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Carbon Sequestration by Different Tree Species at Malanjkhand, district Balaghat, Madhya Pradesh, India

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Abstract: *Carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues, plants and other organic solids. In the present study the carbon sequestration potentiality of selected tree species of Malanjkhand copper project (MCP) forest area in district Balaghat, Madhya Pradesh was measured through computation. The studies was conducted in one hectare of forest area found 193 trees of 8 different species in which 38,36,31,22,21,17,16,12 numbers of Tectona grandis, Madhuca indica, Butea monosperma, Delonix regia, Mangifera indica, Dalbergia sisso, Azadirachta indica and Eucalyptus citriodora respectively with a total carbon sequestered 6.414t/ha. Among the eight different species the maximum total carbon sequestered was 2.015t by Mangifera indica and lowest 0.96t by Eucalyptus citriodora.*

Keywords: *Carbon sequestration, ecosystem, wood density, organic carbon, biomass.*

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I. INTRODUCTION

Carbon sequestration is the process of storing carbon underground to curb the accumulation of carbon dioxide in the atmosphere. Although the earth naturally stores carbon in forests, oceans and soils, these carbon sinks are unable to accommodate the excessive and increasing amounts of carbon dioxide humans continue to emit [146]. As a result, researchers have begun to explore way of enhancing to absorption of natural carbon sinks, as well as ways to artificially store carbon dioxide underground. Indiscriminate deforestation in tropical world has become a major cause of increased carbon dioxide concentration in our atmosphere due to mining and industrialization [1,2,3,4,5,6,7,8,]. In the global carbon cycle biomass is an important building block, significantly carbon sequestration and changes of green house gases from the terrestrial biosphere to the atmosphere associated with land use and land cover changes [9,10,11,12,13,14,15,16,17,18,19,20,21,22,23]. Primary productivity and biomass gain which are directly proportionate to carbon stored in a plant or an ecosystem varies with the availability of resources and characteristics of the environment in which they grow. Strongest ecological factors like climate and age influence primary productivity of a species or ecosystem thus changes in climate and age can cause changes in amount of carbon sequestered [146]. The rate of carbon sequestration depends on the growth characteristics of the tree species, the conditions for growth where the tree is planted, and the density of the tree's wood. It is greatest in the younger stages of tree growth, between 20 to 50 years [146]. Soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic solids, and in a form that is not immediately reemitted. This transfer or "sequestering" of carbon helps off-set emissions from fossil fuel combustion and other carbon-emitting activities while enhancing soil quality and long-term agronomic productivity. Soil carbon sequestration can be accomplished by management systems that add high amounts of biomass to the soil, cause minimal soil disturbance, conserve agriculture, soil and water if it is done properly with proper planning in season (according to the calendar and chronology [36,37,38,39,40,41,42,43,44,45,46,47,48,49,50], improve soil structure, and enhance soil fauna activity [24,25,26,27,28,29,30,31,32,33,34,35]. Besides this, wise use of bio-waste as bio-fertilizers, utilization of rain water harvesting, effective management of waste water and modeling of the natural resource, proper management and proper species selection can help the increase in biomass ultimately helps in

carbon sequestration [51,52,53,54,55,56,57,58,59,60,61,62,63,64,65]. Other means of pollution abatement in industrial areas may be through roof top garden which are more affective (147 and 148).

The carbon sequestrations through plantation can only the best option to decrease the carbon content on the earth. The effective utilization of medicinal and local species can minimize the land degradation and improve quality of land. The wastewater like mine water can be utilized through bio-purification by using water plants or algae to clean impurities to enhance the ground water quality to sustain the plant [66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95].

Micro-algae can not only purify mine or waste water but also help in adsorbing carbon through carbon sequestration mechanism ultimately help in fixing carbon and at last merging it in soil through converting themselves as bio-fertilizer [96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135,136,137,138,139,140, 141, 143, 144 and 145].

In this paper the estimation of biomass and carbon sequestration rates for the various tree species carried out with diameter and chest height in Malanjkhand Copper Project (MCP) area, Malanjkhand, Balaghat District, Madhya Pradesh, India.

