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ESTIMATION OF CARBON STOCKS IN ABOVE GROUND BIOMASS IN MUTHUPET MANGROVE, SOUTHEAST COAST OF INDIA

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ABSTRACT

Mangroves are defined as woody trees and shrubs that grow in places where river water mixes with seawater. The need of the study is selected quantification of terrestrial carbon and monitoring of these stocks over time is important for reasons of climate change mitigation. The anthropogenic responses to climate change have the potential to exacerbate the adverse effects of climate changes on mangrove ecosystems. Which leads mangrove system can also release large quantities of stored carbon and exacerbate global warming and other climate change causes. In order to carbon stock were estimated in Above Ground Biomass of different mangrove species and associated marshy vegetal parts. Mangroves and marshy vegetation were partitioned into leaves, stems and roots. The moisture, dry weight, mineral matter, organic matter and organic carbon content was estimated for mangrove and associated plant species. The moisture content varied from 43% to 88%,the lower percent of moisture content was observed in the Exoecaria agallocha leavesand high moisture content was observed in Sesuvium portulacastrum leaves.The dry matter falls between 13 to 64%, lowest level in Sesuvium portulacastrum and higher level in Exoecaria agallocha. Organic carbon varied between 45 to 54% for mangrove species and 30 to 54% for marshy vegetation.The dominant mangrove species of Avicennia marina mangrove occupied 45.9, 53.1 and 53.3% of organic carbon in their leaves, stems and roots respectively.

I INTRODUCTION

Mangroves are trees and shrubs that grow in salinecoastal habitats. The word mangrove can also be used to describe the habitat as well as the speciesof trees and shrubs that grow in that habitat.Mangroves are found in depositional coastal environments where sediments, often with very highorganic content, collected in areas protected from high energy wave action. Mangrove forests provide arange of important goods and services, including carbon sequestration and coastal protection. Mangrove forests are one of the most productive and bio diverse wetlands on earth which can be divided into two distinct groups: restricted and unrestricted. Restricted mangrove group are the largest, comprising around 60 species (Saenger *et al*., 1983). The remaining 20 plant species considered to be mangroves are referred to as non-exclusive or unrestricted. This wetlands produce as wax, tannin, dye,fodder, honey, plant materials for thatching, availability of aquatic food such as fish, prawn, crabs, mussel, clam and oysters. They enhance the fishery productivity in adjacent coastal waters by providing them with large quantities of organic and inorganic nutrients. Apart from these, mangrove wetlands provide a variety of amenities to coastal communities. Mangroves mitigate the adverse impact of storms and cyclones in coastal areas. They reduce coastal erosion. The total area of mangroves in India is covered as to be 6,740 sq. km. In Tamil Nadu estimated is about 150 sq. km. at Muthupet and Pitchavaram (Ashok et al., 2014). The need of the

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study is selected quantification of terrestrial carbon and monitoring of these stocks over time is important for reasons of climate change mitigation. The anthropogenic responses to climate change have the potential to exacerbate the adverse effects of climate changes on mangrove ecosystems. In this provision mangrove environment can also release large amount of stored carbon and make worse global warming and other climate change causes.

Naturally or artificially some amount of the carbon accumulate and stores for indefinite periods is known as carbon sink. Removal of CO_2 from the atmosphere is known as carbon sequestration. Responses to this concern have focused on reducing emissions of CO_2 and measuring of carbon absorbed and stored in forests, soil, and marine environment. During photosynthesis trees removes large amount of CO_2 from the atmosphere and store the carbon in their leaves, branches, stems, bark and roots but the respiration process in each part varies enormously. Carbon sequestration is depending on the plant species and the individual age and growth pattern. In these stripes mangroves absorb a significant amount of carbon into the plant biomass through net primary production. Importantly, they also sequester some of this carbon in the soil for long periods of time. Present study deals with estimate the carbon stock in above ground biomass in mangrove and associate plant species.

