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APPLICATION OF REMOTE SENSING TO STUDY THE ENVIRONMENT AND ECOSYSTEM. A CASE STUDY FOR PRIMARY ANALYSIS OF VEGETATION

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ABSTRACT

Four major types of forest vegetation *viz*., moist sal forest, moist mixed forest, dry mixed forest and seral vegetation were identified at the Kanha National Park using remote sensing data products *viz*., satellite imageries (Landsat - TM - FCC 1:50,000 scale) and aerial photographs (B/W panchromatic 1:10,000 scale). Primary analysis of the vegetation has revealed that sal (*Shorea robusta*) was more abundant (60.13) with highest importance value index (IVI) of 180.11 followed by *Terminalia tomentosa* in moist sal group of forests in valleys. *T.tomentosa* was found to be a close associate of sal. In moist miked forests (on hill slopes), *I. tomentosa* were abundant with high frequency, density and highest IVI (94.88). Total absence of sal and less abundance of *I. tomentosa* were the significant aspects in characterizing the dry mixed forest. In dry mixed forest, *Boswellia serrata* and *Lagerstroemia parviflora* are the most abundant species constituting the ridge vegetation. The seral vegetation was dominated by *Butea monosperma* and *L. parviflora* which were invading the grasslands in pure patches, respectively, into meadows and dadar grasslands.

KEY WORDS : Remote sensing, ecosystem, environment, vegetation analysis, phytosociology, satellite imageries, aerial photographs

Vegetation analysis is paramount importance in understanding about our forest ecosystem and their environment. The various components of forest ecosystem interacts either directly or directly, in such a way that all the components together perform some system function. Forest fire, illegal felling or large scale deforestation in tropical forest area will certainly affect our forest ecosystem. Because of these unexpected biotic and abiotic events the phytosociological settings of natural forest ecosystem gets disturbed. Primary analysis of forest vegetation aims at quantitative description of phytosociology and ecology of plant communities. This is not an easy job if we go for conventional methods of vegetation analysis considering the vastness and inacessibility of tropical forest environment. This becomes an uphill task especially if we want to have vegetation analysis of particular forest ecosystem at very frequent intervals. In the light of these conditions, remote sensing as a tool for vegetation analysis had gained momentum only a decade back by virtue of its synoptic coverage of vast terrain and repeatability (Roy, 1983). The present study was undertaken to delineate the different types of forest as well as to have primary analysis of forest vegetation using remote sensing technique.

MATERIALS AND METHODS

The study area comprised part of the Kanna National Park ($80^{\circ}\ 26^{1}$ to $80^{\circ}\ 30^{1}$ E longitude and $22^{\circ}\ 07^{1}$ to $22^{\circ}\ 22^{1}$ N latitude). Remote sensing data products viz., satellite imageries and aerial photographs pertaining to the study area were obtained from the National Remote Sensing Agency (NRSA), Hyderabad. The boundary of the study area was marked using survey of India toposheets (1:50,000 scale). The satellite imageries (Landsat -TM - FCC 1:50,000 scale) were used to identify visually the broad physiognomic units of forest vegetation as it was unable to give 3- D view of the objects in the study area. Whereas the aerial photographs (B/W panchromatic 1 : 10,000 scale) were used to identify specific vegetation or forest types (Champion and Seth, 1968) within each of the broader physiognomic units identified on satellite imageries. Informations such as stand height, crown diameter, crown density, slope of the terrain, topstorey and understorey vegetation etc., of the study area were also obtained through aerial photographs in view of its 3-D effect. 31 sample plots were marked on aerial photographs for various forest types following proportional stratified random sampling technique. These sample plots were located on the ground (study

area) for collecting ground truth besides checking for the correctness of the already interpreted / identified details on aerial photographs and satellite imageries. Ground truth was collected from sample plots of 0.1 ha in the field (forest area).