II. MATERIALS AND METHODS

1. **Study Area-** This study area is situated at MCP (Malanjkhand Copper Project) of district Balaghat in Madhya Pradesh state, India. Malanjhkhand referred to as is a largest open-pit copper mine in India, located at Malanjkhand city lies between 80º41’51” to 80º42’38” East longitude and 22º00’59” to 22º02’24” North latitude (**Figure.1**). Malanjhkhand has typical subtropical type of climate with summers being hot and dry from mid of February to mid of June followed by mansoon period is from the June to mid of October. The October is the month of transistion period for mansoon to winter. The cold season is from November to February followed by summer season. The mean of annual rainfall is 900mm. The minimum temperature recorded during winter is 5°c while maximum temperature during summer ranges 43°c [142].
2. **Sampling Technique-** Firstly we plot the 100 meter square to estimate the various tree population on it. The size of square is 100*100 meter, and total area studied 10,000 mtr^2=1hectare.
3. **Measurement:** To estimate biomass from selective tree species in plotted square, measured by diameter at chest height and height calculated with the help of plant height, diameter at chest height, wood density of various plant species, above ground biomass and below ground biomass. Calculation of volume of biomass based on girth and height. Wood density value for the various tree species obtained from website of world agro forestry [142].

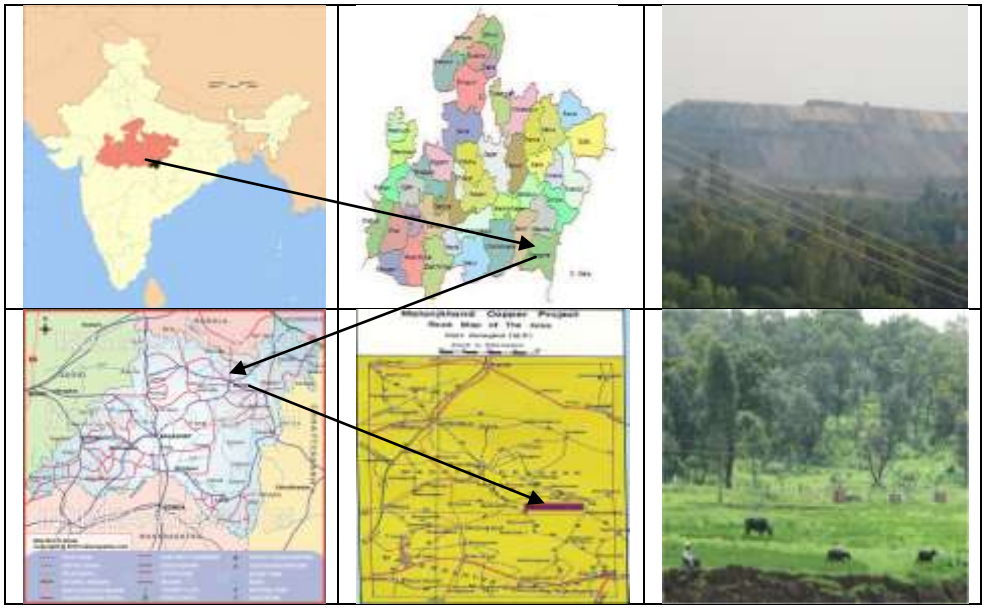

Figure.1: Location map and forest area within Malanjkhand, district Balaghat, Madhya Pradesh, India

III. FINDING AND DISCUSSION

The total trees in a square of 100X100sqmts and wood density with total carbon sequestered by different tree species were tabulated in **Table.1**. This shows that there are 8 species including 193 individuals have been recorded in study area of Malanjkhand Copper project (MCP). The organic carbon sequestrated per species is shown for comparison purpose (**Figure.2**). The estimated carbon has been compared with other

sources. *Tectona grandis* species are dominant in study area having 38 trees and sequestrated 81.80 tons of carbon. The major carbon sequestrating species were *Mangifera indica* (98.65 tons) followed by *Madhuca latifolia* (70.76 tons), *Butea monosperma* (22.68 tons), *Dalbergia sisso* (14.04 tons), *Delonix regia* (14.02 tons), *Azadirachta indica* (8.85 tons), and *Eucalyptus citriodora* (4.75 tons). The *Eucalyptus citriodora* has lowest carbon sequestration potential 4.75 tons and the second lowest carbon sequestration potential species was 8.85 tons in *Azadirachta indica* (142).

