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QUANTITATIVE ANALYSIS ON CARBON STORAGE OF 25 VALUABLE TREE SPECIES OF GUJARAT, INCREDIBLE INDIA

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ABSTRACT

Trees are carbon reservoir on earth. In nature, photosynthesis is the unique mechanism through which carbon flows in ecosystems and utilize by plants in the form of CO_2. Worldwide, we are losing the number of trees every year; the reasons are known to everybody which leads to the climate change globally. From the available data of tree's girth and height we estimated the carbon storage by non-destructive or allometric method. We estimated the carbon storage in 25 species belongs to Gujarat, India. The maximum carbon storage in *Tamarindus indica* 55.95 tC followed by 44.81 tC in *Terminalia arjuna* is concluded. The lowest carbon storage value estimated in *Emblica officinalis* 1.77tC.

KEYWORDS : Diameter, Species, Biomass, Carbon Storage

Trees are carbon reservoir on earth.In nature, forest ecosystem act as a reservoir of carbon. They store huge quantities of carbon and regulate the carbon cycle by exchange of CO_2 from the atmosphere. Forest ecosystem is one of the most important carbon sinks of the terrestrial ecosystem. It uptakes the carbon dioxide by the process of photosynthesis and stores the carbon in the plant tissues, forest litter and soils. Thus, forest ecosystem plays important role in the global carbon cycle by sequestering a substantial amount of carbon dioxide from the atmosphere (Vashum and Jay Kumar, 2012). Carbon sequestration is a mechanism for the removal of carbon from the atmosphere by storing it in the biosphere (Chavan and Rasal, 2012).

Millions of plants, animals, and microorganisms are present on earth in various ecosystems we called it biodiversity. Present definition considers genetic variation, species and ecosystem varieties as biodiversity. India has covered 1, 26,188 species of plants and animals. India with a total area of about 3029 million ha is considered to be one of the 12 mega biodiversity hotspots of the origins and diversity of several plant species. Gujarat state harbors 2,198 species of higher plants including 27 species of mangroves and its associates, which accounts for the almost 9.33% of the total floral wealth of India (Kumar et al., 2007; 2005). In Gujarat, about 419 million trees have been estimated; 150 million in forest and 269 million trees outside of the forest and total carbon store 177 million tonnes (Singh, 2011a). Gandhinagar 8,66,670 trees, Surat 333,970 trees, Vadodara 747,200 trees, Rajkot 137,500 trees, Bhavnagar 4,76,000 trees, Jamnagar 45,900 trees, Junagadh 76,700 trees, and Valsad 67,252 trees are estimated respectively by tree counting in aforesaid districts of the Gujarat State. There are 618,050 urban trees in Ahmedabad district, which store 1.27 million tonnes carbon and annual sequestration rate may be over 4,640 Carbon tonnes(Singh, 2011b). 73.59 tonnes of carbon dioxide are removed from urban trees by the Vadodara city (Kiran and Shah, 2011). The figure, 1 (FSI, 2009) represents the district wise forest density class (very dense, moderate dense, open or sparse forest, Scrubland) of Gujarat State. Worldwide, the forests and species biodiversity and number of trees are being degraded, and every day cause of increasing demands of fuel-wood and timbers, and other agro-forestry practices including anthropogenic pressure on the ecosystem. In such critical situations, Ministry of Environment and Forests, Gujarat State, has put an outstanding and inspiring example of species conservation, protection and developed the data of 'Heritage trees of Gujarat'. In present investigation our main objective is to quantify the carbon storage in few selective (Table, 1) species or heritage tree species of Gujarat.

