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The Older Trees in Biodiversity Rich Forests of South Lakhimpur Khiri Forest Division (Uttar Pradesh) Sequesters More Carbon than Young Trees

UMA SHANKER SINGH, IFS, PhD

3/184,Vibhav Khand, Gomti Nagar,

Lucknow,Uttar Pradesh

Umashankar.87@gmail.com

ABSTRACT- India is one of the 12 mega diversity countries having a vast variety of flora and fauna. It commands 7% of world's biodiversity and support 16 major forest types, varying from alpine pastures in the Himalayas to temperate, sub-tropical and tropical forests, mangroves of the coastal regions. The country's forest cover is7, 08,273 sq km which is 21.54 % of the of the geographical area. While deforestation is responsible for about 20 percent of greenhouse gases, overall, forests currently absorb more carbon than they emit. Over the past 150 years, deforestation has contributed an estimated 30 percent of the atmospheric build-up of CO2. It is also a significant driving force behind the loss of genes, species, and ecosystems. It is expected that there would be large scale shifting of forest biomes throughout India. The highest impact is expected on the teak and Sal forests of central and eastern regions and the temperate Himalayas. 85% of the forest grids of the country would change their type. The Western Ghats and forests of the Northeast would be impacted comparatively less. Carbon sequestration is one of the important functions of forest ecosystem. Trees and forests help by removing carbon dioxide from the atmosphere and converting it during photosynthesis to carbon, which they store in the form of wood and vegetation, a process referred to as carbon sequestration. Trees are generally about 20% carbon by weight. The overall biomass of forests also acts as a carbon sink with the organic matter in forest soils such as the humus produced by the decomposition of dead plants. I conducted a study to find out sequestered carbon dioxide in different species of sub tropical forest of South Kheri Forest Division of Uttar Pradesh. Twenty five compartments were indentified for the purpose of carbon sequestration analysis. Of the total twenty-five compartments randomly surveyed, sampling was undertaken with a view to ear marking 1% of the total area for complete enumeration in terms of girth measurement at breast height. The total area of the twenty-five compartments selected for the present study comes to 3212.80 ha. These compartments represent the all possible forest types for the purpose of detailed study i.e. enumeration and data collection. A sample size of 1% of the total compartment area was selected. In order to achieve this plot of designated dimension amounting to 1% of the total compartment area was randomly laid out in each compartment. The total area thus selected came to 32.13 ha which is 1% of the selected forest area. A total eight thousand two hundred trees were enumerated of which Teak constitutes the highest number i.e. 3903 followed by Sal which figured around 1557. Jamun was the third largest in number. Calculation of carbon in the stem of all species has been worked out by the chemical analysis (Walkley-Black Method, 1934 and reaffirmed again in 2006) by taking out wood sample through Pressler's borer.

KEY WORDS-Carbon Sequestration, Tropical and Sub tropical Forest, Climate change, Carbon dioxide concentration in atmosphere, Ecosystem, Carbon Sequestration, Forest Soil, Biodiversity, Carbon Sink, State of Forest Report.

INTRODUCTION:

THE July 2019 global land and ocean surface temperature departure from average was the highest for July since global records began in 1880 at 0.95°C (1.71°F) above the 20th century average. This value surpassed the previous record set in 2016 by 0.03°C (0.05°F). Nine of the 10 warmest Julys have occurred since 2005, with the last five years (2015–2019) ranking among the five warmest Julys on record. July 1998 is the only July from the 20th century to be among the 10 warmest Julys on record. July 2019 marked the 43rd consecutive July and the 415th consecutive month with temperatures, at least nominally, above the 20th century average. Julys 2016, 2017, and 2019 are the only Julys that had a temperature departure from average at or above 0.90°C (1.62°F). Climatologically, July is the globe's warmest month of the year. With July 2019 the warmest July on record, at least nominally, this resulted in the warmest month on record for the globe. The global land – only surface temperature for July2019 was 1.23°C (2.21°F) above the 20th century average and was the second highest July temperature in the 140-year record. July 2017 holds the record for the highest July global land-only temperature at +1.24°C (+2.23°F). The July 2019 globally averaged ocean-only temperature departure from average of +0.84°C (+1.51°F) was the highest on record for July, surpassing the previous record set in 2016 (+0.82°C / +1.48°F). Compared to all months, this value tied with September 2015 as the sixth highest monthly global ocean temperature departure from average among all months (1675 months) on record. The 10 highest global ocean monthly temperature departures have all occurred since September 2015[1]

Global Carbon Dioxide Concentration Is On Increase:

The concentration of carbon dioxide in the atmosphere has increased by the second highest annual rise in the past six decades, according to new data. Atmospheric concentrations of the greenhouse gas were 414.8 parts per million in May, which was 3.5ppm higher than the same time last year, according to readings from the Mauna Loa observatory in Hawaii, where carbon dioxide has been monitored continuously since 1958.Scientists have warned for more than a decade that concentrations of more than 450ppm risk triggering extreme weather events and temperature rises as high as 2C, beyond which the effects of global heating are likely to become catastrophic and irreversible. This is the seventh consecutive year in which steep increases in ppm have been recorded, well above the previous average, and the fifth year since the 400ppm threshold was breached in 2014. In 2016, the highest annual jump in the series so far was recorded, from 404.1 in 2015 to 407.66 in 2016. As recently as the 1990s, the average annual growth rate was about1.5ppm, but in the past decade that has accelerated to 2.2ppm, and is now even higher. This brings the threshold of 450ppm closer sooner than had been anticipated. Concentrations of the gas have increased every year, reflecting our burning of fossil fuels [2]

Carbon Dioxide Concentration Over India:

India emitted 2,299 million tonnes of carbon dioxide in 2018, a 4.8% rise from last year. India's emissions growth this year was higher than that of the United States and China, the two biggest emitters in the world and this was primarily due to a rise in coal consumption. China, the United States, and India together accounted for nearly 70% of the rise in energy demand. India's per capita emissions were about 40% of the global average and contributed 7% to the global carbon dioxide burden. The United States, the largest emitter, was responsible for 14% [3]. As per its commitments to the United Nations Framework Convention on Climate Change, India has promised to reduce the emissions intensity of its economy by 2030, compared to 2005 levels.