STUDY AREA

The Mullipallam creek is a semi enclosed coastal wetland surrounded by mangrove swamps and intertidal land situated on the south-eastern coast of India, approximately 400 km south of Chennai. The study area spreads over 10º18′ to 10º22′ N latitude and 79º28′ to 79º36′ E longitude and is a medium tropical transition climate, characterized by a monthly average temperature of over 27ºC.Thisregion is the average annual rainfall 1201 mm to1400 mm. The extensive mangrove habitat is estimated to be about 1,500 ha and the creek is used for fishing and it serves as a nursery ground for marine fish and shrimps. The creek receives freshwater from five tributaries of the Cauvery River, such as the River Kilathangiyar, Paminiyar, Korayar, Marakkakorayar and the Kandankurichanar channels.(Fig.1.)

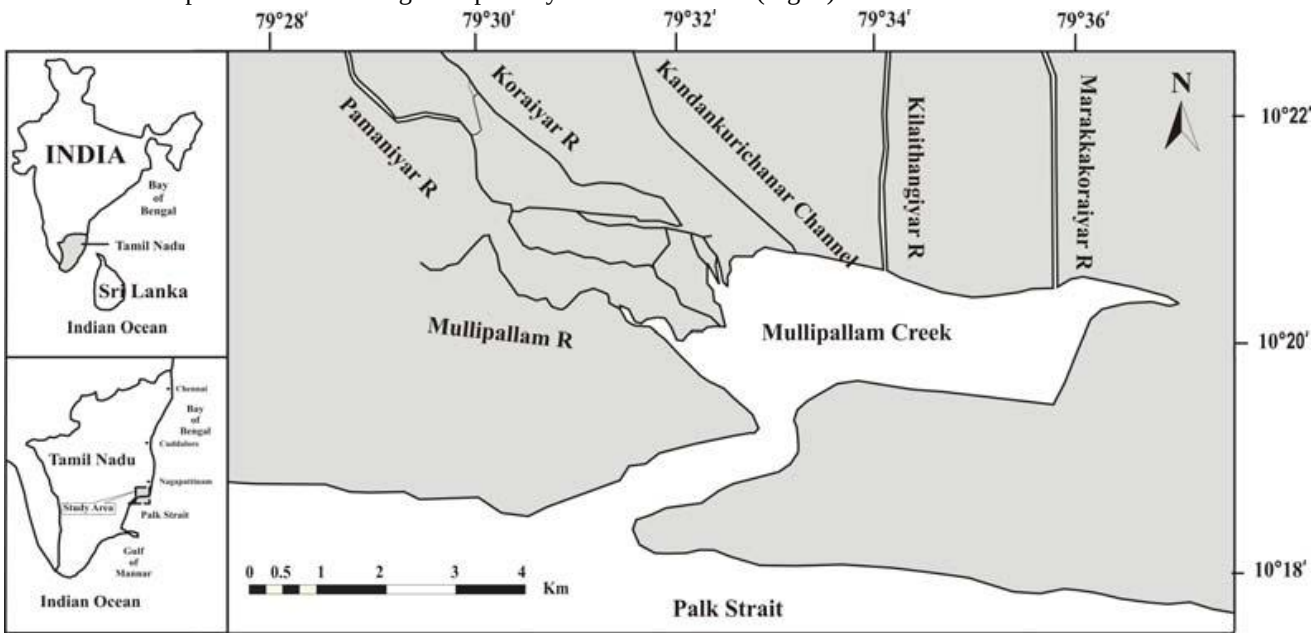


Fig.1.Study area location map

The creek receives fresh water mostly during the north eastern monsoon season, from October to November but fresh water input into the creek is limited to the north-eastern monsoon period. The

developmental activities around the Mullipallam creek area are very scanty, and the commercial activities include salt pans, aquaculture ponds, agricultural. The multifarious uses and values of the Muthupet mangroves were reduced over a period of time due to direct and indirect natural and man-made activities.

Muthupet forest encompasses the lagoon, mudflat and rivers. Muthupet lagoon is a spectacular natural creation, which is the nearby Muthupet town is 8 km and can be reachable only travel by boat. The lagoon shallow depth is 1m average. The lagoon bottom is silt clay formed substratum. The tidal fluctuations can be observed well with the exposure of roots and beds during low tide.

