EUROPEAN ACADEMIC RESEARCH
Vol. II, Issue 12/ March 2015

Impact Factor: 3.1 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Studies on the Distribution of Mangrove Flora and Fauna at Nizampatnam and Palarevu

K. SASIDHAR
P. BRAHMAJI RAO
Department of Environmental Sciences
Acharya Nagarjuna University
Nagarjuna Nagar, Guntur (Dist.)
Andhra Pradesh, India

Abstract:

Mangrove vegetation was observed along the sheltered places of Andhra Pradesh coastline, coastal backwater formations and the estuarine complex of the Guntur Delta has been studied in detail. The importance and utility of mangrove ecosystems which provide adequate nutritional values, energy supply and provide the raw materials needed for building houses, producing wood material for making boats, fishing, significantly to social and economic benefit to the people living along the coastline are well-known.Vegetation analysis methods include systemic classification of the plant species, status of mangrove plant species which is based on relative frequency, species dominance which is based on Important Value Index(IVI), species-wise distribution pattern, Maturity Index Value (MIV) .There are 43 species belonging to four major vertebrate (mammals, aves, amphibians and reptiles) with significant wildlife importance in the study area . There was no migratory birds prevail for nesting and breeding activity in region. There is migration of birds to region only for food.Management of Mangrove Areas needs Restoration & Regeneration of Mangrove Vegetation in the two regions by the process i.e. digging "fish bone" type of canals, De-silting of canals and casualty replacement. There is a need to know the "pre environmental impact assessment" for the proposal of future development activities and

industries and to take measures for the restoration and regeneration of mangrove vegetation.

Key words: mangrove ecosystems, Important Value Index (IVI), species-wise distribution pattern, Maturity Index Value (MIV), Similarity Index (SI), Coefficient difference(CD).

1. Introduction

Mangroves are salt-tolerant evergreen forests found along sheltered coastlines, shallow-water lagoons, estuaries, rivers and deltas. Mangroves are specialized and unique ecosystems in the world. They have some morphological and physiological adaptations such as viviparous germination, pneumatophores, stilt roots, knee roots, salt excreting leaves, breathing roots by which these plants survive in water-logged, anaerobic saline soils of coastal environments. Some mangrove species exclude salt form their internal systems, others actually excrete the salt they take via their leaves, roots and branches. The mangrove root system is so effective in filtering out salt. Another special character of mangroves is vivipary. Through viviparity, "embryo germination begins on the tree itself, the mother tree later drops its developed embryo" called as seedlings. During this viviparous development, the propagules are nourished on the mother tree, thus accumulating the necessary nutrients and other vital compounds required for later autonomous growth. Mangroves play a critical ecological role as a transition habitat form the marine to freshwater and terrestrial system. In ecological point of view mangroves provide nutrient inputs and act as primary sources of ecosystem for tropical estuaries. Mangroves also help and protect coastline form erosion, storm damage and wave action. They prevent shoreline erosion by acting as buffer and catch alluvial materials, thus stabilizing land elevating by sediment accretion that balances sediment loss. Mangrove forests and estuaries are the breeding and feeding grounds for a number of marine fauna including

commercially valuable shrimps, crabs and fish. These also provide shelter to a variety of life forms like invertebrates, amphibians, reptiles, birds and mammals.

Mangroves perform a number of vital ecological functions such as nutrient recycling, maintenance of hydrological regime, coastal protection and fish production. Mangrove vegetation provides legitimate resource for socio-economic development. It provides firewood, timber, fodder, fruits, medicines, honey, etc. to the inhabitants. Mangrove forests and estuaries are the breeding and nursery grounds for a number of marine organisms including the commercially important shrimps, crabs and fish species. These also provide shelter to a variety of life forms like invertebrates, amphibians, reptiles, birds and mammals. These mangrove zones are rich resources of income generation for shoreline communities like fisher folk. Till date, the usage of the term 'mangrove' and the number of mangrove species assigned on that basis vary remarkable among different workers. In India, the reported number of mangrove species varies among researchers; 50-60 species (Blasco et al. 1975); 33 species form West Coast and 47 Species from East Coast, but about 55 species form all the habitats (Untawale 1987); 35 true mangroves , 28 mangrove associates and 7 back mangals (Noronha,l and Nairy 2003); 59 species, our of which 34 species from East Coast and 25 species form West coast (Banerjee et al. 1989); and 50 species (Jagtap et al. 1993).

The Indian coast line is about 7400 km and approximately 6740 Sq.kmof the littoral region is protected by mangrove forest. It is the third largest formation of mangroves in the world after Indonesia and Australia (Banerjee, 1998). According to FSI report 2009, the mangrove area in coastal states and union territories is 4639 Sq.km (0.14% of geographic area), of which Andhra Pradesh has 354 Sq.km. It is worth noting that the mangrove area in Andhra Pradesh increased by 58 Sq.km to that recorded in 2005.In India, out of 487,100 ha

(4871 Sq.km) of mangrove wetlands, nearly 56.7% (275,800 ha i.e. 2758 Sq.km) of mangroves are located along the east coast, 23.5% (114,700 ha i.e. 1147 Sq.km) along the west coast and the remaining 19.8% (96,600 ha i.e. 966 Sq.km) are found in the Andaman and Nicobar islands (Selvam, 2003).