Data on number of tree species, tree height, diameter at breast height (DBH), basal area, topstorey and understorey species etc., were collected from a quadrate of 10 m x 10 m in each sample plot in the field. The whole spectrum of work was done systematically in three phases *viz.*, pre-field, field and postfield work (Kuchlex, 1967). Primary analysis of vegetation interms of abudance, density, frequency, basal area, relative frequency (RF), relative density (RD), relative basal area (RBA) and importance value indek (IVI) were done using the sample plot data following the procedures adopted by Phillips (1959). The abudance/ frequency ratio (Ab/F) suggested by Whitford (1948) as a measure of contagiousness or dispersion was also worked out.

RESULTS AND DISCUSSION

Four major types of vegetations *viz.*, sal forest, moist mixed forest, dry mixed forest and seral vegetation were identified in the study area from the remote sensing data products *viz.*, satellite imageries and aerial photographs based on the physiognomical variations. The primary analysis

Table 1. Primary analysis of vegetation

Group : Moist Sal Forest Plot size : 0.1 ha No.of plots studied : 8

Name of the species	No.of tress	Av. DBH (cm)	No.of Plots occured	Abun-dance	Density	Frequ-ency (%)	Basal area (m2)	R.F.	R.D.	R.B.A	I.V.I.	Ab/F ratio
1	2	3	4	5	6	7	8	9	10	11	12	13
Top Canopy												
Shorea robusta	481	22.20	8	60.13	60.13	100.00	18.620	13.79	78.72	87.60	180.11	0.60
Terminalia tomentosa	28	18.91	5	5.60	3.50	75.00	0.815	8.62	4.58	3.84	17.04	0.07
Syzigium cumini	2	14.50	1	2.00	0.25	12.50	0.033	1.72	0.33	0.16	2.21	0.16
First storey												
Ougeinia oojeinensis	20	15.58	3	6.67	2.5	37.5	0.391	5.17	3.27	1.84	10.22	0.18
Lagerstroemia parviflora	8	17.00	2	4.00	1.00	25.00	0.189	3.44	1.31	0,89	5.60	0,16
Diospyros melanoxylon	8	16.19	3	2.67	1.00	37.5	0.151	5.17	1.31	0.71	7.19	0.07
Anogeissus latifolia	6	14.43	4	1.50	0.75	50.00	0.099	6.89	0.98	0.47	8.34	0.03
Ghirri	11	13.99	4	2.75	1.38	50.00	0.063	6.89	1.80	0.30	8.99	0.06
Sterospermum suavelens	6	15.55	3	2.00	0.75	37.5	0.116	5.17	0.98	0.55	6.61	0.05
Emblica officinalis	5	15.46	3	1.67	0.63	37.5	0.138	5.17	0.92	0.86	6.95	0.04
Others												
Bauhinia retusa	1	10.00	1	1.00	0.130	12.5	0.008	1.72	0.16	0.04	1.92	0.08
Terminalia chebula	1	20.00	1	1.00	0.13	12.5	0.131	1.72	0.16	0.15	2.03	0.08
Coccinia grandis	1	11.50	1	1.00	0.13	12.5	0.010	1.72	0.16	0.05	1.93	0.08
Careya arborea	3	13.00	3	1.00	0.375	37.5	0.041	5.17	0.49	0.19	5.85	0.03
Barga	1	15.00	1	1.00	0.13	12.5	0.018	1.72	0.16	0.08	1.96	0.08
Buchanania lanzan	2	12.80	1	2.00	0.25	12.5	0.026	1.72	0.33	0.12	2.17	0.16
Madhuca longifolia	2	16.13	2	1.00	0.25	25.0	0.041	3.44	0.33	0.19	3.96	0.04
Bauhinia vahlii	1	9.55	1	1.00	0.13	12.5	0.007	1.72	0.16	0.03	1.91	0.08
Bhadur	1	12.41	1	1.00	0.13	12.5	0.012	1.72	0.16	0.06	1.94	0.08
Bhirri	8	15.42	2	4.00	1.00	25.0	0.150	3.44	1.31	0.71	5.46	0.16
Lannea caromandelica	3	14.35	2	1.50	0.38	25.0	0.049	3.44	0.49	0.23	4.16	0.06
Bassa	1	14.00	1	1.00	0.13	12.5	0.015	1.72	0.16	0.071	1.95	0.08
Bauhinia malabaricum	3	13.16	1	3.00	0.38	12.5	0.048	1.72	0.49	0.23	2.44	0.24
Kydia calycina	1	10.82	1	1.00	0.13	12.5	0.009	1.72	0.16	0.04	1.92	0.08
Saccopetalum tomentosum	2	17.10	2	1.00	0.25	25.0	0.046	3.44	0.33	0.22	3.99	0.04
Wendlandia heynei	1	12.00	1	1.00	0.13	12.5	0.011	1.72	0.16	0.05	1.93	0.08
Mitragyna parvilora	2	17.75	1	2.00	0.25	12.5	0.049	1.72	0.33	0.23	2.28	0.16
Bauhinia racemosa	2	12.50	1	2.00	0.25	12.5	0.024	1.72	0.33	0.11	2.16	0.16