The density of Muthupet mangroves is very high, but the true mangrove species diversity is low when compared to the mangroves of Pichavaram (Muniyandi, 1985). The Muthupet mangrove wetland is characterized by the presented by various number of species is *Avicennia marina, Aegiceras corniculatum, ilicifolius, Excocaria agallocha, Lumnitzera* racemosa *and Rhizophora mucronatoa*. The species of the bio-diversity in Muthupet is dominated by single species *Avicennia marina* constituting more than 95% populations in around muthupet wetlands and other species in mangrove wetland is limited. In the wetlands, have two distinct zone viz., *Avicennia*zone and degraded zone. The former is characterized by the presence of dense evergreen *Avicennia marina* 3 to 8 m followed by *Aegiceras corniculatum* and *Excocaria agallocha*as small bushed of 1 to 2 m. This zone occurs in the fringe area of tidal creeks, manmade fishing canals and along the muddy shore of the Palk Strait. Palynological studies carried out in Muthupet mangrove wetland indicate that true mangrove species belonging to Rhizophoraceae were the dominant species about ago 150 yrs. but now they are local extinct (Caratini*et.al.*, 1973).

MATERIALS AND METHODS

The remote sensing geo cover data set was downloaded from the global land coverfacility (GLCF) (http://glcf.umd.edu and http://earthexplorer.usgs.gov/), which is available free of cost. Geo cover is a collectionof Landsat data that provides cloud free images collected for the year 11 NOV 1999 and IRS P6 LISS III 20 MAY 2007. Base map and drainage map was prepared from SOI Toposheet on 1: 50, 000 scale and updated using satellite data. Geological map of the area was prepared from Geological Quadrangle Map published by Geological Survey of India (GSI). Soil map was prepared from soil survey of India map. The wetland features (i.e., mangroves, rivers, mudflat and tidal flat, saltpan, aquaculture pond) were mapped using Landsatdatas and IRS-LISS III satellite imageries for the year of 1999 and 2007.All the basic thematic maps like geology, soil, geomorphology, Landuse/land cover maps were digitized using Arc GIS 9.3 software.. Above ground biomass of different mangrove species and associated marshy vegetal parts and soil samples were collected for organic carbon estimation from the mangrove wetland. Mangroves and marshy vegetation were partitioned into leaves, stems and roots. Fresh weight of each samples were taken accordingly (Fig.2).

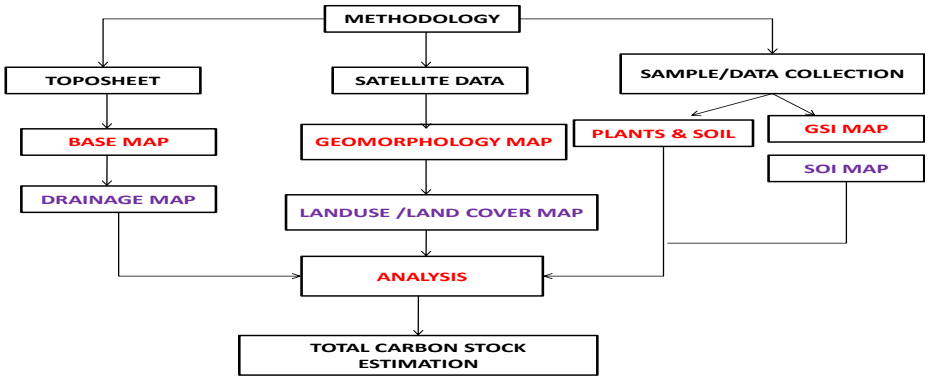


Fig.2.METHODOLOGY

RESULT AND DISCUSSION

Land use /land cover changes during 1999-2007

A broad classification of different types of vegetation and land use patterns was done and 11 different classes were identified. The land use features like mangroves, creek, river, aquaculture, waterlogged area,mudflat/tidal flat, saltpan, agriculture land and other vegetation, such as the identified Prosopis categories from the satellite imagery.The study area occupies about 203 sq kmin the deltaic region of the Cauvery River, which includes the Muthupetwetland forest, agricultural use of the land and large areas of mud flats. The satellite data (1999) indicate that mangrove occupy only 20.9 sq.km (10%) and mud /tidal flat, water bodies cover the rest of the area (Table.1).