Forest and Climate Change:

Forests and Climate Change are intimately intertwined. Forests have regulated the climate, rain, groundwater, soil of the earth over millennia .Their transpiration act as a regulator of the balance of oxygen and carbon dioxide. The world's forests and forest soils currently store more than one trillion tons of carbon, twice the amount found floating free in the atmosphere. While deforestation is responsible for about 20 percent of greenhouse gases, overall, forests currently absorb more carbon than they emit. The problem is that this critical carbon-regulating service could be lost entirely if the earth heats up 2.5 degrees Celsius or more relative to pre-industrial levels, which is expected to occur if emissions are not substantially reduced. Further, higher temperatures, along with the prolonged droughts, more intense pest invasions, and other environmental stresses that could accompany climate change, would lead to considerable forest destruction and degradation. India is one of the 12 mega diversity countries having a vast variety of flora and fauna. It commands 7% of world's biodiversity and support 16 major forest types, varying from alpine pastures in the Himalayas to temperate, sub-tropical and tropical forests, mangroves of the coastal regions. The 15th State of Forest Report shows that India's total forest cover increased by 0.94 per cent, from 7,01,673 square kilometers to 7,08,273 square kilometers since its last assessment in 2015. The report also points towards an expansion of agro-forestry and private forestry. There is a jump from 42.77m^3 in the 2011 assessment to 74.51m^3 in timber production in 'Trees outside Forests' (TOF) category[4].

Impact Of Climate Change On Forests:

Over the past 150 years, deforestation has contributed an estimated 30 percent of the atmospheric build-up of CO2. It is also a significant driving force behind the loss of genes, species, and ecosystems. It is expected that there would be large scale shifting of forest biomes throughout India. The highest impact is expected on the teak (Tectona grandis) and sal (Shorea robusta) forests of central and eastern regions and the temperate Himalayas. 85% of the forest grids of the country would change their type. The Western Ghats and forests of the Northeast would be impacted comparatively less. India, currently, has a dominant forest cover of the Tropical Dry Forest (37.2%) type, followed by Dry Savanna (33%) and Moist Savanna (32.5%) types. This is projected to change with Tropical Dry Forest and Tropical Seasonal Forest (28.4%) becoming dominant. Xeric Scrubland, to a smaller extent, is set to decrease in area and Xeric Woodland is expected to increase in the drier regions. In the colder regions, Boreal and Temperate Conifer coverage decreases while Temperate Deciduous and Temperate Evergreen coverage increases. This projected shift in vegetation may lead to large-scale forest dieback and loss of biodiversity especially in the transition between forest types.

Carbon Sequestration Potential Of Forest Is Important To Be Estimated:

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Forests store a large amount of carbon, thus playing a key role in mitigating climate change. Conversely forest degradation, disturbances and harvest may lead to carbon emissions. Therefore, forest management influences the amount of carbon stored in biomass, soils, and forest products. Forest management aims to achieve multiple objectives, and carbon storage and the contribution to mitigation of climate change as part of this, is in-creasing in importance worldwide. Therefore, the major objectives of my study were to carry out the estimation of carbon in the present standing forest of south Kheri forest division, a tract of forest on the foothill of Nepal, besides, assessment of soil carbon to find out the carbon available in the forest area. Carbon sequestration is one of the main ecosystem services provided by forests, and one that will become increasingly important at ecological, economic and societal levels as plans for climate change mitigation and adaptation are carried forward and promoted after COP22. However, carbon sequestration potential in forest ecosystems under novel environmental conditions is still under research, as many complex interactions influence tree growth and forest soil processes. In one of the studies on Chinese forest this has been found that the C densities of vegetation and soil (0–100 cm) were about 69.23 Mg C/ha and 116.52 Mg C/ha, respectively [5].

Forest in Uttar Pradesh:

Uttar Pradesh is one of the very important States of the country. The total geographical area of the State is 240,928 km^2. It also happens to be the most populous State of the nation. The forest area is 16526.77 km^2 which comes to 6.9% of the total geographical area. Most of the forest area is under tremendous biotic pressure and under different stages of degradation except a few patches which run along the tarai area which are rich in biodiversity. The dominant species of the terai forest which runs along Gorakhpur, Gonda, Bahraich, Lakheempur, Peelibhit and Barreily, are Sal (*Shorea robusta*), Teak (*Tectona grandis*) and other Sal associates. The forest in Uttar Pradesh is mostly under heavy pressure either by human population or by live stock population as depicted in the following table-

TABLE-1 DIFFERENT TYPES OF FORESTS IN UP

FOREST COVER	PERCENTAGE OF GEOGRAPHICAL AREA
NON FOREST AREA	93.67
VERY DENSE FOREST(VDF)	1.09
MODERATELY DENSE FOREST(MDF)	1.69
OPEN FOREST(OF)	3.32
SCRUB	0.23

TABLE-2 CHANGE MATRIX OF UP

FOREST TYPES	2017 ASSESSMENT(AREA IN km^2)					
	VERY DENSE FOREST	MODERATELY DENSE FORST	OPEN FOREST	SCRUB	NON FOREST(NF)	TOTAL 2015
VDF	1,984	166	15	00	06	2,171
MDF	475	3,005	434	07	122	4,043
OF	147	771	6,018	47	1,204	8,187
SCRUB	1	20	204	339	234	798
NF	10	107	1,322	158	2,24,132	2,25,729
TOTAL 2017	2,617	4,069	7,993	551	225,698	240,928
NET CHANGE (FROM 2015)	446	26	-194	-247	-31	

SOURCE: ISFR (2017)

The figures conceal more than it reveals. There are 25 districts in the Uttar Pradesh where forest cover has declined substantially [4]. This indicates that forests are not only under different stages of degradations but also the resources spent on it are scarce and emission of carbon dioxide is unchecked. With the loss of forest we are not only loosing biodiversity but also soil which not only sequesters carbon dioxide and mitigates climate change but also adds productivity of the forest ecosystem. Land use, currently accounting for about 25% of global GHG emissions, must be part of an effective climate change mitigation strategy. Furthermore, it may not be possible to achieve large enough emissions reductions in the energy, transport, and industrial sectors alone to stabilize GHG concentrations at a level commensurate with a less than 2°C (3.6°F) global average temperature increase, without the help of a substantial CO_2 sink from the land use sector [6]. A 4% annual growth rate of the soil carbon stock would compensate the current in-crease in atmospheric CO_2. This is the backbone of the 4 per 1000 Initiative launched by France in its forest ecosystems. The driving idea is that even a small change in soil C can contribute to mitigate climate changes, with multiple co-benefits (soil fertility, water holding capacity, soil structure)

Plant Composition of Forest of South Kheri Forest Division:

Based on the classification given by[26] H.G. Champion in his "Preliminary survey of forest types of India and Burma- Indian forest records 1, volume 1936", ten forest types have been found in study area.The forest of south Kheri Forest Division mainly comprises Sal (*Shorea robusta*) and Teak (*Tectona grandis*) and other miscellaneous species. These were allotted to the private owners in the early nineteenth century for cultivation. Between the year, 1861 to 1875 the grantees felled forests recklessly for poles in all accessible areas, lying south of UL river. This wasteful process was stopped when the Forest Department took over the management of the forest in 1877 and for the first time the forest adjoining the Madha village was brought under fire protection. For the first time a management plan was prepared for the working of this forest on specific prescriptions inscribed in to the plan. For the management of Sal forest improvement, exclusively felling were carried out. The present study area is situated to the South of Sharda River and lies between $28^{0}0''$ to $28^{0}3'$ north latitude and $80^{0}60''$ to $80^{0}35''$ east longitude. The forest of the study area chiefly comprises of Sal forest, miscellaneous forest, riverine forest and grasslands. Sal forest could be broadly divided into two groups, firstly Reserve forest and secondly, the areas which have been vested into forest after zamindari abolition act 1952. It consists of Sal forest which is of coppice origin of different age classes. The Miscellaneous forest or Savanna is kind of forest area which includes miscellaneous species with a few or no Sal trees. This type is poorly represented in this division but occurs at narrow broken strips along the sides of the Ul River and other depressions where the soil is damp. The forest density is not very good. Grass is sometimes light or absent where overhead canopy is dense but elsewhere there is usually dense *Imperata* a*rundinacea* and other grasses. Riverine forests run along the southern belt of Sharda River and mainly consist of khair and shisham which are probably the pioneer tree species on the river belts. Grasslands have been the consequences of massive illegal felling in the past. Grasslands are varying in sizes depending upon the various external practices and biotic interference. Sub tropical Sal (Shorea robusta) forest of South Lakhimpur Forest Division is very rich in biodiversity and contains many floras and fauna which are still unidentified. In a study in the adjoining foot hill area of Gorakhpur sal forest (Sohagibarua wild life sanctuary), this has been found that the Sal (*Shorea robusta*) forest vegetation contains a total of 208 plant species representing 165 genera and 72 families. Species richness, mean density and basal area of individuals in the observed forest were compared with those of other sal-dominated forests of India. The sal forest was rich in Papilionaceae (23 species), which contributed maximally to the total number of individuals of <30 cm girth. After sal, density was maximal for a leguminous shrub, *Moghania chappar*. In addition to the usual recruitment by seed, a number of species also showed non-seed regeneration through storage roots, sprouts[7].In yet another study on the composition of the Sal forest of Kamrup district of Assam, this has been found that Sal is a very important tree species but the forest is subjected to highest degree of degradation. Altogether, 71 plant species were recorded from the selected Sal forest. Herbaceous layer of the forest was most species rich (30 species) layer followed by tree and shrub species. Leguminosae and Asteraceae were among the most dominant families in the forest while large number of families was mono-specious. *Shorea robusta* has contributed about 90% of the total stand density (2559 individual ha-1) of the forest, while species like *Erythrina suberosa, Delonix regia* and *Pterospermum acerifolium* were represented by single stem. Similar to that of stand density, Sal has contributed to the maximum basal area of the forest. Diversity index for tree, shrub and herb species was recorded 1.43, 2.30 and 3.28, respectively. Dominance index showed reverse trend to that of diversity index. About 84% of the plant species showed contagious distribution, however none of the species exhibited regular distribution. The forest is heterogeneous in composition with high dominance of *Shorea* and is under regenerating stage. Therefore, for sustainability of the forest it requires effective conservation measures for sal and its associate plant species[8]. Doon valley is also known to have a good Sal forest but on account of very high biotic pressure this is going down in its composition. Doon valley is famous for mono cultures of moist Sal resulted due to various silvicultural operations in the past. However in recent years these forests were subjected to numerous anthropogenic perturbations, which have posed a great threat to their existence. In a study on Doon sal, composition diversity and structure of moist Sal forests have been compared with the previous studies on the same parameters. After analyzing the results, it was found that these forests are still dominated by the Sal tree however, the structure of shrub and herb layers has changed manifold. These layers, once dominated by shade loving Clerodendrum viscosum, are now being dominated by xerophytic species like Mallotus philippensis, Litsea glutinosa, Flacourtia indica etc. The general diversity of tree, shrub and herb layers has increased in these forests and so is the heterogeneity [9].

Material and Methods

Study Area:

The total forest of the study area falls mainly into three working circles *viz*, Sal improvement working circle, Teak working circle and Forest block plantation working circle and all three of them account for 41136.74 hectare of forest land. The reasons for selecting the three working circles for the study are as follows.

(A)The three working circles were representatives of the typical Sal and Teak forests of the Terai areas. This constitutes the major area of the forests and as a rule the crop is almost pure Sal and Teak with a preponderance of middle aged trees with all Sal associates present in this. This forest also includes certain areas where Teak was introduced in the past because Sal regeneration was lacking. Therefore, the study area has a fairly good mixture of representative species grown over a long period of time.

(B)The Plantation Working Circle covered those areas which were open and blank and fit to be planted. The plantation activities in those areas were carried out since 1930s. Therefore, study area has a fairly good representation of planted forest also. The plantation of working circle initially started as Taungya working circle in 1939 to 1949 and gradually merged into Plantation Working Circle when the Taungya system was discontinued. The forests of South Kheri division are quiet old and the government acquired proprietary rights over the forest in 1856 and since then it has been managed under different set of management principles. Therefore, it is a typical representative of an old sub tropical Sal forest for giving us an opportunity to understand the carbon sequestration potential of forest.

Selection of Areas for Enumeration:

There are 105 compartments in Sal Improvement Working Circle of which 10 compartments have been selected randomly for the present study which comes to roughly 9.52 % of the total compartments. Likewise Teak working circle has total 140 compartments of which 12 compartments were selected for study which comes to 9% of the total. Plantation Working Circle consists of areas which are blank and has degraded forest and degraded land. This also consists of those areas which are devoid of Sal regeneration. This working circle mainly comprises of Sal forest, devoid of regeneration, and other blank areas. Therefore only three compartments have been taken into the study which constitutes 2.8% of the total compartments of this working circle.

Area Statement of the Study Area:

Twenty five compartments were indentified for the purpose of carbon sequestration analysis. Of the total twenty-five compartments randomly surveyed sampling was undertaken with a view to ear marking 1% of the total area for complete enumeration in terms of girth measurement at breast height. The total area of the twenty-five compartments selected for the present study comes to 3212.80 ha. These compartments represent the all possible forest types for the purpose of detailed study i.e. enumeration and data collection. A sample size of 1% of the total compartment area was selected. In order to achieve this plot of designated dimension amounting to 1% of the total compartment area was randomly laid out in each compartment. The total area thus selected came to 32.13 hectare which is 1% of the selected forest area. The relative advantages of the partial enumeration or sampling are many like reduced cost and saving of time, relative accuracy, knowledge of error etc. In the present area of research, the random sampling method was adopted.