METHODOLOGY

There are two methods of carbon estimation in tree

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Table 1: Selected Tree Species And Districtwise Their Physiological Details: (Singh H.S., 2010)

Species code	Vulnerable Name	Scientific Name	GBH (meter)	Height (meter)	Location
S1	Largest Rukhado Tree	*Adinsonia digitata*	11.3	20	Junagadh
S2	Largest Kadaya Tree	*Sterculia urens*	3.86	25	Junagadh
S3	Largest Mango Tree	*Mangifera indica*	7.4	16	Narmada
S4	Largest Semal Tree	*Bombex ceiba*	13.5	35	Dahod
S5	Largest Amla Tree - Mahavriksh	*Emblica officinalis*	3.4	10	Nadiad
S6	Largest Neem Tree	*Azardirachta indica*	6.9	24	Surendranagar
S7	Largest Baheda Tree	*Terminalia bellirica*	6.15	39	Dangs
S8	Tallest Sadad Tree	*Terminalia tomentosa*	3.05	36	Dangs
S9	Largest ArjunSadad Tree	*Terminalia arjuna*	7.3	35	Panchamahals
S10	Large Haldu Trees	*Adina cordifolia*	4.2	35	Panchamahals
S11	Old and Largest Bordi Tree	*Ziziphus mauritiana*	4.68	15	Junagadh
S12	Old Amli Tree	*Tamarindus indica*	7.55	30	Kheda
S13	Large and Old Rayan Tree	*Manilkara hexandra*	6.5	30	Mahesana
S14	Tallest Teak Tree	*Tectona grandis*	4.21	41.5	Dangs
S15	Largest Rain Tree	*Samanea saman*	5.56	41	Navasari
S16	Largest Kalam Tree	*Mitragyna parviflora*	4.1	41.5	Dangs
S17	Tallest Kilai Tree	*Albizia procera*	2.3	38	Dangs
S18	Largest Mahuda	*Madhuca indica*	6.05	32	Vadodara
S19	Tallest Umbh Tree	*Miliusa tomentosa*	2.3	37	Dangs
S20	Oldest Piloo Tree	*Salvadora oleoides*	6.45	12	Gandhinagar
S21	Largest Mahogany Tree	*Swietenia mahogani*	6.8	30	Junagadh
S22	Oldest Pipal or Pipado Tree	*Ficus religiosa*	9.4	16	Valsad
S23	Large Pipada Tree	*Ficus tsila*	6.4	24.7	Sabarkantha
S24	Oldest and Largest Borsalli Tree	*Manilkara elengi*	4.1	18	Junagadh
S25	Largest Shivlingi Tree	*Couroupita guianensis*	3.55	23	Navasari

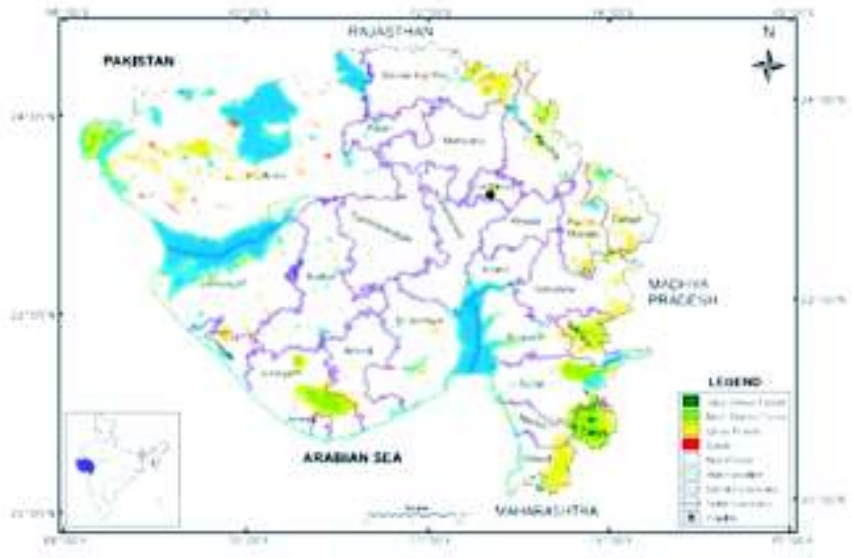

Figure 1: Forest Density Map: India, Gujarat; Source: Forest Survey of India (FSI, 2009)