Table 1. Land-use / Land cover changes during 1999-2007 in the Muthupet mangroves, south eastern coast of India

Classes	1999 (sq km)	In %	2007(sq.km)	In %	% of changes 1999-2007
Creek	20.6	10.0	17.2	8.4	-1.6
River	3.5	1.7	4.2	2.1	0.4
Mangroves	20.9	10.2	31.3	15.4	5.2
Water bodies	0.1	0.0	0.1	0.0	0.0
Plantation	9.1	4.4	16.2	8.0	3.5
Aquaculture pond	15.3	7.5	18.5	9.1	1.6
Mud flat	93.3	45.5	87.0	42.7	-2.8
Settlement	0.3	0.1	0.4	0.2	0.1
Agriculture land	27.6	13.5	19.8	9.7	-3.7
Marshy vegetation	13.2	6.4	7.7	3.8	-2.7
Salt pan	1.3	0.6	1.3	0.6	0.0

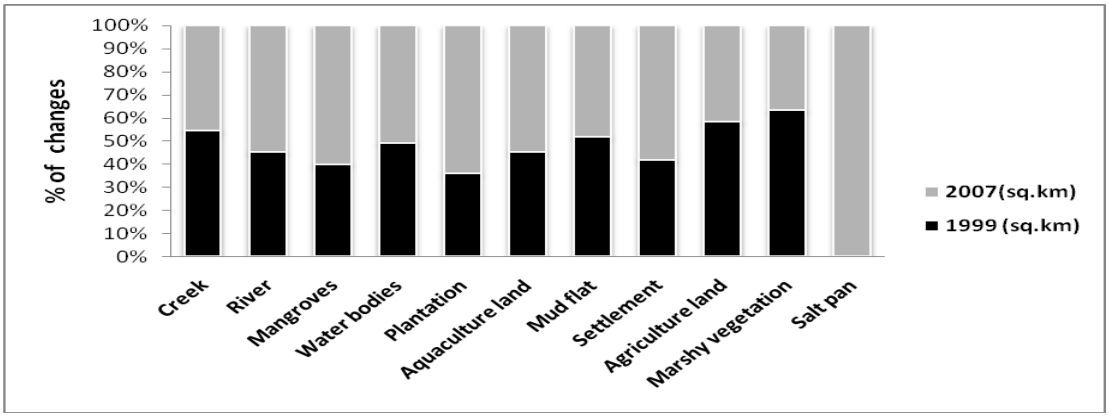


Fig.2. Percentage of land use and land cover changes 1999- 2007

There was a significant increase in the mangroves different class from 1999 to 2007(Fig.2). The mangroves were covered by estimated to 20.9sq km (10% of the total study area) in 1999, and 31.3 sq km (15%) in 2007. There was a significant increase in mangrove areas was due to the restoration activity of the mangrove forestand a significant degradation of dense mangrove areas occurred due to human activities(Fig.3).

