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A study on floristic diversity using Geo-Spatial technologies in the Paderu mandal of Andhra Pradesh, India

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Abstract- The present paper studies the floristic diversity in the Paderu mandal, Visakhapatnam district, Andhra Pradesh which comes under the Eastern Ghats of India. Visual interpretation of LISS-III satellite imagery of IRS P6 and intensive field surveys have identified the following forest types: dense, open and scrub forest that comprise 248.5km^2 out of total study area. Further, the botanical data collected from various secondary data (Botanical Survey of India and Forests Department Records) have recorded a total of 282 species and 95 families in the reserve forest of the Paderu mandal. In this study, 112 species belonging to 82 genera and 50 families of medicinal plants were also identified through the Ethno-medical survey.

Index Terms- Floristic diversity; Visual interpretation; GIS; medicinal plants; ethno-medical

1. INTRODUCTION

Forests on the Earth are one of the most important renewable natural resources that play vital roles in ecological balance, environmental stability, biodiversity conservation, food security and sustainable development [1]. They are a gift to the mankind especially to the people in tribal areas. Forests and tribal people are inseparable and coexist in their developments. Tribal people have got a symbolic relationship with the forests and mountains around them [2], yet these are in a state of permanent flux at a variety of spatial and temporal scales. [3]. The Indian sub-continent is unique in the richness of plant wealth. Knowledge of medicinal use of plants in India is amassed over millennia by tribal [4]. About 15,000 higher plant species occur, of which 9,000 wild plants are used by the tribal, for their requirements. Out of the 7,500 wild plants used for medicinal purposes by the tribal, about 950 species found to be new claims and worthy for the scientific investigation [5]. Recent investigators showed interest on investigating medicinal plants and collection of folklore claims. Many scientists of different disciplines have paid good attention in screening the medicinal plants used in different traditional systems. At this juncture, forests are not only helpful by sourcing various resources but also help to pave the path for scientific people to explore new resources and healing agents.

The forests are rich in flora diversity that is used in commercial purposes which influence the economical growth of the nation. The knowledge of their occurrence, phenology and medicinal importance is required for its socio economic development [6][7].

The medicinal plants are the treasures not only for tribal people but also for determining the health of the nation. It proves that the conservation of biodiversity is pertinent in the global scale. Many species of flora that are vulnerable are being protected since centuries by the tribes due to their religious beliefs [8]. The plantations form a very important source of livelihood to the tribal communities living in the vicinity [9]. There is very little or no documentation of this ethno-medicinal knowledge pertaining to tribal areas. There are several wild medicinal plants which are fast disappearing due to the destruction of forest by inhabitants, invasion of exotic flora and introduction of new crops. It needs the hour to protect the flora biodiversity.

The present scenario is a harbinger that briefs the need of exploration of this traditional knowledge in order to ascertain the conservation value of the local ethno-medicinal plants of the forests [10]. There is an immense need of inventories that record all ethno-medicinal information among the diverse ethnic communities before the traditional cultures are completely lost [11]. The use of GIS in the forest resources led to the development of sophisticated tools for forest management. Even though majority of forestry datasets are obtained manually by field inventory, some foresters are using GIS for cost effective alternatives [12]. Geospatial technologies are widely used for measuring, monitoring and mapping forests in an accurate, repeatable, and inexpensive manner to provide information by scientists, decision makers, and the public in a transparent way [13]. Forest mapping is a primary requirement for various

management and planning activities at the regional and global level [14]. Also, it provides critical information for managing landscapes to sustain their biodiversity and function of their ecosystems [15][16]. The present study mainly focuses on demarcation of the Reserve forest boundaries and preparation of detailed different forest types, their distribution and assessment of pertinent ethno-medicinal observations within Paderu Mandal using geo spatial technologies.

2. STUDY AREA

Paderu Mandal comes under Visakhapatnam agency and is the largest tribal area in Andhra Pradesh, India. It is positioned geographically in between the latitudes 17^0 55' 48"- 18^0 32' 59" North and longitudes 82^0 18' 41" - 83^0 01' 04" East, occupies an area of 435 km^2 (Figure 1) .The majority population is comprising of various tribal groups that are Bhagatha, Kondadora,Valmiki,Kondakapus, Kotia, Benthoriya, Yendia, Yerukalas, Nookadoras, Kammara, Khonds, Gadaba and Poorja [17]. They depend up on the nature for their food, shelter and livelihood, thus the vegetation has much influence on the tribal life [18]. The major river Machkund flowing in the forest division provides an excellent environment for diverse floral species in the region.