Total Number Of Trees Enumerated For The Study:

A total eight thousand two hundred trees were enumerated of which Teak constitutes the highest number i.e. 3903 followed by Sal which figured around 1557. Jamun was the third largest in number. The following table presents the total number of tree species wise and their percentage components of the total

TABLE- 3 SPECIESWISE TOTAL NUMBER OF TREES WHICH WERE ENUMERATED IN DECENDING ORDER

SL.NUMBER	NAME OF TREE	TOTAL NUMBER OF TREES	PERCENTAGE OF GRAD TOTAL
1	TEAK	3903	47.59
2	SAL	1557	18.98
3	KUKAT Misc. spp	841	10.25
4	JAMUN	516	6.29
5	ROHINI	492	6

6	Eucalyptus spp.	339	4.13
7	ASNA	163	1.99
8	ARJUN	156	1.9
9	MAHUA	48	0.59
10	KANJI	35	0.43
11	BEL	28	0.34
12	TENDU	28	0.34
13	DUDHI	24	0.29
14	KHAIR	21	0.26
15	KUSUM	21	0.26
16	BARGAD	9	0.11
17	GOOLAR	6	0.07
18	KAIM	5	0.06
19	BAHERA	4	0.05
20	PEEPAL	3	0.04
21	LAVERA	1	0.01
22	NEEM	1	0.01
23	SHISHAM	1	0.01
	TOTAL	8200	

SOURCE: Thesis on Carbon sequestration in natural Sal (*Shorea robusta*) Forest Of South Kheri Forest Division, Lakhimpur Kheri by Uma Shanker Singh

Girth Mesurement

The main object of the measurement of individual tree is to estimate the volume of the individual standing tree. Volume of a tree is usually dependent on diameter or girth at the breast height. Diameter or girth measurement is very important for calculating volume. In case of a standing tree, the girth was measured at breast height (4 feet 6 inches above ground level). Each individual tree was enumerated by their species and duly recorded in the pre designated format. The species which are important and whose volume equations are separately known were kept in one group and the other which constituted trees of lesser significant and shrubby in character were kept in another group called Kukat. Kukats are the group of miscellaneous species which are less significant from commercial forestry point of view The above table clearly shows that Teak constitutes about 47.59% of the total species followed by Sal (18.98%) and Safeda(Eucalyptus spp.) (4.13%) in the forest in the South Kheri Forest Division and two percentage of the remaining species is indicative of the fact that they are sparse in number which normally happens in a forest which is surrounded by dense human population and where illicit felling is rampant.

Carbon Estimation

Stem

Circumference of every species was recorded at breast height level and from this figure the diameter for each individual species was calculated by dividing circumference with 3.4 The next stage was to work out the volume of each and every species listed in the study area through regression equation developed for individual species by Forest Survey of India [33]. The volume of each and every species was calculated on the basis of above regression equation. In order to work out the green weight, the volume was multiplied with their respective wood densities. The value of wood density used in the present study are given in from the studies by Sandra Brown[30] in his study on estimating Biomass and biomass change in tropical forests in 1997 and web sites of FSI (Forest survey of India) Green weight of each species was calculated by simply multiplying volume of individual species with the wood density of that particular individual wood densities of each species. The average dry weight of the wood sample is calculated on the basis of drying the sample of wood pieces of individual species in a drier in the laboratory at a controlled constant temperature of 70° C until the wood sample is completely dried. Dry weight factor has been calculated by average dry weight of an individual species divided by green weight of the stem of that species. Green weight/Fresh weight of the stem is the weight which was taken at the time of sample collection of individual tree species. The dry weight of a stem of an individual species is calculated simply by multiplying green weight of the sample of that particular species with dry weight factor of that species. Calculation of carbon in the stem of all species has been worked out by the chemical analysis[32]by taking out wood sample through Pressler's borer. The carbon content of the stem is calculated by simply multiplying dry weight of the stem with carbon factor and this gave the carbon content present in the stem of that particular species.

Branches

The carbon is also locked in branches of the stem. A fully grown tree is very branchy, the branches are thick on the lower side and as one goes up the stem, the branches become thinner. To find out carbon stocking in the branches, two branches of each tree species were chosen, one, the lower most branch and the second branch, just above the first branch. It was not possible physically to calculate carbon in the entire branch system therefore, only two branches were taken for study. The lower branch (henceforth will be called as branch-1) and the upper branch (henceforth will be called branch-2) of all the individual species were cut into small pieces of five centimeter. They were tagged properly with their botanical names, name of compartment, time and date of sample collection and their fresh/green weights were immediately taken and duly recorded. The samples were analyzed with walkley- Black method as stated earlier to find out carbon content. Here also the samples of cylindrical wood were taken out through Pressler's borer as was done in case of stem. The volume of the branches has been calculated on the basis of volume table given by Chaturvedi and Khanna (1982)[31]. Green weight of branches is calculated by multiplying volume of branches with their respective densities. Average weights of the branches were also found out. The carbon percentage of branches of individual species was found out in laboratory through chemical analysis and the carbon was calculated by simply multiplying carbon factor of that particular species with average dry weight of branches of that individual species

Roots

Once the carbon content of the branch and the stem were calculated we will now find out the carbon content present in the root. The root content is 26 % of the total biomass of the tree (carbon content of stem + carbon content of the branch). The amount of carbon stored by a tree depends on its size which is influenced by many factors e.g. the age of the species and the local conditions favoring the growth. It is very difficult to dig up the roots and actually measure its volume and weight. That is why the secondary data was used for estimation of root carbon. The biomass of the roots, branches and leaves of a Sycamore tree are known to be around26%, 11% and 1% of the total biomass respectively[29]. Based on these assumptions, the carbon in root has been considered to be 26% of the total carbon present in stem and branches.

Result:

The following table shows that Teak is the tree which sequesters highest amount of carbon dioxide from the atmosphere. This finding also gets support from the research done at Gujarat Ecological Education and Research (GEER).