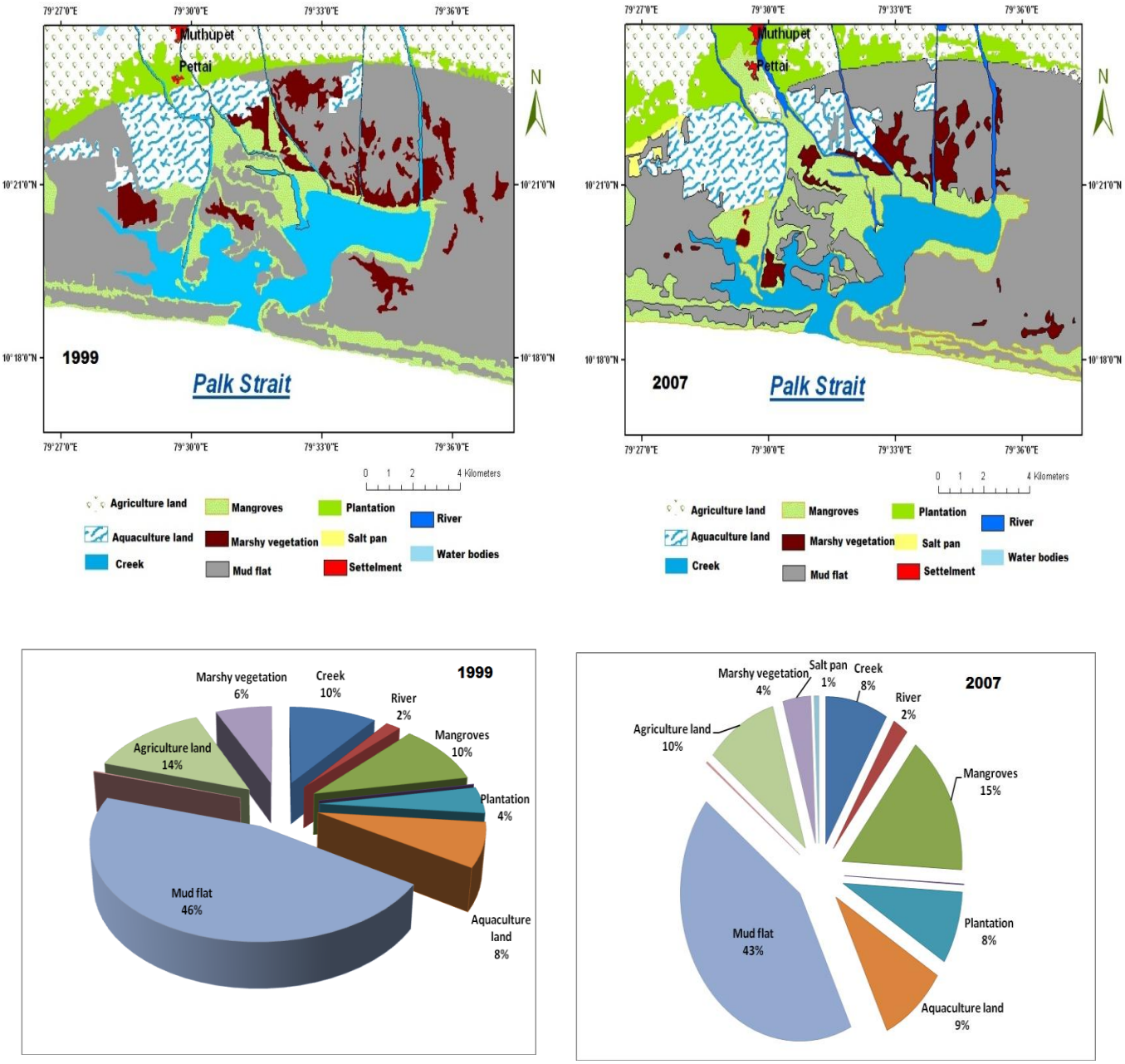


Fig.3. Land-use / Land cover changes during 1999-2007 in the Muthupet mangroves, south eastern coast of India

Moisture Content

The most widely known biomasses are moisture content that have stored water content by plants. Moisture content is diffuse wetness that can be felt as vapor in the atmosphere (water content). In the case of moisture contents in mangrove and marshy vegetation, high moisture content was stored by *Sesuvium Portulacastrum* (88% in leaf and 87% in

stem) (Table 2). However the low level of moisture content was stored in of *Exoecaria Agallocha* (43% in leaf and -35% in stem). The mangrove species and associated vegetation *Rhizophora*, *avicennia marina* is prominently root structure at the surface area , hence we have collected root part in the both in mangrove species. Among the *Rhizophora*, *Avicennia marina* mangrove species high level of moisture content stored at *Rhizophora* 66% then *Avicennia marina* is 41%.(Fig.4a).

Table 2. Percentage ofMoisture content in mangrove species

Species	Leaf %	Stem %	Root %
Avicennia marina	20.88	8.35	8.17
Salicornia Brachiata	35.27	6.60	-
Suaeda monoica	45.54	9.52	-
Sesuvium portulacastrum	47.59	42.81	-
Rhizophora	11.01	7.64	7.80
Acanthus Ilicifolius	15.43	11.02	-
Aegiceras Corniculatum	6.79	5.58	-
Exoecaria Agallocha	12.66	7.92	-
Prosopis	11.67	5.94	-

Dry matter %

The dry matter is plant or animal tissue residue after it has heated to a constant weight and all of the moisture in the sample has been driven off by great heat of a feed contain all the nutrients except water. The dry matter in leaf, stem and root ranged from 11 – 56%, 13.3-64.6% and 33.5-59.7% respectively (Table.3). The high level of dry matter content in leaf and stem was stored by *Exoecaria agallocha* and low level of dry matter stored in *sesuvium portulacastrum* (Fig.4b). Similarly more level of dry matter content in root stored by *Avicennia marina* (59.7%).

