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CARBON STOCKS IN THE MANGROVE VEGETATION OF LOTHIAN WILD LIFE SANCTUARY OF INDIAN SUNDARBANS: IMPLICATION FOR CLIMATE CHANGE MITIGATION

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ABSTRACT

A study was undertaken during August 2017 at Lothian Wild Life Sanctuary of Indian Sundarbans to estimate the stored carbon in the mangrove vegetation of the island. 34 true mangrove species were documented from the island, but on the basis of criterion DBH ≥ 5 cm, only 26 species were selected for the estimation. We focused on the stem biomass and the carbon locked in this compartment as the other above ground structures (like leaves, twigs and branches) are converted into litter and act as relatively temporary sink of carbon. Stem carbon exhibited direct proportionality with stem biomass in all the species. The total biomass of the documented species (except those whose DBH values are less than 5 cm) was 164.24 t ha^{-1}. The stored carbon in the stem region of these species was 74.18 t ha^{-1}, which is equivalent to 272.25 tonnes of carbon dioxide.

Keywords: *Red Mud, Fly Ash, cement, Unconfined compressive strength, Embankments.*

I. INTRODUCTION

Climate change at local and global scale has become an environmental issue in the present *era* because of several threats associated with the phenomenon like global warming, retreat of glacier, acidification, weather extremes, natural hazards, decrease of agriculture productivity, biodiversity loss, spreading of insect borne diseases etc. [1]. Climate change is mainly caused by natural forces, but the anthropogenic factors like the burning of fossil fuels, deforestation and change of land – use pattern have accelerated the process. Forests are known in contributing to green house gas reductions through carbon sequestration [2-4]. These benefits can be perceived to be more important at the global than at national regional or local levels [5].

In the past 60 years the amount of carbon dioxide emitted to the atmosphere is primarily due to the increased use of fossil fuels. This has resulted in the rise of carbon dioxide level from pre-industrial level of 280 ppm to present level of 407.25 ppm as on July 2017 [6]. This can be cut down through planned and managed afforestation programme that can be taken up on the basis of carbon storage potential of the floral species.

In the maritime state of West Bengal (India) people particularly in the coastal areas are highly dependent on forest resources. The Indian Sundarbans is mostly exploited in terms of fishery resources, timber and fuel wood etc. Deforestation, forest degradation, change of land use due to growth of shrimp culture, tourism, brick kilns etc. are the key processes in producing green house gases in the present geographical locale [1, 7-9] .The present study covers a very small patch (38 Km^2) in Indian Sundarbans namely the Lothian Wild Life Sanctuary (LWLS) with centre coordinates 21º38'21.20"N and 88º20'29.32"E. The area is much stressed due to presence of fish landing stations, harbours, several brick kilns and shrimp culture activities, which generate considerable carbon dioxide to the atmosphere, but cannot be stopped as the livelihood and local economy are directly linked with these activities. The present study is therefore important for achieving a win-win strategy.

No study has yet been conducted on stored carbon by true mangrove floral species in this particular forest patch, although lot of such kind of reports are available in the adjacent regions within the framework of Indian Sundarbans [1,8,9,10,11]. Therefore, this study was taken up during August 2017 to estimate the carbon stock capacity of the existing mangrove forest patch by quantifying the major carbon pools locked in the stem region of the selected species.

II. MATERIALS AND METHOD

1. Study Area

Lothian Island Wild Life Sanctuary (of Indian Sundarbans) is situated on the northeast coast of India in the maritime state of West Bengal in the district of South 24 Parganas. The island has profuse growth and regeneration of *Avicennia* spp. while *Ceriops decanadra* and *Excoecaria agallocha* are abundantly scattered in the forest [Fig 1].

Fig. 1. A view of Lothian Wild Life Sanctuary in the western sector of Indian Sundarbans

The climate is tropical humid with three main seasons namely premonsoon, monsoon and postmonsoon. The rainfall ranged between 1400-2200 mm during 2010-2016. Rainfall is usually heaviest in August and September. A record rainfall occurred during 15th August to 30th August 2017 which is 349 mm [12]. Considerable dilution factor due to high rainfall along with the fresh water discharge from the Farakka barrage has resulted in the luxuriant growth of the mangroves in this island.