India has a geographic area of 2,75,068 Sq.km, out of which an area of 63,814 Sq.km (23.2% of geographic area) falls under general forest cover, according to FSI report in 2009. Mangrove forests contribute an area of about 585 Sq.km (0.9% of general forest area) to it. However, the actual area (according toFSI report in 1991) under mangrove cover is about 400 Sq.km, the remaining area being covered by sand bars, casuarina plantation and open blanks. The coastline of Andhra Pradesh is 974 km located between 13°.24'-19°.54' N latitudes and 80°.02'- 86°.46' E longitudes. In Andhra Pradesh, about 354 Sq.km is covered by mangrove vegetation, out of which about 347 Sq.kmis located in the estuarine complex of Krishna-Godavari rivers, spreading over Krishna & Guntur and East Godavari districts. The remaining mangrove area (7 Sq.km) is present in Prakasam district (FSI, 2009).There are four major Indian deltas along the east coast viz. the Gangetic Sunderbans, the Mahanadi, the Krishna-Godavari and Cauvery deltas. In Mangrove forest formation and species concentration the Krishna-Godavari delta is in the third position. The Krishna-Godavari delta is hit by most of the cyclones including 1977 and 1990 cyclones, because it is associated with depression track. The Krishna river is the second largest one in Andhra Pradesh. It has its origin in the western ghats at an altitude of 1,337 meters, north of Mahabaleswar, about 64 kilometers from the Arabian Sea. It flows across three states, namely Maharastra, Karnataka and eventually into Andhra Pradesh, before emptying into Bay of Bengal. Krishna delta is situated between 15°.40' N and 16°.55'N latitude and 80°.0' and 82°.23' E longitudes. It is bound in the north by Diviseema (Krishna district), in the east by Bay of Bengal, in the west by

Repalle (Guntur district) and in the south by Nizampatnam (Guntur district). Nizampatnam Bay is an embayment adjoining the Krishna delta in its southern side. It has coast line of about 125 km between Kottapalem in SW and False Divi point in the NE. Nizampatnam is from 15° 53' 7" N latitudes and from 80° 38' 28" E longitudes on the south east coast of India and the southern corner of Andhra Pradesh.

The present study is carried out to identify the mangrove vegetation distributed in Krishna Estuary. The Krishna estuarine region has been continuously in the severe pressure of urbanization even under the British regime which continued with accelerated pace in the post-independence era. The mangrove vegetation present in Nizampatnam, and Palarevu areas shows a very divergent distribution of mangroves in the different selected field stations. The mangrove vegetation is helpful in creating livelihood opportunities for the people in the nearby villages. Ecological study in the mangrove forest form a basis to evaluate the socio-economic and resource development activities. The utilization of mangrove flora and fauna for traditional and commercial purpose depletes the resources. Hence conservation of the mangrove vegetation is very essential. So the present study on the ecological and socio-economic aspects of mangrove vegetation in the above field stations has been taken up to achieve the following specific objectives.1. To study the distribution of mangrove flora at different field stations present in the region viz., Nizampatnam, Palarevu. The ecological status of the mangrove vegetation is estimated based on their Diversity, Status, Species Dominance, Important Value Index (IVI), Maturity Index, among the field station of flora in the region.

2. Methodology

2.1 Study Area

The present study has been conducted in the Guntur mangrove forest area along the (West) east coast of Andhra Pradesh for a period of three years i.e. from June 2011 to June 2014. Several field trips are made to select the field stations, to study the distribution of mangrove vegetation, geographic nature of riverine system, environmental quality and human interference. While selecting the study area, high tidal impact villages Nizampatnam and Dindi are considered. The distributaries, along with other criteria like vegetation structure, inundation frequency and the extent of human interference are taken into account while selecting a main field station. The above criteria have been selected (according to Smith, 1992) to observe the factors responsible for the degradation of mangrove belts. Consequently the region-I is divided into two main field stations, each main field station having its ecological significance for the quantification of mangrove vegetation.

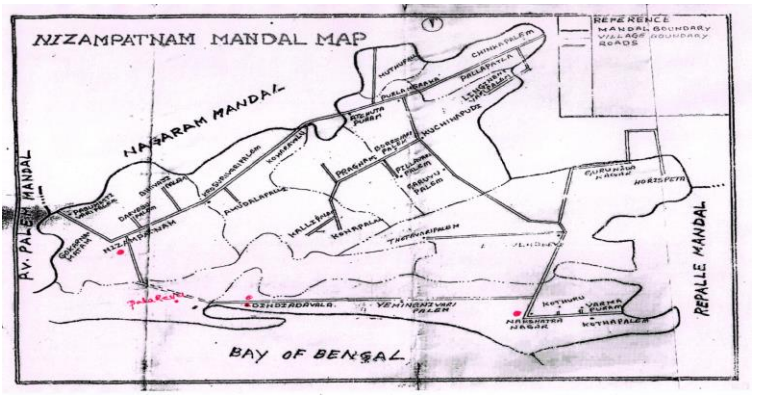

Figure - 1: A Map Showing The Krishna Riverine System

Study areas are selected in the coastal and delta regions of Krishna riverine system merging into the sea, where the mangrove forests are divided into two areas by the riverine

system (map: Figure - 1). Krishna River divides into two main branches after leaving Prakasam Barrage at Vijayawada. One branch goes to north and enters Bay of Bengal near Diviseema in Krishna District. Another branch runs towards south and enters into Bay of Bengal at Nizampatnam in Guntur District. Both Nizampatnam and Diviseema form two important hubs of mangrove forests in the Krishna Estuary. The present study has been conducted at the Southern Fringes of the Krishna Estuary at main region namely Nizampatnam, Dindi (Region – 1) Study areas are selected on the northward and eastward regions of riverine systems to identify the mangrove diversity at which the river joins the sea. The Studies are included vast expanse of submerged lands, elevated inner fringes of backwaters and landward marshy lands, which form typical mangrove habitats. The utility of species, the distribution and diversity of mangrove flora and funa, the identification of the ecological status of the mangrove diversity in the this region during the period of 2011-2014.