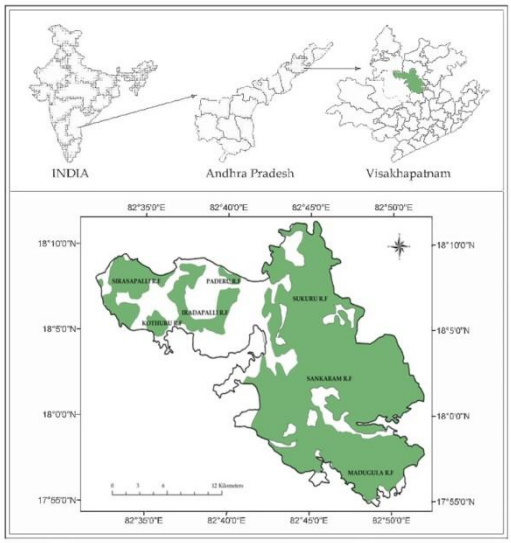

Figure 1: Location map of the Study Area

3. MATERIALS AND METHODS

In this study, the toposheets used are 65K9, 65K13, 65J12 and 65J16 of Survey of India (SOI) on 1:50,000 scale dated in 1983. They are geo-rectified and set to polyconic type of projection. Onscreen visual interpretation of LISS- III data of IRS P6 dated on March 2011, having 23.5 meters spatial resolution is used for identifying forest types based on canopy density namely Scrub (0 to 10% canopy), Open forests (10 to 40% canopy) and Dense forests (>40% canopy) within reserved forest area of study (Figure 2). The change in forest cover is calculated using the satellite data and the toposheet data. Different species of flora including ethno-medicinal plants are identified by [19][20][21][22][23].

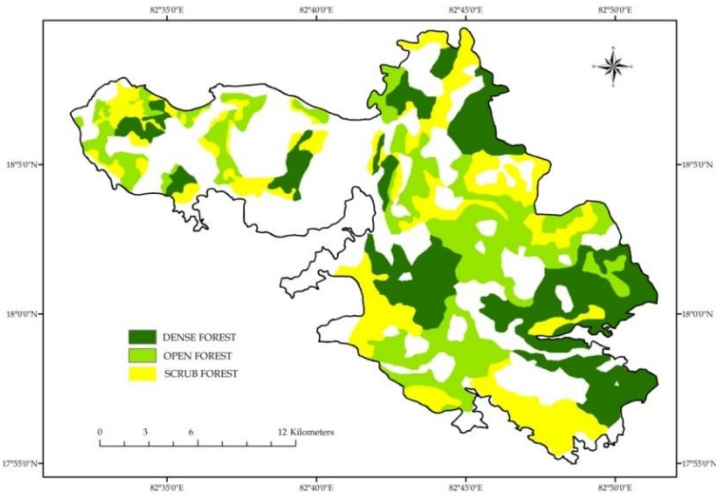

Figure 2: Classification of forest derived from IRS- P6 imagery of LISS III

4. RESULTS AND DISCUSSIONS

The total area of forest according to satellite data in Sirasaram, KottaUru, Paderu, Iradapalle, Sukuru, Sankaram and Madugula is 24850 hectares or 248.5km^2 while total forest area according to toposheets is 29754 hectares or 297.54km^2. Therefore, the interpretation of satellite imagery and toposheets has revealed the total loss of the forest cover as 49km^2 or 4904 hectares in 28 years. The reserve forests extent about 57% of total study area. Within this portion, the scrub forest occupies 15.7%, open forest occupies 20.04% and dense forest occupies 21.23 % (Table 1). Topographic maps were referred to classify the villages under different categories of reserve forests. Some of the villages that come under the Scrub forests are Bongajangi, Boradaputtu, Totalagondi, Pottamamidi, Gondeli, Olval, Bodimeli, Lingaputtu, Punuku, Koraputtu, Paderu, Devarapalli, Bhimavaram etc.; Open forests are Iskaif, Mulisobha, Dalingput, Modeputtu etc.; Dense forests are Iskagur, Kotta Uru, Nittamamidi, Dummaputtu, Vallapuram, Kavarat, Massiputtu etc.