No.	Tree Species	Botanical Name	Number of Trees in (100X100 m^2)	Mean of Girth (m)	Mean of Height (m)	Wood Density (kg/m^3)*	Total Carbon sequestered (Tons)
01	Teak	*Tectona grandis*	38	0.423	17.39	550	81.80
02	Mango	*Mangifera indica*	21	0.517	16.26	860	98.65
03	Mahua	*Madhuca indica*	36	0.344	16.38	810	70.76
04	Palash	*Butea monosperma*	31	0.309	12.67	480	22.68
05	Nilgiri	*Eucalyptus citriodora*	12	0.196	16.12	510	4.75
06	Neem	*Azadirachta indica*	16	0.215	13.73	690	8.85
07	Shisham	*Dalbergia sisso*	17	0.274	14.17	620	14.04
08	Gulmohar	*Delonix regia*	22	0.291	11.71	510	14.02
		Total Plants	**193**	**Grand Total of Carbon Sequestered**			**315.55**

Table.1: Total Carbon Sequestration/ha with wood density for different tree species of MCP, Malanjkhand, district Balaghat, Madhya Pradesh, India.

***(Standard wood density of trees obtained from website of world agro forestry)**

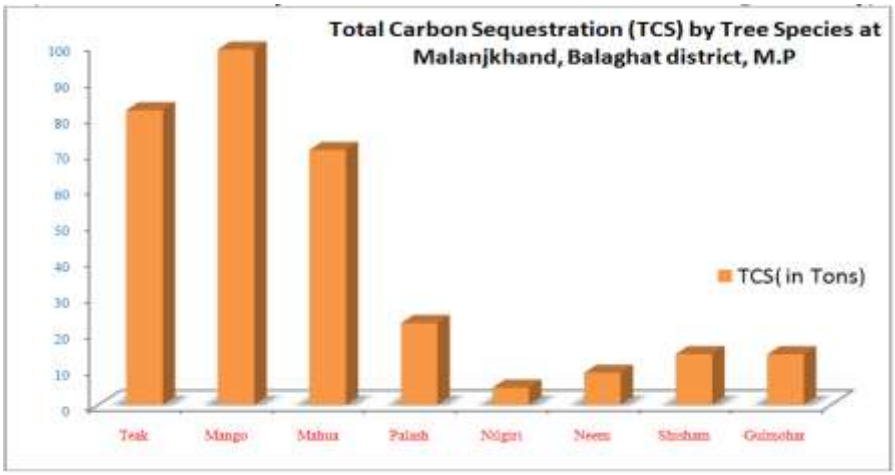

Figure. 2: Total Carbon sequestration (TCS) by different tree species (Tons)

IV. CONCLUSION

The carbon sequestration capacity of a tree species depends upon its age, height, girth size, biomass accumulation capacity, canopy diameter and most important wood specific density. The carbon sequestration by the tree species like *Tectona grandi*, *Mangifera indica Madhuca latifolia*, *Butea monosperma*, *Dalbergia sisso*, *Delonix regia*, *Azadirachta indica*, and *Eucalyptus citriodora* have the maximum carbon sequestration capability among all the vegetation found in that area.

Therefore, the plantation of that area must be plan accordingly with the trees to be chosen for sequestering maximum amount of carbon in the scenario of climate change, chosen with properties of highest specific density, fast growing, increasing biomass at a fast rate, with the huge canopy and also should have a better climate adaptability, richer litter productivity, shorter rotation and finally very impotent that they should be disease resistant.

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