Estimation of Tree Biomass and Carbon Density of Tropical Moist Deciduous Forest in Semi-Arid Regions-Katridaddi Hillock, Belagavi, Karnataka

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Abstract: This present work was carried out in semi-arid regions of Katridaddi hillock, Belagavi district Karnataka to study total biomass and carbon sequestration potential by quadrat method. A total of 30 quadrats of 32m × 32m were laid in the study area, and tree species were calculated accordingly. During the study, 22 tree species belonging to 12 families are recorded. Among the recorded tree species, the top dominant family with highest number of species comprises of Fabaceae with 88 species. The total carbon sequestered in the Hillock is 16.522 tons.

Keywords: Basal area, Biodiversity, Carbon sequestration, Total biomass, Quadrat method

Phytosociology is one of the important aspects to understand the composition, structure, distribution pattern, and vegetation dynamics of forest ecosystem (Rout, et al., 2018). Carbon sequestration in growing forests is known to be economically best option for reduction of global warming and global climatic change (Chavan and Rasal 2011). The aboveground biomass (AGB) of forest ecosystem is one of the primitive parameters describing its functioning. Studies on biomass of forest ecosystem are essential for determining storage of the carbon in tree component and carbon cycling at regional as well as global level (Behera et al., 2020). Forest play an important role in global carbon cycle and especially evergreen forests have a significant share in sequestering total earth's carbon as they account for half of global biomass (Prasad and Lakshmi 2015)

Kumar et al. (2015) estimated forest carbon stock for tree species of Balaganga Reserved Forest (BRF) in district Tehri Garhwal, Uttarakhand. Carbon sequestration of 610 trees belonging to 45 species was estimated. The average carbon content of these trees was 50.391t/tree. Jithila & Prasadan (2018) observed total carbon sequestered was 138.367t/year from Wayanad. Srinivas and Sundarpandian (2018) assessed the biomass and carbon stock in East Godavari region of Eastern Ghats in Andra Pradesh and showed that *Terminalia arjuna and Xylia xylocarpa* are the important tree species to endure and sink more carbon. Biradar and Mouna et al. (2021) have calculated Importance value index of 1387 species with Fabaceae with highest IVI.The objective of current studyto find out the physiology and carbon estimation by that hillock with tree diversity.

MATERIAL AND METHODS

Study area: The present study was undertaken in the semi-arid regions of Katridaddi Hillock, Belagavi district Karnataka. This Hillock is located in Katridaddi , small village in Bailhongal taluk in Belgavi district of Karnataka state, India. It is situated between 15.4924° north latitude and between 74.7765° east longitude and surrounded by Khanapur taluk towards west, Belagavi taluk towards west, Saundatti taluk towards East, Dharwad taluk towards South (Fig. 1). The preliminary phyto-sociological analysis of the study sites was performed by using quadrants. The size and number of quadrants needed for each site was determined separately using the species area curve method (Misra 1968)

Identification of specimen: The photographs of each plant species were taken during January 2024 to July 2024 by Phone (Poco X2) and specimen identification was done (Cooke 1906, Gamble 1928, Seetharam et al., 2000, Bhat 2003, Ramaswamy and Razi 1973, Saldanha 1984, 1996, Yoganarasimhan et al., 2018)

Tree height: Height of the trees is measured using a handmade hypsometer.

Girth classes: The tree girth was measured at breast height (GBH) approximately 1.37m above the ground. Trees only with diameter greater than 10cm were considered. GBH was measured and four girth classes (30-60, 60-90, 90-120) were considered to study the vegetation structure of the hillock.

Tree Bio volume: The volume of the tree stem can be calculated using the following formula

$$TBV = 0.4 \times (Diameter)2 \times height$$

Abovethe Ground Biomass (AGB): It was calculated by

multiplying tree bio volume and wood density. The wood density of the tree were obtained from world agroforestry database. The standard average value of $0.6g/cm^3$ is taken for the tree species whose wood density values are not available.

