PROSIDING
PERSIDANGAN KEBANGSAAN
PENILAIAN EKONOMI SUMBER HUTAN 2014

"PENJANAAN KEKAYAAN BARU BARANGAN DAN PERKHIDMATAN HUTAN KE ARAH NEGARA MAJU BERPENDAPATAN TINGGI"

HOTEL THE EVERLY PUTRAJAYA
2-5 SEPTEMBER 2014




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“PENJANAAN KEKAYAAN BARU BARANGAN DAN PERKHIDMATAN HUTAN KE ARAH NEGARA MAJU BERPENDAPATAN TINGGI”

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KANDUNGAN

PRAKATA

Bismillahirrahmanirrahim.

Segala puji bagi Allah, tuhan semesta alam dan selawat serta salam ke atas junjungan besar Nabi Muhammad Rasulullah S.A.W.

Salam 1Malaysia;
Salam 1NRE; dan
Salam 1JPSM.

Bersyukur ke hadrat Allah S.W.T. kerana dengan limpah kurnia dan izin-Nya, Prosiding Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014 dapat diterbitkan untuk mendokumentasikan segala isu yang telah dibincangkan sepanjang sesi persidangan ini.

Hutan tropika merupakan khazanah alam yang amat berharga. Hutan kita amat kaya dengan kepelbagaian sumber yang bernilai tinggi sekaligus menjadi aset penting dan berpotensi menjana pendapatan ekonomi negara. Ia menjadi satu tanggungjawab kita sebagai masyarakat negara Malaysia untuk memanfaatkan sumbangan yang diperolehi daripada hutan sebaik-baiknya. Antara sumber-sumber hasil hutan yang diperolehi adalah seperti kayu balak, rotan, buah-buahan, buluh, hidupan liar, tumbuhan herba dan sebagainya. Selain daripada itu, hutan juga memainkan peranan penting dalam sistem rantaian ekologi disekelilingnya seperti mengawal kestabilan alam sekitar, menjadi kawasan habitat semulajadi haiwan, kawasan tadahan air, membekalkan oksigen, kawasan rekreasi dan sebagainya. Dengan lain perkataan, adalah amat wajar agar usaha-usaha menilai hutan dan potensinya kepada masyarakat dipertingkatkan.

Oleh yang demikian, Jabatan Perhutanan Semenanjung Malaysia (JPSM) telah mengambil langkah inisiatif dengan menganjurkan Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan yang bertemakan **"Penjanaan Kekayaan Baru Barangan dan Perkhidmatan Hutan Ke Arah Negara Maju Berpendapatan Tinggi"** untuk menilai dan menterjemahkan nilai ekonomi sumber semulajadi hutan tersebut. Sejumlah 20 kertas kerja telahpun dibentangkan oleh agensi-agensi kerajaan dan institusi-institusi tempatan. Justeru itu, segala pengetahuan, kemahiran dan pengalaman sepanjang persidangan tersebut didokumenkan supaya ia dapat dikongsi bersama serta menjadi panduan dan rujukan kepada pihak yang terlibat sama ada secara langsung atau tidak langsung dalam pengurusan dan pemuliharaan hutan di negara kita.

Akhir kata, saya ingin mengambil kesempatan untuk merakamkan ucapan tahniah dan terima kasih kepada semua pengarang kertas kerja yang telah memberi sumbangan di dalam penyediaan prosiding ini. Tidak lupa juga kepada kumpulan penyunting prosiding ini yang telah berusaha mengumpul dan menyemak kertas kerja tersebut sehinggalah ia berjaya diterbitkan.

Sekian, terima kasih.

(DATO' SRI DR. HJ. ABD. RAHMAN BIN HJ. ABD. RAHIM)
Ketua Pengarah Perhutanan
Semenanjung Malaysia

OBJEKTIF PERSIDANGAN

1. Menterjemahkan barangan dan perkhidmatan sumber hutan yang berpasaran dan bukan pasaran dalam bentuk nilai ekonomi agar nilai keseluruhan hutan *(total economic valuation)* dapat ditentukan.

2. Mengenalpasti kaedah-kaedah pengiraan penilaian ekonomi barangan dan perkhidmatan sumber hutan ke arah penentuan kos dan faedah (*cost-benefit analysis*) sesuatu projek perhutanan.

3. Menyediakan platform kepada jabatan dan agensi kerajaan, pihak swasta, institusi penyelidikan, pusat pengajian tinggi, dan badan bukan kerajaan (NGOs) untuk berkongsi maklumat mengenai penilaian ekonomi sumber hutan.

