

FINAL REPORT ON RACE RESEARCH GRANT 2012

PROJECT TITLE:

**CARBON STOCKS AND SEQUESTRATION POTENTIAL IN AGROFORESTRY
SYSTEM**

PROJECT LEADER:

PROF MADYA DR NORMAH AWANG BESAR @ RAFFIE

CO-RESEARCHERS:

PROF MADYA DR PHUA MUI HOW

PROF DATO' DR MAZLIN MOKTHAR

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SYNOPSIS

Studies on carbon stock in agroforestry systems has been conducted in Balung River Plantation, Tawau, Sabah. The objective of the study are to determine carbon content of above ground vegetation including crops, shrubs and trees in agroforestry system, to determine carbon content of soil in agroforestry system, to estimate aboveground carbon stock using LiDAR data and to estimate carbon sequestration potential in agroforestry system. Three combination of oil palm (*Elaeis guineensis*) and agarwood (*Aquilaria malaccensis*) in agroforestry system with different age were investigated. The combinations are oil palm (27 years) and agarwood (7 years), palm oil (20 years) and agarwood (7 years) and oil palm (17 years) and agarwood (5 years). Oil palm plantation (16 years) and forest reserve was investigated as a control. Agroforestry system of teak (*Tectona grandis*), agarwood (*Aquilaria malaccensis*) and snake fruit (*Salacca zalacca*) were also assessed for carbon storage ability in comparison with LiDAR data. A random systematic sampling method was used for conducting the forest inventory. Three square plots of 0.25 ha were established in each of the agroforestry system site. Soil were taken at the depth 0-5 cm, 5-10 cm and 10-30 cm. Shrub layer and organic layer were taken at five randomly selected positions in each plot. Field measured attributes such as height and DBH were measured and then converted into above ground biomass by using site specific allometric equation. Carbon stocks were considered to be 50 percent of the total biomass. The results shows that forest have the highest carbon stock (287.38 tan C ha⁻¹) in comparison with three oil palm agroforestry systems (79.12 tan C ha⁻¹, 85.39 tan C ha⁻¹ and 78.27 tan C ha⁻¹) and monoculture oil palm plantation (76.44 tan C ha⁻¹). In teak, agarwood and snake fruit agroforestry combination, the total carbon stock is 44.04 tan C ha⁻¹ in which 70 percent of it were contributed by the teak stand. Significance correlation were also found for field measured height and LiDAR maximum height for teak and agarwood ($R^2 = 0.807$, teak; $R^2 = 0.923$, agarwood) in individual tree analysis. For plot level approach, canopy coverage percentage flor LiDAR data shows strong correlation with above ground carbon of snake fruit ($R^2 = 0.756$). This study found that agroforestry systems have great potential in carbon storage and carbon sequestration and the use of remote sensing technology offers were capable in improving above ground carbon stock estimates.

Key words: agroforestry system, carbon stock, teak, agar wood, oil palm, living biomass, LiDAR

SINOPSIS

Kajian mengenai simpanan karbon di dalam sistem perhutani telah dilakukan di Balung River Plantation, Tawau, Sabah. Objektif kajian ini adalah untuk menentukan kandungan simpanan karbon bagi vegetasi atas tanah yang merangkumi tumbuhan renek dan pokok dalam sistem perhutani, untuk menentukan kandungan karbon dalam tanah sistem perhutani, untuk menganggar simpanan karbon atas tanah menggunakan LiDAR dan juga untuk menganggar potensi sistem perhutani dalam sequestrasi karbon. Tiga kombinasi sistem perhutani dikaji iaitu kelapa sawit (*Elaeis guineensis*) dan gaharu (*Aquilaria malaccensis*) pada peringkat umur berbeza. Kombinasi tersebut ialah kelapa sawit (27 tahun) dan gaharu (7 tahun), kelapa sawit (20 tahun) dan gaharu (7 tahun) serta kelapa sawit (17 tahun) dan gaharu (5 tahun). Tanaman perladangan kelapa sawit (16 tahun) dan hutan simpan turut dikaji dan dijadikan sebagai kawalan. Kombinasi sistem perhutani, pokok jati (*Tectona grandis*), gaharu (*Aquilaria malaccensis*) dan salak (*Salacca zalacca*) turut dikaji untuk mengetahui potensinya dalam menyimpan karbon dan dibandingkan dengan data LiDAR. Kaedah persampelan rawak secara sistematik digunakan untuk melakukan kerja-kerja inventori. Tiga plot segi empat dengan keluasan 0.25 hektar dibuat di dalam setiap sistem perhutani yang dikaji. Sampel tanah diambil pada kedalaman 0-5 cm, 5-10 cm dan 10-30 cm. Lapisan tumbuhan renek dan bahan organik diambil di 5 lokasi rawak disetiap plot. Tinggi dan diameter pokok diukur dan kemudian ditukar kepada biojisim atas tanah menggunakan persamaan alometrik spesifik. Simpanan karbon dianggarkan sebagai 50 peratus daripada jumlah biomassa. Berdasarkan keputusan yang diperolehi, hutan simpan mempunyai jumlah simpanan karbon tertinggi (287.38 tan C ha⁻¹) berbanding ketiga-tiga kombinasi sistem perhutani, kelapa sawit dan gaharu (79.12 tan C ha⁻¹, 85.39 tan C ha⁻¹ dan 78.27 tan C ha⁻¹) serta perladangan kelapa sawit (76.44 tan C ha⁻¹). Bagi kombinasi sistem perhutani, hutan jati, gaharu dan salak, jumlah karbon adalah 44.04 tan C ha⁻¹ di mana 70 peratus karbon disumbangkan oleh dirian pokok jati. Hasil kajian juga menunjukkan terdapat hubungkait signifikan antara tinggi yang diukur di lapangan dengan tinggi maksimum LiDAR bagi pokok jati dan gaharu ($R^2 = 0.807$, jati; $R^2 = 0.923$, gaharu) dalam analisis pokok individu. Bagi pendekatan secara plot, peratus litupan kanopi dari data LiDAR menunjukkan hubungkait yang tinggi dengan jumlah karbon pokok salak ($R^2 = 0.756$). Kajian ini menunjukkan bahawa sistem perhutani mempunyai potensi yang besar dalam simpanan karbon dan berpotensi dalam sequestrasi karbon manakala penggunaan teknologi penderiaan jauh mampu membantu dalam penganggaran simpanan karbon atas tanah.

Kata kunci: Sistem perhutani, simpanan karbon, jati, gaharu, kelapa sawit, biojisim hidup, LiDAR