Station I : Nizampatnam RF

Nizampatnam Reserve Forest (RF) is the largest reserve forest stretch in the east coast of Andhra Pradesh of which the present study covered approximately 12 on the eastern fringe (80^0 38' to 80^0 40' E and 15^0 52' to 15^0 54' N). The whole area is reticulated with backwater channels as well as influent canal of the Krishna River where it empties into the Bay of Bengal. This station is thickly populated. The demographic details were also collected. Except this reserve forest block the remaining part is urbanized with fishing harbor, landing sites, colonies with pakka houses, BT roads etc. The population is engaged in diverse occupation.

Station II: Dindi

Next to Nizampatnam R.F, Dindi is considered to be rich in diversity. It falls under Amudalaplli Reserve Forest. Dindi is

located between 80^0 42' to 80^0 44' E and 15^0 54' to 15^0 56' N. The population density is less than Nizampatnam. The station mainly supports mangroves through network of backwater channels. Salt pans are not found in this station. Though it is having good diversity of mangrove species, it is occupied by people engaged into different occupations. The extent of dependency of people on the mangroves and mangrove resources is delineated in the subsequent parts. This station covered about four Sq km**.**

2.2 Determination of Ecological Status

Several field inventories have been made to study the mangrove distribution pattern, frequency and species abundance, which are used to determine the ecological status of the mangrove vegetation. Line transects of varying widths and quadrates from 4 m x 4 m to 10 m x 10 m are laid on either side of the canals and data from each one are recorded from ten such transects / quadrats. Plant materials collected during sampling are identified with the help of the standard herbaria of the Botanical Survey of India and Gamble Volumes of the Department of Botany, Acharya Nagarjuna University, Guntur.

2.3 Vegetation Analysis

2.3.1 Frequency: Frequency, as introduced by Raunkiaer (1934), indicates the number of sampling units in which a given species occurs (Mishra, 1968). Frequency of mangrove vegetation refers to the degree of dispersion of individual species in an area and is usually expressed in terms of percentage of occurrence. Frequency and relative frequency of species in the study area are measured by using the formulae of Curtis (1933), which are given below.

$$\text{Frequency} = \frac{\text{No of occurrences of a species}}{\text{Total no of site samples taken}} \text{ X } 100$$

$$\text{Relative Frequency} = \frac{\text{No of occurrences of particular species}}{\text{Total no of occurrences of all the species}} \text{ X } 100$$

The values of relative frequency are calibrated on a 10-point scale to assign a status to the species in each region. Four distinct groups are derived from this 10-point scale and each group in each region is designated as follows:7 – 10Very Frequent, 5 – 7Frequent, 3 – 5LesFrequent,< 3 Rare .

2.3.2 Abundance:

The abundance and density represent the numerical strength of species in the community (Mishra, 1968). Abundance is described as the number of individuals occurring per sampling unit and density as the number of individuals per sampling unit. Abundance and density are calculated using the following formulae:

$$\text{Abundance (A)} = \frac{\text{Total number of individuals}}{\text{Number of Sampling units of occurrence}} \text{ X } 100$$

The abundances are grouped to assign abundance-categories, as suggested by Dagar et al (1991) and are detailed below:

> 25	d	Dominant,
15 – 25	Va	Very abundant,
10-15	a	Abundant,
6-10	f	Frequent,
3- 6	o	Occasional
1 - 3	r	Rare
<1	Vr	Very rare

$$\text{Relative Abundance} = \frac{\text{Abundance of a particular species}}{\text{Sum of the abundances of all species}} \text{ X } 100$$

$$\text{Density} = \frac{\text{Total no of individuals of a species in all quadrats}}{\text{Total no of quadrats sampled}} \times 100$$

$$\text{Relative density} = \frac{\text{Density of a particular species}}{\text{Sum of the densities of all species}} \times 100$$

2.4 Importance Value Index (IVI):

The concept of 'Important Value Index (IVI)' has been developed for expressing the dominance and ecological success of any species, with a single value (Mishra, 1968). This index utilizes three characteristics, viz. relative frequency, relative density and relative abundance. The three characteristics are computed using frequency, density and abundance for all the species falling in all the transects by using the following formula. IVI = Relative *frequency* + *Relative abundance* + *Relative density*

Maturity Index Value (MIV), Similarity Index (SI), Coefficient Difference (CD) and Diversity Index are used to assess the maturity, similarity, diversity of mangrove vegetation among various field stations (Philips 1959).

2.5 Maturity Index Value (MIV):

The degree of maturity of a plant community is established based on the percent frequency of all species in the sites of study regions and divided by the number of species of occurrence. This is Maturity Index Value (MIV). Sampling is done by selecting 10 quadrats at each site and the frequency of each species is calculated, before calculating the percentage frequency. The Maturity Index Values are compared among different sites and it is inferred that the one nearer to 100 is highly matured in the community over others as suggested by Pichi-Sermolli (1948).

$$MIV = \frac{Frequency\ of\ all\ species}{No\ of\ species\ studied} \times 100$$

3 .Results and discussion

3.1 Mangrove Vegetation

The mangrove vegetation of Guntur delta has been broadly classified into three main categories, based on the composition of species and distribution pattern, Pawar tushar anant (2012).

1. The interior group of mangrove vegetation, which mainly consists of species of Avicenniaceae, Rhizophoraceae and Euphorbiaceae.
2. The mangrove vegetation of central area, which mainly consists of species of Sonneratiaceae, Combretaceae and Myrsinaceae.
3. Mangrove vegetation spread at peripheral or marginal areas, which consists of species of Acanthaceae, Verbenaceae, Chenopodiaceae and Fabeceae.

