DIVERSITY, QUANTIFICATION AND CARBON SEQUESTRATION OF TREES IN DR. BRR GOVERNMENT DEGREE COLLEGE CAMPUS, JADCHERLA, MAHABUBNAGAR DISTRICT, TELANGANA STATE.

Dissertation
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Student Study Project
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by
D. POOJITHA
M. BHAGYAMMA
P. MEENA
G. PUSHPALATHA
R. SWAMY

Research Supervisor
Dr. B. SADASIVAIAH
Assistant Professor of Botany

Submitted to
DEPARTMENT OF BOTANY
DR. BRR GOVERNMENT DEGREE COLLEGE
JADCHERLA – 509 301

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DECLARATION

We hereby declare that the Research work presented in this Dissertation entitled **"Diversity, Quantification and Carbon sequestration of Trees in Dr. BRR Government Degree College, Jadcherla, Mahabubnagar District, Telangana State"** is original work carried out by us under the supervision of **Dr. B. Sadasivaiah**, Department of Botany, Dr. BRR Government Degree College, Jadcherla during the period 2022-2023 for the award of the degree of Student Study Project in Botany. The research work is original and no part of the work has been submitted for the award of any degree or diploma of this College or any other College/University.

Place: Jadcherla

Date: 15-5-2023

Name of the Student	Hall Ticket Number	Class	Signature
D. Poojitha	20033006445023	III BZC EM	D. Poojitha
M. Bhagyamma	20033006445568	III BZC TM	M. Bhagyamma
P. Meena	20033006445584	III BZC TM	P. Meena
G. Pushpalatha	20033006445025	III BZC EM	G. Pushpalatha
R. Swamy	20033006445591	III BZc TM	R. Swamy

Dr. B. Sadasivaiah
Assistant Professor
Coordinator-
Biodiversity Research & Education Centre

Department of Botany
Dr. BRR Government Degree College
Jadcherla
Cell No: +91 9963536233
Email: sadasivaiahbyalla@gmail.com

CERTIFICATE

Certified that the thesis entitled **"Diversity, Quantification and Carbon sequestration of Trees in Dr. BRR Government Degree College, Jadcherla, Mahabubnagar District, Telangana State"** is a bonofide research work done by **Ms. D. Poojitha, Ms. M. Bhagyamma, Ms. P. Meena, Ms. G. Pushpalatha, Mr. R. Swamy** under my supervision in Biodiversity Research & Education Centre, Department of Botany, Dr. BRR Government Degree College, Jadcherla.

Date : 15-05-2023
Place : Jadcherla

(Dr. B. SADASIVAIAH)
Research Supervisor

Dr. B. SADASIVAIAH
Assistant Professor of Botany
Dr. B.R.R. Government College
JADCHERLA.

External Examiner

Head
HEAD
DEPARTMENT OF BOTANY
Dr.B.R.R. DEGREE COLLEGE
Jadcherla-509 301
Dist.Mahabubnagar (T.S.)

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………Poojitha, Bhagyamma, Meena, Pushpa Latha & Swamy

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Chapter-I

INTRODUCTION

India is one of the 17 mega diverse country and ranks eighth among these biodiversity rich countries owing to its rich biodiversity and ecosystems. This has arisen mainly due to relatively large tropical forest area (6,92,077 Km^2) and varied forest types (16 major forest types; ISFR, 2015). Tropical forests comprise of rich as well as varied range of biodiversity among all terrestrial ecosystems due to their occurrence in wide range of climatic variability and environmental conditions (Mohanta et al., 2020). Understanding the regulatory mechanisms that influence the varying plant species diversity among tropical forests is one of the central objectives of forest ecosystem studies. For which large scale as well as small scale (at one-hectare level) biodiversity inventories are helpful to determine the nature and distribution of plant diversity (Pragasan and Parthasarathy, 2010). Biotic features like seedling and sapling establishment ability (Ankalaiah and Sridhar Reddy, 2017) and Niche differentiation among the tree species in regard to the ability to utilize the light availability and soil nutrients may also influence the varied range of tree diversity (Anitha et al., 2010). Among the tropical forests, tropical dry forests represent 42% of the tropical forest regions and occur mainly in Central and South America, Africa, Central Asia, India, and Australia (Murphy and Lugo, 1986). In India, dry and dry deciduous forests constitute the largest forest area by sharing about 36.2 % of the total forested area. These tropical dry forests occur in those regions where prominent seasonality prevails with a dry season of 2–6 months in each year and with a mean annual temperature >25 ◦C, precipitation between 700–2000 mm and constituting mainly at least 50% of deciduous trees (Reddy et al., 2015). Hence environmental conditions such as dry length period, rainfall amount, fire regime and human impacts will influence the maintenance of tree diversity in these dry forests (Agarwala et al., 2016).

Tropical forests of Eastern Ghats along the East coast and central portion of them in Telanagana state and Andhra Pradesh are considered as plant diversity rich areas as well as regional centres for plant endemism. These areas comprise of mainly Moist Deciduous, Dry deciduous and Scrub forests and among them dry deciduous forests represent about 40% of the total forest area (Gopalakrishna et al., 2015). The composition and forest structure of tropical deciduous forests show variations with respect to length of wet period, amount of rainfall, altitude and influence of human and animal activities (Ramana and Sridhar Reddy, 2021). But alarmingly 16-40% of forest loss was recorded over the past 95 years and major portions of natural forests are in degraded stage throughout the Eastern Ghats region (Ramachandran et al., 2020). Hence acquiring information on spatial distribution and effect of human activities on dry forests structure in Eastern Ghats is essential for their conservation as they are not only most threatened due to extension on non-forestry activities, logging etc., and large number of people depends on them for fodder, fuel wood collection and forest products (Ratnam et al., 2019). For which quantitative studies on plant diversity in relation to altitude, microclimate and human impacts are very helpful as certain changes can be predicated easily by means of quantitative data as the population sizes of certain species can be acquired through these studies (Sagar et al., 2003).

Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change. Carbon dioxide is naturally captured from the atmosphere through biological, chemical and physical process. These changes can be accelerated through changes in the land use and agricultural practices, such as converting crop land into land for non crop fast growing plant.

Forests, klep bed and other forms of plant life absorb carbon dioxide from the air as they grow and bind it into biomass. However, those biological stores are considered volatile carbon sinks as the long term sequestered cannot be guaranteed. For the example, natural events such as wildfires or diseases, economic pressures and changing political priorities can result in the sequestration carbon being released back into the atmosphere. To the enhance carbon sequestration processes in oceans the following technologies have been proposed but none have achieved large scale application so far.

According to Brown et al. (1999) the quantity of biomass in a forest determines the potential amount of carbon. Carbon sequestration is a net removal from atmosphere, which includes the uptake of carbon from atmosphere by all chlorophyll plants through photosynthesis. This carbon is stored as plant biomass in vegetation and organic matter in the soil. Various terrestrial ecosystems such as forests, grasslands and agricultural systems have different potential of carbon storage (DOE 1999). For instance forest ecosystem contains more carbon per unit area than any other land type. The rate of carbon sequestration varies with the species composition, region, climate, topography and management practices.

In the India, forest department follow the selection system for felling where only the marked trees are taken out and leaving behind the unmarked trees. Therefore the biomass estimation on unit area basis of vegetation is not possible. Measurement for basal area, height and species specific gravity in field are good parameters for estimating biomass as nondestructive methods. In the present study, the nondestructive methods for estimation of biomass was considered, where the basal area, tree height, species specific gravity and volume equations were used as inputs.

The increase of carbon dioxide concentration in the atmosphere and its potential effect on climate are the most important global environmental issues on the earth. The life time of carbon dioxide in global atmosphere is much higher, from 5 to 200 years. Currently humans are releasing 70Mt of carbon dioxide per day into the atmosphere due to fossil-fuel burning in large scale for power generation and automobiles. One of the major global concerns is the increase of atmospheric carbon dioxideby15-25% over the 100 years and its potential to change the world climate.

Biomass represents the largest organic carbon pool in mature tropical forest ecosystem. Despite its importance it is treated as poorly quantified stock, because changes in biomass dramatically induced by gap dynamics and succession after natural and human induced disturbances. Moreover, biomass shows wide variability within and between forest communities. The change in forest biomass has considered as key characteristics of forest ecosystem.

The floristic, quantification of flora and estimation of Carbon in educational institutions are very rare in India as well as in Telangana State. Dr. Burgula Ramakrishna Rao Government Degree College is not exempted from that studies. Hence, the present work has been undertaken with the following objectives.

The primary objectives of the study are–

- To enumerate the trees and to determine their diversity
- To know the quantitative characters of trees in the college campus
- To estimate the Carbon pool of the college through non-destructive method.
- To propose effective strategies for conservation of plant resources in the study area.

Chapter-II
REVIEW OF LITERATURE

The literature referring to the present work is having three aspects: A) Tree diversity, B) Quantification, C) Estimation of Carbon.

Diversity

Christenhusz and Byng (2016) reported a total 3,08,312 vascular plant species worldwide belonging to 13,467 genera and 412 families. Recently in the year of 2021 theWorld checklist of vascular plants (WCVP) included 1,383,297 plant names; of which, 342,953 accepted vascular plant species were mentioned by Govaerts et al. (2021).

The past works on flora and vegetation of India includes Roxburgh (1832), Hooker (1872-1897), Gamble and Fischer (1915-35), Fyson (1931), Khan (1953), Champion and Seth (1968), Beddome (1869-74), Gamble (1881), Brandis (1906), Troup (1921), Blatter (1926, 1929, 1937), Ireland (1934), Colthurst (1937), Boulton (1944), McCann (1947), Cowen (1950), Bor (1953), Blatter and Millard (1954), Karthikeyan et al. (1989), Sanjappa (1991), Neginhal (2004), Cooke (1908), Achariyar and Tadulingam (1921), Blatter and McCann (1935), Chinnamani (1981), Karthikeyan (1971), Nair and Nair (1981), Matthew (1981-1983, 1982), Sharma et al.(1984), Deshpande and Singh (1986), Henry et al. (1989), Sreekumar and Nayar (1991), Lakshminarasimhan (1996), Mathew (1996), Kabeer and Nair (2009).