TABLE 4-SPECIES WISE CARBON CONTENT IN DIFFERENT PARTS OF TREES IN DESCENDING ORDER

SL. NUMBER	NAME OF SPECIES	SPECIES WISE CARBON CONTENT IN DIFFERENT PARTS OF TREES						
		STEM	NAME OF SPECIES	BRANCH	NAME OF SPECIES	ROOT	NAME OF SPECIES	TOTAL (STEM+BRANCH+ROOT)
1	TEAK	3892.34	TEAK	211.86	TEAK	1070.738	TEAK	5,174.93
2	SAL	3806.63	KUKAT	10.38	SAL	994.755	SAL	4,806.72
3	ASANA	2851.61	ROHINI	7.99	ASANA	745.229	ASANA	3,597.47
4	JAMUN	1588.17	EUCALYPTUS	7.41	JAMUN	417.765	JAMUN	2,010.53
5	KUKAT	1125.71	SAL	5.341	KUKAT	299.027	KUKAT	1,435.12
6	BARGAD	658.274	JAMUN	4.6	BARGAD	174.79	BARGAD	833.07
7	KUSUM	345.77	ARJUN	2.5089	KUSUM	93.583	KUSUM	439.5
8	ROHINI	341.24	KHAIR	0.7767	MAHUA	43.188	ROHINI	365.43
9	MAHU	151.	ASAN	0.639	EUCA	40.8	MAHU	195.27

	A	84	A	4	LYPTUS	43	A	
10	EUCALYPTUS	135.66	KANJI	0.599	ROHINI	16.249	EUCALYPTUS	183.91
11	PIPAL	48.48	BEL	0.482	PIPAL	16.249	PIPAL	64.733
12	BAHERA	18.81	MAHUA	0.25	ARJUN	9.181	ARJUN	30.44
13	ARJUN	18.79	KAIM	0.2479	BAHERA	8.534	BAHERA	27.34
14	KAIM	17.53	GULAR	0.2	KAIM	8.266	KAIM	26.04
15	KANJI	16.06	KUSUM	0.15	KANJI	7.973	KANJI	24.63
16	TENDU	13.01	DUDHI	0.108	TENDU	7.053	TENDU	20.16
17	BEL	10.32	TENDU	0.104	BEL	6.451	BEL	17.25
18	GULAR	7.53	SHISAM	0.044	GULAR	5.654	GULAR	13.38
19	DUDHI	2.76	BARGAD	0.0158	DUDHI	4.389	DUDHI	7.25
20	LAVERA	0.943	BAHERA	0.0078	KHAIR	4.034	KHAIR	5.54
21	NEEM	0.941	LAVERA	0.005	LAVERA	3.888	LAVERA	4.83
22	KHAIR	0.733	PIPAL	0.0042	NEEM	3.887	NEEM	4.83
23	SHISAM	0.011	NEEM	0.0038	SHISAM	3.656	SHISAM	3.71
TOTAL		150053.16		253.7275		3985.382		19,292.08

SOURCE: Thesis on Carbon sequestration in natural Sal (*Shorea robusta*) Forest Of South Kheri Forest Division, Lakhimpur Kheri by Uma Shanker Singh

In its lifetime, a teak tree with a girth of 10-30 cm can absorb 3.70 lakh tonnes of carbon dioxide from the atmosphere.This has been found in the research that Teak is followed by Neelgiri tree which absorbs 2.46 lakh tonnes of carbon dioxide and the Neem tree with a carbon sequestration capacity of 1.45 lakh tonnes in its lifetime. A total of 33.66 million tonnes of carbon dioxide had been sequestered by trees in non-forest areas of Gujarat[35].

TABLE 5- SPECIES WISE CARBON STOCK

BOTANICAL NAME	CARBON SEQUESTRATION IN TONNES
Tectona grandis	3.70
Eucalyptus globules	2.47
Prosopis juliflora	1.67
Azadirachta indica	1.45
Casurina equsetifolia	1.28
Accacia tortilis	1.04

SOURCE: Gujarat Ecological Education and Research (GEER).

Tectona grandis is found in a variety of habitats and climatic conditions from arid areas with only 500 mm of rain per year to very moist forests with up to 5,000 mm of rain per year. Typically, though, the annual rainfall in areas where teak grows averages 1,250-1,650 mm with a 3-5 month dry season[34]. Teak is tropical hardwood species and belongs to family of Lamiaceae. It is most valuable and high price timber crop of India. It is deciduous tall tree upto 40m tall with gray to grayish brown branches. Sal (Shorea robusta) is yet another important species from ecology and carbon sequestration point of view. A study was carried out and it was found that Sal stem and root contain second highest amount of carbon stock in the forest. This is observed in the research that the total carbon in Sal stem and root was found to be 3806.63 MT and 994.755 MT. This result of mine was supported by other researches also. In yet another study done in the "Carbon Stocks in *Shorea robusta* and *Pinus roxburghii* forests in Makawanpur district of Nepal" this was found that total biomass carbon in Shorea robusta and Pinusroxburghii forest was 170.75t/ha and 144.96 t/ha, respectively. Total carbon sequestration in Shorea robusta forest was 1.21 times higher than in the Pinus roxburghii forest. Shorea robusta [40]. Broadly, Sal's natural range lies between the longitudes of 75° and 95° E and the latitudes of 20° to 32° N. Within this range, the distribution is controlled firstly by climate and then by edaphic factors. Sal forests are distributed on the plains and lower foothills of the Himalayas including the valleys [36]. It penetrates through mid-mountain range (Mahabharat region) to the far north along river slopes and valleys. Sal forests cover ~110 000 ha in Bangladesh [37], 10 million ha in India [39] and 1 million ha in Nepal [38]. This forest type extends from a few metres to 1500 m above mean sea level.In the past, sal forests were managed solely in the interests of the ruling elite; accordingly, management norms were developed to maximize revenue.The third species which sequestered more carbon than others was Pterocarpus marsupium, locally called as Asna. This is a large sized tree with spreading branches and clean bole. This wood is often used as ndurable timber and normally compared with teak. This species is disappearing very fast from the native forest on account of uncontrolled illegal felling and lack of natural regeneration. Unfortunately, the foresters are paying no attention to its conservation and it is virtually untried in plantations.Bark is about 1.25 cm thick, grey, rough, longitudinally fissured in small irregular scales, blaze pink with whitish markings and older trees exuding a blood red astringent gum resin. Leaves are imparipinnate, 17.5-22.5 cm long, usually leaflets 5-7, oblong and coriaceous. The tree is found to be nearly evergreen or leafless for a very short time in the hot season in April-May, the new leaves appear in May-June. Under favorable conditions the tree attains a height of 33 m and a girth of 2.6 m or more. Wood is hard and durable[41]**.** Pterocarpus marsupium has been found to contain a carbon stock of 2851.61MT and 745.229 MT in stem and root respectively which is incidentally third highest in the above mentioned study. A study was carried out on the potential of Carbon sequestration by trees in the western Ghats,Waynad Region in 45 trees and this was found that in case of Pterocarpus marsupium the carbon sequestered was 8 kg/tree[42]. The highest amount of carbon was found in Teak and the lowest was found in shisam. Sal ecosystem is very unique system and has its indicators built in the ecosystem itself. There are many indicator species which are either negatively or positively associated and indicates whether Sal ecosystem is on decline or static. Sal at maturity (i.e. treelayer) was negatively associated with Mallotus philippensis and Terminalia alata. This is reported that these species are not favorable for the growth of Sal because the presence of both the species indicates different things for sal natural regeneration; for example, the presence of T.alata indicates a clayey and water-logged situation, which is unfavorable for sal reproduction. M. philippensis indicates the prevalence of dry conditions especially in the surface layer, which is not good for Sal regeneration. M. philippensis is a true associate of Sal and found to contain more carbon stock in stem. The carbon stock in the stem is 341.24MT.Syzygium cumini is a moisture-loving evergreen species. Competition for soil moisture between Sal and S. cumini (both have almost similar height and growth) may be responsible for their negative association in all the three strata. S. cumini occurs and regenerates better in localities where the ground moisture supplies are comparatively high[43]. Therefore, this has been found in this study that the native species of Sal ecosystem contain more carbon than those species which are not naturally found in the ecosystem except Tectona grandis and there is a reason for T. grandis to contain more carbon. Teak being a strong light demander grows faster than S.robusta in the earier stages therefore accumulates more biomass and more carbon. Another type of uninterrupted growth pattern of Sal associated species was Schleichera oleosa in all sites quality I, II, III and IV. These tree species are successfully crosses the sapling layer and attained the first tree size class. This is found that in the mature Sal crop the number of Schleichera oleosa trees dwindles down or completely absent [44].This is dioecious, deciduous tree, up to 40 m tall. Bole occasionally up to 2 m in diameter, but generally much less, usually crooked and slightly buttressed. S. oleosa requires 750-2500 mm annual rainfall and a dry season, which explains its absence from westernpart. It tolerates absolute maximum temperatures of 35-47.5 °C and absolute minimum temperatures of -2.5 °C. It occurs usually at low altitudes, but can be found up to 900(-1200) m. It occurs spontaneously in dry, mixed deciduous forest and savanna with only scattered trees, sometimes gregariously. S.oleosa has been found to be containing more carbon in stem and roots than other parts of the tree. The stem and root stocks carbon to the tune of 345.77MT and 93.583 MT respectively. T.arjuna **(**Arjuna) tree is about 60-80 ft in height, and is seen along rivers, streams, and dry water bodies throughout the Indo-sub-Himalayan tracts of Uttar Pradesh, southern Bihar, Chota Nagpur, Burma, Madhya Pradesh, Delhi, and Deccan region[45].T.arjuna **(**Arjuna) has not been found in larger number in the study area and confined to a very limited number of compartments. A total 156 trees of Arjuna have been found only in two compartments but its stem contains comparatively larger amount of carbon than other species. The carbon stock is found to be18.79 MT in stem. The result seems to be very interesting in the sense that there is differential level of carbon sequestration in different species. Contrary to common belief that in a Sal forest ecosystem, Shorea robusta should be the one species containing maximum carbon stock but it was F.bengalensis which contained maximum carbon/tree.