S.No.	Family	Name of the Species	Vernacular name	Habitat
1	Myrsinaceae	*Aegiceras corniculatum* (L.)	Guggilam	Tree
2	Avicenniaceae	*Avicennia alba*	Gudammada	Tree
3	Avicenniaceae	*Avicennia marina* (Forsk.)	Tellamada	Tree
4	Avicenniaceae	*Avicennia officinalis* (L.)	Nallamada	Tree
5	Rhizophoraceae	*Bruguiera cylindrical* (L.)	Uradu	Tree
6	Rhizophoraceae	*Bruguiera gymnorrhiza* (L.)	Thoddu ponna	Tree
7	Rhizophoraceae	*Ceriops decandra* (Griff.)	Calhasu / Thogara	Tree
8	Euphorbiaceae	*Excoecaria agallocha* (L.)	Tilla	Tree
9	Combretaceae	*Lumnitzera racemosa*	Thanduga	Tree
10	Rhizophoraceae	*Rhizophora apiculata* (Bl.,)	Ponna	Tree
11	Rhizophoraceae	*Rhizophora mucronata*	Uppu Ponna	Tree
12	Sonneratiaceae	*Sonneratia apetala*	Pedda kalinga	Tree
13	Acanthaceae	*Acanthus ilicifolius* (L.)	Allchi	Shrub
14	Verbenaceae	*Clerodendrum inerme* (L.)	Pisingi	Tree
15	Fabaceae	*Dalbergia spinosa Roxb.*	Chillangi	Shrub
16	Fabaceae	*Derris trifoliate*	silasila/ Nalla Theega	Shrub
17	Chenopodiaceae	*Salicornia brachiata*		Tree
18	Aizoaceae	*Sessuvium portulacastrum*		Herb
19	Chenopodiaceae	*Suaeda fruticosa* (L.)	Elakura	Shrub
20	Chenopodiaceae	*Suaeda maritima* (L.)	Elakura	Herb

Table – 1: Systematic Position Of The Species Present In The Mangrove Region – I Of The Study Area

3.2 Floral Composition

Mangrove vegetation in the region–I consisting of 12 genera and 20 species of 11 families has been recorded as 14 trees, 4 shrubs and 2 herbs (Table – 1**).** Habitat-wise distribution of mangroves in the two field stations of Region is shown in the Figure – 2(a) and (b).

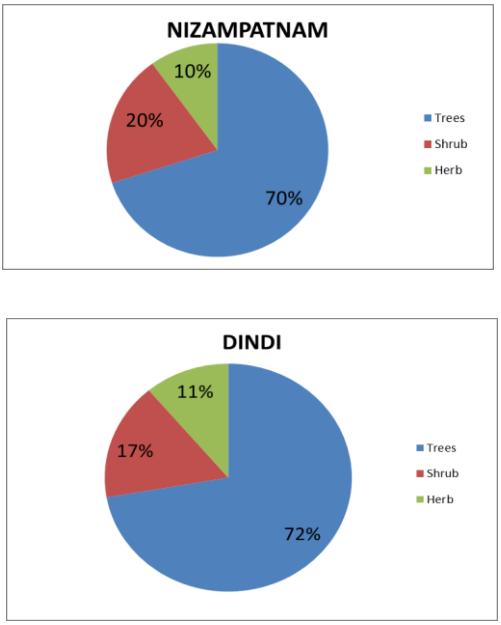

Figure - 2(A,B): Habitat-Wise Distribution Of Mangroves In Region

3.4 Distribution Pattern-Region – I

The mangrove habitat-wise distribution is calculated in the two field stations i.e. Nizampatnam and Dindi of Region - I and species-wise distribution in those field stations (Figure – 3) is discussed below, Nabi A. and Brahmaji Rao P. (2012).

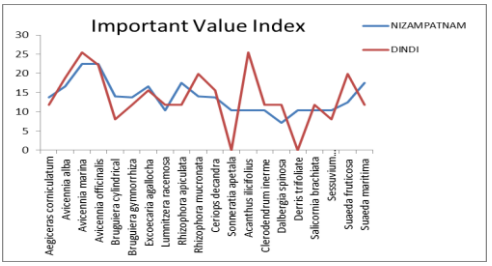

Figure – 3: Distribution Of Mangroves In Region-I Based In Ivi Values

Nizampatnam:

Characteristic vegetation in Nizampatnam area towards sea fringes is dominated by plant species belonging to different families. In this village a total number of 7 species, classified into two main categories, is recorded at channels and mud flats. The first category of vegetation spread along the channels consists of *Avicennia marina, Sonneretia apetala, Rhizophora mucronata* and *Bruguiera gymnorrhiza.* The second category spread on mud flats consists of the species *like Suaeda maritima, Suaeda fruticosa.* Habitat-wise distribution of mangrove vegetation in this region is observed as trees 70%, herbs 20 % and shrubs 10% and shown in the Figure – 2a. Species status of abundance is enumerated based on Relative Frequency values. It is worth noting that there are no species with "very frequent" status. The species Aegiceras corniculatum, *Avicennia alba, Avicennia marina* and *Avicennia officinalis, Bruguiera gymnorrihiza, Excoecaria agallocha, Ceriops decandra* are "frequent" species with a maximum Relative Frequency of 5.00%. *Bruguiera cylindrical, Lumnitzera racemosa, Rhizophora apiculata, Rhizophora mucronata, Sonneratia apetala, Acanthus ilicifolius,Clerodendrum inerme, Derris trifoliate, Salicornia brachiata, Sessuvium portulacastrum, Suaeda maritime* are in " less frequent" status with a Relative Frequency value of 3.33%.There are "rare" species, *Ae Dalbergia spinosa Roxb., Suaeda fruticosa* with a

Relative Frequency value of 1.67%. The Relative Frequency values and status of 20 existing species are shown in Table – 2.