Ranjitakaani (1998) studied floristic analysis on Kolli hills of southern Eastern Ghats and recorded 856 angiosperms, 45 pteridophytes and 5 gymnosperms. Saxena and Brahmam (1998) recorded a total of 2561 taxa occur in Eastern Ghats of Orissa. Sri Ramamurty et al. (1998) reported a check list of 328 legumes of Eastern Ghats. Satyanarayana and Sanjappa (1998) worked on endemic legumes of Eastern Ghats and listed a total of 25 taxa from the Eastern Ghats eco-region. Pradeep and Sunil (1999) described *Tripogon sivarajanii* and *Tripogon vellarianus* from the Western Ghats of Kerala. Ravi et al. (2000) discovered *Ischaemum lanatum* and *Chrysopogon purushothamanii* from Kerala, India. Sunil and Pradeep (2001) described *Tripogon ravianus* from Western Ghats of Kerala. Potdar et al. (2003) discovered *Themeda pseudotremula* from Western

Ghats of Maharashtra, India. Rajasekharan et al. (2002) Studied ecological observations on flora and fauna through 40 random plots in Baphlimali hills in the Eastern Ghats of Orissa and recorded 195 plant species. Pradeep and Sunil (2003) described *Eriocaulon ansarii* from Trichur district of Kerala. Two infra-generic varieties of *Caralluma stalagmifera* reported from Peninsular India (Karuppusamy and Pullaiah, 2007). Kottaimuthu and Ganesan (2008) reported *Arisaema agasthyanum* as a new record for the state of Tamil Nadu during their explorations in Tirunelveli hills. Rao et al. (2009) while working on the grass flora of Eastern Ghats of Andhra Pradesh with his team, they reported *Digitaria nodosa* and *Tripogon purpurascens* as new distributional records for Peninsular India. Jung et al. (2010) descried *Hypochaeris chillensis, Microstegium fasiculatum* from Taiwan. Gaikwad et al. (2014) described *Crinum solapurense* from Maharastra, India. Sarvalingam and Rajendran (2016) reported 285 climbers belong to 125 genera of 41 families; of which 33 threatened from Southern Western Ghats, India. Balan et al. (2017) worked on floristic analysis of Thevarmala sacred grove, Western Ghats of Kerala and recorded 153 flowering plants. Kellogg et al. (2020) worked on a check list of grasses in India and mentioned a total of 1506 species. Chandramohan et al. (2020) worked on a taxonomic revision of the genus *Eriolaena* in India. Raja et al. (2020) recorded a new distribution of two endemic plant species, *Euphorbia kadapensis* and *Lepidagathis keralensis* form Karnataka, India.

Studies on plant resources of Eastern Ghats includes Nallamalais by Ellis (1982, 1987, 1990), Reddy et al. (1988), Krishna Mohan and Bairava Murthy (1992), Vijayalakshmi (1993), Kumar (1995), Goud and Pullaiah (1996), Rama Rao and Henry (1996), Goud (1997), Muralidhara Rao (1997), Vijayakumar (1998), Rajkumar et al. (1998), Kumar and Pullaiah (1999), Goud et al. (1999), Pullaiah and Sri Ramamurthy (2000), Rao et al. (2001), Bhakshu (2002), Goud et al. (2002), Pullaiah and Muralidhara Rao (2002), Pullaiah et al. (2003), Rajasekhar Reddy et al. (2006), Venkataratnam (2006), Muralidhara Rao and Pullaiah (2007), Pullaiah et al. (2007), Thulsi Rao et al. (2007), Reddy et al. (2007), Jeevan Ram and Venkata Raju (2007) and Murthy and Benjamin (2008), Shali Saheb (2008), Basha (2009), Sadasivaiah (2009).

Quantification

Quantitative ecological methods to study plants were proposed by Johns et al. (1990), Moerman (1991) and Cotton (1997). Dallmeier (1992) stated that floristic inventories and studies on forest dynamics usually rely on sampling plots. He observed different types of primary and secondary tropical forests through plotting methods in biosphere reserves of Bolivia, Peru, Peurto Rico, US Virgin Islands and other sites. The effects of plot size and the influence of plot shape on the estimates of plant diversity were assessed by Kilburon (1966), Greg-Smith (1983) and Laurance et al. (1998) respectively. Davis and Richards (1934) carried out in the tropical evergreen forest of Moragalli Creek, Guyana and inventoried all the trees ≥10cm dbh in five 1.5 ha plots. Van Claster et al. (2008) studied a total of 255 plots with the size of 10×10m for estimated the over storey and under storey. A nested quadrat of <1m is laid for herbaceous plants in every 10×10m plot.

Tree size has been used for enumeration of girth class distribution. Studies include the enumeration of individual trees as small as 2.5cm dbh (Knight, 1975), 4.5cm dbh (Bunyavejchewin, 1999), 5cm dbh (Valencia et al., 1994; Upadhaya et al., 2003; Small et al., 2004) and 10cm gbh (Venkateshwaran and Parthasarathy, 2003), 30cm gbh (Campbell et al., 1986; Kanade et al., 2008), 91cm gbh (Poore, 1968), 152.4 cm gbh class (Fox, 1967). Newbery et al. (1992) said that frequently used girth thresholds are 10cm dbh or 30cm gbh, this size class plays a major role in forest structure and functioning than the lower sizes.

Hurka and Heinrich (2004) studied plant diversity and composition of all life forms in tropical dry forests of north-western Costa Rica and encountered 328 species of 77 families in 18 sampling plots, of which 102 trees, 50 climbers, 43 shrubs, 133 herbs were recorded. Jacquemyn et al. (2005) studied elevation gradients of orchid diversity, breeding system and floral traits on Reunion Islands using 500m line transects and stated that orchid species richness decreased significantly with increasing altitude. Engel and Martins (2005) conducted eleven-year survey of phenology of 41 tree species in Atlantic forest in Brazil and reported 13 species had regular flowering, 11 species with Infra-annual flowering, 4 species with Infra-annual fruiting, 4 species with Supra-annual flowering, 7 species with Supra annual fruiting and 1 species had regular flowering and fruiting. Arshad (2002) worked on phytosociological assessment of natural reserve of National park Lalsuhanra from Pakistan and explained that most of the herbaceous form decreased due to overgrazing.

In India, Rai (1981) initiated quantitative inventory studies by studying all trees ≥10cm dbh in four sampling plots of different sizes. Most of the workers have followed the plot methods including square plots of 100×100m (Gentry, 1988); 10×10m (Shali saheb 2008) to rectangular plots 10×1000m by Boom (1986). Plot based research occurs with a range of plot sizes from 0.1ha (Uhl and Murphy, 1981), 50 ha (Hubbell and Foster, 1983) to 52 ha (Condit et al. 1996, 2000). Khera et al. (2001) studied plant biodiversity assessment in relation to disturbances in mid-elevational forest in central Himalaya, India and studied plant diversity along with elevation gradient i.e., hill base (1300-1500m), hill slope (4500-1800m) and hill top (1800-2000m), a total of 92 species were recorded, of which 15 trees, 31 shrubs, 46 herbs. Mohanty et al. (2002) conducted survey on the phyotosociology of Similipal Biosphere Reserve and recorded 189 species of trees belonging to 169 genera and 60 families. Tree species composition and diversity along with disturbance gradient in a dry tropical forest of India studied through the fifteen 1 ha permanent plots by Sagar et al. (2003). Upadhaya et al. (2004) studied diversity and population characteristics of woody species in Meghalaya, Northeast, India and explain population structure based on different girth class, it showed high species richness in 5-15cm, medium species richness 16-25cm and decreased up to 65cm.

Padalia et al. (2004) studied 462 sample plots in different forest types of Andaman for the patterns of tree species diversity girth class relationship, evenness and similarity parameters and reported 369 species belonging to 233 genera and 77 families. Nath et al. (2005) worked on the vegetation analysis and tree population structure in three strands of the tropical wet evergreen forests in Namdapha National Park, Arunachal Pradesh and recorded 71 trees with a girth class size of >30cm, belongs to 62 genera and 27 families. Geeta et al. (2005) studied the phytodiversity and growth form in relation to altitudinal gradient in the Central Himalayan region of India and explained that the pattern of species richness and their distribution depend upon the altitude and climatic changes like rainfall and temperature. Supriya Devi and Yadava (2006) conducted survey on floristic diversity assessment and vegetation analysis of tropical semi evergreen forests of Manipur and resulted that the diversity index of shrubs and herbs were found to be greater than the tree species in Manipur. Sridhar Reddy and Parthasarathy (2006) worked on liana diversity and their distribution on host trees in tropical dry evergreen forests of peninsular India and reported 2,678 individuals more the ≥1cm gbh represents to 35 species belongs to 32 genera and 22 families with the basal area of 3.88m^2, Shannon index 2.76 and evenness index is 0.77. Anuradha Asthana et al. (2007) carried out a phytosociological study on the world heritage center, Bhimbetka in Madhya Pradesh, with size of 1×1m quadrats. Tripathi and Shukla (2007) worked on effect of grazing in two grassland communities in Gorakhpur, Uttar Pradesh and laid 100 quadrates in each community, recorded 100 species, of which 65 are common in both sites. Sahu et al. (2007) studied phytosociological attributes in the dry deciduous forests of Boudh district of Orissa in Northern Eastern Ghats and laid a nested quadrate of size 5×5m for quantifying the shrubs, climbers and also herbaceous flora. Phytosociological observations on tree diversity was carried out by Reddy et al. (2007) in forests of Similipal Biosphere Reverve, Orissa, India and recorded a total of 549 species, of which 4819 tree stems were enumerated belongs to 185 tree species and tree density showed 48.9% of individuals belongs to 30-60cm girth class interval. Srivastava (2008) laid 10 quadrates with size of 100m^2 in thirteen forest stands located perpendicular to a river course were studied to enumerated species composition and regeneration pattern in the Bhabhar belt located at the foot hills of the Himalaya. Shah Hussain et al. (2008) studied the species composition and community structure of 23 forest stands in Kumaon Himalaya by laying a total of 902 plots and reported 19 tree communities and 17 ground vegetation communities. Sachi Gupta and Rup Narayan (2008) studied a total of 245 quadrates at a size of 25×25cm for herbaceous flora from peri-urban areas in Bulandshahr in Uttar Pradesh.

