UNIVERSITI PUTRA MALAYSIA

ABOVEGROUND BIOMASS AND CARBON STOCK ESTIMATION IN LOGGED-OVER TROPICAL LOWLAND FOREST

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman: Associate Professor Ahmad Ainuddin Nuruddin, PhD

Faculty: Faculty of Forestry

Global climate change is one of the most pressing environmental concerns of humanity. This is cause by the increasing concentration of greenhouse gases (GHG) especially carbon dioxide (CO_2). Forest plays a vital role in controlling the capacity of atmosphere CO_2 where they are also known as a 'carbon sinker' as they manage to significantly capture carbon and store them as biomass. Tropical forest ecosystem is believed to sequester a large number of carbon (C) compared to other natural ecosystem where the majority of C stored in the aboveground vegetation. In Malaysia, accurate information on aboveground carbon storage is lacking. Hence, the objectives of this study were to estimate and develop equations of biomass in logged-over tropical lowland forest, measure wood density of selected trees in the study area and to quantify carbon in different type of aboveground biomass components. This study was conducted at two logged-over tropical lowland forest; Bubu Forest Reserve, Perak Darul Ridzuan and Ayer Hitam Forest Reserve, Selangor Darul Ehsan. In both study sites, ten 50m x 20m plots were randomly established within the study area and trees with 10cm DBH (diameter breast height) were inventoried. Sub-sampling of seedlings (1m x 1m) and saplings (3m x

3m) were also carried out within the 50m x 20m plot. Forest litter were sampled using 22 one meter square quadrate in 50m x 20m plot. Sub-sampling of downed woody material was also done within the plot. Their length, diameter and height were recorded. Decayed downed woody material were categorised according to three states of decomposition. Samples were taken, dried; weight and density were calculated as dry mass divided by fresh volume. In Bubu Forest Reserve, 14 trees were selected and felled and biomass of each component was weighed separately (main stem, branches, twigs, leaves) and discs from three sections (base, middle, top) of the main stem were obtained for further testing. After being weighted at the site, all samples were brought to the laboratory for further analysis. Samples were analysed using CNS 2000 Elemental Analyser for C content. From the analysis, two allometric equations was formulate for two different group based on the wood density from tree sampled which is high wood density class ($AGB = 0.05633DBH^{2.75756}$) and medium wood density class ($AGB = 0.00023DBH^{3.75745}$). From this information, it was determined that the Bubu Forest Reserve aboveground biomass was 501.30 t ha^{-1} while Ayer Hitam Forest Reserve aboveground biomass was 420.08 t ha^{-1}. The result also showed that tree component stored 98% of the aboveground biomass, followed by downed woody (0.96%), forest litter (0.76%) and palm (0.28%). The carbon content for all biomass components ranged from 45% to 47%. From these results, the carbon stock for Bubu Forest Reserve was estimated to be 225 t C ha^{-1} while for Ayer Hitam Forest Reserve, it was 189.18 t C ha^{-1}. The biomass equation develops for this study can be used to assess aboveground biomass in the forest especially in areas where tree cutting is not allowed. However, additional ground based data are needed to increase the precision of forest biomass estimate.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Master Sains

