UNIVERSITI TEKNOLOGI MARA

MODELLING OF CARBON SEQUESTRATION POTENTIAL IN RUBBER TREE (*Hevea brasiliensis*) SAPLINGS AND PLANTATIONS IN MALAYSIA

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ABSTRACT

The climate change and global warming occurred due to excessive build-up of greenhouse gases (GHGs) especially CO_2 in the atmosphere. In order to stabilize the GHGs, the forest has to be conserved because the terrestrial ecosystems are vital carbon sink that store large amount of atmospheric CO_2. Rubber plantation is man-made forest and is classified as forest plantation. In the Southeast Asia, increasing demand on natural rubber and rubber wood industry are factors that contribute to the expansion of rubber plantations which is predicted to replace the secondary forests in 2050. Thus, the ecosystem functions of rubber in sequestering carbon have to be studied in order to determine the potential of rubber plantation in mitigating climate change. The objectives of this study were (1) to determine the total of biomass in rubber tree saplings using destructive sampling method and to estimate carbon sequestration potential in rubber plantations using allometric equations, (2) to investigate the trend of diameter (D), height (HT), stomatal conductance (SC), chlorophyll content (CC), photosynthesis rate (PN), transpiration rate (TRPT) and leaf area index (LAI) for rubber saplings and plantations at the age ranges between 45 days to 28 years, (3) to study the relationships between biomass for rubber tree saplings and carbon sequestration for rubber plantations and selected morphological and physiological variables used in this study, (4) to develop biomass predictive model for rubber tree saplings for the range age of 45 to 225 day) based on morphological and physiological variables and, (5) to develop carbon sequestration predictive model for rubber plantations within the age ranges from 1to 28 years based on morphological and physiological variables. Biomass (W) of rubber tree saplings were obtained through oven-dried method while for rubber plantation the W and carbon sequestration (CS) were obtained using published allometric equation. Then, the predictive models were developed based on morphological variables (i.e., D, HT and AG) and physiological variables (i.e., SC, CC, PN, TRPT and LAI) of rubber tree saplings and plantations. Means of biomass of rubber tree saplings at five different growth stages were 0.02, 0.06, 0.11, 0.19 and 0.30 kg/tree, respectively. For rubber plantations, the means of carbon sequestration of 14 different ages were 7.62, 68.42, 52.88, 116.38, 167.72, 184.22, 233.80, 274.09, 453.49, 504.91, 522.07, 588.84, 644.84 and 1239.70 tC/ha, respectively. From Analysis of Variance (ANOVA), the ages of rubber tree saplings were significantly affected all variables, i.e., CS, D, HT, SC, CC, TRPT and LAI ($P \leq 0.05$) except for PN ($P \geq 0.05$). All variables in rubber plantations are significantly affected by ages ($P \leq 0.05$). The highest positive correlations in both saplings and plantations were recorded for CS versus DBH followed by CS versus HT, AG, LAI, CC. However CS versus PN, SC and TRPT were inversely correlated with CS. From the model building and model validation analysis, the results showed that Model 5 appeared to be the best allometric equation for biomass of rubber tree saplings, i.e., $\log_{10} W = 0.184 + 0.050 \log_{10} D + 0.734 \log_{10} HT + 0.003 \log_{10} AG$ (R^2=0.96; P= 0.0001) whereas Model 3 was the best performing model, $\ln Y = -1.108 + 1.494 \ln DBH + 0.813 \ln HT$, ($R^2$=0.99; P=0.0001) among seven selections candidate models for rubber plantation. The predictive models developed provide a convenient and useful tool and may assist in the development of policy recommendations, strategies and management plan to address the climate change agenda.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

The problem of global climate change emerged during the last century and was widely discussed and debated throughout the scientific world. The climate change could leads to the increase in temperature, change in precipitation, raise the sea level and increase the frequency and intensity of extreme climatic event. One of the major causes of climate change is the excessive emission of global greenhouse gases (GHGs), such as carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) into the atmosphere as a result of natural and anthropogenic activities. The greatest carbon source originates from fossil fuels burning and cement production (6.3Gt C year^{-1}) (IPCC, 2002). However, emission from land use and cover change also contributed to a high value of 2.2 Gt C year^{-1} and this mainly the result from tropical deforestation (Hounghton, 2003). These GHGs have the ability to trap excessive sunlight energy that in turn warm up the Earth's atmosphere. The global temperature continues to rise as the human activities continue to emit the GHGs. In addition, over the last 100 years, the global mean surface temperature has increased by 0.6°C with 1998 being the warmest year (IPCC, 2002).

As a consequence to mitigate climate change, The United Nations Framework Convention on Climate Change (UNFCCC or FCCC) produced an international environmental treaty at the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro from 3rd to 14th June 1992. The objective of the treaty is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Subsequently, in 1997 the UNFCCC proposed a meeting in Kyoto, Japan which established the Kyoto Protocol where six greenhouse gases were identified as the main causes of global warming or the greenhouse effect. These were CO_2, CH_4, N_2O, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6) (UNFCCC, 2008) in which CO_2 contributes the largest share in the greenhouse effect.