Table 1: Areal distribution of reserved forest in the Paderu Mandal

S. No	Name of Reserved forest	Dense forest (Km^2)	Open forest (Km^2)	Scrub forest (Km^2)	Total forest area (Km^2)	Percent (%)
1.	Sirasaram	5.19	8.64	4.67	18.50	7.45
2.	KottaUru	1.69	0.70	-	2.39	0.96
3.	Paderu	-	1.11	0.52	1.63	0.66
4.	Iradapalle	4.31	6.17	7.74	18.21	7.33
5.	Sukuru	19.62	17.05	24.36	61.03	24.56
6.	Sankaram	47.16	46.74	22.46	116.36	46.83
7.	Madugula	14.61	6.96	8.80	30.36	12.22
	Total	**92.57**	**87.38**	**68.55**	**248.50**	**100.00**

A total of 282 plant species have been identified from the records of Botanical Survey of India and Andhra Pradesh State of Forest report in which the species are represented by Euphorbiaceae (20 species), followed by Fabaceae (15 species), Asteraceae and Poaceae (with 11 species each), Orchidace and Rubiaceae (with 10 species each), Rutaceae (with 9 species), Araceae and Lamiaceae (with 8 species each), Verbenaceae and Acanthaceae (with 7 species each), Moraceae and Malvaceae (with 6 species each), Commelinaceae, Mimosaceae, Zingiberaceae, Boraginaceae, Caesalpiniaceae and Urticaceae (with 5 species each), Piperaceae, Solanaceae, Meliaceae and Adiantaceae (with 4 species each), Dioscoriaceae, Amaranthaceae, Sterculiaceae, Burseraceae, Apiaceae, Vitaceae, Cucurbitaceae and Ranunculaceae (with 3 species each), Convolvulaceae, Liliaceae, Sapindaceae, Stilaginaceae, Myrsinaceae, Apocynaceae, Asclepiadaceae, Violaceae, Oleaceae, Cordiaceae, Schrophulariaceae, Polygonaceae, Marsileaceae, Oxalidaceae, Combretaceae, Lythraceae, Cyperaceae, Bombacaceae, Sapotaceae, Cannaceae, Lauraceae, Menispermaceae (with 2 species each), Actinopteridaceae, Gnetaceae, Simaroubaceae, Rhamnaceae, Flacourtiaceae, Portulacaceae, Dilleniaceae, Elaeocarpaceae, Basellaceae, Leeaceae, Caryophyllaceae, Bixaceae, Ebenaceae, Blechnaceae, Loganiaceae, Schizaceae, Nyctaginaceae, Smilacaceae, Anacardiaceae, Stemanaceae, Selaginellaceae, Gentianaceae,Araliaceae, Celastraceae, Melastomataceae, Cyatheaceae, Caricaceae, Magnoliaceae, Musaceae, Ulmaceae, Bignoniaceae, Rosaceae, Polypodiaceae, Tiliaceae, Myrtaceae, Costaceae, Pteridaceae, Amarylladaceae, Hypoxidaceae, Cuscutaceae (only 1 specie each).