2. Sampling method

Simple random sampling method was used to collect the samples. Sample plots were laid along line transects based on tidal variation in the study area. 15 random sampling plots of 10 m × 10 m were selected on the intertidal mudflats. To evaluate the stored carbon in the stem biomass, the taxonomic diversity, population density and stem biomass of all the true mangrove floral species were recorded. Sampling was carried out during low tide and only

the live trees with a diameter at breast height (DBH) ≥ 5 cm were recorded. The DBH was measured at breast height, which is 1.3 m from the ground level. It was measured by using tree caliper and measuring tape.
Trees with multiple stems connected near the ground were counted as single individuals and bole circumference was measured separately. Tree height was recorded by using laser based BOSCH height measuring instrument. The methodology and procedures to estimate the stem biomass of the selected true mangrove tree species were carried out step by step as per the VACCIN project manual of CSIR [13].

3. Carbon estimation

Direct estimation of percent carbon in the stem biomass was done by *Vario MACRO elementar* CHN analyzer, after grinding and random mixing the oven dried stems from 15 different sampling plots. The estimation was done separately for each species and mean values were expressed as t ha^{-1}.

III. RESULTS

1. Taxonomic diversity

A total of 34 mangrove floral species were documented from the study area (Annexure I) and the population density (in No./100 m2) followed the order as presented in Fig 2.

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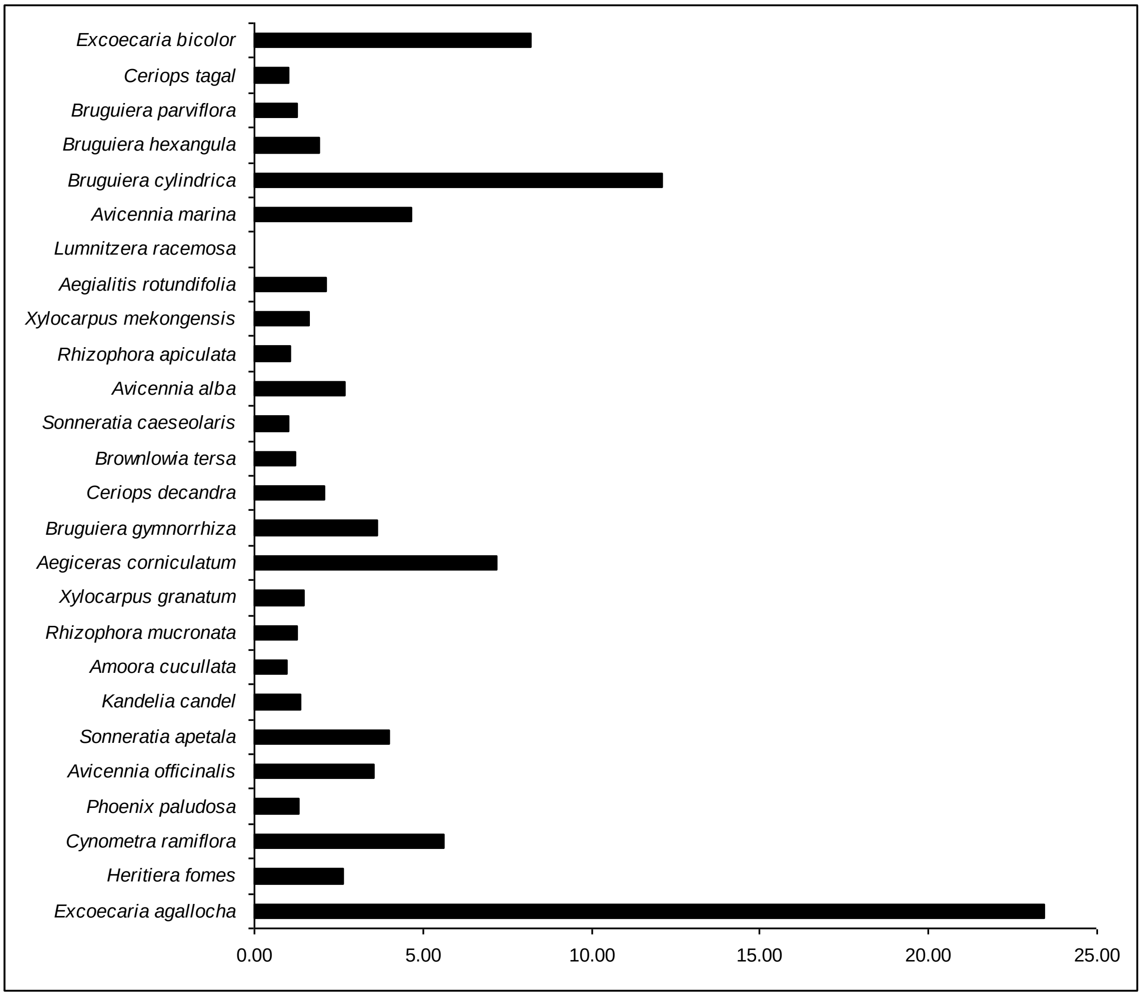