4. Mengenalpasti dasar dan strategi bagi mengarusperdanakan penilaian sumber hutan dalam perancangan dan pembangunan sumber tanah negara.

UPACARA PERASMIAN

Lebah Belanda (*Apis mellifera*)

UCAPAN ALUAN

YBHG. DATO' SRI DR. HJ. ABD. RAHMAN bin HJ. ABD.RAHIM

KETUA PENGARAH PERHUTANAN SEMENANJUNG MALAYSIA

SEMPENA PERSIDANGAN KEBANGSAAN PENILAIAN EKONOMI SUMBER HUTAN 2014

PADA 4 SEPTEMBER 2014 (KHAMIS) DI HOTEL THE EVERLY PUTRAJAYA

Bismillahirrahmanirrahim.

Segala puji bagi Allah, tuhan semesta alam dan selawat serta salam ke atas junjungan besar Nabi Muhammad Rasulullah S.A.W.

Assalamualaikum WBT;
Salam Sejahtera;
Salam 1Malaysia;
Salam 1NRE; dan
Salam 1JPSM.

Terima kasih Saudara/ri Pengacara Majlis.

YB. Datuk Seri G. Palanivel
Menteri Sumber Asli dan Alam Sekitar Malaysia.

YBhg. Datuk Dr. Abdul Rahim bin Haji Nik
Timbalan Ketua Setiausaha II
Kementerian Sumber Asli dan Alam Sekitar Malaysia.

Yang Dihormati,
Dif-dif Jemputan, Para Pembentang Kertas Kerja.

YB. Datuk Seri, Dato'-Dato', Datin-Datin, Tuan-tuan dan Puan-puan yang saya hormati sekalian,

Pertama-tamanya, marilah kita memanjatkan kesyukuran kehadrat Allah SWT kerana dengan limpah dan iradah-Nya kita telah diberikan kesempatan untuk berkumpul beramai-ramai pada pagi ini di Dewan Banquet, Hotel The Everly Putrajaya, Malaysia bersempena dengan Majlis Perasmian Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014.

2. Di kesempatan ini, izinkan saya juga merakamkan ucapan setinggi-tinggi terima kasih yang tidak terhingga kepada YB. Datuk Seri G. Palanivel, Menteri Sumber Asli dan Alam Sekitar Malaysia di atas kesudian YB. Datuk Seri meluangkan masa untuk menghadirkan diri pada pagi ini sekalipun kita semua tahu bahawa YB. Datuk Seri agak sibuk dengan tugas yang komited sebagai Menteri NRE dan seterusnya akan menyempurnakan perasmian "Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014" yang bertemakan **"Penjanaan Kekayaan Baru Barangan dan Perkhidmatan Hutan Ke Arah Negara Maju Berpendapatan Tinggi"** yang berlangsung selama tiga (3) hari bermula pada 3 September sehingga 5 September 2014 di Hotel The Everly Putrajaya ini. Sesungguhnya, kesudian YB. Datuk Seri untuk melapangkan masa untuk hadir ke Persidangan ini bersama-sama kita semua sudah pastinya memperlihatkan akan keprihatinan serta komitmen tinggi YB. Datuk Seri kepada usaha-usaha Jabatan Perhutanan Semenanjung Malaysia untuk terus memperkasakan peranan dan sumbangan sumber hutan ke pada pembangunan sosioekonomi negara Malaysia yang kita cintai ini.

3. Tidak ketinggalan juga, izinkan saya untuk mengambil kesempatan ini bagi merakamkan ucapan setinggi-tinggi terima kasih kepada semua hadirin sekalian serta dif-dif jemputan kerana bersama-sama menjayakan majlis perasmian pada pagi ini, terutama sekali kepada pembentang-pembentang kertas kerja dan para peserta Persidangan kali ini. Adalah menjadi harapan tinggi saya, agar semua pembentang kertas kerja dan peserta yang hadir pada pagi ini dapat memanfaatkan sepenuhnya persidangan kebangsaan ini dan sama-sama terlibat secara aktif dengan mencurahkan segala ilmu dan kepakaran masing-masing untuk dikongsi bersama bagi mencapai satu tujuan yang murni kearah penjanaan kekayaan baru barangan dan perkhidmatan hutan serta untuk terus meningkatkan peranan dan sumbangan hutan kepada kesejahteraan masa depan Malaysia mencapai status "Negara Maju Berpendapatan Tinggi" pada tahun 2020.