Verma et al. (2008) conducted a random 1×1m size quadrate survey in Alpine pasture of Talra Wildlife Sanctuary in Himachal Pradesh. Pankaj and Sanjay (2008) conducted survey for vegetation characteristics and under-canopy assemblages in two different sites of sub-tropical Chir pine forests in Western Himalaya by laying 10×10m for trees, 5×5m for shrubs and climbers and 1×1m for herbs and recorded a total of 40 species belongs to 27 families. Diversity and distribution pattern of medicinal and aromatic plants were quantitatively assessed four sites in Sangla Valley in Himachal Pradesh by Negi and Dutt (2008), through 1×1m and 5×5m size quadrats for herbs and shrubs. The species diversity was served by Tripathi and Singh (2009) based on structure and concentration of dominance of woody plants at various strata of natural and plantation forests within Katerniahat wildlife sanctuary, North India, by laying 15×20m quadrates. Mani and

Parthasarathy (2009) carried out tree population and above-ground biomass changes after 10 years period in two forest site of tropical dry evergreen forest, Tamilnadu, Peninsular India and analysis showed that decreased tree density by 10.5% in site I, increased by 17.5% in site II, basal area increased by 2.3% in site I and decreased by 6.8% in site II. Mohandass and Davidar (2009) studied 19 montane evergreen forests (Sholas) of Nilgiri Mountains by laying 30mx30m plots and inventoried plants of ≥ 1cm dbhand reported 87 species, 65 genera and 42 families. Tree species diversity and population structure across major forest formations and disturbance categories in Little Andaman Island was studied by Rasingam and Parthasarathy (2009) and reported 186 species with 125 genera and 56 families by measuring a gbh of >30 cm. Kumar et al. (2010) carried out tree diversity and soil nutrient status of three forest sites of Udaipur district of Rajasthan and reported 93 tree species belongs to 24 families with in the 25 quadrates. Soil nutrient status shows that tree density showed negative correlation with variables like phosphorus and nitrogen and positive with carbon. Sarker and Devi (2014) followed random sampling method for assessment of tree diversity, population structure and regeneration status in Hollongapar Gibbon Wildlife Sanctuary from Assam and laid 100 quadrates, enumerated all trees above 30cm girth and recorded highest density with 7756 individuals ha^{-1} and species richness with 73 and highest basal area with 9.62 m^2 ha^{-1}. Gairola et al. (2014) studied population structure and regeneration patterns of tree species in forests of Indian Western Himalaya and stated that increasing altitude of the forest decline in tree density and basal area. Ray et al. (2015) studied the hydrological importance of sacred forest fragments in Central Western Ghats through laying five quadrats of 20×20m for trees, 5×5 m for shrubs and 1×1m nested quadrate for herbs along the left and right sides of the line transect alternatively. Kothandaraman and Sundarapandian (2017) worked on structure of plant community in 2 sites of tropical deciduous of Kanyakumari Wildlife Sanctuary and enumerated all the trees with the size of ≥10cm dbh, reported 518 individuals per hectare in site I and 448 individuals for hectare in site II, a total of 76 species belongs to 41 families. Veena et al. (2017) investigated species composition structure and phytosociological attribute in Sirumugai Range, Coimbatore district by laying 5 sampling plots each with size of 150m^2 and recorded a total of 141 species, the dominated families are Poaceae (16 taxa), followed by Fabaceae (15 taxa), Rubiaceae and Euphorbiaceae (9 taxa respectively), Lamiaceae (7 taxa), Moraceae and Malvaceae (6 taxa respectively).

Subashree et al. (2021) carried out phytosciological assessment in tropical forests across Kanyakumari Wildlife Sanctuary by laying 70 plots and reported a total of 267 species belongs 205 genera and 70 families. Forest structural diversity and regeneration of forest communities in Parbati Valley of North Western Himalaya, India has studied by Barman et al. (2021) and studied 81 sites in different aspects like shady moist (32 sites), dry (28 sites), rocky (12 sites), riverine (10 sites), degraded (3 sites), bouldery (2 sites) and shady (1 site). Borah et al. (2021) studied floristic diversity and composition of the herbaceous species in Behali Reserve Forest in Assam and laid a total 96 quadrats with the size of 1×1 m sampling plots, of which 77 species belonging to 71 genera from 33 families were recorded. The dominant families are Acanthaceae with 7 species, Asteraceae with 6 species, Poaceae with 6 species, Lamiaceae with 5 species and Asparagaceae with 5 species. Pandian et al. (2021) worked on assessment of tree diversity in two disturbed tropical dry evergreen forests of Coromandel Coast of India and established 2 plots with size of 100m×100m, with in that they measured all trees with ≥ 10 cm gbh and recorded 35 tree species belongs to 34 genera and 24 families. Bilyaminu et al. (2021) worked on ecological studies in moist deciduous forest of Shendurney Wildlife Sanctuary, Kollam from Kerala and laid random quadrates of size 20×20m to enumerate all the trees with dbh ≥ 10 cm, estimated that Shannon-Weiner index is 3.22, Simpson index as 0.92, dominance as 0.10, and Margalef index as 7.92, Evenness index as 0.43 and Equitability index 0.80 respectively. Borah et al. (2021a) worked in semi-evergreen forest of Behali Reserve Forest of Assam to analyze the woody species diversity and community characteristics using 35 random sampling plots and reported 128 species from 83 genera and 43 families with mean basal area of 44.42 m^2 ha^{-1} and stem density of 788 individuals per 1.4 ha. Singh et al. (2021) established 39 permanent preservation plots across the 22 different forest sub-types in Madhya Pradesh to assess the phytosociology and regeneration status of tree species and studied a total of 945 quadrates, for each permanent plot 25 quadrates were laid, reported a total of 109 species with >9cm gbh. Hebbar and Krishnaswamy (2021) worked on tree diversity and distribution and regeneration status in Sringeri Forest Range from Western Ghats of Karnataka and laid 50 belt transect of size 5×100m reported 97 trees with the Shannon index value is 3.71 and Simpson index value is 0.97. Floristic diversity and structural composition of Surat District, South Gujarat has carried out by Chaudhari and Pathak (2022), to analysis assess the vegetation they laid a total of 50 plots by using stratified random and recorded 77 plant species out of which 47 trees, 20 shrubs, 3herbs, 2 climbers, 2 grass and 1 weed species belonging to 18 families.

Carbon Estimation

Salunkhe et al., (2016) worked on estimation of Tree biomass reserves in tropical deciduous forests of central India by nondestructive approach in Madhya Pradesh and stated that the tree density, basal area and biomass varied with forest type. These were higher in DDF as compared to MDF, at most of the sites. Maximum tree density was recorded at Panna and minimum at Satna; basal area was maximum at Sagar and minimum at Satna; and biomass was maximum at Panna and minimum at Satna. Regression analysis between biomass and basal area showed positive relationship, which suggested that as the basal area increases, biomass will also increase. Lowest biomass was estimated at Satna and Katni among all the study sites. It was concluded that industrialization is responsible for reduced tree density and thus above-ground biomass.

Manas Ranjan Mohanta (2020), worked on "Carbon stock assessment and its relation with tree biodiversity in Tropical Moist Deciduous Forest of Similipal Biosphere Reserve, Odisha, India" said that the total carbon stock (Agbc + Bgbc+Soc) in the moist deciduous forest of sbr was 280.83 mg c ha indicates the high potential of moist deciduous forest in carbon storage AGBC was found as the greatest storehouse of the carbon, followed by soc and bgbc. *Shorea robusta* was found as most important species for storing carbon in both the sites and thus requires more protection from overuse of its natural prod- ucts and exudates. however, attention should be given for the conservation of other native tree species like *Xylia xylocarpa*, *Protium serratum*, *Terminalia tomentosa*, *Anogeissus latifolia*, *Syzygium cumini*, *Haldinia cordifolia*, *Dalbergia sisoo* etc. showing high storage capacity of biomass and carbon. The present field based biomass and carbon data for moist deciduous forest, has its implications in carbon flux modelling at ecosystem level and provide inputs for regional and global climatic model projections. Further, this study provides clues for mitigation and adap- tation options to manage the changing climate.

Vendrapati Srinivasa Rao (2015) worked on the Carbon sequestration potential of tropical deciduous forests of Nallamalais in Eastern Ghats of Andhra Pradesh covered 120 sampled plots of size 0.1ha and recorded a total of 306 plant species. The Total Above ground biomass (TAGB) estimated for Nallamalais is 53.49 Mt of which AGLB is 50.69 Mt and AGDB is 2.78 Mt. Of the AGLB, trees/liana comprises 49.041 Mt (97.3%), shrubs contribute 0.58 Mt (0.47%) and herbaceous 1.41 Mt (2.79%). Of the AGDB, litter contributes 0.33 Mt (12.97%) and dead wood 2.44 Mt (87.81%). BGB of Nallamalais is estimated at 2.551 Mt and accounts for 4.52% of the total biomass. Thus, the total biomass density of Nallamalais is 73.36±47.20 Mg ha-1 and accounts for 56.047 Mt. The total carbon pool density of the study area is 34.48±22.18 Mg ha-1 and the total carbon stocks of the study area are estimated at 26.34 Mt which equals 97.568 Mt of sequestered atmospheric carbon dioxide. When compared with the total carbon stock in Indian forests worked out in different studies Nallamalais share 0.26% to 0.9% of the total national carbon stocks. It is observed that anthropogenic fire and illegal cutting of trees for timber has major impact on the carbon stocks of the forests of Nallamalais.

Prabhu gowda et al. (2021) has started Assessment of biomass and carbon sequestration potential of sacred Kaans in Soraba taluk of central Western Ghats, Karnataka that the reduction in total areas of forests, isolation of small mosaic patches, loss of habitat with increased disturbance are all due to forest fragmentation. All these were responsible for decrease in total biomass and carbon stock in the smaller Kaans. Large Kaans which were less disturbed than small Kaans, which harbored such dominant species which were not present in small Kaans. However, the species composition, density and basal area as well as special categories of species such as threatened, endemic and evergreen species also increase with area. Thus, both small and large Kaans together enhanced the plant diversity, total biomass and carbon stock potentiality of the Kaan forests. Therefore, to safeguard the relic scared Kaan forests a strategic conservation measures is required to protect the diverse habitat specialist species from anthropogenic pressure. In this context, study on impact of forest fragmentation especially in Kaan forests on above ground biomass and carbon stock will provide significant support to develop effective conservation strategies in protecting these pristine habitats.