AGB=Tree Bio Volume×Wood density

Below the Ground Biomass (BGB): It includes all the living biomass below the soil excluding roots having diameter less than 2mm.

BGB=0.26 ×Above Ground Biomass

Total Biomass: It includes the complete biomass of the standing tree species. It is the sum of the above and below ground biomass.

Total Biomass = Above the Ground Biomass + Below the Ground Biomass

Carbon Storage: The 50% of the total biomass of a species is its carbon sequestration value.

Carbon storage=Biomass/2orBiomass×50%

Importance value index: In calculating this index, the percentage values of the relative frequency, relative density and relative dominance area summed up together (Curtis 1950).

Important Value Index= Relative Frequency+ Relative Density + Relative Dominance

$$\text{Relative frequency} = \frac{\text{Frequency of species A}}{\text{Total frequency of all species}} \times 100$$

$$\text{Relative density} = \frac{\text{Number of individuals of the species}}{\text{Number of individuals of all the quadrats}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all the species}} \times 100$$

RESULTS AND DISCUSSION

A total of 22 tree species belonging to 12 families are recorded (Fig. 2, 3). Among these tree species, top 5 dominant families with highest number of species comprises of Fabaceae with 88 species, followed by Combretaceae (25 species), Rutaceae (18 species) and Anacardiaceae (16 species) . Biomass and carbon sequestration of a total 192 tree species in Katridaddi hilllock were calculated using the ground data with their height and girth at breast height measurements. The wood density values of each tree were obtained from World Agroforestry database for calculating

Table 1. Frequency, abundance and density of plant species in Katridaddi hillock, Belagavi district

Plant species	Frequency	Abundance	Density
Adina cordifolia (Roxb.) Brandis	16.66	1.2	0.2
Albizia odoratissima(L.f.) Benth	30	1.33	0.4
Bauhinia racemosa Lam.	26.66	1.12	0.3
Butea monosperma (Lam.) Kuntze	26.66	1.12	0.3
Careya arborea Roxb.	16.66	1.2	0.2
Cassia fistula L.	23.33	1.85	0.43
Chloroxylon swietenia DC.	36.66	1.63	0.6
Dalbergia lanceolaria L. f.	23.33	1.57	0.36
Dalbergia latifolia Roxb.	30	1.66	0.5
Diospyros melanoxylon Roxb.	13.33	1.25	0.16
Glycosmis cochinchinensis (Lour.) Pierre ex Engl.	13.33	2.0	0.26
Gymnosporia senegalensis (Lam.) Loes	16.66	1.2	0.2
Holarrhena pubescens Wall. ex G. Don	13.33	1.75	0.23
Lannea coromandelica (Houtt) Merr.	20	1.33	0.26
Phyllanthus emblica L.	10	1.33	0.13
Pteroearpus marsupium Roxb.	26.66	1.37	0.36
Sterculia *foetida* L.	10	0.37	0.1
Tectona grandis L.f.	20	1.33	0.26
Terminalia anogeissiana Gere & Boatwr.	33.33	1.2	0.4
Terminalia arjuna (Roxb.ex DC.) Wight & Arn.	16.66	1.2	0.2
Terminalia paniculata B.Heyne ex Roth	23.33	1.0	0.23
Xylia xylocarpa (Roxb.) W. Theob	36.66	1.81	0.66

tree bio volume, above ground biomass, below ground biomass, total biomass and total carbon sequestered by the trees. In Katridaddi Hillock total above and below ground biomass was26.45 tons 6.813 tons. The total biomass was 33.63 tons. The highest above ground biomass was 4.596 tons and lowest0.139 tons. The highest below ground biomass 1.194 tons and lowest below ground was 0.036 tons. *Albizia odoratissima* (L.f.) Benth. has highest tree bio volume of 7.535 cm^3 and lowest tree of 0.0.232 cm^3. *Xylia xylocarpa* (Roxb.) W. Theob.sequesters highest carbon of 2.895 tons followed by *Bauhinia racemosa* Lam.sequesters, *Gymnosporia senegalensis* (Lam.) Loes. sequesters,