Table – 2: Status of Mangrove Species Based on Relative Frequency Present at *Nizampatnam* In Region – I

S.No.	Name of the Species	frequency	Relative frequency	Status
1	*Aegiceras corniculatum* (L.)	100	5.00	II
2	*Avicennia alba*	100	5.00	II
3	*Avicennia marina* (Forsk.)	100	5.00	II
4	*Avicennia officinalis* (L.)	100	5.00	II
5	*Bruguiera cylindrical* (L.)	67	3.33	III
6	*Bruguiera gymnorrhiza* (L.)	100	5.00	II
7	*Excoecaria agallocha* (L.)	100	5.00	II
8	*Lumnitzera racemosa*	67	3.33	III
9	*Rhizophora apiculata* (Bl.,)	67	3.33	III
10	*Rhizophora mucronata*	67	3.33	III
11	*Ceriops decandra* (Griff.)	100	5.00	II
12	*Sonneratia apetala*	67	3.33	III
13	*Acanthus ilicifolius* (L.)	67	3.33	III
14	*Clerodendrum inerme* (L.)	67	3.33	III
15	*Dalbergia spinosa Roxb.*	33	1.67	IV
16	*Derris trifoliate*	67	3.33	III
17	*Salicornia brachiata*	67	3.33	III
18	*Sessuvium portulacastrum*	67	3.33	III
19	*Suaeda fruticosa* (L.)	33	1.67	IV
20	*Suaeda maritima* (L.)	67	3.33	III

> 7= Very Frequent – I, 5 –7 = Frequent – II, 3 – 5 = Less Frequent - III, < 3 = rare - IV

Species dominance is calculated based on the Important Value Index (IVI). In Nizampatnam the highest IVI value is 22.50 for *Avicennia marina* and *Avicennia officinalis,* followed by 17.50 for *Rhizophora apiculata* and *Suaeda maritima* and 16.67 for *Avicennia alba, Excoecaria agallocha* (Table –3). Therefore *Avicennia marina* and *A. officinalis* are the dominant species in this village.

Table –3: Species Dominance Based On The Important Value Index (Ivi) Valuespresent In The Study Region – I

S.No.	Name of the Species	Important Index Value (IVI)	
		NIZAMPATNAM	***DINDI***
1	*Aegiceras corniculatum* (L.)	13.75	11.83
2	*Avicennia alba*	16.67	18.86
3	*Avicennia marina* (Forsk.)	22.50	25.47
4	*Avicennia officinalis* (L.)	22.50	22.17
5	*Bruguiera cylindrical* (L.)	13.96	8.09
6	*Bruguiera gymnorrhiza* (L.)	13.75	11.83
7	*Excoecaria agallocha* (L.)	16.67	15.56
8	*Lumnitzera racemosa*	10.42	11.83
9	*Rhizophora apiculata* (Bl.,)	17.50	11.83
10	*Rhizophora mucronata*	13.96	19.88
11	*Ceriops decandra* (Griff.)	13.75	15.56
12	*Sonneratia apetala*	10.42	0.00
13	*Acanthus ilicifolius* (L.)	10.42	25.47
14	*Clerodendrum inerme* (L.)	10.42	11.83
15	*Dalbergia spinosa Roxb.*	7.08	11.83
16	*Derris trifoliate*	10.42	0.00
17	*Salicornia brachiate*	10.42	11.83
18	*Sessuvium portulacastrum*	10.42	8.09
19	*Suaeda fruticosa* (L.)	12.50	19.88
20	*Suaeda maritima* (L.)	17.50	11.83
		274.99	273.62

Dindi:

The areas in between sea fringes and interior land are influenced by river water and rare flood water. The interior land is characterized by the vegetation composition of 6 species viz., *Avicennia alba, Avicennia marina, Avicennia officinalis* and *Excoecaria agallocha,Ceriops decandr* and *Acanthus ilicifolius.*The composition of the peripheral area consists of the species *Suaeda maritima, Suaeda fruticosa.* Habitat-wise distribution of mangrove vegetation in this region is observed as trees 72%, herbs 17 % and shrubs 11% and shown in the Figure- 2b.

Status of abundance of species is computed with Relative Frequency. It is worth noting that there are no species with "Very frequent" status.. Another 6 species, with "frequent" status having a Relative Frequency value of 5.66 and 10 species

with "less frequent" status having a Relative Frequency value 3.77**.** 4 species are "rarely" abundant with a Relative Frequency value of 1.89. The Relative Frequency values and status of 20 existing species are shown in Table – 4. The values show that the species have equal status of abundance in this region. Because this region is the central part of the inundation zone having a tidal flushing, all the species are distributed uniformly.

Table – 4: Status of Mangrove Species Based on Relative Frequency Present at *Dindi* In Region – I

S.No.	Name of the Species	Frequency	Relative frequency	Status
1	*Aegiceras corniculatum* (L.)	67	3.77	III
2	*Avicennia alba*	100	5.66	II
3	*Avicennia marina* (Forsk.)	100	5.66	II
4	*Avicennia officinalis* (L.)	100	5.66	II
5	*Bruguiera cylindrical* (L.)	33	1.89	IV
6	*Bruguiera gymnorrhiza* (L.)	67	3.77	III
7	*Excoecaria agallocha* (L.)	100	5.66	II
8	*Lumnitzera racemosa*	67	3.77	III
9	*Rhizophora apiculata* (Bl.,)	67	3.77	III
10	*Rhizophora mucronata*	67	3.77	III
11	*Ceriops decandra* (Griff.)	100	5.66	II
12	*Sonneratia apetala*	0	0.00	IV
13	*Acanthus ilicifolius* (L.)	100	5.66	II
14	*Clerodendrum inerme* (L.)	67	3.77	III
15	*Dalbergia spinosa Roxb.*	67	3.77	III
16	*Derris trifoliate*	0	0.00	IV
17	*Sessuvium portulacastrum*	67	3.77	III
18	*Salicornia brachiata*	33	1.89	IV
19	*Suaeda fruticosa* (L.)	67	3.77	III
20	*Suaeda maritima* (L.)	67	3.77	III

> 7= Very Frequent – I, 5 –7 = Frequent – II, 3 – 5 = Less Frequent - III, < 3 = rare - IV

Species dominance is calculated based on the Important Value Index (IVI). In Dindi the highest IVI value is 25.47 for *Avicennia marina* and *Acanthus ilicifolius,* followed by 22.17 for *Avicennia officinalis and 19.88 for Rhizophora mucronataand Suaeda fruticosa,* and 18.86 for *Avicennia alba* (Table – 5).