Dhanwantri et al. (2014) worked on the carbon sequestration, it's methods and significance that Carbon Sequestration can assist significantly in maintaining the natural carbon cycle. Therefore, requirement is that we need to implement this practice properly. There is a need to go for natural sequestration first, thus conservation of existing forests and more and more reforestation is required. Only then we will be able to reduce carbon emission and corresponding harmful impacts. Later on there is an immigrate requirement to install carbon capture and store mechanism in every thermal power plants. So that carbon emission can be managed at its point source.

Ningaraj (2021) started a work on Estimation of tree biomass and carbon sequestration in Karnatak college campus, Kharwad, Karnataka, said that about 25% of our carbon emissions have historically been captured by Earth's forests, farms and grasslands. With increasing global warming small scale changes can be implemented at educational institutional level by planting trees with highest carbon sequestering capacities. Hence this study shows that tree species such as *Senna siamea, Peltophorum pterocarpum, Tamarindus indica, Delonix regia* and *Holoptelea integrifolia, Azadirachta indica, Pongamia pinnata, Libidibi acoriaria, Samanea saman* etc. can be planted more in the campuses to increase carbon capture and storage. Trees such as these also have large canopy cover providing shade and good amount of biomass and thus increases soil health. Along with carbon capture trees are economically useful when they attain certain age of growth. They add to the beauty of the campuses and green value as well. It helps to keep landscapes vegetated and soil hydrated and stops the soil erosion for plants to grow and sequester carbon.

Ankit Arya (2017) worked on the Carbon Sequestration Analysis of dominant tree species using Geo-informatics Technology in Gujarat State (INDIA) said that the carbon stock of major tree species has been estimated by non-destructive method. The carbon stock estimated for three major tree species indicate that *Azadirachta indica* has maximum carbon sequestration potential as compared to *Acacia* sp. and *Cassia* sp. The maximum of carbon stock was present in GBH size >180 cm which is followed by GBH size 90 to 180 cm and girth class 0 to 90 cm.

STUDY AREA

About District

Mahabubnagar is the largest district in telangana state in terms of area (5,285. 1 sq. km) covered. It is also known as palamoor. It is located between 15° 55' and 17° 29' N latitudes and between 77" 15' and 79" 15' E longtitudes. The area of the district is 5,285.1 sq. kms. It is bounded on the north side by Ranga reddy district, on the east side by Nagarkurnool district, on the south by Wanaparthy and Jogulamba - Gadwal districts and on the west by Karnataka state. The Krishna river flows through the district, as well as the Tungabhadra. The district has most interesting place called the famous banyan tree called Pillalamiri, which is about 4 km from the town. It is 700 year old banyan tree, looks like a large green umbrella and its branches extend over an area of 3 acres.

Climate

Generally, the climate of Mahabubnagar district is pleasant from January to March with an average temperature varies from 24° to 30°C and in April and May the climate is too hot with an average temperature of 35°C-45°C. The maximum temperature ranges during this season is 45°C and minimum is 30°C. The average rainfall for Mahabubnagar district is about 600-900mm.

Soil

The district is mainly covered by three types of soils Viz. red soil, sandy soil black cotton soils and.

About Collage

Dr. B.R.R Government College Jadcherla was established in 1963 by the merchants association under private management to center of the educational needs of the people Jadcherla and surrounding villages. It was started with a great vision and mission to impart higher education to the poor and the transform it into a knowledge society. The college was taken over by the government in 1970 and named after the first chief minister of Hyderabad state Dr. Brugula Ramakrishna Rao. It is located in a predominantly rural settings in the town of Jadcherla, 16 kms. from the district headquarter mahabubnagar.

Telangana Botanical Garden

Telangana Botanical Garden (TBG) was established in 2020 at Dr. Burgula Ramakrishna Rao Government College, Jadcherla, Mahabubnagar district, Telangana with a unique idea OF Dr. B. Sadasivaiah, Assistant Professor of Botany. The garden established in 6.5 acres of land in the college premises. Out of 6.5 acre, 3 acres are in the shape of the geographical map of Telangana state with demarcation of 33 districts. Other than map area (3.5 acres) yet to be planned. In 2019 a small Botanical Garden was established with Special interest of Dr. B. Sadasivaiah, Assistant Professor of Botany of the College in I acre. The I acre land was demarcated with 7 different sections namely Ornamental Section, Medicinal Section, Endemic section, Threatened Section, Xerophyte section, Fruit arboretum and Forest section.

The Telangana Botanical Garden was attracted the Chief Minister of Telangana state and he sanctioned Rs. 50 lakhs for the development. Within a span of 1.5 year a total of 4500 saplings of 457species were planted in the garden. Among them around 130 species are medicinally important, 20 are palm trees, 70 are ornamentals, 150 are wild trees, 10 RET species, 10 Endemic species, 10 Gymnosperms, 10 species of spices, which are collected from Eastern Ghats forests especially Nallamalais of Telangana. To attract all the age groups Butterfly garden, Rasi Vanam, Nakshatra Vanam, Sacred forest, Kartheeka vanam, Timber yielding plants, Gum yielding parts, wild edible plants, wild ornamentals and fruits sections were established in the garden. Kotha Kesavulu Green Net house, Vanajeevi View Point, 12 lakhs litre capacity water percolation pit are the another attractive areas of Garden. The over view of Dr. BRR Government Degree College was presented in **Plate-1**.

Plate 1: Over view of Dr. BRR Government Degree College, Jadcherla

Chapter-IV

METHODOLOGY

Enumeration of all tree resources in Dr. BRR Government Degree College, Jadcherla was carried out through sampling. The inventory was done by laying quadrates of size 100×100m. The present study with the systematic attempt towards a fine scale assessment of the tree resources of Dr. BRR Government Degree College campus, Jadcherla of Telangana based on explorations by stratified sampling method. The methodology of the present study is categorized into 3 major aspects namely 1. Tree Diversity 2. Quantification and 3. Estimation of Carbon. The materials used and methodology adopted for fulfilling the objectives of the work are presented below.

A. PLANT DIVERSITY (INVENTORY)

Field explorations and Identification

Field explorations were conducted in the college campus for a period of 3 months, during February 2023-May 2023. All the trees present in sampling unit (100×100 m) were recorded. For each representative specimen's photographs of floral parts, vegetative parts were taken for easy identification. The photographs were taken with Nikon D3200. The flowering twigs were collected for identification.

The specimen identification was done following 'Flora of Presidency Madras' (Gamble and Fischer, 1915-1935), Flora of Telangana state (Pullaiah, 2015; Reddy and Reddy, 2016) and further confirmed in certain cases, by comparing with the herbarium material housed at Telangana State Herbarium (TBGH), Dr. BRR Government Degree College, Jadcherla. The significant steps of field methodology are presented in **Plate-2.**

Systematic enumeration of taxa

The present work is pertaining to the naturalized and planted taxa collected all sampling points of the college campus. All the recorded taxa were systematically enumerated following Angiosperm Phylogeny Group (APG, 2016). Uniformity is followed in abbreviating the author's names (Mabberley, 2008; The Plant list, 2013; POWO 2022). All the taxa are described with its authorship, family, distribution and specimen voucher number, occurrence in sampling units and phenology.

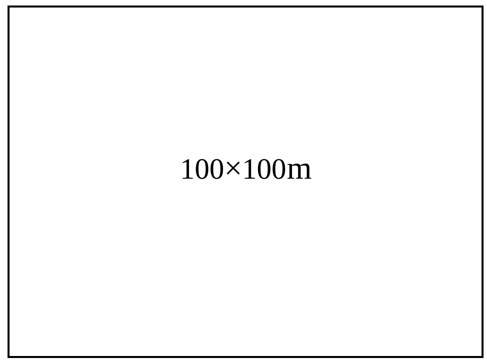
Plate-2: Methodology

B. QUANTITATIVE STUDIES

Sample size and Collection of data

The fieldwork plan carried out in the study area is provided in **Fig. 1**.

Fig. 1: Schematic representation of Field work.



The phytosociological study was conducted to know the quantitative characters of trees by lying of 5 quadrates. The stratified sampling strategy was adopted for the present study. For each quadrate geographical coordinates (at NE corner), elevation, area covered, date were noted. All the trees with and ≥ 30 cm girth at 1.37m height (gbh) were enumerated and for multi stemmed trees girth was measured separately.

The quantitative characters of the plant species, Abundance (A), Basal Area (BA), Density (D), Frequency (F) were calculated for each species following Curtis and Cottom (1956), Mueller-Dombois and Ellenberg (1974).

$$\text{Abundance} = \frac{\text{Total number of individuals in all quadrates}}{\text{Total number of quadrates in which a species occurs}}$$

$$\text{Density} = \frac{\text{Total number of individuals in all quadrates}}{\text{Total number of quadrates studied}}$$

$$\text{Frequency} = \frac{\text{Number of quadrates in which a species occurs}}{\text{Total number of quadrates}}$$

Basal Area: The basal area of individual trees and multiple stems were calculated separately. Stem Density is calculated as the number of individuals per unit area. The formula for Basal Area is mentioned below.

BA= $\pi d^2/4$. (Where d = diameter) OR $C^2/4\pi$ (where C = circumference/girth of the tree)

Importance Value Index (IVI)

Importance Value Index (IVI) was calculated to known the dominant species in a community. It is the sum of relative values of any three quantitative characters: Relative Abundance (RA), Relative Density (RD) and Relative Frequency (RF). These quantitative characters are calculated for each species following Curits and Cottom (1956). The maximum value of IVI can take is 300, since three different percentages are added and each can attain a maximum value of 100.

The Importance Value Index (IVI) was calculated by using the following formulae:

IVI = Relative Abundance + Relative density + Relative frequency

$$RA = \frac{\text{Abundance of the individual species}}{\text{Sum of abundance value of all species}} \times 100$$

$$RD = \frac{\text{Density value of the individual species}}{\text{Sum of density value of all species}} \times 100$$

$$RF = \frac{\text{Frequency value of the individual species}}{\text{Sum of frequency value of all species}} \times 100$$

All the taxa with IVI are presented in the form of a table and the top 10 taxa are graphically represented.