Habitat wise analysis of flora in the study area shows comparatively higher percentage of herbs (46.8%) followed by trees (29%), shrubs (12.7%) and climbers (10.2%).Further, Ethno-medical survey [4] carried out in the study area has identified a total of 112 species of medicinal plants which are used by the tribal communities. These medicinal plants are used for treatment of 32 different diseases such as jaundice, rheumatism, asthma, diabetes, piles, leucoderma, paralysis and snake bite. Various parts of plants such as roots, leaves, barks, stem etc. are used to prepare medicine by tribal communities. Botanical name, family, part of plant used for medicinal purpose and their use in treatment of diseases are mentioned in the tabular form (Table 2). There are 11 species of Fabaceae family, 7 species of Euphorbiaceae, 6 species of Asteraceae, 5 species of Caesalpiniaceae and 4 species of Zingiberaceae which are the most dominant families of ethno-medical importance. Apart from these dominant families, there are other species of Malvaceae, Acanthaceae, Rutaceae, Boraginaceae, Moraceae, Lamiaceae, Cannaceae, Mimosaceae, Amaranthaceae, Cucurbitaceae, and Bombacaceae. Further, the percentage of coverage of each habit type and the percentage of various plant parts that have medical use are also shown in Figure 3 and Figure 4 respectively. The medicinal floral species mainly consists of herbs (45%), trees (25%), shrubs (22%) followed by other minor habit types like climber, lian, creeper and straggler (Figure 3). The major medicinal important part of the species are leaves (28%), roots (21%), bark (12%), fruit (11%) and others being minor include the flower, stem, tuber etc. (Figure 4.)

Table 2: Medicinal plants present in the study area

S. No	Scientific name	Family	Habit	Plant parts	Disease
1	Abelmoschus moschatus Medik.	Malvaceae	Herb	Seed	Fever
2	Abrus precatorius Linn.	Fabaceae	Straggler	bark	Intermittent fevers
3	Acacia mangia Willd	Mimosaceae	Tree	Stem bark	Paralysis
4	Acacia nilotica (Linn.) Willd.	Mimosaceae	Tree	Stem bark	Diarrhoea
5	Acalypha indica Linn.	Euphorbiaceae	Herb	Leaf	Skin disease
6	Acanthospermum hispidum DC.	Asteraceae	Herb	Leaves	wounds
7	Achyranthes aspera Linn.	Amaranthaceae	Herb	Root	Tooth problems
8	Acorus calamus Linn.	Araceae	Herb	Rhizome	Cough
9	Actinopteris radiata (Swartz) Link.	Actinopteridaceae	Herb	Root	Snake bite
10	Adhatoda zeylanica Medik.	Acanthaceae	Shrub	Leaf	Cough
11	Adiantum philippense Linn.	Adiantaceae	Herb	Root	Cough
12	Aegle marmelos (Linn.) Correa	Rutaceae	Tree	Fruit	Dysentery
13	Ageratum conyzoides Linn.	Asteraceae	Herb	Leaves	Itching
14	Ailanthus excelsa Roxb.	Simaroubaceae	Tree	Stem bark	Cough
15	Alpinia galanga (Linn.) Willd.	Zingiberaceae	Herb	Tuber	Rheumatism
16	Asparagus racemosus	Liliaceae	Climber	bark	Stomach ache
17	Atlantia monophylla	Rutaceae	Climber	Fruit	Stomach ache
18	Basella rubra Linn.	Basellaceae	Herb	Leaves	Piles
19	Bauhinia purpurea Linn.	Caesalpiniaceae	Tree	Bark	Leucorrhoea
20	Bauhinia vahlii Wight & Arn.	Caesalpiniaceae	Lian	Bark	Dysentery
21	Benincasa hispida (Thunb.) Cogn.	Cucurbitaceae	Creeper	Fruit	Stomachache
22	Bidens pilosa Linn.	Asteraceae	Herb	Leaves	Whitlow
23	Bixa orellana Linn.	Bixaceae	Tree	Root	Fever
24	Boerhavia diffusa Linn.	Nyctaginaceae	Herb	Root	Antidote
25	Bombax ceiba Linn.	Bombacaceae	Tree	Root	Fertility
26	Boswellia serrata Roxb. ex Colebr.	Burseraceae	Tree	Bark	Diarrhoea
27	Bridelia montana (Roxb.) Willd.	Euphorbiaceae	Tree	Bark	Jaundice
28	Butea monosperma (Lam.) Taub.	Fabaceae	Tree	Bark	Wounds
29	Cadaba fruticosa	Capparaceae	Shrub	Root	Skin purification
30	Caladium bicolor Vent.	Araceae	Herb	Tuber	Snake bite
31	Calycopteris floribunda	Combretaceae	Shrub	Bark	Wounds