RF = Relative frequency; RD = Relative density; RBA = Relative basal area; IVI = Importance value index; Ab = Abundance; F = Frequency

pertaining to these vegetations are furnished in Tables 1 to 4.

Sal forest

The sal was more abundant (60.13) followed by *Ougenia* (6.67), *Terminalia* (5.6) and *Lagerstroemia* (4.0). The frequency of sal was highest (100%) followed by *Terminalia* (75%) *Anogeissus* and *Ghirri* (50%), *Ougenia, Diospyros, Emblica, padar* and *Kumbhi* (37.5%). The IVI of the sal was the highest (180.11) followed by *Terminalia* (17.04) and *Ougenia* (10.22).

The top canopy was constituted by Sal, Terminalia and Jamun. But Terminalia was observed as very close associate of sal which was evident from the abundance, freequency, and IVI of Terminalia. Though Jamun was observed in the top canopy, it was not frequent as that of Terminalia which was confirmed by less abundance (2.0), low frequency (12.5), very low IVI (2.21) and irregular dispersion of Jumun (Ab/F ratio was 0.16)

The first storey was constituted by some prominent species *viz., Anogeissus, Ghirri, Ougenia, Diospyros, Sterospermum, Emblica, Kumbhi, Lagerstroemia* etc., besides other