Avicennia marina and *Acanthus ilicifolius* are, therefore the dominant species in this village.

3.5 Diversity Measures

Species-wise distribution:

Species-wise distribution pattern (Table – 5) of different field stations of the mangrove region–I i.e., Nizampatnam and Dindi is analysed by using the species area curve and quadrat species curve. The curves are drawn based on the observations made in sub-field station which are selected equally (3 in each place) in all the field stations. The variation in species present in various sub-field stations is shown in the Table - 5 which indicates that all the species are not equally distributed in all the field station. From the table- 5, diversity of various species in the various field stations of region-I is arrived at. The table is also used to obtain Maturity Index Value(MIV), Similarity Index(SI) and Coefficient Difference(CD) and Simpson and Shannon-Wiener Indices in the Region – I.

Table –5: Species-Wise Distribution Pattern of Different Field Stations of the Mangrove Region – I

S.No	Name of the species	Sites					
		1	2	3	4	5	6
1	***Aegiceras corniculatum*** (L.)	+	+	+	+	-	+
2	***A. alba Blume***	+	+	+	+	+	+
3	***A. marina*** (Forsk.) Vierh.	+	+	+	+	+	+
4	***Avicennia officinalis*** L.	+	+	+	+	+	+
5	***B. cylindrica*** (L.) Bl.	+	+	-	-	+	-
6	***Bruguiera gymnorrhiza*** (L.)	+	+	+	+	+	-
7	***Ceriops decandra*** (Griff.)	+	+	+	+	+	+
8	***Excoecaria agallocha***L.	+	+	-	+	+	-
9	***Lumnitzera racemosa***Willd.	+	+	-	+	+	-
10	***Rhizophora apiculata*** Bl.	+	+	-	+	+	-
11	***R. mucronata*** Poir.	+	+	+	+	+	+
12	***Sonneratia apetala***Buch.Ham.	+	-	+	+	+	+
13	***Clerodendrum enerme***(L.) .	-	+	+	+	+	-
14	***Dalbergia spinosa Roxb.***	+	+	-	+	-	+
15	***Derris trifoliate***	-	+	-	+	+	-
16	***Acanthus ilcifolius*** L.	+	+	-	+	-	-

17	***Salicornia brachiata Roxb.***	+	+	-	-	+	+
18	***Sesuvium portulacastrum***L.	+	+	-	-	+	+
19	***Suaeda fruticosa***	-	-	+	-	+	+
20	***S. maritima***(L.) Dum.	-	+	+	-	-	+
Total no. of species in each station		**16**	**18**	**11**	**15**	**16**	**12**

Maturity Index:

Maturity index values of the field stations in Region – I i.e. 75 of Nizampatnam and 74 of Dindi show that there is the densest mangrove vegetation at both the two place, Further, it can be inferred that places where there is less frequency of inundation, have less dense mangrove vegetation (Table -6).

Table –6: Maturity Index Values (MIV) of Mangrove at Different Field Stations of the Study Region - I

S.No.	Name of the Species	Frequency %	
		NIZAMPATNAM	***DINDI***
1	*Aegiceras corniculatum* (L.)	100	67
2	*Avicennia alba*	100	100
3	*Avicennia marina* (Forsk.)	100	100
4	*Avicennia officinalis* (L.)	100	100
5	*Bruguiera cylindrical* (L.)	67	33
6	*Bruguiera gymnorrhiza* (L.)	100	67
7	*Excoecaria agallocha* (L.)	100	100
8	*Lumnitzera racemosa*	67	67
9	*Rhizophora apiculata* (Bl.,)	67	67
10	*Rhizophora mucronata*	67	67
11	*Ceriops decandra* (Griff.)	100	100
12	*Sonneratia apetala*	67	0
13	*Acanthus ilicifolius* (L.)	67	100
14	*Clerodendrum inerme* (L.)	67	67
15	*Dalbergia spinosa Roxb.*	33	67
16	*Derris trifoliate*	67	0
17	*Salicornia brachiata*	67	67
18	*Sessuvium portulacastrum*	67	33
19	*Suaeda fruticosa* (L.)	33	67
20	*Suaeda maritima* (L.)	67	67
		1500	1333
		75	**74**

A comparison of MIV values of the field stations in Region – I is shown in the bar graph (Figure- 4)

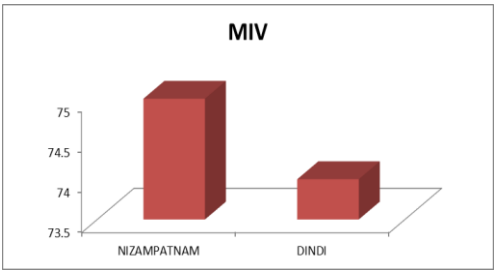

Figure – 4: Station-Wise Maturity Index Values (MIV) of Mangrove Vegetation at Region – I.

3.9.1 Faunal Composition

Major faunal resources are the combination of different invertebrates and vertebrates. Groups of mollusca, crustacea and fishes are the main fishery resources. Apart from fisheries, vertebrate fauna like amphibians reptiles, aves and mammals are also found.