species, destructive method and non-destructive method approved by many researches. I employed the non-destructive method for carbon estimation, in this method we need not to harvest the entire bio-volume and sacrifice the tree. For quantitative data analysis of carbon storage, many programming based bio-statistical tools are used like SPSS Software, ANOVA, and Regression equations. In the present study, the data's of species complied, tabulated and above equations were inserted in MS-Excel-2007 and the following results were obtained.The girth of the tree is measured at the girth at breast height (GBH) 1.32m above ground surface. Data of the girth and height is procured from the Publication of Gujarat Forest Department "Heritage trees of Gujarat" (Singh, 2010). Tree diameter (D) was measured by dividing π (3.14) to the actual marked girth of species (Bohre et al., 2012) i.e. GBH/3.14.Biomass is evaluated in above listed tree species is calculated by simply applying of bio-statistics based allometric equations. Above ground Biomass (AGB) are estimated by multiplying the bio-volume to the green wood density of tree species. Tree bio-volume (TBV) value established by multiplying of diameter and height of tree species to factor 0.4.

Bio-volume(T_{BV})=0.4 X $(D)^2$x H ……Eq.-1

AGB =Wood density x T_{BV} .....Eq. -2

Where; D = (GBH/π), diameter (meter) calculated from GBH, assuming the trunk to be cylindrical, H = Height (meter). Wood density is used from Global wood density database, Zanne et al., (2009). The standard average density of 0.6 gm/ cm^3 is applied wherever the density value is not available for tree species.

Below Ground Biomass (BGB)

The belowground biomass has been calculated by multiplying the above ground biomass (AGB) by 0.26 factors as the root: shoot ratio (Hangarge et al., 2012).

BGB = AGB x 0.26 .....Eq.-3

Total Biomass

Total biomass is the sum of the above and below ground biomass. (Sheikh et al., 2011)

Total Biomass (TB) = Above Ground Biomass + Below Ground Biomass Eq.-4

Carbon Estimation

Generally, for any plant species 50% of its biomass is considered as carbon (Pearson et al., 2005) i.e.

Carbon Storage = Biomass x 50% or Biomass/2

…….Eq.-5

RESULTS AND DISCUSSION

Gujarat trees store 177.5 million tonnes of carbon out of which the selected 25 tree species contributed (the sum of all species carbon) $421.47x10^{-6}$ million tonnes carbon.The lowest carbon storage value estimated in *Emblica officinalis* 1.77tC and maximum carbon storage found in *Tamarindus indica* 55.95tC. From above equations we can conclude the ecological significance of these plant species. As the diameter of species increases its biomass and carbon storage capacity increases also sequester more carbon, removes more carbon dioxide from atmosphere.. List of species and their above ground, below ground, and total biomass with carbon is given in table, 2. Species should be planted according to keeping all environmental parameters (Location/Bio-geographic Zone, Climate, Soil type, annual temperature, Ground water availability, annual rainfall, etc.) in mind. Also the species which harvest more CO_2 from atmosphere, should planted more (Figure, 2).