Girth Measurement:

All tree species in the 100×100m quadrate with ≥30cm girth at a height of 1.37m (gbh) from the ground were measured by using a measuring tape and their height was estimated by ocular estimates, while ≥10 to <30cm gbh stems frequency were noted. For multiple stemmed trees, bole girths were measured separately; basal area was calculated for each stem.

Analysis of Girth class distribution

Based on the girth recorded at breast height (gbh) i.e. at 1.37m from the ground, frequency distribution of the various girth classes of tree species was calculated. All the tree species were categorized with respect to the seven girth classes viz., 30-50, 51-70, 71-90, 91-110, 111-130, 131-150 and >150cm.

C. ESTIMATION OF CARBON

Volume Estimation: Volume of each tree with morethan31cm GBH was estimated using the selected volumetric equation developed and compiled by Forest Survey of India (FSI) (1996).

The formulas were selected based on the following criteria.

Criteria 1: Species specific volumetric equation of the same study area.

Criteria 2: If criteria one is not available the species specific volumetric equation of neighboring area of same phytogeographical zone were considered.

Criteria 3: If criteria one and two are not available the volumetric equation belongs to the same species or same genus of the same state or other states has been selected by checking equations of different regions and finally the appropriate equation was selected.

Criteria 4: If criteria one, two and three are not available for those species, the common equation of the same study area is selected.

Specific Gravity: Specific gravity values of different species were selected from literature (Reyes et al., 1992; FRI, 1996; Mani and Parthasarathy, 2007). These values are available for 75-80% stems. For stems with unknown specific gravity, the arithmetic mean of all known species was substituted and was followed of Brown et al., (1989).

Biomass: The estimated volume was converted into biomass by multiplying with specific gravity (Rajput et al., 1996; Limaye and Sen 1956). Biomass of all the trees was summed to obtain biomass of the plot.

Biomass (t/ha) = Volume (m^3) × Specific Gravity

Estimation of Carbon Stock: Estimation of carbon stocks from the biomass consists of multiplying the total biomass by a conversion factor as 0.5 (IPCC- McGroddy et al., 2004) that represents the average carbon content in biomass.

Carbon (tonnes) = Biomass (tonnes) × Carbon %

Chapter-V

RESULTS

A. TREE DIVERSITY

The tree resources of Dr. BRR Government Degree College Campus, Jadcherla of Telangana were assessed through quantitatively by laying 5 stratified (100x100m) sampling quadrates.

FLORISTIC ANALYSIS

In the present study, a **total of 100 wild/naturalized and planted angiosperm tree taxa belonging to 80 genera and 41 families were recorded** in the 5 sampled units. All the recorded 100 taxa are mentioned along with their correct name, author citation, family, habit, occurrence in sampling units and number of individuals in sampling units were presented in **Table-1** by following Bentham & Hooker Classification.

Table-1: List of tree species recorded in Dr. BRR Government Degree College Campus.

S. No.	Name of the taxon	Family	Q. No.	TNI
1	Acacia nilotica	Mimosaceae	3	4
2	Albizia amara	Mimosaceae	1	1
3	Albizia lebbeck	Mimosaceae	3	24
4	Albizia procera	Mimosaceae	1	2
5	Alstonia scholaris	Apocynaceae	2	2
6	Anacardium occidentale	Anacardiaceae	1	1
7	Annona squamosa	Annonaceae	2	5
8	Anogeissus acuminata	Combretaceae	1	3
9	Anthocephalus kadamba	Rubiaceae	1	4
10	Araucaria araucana	Araucariaceae	3	5
11	Areca catechu	Arecaceae	1	6
12	Artocarpus altilis	Moraceae	1	1
13	Artocarpus heterophyllus	Moraceae	3	4
14	Azadirachta indica	Meliaceae	5	132
15	Bauhinia purpurea	Caesalpiniaceae	4	62
16	Bauhinia racemosa	Caesalpiniaceae	2	6
17	Boswellia ovalifoliolata	Burseraceae	1	1
18	Boswellia serrata	Burseraceae	1	2
19	Bridelia retusa	Euphorbiaceae	1	1

20	Butea monosperma	Fabaceae	5	19
21	Calophyllum inophyllum	Clusiaceae	1	1
22	Caryota urens	Arecaceae	1	1
23	Cassia fistula	Caesalpiniaceae	1	1
24	Chukrasia tabularis	Melaceae	1	1
25	Cocos nucifera	Arecaceae	2	2
26	Cordia dichotoama	Cordiaceae	1	2
27	Cupressus macrocarpa	Cupressaceae	1	1
28	Dalbergia latifolia	Fabaceae	1	2
29	Dalbergia sissoo	Fabaceae	3	26
30	Delonix regia	Caesalpiniaceae	2	3
31	Dillenia indica	Dilleniaceae	1	1
32	Elaeocarpus angustifolius	Elaeocarpaceae	1	1
33	Eucalyptus globulus	Myrtaceae	1	4
34	Ficus benghalensis	Moraceae	2	3
35	Ficus benjamina	Moraceae	4	12
36	Ficus racemosa	Moraceae	2	2
37	Ficus religiosa	Moraceae	3	10
38	Ficus virens	Moraceae	1	4
39	Flacourtia indica	Flacourtiaceae	1	1
40	Gliricidia sepium	Fabaceae	1	1
41	Gmelina arborea	Verbenaceae	1	1
42	Grevillea robusta	Protiaceae	1	9
43	Grewia asiatica	Tiliaceae	1	1
44	Haldina cardifolia	Rubiaceae	1	2
45	Hardwicikia binata	Caesalpiniaceae	1	1
46	Holoptelea integrifolia	Ulmaceae	4	18
47	Kydia calycina	Malvaceae	1	2
48	Lagerstroemia indica	Lythraceae	1	15
49	Lepisanthes tetraphylla	Sapindaceae	1	1
50	Leucaena leucocephala	Mimosaceae	4	50
51	Limonia acidissima	Rutaceae	4	2
52	Litsea monophylla	Lauraceae	1	1
53	Madhuca longifolia	Sapotaceae	3	5
54	Mangifera indica	Anacardiaceae	4	6
55	Melia azedarach	Meliaceae	1	1
56	Milligtonia hortensis	Bignoniaceae	2	10
57	Mimusops elengi	Sapotaceae	3	3
58	Moringa oleifera	Moringaceae	3	4
59	Muntingia calabura	Muntingiaceae	1	3

60	Peltophorum pterocarpum	Caesalpiniaceae	3	6
61	Phyllanthus emblica	Euphorbiaceae	4	36
62	Pithecellobium dulce	Mimosaceae	2	5
63	Polyalthia cerasoides	Annonaceae	1	1
64	Polyalthia longifolia	Annonaceae	1	3
65	Pongamia pinnata	Fabaceae	4	81
66	Pouteria campechiana	Sapotaceae	1	1
67	Prunus dulcis	Rosaceae	1	1
68	Psidium guajava	Myrtaceae	1	13
69	Pterocarpus marsupium	Fabaceae	1	21
70	Pterocarpus santalinus	Fabaceae	2	11
71	Roystonea regia	Arecaceae	1	4
72	Samanea saman	Mimosaceae	1	1
73	Santalam album	Santalaceae	1	1
74	Senna siamea	Caesalpiniaceae	2	5
75	Simarouba glauca	Simaroubaceae	1	13
76	Spathodea campanulata	Bignoniaceae	1	8
77	Sterculia foetida	Sterculiaceae	2	22
78	Stereospermum tetragonum	Bignoniaceae	1	1
79	Swietenia mahogani	Meliaceae	4	101
80	Syzygium cumini	Myrtaceae	4	11
81	Syzygium samarangense	Myrtaceae	1	2
82	Tabebuia aurea	Bignoniaceae	1	3
83	Tabebuia pallida	Bignoniaceae	2	6
84	Tamarindus indica	Caesalpiniaceae	3	6
85	Tecoma stans	Bignoniaceae	1	1
86	Tectona grandis	Laminaceae	5	122
87	Terminalia arjuna	Combretaceae	3	52
88	Terminalia bellirica	Combretaceae	1	2
89	Terminalia catappa	Combretaceae	2	11
90	Terminalia chebula	Combretaceae	1	1
91	Terminalia elliptica	Combretaceae	2	2
92	Terminalia mantaly	Combretaceae	1	1
93	Thespecia maderaspatana	Malvaceae	1	4
94	Thespesia populnea	Malvaceae	1	11
95	Thuja occidentalis	Cupressaceae	1	2
96	Trewia nudiflora	Euphorbiaceae	1	1
97	Tylosema esculentum	Fabaceae	1	2
98	Woodyetia bifurcata	Arecaceae	4	88
99	Wrightia tinctoria	Apocynaceae	1	1
100	Ziziphus mauritiana	Rhamnaceae	4	19

Analysis of Families and Genera

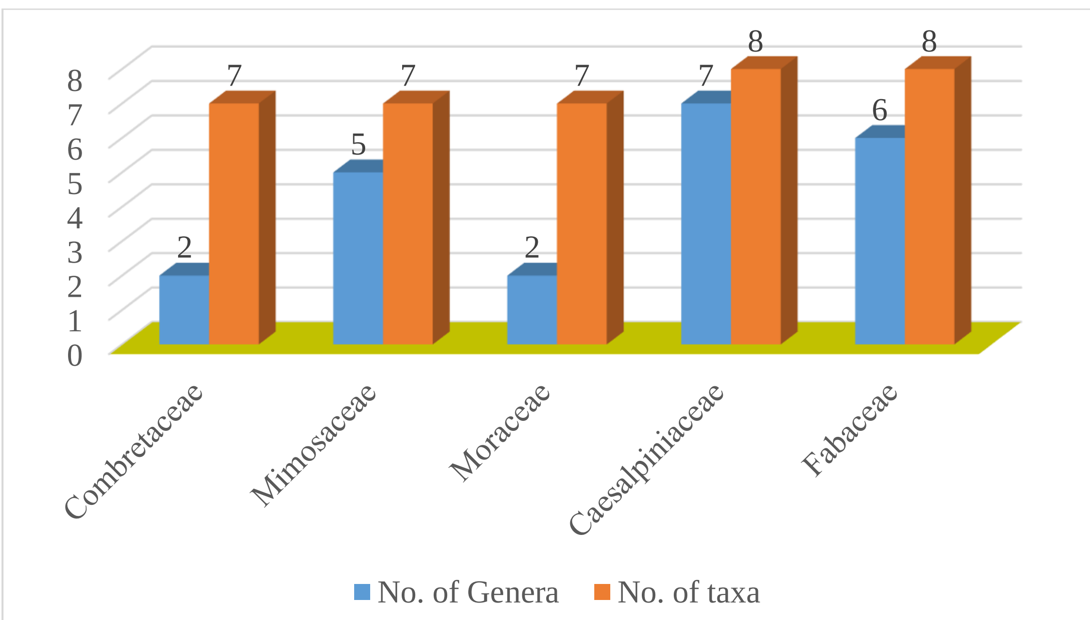
A total of 41 families were recorded in the study area and presented in the **Table-2** along with number of genera and species. Among them, Fabaceae and Caesalpiniaceae are the largest families with 8 species followed by Combretaceae, Mimosaceae and Moraceae are represented with 7 species. A total of 23 families were represented with only one species (Eg. Dilleniaceae); 5 families represented with 2 species (Eg. Burseraceae); 5 families with 3 species (Eg. Meliaceae); Myrtaceae with 4 species, Arecaceae with 5 species and Bignoniaceae with 6 species. The top 5 families with genera and species presented in **Fig. 2.**

Table-2: List of Families with number of Genera and Species.