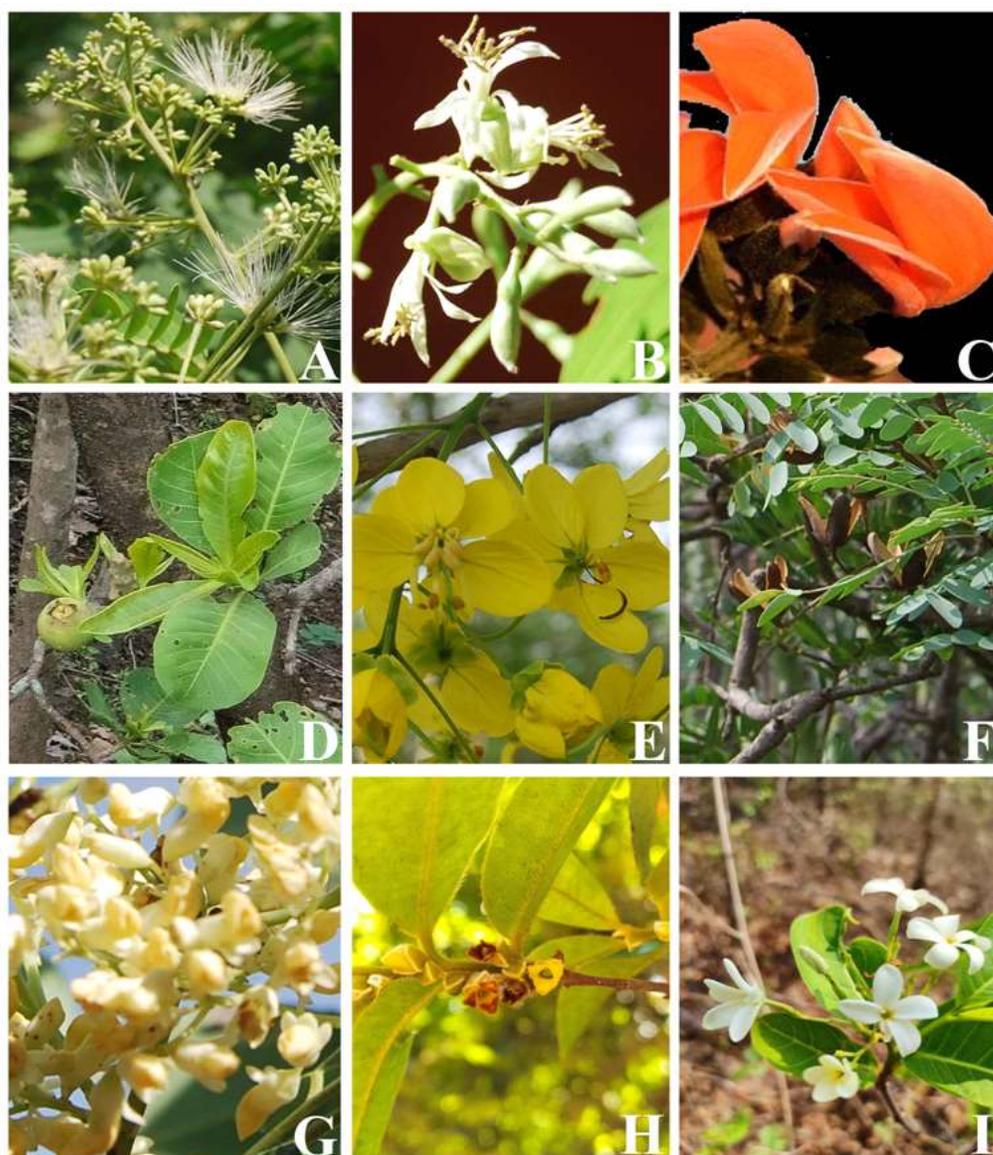**Fig. 1.** Katridaddi hillock Bailhongal Taluk, Belagavi, Karnataka

Fig. 2. A. *Albizia odoratissima* (L.f) Benth; **B.** *Bauhinia racemosa* Lam; **C.** *Butea monosperma* (lam) Kuntze; **D**. *Careya arobrea* Roxb.; **E**. *Cassia fistula* L.; **F**. *Chloroxylon swietenia* DC.; **G**. *Dalbergia latifolia* Roxb; **H.** *Diospyros melanoxylon* Roxb; **I.** *Holarrhena pubescens* Wall ex. G. Don.

