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Development of allometric equations to estimate the stem carbon content of *Lumnitzera racemosa* and *Avicennia marina* in a tropical mangrove ecosystem: A novel non-destructive approach

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ABSTRACT

Non-destructive methods for estimating carbon storage capacity are becoming increasingly popular as they do not harm the individual trees or the ecosystem. However, currently the destructive method of sampling trees for estimating their carbon storage capacity is widely practiced throughout the world. Therefore, the present study was conducted in a mangrove conservation forest located in a tropical island, Sri Lanka, with the objective of developing allometric equations to predict the stem carbon content of *Lumnitzera racemosa* and *Avicennia marina* using non-destructive method of sampling. The allometric model developed for *Lumnitzera racemosa* from this study, to determine stem carbon content is: Ln C = -3.485+ 1.155 Ln SH + 1.892 Ln DBH, Where, C: Stem carbon content, SH: merchantable stem height, DBH: Diameter at breast height. For *A. marina*, only diameter at breast height was statistically significant with stem carbon content and the allometric equation was, Ln C = −3.483 + 2.407 Ln DBH. The models were evaluated using *p* value, R^2 value, residual diagram, model bias values and model efficiency values. The models were validated by calculating residual values as the difference between the actual stem carbon content and predicted stem carbon content from the models for *Lumnitzera racemosa* and *A. marina.* Further, there was no significant difference between the mean values of the measured stem carbon content and the predicted stem carbon content using the prediction models. The results indicate that the developed allometric equations in the present study are practically applicable in the field to estimate the stem carbon content of *Lumnitzera racemosa* and *A. marina*. Further, these estimations can contribute to make more accurate valuations on carbon stocks of sequestered carbon necessary for carbon trading purposes and sustainable management of mangrove forest ecosystems.

1. Introduction

Mangrove ecosystems are located in inter-tidal coastal areas and are one of the most productive ecosystems in the world [1]. Mangrove ecosystems support high biodiversity as they provide food and habitats for many estuarine and marine organisms. Their extensive root system stabilizes the shorelines to protect the coastal environment against waves and storms. Mangrove ecosystems also serve as nursery grounds to the eggs and juvenile stages of many marine organisms. In addition, the carbon sequestrating ability of the mangrove ecosystems is very important in the context of managing global climate change and aiding in nutrient cycling in the coastal ecosystems [2–4].

Mangrove forests account for nearly 1% (13.5 Gt year $^{-1}$) of global carbon sequestration. However, among coastal habitats, they account for 14% of carbon sequestration [5–8]. Carbon sequestration by mangrove ecosystems can be estimated in terms of above ground biomass and below ground biomass. The belowground carbon storage includes the carbon stored in the sediments of the mangrove ecosystems. The above ground biomass is storage of carbon in all biomass in living vegetation, above the soil including stems, stumps, branches, bark, seeds and foliage. Above ground carbon storage capacity of mangrove plants have been estimated using destructive and non-destructive methods [8].

Destructive method of estimating carbon sequestration capacity is also known as the harvesting method and involves cutting down trees to determine the carbon content of the plant parts. This method is not an environmentally friendly method as it involves removal of the trees from their native habitat. Moreover, it is not practical to weigh all the biomass for each sampled tree. Therefore, due to these disadvantages associated

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