Fig. 2. Population density (No. /100m^2) of selected mangrove trees in Lothian Wild Life Sanctuary (Note: Out of 34 true mangrove species, population count was done only for 26 species as per the criterion for carbon assessment DBH ≥ 5 cm

2. Stem Biomass

The stem biomass values were computed only for those species whose DBH ≥5 cm. In this context, the species *Hibiscus tiliaceous, Pongamia pinnata, Hertiera littoralis, Cerebra manghas, Intsia bijuga, Thespesia populnea, Tamarix troupii* and *Xylocarpus molluccensis* were excluded from the record. Thus in this study only 26 species were studied for stem biomass and subsequently stem carbon. The values are represented in Fig 3.

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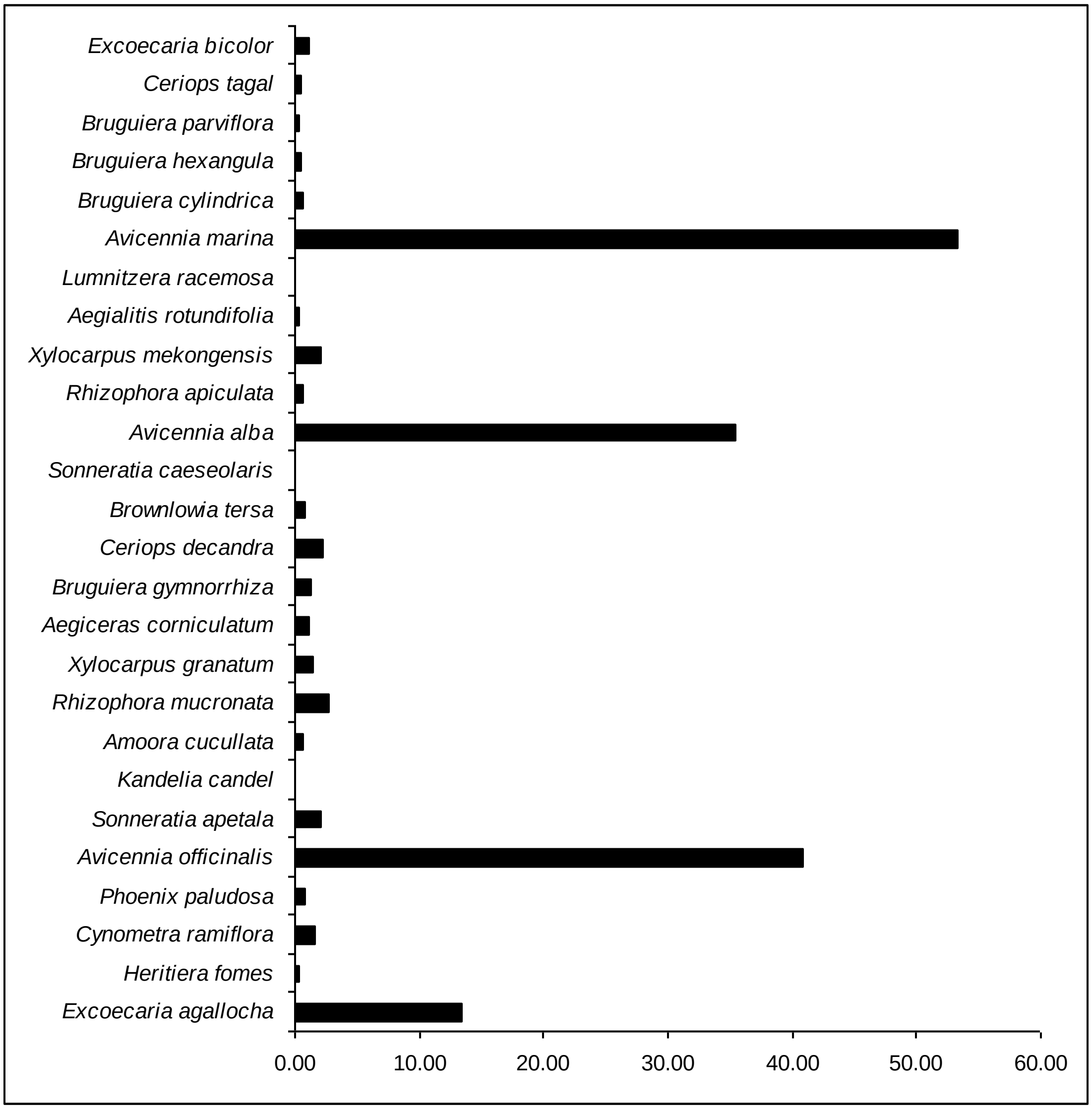

Fig. 3. Stem biomass (in t ha^{-1}) of selected mangrove trees in Lothian Wild Life Sanctuary

3. Stem Carbon

The stored carbon in the stem of the selected species varied from 0.02 t ha^{-1} in *Lumnitzera racemosa* to 24.54 t ha^{-1} in *Avicennia marina.*