YB. Datuk Seri, Dato'-Dato', Datin-Datin, Tuan-tuan dan Puan-puan yang saya hormati sekalian,

4. Sukacitanya saya memaklumkan bahawa penganjuran Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014 ini akan memberikan penekanan yang lebih terhadap beberapa aspek penting ekonomi yang merangkumi dasar dan rangka kerja serta prinsip kaedah-kaedah penilaian ekonomi sumber hutan agar sektor perhutanan kekal merupakan salah satu sektor penting dalam pembangunan negara Malaysia. Di samping itu, Persidangan kali ini juga adalah diharapkan dapat memberikan lebih fokus termasuk juga penyelidikan, pembangunan dan inovasi, serta penilaian ekonomi sumber barangan dan juga perkhidmatan hutan kepada kesejahteraan masyarakat. Penekanan-penekanan ini secara khususnya diharapkan dapatlah mengenalpasti barangan dan perkhidmatan hutan samada yang berpasaran dan bukan pasaran dalam bentuk nilai ekonomi agar nilai keseluruhan sumber hutan dapat diperolehi nilainya dan sekaligus berupaya menjana pendapatan baru kepada negara. Melalui penganjuran Persidangan pada kali ini juga, adalah disasarkan bahawa satu garis panduan berkaitan "Kaedah-kaedah khusus pengiraan penilaian ekonomi barangan dan perkhidmatan sumber hutan" dapat dihasilkan dan diterima pakai di masa hadapan oleh semua pihak yang berkepentingan dengan perhutanan, terutamanya agensi kerajaan dan swasta yang terlibat untuk menilai kos dan faedah sesuatu projek perhutanan. Selain daripada itu, adalah diharapkan juga agar Persidangan pada kali ini terus menyediakan satu platform pertemuan dan perbincangan kepada jabatan, agensi

kerajaan mahupun swasta untuk berkongsi maklumat melalui idea-idea yang dicetuskan berkaitan nilai ekonomi sesuatu sumber hutan agar kepentingan hutan dapat dipertingkatkan dari segi nilai ekonominya dalam rangka sumbangannya kepada pendapatan negara.

5. Seperti semua sedia maklum, hutan merupakan khazanah sumber asli negara Malaysia yang amat kaya dengan kepelbagaian biologinya yang amat ternilai. Sumber hutan yang terdiri daripada sumber kayu-kayan dan bukan kayu ini telah sekian lama menjadi penyumbang kepada pembangunan sosioekonomi negara yang mana hasilnya bukanlah semata-mata datang dari sumber kayu-kayan sahaja malah terdapat banyak sumber dan perkhidmatan hutan lain yang telah dan akan dikomersialkan. Sumber hutan yang penting diantaranya termasuklah kayu balak, rotan, buluh, buah-buahan liar, tumbuhan hiasan liar, madu, hidupan liar, tumbuhan herba dan ubatan dan lain-lain. Di samping itu, peranannya dari segi perkhidmatan hutan dan kawalan kestabilan alam sekitar juga tidak dapat dinafikan sumbangannya secara tidak langsung kepada kesejahteraan masyarakat. Peranan ini termasuklah sebagai kawasan habitat semulajadi untuk pelbagai kumpulan haiwan seperti spesies mamalia, reptilia, ikan, burung dan serangga, kawasan tadahan air, stok simpanan karbon, pembekal oksigen yang utama, pemeliharaan tanah dari hakisan, kawasan rekreasi, eko-pelancongan dan sebagainya. Di samping itu, hutan juga merupakan bekalan sumber genetik pelbagai spesies flora dan fauna yang mana boleh di gunakan untuk aktiviti-aktiviti pembaik-biak tumbuhan dan haiwan bagi kepentingan masyarakat tempatan dan luar.

6. Pada masa ini, hanya lebih kurang 20% sahaja sumber hutan yang telah dinilai dari aspek ekonomi. Oleh yang demikian, pelbagai kajian perlu dilaksanakan bagi menilai semula sumber hutan agar hutan kita mempunyai nilai ekonomi secara keseluruhannya. Pada hemat saya, penganjuran Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014 ini amatlah tepat waktu kerana kita pada masa ini sedang berada di penghujung tempoh Rancangan Malaysia Ke-10: 2011-2015 dan akan memasuki tempoh Rancangan Malaysia Ke-11: 2016-2020 yang merupakan laluan masa untuk kita bersama-sama merealisasikan Wawasan 2020. Dalam hal ini, Jabatan Perhutanan Semenanjung Malaysia tidak mahu ketinggalan dengan usaha-usaha Kerajaan Malaysia untuk mengarusperdanakan pencapaian Malaysia mencapai status “Negara Maju Berpendapatan Tinggi” pada tahun 2020.