Invertebrates:

Invertebrates of fishery importance in the study area are recorded (Table - 7).These are found abundant in maritime sediment and nearer to coastal waters of the study area. The molluscans shell fish of the region are divided into three groups namely cephalopods, bivalves and gastropods. 16 species belonging to mussels and clams form 75% of the dominant groups. Cephalopods and gastropods form 25%. Molluscan species occurring near to shore of the surveying areas include Mytilus indica, M. viridis, Crossostrea madrasensis, Xancus psycum. At low salinity areas, the species mostly found are Meretrix meretrix, vellorita cyprinoids, Anadora granosa and Katelysia spina. The other species such as Ammusium, Pecten, Anadora and mecter are exclusively available at the marginal areas.Mangrove swamps play a vital role as nursery grounds for shrimps and other crustacean species. Crustaceans are divided into crabs and prawns.Among the crabs, riddler crab (Uca dussumieri) is the most commonly found crab towards sea whereas other species like Scylla serrata, S. oceanic, S.

trangubarica and S. paramansina are the common forms noticed in brackishwater. Remaining two species viz. portunus pelaginus and Charubdis curciate.Mangrove waters rich in detritus form highly potential breeding medium of prawns and fishes. The study area accounted for nine species of penaeid prawns like Penaeus indicus, P. monodon, P. semisulcatus, P. mergiensis, Metapenaeus dobsoni, M. monoceros, M. brevicornis, M. affinis and Macrobrachium rosenbergii. Some commercially important fish species encountered in the current investigation are listed in (Table - 7) Sasidhar .K PhD thesis (2015).

Table–7: A List of Fishery Fauna of Commercial Importance in the Study Area

Group			Scientific Name	Common Name
1	Crustations			
	a.	Prawns	*Penaeus indicus*	White Prawn
			Penaeus monodon	Tiger Prawn
			PenaeusSemisulcatus	Flower Prawn
			Penaeus merguiensis	
			Metapenaeus affinis	King Prawn
			M. monoceros	Brown Shrimp
			M.dobsonii	Pink Shrimp
			Macrobrachium monoceros	Freshwater Prawn
			M.rosenberghii	Giant freshwater Prawn
	b.	Lobsters	*Panilurus sp.*	Deep sea lobsters
			Thenus orientalis	sand lobsters
	c.	Crabs	*Scylla serrata*	Mud crab
			S.tranguibarcil	Sea crab
			Charybdis cruciata	Sea crab
2	Molluses			
	a.	Cephalopods	*Sepia sp.*	Cuttle fish
			Loligo sp.	Squid
	b.	Bivalves	*Perna indica*	Brown mussel
			P.viridis	Green mussel
			Villorita cyprinoides	Clam
			Anadora granosa	Clam
			Crossostrea madrasensis	Clam
			Katelysia opima	Oyster
	c.	Gastropoda	*Achantina fulica*	
			Cerithidea fiuviatilis	Giant African sand snail
3	Fishes		*Rastrelliger kanaguta*	
			Mugil cephalus	Mackerel

		Lates calcarifer	Mullet
		Epinephalus sp., Nemipterus sp.,	Purches
		Panprus argentius	White pamfret
		P.niger	Black pomfret
		Sardinella longiceps	Sardina
		S.fimbricata	Sardina
		S.gibbosa	Sardina
		Euthunnus affinis	Tuna
		Scomberomorus guttatus	Seer fisg
		Periophthalmus crysocephalus	Mud fish

3.9.2 Vertebrates:

Table–8: A List of Vertebrate Fauna of Wild Life Importance in the Study Area

Group	Name of the species	Common Name	Status
Amphibians	**Rana hexadactyla**	Skipper frog	Common
	R. cyanophlyctis	Common frog	Common
	Bufo melanostictus	Toad	Common
	Microhyla ornate	Tree frog	Rare
Reptilia	*Lepidochelys olivaceae*	Olive ridley	Rare
	Kachuga tectum tentorica	Reed turtles	Common
	Lissemys punctata punctata	Terrapin	Common
	Varanus bengalensis	Monitor lizard	Rare
	Amphiesma stolata	Land snake	Common
	Natrix piscator	Freshwater snake	Common
	Dryophis pulverulentus	Green snake	Rare
	Naja naja	Common cobra	Vulnerable
	Bungarus caeruleus	Viper	Vulnerable
	Vipera russelli	Viper	Vulnerable
Birds	*Anihinga rupa*	Darters	Resident
	Phalacrocorax niger	Little cormorant	Local
	Egretta grazetta	Little egret	Resident
	Bubalicus ibis	Cattle egret	Resident
	Ardeola grayii	Pond heron	Resident
	Larus brunnicephalus	Black headed gulls	Migratory
	Ringo glariola	Sand pipers	Migratory
	Numerous arguata	Curlew	Migratory
	Ceryle rudis	Pied kingfisher	Resident
	Alcedo althis	Common kingfisher	Resident
	Anas actua	Pintail	Migratory
	A. clypeata	Stoveler	Migratory
	A. crecca	Common teal	Migratory
	Tringa nebularia	Green shank	Migratory
	T. tetanus	Common red shank	Migratory
	Rostradella bengalensis	Painted snipe	Local
	Corvus splendens	Common crow	Local

	Recurvirostra avosetta	Avocet	Migratory
Mammals	*Macca mullatta*	Rhesus monkey	Vulnerable
	Lutra perspicillata	Water otter	Endangered
	Felis chanos	Fishing cats	Endangered
	Cannis aureaus	Jackal	Vulnerable
	Vulpes bengalensis	Indian fox	Vulnerable
	Herpestres bengalensis	Mongoose	Common
	Tupia elliotti	Tree shrew	Common
	Funambulus pennati	Common squirrel	Common
	Pteropus giganteus	Flying fox	Common
	Lepus nigricornis	Hare	Vulnerable
	Mus buduga	Field mouse	Common
	Rattus rattus	Field rat	Common

There are 43 species belonging to four major vertebrate (mammals, aves, amphibians and reptiles) with significant wildlife importance in the study area (Table - 8) . There was no migratory birds prevail for nesting and breeding activity in region. There is migration of birds to region only for food. The commonly migrating birds in both the regions are listed (Table-8).