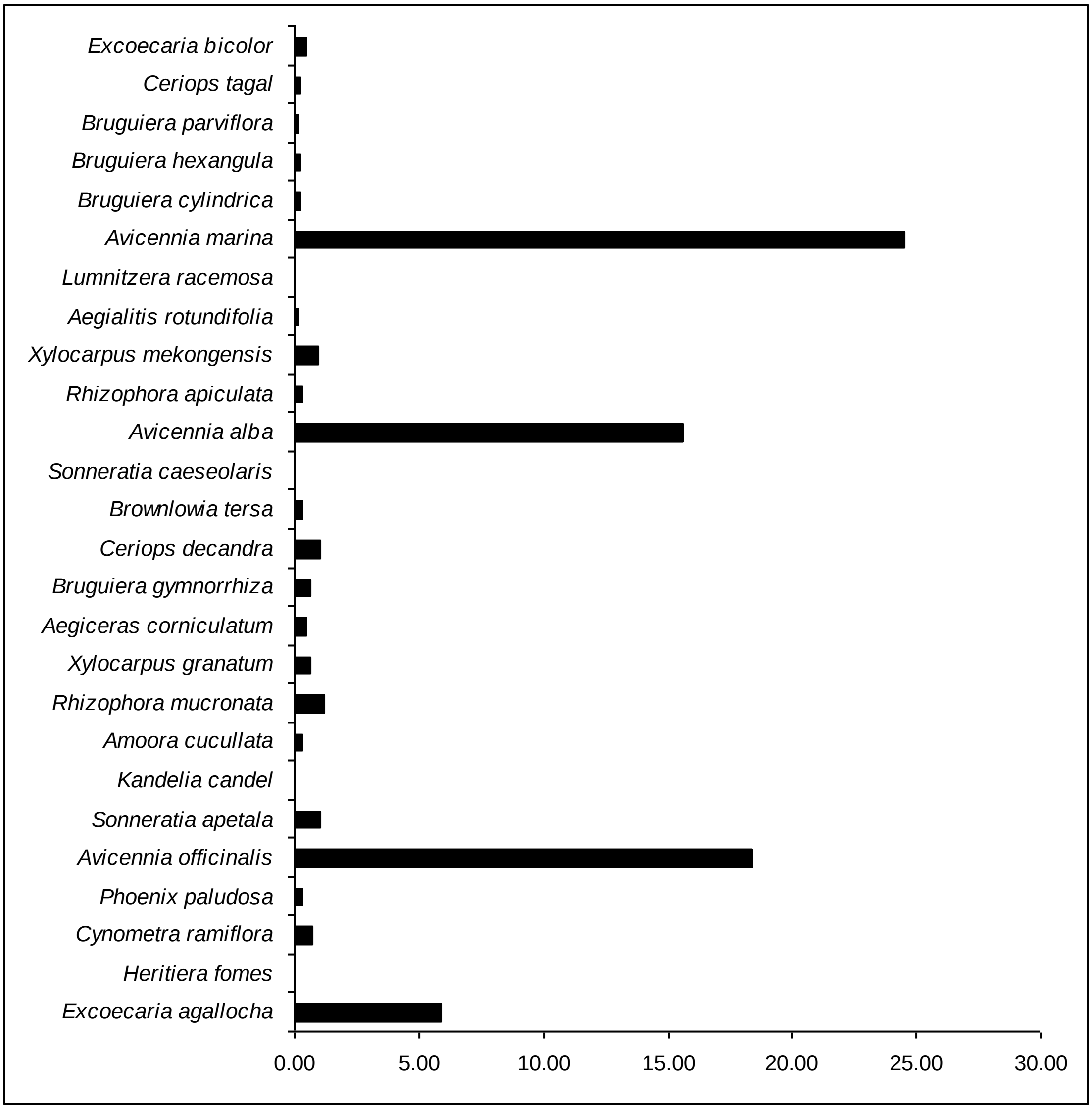

Fig. 4. Stem carbon (in t ha-1) of selected mangrove trees in Lothian Wild Life Sanctuary

IV. DISCUSSION

The present study shows that the mangrove forest patch in LWLS contains 34 true mangrove floral species with luxuriant growth. The high population densities as well as considerable biomass of *Excoecaria agallocha* and *Avicennia* spp. indicate a trend of salinification in the Hooghly-Matla estuarine complex, which may be due to siltation in the upstream region and gradual decrease of the Farakka barrage discharge. This phenomenon is also confirmed by significantly low population density and biomass of *Heriteria fomes*, which is a fresh water loving true mangrove floral species.

The total biomass of the documented species (except those whose DBH values are less than 5 cm) was 164.24 t ha^{-1}. The stored carbon in the stem region of these species was 74.18 t ha^{-1}, which is ~ 45.15% of the total biomass.

In this study we have estimated the stored carbon in the stem region of the documented mangrove floral species, which is basically incomplete in the sense that carbon is also stored in the branch and leaves in the above ground structures of the floral species. However considering the stem region as the major biomass contributor to the AGB of the tree species our estimate is mostly correct because of the two major causes viz. (i) the stem region is relatively permanent unlike the branches and leaves of mangroves, which are mostly drained out to the adjacent water bodies in the form of litter (Fig. 4) and (ii) most of the carbon is locked in the stem, which constitutes some 40-50% of above ground structures of the plant.

