DOI :10.31357/fapsmph.2013.00564

DETERMINATION OF THE BIOMASS PRODUCTION AND CARBON SEQUESTRATION CAPACITY OF WET – ZONE FORESTS IN SRI LANKA

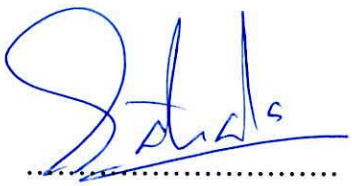
by

Wahala Mudiyanselage Palitha Sampath Bandara Wahala

Thesis submitted to the University of Sri Jayewardenepura for the award of the Degree of Doctor of Philosophy in forestry on 10th May 2013.

DECLARATION

"The work described in this thesis was carried out by me under the supervision of Prof. Hemanthi Ranasinghe and Prof. H. S. Amarasekera (interim supervisor) of the Department of Forestry and Environmental Science at the University of Sri Jayewardenepura, Nugegoda, Sri Lanka and a report on this has not been submitted in whole or in part to any university or any other institution for another degree or diploma"



W M P S B Wahala

10th May 2013

SUPERVISORS'NOTE

"We certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the University for the purpose of the evaluation."

Supervisor:

.....

Prof. D.M.S.H.K. Ranasinghe

Department of Forestry and

Environmental Science

University of Sri Jayewardenepura

Date: 19/06/2013

Interim Supervisor:

.....

Prof. H. S. Amarasekera

Department of Forestry and

Environmental Science

University of Sri Jayewardenepura

Date: 19/06/2013

ACKNOWLEDGEMENTS

This work would not be possible without the help and support of many individuals, many of whom I may forget to mention and I apologize if that occurs.

First, I would like to express my deepest gratitude and I am greatly honored to Prof. Hemanthi Ranasinghe, Professor of Forestry and Environmental Science of the Department of Forestry and Environmental Sciences, University of Sri Jayewardenepura, for being my internal supervisor and suggesting me this research topic that has national global importance. Without her suggestions, help and guidance my approach on this study would not be successful. She has been a great inspiration not only for this study but also for my entire academic career.

I wish to extent my gratitude to Prof. W.A.J.M. De Costa, Professor of Crop Science of the Faculty of Agriculture, University of Peradeniya, for providing me the expertise guidance and information, Hemispherical photography camera setup and the HemiView 2.1 Canopy Analysis computer software for this study, and specially for the facilitating me to carry out seedling level photosynthesis estimation at crop physiology lab of the agriculture faculty of University of Peradeniya.

I wish to express my heartiest gratitude to Prof. Hiran S Amarasekera, Professor of Department of Forestry and Environmental Sciences, University of Sri Jayewardenepura

for being the internal supervisor during Prof Hemanthi's Sabbatical leave period in year 2011. More than a supervisor, you were a spirit for me in many mile stones in my life.

I would like to extend my sincere thanks to Mr. I. D. Wijesinghe , Mr. Suresh Weththasinghe and Mr. Suranjan who are the technical officers in the department for their cooperation in providing me with the field equipments and to the rest of the staff of the Department of Forestry and Environmental Science, University of Sri Jayewardenepura. Also I wish to thank Mr. Gemunu , Mrs. Janakie , Mr. Aththanayake and other technical staff at the Faculty of Agriculture, University of Peradeniya for the support given me specially during the measurement of photosynthetic parameters of seedlings with LICOR 6400 portable photosynthesis measurement system.

I wish to give my special thank to Mr. Dharshana, and Dr. Thilantha Dammalage of the Faculty of Geomatics of Sabaragamuwa University of Sri Lanka, for their technical guidance during the development of vegetation indices using MODIS data with ENVI and ArcGIS computer softwares.

I am appreciative to those who have provided financial support for this work. This project was initially funded by the NSF grant no RG/2003/FR/01.

I am also grateful to the Forest Department of Sri Lanka and the Department of Wildlife Conservation of Sri Lanka for providing me the permission to carry out my field work at Forest Reserves and National parks.

I must thank to the Department of Meteorology, Sri Lanka for providing me the necessary data for the calculation which direct my study for the success.

I specially would like to thank Mr. Nilantha Vishwanath who gave me the finest support by giving me his own vehicle for the field work and all the supports gave me at the field.

I am grateful to pen these few words to thank Mr. Chithrasekera at Kanneliya and the forest officers at the field station and Wimale at Sinharaja who was the caretaker at Sinharaja field station during my work period at Sinharaja. Thank you for giving me accompanies and genuine and kind helps in many ways when I was at field alone. I would like to extend my sincere thanks to Prof. Swarna Piyasiri, the Dean, Faculty of Graduate Studies, Prof. Sadun Senerath, Chairperson, Board of Life Science for the assistance gave throughout the study period. I would also like to thank Mr. Risvi, and Ms. Sachintha at Faculty of Graduate faculty, University of Si Jayewardenepura for their friendly and keen administrative support done for me in various ways.