Most of the common fauna occur in the marginal areas where as rare and vulnerable fauna are confined to a particular living habitat of dense mangrove vegetation in the central areas. The other category of endangered status is strictly associated for fauna in the interior areas towards sea fringes.

Mangrove forests serve as diverse habitats for many species, including fish, bird, reptiles, amphibians, mollusks, crustaceans and many other invertebrates. Mangroves act as root of sea and if there is no mangrove along the coast, there will be no or fewer fish in the sea and the sea will act as tree without its root. Mangroves provide nursery grounds for fish, prawns & crabs and support fisheries production in coastal waters. The exposed prop roots and pneumatophores provide ample hiding place for fish. Many commercial shrimp and fish species are commonly available here. Mangroves produce leaf litter and detritus matter, from the leaves of mangrove trees, which are valuable sources of food for aquatic animals of coastal

waters. Up to 80% of global fishing is directly or indirectly dependent on mangroves (Fujimoto 2000). From Sundarban mangrove forests, an average of 6000 tons of fish per hectare per year provides a great source of natural food (Hossain 2008). Mangroves serve as recreational grounds for bird watching and observation of other wildlife by providing shelter for local and migratory wildlife.

4.0 Conclusion

Vegetation analysis methods include systemic classification of the plant species, status of mangrove plant species which is based on relative frequency, species dominance which is based on Important Value Index(IVI), species-wise distribution pattern, Maturity Index Value (MIV), Similarity Index(SI), Coefficient difference(CD) of mangrove, Shannon-Weiner and Simpsons' Indices. They are computed by statistical methods, for a comparative study of mangroves in the region at two stations.There are 43 species belonging to four major vertebrate (mammals, aves, amphibians and reptiles) with significant wildlife importance in the study area . There was no migratory birds prevail for nesting and breeding activity in region. There is migration of birds to region only for food.

Acknowledgement

The authors also gratefully acknowledge the co-faculty members of the Department of Environmental sciences, Acharya Nagarjuna University. I also thank Prof z. Vishnu vardhan and Dr. R. Hema Krishna for his valuable help in proof reading the text.

REFERENCES

1. Blasco, F. (1975). the mangroves in india. Institute francais de pondicherry, sect.sci.tech., india. 14, pp. 180

2. Untawale, a.g. (1987). India. pp 51-87 ln: umali, R.M. Et al (eds.) Mangroves of asia and the pacific: status and management. Natural resources management center and national mangrove committee, ministry of natural resources, manila, Philippines.
3. Noronha, l. And nairy, k.s. (2003). Changing uses, ecosystem valuation, and perceptions: the case of khazans in goa; ln: coastal tourism, environmental, and sustainable local development; teri; new deli; pp. 253-268.
4. Banerjee et al. (1989).mangroves in india, identification manual, botanical survey of india, govt. of India.
5. Banerjee *et.al.*, (l998). Mangroves, associates and salt marshes of the godavari and krishna delta.botanical survey of india, envis centre, calcutta
6. Selvam, v. (2003). Environmental classification of mangrove wetlands of India current science, 84 (6) pp. 757-765.
7. Forest survey of india (fsi) report. (2009). Ibid.
8. Smith, t.j. Iii (1992). Forest structure. Ln "tropical mangrove ecosystems" (a.i.robertson and d.m. Alongi, eds), pp. 101-136. American geophysical union, washinton DC., USA.
9. Raunkiaer, C. (1934).the life forms of plants and statistical grography. Claredon , Oxford, Pp.632
10. Philips, e.d. (1959). Methods of vegeration study holt. Rinehart and mirston inc. Usa.pp.1-105.,
11. Pichi-sermolli, r.(1948). An index for establishing the degree of maturity in plant communities j ecol. 36 pp. 85-90.
12. Alagarswamy, k. (1995). Sustainable development of shrimp farming in das, banka behary, prawn culture.a demonstration on the coast, bhuvaneswar, orissa.pp.14-20.

13. Ludwig, j.a. And reynolds, j.f. (1988). Statistical ecology: a premier on methods and computing. New york.
14. Turner, d. P. J. K. Winjum, t. P. Kolchugina, and m. A. Cairns.(1997).accounting for biological and anthropogenic factors in national land-base carbon budgets. Ambio 26:220-226.
15. Mueller-dombois, d. And h. Ellenberg.(1974). *Aims and methods of vegetation ecology*.wiley, new york.547 p.
16. Fujimoto, k., (2000). Belowground carbon sequestration of mangrove forests in the asia-pacific region proceedings of asia-pacific cooperation on research for conservation of mangroves, okinawa, japan, pp.87-96.
17. Hossain, m.s., sam, w. And shamsuddoha, m. (2008). Care mangrove forest care coastal people. (institute of marine sciences and fisheries, chittagong university, bangladesh).
18. Pawar tushar anant (2012) study of mangrove flora along the zuari river (case study on curtorim village – goa-india) international research journal of environment sciences vol. 1(5), pp35-39.
19. Nabi a. And brahmaji rao p. (2012). Analysis of mangrove vegetation of machilipatnam coastal region,Krishna district, andhra pradesh, pp 1744 – 1754.
20. Sasidhar .k PhD, Thesis (2015). Ecological studies for the conservation and management of Guntur mangrove forests in Andhra Pradesh, India
21. K.Sasidhar, Ch.Tirupathi, R Hema Krishna, Z Vishnuvardhan, AVV S Swamy, P Brahmajirao (2013).Studies of mangroves and identification of various salt resistance Species at southern Krishna delta. International Journal of Engineering & Science Research Vol-3(1), pp555-562.