Allometric Equations to Estimate the Aboveground Biomass of Seedling and Sapling Plants in 10 and 20 Years Old of Secondary Forests in Sarawak, Malaysia

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ABSTRACT
The seedlings and saplings plant stage determines the successional stages in the secondary forest establishment process. The estimation on aboveground biomass (AGB) of seedling and sapling plants is needed to describe undergrowth's contribution in the secondary forest. This study's objective was to develop allometric equations for accurate estimation of AGB for seedlings-saplings in 10 and 20 years old of secondary forests. The study was carried out at sites with two stages of the fallow period: lands with a fallow period of 10 and 20 years, respectively, in Sarawak, East Malaysia. The AGB data of all selected seedlings and saplings with the different species within 100 sample quadrates were used to develop allometric equations for seedlings and saplings in each study site. This study developed allometric equations to estimate AGB of seedlings-saplings (diameter at the ground surface of < 5 cm), particularly in 10 and 20 years of fallow ages.

Keywords: *Aboveground Biomass, Seedling, Sapling, Secondary Forest, Allometric Equation*

1. INTRODUCTION

Tree diversity is essential to predict tree carbon storage in hyperdiverse forests [1]. The total standing aboveground biomass (AGB) of woody vegetation elements is often one of the largest carbon pools. The AGB comprises all woody stems, branches, leaves of living trees, creepers, climbers, epiphytes, and herbaceous undergrowth [2]. AGB estimation is an essential aspect of carbon stocks studies and the effects of deforestation and carbon sequestration on the global carbon balance [3]. Because direct measurement of biomass cannot be made on an entire community or population, samples must be taken from a community or population [4]. Moreover, weighing tree biomass in the field is undoubtedly the most accurate method of estimating AGB. It is still an extraordinarily time-consuming and destructive method, generally limited to small areas and tree sample sizes [3].

An estimate of the vegetation biomass can provide information about the nutrients and carbon stored in the vegetation as a whole or the amount in specific fractions such as extractable wood [2]. Allometry is an effective method for accurately estimating trees' biomass, tree components, and stands [5]. It is hardly ever possible to measure all biomass on a sufficiently large sample area by destructive sample. Some form of allometry is used to estimate individuals' trees' biomass to an easily measured property such as its stem diameter [2]. Various dimensions and partial biomass of trees, such as bole wood, bark, branch, and foliage mass, are estimated from the diameter at breast height (DBH) by the allometric correlation method [6,7].

The allometric equation expresses the relationship between a tree's dimension or different parts of plants with the biomass [8,9]. Regression models are used to convert inventory data into an estimate of trees' biomass [9,10]. Once an allometric equation has been established for different classes of trees in vegetation, one only needs to measure DBH (or other parameters used as a basis for equation, such as height and total biomass or carbon content) to estimate the biomass of individual trees [2,8].