Fig. 3. A. *Lannea coromandelica* (Houtt) Merr. ; **B.** *Phyllanthus emblica* L.; **C.** *Pterocarpus marsupium* Roxb.; **D.** *Sapindus trifoliatus* L. **E.** *Stericula foetida* L.; **F.** *Tectona grandis* L. f. ; **G.** *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.; **H.** *Terminalia paniculata* B. Heyne ex Roth. ; **I.** *Xylia Xylocarpa* (Roxb.) W. Theob.

Table 2. Importance value index of tree species in Katridaddi Hillock Belagavi district

Plant species	Mean GBH (in m)	Total basal area	Relative dominance	Relative frequency	Relative density	IVI
Adina cordifolia (Roxb.) Brandis	0.80	5.09	1.73	75.86	3.125	80.71
Albizia odoratissima (L.f.) Benth	1.16	10.70	3.65	136.6	6.25	146.5
Bauhinia racemosa Lam.	0.68	3.67	0.012	121.40	4.687	126.09
Butea monosperma (Lam.) Kuntze	0.41	1.33	0.45	121.4	4.687	126.5
Careya arborea Roxb.	0.23	0.42	0.14	75.86	3.125	79.125
Cassia fistula L.	0.37	1.08	0.37	106.2	6.77	123.34
Chloroxylon swietenia DC.	0.29	0.66	0.22	166.93	9.375	176.52
Dalbergia lanceolaria L.f.	0.70	3.89	1.32	106.2	5.729	113.24
Dalbergia latifolia Roxb.	0.59	2.76	0.009	136.61	7.812	144.43
Diospyros melanoxylon Roxb.	0.32	0.81	0.27	60.70	2.604	91.094
Glycosmis cochinchinensis (Lour.) Pierre ex Engl.	0.56	2.49	0.85	60.70	4.16	65.71
Gymnosporia senegalensis (Lam.) Loes	0.79	4.96	1.69	75.86	3.125	80.67
Holarrhena pubescens Wall.ex G. Don	0.37	1.08	0.37	60.70	3.64	64.71
Lannea coromandelica (Houtt) Merr.	0.84	5.61	1.915	91.07	4.166	97.1
Phyllanthus emblica L.	0.64	3.25	1.11	45.53	2.083	48.72
Pteroearpus marsupium Roxb.	0.41	1.33	0.45	121.40	5.72	127.57
Sterculia foetida L.	0.28	0.62	0.211	45.53	1.562	47.30
Tectona grandis L.f.	0.71	4.00	1.36	91.07	4.16	96.59
Terminalia anogeissiana Gere & Boatwr.	0.54	2.31	0.78	151.77	6.25	158.8
Terminalia arjuna (Roxb.ex DC.) Wight & Arn.	0.36	1.03	0.35	75.86	3.12	79.33
Terminalia paniculata B. Heyne ex Roth	0.76	4.59	1.56	106.2	3.64	111.42
Xylia xylocarpa (Roxb.) W. Theob	0.58	2.67	0.912	166.93	10.57	178.25