S. No.	**Name of the family**	**No. of Genera**	**No. of taxa**
1	Anacardiaceae	2	2
2	Annonaceae	2	3
3	Apocynaceae	2	2
4	Araucariaceae	1	1
5	Arecaceae	5	5
6	Bignoniaceae	5	6
7	Burseraceae	1	2
8	Caesalpiniaceae	7	8
9	Clusiaceae	1	1
10	Combretaceae	2	7
11	Cordiaceae	1	1
12	Cupressaceae	2	2
13	Dilleniaceae	1	1
14	Elaeocarpaceae	1	1
15	Euphorbiaceae	3	3
16	Fabaceae	6	8
17	Flacourtiaceae	1	1
18	Laminaceae	1	1
19	Lauraceae	1	1
20	Lythraceae	1	1
21	Malvaceae	2	3
22	Melaceae	1	1
23	Meliaceae	3	3
24	Mimosaceae	5	7
25	Moraceae	2	7

26	Moringaceae	1	1
27	Muntingiaceae	1	1
28	Myrtaceae	3	4
29	Protiaceae	1	1
30	Rhamnaceae	1	1
31	Rosaceae	1	1
32	Rubiaceae	2	2
33	Rutaceae	1	1
34	Santalaceae	1	1
35	Sapindaceae	1	1
36	Sapotaceae	3	3
37	Simaroubaceae	1	1
38	Sterculiaceae	1	1
39	Tiliaceae	1	1
40	Ulmaceae	1	1
41	Verbenaceae	1	1

Figure-2: Top 10 dominant families with Genera and Species



A total of 1184 individuals (10-30 and >30cm gbh) belonging to 100 tree species, 80 genera and 41 families were inventoried within the 5 sampled quadrates. The total number of individuals (TNI) of each species, and the quantitative characters like abundance (A), basal area (BA), density (D), frequency (F), relative abundance (RA), relative density (RD), relative frequency (RF), Relative Density (RD) and Importance Value Index (IVI) of trees were given in **Table 3** for all the species.

Table 3: Phytosociological attributes of Trees

S. No.	Name of the tree	Q. No.	TNI	A	D	F	RA	RD	RF	IVI
1	*Acacia nilotica*	3	4	1.3	0.8	60	0.29	0.34	1.63	2.26
2	*Albizia amara*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
3	*Albizia lebbeck*	3	24	8	4.8	60	1.76	2.03	1.63	5.43
4	*Albizia procera*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
5	*Alstonia scholaris*	2	2	1	0.4	40	0.22	0.17	1.09	1.48
6	*Anacardium occidentale*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
7	*Annona squamosa*	2	5	2.5	1	40	0.55	0.42	1.09	2.06
8	*Anogeissus acuminata*	1	3	3	0.6	20	0.66	0.25	0.54	1.46
9	*Anthocephalus kadamba*	1	4	4	0.8	20	0.88	0.34	0.54	1.76
10	*Araucaria araucana*	3	5	1.7	1	60	0.37	0.42	1.63	2.42
11	*Areca catechu*	1	6	6	1.2	20	1.32	0.51	0.54	2.37
12	*Artocarpus altilis*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
13	*Artocarpus heterophyllus*	3	4	1.3	0.8	60	0.29	0.34	1.63	2.26
14	*Azadirachta indica*	5	132	26	26.4	100	5.82	11.19	2.72	19.72
15	*Bauhinia purpurea*	4	62	16	12.4	80	3.42	5.25	2.17	10.84
16	*Bauhinia racemosa*	2	6	3	1.2	40	0.66	0.51	1.09	2.26
17	*Boswellia ovalifoliolata*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
18	*Boswellia serrata*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
19	*Bridelia retusa*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
20	*Butea monosperma*	5	19	3.8	3.8	100	0.84	1.61	2.72	5.17
21	*Calophyllum inophyllum*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
22	*Caryota urens*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
23	*Cassia fistula*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
24	*Chukrasia tabularis*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
25	*Cocos nucifera*	2	2	1	0.4	40	0.22	0.17	1.09	1.48

26	*Cordia dichotoama*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
27	*Cupressus macrocarpa*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
28	*Dalbergia latifolia*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
29	*Dalbergia sissoo*	3	26	8.7	5.2	60	1.91	2.20	1.63	5.74
30	*Delonix regia*	2	3	1.5	0.6	40	0.33	0.25	1.09	1.67
31	*Dillenia indica*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
32	*Elaeocarpus angustifolius*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
33	*Eucalyptus globulus*	1	4	4	0.8	20	0.88	0.34	0.54	1.76
34	*Ficus benghalensis*	2	3	1.5	0.6	40	0.33	0.25	1.09	1.67
35	*Ficus benjamina*	4	12	3	2.4	80	0.66	1.02	2.17	3.85
36	*Ficus racemosa*	2	2	1	0.4	40	0.22	0.17	1.09	1.48
37	*Ficus religiosa*	3	10	3.3	2	60	0.73	0.85	1.63	3.21
38	*Ficus virens*	1	4	4	0.8	20	0.88	0.34	0.54	1.76
39	*Flacourtia indica*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
40	*Gliricidia sepium*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
41	*Gmelina arborea*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
43	*Grevillea robusta*	1	9	9	1.8	20	1.98	0.76	0.54	3.29
44	*Grewia asiatica*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
45	*Haldina cardifolia*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
46	*Hardwicikia binata*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
47	*Holoptelea integrifolia*	4	18	4.5	3.6	80	0.99	1.53	2.17	4.69
48	*Kydia calycina*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
49	*Lagerstroemia indica*	1	15	15	3	20	3.31	1.27	0.54	5.12
50	*Lepisanthes tetraphylla*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
51	*Leucaena leucocephala*	4	50	13	10	80	2.75	4.24	2.17	9.17
52	*Limonia acidissima*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
53	*Litsea monophylla*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
54	*Madhuca longifolia*	3	5	1.7	1	60	0.37	0.42	1.63	2.42
55	*Mangifera indica*	4	6	1.5	1.2	80	0.33	0.51	2.17	3.01
56	*Melia azedarach*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
57	*Milligtonia hortensis*	2	10	5	2	40	1.10	0.85	1.09	3.04
58	*Mimusops elengi*	3	3	1	0.6	60	0.22	0.25	1.63	2.11
59	*Moringa oleifera*	3	4	1.3	0.8	60	0.29	0.34	1.63	2.26
60	*Muntingia calabura*	1	3	3	0.6	20	0.66	0.25	0.54	1.46
61	*Peltophorum pterocarpum*	3	6	2	1.2	60	0.44	0.51	1.63	2.58
62	*Phyllanthus emblica*	4	36	9	7.2	80	1.98	3.05	2.17	7.21
63	*Pithecellobium dulce*	2	5	2.5	1	40	0.55	0.42	1.09	2.06
64	*Polyalthia cerasoides*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
65	*Polyalthia longifolia*	1	3	3	0.6	20	0.66	0.25	0.54	1.46
66	*Pongamia pinnata*	4	81	20	16.2	80	4.46	6.86	2.17	13.50

97	*Pouteria campechiana*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
67	*Prunus dulcis*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
68	*Psidium guajava*	1	13	13	2.6	20	2.86	1.10	0.54	4.51
69	*Pterocarpus marsupium*	1	21	21	4.2	20	4.63	1.78	0.54	6.95
70	*Pterocarpus santalinus*	2	11	5.5	2.2	40	1.21	0.93	1.09	3.23
71	*Roystonea regia*	1	4	4	0.8	20	0.88	0.34	0.54	1.76
72	*Samanea saman*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
73	*Santalam album*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
74	*Senna siamea*	2	5	2.5	1	40	0.55	0.42	1.09	2.06
75	*Simarouba glauca*	1	13	13	2.6	20	2.86	1.10	0.54	4.51
76	*Spathodea campanulata*	1	8	8	1.6	20	1.76	0.68	0.54	2.98
77	*Sterculia foetida*	2	22	11	4.4	40	2.42	1.86	1.09	5.38
78	*Stereospermum tetragonum*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
79	*Swietenia mahogani*	4	101	25	20.2	80	5.56	8.56	2.17	16.30
80	*Syzygium cumini*	4	11	2.8	2.2	80	0.61	0.93	2.17	3.71
81	*Syzygium samarangense*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
82	*Tabebuia avallanedae*	1	3	3	0.6	20	0.66	0.25	0.54	1.46
17	*Tabebuia pallida*	2	6	3	1.2	40	0.66	0.51	1.09	2.26
83	*Tamarindus indica*	3	6	2	1.2	60	0.44	0.51	1.63	2.58
84	*Tecoma stans*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
85	*Tectona grandis*	5	122	24	24.4	100	5.38	10.34	2.72	18.43
86	*Terminalia arjuna*	3	52	17	10.4	60	3.82	4.41	1.63	9.86
87	*Terminalia bellirica*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
88	*Terminalia catappa*	2	11	5.5	2.2	40	1.21	0.93	1.09	3.23
89	*Terminalia chebula*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
90	*Terminalia elliptica*	2	2	1	0.4	40	0.22	0.17	1.09	1.48
91	*Terminalia mantaly*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
92	*Thespecia maderaspatana*	1	4	4	0.8	20	0.88	0.34	0.54	1.76
93	*Thespesia populnea*	1	11	11	2.2	20	2.42	0.93	0.54	3.90
94	*Thuja occidentalis*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
95	*Trewia nudiflora*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
96	*Tylosema esculentum*	1	2	2	0.4	20	0.44	0.17	0.54	1.15
98	*Woodyetia bifurcata*	4	88	22	17.6	80	4.85	7.46	2.17	14.48
99	*Wrightia tinctoria*	1	1	1	0.2	20	0.22	0.08	0.54	0.85
100	*Ziziphus mauritiana*	4	19	4.8	3.8	80	1.05	1.61	2.17	4.83
				454	**236.4**	**3680**	**100**	**100**	**100**	**300**