Table 2. Primary analysis of vegetation

Group: Moist Mixed Forest Plot size : 0.1 ha No.of plots studied:7

Name of the species	No.of trees	Av. DBH (cm)	No.of plots occured	Abun-dance	Density	Frequ-ency (%)	Basal area (m2)	R.F.	R.D.	R.B.A	I.V.I.	Ab/F ratio
1	2	3	4	5	6	7	8	9	10	11	12	13
Top Canopy												
Terminalia tomenosa	148	19.00	7	21.14	21.14	100.00	4.31	10.00	41.46	43.42	94.88	0.21
Shorea robusta	22	23.00	2	11.00	3.14	28.57	0.94	2.86	6.16	9.47	18.49	0.39
Diospyros melanoxylon	18	17.51	5	3.60	2.57	71.43	0.46	7.14	5.04	4.63	16.81	0.05
Anogeissus latifolia	6	14.58	3	2.00	0.86	42.86	0.103	4.28	1.68	1.04	7.00	0.05
Bridelia retusa	6	19.58	2	3.00	0.86	28.57	0.122	2.86	1.68	1.21	5.75	0.11
First storey												
Lagerstroemia pariflora	25	13.66	4	6.25	3.57	57.14	0.37	5.71	7.00	3.72	16.43	0.11
Ougeinia oojeinensis	28	13.66	4	6.25	3.57	57.14	0.37	5.71	7.00	3.72	16.43	0.11
Flacourtia indica	5	12.3	1	5.00	0.71	14.29	0.06	1.43	1.40	0.60	3.43	0.35
Bahuinia retusa	11	25.32	2	5.50	0.57	28.57	0.56	2.86	3.08	5.64	11.58	0.19
Terminalia chebula	14	15.32	4	3.50	2.00	57.14	0.27	5.71	3.92	2.72	12.35	0.06
Emblica officinalis	18	14.97	6	3.00	2.57	85.71	0.33	8.57	5.04	3.32	16.93	0.04
Others												
Careya arborea	4	19.25	2	2.00	0.57	28.57	0.120	2.86	1.12	1.20	5.18	0.07
Antidesma diamdurm	1	13.00	1	1.00	0.14	14.00	0.013	1.43	0.28	0.13	1.84	0.07
Grewia tiliaefolia	4	18.00	2	2.00	0.57	28.57	0.130	2.85	1.12	1.31	5.28	0.07
Zizyphus xylophora	6	17.00	3	2.00	0.86	42.86	0.095	4.28	1.68	0.96	6.92	0.05
Butea monosperma	1	20.50	1	1.00	0.14	14.29	0.033	1.43	0.28	0.33	2.04	0.07
Syzigium cumini	11	24.87	3	3.67	1.57	42.86	0.650	3.08	6.55	13.91	0.09	
Chloroxylon swietenia	2	10.75	1	2.00	0.29	14.29	0.018	1.43	0.56	0.18	2.17	0.14
Buchnania lanzan	3	17.00	2	1.50	0.43	28.57	0.070	2.85	0.84	0.70	4.39	0.05
Madhuca indica	3	18.33	2	1.50	0.43	28.57	0.080	2.85	0.84	0.80	4.49	0.05
Stereospermum suavelens	2	20.00	1	2.00	0.29	14.29	0.063	1.43	0.56	0.63	2.62	0.14
Saccopetalum tomentosum	1	22.00	1	1.00	0.14	14.29	0.039	1.43	0.28	0.38	2.19	0.07
Lannea caromandelica	1	15.25	2	2.00	0.57	28.57	0.073	2.85	1.12	0.73	4.70	0.07
Bauhinia malabaricum	1	19.00	1	1.00	0.14	14.29	0.028	1.43	0.28	0.29	2.10	0.07
Casearia graveolens	2	18.00	2	1.00	0.29	28.57	0.060	2.85	0.56	0.60	4.01	0.04
Bhormal	1	18.38	1	1.00	0.14	14.28	0.130	1.43	0.28	1.31	3.01	0.07
Pterocarpus marsumpium	1	12.00	1	1.00	0.14	14.28	0.010	1.43	0.28	1.10	1.81	0.07
Mendha	1	10.50	1	1.00	0.14	14.28	0.009	1.43	0.28	0.09	1.26	0.07
Mallotus philippensis	5	17.20	1	5.00	0.71	14.28	0.120	1.43	1.40	1.21	4.04	0.35
Papar	3	11.67	1	3.00	0.43	14.28	0.030	1.43	0.84	0.30	2.57	0.21

RF = Relative frequency; RD = Relative density; RBA = Relative basal area ; IVI = Importance value index; Ab = Abundance, F = Frequency

miscellaneous species (Table 1). Bamboo, grass, shrubs, seedlings of Sal, *Terminalia, Diospyros, Lagerstroemia* etc., forms ground storey.

Moist mixed forest

The top canopy was constituted by Terminalia, Sal, Diospoyros, Anogeissus and *Bridelia retusa*. Among these species Terminalia was more abundant (21.14) with highest frequency (100 percent) and density (21.14) and ultimately registered highest IVI (94.88), followed by Sal. *Diospyros, Anogeissus* and *Bridelia retusa*.

The first storey comprised of prominent species *viz., Lagerstroemia, Ougenia, Terminalia chebula, Bauhinia retusa* and Emblica besides other miscellaneous species (Table 2). Bamboo, grass, shrubs, seedlings of prominent species etc., occurred as groundstorey.