Table 3. Percentage of Dry matter in mangrove species

Species	Leaf %	Stem %	Root %
Avicennia marina	52.1	60.5	59.7
SalicorniaBrachiata	22.5	61.9	-
Suaedamonoica	14.3	54.7	-
Sesuviumportulacastrum	11.2	13.4	
Rhizophora	40.0	48.1	33.5
Acanthus Ilicifolius	49.5	34.6	
AegicerasCorniculatum	54.9	55.4	
ExoecariaAgallocha	56.9	64.7	
Prosopis	32.4	41.7	

Mineral Matter %

The most widely known biomass is that mineral matter that have stored by plants and having

a distinct various chemical composition, crystalline structure, color, and hardness. Estimation of mineral matter in mangrove wetland shows high in of *Suaedo Monoica* (45 %) leaf and low level in *Rhizophora* (11 %) (Table.4). High content of mineral matter in stem part observed in *Sesuvium Portulacastrum* (42%) and low level in *Aegicerous Corniculatum*(5%) (Fig.4c).

Table 4. Percentage of Mineral matter in mangrove species

Species	Leaf %	Stem %	Root %
Avicennia marina	20.88	8.35	8.17
Salicornia Brachiata	35.27	6.60	
Suaeda monoica	45.54	9.52	
Sesuvium portulacastrum	47.59	42.81	
Rhizophora	11.01	7.64	7.80
Acanthus Ilicifolius	15.43	11.02	
Aegiceras Corniculatum	6.79	5.58	
Exoecaria Agallocha	12.66	7.92	
Prosopis	11.67	5.94	

Organic Matter %

The organic matter is the dead plants and animal's particular period of time decomposition and deposited at subsurface soil region and this organic matter will be utilized plant through root respiration. The high level of organic matter stored in mangrove species about 93 % in leaf and stem of *Aegicerous Corniculatum* (Table.5).

Table 5. Percentage of Organic matter in mangrove species

Species	Leaf %	Stem %	Root %
Avicennia marina	79.12	79.11	91.83
Salicornia Brachiata	64.73	64.73	
Suaeda monoica	54.46	54.46	
Sesuvium portulacastrum	52.41	52.41	
Rhizophora	88.99	88.99	92.20
Acanthus Ilicifolius	84.57	84.57	
Aegiceras Corniculatum	93.21	93.21	
Exoecaria Agallocha	87.34	87.34	
Prosopis	88.33	88.33	

The low level organic matter stored in *Sesuvium portulacastrum* (52 % in leaf). Among the all vegetal part root stored more organic matter about 92.2 and 91.8% in *Rhizophora* and *Avicennia* species as respected (Fig.4d).