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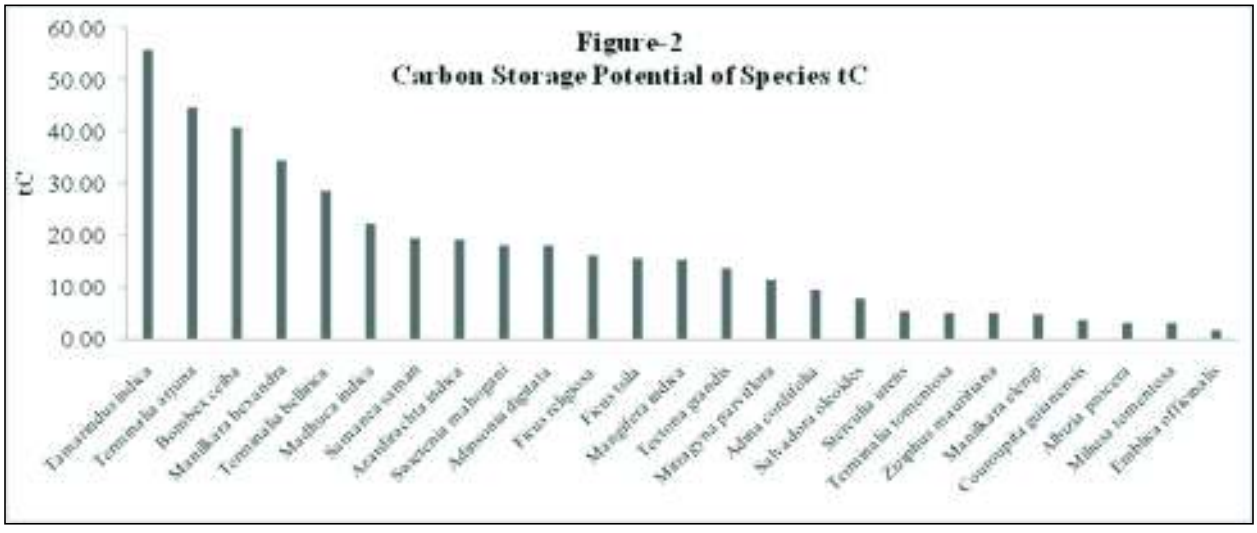
Table 2: List of Species And Their Above Ground, Below Ground, And Total Biomass With Carbon

Species	AGB (Kg)	BGB (Kg)	TB (Kg)	C (Kg)	tC/Species
Tamarindus indica	88802.63	23088.68	111891.31	55945.66	55.95
Terminalia arjuna	71128.28	18493.35	89621.63	44810.82	44.81
Bombex ceiba	64695.83	16820.92	81516.75	40758.37	40.76
Manilkara hexandra	54507.28	14171.89	68679.18	34339.59	34.34
Terminalia bellirica	45480.91	11825.04	57305.94	28652.97	28.65
Madhuca indica	35163.58	9142.53	44306.12	22153.06	22.15
Samanea saman	30852.15	8021.56	38873.70	19436.85	19.44
Azardirachta indica	30595.25	7954.77	38550.02	19275.01	19.28
Swietenia mahogani	28701.85	7462.48	36164.34	18082.17	18.08
Adinsonia digitata	28595.43	7434.81	36030.24	18015.12	18.02
Ficus religiosa	25408.56	6606.23	32014.79	16007.39	16.01
Ficus tsila	24626.85	6402.98	31029.83	15514.91	15.51
Mangifera indica	24170.91	6284.44	30455.35	15227.67	15.23
Tectona grandis	21485.50	5586.23	27071.73	13535.87	13.54
Mitragyna parviflora	18113.25	4709.45	22822.70	11411.35	11.41
Adina cordifolia	14778.12	3842.31	18620.44	9310.22	9.31
Salvadora oleoides	12152.14	3159.56	15311.69	7655.85	7.66
Sterculia urens	8205.69	2133.48	10339.17	5169.59	5.17
Terminalia tomentosa	8151.81	2119.47	10271.28	5135.64	5.14
Ziziphus mauritiana	7997.14	2079.26	10076.40	5038.20	5.04
Manilkara elengi	7365.33	1914.99	9280.31	4640.16	4.64
Couroupita guianensis	5526.92	1437.00	6963.92	3481.96	3.48
Albizia procera	4893.18	1272.23	6165.41	3082.70	3.08
Miliusa tomentosa	4764.41	1238.75	6003.16	3001.58	3.00
Emblica officinalis	2813.91	731.62	3545.52	1772.76	1.77



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