TABLE 6- SHOWING CARBON SEQUESTERED PER TREE IN THE STUDY AREA

BOTANICAL NAME.	LOCAL NAME OF TREES	TOTAL NUMBER OF TREES	TOTAL CARBON SEQUESTERED IN MT	CARBON SEQUESTERED PER TREE IN MT	TOTAL NO. OF COMPARTMENTS IN WHICH TREES ARE SPREAD	DIAMETER CLASS(cm)		TOTAL NUMBER OF TREES
Ficus benghalensis	**BARGAD**	**9**	**833.07**	**92.56**	**4**	**-**	**9**	**9**

Terminalia elliptica	**ASNA**	**163**	**3,597.47**	**22.07**	**11**	**7**	**156**	**163**
Ficus religiosa	**PEEPAL**	**3**	**64.733**	**21.57**	**3**	**-**	**3**	**3**
Schleichera oleosa	**KUSUM**	**21**	**439.5**	**20.9**	**10**	**-**	**21**	**21**
Terminalia bellirica	**BAHERA**	**4**	**27.34**	**6.83**	**2**	**-**	**4**	**4**
Linaria caucasigena	**KAIM**	**5**	**26.04**	**5.08**	**3**	**-**	**5**	**5**
Lavandula vera	**LAVERA**	**1**	**4.83**	**4.83**	**1**	**-**	**1**	**1**
Azadirachta indica	**NEEM**	**1**	**4.83**	**4.83**	**1**	**-**	**1**	**1**
Madhuca longifolia	**MAHUA**	**48**	**195.27**	**4.06**	**11**	**5**	**43**	**48**
Syzygium cumini	**JAMUN**	**516**	**2,010.53**	**3.89**	**19**	**65**	**451**	**516**
Dalbergia sissoo	**SHISHAM**	**1**	**3.71**	**3.71**	**1**	**1**	**-**	**1**
Shorea robusta	**SAL**	**1557**	**4,806.72**	**3.08**	**20**	**55**	**1502**	**1557**
Ficus racemosa	**GULAR**	**6**	**13.38**	**2.23**	**3**	**-**	**6**	**6**
A BUNCH OF NON COMMERCIAL TREE SPECIES	**KUKAT Misc. spp**	**841**	**1,435.12**	**1.7**	**23**	**247**	**594**	**841**
Tectona grandis	**TEAK**	**3903**	**5,174.93**	**1.32**	**17**	**1231**	**2672**	**3903**
Mallotus philippensis	**ROHINI**	**492**	**365.43**	**0.742**	**17**	**166**	**326**	**492**
Diospyros melanoxylon	**TENDU**	**28**	**20.16**	**0.72**	**7**	**2**	**24**	**26**
Pongamia pinnata	**KANJI**	**35**	**24.63**	**0.7**	**1**	**8**	**27**	**35**
Aegle marmelos	**BEL**	**28**	**17.25**	**0.61**	**4**	**6**	**22**	**28**
EUCALYPTUS SPP.	**Eucalyptus spp.**	**339**	**183.91**	**0.542**	**5**	**102**	**237**	**339**
Wrightia tinctoria	**DUDHI**	**24**	**7.25**	**0.3**	**2**	**9**	**15**	**24**
Senegalia catechu	**KHAIR**	**21**	**5.54**	**0.26**	**1**	**12**	**9**	**21**
Terminalia arjuna	**ARJUN**	**156**	**30.44**	**0.195**	**2**	**60**	**96**	**156**
TOTAL						**1976**	**6224**	**8,200**

SOURCE: Thesis on Carbon sequestration in natural Sal (*Shorea robusta*) Forest Of South Kheri Forest Division, Lakhimpur Kheri by Uma Shanker Singh