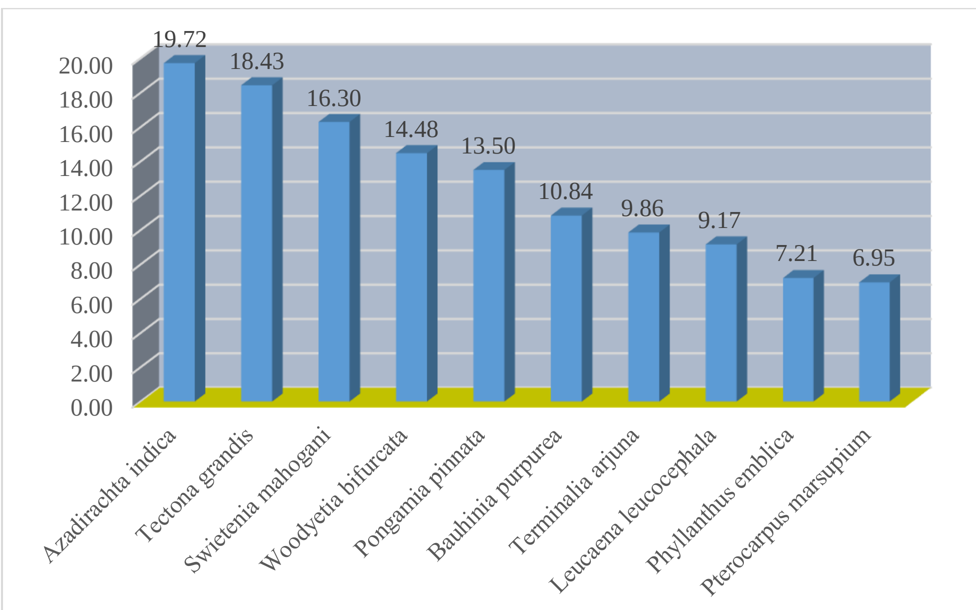
Abundance: The total number of individuals (TNI) of trees in the study site was 1182. The total abundance value for all the trees is 453.7, with an average of 4.53. The highest abundance was recorded for *Azadirachta indica* (26) and the lowest abundance was recorded for 36 taxa with 1 (Eg. *Gmelina arborea*).

Density: The total density of 100 trees is 236, with an average of 2.36. The highest density value was recorded for *Azadirachta indica* (26.4) and the lowest density was recorded for 31 taxa with 0.2 (Eg. *Wrightia tinctoria*).

Frequency: The total frequency for all the trees is 3680, with an average of 36.8. The high-frequency was recorded for *Azadirachta indica, Butea monosperma* and *Tectona grandis* with 100 and least frequency was observed in 59 taxa with 20 (Eg. *Pterocarpus marsupium*).

Importance Value Index (IVI): Importance Value Index of individual tree species encountered in the sampled plots was identified *Azaqdirachta indica* (19.72) as the most important species followed by *Tectona grandis* (18.43) and *Swietenia mahagoni* (16.3). The lowest IVI value (0.85) was observed in 31 taxa. The top 10 dominant IVI trees are presented in **Figure 3.**

Figure 3. Top 10 IVI Species



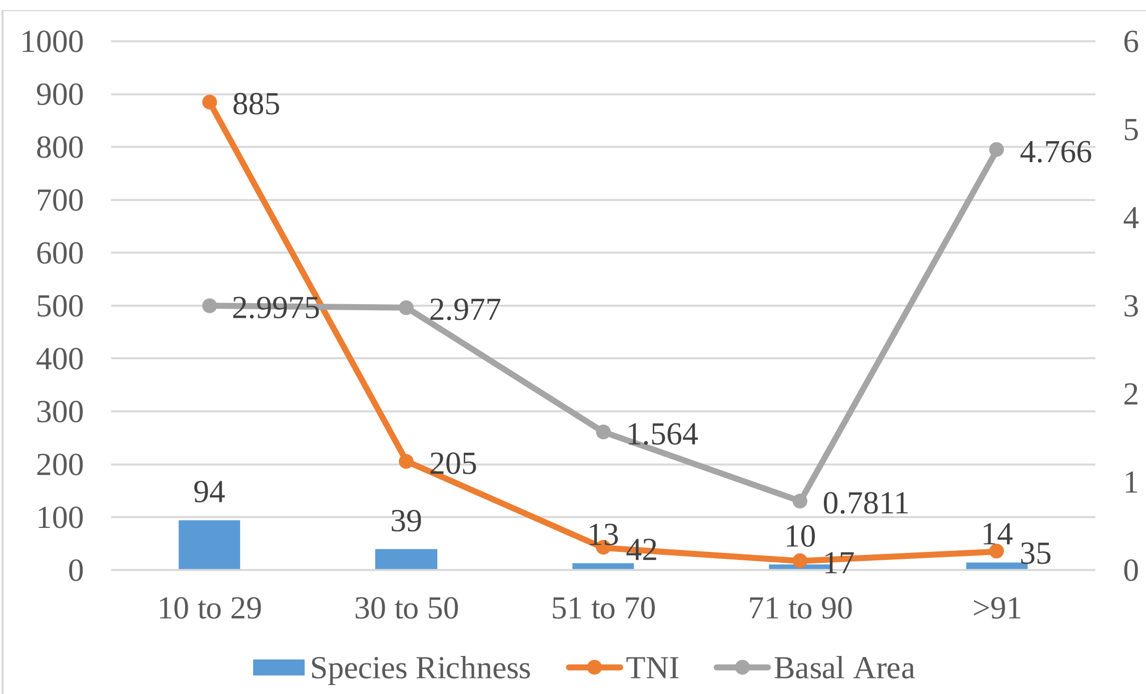
Girth class analysis: The population structure of trees was delineated by classifying all the tree individuals belonging to 100 species into five gbh classes i.e. 10-29cm, 30-50cm, 51-70cm, 71-90cm, >91cm. The details like species richness, total number of individuals (TNI) and basal area to particular gbh class are provided in **Table 4**.

Table 4: Girth class distribution of Species

S. No.	Girth class(Cm)	No. of Species	TNI	Basal Area
1	1 to 29	94	885	2.9975
2	30 to 50	39	205	2.977
3	51 to 70	13	42	1.564
4	71 to 90	10	17	0.7811
5	>91	14	35	4.766

The <30cm gbh class represented the gbh class with not only higher species richness (94 tree species) as well as higher tree density (885 individuals; 74.8%) and basal area 2.9975m^2. The species richness in the 30-50cm gbh class is 39 species and its contribution to tree density is 17.34% (205 individuals) and basal area is 2.977m^2, in 51-70cm gbh class the species richness is 13 species and its contribution to tree density is 3.5% (42 individuals) and basal area is 1.564m^2 and in > 91 cm girth class is with 14 species and its contribution to tree density is 35 and basal area is 4.766 m^2. The graphical representation regarding Species richness and girth class distribution presented in **Figure 4.**

Fig. 4: Species richness vs Girth class



C. Estimation of Carbon

Basal Area

The Basal area (stock volume) of all the trees enlisted in the sampled plots is 14.1977m^2 (**Table 5**). The highest basal area was recorded in *Azadirachta indica* (1.97m^2), followed by *Pongamia pinnata* (1.143m^2), *Tectona grandis* (1.037m^2), *Acacia nilotica* (0.7948m^2) and *Holoptelea integrifolia* (0.754m^2). The least Basal Area was recorded for *Polyalthia ceresoides* and *Terminalia chebula* (0.000796 m^2).

Table 5: Basal Area of Trees

S. No.	Name of the tree	Basal Area
1	*Acacia nilotica*	0.794836
2	*Albizia amara*	0.0357
3	*Albizia lebbeck*	0.72952
4	*Albizia procera*	0.0109
5	*Alstonia scholaris*	0.24501
6	*Anacardium occidentale*	0.002578
7	*Annona squamosa*	0.00992
8	*Anogeissus acuminata*	0.00478
9	*Anthocephalus kadamba*	0.010288
10	*Araucaria araucana*	0.019
11	*Areca catechu*	0.024132
12	*Artocarpus altilis*	0.002872
13	*Artocarpus heterophyllus*	0.00595
14	*Azadirachta indica*	1.971316
15	*Bauhinia purpurea*	0.38767
16	*Bauhinia racemosa*	0.428588
17	*Boswellia ovalifoliolata*	0.031587
18	*Boswellia serrata*	0.00884
19	*Bridelia retusa*	0.00461
20	*Butea monosperma*	0.45825
21	*Calophyllum inophyllum*	0.00179
22	*Caryota urens*	0.009198
23	*Cassia fistula*	0.004209
24	*Chukrasia tabularis*	0.000963
25	*Cocos nucifera*	0.1049
26	*Cordia dichotoama*	0.00774
27	*Cupressus macrocarpa*	0.000936