	Lam.				
32	Capparis sepiaria	Capparaceae	Shrub	Root	Tooth problems
33	Capparis zeylanica	Capparaceae	Shrub	Root	Appetizer
34	Canna indica Linn.	Cannaceae	Herb	Tuber	Ringworm
35	Canna edulis Linn.	Cannaceae	Herb	Tuber	Throat pain
36	Carica papaya Linn.	Caricaceae	Tree	Fruit	Galactogauge
37	Cascabela thevetia (Linn.) Lipp.	Apocynaceae	Tree	Leaves	Skin disease
38	Cassia alata Linn.	Caesalpiniaceae	Shrub	Leaves	Eczema
39	Cassia auriculata Linn.	Caesalpiniaceae	shrub	Leaves	Dysentery
40	Cassia fistula Linn.	Caesalpiniaceae	Tree	Fruit	Ingredient
41	Cayratia pedata	Vitaceae	Shrub	Leaves	Ingredient
42	Ceiba pentandra (Linn.) Gaertn.	Bombacaceae	Tree	Bark	Skin disease
43	Celosia argentea Linn. var. plumose	Amaranthaceae	Herb	Leaves	Ulcers
44	Cipadessa baccifera (Roth) Miq.	Meliaceae	Shrub	leaves	Chikenpox
45	Cissampelos pareira Linn.	Menispermaceae	Climber	Root	Stomachache
46	Cissus quadrangularis Linn.	Vitaceae	Climber	Stem	Paralysis
47	Cleome gynandra	Cleomaceae	Herb	Leaves	Stomach disorders
48	Cleome viscosa	Cleomaceae	Herb	Leaves	Stomach disorders
49	Clitoria ternatea	Fabaceae	Herb	Flower	Antidote
50	Coldenia procumbens Linn.	Boraginaceae	Herb	Leaves	Rhuematism
51	Corchorus olitorius Linn.	Tiliaceae	Herb	Seed	Ear pain
52	Cordia dichotoma Forest. f.	Boraginaceae	Tree	Leaves	Jaundice
53	Costus speciosus (Koen.) Sm.	Zingiberaceae	Herb	Rhizome	Galactogogue
54	Crotalaria laburnifolia Linn.	Fabaceae	Shrub	Root	Snake bite
55	Crotalaria pallida Dryd.	Fabaceae	Shrub	Seeds	Narcotics
56	Curculigo orchioides Gaertn.	Hypoxidaceae	Herb	Root	Headache
57	Curcuma aromatica Sal.	Zingiberaceae	Herb	Rhizome	Skin disease
58	Curcuma angustifolia Roxb.	Zingiberaceae	Herb	Rhizome	Galactogogue
59	Cuscuta reflexa Roxb.	Cuscutaceae	Herb	Plant	Piles
60	Dalbergia paniculata	Fabaceae	Shrub	Stem	Body sprains
61	Datura innoxia Mill.	Solanaceae	Shrub	Leaf	Itching
62	Desmodium gangeticum (Linn.) DC.	Fabaceae	Shrub	Root	Rheumatism
63	Desmodium pulchellum (Linn.) Benth.	Fabaceae	Shrub	Leaves	Wounds
64	Diplocyclos palmatus (Linn.) Jeffrey	Cucurbitaceae	Climber	Root	Tooth decay
65	Dillenia indica Linn.	Dilleniaceae	Tree	Bark	Stomachache