YB. Datuk Seri, Dato’-Dato’, Datin-Datin, Tuan-tuan dan Puan-puan yang saya hormati sekalian,

7. Pada masa sekarang ini juga, aspek-aspek yang mencakupi kegunaan dan fungsi hutan terus berkembang serta telah dijadikan sebagai salah satu teras penting bagi menyumbang kepada ekonomi negara. Di Malaysia sahaja terdapat lebih daripada 2,000 spesies tumbuhan herba, di mana pasaran industri herba negara pada masa ini bernilai lebih daripada RM7 bilion dan berpotensi untuk berkembang sebanyak 15% setahun mencapai RM29 bilion menjelang tahun 2020. Perkembangan yang memberangsangkan ini berlaku sejajar dengan pelbagai penemuan saintifik khasiat herba sebagai sumber ubatan, makanan tambahan, penjagaan kesihatan dan kecantikan dalam kehidupan di mana tumbuhan herba menjadi bahan asas yang utama. Pada suatu ketika dahulu, tumbuhan ubatan dan herba seumpama ini hanyalah dipelopori masyarakat luar bandar dan digunakan secara tradisional dan tidak dikomersialkan secara meluas. Tetapi, peralihan zaman dan

perkembangan teknologi telah menunjukkan bahawa tumbuhan ubatan dan herba telah pun berjaya menguasai di setiap pelusuk negara dengan terhasilnya pelbagai produk kesihatan, makanan tambahan mahupun produk kecantikan melalui pemprosesan secara moden. Malah setiap satu tumbuhan ubatan dan herba yang dipelopori oleh setiap pengusaha mempunyai nilai yang berbeza mengikut kepentingan, khasiat dan keberkesanannya didalam tujuan tertentu. Sehingga kini, adalah didapati bahawa potensi tumbuhan ubatan dan herba tidak perlu diperkecilkan lagi dimana sumbangannya terhadap penjanaan ekonomi negara diperhatikan sentiasa meningkat dari setahun ke setahun.

8. Dalam konteks ini, saya amatlah penuh berkeyakinan bahawa penganjuran Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014 yang berlangsung selama tiga (3) hari ini dapat membantu mencapai hasrat murni ini dan seterusnya dapat menyampaikan mesej Jabatan Perhutanan Semenanjung Malaysia kepada semua pihak yang mempunyai kepentingan secara langsung atau tidak langsung dengan hutan diberikan peluang seluas-luasnya mengenalpasti nilai-nilai sumber ekonomi baru hutan dan juga mempelopori sumber kekayaan baru tersebut ke pasaran domestik mahupun luar negara. Sejumlah 20 kertas kerja yang merangkumi pelbagai aspek penilaian sumber dan perkhidmatan hutan akan dibentangkan di sepanjang Persidangan kali ini. Tidak ketinggalan juga, saya amatlah berterima kasih serta amat menghargai akan penglibatan aktif Prof. Dr. Mohd Shahwahid bin Hj. Othman, Dekan Fakulti Ekonomi dan Pengurusan Universiti Putra Malaysia (UPM) yang sudi menyampaikan ucaptama yang mana ianya merupakan panduan arah penting dalam hala tuju penganjuran Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014 pada kali ini.

YB. Datuk Seri, Dato'-Dato', Datin-Datin, Tuan-tuan dan Puan-puan yang saya hormati sekalian,

9. Sebelum saya mengundur diri, izinkan saya mengambil kesempatan di sini untuk sekali lagi merakamkan ucapan setinggi-tinggi penghargaan dan ucapan terima kasih JPSM kepada YB. Datuk Seri G. Palanivel, Menteri Sumber Asli dan Alam Sekitar Malaysia di atas kesudian YB. Datuk Seri Menteri menyempurnakan perasmian Persidangan pada kali ini. Saya juga mengucapkan tahniah dan syabas kepada pengerusi dan ahli-ahli Jawatankuasa Penganjur Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014 di atas dedikasi dan komitmen yang telah diberikan dalam merancang dan menjayakan Persidangan Kebangsaan ini. Di kesempatan ini juga, izinkan saya bagi pihak Jabatan Perhutanan Semenanjung Malaysia untuk menyusun sepuluh jari memohon maaf jika terdapat sebarang kekurangan dan kelemahan dalam perjalanan Persidangan ini. Kepada semua peserta dan pembentang kertas kerja, adalah menjadi harapan tinggi saya semoga Persidangan pada kali ini dapat berjalan dengan lancar dan produktif serta dapat mencapai objektif yang disasarkan. Selamat Bersidang!