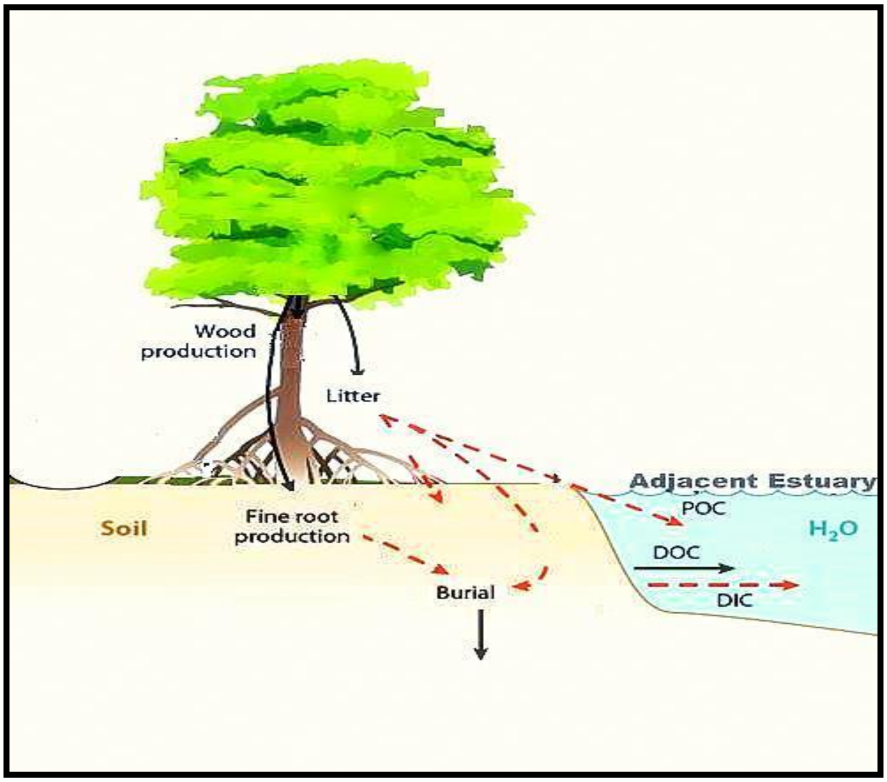

Fig. 5. Contribution of carbon through mangrove litter (sourced from branches, twigs and leaves) to adjacent water bodies (bays, estuaries and creeks)

Considering the magnitude of stored carbon in the stems of the documented species it seems logical to state that mangrove vegetation of LWLS can be referred to as the rain forest of aquatic sub-system of Indian Sundarbans. The amount of stored carbon only in the stem compartment of 26 estimated true mangrove floral species is equivalent to 272.25 tonnes of carbon dioxide, which is a promising figure from a small patch of 38 Km^2 for mitigating carbon dioxide at local scale.

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ANNEXURE 1

Species
1. *Excoecaria agallocha*
2. *Heritiera fomes*
3. *Cynometra ramiflora*
4. *Phoenix paludosa*
5. *Avicennia officinalis*
6. *Sonneratia apetala*
7. *Kandelia candel*
8. *Amoora cucullata*
9. *Rhizophora mucronata*
10. *Xylocarpus granatum*
11. *Aegiceras corniculatum*
12. *Bruguiera gymnorrhiza*
13. *Ceriops decandra*
14. *Brownlowia tersa*
15. *Sonneratia caeseolaris*
16. *Avicennia alba*
17. *Rhizophora apiculata*
18. *Xylocarpus mekongensis*
19. *Aegialitis rotundifolia*
20. *Lumnitzera racemosa*
21. *Avicennia marina*
22. *Acanthus ilicifolius*

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23.	*Acanthus volubilis*
24.	*Bruguiera cylindrica*
25.	*Bruguiera hexangula*
26.	*Bruguiera parviflora*
27.	*Ceriops tagal*
28.	*Derris trifoliata*
29.	*Derris umbellatum*
30.	*Excoecaria bicolor*
31.	*Hibiscus tortuosus*
32.	*Nypa fruticans*
33.	*Tamarix dioica*
34.	*Tamarix gallica*