66	Dysophylla quadrifolia Benth.	Lamiaceae	Herb	Leaves	Chickenpox
67	Elephantopus scaber Linn.	Asteraceae	Herb	Root	Tooth decay
68	Elytraria acaulis (Linn.f.) Lindau	Acanthaceae	Herb	Leaves	Ringworm
69	Emilia sonchifolia (L.) DC.	Asteraceae	Herb	Tuber	Fits
70	Eryngium foetidum Linn.	Apiaceae	Herb	Root	Stomachache
71	Erythrina variegata Linn.	Fabaceae	Tree	Bark	Backache
72	Euphorbia hirta Linn.	Euphorbiaceae	Herb	Plant	Wounds
73	Euphorbia ligularia Roxb.	Euphorbiaceae	Tree	Latex	Backache
74	Euphorbia nivulia Buch.-Ham.	Euphorbiaceae	Tree	Latex	Cuts
75	Euphorbia tirucalli Linn.	Euphorbiaceae	shrub	Latex	Galactogauge
76	Evolvulus alsinoides Linn.	Convolvulaceae	Herb	Plant	Asthma
77	Ficus benghalensis Linn.	Moraceae	Tree	Leaf	Skin allergy
78	Ficus hispida Linn. f.	Moraceae	Tree	Leaf	Ringworm
79	Ficus microcarpa Linn.f.	Moraceae	Tree	Bark	Dysentery
80	Flemingia stricta	Fabaceae	Shrub	Flowers	Cuts and wounds
81	Gloriosa superba Linn.	Liliaceae	Herb	Tuber	Backache
82	Glycosmis pentaphylla (Retz.) DC.	Rutaceae	Tree	Leaf	Wounds
83	Glycyrrhiza glabra (Retz.) DC.	Fabaceae	Shrub	Root	Cough
84	Gmelina arborea Roxb.	Verbenaceae	Tree	Leaf	Headache
85	Helicteres isora Linn.	Sterculiaceae	Shrub	Fruit	Dysentery
86	Heliotropium indicum Linn	Boraginaceae	Herb	Leaves	Dog bite
87	Hibiscus vitifolius Linn.	Malvaceae	Shrub	Root	Tumour
88	Hoya pendula R. Br.	Asclepiadaceae	Shrub	Root	Jaundice
89	Indigofera linnaei Ali	Fabaceae	Herb	Leaves	Asthma
90	Indigofera trifoliata	Fabaceae	Herb	Leaves	Edible
91	Jatropha curcas Linn.	Euphorbiaceae	Shrub	Latex	Wounds
92	Justicia glauca Rottl.	Acanthaceae	Herb	Leaf	Backache
93	Lawsonia inermis Linn.	Lythraceae	Shrub	Leaf	Headache
94	Leonotis nepetiifolia (Linn.) R. Br.	Lamiaceae	Herb	Flowers	Cuts
95	Leucas cephalotes (Roth) Spreng.	Lamiaceae	Herb	Leaves	Headache
96	Limonia acidissima Linn.	Rutaceae	Tree	Fruit	Dysentery
97	Madhuca indica Gmel.	Sapotaceae	Tree	Bark	Dog bite
98	Marsilea quadrifolia Linn.	Marsileaceae	Herb	Leaves	Skin disease
99	Martynia annua Linn.	Martyniaceae	Herb	Fruit	Scorpion sting
100	Mucuna pruriens (Linn.) DC.	Fabaceae	Herb	Fruit	Dysentery
101	Musa paradisiaca Linn.	Musaceae	Herb	Tuber	Dysentery
102	Pueraria tuberosa	Fabaceae	Climber	Stem	Ingredient
103	Rauvolfia serpentina	Apocynaceae	Herb	Fruit	To reduce blood

					pressure
104	Semecarpus anacardium	Anacardiaceae	Shrub	Seeds	Skin diseases
105	Strychnos potatorum Linn. f.	Loganiaceae	Tree	Root	Skin disease
106	Tephrosia procumbens Buch.-Ham.	Fabaceae	Herb	Root	Stomachache
107	Tinospora cordifolia	Menispermaceae	Herb	Root	Constipation
108	Thalictrum foliolosum DC.	Ranunculaceae	Herb	Root	Rheumatism
109	Urena lobata Linn	Malvaceae	Herb	Root	Stomachache
110	Vernonia cinerea (Linn.) Less.	Asteraceae	Herb	Plant	Fever
111	Vitex negundo	Lamiaceae	Shrub	Fruit	Skin diseases
112	Zizyphus mauritiana Lam.	Rhamnaceae	Tree	Fruit	Cold

Table 3: Number of habits types in the flora

S. No.	**Habit type**	**Number of habits**
1.	Herb	50
2.	Tree	28
3.	Shrub	25
4.	Climber	6
5.	Lian	1
6.	Creeper	1
7.	Straggler	1
Total		**112**