Table 3. Primary analysis of vegetation

Group: Dry Mixed Forast Plot size : 0.1 ha No.of plots studied: 12

Name of the species	No.of trees	Av. DBH (cm)	No.of plots occured	Abun-dance	Density	Frequ-ency (%)	Basal area (m2)	R.F.	R.D.	R.B.A	I.V.I.	Ab/F ratio
1	2	3	4	5	6	7	8	9	10	11	12	13
Top Canopy												
Terminalia tomenosa	56	19.66	10	5.60	4.67	83.33	1.96	16.47	9.70	20.36	46.53	0.07
Anogeissus latifolia	28	16.90	9	3.11	2.33	75.00	0.69	8.24	8.73	7.17	24.14	0.04
Bosewellia serrata	41	24.67	6	6.82	3.42	50.00	1.99	12.06	5.82	20.67	38.55	0.14
Laqerstroemia parviflora	68	16.13	10	6.80	5.67	83.33	1.39	20.00	9.70	14.44	44.14	0.08
First storey												
Buchanania lanzan	40	12.45	9	4.44	3.33	75.00	0.49	11.76	8.73	5.09	25.58	0.06
Diospyros melanoxylon	7	13.37	3	2.33	0.58	25.00	0.10	2.06	2.91	1.03	6.00	0.09
Gabdi	5	11.30	2	2.50	0.42	16.67	0.05	1.47	1.94	0.52	3.93	0.15
Emblica officinalis	13	17.23	6	2.15	1.08	50.00	0.31	3.82	5.82	3.22	12.86	0.04
Ghatta	9	17.00	4	2.25	0.75	33.33	0.22	2.65	3.88	2.28	8.81	0.07
Others												
Zinyphus xylophora	9	13.49	4	2.25	0.75	33.33	0.13	2.65	3.86	1.35	7.88	0.07
Sterospermum chelinoides	3	12.80	2	1.50	0.25	16.67	0.04	0.88	1.94	0.42	3.25	0.09
Coclospermum	2	15.65	1	2.00	0.17	8.33	0.04	0.59	0.97	0.42	1.98	0.24
Terminalia bellirica	1	38.00	1	1.00	0.08	8.33	0.11	0.29	0.97	1.14	2.40	0.12
Pterocarpus marsupium	8	23.04	5	1.80	0.67	41.67	0.34	2.35	4.85	3.53	10.73	0.04
Bridelia retusa	3	22.33	3	1.00	0.25	25.00	0.13	0.88	2.91	1.35	5.14	0.04
Casearia qraveolens	1	10.70	1	1.00	0.08	8.33	0.009	0.29	0.97	0.09	1.35	0.12
Bhador	1	12.00	1	1.00	0.08	8.33	0.011	0.29	0.97	0.16	1.37	0.12
Lannea caromandelica	3	24.10	1	1.00	0.25	25.00	0.150	0.88	2.91	1.55	5.34	0.04
Ficus religiosa	1	15.00	1	1.00	0.08	8.33	0.018	0.29	0.97	0.19	1.45	0.12
Terminalia chebula	6	15.75	4	1.50	0.50	33.38	1.25	6.89	0.05			
Biararu (karer)	1	16.00	1	1.00	0.08	8.33	0.02	0.29	0.97	0.20	1.46	0.12
Kydia calycina	4	11.38	2	2.00	0.25	16.67	0.04	1.17	1.94	0.41	2.72	0.12
Albizzia odoratissima	1	10.00	1	1.00	0.08	8.33	0.08	0.29	0.97	0.08	1.34	0.12
Grewia tiliaefolia	1	10.00	1	1.00	0.08	8.33	0.008	0.29	0.97	0.08	1.34	0.12
Schlichera oleosa	2	23.75	1	2.00	0.17	8.33	0.09	0.59	0.97	0.94	2.50	0.24
Semecarpus anacardium	3	26.83	1	3.00	0.25	8.33	0.17	0.88	0.97	1.76	3.61	0.36
Kakai	2	13.50	2	1.00	0.17	16.67	0.03	0.59	1.94	0.31	2.04	0.06
Garuga pinnata	3	26.27	2	1.50	0.25	16.67	0.16	0.88	1.94	1.66	4.48	0.09
Mitagyna parviflora	5	17.00	1	5.00	0.42	8.33	0.11	1.47	0.97	1.14	3.58	0.60
Cassia fistula	1	17.19	1	1.00	0.08	8.33	0.023	0.29	0.97	0.24	1.50	0.12
Rotula aquatica	6	23.63	1	6.00	0.50	8.33	0.26	1.76	0.97	2.70	5.43	0.72
Ouqeinia oojeinensis	3	23.18	2	1.50	0.25	16.67	0.13	0.88	1.94	1.35	4.17	0.09
Bauhinia racemosa	1	37.00	1	1.00	0.08	8.33	0.11	0.29	0.97	1.14	2.40	0.12