Table 3. Total carbon per species in Katridaddi Hillock, Belagavi district

| Plant species	Wood density (in g/cm^3)	T_{BV} (in cm^3)	AGB (in tons)	BGB (in tons)	TB (in tons)	Total carbon per species (in tons)
Adina cordifolia (Roxb.) Brandis	0.600	2.048	1.228	0.319	1.547	0.773
Albizia odoratissima (L.f.) Benth	0.610	7.535	4.596	1.194	5.790	0.980
Bauhinia racemosa Lam.	0.782	3.144	2.458	0.639	3.094	1.547
Butea monosperma (Lam.) Kuntze	0.610	1.008	0.614	0.159	0.773	0.386
Careya arborea Roxb.	0.600	0.232	0.139	0.036	0.175	0.087
Cassia fistula L.	0.434	0.547	0.237	0.061	0.298	0.149
Chloroxylon swietenia DC.	0.486	0.504	0.244	0.063	0.307	0.153
Dalbergia lanceolaria L.f.	0.600	3.136	1.881	0.489	2.370	1.185
Dalbergia latifolia Roxb.	0.782	2.227	1.741	0.452	2.193	1.096
Diospyros melanoxylon Roxb.	0.829	0.409	0.339	0.088	0.427	0.213
Glycosmis cochinchinensis (Lour.) Pierre ex Engl.	0.508	0.878	0.446	0.115	0.561	0.280
Gymnosporia senegalensis (Lam.) Loes	0.600	3.994	2.396	0.622	3.018	1.509
Holarrhena pubescens Wall.ex G. Don	0.440	0.657	0.289	0.075	0.364	1.220
Lannea coromandelica (Houtt) Merr.	0.581	2.540	1.475	0.383	1.858	0.929
Phyllanthus emblica L.	0.610	1.966	1.199	0.311	1.510	1.155
Pteroearpus marsupium Roxb.	0.500	0.874	0.437	0.113	0.550	0.275
Sterculia foetida L.	0.727	0.564	0.410	0.106	0.516	0.258
Tectona grandis L.f.	0.600	3.226	1.935	0.503	2.438	0.219
Terminalia anogeissiana Gere & Boatwr.	0.580	1.516	0.879	0.228	1.107	0.553
Terminalia arjuna (Roxb.ex DC.) Wight & Arn.	0.512	0.933	0.477	0.124	0.601	0.300
Terminalia paniculata B. Heyne ex Roth.	0.610	2.079	1.268	0.329	1.597	0.798
Xylia xylocarpa (Roxb.) W. Theob	0.772	2.018	1.557	0.404	1.961	2.895
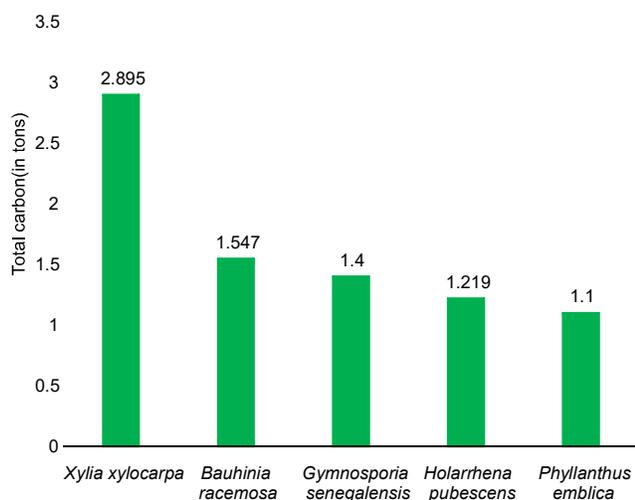
Fig. 4. Dominant families with highest number of species with total carbon estimation

Holarrhena pubescens Wall. ex G. Donsequesters, *Phyllanthus emblica L.* sequesters tree in Katridaddi Hillock (Table 1, 2, 3, Fig. 4).

CONCLUSIONS

The hillock area is considerably rich in diversity but also indicate human disturbances, thus altering their structure and distribution.. Fabaceae with 88 species being the dominant family reported during study. Highest tree bio volume in *Albizia odoratissima* (L.f.) Benth. (Fabaceae) need to be conserved. The woody plants has highest carbon sequestration potential than others as they store more carbon in their woody biomass. It is recommended that populations in plant species must be monitored regularly and updated in an open access database for threat assessment for interpretation of conservation status in the future.

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