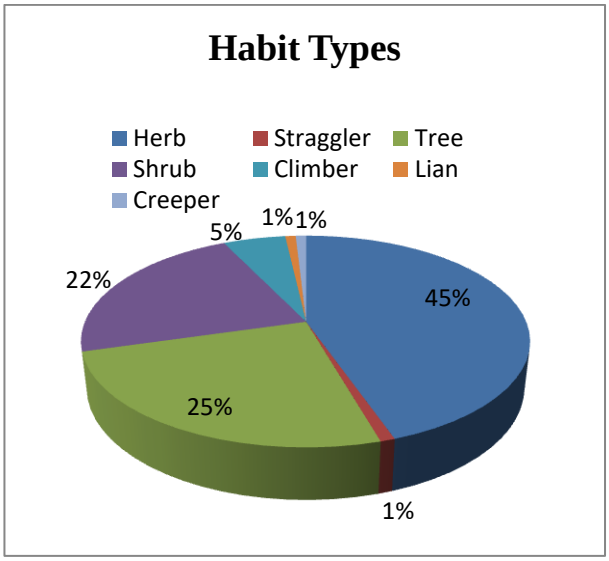

Figure 3: Percentage of distribution of the habit type

Table 4: The plant parts and their medicinal use

S. No.	Plant Parts	Number
1.	Leaf	31
2.	Root	24
3.	Bark	13
4.	Fruit	12
5.	Tuber	7
6.	Seed	4
7.	Rhizome	4
8.	Plant	4
9.	Latex	4
10.	Stem	3
11.	Flower	3
12.	Stem bark	3
Total		**112**

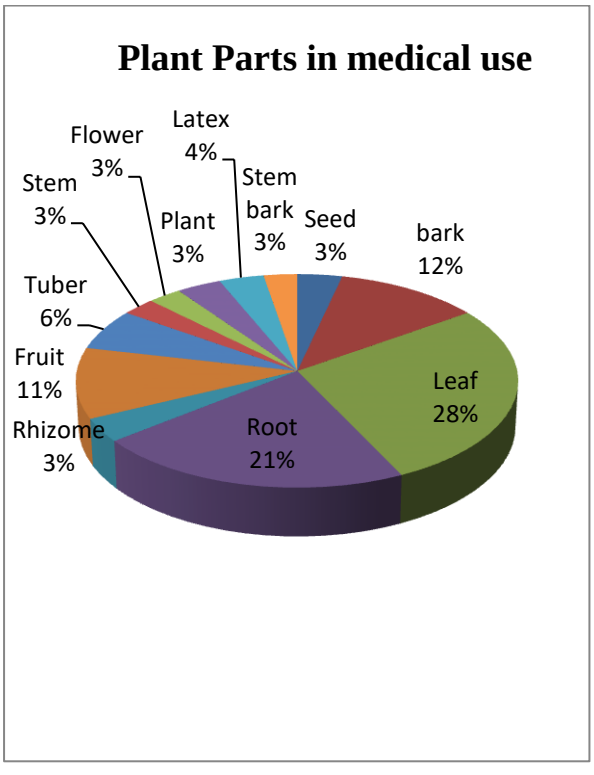

Figure 4: Percentage of distribution of plant parts in medical use

5. CONCLUSION

The study on floristic diversity is carried out using geo spatial technologies. The total loss of forest cover in toposheets (49km^2) has been integrated with satellite data for conservation, protection and identifying various species of flora in the Paderu Mandal. It is observed that the reserved forest area of Paderu mainly comprises of dense forests (21.23 %) and Sankaram Reserved forest covers the maximum portion of the study area (46.83%). It is concluded that the major medical flora species are herbs (45%) out of all. Further, the major part of the plants having maximum medicinal values is the leaf (28%). These medicinal plants are used for treatment of 32 different diseases such as jaundice, rheumatism, asthma, diabetes, piles, leucoderma, paralysis and snake bite. This kind of scientific validation and availability of the medicinal plants in the Paderu mandal may help all kinds of communities in identifying new drugs from the flora species. The traditional use of medicinal plants by the tribal communities combined with the geospatial technologies may help them in socio-economic development. Geo-spatial technologies may also be utilized to identify the depletion of the flora species on temporal basis and may help in conserving them. This study revealed the presence of all the plant species in the forest division of Paderu mandal and an inventory is prepared for the future use.

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