28	*Dalbergia latifolia*	0.00258
29	*Dalbergia sissoo*	0.11698
30	*Delonix regia*	0.11507
31	*Dillenia indica*	0.002875
32	*Elaeocarpus angustifolius*	0.0021
33	*Eucalyptus globulus*	0.488009
34	*Ficus benghalensis*	0.412141
35	*Ficus benjamina*	0.060948
36	*Ficus racemosa*	0.011537
37	*Ficus religiosa*	0.6373
38	*Ficus virens*	0.022819
39	*Flacourtia indica*	0.017274
40	*Gliricidia sepium*	0.023623
41	*Gmelina arborea*	0.00866
42	*Grevillea robusta*	0.018467
43	*Grewia asiatica*	0.00481
44	*Haldina cardifolia*	0.0021
45	*Hardwicikia binata*	0.00287
46	*Holoptelea integrifolia*	0.75436
47	*Kydia calycina*	0.008951
48	*Lagerstroemia indica*	0.035033418
49	*Lepisanthes tetraphylla*	0.000963
50	*Leucaena leucocephala*	0.56949
51	*Limonia acidissima*	0.0434277
52	*Litsea monophylla*	0.001146
53	*Madhuca longifolia*	0.00156
54	*Mangifera indica*	0.019231
55	*Melia azedarach*	0.014036
56	*Milligtonia hortensis*	0.0908099
57	*Mimusops elengi*	0.0323122
58	*Moringa oleifera*	0.065412
59	*Muntingia calabura*	0.068348
60	*Peltophorum pterocarpum*	0.306691
61	*Phyllanthus emblica*	0.0898631
62	*Pithecellobium dulce*	0.020711
63	*Polyalthia cerasoides*	0.000796
64	*Polyalthia longifolia*	0.007845
65	*Pongamia pinnata*	1.1436823
66	*Pouteria campechiana*	0.27737
67	*Prunus dulcis*	0.002872

68	*Psidium guajava*	0.0221514
69	*Pterocarpus marsupium*	0.09773233
70	*Pterocarpus santalinus*	0.01608
71	*Roystonea regia*	0.028906
72	*Samanea saman*	0.183832
73	*Santalam album*	0.005379
74	*Senna siamea*	0.097127
75	*Simarouba glauca*	0.06182367
76	*Spathodea campanulata*	0.031532
77	*Sterculia foetida*	0.09505
78	*Stereospermum tetragonum*	0.001345
79	*Swietenia mahogani*	0.190746
80	*Syzygium cumini*	0.128707
81	*Syzygium samarangense*	0.009255
82	*Tabebuia avallanedae*	0.007972
83	*Tabebuia pallida*	0.01207
84	*Tamarindus indica*	0.0692632
85	*Tecoma stans*	0.00287
86	*Tectona grandis*	1.03757956
87	*Terminalia arjuna*	0.141414
88	*Terminalia bellirica*	0.0026593
89	*Terminalia catappa*	0.5060709
90	*Terminalia chebula*	0.000796
91	*Terminalia elliptica*	0.01257161
92	*Terminalia mantaly*	0.009747
93	*Thespecia maderaspatana*	0.058076
94	*Thespesia populnea*	0.050358
95	*Thuja occidentalis*	0.008672
96	*Trewia nudiflora*	0.001345
97	*Tylosema esculentum*	0.004049
98	*Woodyetia bifurcata*	0.002872
99	*Wrightia tinctoria*	0.239282
100	*Ziziphus mauritiana*	0.239282
		14.19777259

The total Basal area of 6 plots is 14.19777 $m^2 ha^{-1}$. The basal area of trees with ≤29 cm GBH is 2.9975 m^2 ha^{-1} it ranges between 0.00079-0.0066 m^2 ha^{-1} in the sampled plots while the average value 0.0026 m^2 ha^{-1}. The dominant tree species are *Pterocarpus santalinus* 2.6648m^2 ha^{-1}. The basal area of trees with ≥30 cm GBH is 11.2002 m^2 ha^{-1}. The dominant species are

Volume

The total volume of trees is 119.670m^3 ha^{-1}. The dominant tree species are *Pterocarpus marsupium* is with 14.524 $m^3 ha^{-1}$, *Albizia lebbeck* 7.866m^3 ha^{-1}, *Bauhinia racemosa* 7.563m^3 ha^{-1}, *Pterocarpus santalinus* 7.287m^3 ha^{-1} and *Swietenia mahogany* 6.054m^3 ha^{-1}.

Biomass

The biomass of trees is 108.6211 Mg ha^{-1} and it ranges between 0.00455-11.695 Mg ha^{-1} in the sampled plots while the average value is 1.08621 Mg ha^{-1}. The dominant tree species are *Pterocarpus marsupium* is with 11.695 Mg ha^{-1}, followed by *Tectona grandis* with 8.5 Mgha^{-1}, *Pterocarpus santalinus* with 8.45 Mg ha^{-1}, *Albizia lebbeck* with 6.60 Mg ha^{-1} and *Acacia nilotica* with 6.35Mg ha^{-1}.

The total biomass of all 5 sampling points is 108.6211 Mg ha^{-1}. (Above ground biomass + Below ground biomass). The Basal Area, Biomass and the Carbon of the sampled points are mentioned in **Table 6**.

Table 6: Species Richness, TNI, Basal Area and Carbon of sampled blocks

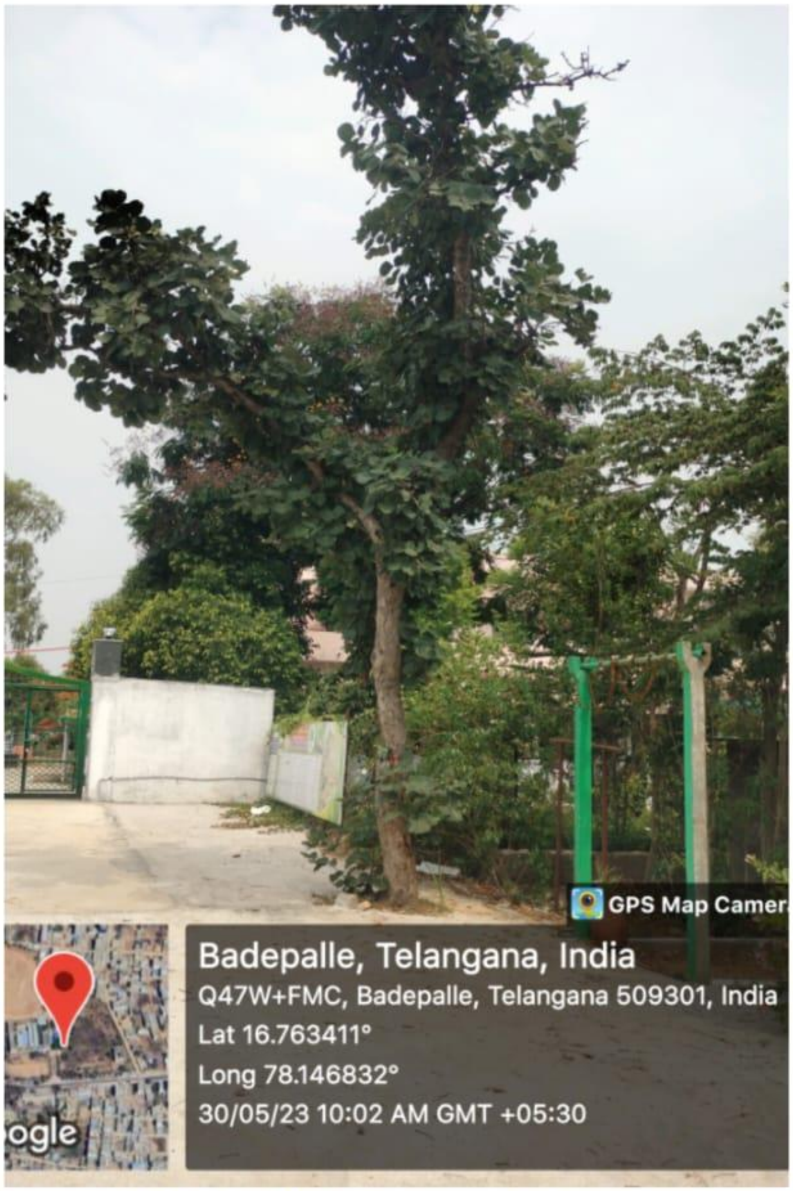
Block No.	No. of species	TNI	BA	Carbon
1	42	321	1.778	13.359
2	24	270	2.456429	6.262474
3	29	118	0.804217	4.780759
4	51	183	0.92087	8.8915997
5	34	290	5.222278	13.097757

Carbon

The carbon pool of the total species is 54.2912 Mg ha^{-1} for 5 sample blocks and it ranges 4.78-13.09 Mg ha^{-1} with an average value of 9.278 Mg ha^{-1}.

Some of the significant tree species mentioned in Plate 3 and 4.

Plate 3. Tree species of GDC, Jadcherla



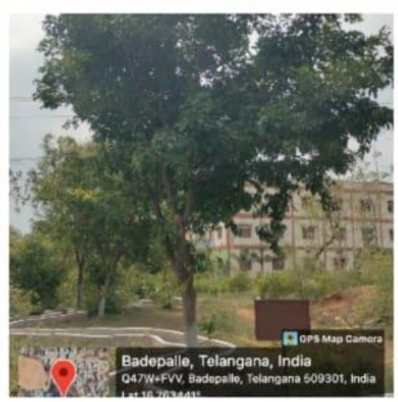


Plate 4. Trees of GDC, Jadcherla

CHAPTER – VI

SUMMARY & CONCLUSION

In the present study, assessment of plant diversity, quantification and estimation of carbon was carried out by quantitative method by laying 5 sampling blocks of 100×100m size covering 5 hectares in Dr. BRR Government Degree College Campus, Jadcherla of Telangana state. The floristic composition of the area shows that a total of 100 wild, naturalized and planted trees species belonging to 80 genera and 41 families were recorded. Among the 41 families, Fabaceae and Caesalpiniaceae are the largest families with 8 taxa followed by Combretaceae, Moraceae and Mimosaceae with 7 taxa.

According to quantification a total of 1182 tree individuals were recorded. Importance Value Index of individual tree species encountered in the sampled plots was identified *Azaqdirachta indica* (19.72) as the most important species followed by *Tectona grandis* (18.43) and *Swietenia mahagoni* (16.3). The lowest IVI value (0.85) was observed in 31 taxa.

According to Basal area, biomass and carbon pool *Azadirachta indica* is the dominate tree species that may store major carbon from the campus.

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