The above table has been shown to contain carbon stock per tree species for the 23 tree species considered in the study area. The highest amount of carbon has been found in Ficus bengalensis and lowest concentration found in Terminalia arjuna. Terminalia elliptica, Ficus religiosa, Schleichera oleosa, Terminalia bellirica, Linaria caucasigena, Lavandula vera, Azadirachta indica, Madhuca longifolia, Syzygium cumini, Dalbergia sissoo, Shorea robusta and Ficus racemosa follow in their carbon content. The carbon content seems to be a little higher than normal but the growth of the above mentioned species in the forest area has always been robust and secondly, almost all of them belong to higher diameter classes as shown in the table-4 &6. This finding gets support from the research carried out on 60 tree species in Gujarat University Campus leading to a PhD. The finding tell us that the average carbon stock (t) determined for all the 60 tree species shows that trees belonging to *Terminalia chebula* Retz (76.93 t) had the maximum amount of C stock followed by *Pithecellobium dulce* (Roxb) Bth (65.88 t) *Limonia acidissima* L (61.31 t) , *Ficus benghalensis* L (54.03 t), *Tamarindus indica* L (52.84 t), *Morus alba* L (47.92 t), *Ailanthus excelsa* Roxb (43.89 t), *Syzygium cumini* (L) Skeel (43.64 t), *Azadirachta indica* A Juss (43.11 t), F. *religiosa* L (42.79 t), *Albizzia lebbeck* (L) Bth (40.57 t) followed by *Terminalia arjuna* (Roxb) W & A (38.21 t), *Eucalyptus globulus* Labill (35.9 t), *Mangifera indica* L (35.75 t), *Casuarina equisetifolia* L (34.59 t) have the maximum carbon sequestration capability and therefore are ideal selection for sequestering CO2 in the present scenario to prevent climate change. While the trees like *Acacia nilotica* (L) Del (2.48t) and the members of family Palmae like *Phoenix sylvestris* (L) Roxb (2.18 t), *Roystonea regia* (1.24 t), *Musa paradisiaca* (0.87 t), *Dicrostachys cinerea* (DC) (0.63 t) are found to sequester least amount of carbon[46].

Discussion

In the present study, 8200 trees spanning over 32.12 hectares have been enumerated, their samples were taken invasively and their carbon content has been found out through chemical process therefore, a clear landscape of carbon content emerges through various tree species present in the forest. Here, it would pertinent to mention that in order to understand which tree species sequesters more carbon, only carbon stored in stem, branches and roots have been taken into account and other components of the forest ecosystem which also store carbon have been disregarded. The table-4 &6 indicates how much of carbon has been sequestered by individual tree species in their stem, branches and roots. After a careful examination of the results, it suggests a very important view point and Table-7 become very important so as to understand the dynamics of the tree distribution in the study area. The maximum numbers of trees belong to Teak, Sal, Kukat, Jamun, Rohini, Eucalyptus, Asna and Arjun in order of descent and after having calculated the carbon sequesteration by individual tree species, then trees like Bargad, Asna, Kusum and peepal occupy much higher position in carbon storage than the other tree species in the study area despite their numbers being in much lesser than Teak and Sal. Around 75.9% of the trees of the study area (Table-7) fall in the 40-70cm+ diameter class and rest 24.1% belongs to the lower segment of 0-40 cm diameter class, therefore, this clearly indicates that most of the trees belonging to 40-70cm+ diameter class are mature and in forestry term nearing its rotation class. This also suggests that the trees of higher diameter class have the highest retention of carbon in its cells. In one of the studies on carbon sequestration by trees, Teak has been found to have the highest capacity for carbon sequestration among trees in India. This is the finding of a study conducted by the Gujarat Ecological Education and Research (GEER) to prepare a hierarchy of local trees in India that can reduce the carbon dioxide content of the atmosphere. In its lifetime, a teak tree with a girth of 10-30 cm can absorb 3.70 lakh tonnes of carbon dioxide from the atmosphere. GEER has sent a list of trees with high capacity for carbon sequestration to different state forest departments that can choose them for plantation in areas where CO2 emission is high[10].

TABLE 7- PREPONDERANCE OF HIGHER DIAMETER CLASS TREES IN STUDY AREA IN DECENDING ORDER

NAME OF TREES	TOTAL NO. OF COMPARTMENTS IN WHICH TREES ARE SPREAD	DIAMETER CLASS(cm)		TOTAL NUMBER OF TREES
		0-40cm	40-70cm and above	
TEAK	17	1231	2672	3903
SAL	20	55	1502	1557
KUKAT	23	247	594	841
JAMUN	19	65	451	516
ROHINI	17	166	326	492
EUCALYPUS	5	102	237	339
ASNA	11	7	156	163
ARJUN	2	60	96	156
MAHUA	11	5	43	48

KANJI	1	8	27	35
BEL	4	6	22	28
TENDU	7	2	24	26
DUDHI	2	9	15	24
KHAIR	1	12	9	21
KUSUM	10	-	21	21
BARGAD	4	-	9	9
GULAR	3	-	6	6
KAIM	3	-	5	5
BAHERA	2	-	4	4
PIPAL	3	-	3	3
LAVERA	1	-	1	1
NEEM	1	-	1	1
SHISAM	1	1	-	1
TOTAL		1976	6224	8,200

SOURCE: Thesis on Carbon sequestration in natural Sal (*Shorea robusta*) Forest Of South Kheri Forest Division, Lakhimpur Kheri by Uma Shanker Singh

Different plant species have different capacity of carbon sequestration and there are many factors which influence carbon sequestration in a forest and this process is not fully understood. A study was done to understand and assess the species wise carbon sequestration in the forests of Nepal in Collaborative and Community Forests and this was found that the estimated carbon stock of Shorea robusta was the highest 35.93 t ha in 2011 which slightly decreased to 34.43 t ha in 2012 and reached 32.02 t ha in 2013 in one of the selected study area[11]. A comparison is also important as a part to study and see how much carbon is sequestered in other system of forestry as afforestation is a very essential tool to go in for an area which is either degraded or grass land. This would be all the more important to know as to how a tree behaves in carbon sequestration when planted with a combination of grasses in Agro forestry model. A comparative study showed the effect of introducing a silvipastoral system in a natural grassland in semi arid Uttar Pradesh, where species of *Albizia procera*, *Eucalyptus tereticornis*, *Albizia lebbeck*, *Embilica officinalis* and *Dalbergia sissoo* accumulated 8.6, 6.92, 6.52, 6.25 and 5.41 t/ha/yr of biomass. This was found that in a silvipastoral system, carbon flux in net primary productivity increased due to the integration of *Prosopis juliflora* and *Dalbergia sissoo* with grasses[12].The rise in the atmospheric concentration of greenhouse gases particularly the carbon dioxide leading to global warming and climate change has attained the international concern the recent years. Realizing the urgent need for quantifying the forest carbon stock for better monitoring and management of the forest biomass carbon, a few studies have been carried out so far. In a study on Carbon Stock Assessment from the Tropical Forests of Bodamalai Hills, India the author has compared the carbon stock of different forest ecosystem and found that the carbon stock of Bodamalai When compared with other tropical forest was lower than others. The following table depicts the difference:

TABLE-8 ASSESMENT OF CARBON STORAGE IN DIFFERENT FOREST ECOSYSTEM

NAME OF THE FOREST ECOSYSTEM	CARBON STOCK PRESENT
BODAMALAI TROPICAL FOREST IN INDIA	10.9tC/ha
KALRAYAN HILLS FOREST IN INDIA	38.88t C /ha
SHERVARAYAN HILLS FOREST IN INDIA	56.55t C/ ha
CHITTERI HILLS FOREST IN INDIA	58.55t C /ha
TROPICAL MOIST FORESTS OF BANGLADESH	48.88-118.45t C/ha
TROPICAL MOIST FORESTS OF SRI LANKA	109.25-299.00 t C/ha
MONTANE RAIN FORESTS OF JAMAICA	131.68-179.40 t C/ha
FORESTS OF NEW GUINEA	290.38 t C/ha
TROPICAL RAIN FORESTS OF MALAYSIA	132.25- 166.75 t C/ha
FORESTS OF NEW GHANA	152.84 t C/ha,

KHADO CHANG, THAILAND	167.10 t C/ha
FORESTS IN COMBODIA	200.10-238.63 t C/ha
WESTERN GHATS IN INDIA	263.47 t C/ha
MONTANE FORESTS AT El Verde, PUERTO RICO	134.21 t C/ha
TROPICAL SEASONAL RAIN FOREST AT XISHUANGBANNA	138.73 t C/ha
RED PINE FORESTS AT GREAT LAKES, NORTH AMERICA	130-195 t C/ ha
TROPICAL EVERGREEN FORESTS IN MYANMAR	5.75tc/ ha

SOURCE: (Arul.L. Pragasan 2015)[13].

Enhancing forest carbon (C) storage is recognized as one of the most economic and green approaches to offsetting anthropogenic CO emissions. In another important study on Regional variation in carbon sequestration potential of forest ecosystems in China this has been found that the C densities of vegetation and soil (0–100 cm) in China's forest ecosystems were about 69.23 Mg C/ha and 116.52 Mg C/ha, respectively. In mature forests, the *C* of vegetation and soil are expected to increase to 129.26 Mg C/ha (87.1%) and 154.39 Mg C/ha (32.4%) in the coming decades, respectively[14].The above table shows that carbon storage varies in accordance many biotic and abiotic factors which are not yet fully researched. In a study on Tissue carbon concentration of 175 Mexican forest species, the author claims that C concentration values for 175 plant species in 18 families from temperate, tropical, subtropical, arid and semiarid zones in Mexico has differed in biomass carbon concentration across environments, taxa and plant tissues [15]. The deforestation is long term menace worldwide and it not only finishes biodiversity but also releases carbon dioxide into the atmosphere to the tune of 22%. There are many species which coppice whereas other species are destroyed once forever. An assessment was done to measure storage of carbon in a secondary growth of forest in Latin America and it was estimated that in 2008, second-growth forests (1 to 60 years old) covered 2.4 million km of land (28.1% of the total study area). Over 40 years, these lands can potentially accumulate a total aboveground carbon stock of 8.48 Pg C (petagrams of carbon) [16]. In an interesting study on the community forest in Ethiopia, this has been found that the result of the study substantiates that community-managed forests are a viable option for conserving ecosystem functions and for storing carbon in the long term[17]. In the last few decades, many forests have been cut down to make room for cultivation and to increase food or energy crops production in developing countries. In a study on carbon sequestration potential in agricultural and afforestation farming systems, carbon sequestration and wood production were evaluated on afforested farms from sample plots of an afforested hardwood forest in Taiwan. An estimated carbon sequestration of 11,254 t C was observed for an 189ha-hardwood forest which is equivalent to 41,264 t CO_2[18].Tropical forests are global centres of biodiversity and carbon storage. As tropical forests can have any combination of tree diversity and carbon stocks both require explicit consideration when optimizing policies to manage tropical carbon and biodiversity [19]. A forest ecosystem is a natural woodland unit consisting of all plants, animals and micro-organisms (Biotic components) in that area functioning together with all of the non-living physical (abiotic) factors of the environment and it has to be studied in its totality. Carbon storage is widely acknowledged as one of the most valuable forest ecosystem services. In the study large data sets on tree species composition and abundance, seed, fruit, and carbon-related traits, and plant-animal interactions were used to estimate the loss of carbon storage capacity of tropical forests in de-faunated scenarios. The results demonstrate that de-faunation, and the loss of key ecological interactions, also poses a serious risk for the maintenance of tropical forest carbon storage [20]. In a study on High carbon dioxide uptake by subtropical forest ecosystems in the East Asian monsoon region, this has been estimated that the total NEP of East Asian monsoon subtropical forests was estimated to be 0.72 ± 0.08 Pg C yr , which accounts for 8% of the global forest NEP[21]. In a very important observation in a study on High carbon dioxide uptake by subtropical forest ecosystems in the East Asian monsoon region, this has been seen that the trees of higher diameter class contain more carbon in its biomass[22].

Conclusion:

The trends in global temperatures in the last few decades are of course consistent with the scientific consensus on climate change. The concentration of atmospheric carbon dioxide (CO_2), the main driver for the current climate change, has recorded a monotonic increase during the same period. It is now well past 408 ppm on 28th October 2019 more than128 ppm above the pre-industrial levels[23]. Considering the ascent of atmospheric temperature over a short span of time, it becomes imperative to look at the mitigation measures so as to keep the temperature rise within 2ºC as per the guidelines set in Paris conference of parties in 2015. Now the tropical and sub tropical forests become increasingly important not because they are rich in biodiversity but diversity rich forests sequester more carbon, however, this area of science requires more researches in the field of basic area of photosynthesis with a number of permutation and combination of different factors. From the present study this could be concluded that in a biodiversity rich forest the carbon storage is high in the species and it proportionately increases with the diameter classes. There may be many other interactions of different components of an ecosystem which may help increase carbon sequestration in a tree species but it requires further scientific research and investigations. The south Kheri forest division is very rich in flora and fauna as it comprises of 84 tree species,53 small tree species and shrub species, 22 species of climbers, two types of parasitic climbers , two types of bamboo, and 25 verities of grasses. This forest area is also rich in wildlife as it borders with a national park therefore, their territories overlap with each other in true sense of wild life protection. Therefore, it is imperative to save our forest as a national heritage because they not only maintain biodiversity but a great carbon sink. At the national level, India's forest and tree cover accounts for about 23.4% of the total geographical area of the country. Over the past decades, national policies of India aimed at conservation and sustainable management of forests have transformed India's forests into a net sink of CO2. In between 2015 and 2017, carbon stocks stored in Indian forests have increased from 7044 to 7082 million tons (mt) registering an annual increment of 38 mt of carbon [25]. This annual removal by forests is enough to neutralize more than 9.31% of our total annual emissions of 2000 level [24].

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