calculated as follows:

$$\text{Relative Abundance} = \frac{\text{Abundance of a species x100}}{\text{Sum of the abundance of all species}}$$

Basal Area is covers the $\mathbf{C2/4\pi}$.

Where C is cbh (Circumference at breast height) for trees andcgh(Circumference at ground level)for shrubs.

Sum of basal cover of individual plants of a species will yield total stand basal cover of that species.

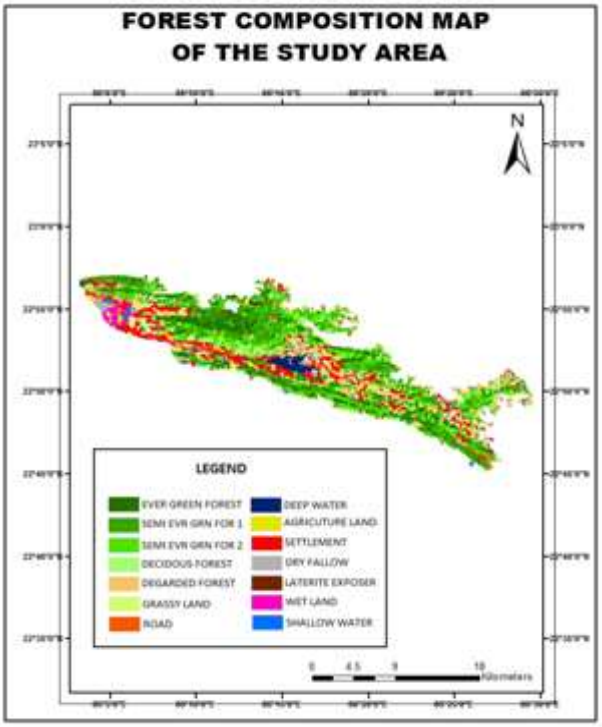


Figure 5: Forest Map

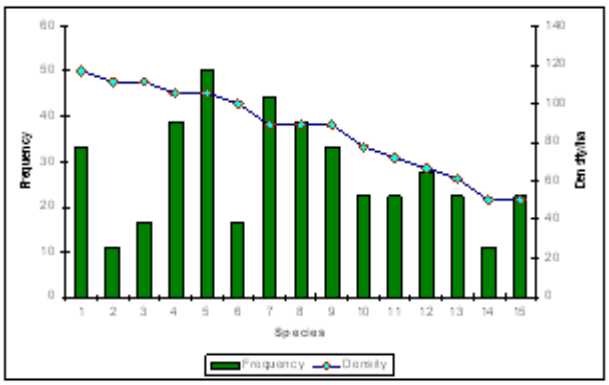


Figure 6: Frequency and Dencity of lu/lc classes

Importance value index (IVI): Importance value index (IVI) show overall picture of a species and indicates their importance in the plant community. It is calculated by summing up the relative values of frequency, density and dominance (Mueller-Dombois and Ellenberg, 1974). This value helps in understanding the sociological structure of a species in a community.

$$\text{IVI} = \text{Relative Frequency} + \text{Relative Density} + \text{Relative Dominance}$$

In the respective forest frequency and density of species are compared to determine their distributional pattern over the area. Density-rank curve is prepared to show the dominant subdominant and associate species over the area and their distribution pattern.

Results & discussions:

Based on the above analysis and result we can divide into two groups one is land use and land cover mapping of forest area and Phytosociological work of the study area. The land use and land cover results determine figure 5. And the Phytosociological work determines the table 2, 3 and figure 6.

Conclusion:

The forest types of Dalma Wildlife Sanctuary are invariably dry deciduous type with exception of evergreen patches in the hill top and some water shade zone. The east-west orientated steep slope with dense mixed forests somewhere is inaccessible for vegetation exploration and sampling. Remote Sensing data and GIS provide adequate tools to analyses the forest non-forest cover, also provides present status of the forest. Multispectral Etm+ image itself do not provide sufficient spectral resolution for fine level classification of forest and so fusion of Etm+ and PAN has been done to resolve spectral property. In addition with highly resolved image NDVI assist to discriminate the healthy and poorly developed forest types. Other techniques like unsupervised and supervised classification help to demarcate the forest boundary and by this way the final land use- land cover

map is prepared. In addition with several RS analyses ground verification is done. During field work quadrate samplings has been done. Due to constrain of time and unavailability of other facilities the limited number of samplings have been done. In the samplings tree species and their number and GBH (girth at breast height) is measured. Plant identification and other assistance during ecological analysis is assisted by expertise personnel. So it can be rightly said that the RS and GIS tools successfully usher to prepare the land use- land cover map on accurate basis.

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