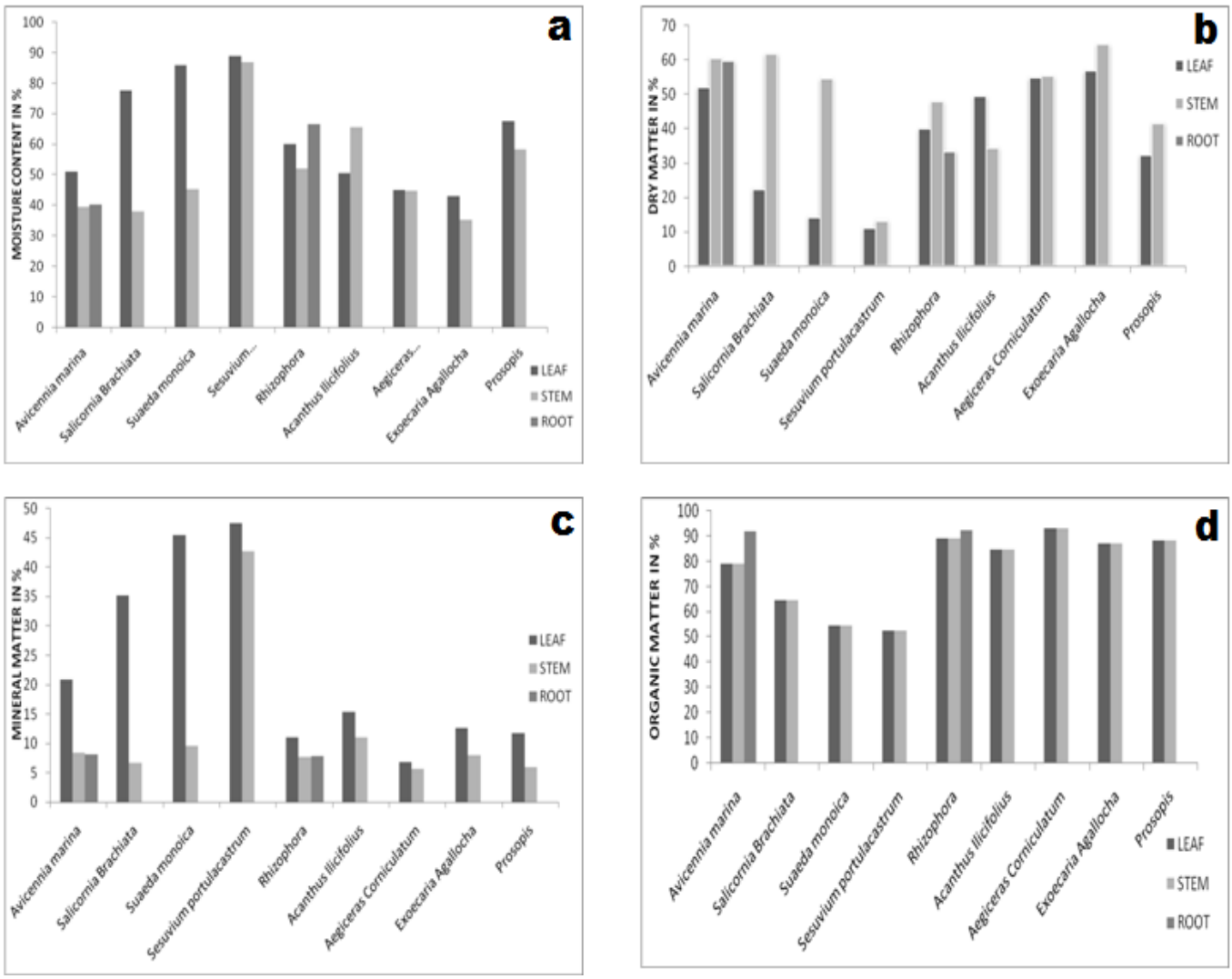


Fig.4. Percentage of mangrove species in vegetal parts

Organic Carbon %

Naturally-occurring organic carbon forms are derived from the decomposition of plants and animals. In soils and sediments, a wide variety of organic carbon forms are present and range from freshly deposited litter (e.g., leaves, twigs, branches) to highly decomposed forms such as humus (Table.6). Present study organic carbon for mangrove and marshy vegetation species was carried out and result showed that organic carbon varied between 45 – 54% for mangrove species and 30 - 54% for marshy vegetation (Fig.5e).

Table 6. Percentage of Organic carbon in Mangrove Species

Species	Leaf %	Stem %	Root %
Avicennia marina	45.89	53.15	53.26

Rhizophora	51.61	53.57	53.48
Acanthus ilicifolius	49.05	51.61	
Aegiceras corniculatum	54.06	54.76	
Exoecaria agallocha	50.65	53.40	
Salicornia brachiata	37.54	54.17	
Suaeda monoica	35.16	52.48	