Last but not least, I would like to thank my mother and beloved family members, for their love and moral support rendered during the whole period.

Finally I am surprised and pleased to have an unseen spiritual support had with me all the time like the shadow of mine to overcome the various obstacles came out the way.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

DEDICATION

To

Appachchi, Ammi & Panchi (Kasundhi)

Determination of the biomass production and carbon sequestration capacity of wet – zone forests in Sri Lanka

Wahala Mudiyanselage Palitha Sampath Bandara Wahala

ABSTRACT

Despite the recognized potential of forests as an important sink to sequester carbon, accurate estimates of the carbon sequestration potential of different ecosystems or their component species are lacking, especially for the different forest types present in Sri Lanka. The primary objective of the study is to determine the carbon sequestration potential of selected important natural forest ecosystems in the wet zone of Sri Lanka. In this study, completely non destructive approach, based on the basic physiology of biomass production process was used to estimate the carbon sequestration potential as a rate in ecosystem scale. Monteith (1972, 1977) showed that the rate of biomass production is directly proportionate to the amount of radiation intercepted by the foliage canopy. The above relationship can be given as: $W = e R_I$, Where, W is the amount of total biomass (above and belowground biomass) produced and R_I is the amount of radiation intercepted by canopy. The proportionality constant, **e** is termed as Radiation Use Efficiency (RUE). These two variables (R_I and e) were determined explicitly for specific vegetation types using different approaches. R_I values were estimated using hemispherical photographs obtained from 337 sampling points representing 44 transect covering four major vegetation types in wet zone in Sri Lanka. RUE values were

derived by canopy level photosynthesis termed as photosynthetic RUE (PhRUE) (with generalized photosynthetic parameters) at selected locations and stand level PhRUE values were derived for each transect in each vegetation type, with the relationship developed between PhRUE and Photochemical Reflectance Index (PRI) which was developed using MODIS (Moderate Resolution Imaging Spectroradiometer) data using satellite image analysis program ENVI 4.5. The canopy level net primary production was highest in lowland wet evergreen forests which was represented by Sinharaja Forest Reserve and Kanneliya Forest Reserve (8.615 ± 1.902 c tons ha^{-1} yr^{-1}) and the lowest in Montane forests represented by Horton Plains National Park and upper reaches of the Peak Wilderness Sanctuary (1.535 ± 0.473 c tons ha^{-1} yr^{-1}). With regard to the net biomass production , the highest values were recorded in the lowland wet evergreen forests (18.02 ± 4.264 t ha^{-1} yr^{-1}) for Sinharaja Forest Reserve and 15.847 ± 2.258 t ha^{-1} yr^{-1} for the Kanneliya Forest Reserve, while the value for the sub montane zone represented by the Peak Wilderness Sanctuary as 13.417 ± 1.841 t ha^{-1} yr^{-1} , Knuckles-Illukkumbura as 6.410 ± 4.690 t ha^{-1} yr^{-1}, Knuckles-Deanston area as 5.204 ± 2.091 t ha^{-1} $yr^{-1}$and . Knuckles-Illukkumbura as 6.904 ± 0.965 t ha^{-1} yr^{-1} represent the semi evergreen vegetation type and Montane zone represented by the Horton Plains National Park as 3.442 t ha^{-1} yr^{-1} 0.957 and upper reaches of the Peak Wilderness Sanctuary (as 2.329 ± 0.169 t ha^{-1} yr^{-1}). Canopy level Radiation Use Efficiency (PhRUE), values varied with the forest type as well as the elevation. The highest levels of 0.0058 ± 0.0013 (mol CO_2 /mol PAR) were observed from Lowland tropical evergreen forests while the lowest values of 0.001007 ± 0.000290 (mol CO_2 /mol PAR) were observed from the montane forests. NDVI (Normalized Different Vegetation Index) and EVI

(Enhanced Vegetation Index) were also derived using MODIS data to develop model between CO_2 sequestration rate and these vegetation index as a tool to extrapolate values to estimate for known extents of selected vegetation types. This study was confined to the natural forests of the wet zone of Sri Lanka. The methodology used should be extended to the other forest types in Sri Lanka including dry mixed evergreen forests and mangroves to get a comprehensive understanding of the net primary production and carbon sequestration capacity of the natural forests in the country.