BIOJISIM PERMUKAAN TANAH DAN ANGGARAN STOK KARBON DI HUTAN TANAH PAMAH TROPIKA YANG TELAH DIBALAK

Oleh

NUR KYARIATUL SYAFINIE BTE ABDUL MAJID

Julai, 2012

Pengerusi: Profesor Madya Ahmad Ainuddin Nuruddin, PhD

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Perubahan iklim global adalah salah satu daripada kebimbangan utama terhadap alam sekitar. Ini adalah disebabkan oleh peningkatan kepekatan gas rumah hijau (GHG) khususnya karbon dioksida (CO_2). Hutan memainkan peranan penting dalam mengawal kapasiti CO_2 di dalam udara. Ia juga dikenali sebagai 'penyimpan karbon' kerana ia mengambil karbon dioksida secara efisien dan menukarkanya kepada karbon dan disimpan sebagai biojisim. Ekosistem hutan tropika dipercayai terdiri daripada sejumlah besar karbon (C) berbanding ekosistem semula jadi yang lain di mana majority C yang disimpan di dalam tumbuh-tumbuhan yang berada di pemukaan tanah. Di Malaysia, maklumat yang tepat mengenai penyimpanan karbon di permukaan tanah masih kurang. Oleh itu, objektif kajian ini dijalankan adalah untuk menganggar dan membangunkan persamaan biojisim di hutan tanah pamah tropika yang telah dibalak, mengukur ketumpatan kayu pokok yang dipilih di kawasan kajian dan kuantiti karbon dalam komponen biojisim permukaan tanah yang berlainan jenis. Kajian ini dijalankan di dua hutan tanah pamah tropika iaitu Hutan Simpan Bubu, Perak Darul Ridzuan dan Hutan Simpan Ayer Hitam,

Selangor Darul Ehsan. Dikedua-dua tapak kajian ini, sebanyak sepuluh plot berukuran 50m x 20m diwujudkan secara rawak di dalam kawasan kajian dan pokok-pokok 10cm DPD (diameter paras dada) ke atas telah diinvetori. Jumlah sub-sampel bagi benih pokok (1m x1m) dan anak pokok (3m x 3m) juga telah dikenalpasti dan direkodkan di dalam plot ini. Sarap hutan telah disampel menggunakan 22 satu meter persegi kuadrat didalam setiap plot 50m x 20m. Sub-sampel bagi bahan berkayu yang tumbang dan serpihan di lantai hutan juga diukur di dalam plot berkenaan. Panjang, diameter dan berat bahan ini direkodkan. Bahan berkayu yang jatuh dan reput dikategorikan mengikut tiga keadaan penguraian. Sampel diambil, dikeringkan, ditimbang sekali lagi dan ketumpatan dikira dimana berat kering dibahagikan dengan berat basah. Di Hutan Simpan Bubu, 14 pokok telah dipilih dan ditebang dan biojisim setiap komponen tersebut telah ditimbang secara berasingan (batang utama, dahan, ranting dan daun) dan cakera daripada tiga bahagian (pangkal, tengah, atas) batang utama diperoleh untuk kajian lanjut. Setelah ditimbang di lapangan, semua sampel dibawa pulang ke makmal untuk dianalisis dengan lebih lanjut. Sampel telah dianalisis menggunakan CNS 2000 Elemental Analyzer untuk C. Daripada analisis, dua persamaan alometrik dapat dirumuskan untuk dua kumpulan yang mempunyai ketumpatan kayu yang berbeza iaitu ketumpatan kayu tinggi ($AGB = 0.05633DBH^{2.75756}$) dan ketumpatan kayu rendah ($AGB = 0.00023DBH^{3.75745}$). Dengan maklumat ini, dapat ditentukan bahawa biojisim permukaan tanah bagi Hutan Simpan Bubu adalah 501.30 t per ha manakala biojisim permukaan tanah bagi Hutan Simpan Ayer Hitam adalah 420.08 t per ha. Keputusan juga menunjukkan komponen pokok menyimpan sebanyak 98% dari jumlah biojisim atas tanah, diikuti bahan kayu tumbang (0.96%), sarap hutan (0.76%) dan palma (0.28%). Kandungan karbon untuk semua biojisim

adalah diantara 45% sehingga 47%. Daripada hasil kajian ini, simpanan karbon untuk Hutan Simpan Bubu dianggarkan sebanyak 225 t C per ha sementara Hutan Simpan Ayer Hitam ialah 189.18 t C per ha. Persamaan biojisim yang dihasilkan untuk kajian ini boleh digunakan untuk menilai biojisim permukaan tanah dikawasan hutan yang mengharamkan pembalakan. Walau bagaimanapun, data tambahan diperlukan untuk meningkatkan ketepatan anggaran biojisim hutan.

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I certify that an Examination Committee has met on February, 2012 to conduct the final examination of Nur Kyariatul Syafinie Bte Abdul Majid on her degree thesis entitle "Aboveground Biomass and Carbon Stock Estimation in Logged-over Tropical Lowland Forest" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the student be awarded the Master of Science

Members of the Examination Committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledge. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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NUR KYARIATUL SYAFINIE BTE ABDUL MAJID

Date: 4th July 2012

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