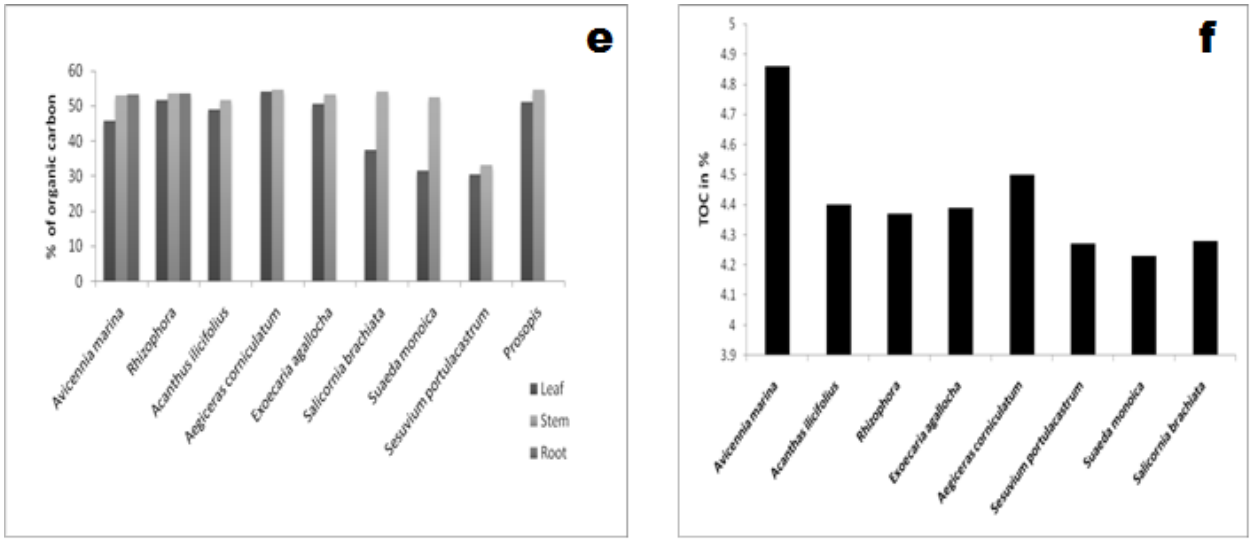
Total Organic Carbon in sediments

The total organic carbonwas carried out in sediments (Table.7). The carbon content varied between 4.2 – 4.8%, low level of carbon content is found in *Sueado monoica* andhigh level of carbon content in *Avicennia marina* sediment (Fig.5f).

Table7. Percentage of Total Organic Carbon in Soil Sediments

Species	*Total organic carbon %*
Avicennia marina	4.86
Acanthas ilicifolius	4.40
Rhizophora	4.37
Exoecaria agallocha	4.39
Aegiceras corniculatum	4.50
Sesuvium portulacastrum	4.27
Suaeda monoica	4.23
Salicornia brachiata	4.28

Fig.5. Percentage of mangrove species in vegetal parts & sediments



CONCLUSION

The landuse/landcover changes study was carriedout using Landsat ETM 1999 and IRS P6 LISS III 2007. In the year 1999 the mangrove cover was about 20.9 sq.km and in 2007 the mangrove cover was increased to 31.3 sq.km. The mangrove cover in the study area was increased to 10.4 sq.km between 1999-2007. The significant increase of mangroves was due to the restoration activity of forest department and NGOs. The moisture, dry weight, mineral matter, organic matter and organic carbon content was estimated for mangrove and associated plant species. The moisture content varied from 43 to 88%. The lower percent of moisture content was observed in the *Exoecaria agallocha* leaves and high moisture content was observed in *Sesuvium portulacastrum* leaves. The mineral matter observed ranges between 5.58 - 47.59%. High content of mineral matter occurred in *Suaeda monoica* (45.5% in leaves) and *Sesuvium portulacastrum* (47.59% in leveas and 42.8% in steam). In dry mater ranged between 13 – 64%, lowest level in *Sesuvium portulacastrum* and higher level in *Exoecaria agallocha.* Organic matter varied between 52 – 93%, in stem and leaf part of the mangrove and associated species. The lowest level of organic matter is recorded in *Sesuvium portulacastrum* and highest level in *Aegiceras corniculatum.*

The estimated above ground biomass of mangrove and associated plants organic carbon varies from 45 to 54% and 30.4 to 54.1% respectively. In 95% covered area of *Avicennia marina* mangrove occupied 45.9, 53.1 and 53.3% of organic carbon in their leaves, stems and roots respectively. Total Organic Carbon analysis was carried out in mangrove sediments. Organic content of the studided sediments samples varied between 4.2 – 4.8%, low level of carbon content is found in *Sueado monoica* sediments andhigh level of carbon content in *Avicennia marina* sediments.

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