RF = Relative frequency; RD = Relative density; RBA = Relative basal area ; IVI = Importance value indek; Ab = Abundance: F = Frequency

Table 4. **Primary analysis of vegetation**

Group: Moist Mixed Forest Plot size : 0.1 ha No.of plots studied: 4

Name of the species	No.of trees	Av. DBH (cm)	No.of plots occurred	Abundance	Density	Frequency (%)	Basal area (m2)	R.F.	R.D.	R.B.A	I.V.I.	Ab/F ratio
1	2	3	4	5	6	7	8	9	10	11	12	13
Top Canopy												
Lagerstroemia parviflora	42	18.76	3	14.00	10.50	75.00	1.16	17.64	26.92	38.43	82.99	0.19
Ougeinia oojeinensis	43	17.14	3	14.33	10.75	75.00	1.00	17.64	27.56	33.13	78.33	0.19
Butea monosoerma	44	10.96	1	44.00	11.00	25.00	0.42	5.88	28.20	13.92	48.00	1.76
Others												
Majini	5	13.80	1	5.00	1.25	25.00	0.07	5.88	3.20	0.32	9.40	0.20
Lasrey	3	14.00	1	3.00	0.75	25.00	0.05	5.88	1.92	1.65	9.45	0.12
Emblica officinalis	7	14.14	3	2.50	1.75	75.00	0.11	17.64	4.49	3.65	20.62	0.03
Bauhinia malabaricum	1	10.50	1	1.00	0.25	25.00	0.009	5.88	0.65	0.29	6.82	0.04
Terminalia chebula	1	11.00	1	1.00	0.25	25.00	0.009	5.88	0.65	0.29	6.82	0.04
Bauhinia racemosa	4	14.88	1	4.00	1.05	25.00	0.07	5.88	2.56	2.32	10.76	0.16
Zizyphus xylophora	6	15.83	2	3.00	1.50	50.00	0.12	11.76	3.85	3.97	19.58	0.06

RF = Relative frequency; RD = Relative density; RBA = Relative basal area ; IVI = Importance value index; Ab = Abundance; F = Frequency

Dry miked forest

The top canopy was formed by *Terminalia, Bosewellia, Lagerstroemia* and *Anogeissus.* The major change in floristic composition was absence of Sal and less abundance of *Terminalia* (5.6) as against 21.14 in the moist miked forest, though the frequency of *Terminalia* was 83.33 per cent. The significant change in the composition of species was due to the abundance of *Bosewellia* and *Lagerstroemia* which are characteristics of ridge vegetations.

The first storey was constituted by prominent species like *Buchnania, Diospyros, Gabi,* Emblica and *Ghatta* besides other miscellaneous species (Table 3). Bamboo and grasses occured as ground storey.

Seral vegetation

This group of vegetation was dominated by *Butea monosperma* and *Lagerstroemia* invading the grasslands in pure patches, respectively, on meadow were dadar grasslands. Occasionally *Ougenia* and *Terminalia* were found to invade grasslands on dadars besides Lagerstroemia. On meadow grasslands Sal was found occasionally intruding besides *Butea.* The understorey was mostly grasses. The other species which occur sparsely in seral formations were Majini, Lasrey, Emblica, *Bauhina racemosa, Terminalia chebula, Bauhinia malabaricum and Zizyphus xylophora* (Table 4).

It is concluded that remote sensing can he used as a tool to do vegetation analysis with adequate ground truth. The integrated use of both aerial photograph and satellite imageries is very essential to accomplish the task.

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