Sekian, terima kasih.

Wabilahitaufikwalhidayah.

Wassalamualaikum W.B.T.

UCAPAN PERASMIAN

YB. DATUK SERI G. PALANIVEL

MENTERI SUMBER ASLI DAN ALAM SEKITAR MALAYSIA

SEMPENA PERSIDANGAN KEBANGSAAN PENILAIAN EKONOMI SUMBER HUTAN 2014

PADA 4 SEPTEMBER 2014 (KHAMIS) DI HOTEL THE EVERLY PUTRAJAYA

Terima kasih Saudara/ri Pengacara Majlis

YBhg. Datuk Dr. Abdul Rahim bin Haji Nik
Timbalan Ketua Setiausaha II
Kementerian Sumber Asli dan Alam Sekitar Malaysia

YBhg. Dato' Sri Dr. Hj. Abd Rahman bin Hj. Abd. Rahim
Ketua Pengarah
Jabatan Perhutanan Semenanjung Malaysia

Ketua-ketua Jabatan dan Agensi di bawah NRE.

Dif-dif Jemputan, Dato'-Dato', Tuan-tuan dan Puan-puan yang saya hormati sekalian.

Selamat Sejahtera,

Salam 1Malaysia, dan

Salam 1NRE,

1. Terlebih dahulu saya ingin merakamkan ucapan terima kasih kepada Jabatan Perhutanan Semenanjung Malaysia (JPSM) serta Jawatankuasa Penganjur **'Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan'** kerana sudi menjemput saya untuk menyampaikan ucapan dan seterusnya merasmikan persidangan pada pagi ini.

2. Saya juga mengucapkan selamat datang dan terima kasih kepada YBhg. Dato'-Dato', tuan-tuan dan puan-puan atas kehadiran semua ke Persidangan ini. Saya percaya banyak pengetahuan yang dapat dikongsi bersama sepanjang tiga (3) hari persidangan ini berlangsung.

Dato' Seri-Dato' Seri, Dato'-Dato', Tuan-tuan dan Puan-puan yang saya hormati sekalian,

3. Malaysia amat bertuah kerana dianugerahi kawasan hutan hujan tropika yang kaya dengan kepelbagaian biologi hutan dan merupakan salah satu ekosistem hutan yang sangat kompleks di dunia. Hutan tropika ini sekian lama menyumbang secara signifikan kepada pembangunan sosioekonomi negara. Pada tahun 2013, sektor perhutanan telah menyumbang sebanyak RM8.5 billion atau 0.9% daripada jumlah Keluaran Dalam Negara Kasar Malaysia sebanyak RM984.45 billion. Jumlah pendapatan eksport produk kayu-kayan

Malaysia telah berkurangan sebanyak 2.9% kepada RM19.33 billion berbanding tahun 2012 (RM19.9 billion). Ianya merupakan 2.7% dari jumlah hasil eksport kasar iaitu f.o.b. RM719.82 billion.

4. Selain hutan untuk menjana sumber kekayaan negara, hutan juga diiktiraf sebagai gedung simpanan sumber genetik flora dan fauna. Sebagai salah satu dari 12 negara mega kepelbagaian dunia, hutan di Malaysia menjadi perumah kepada sekurang-kurangnya 14,500 spesies tumbuhan berbunga dan pokok, 600 spesies unggas, 286 spesies mamalia, 140 spesies ular dan 80 spesies cicak. Memandangkan negara kita mempunyai khazanah kepelbagaian biologi flora dan fauna antara terkaya di dunia, sudah semestinya ia boleh menjana kekayaan dalam konteks pengeluaran barangan dan perkhidmatan untuk dimanfaatkan oleh generasi hari ini dan akan datang.

5. Justeru itu, tema Persidangan kali ini iaitu **"Penjanaan Kekayaan Baru Barangan dan Perkhidmatan Hutan Ke Arah Negara Maju Berpendapatan Tinggi"** amatlah bertepatan dan relevan pada masa kini.

Dato' Seri-Dato' Seri, Dato'-Dato', Tuan-tuan dan Puan-puan yang saya hormati sekalian,

Hutan tropika kita yang kaya ini perlu dimanfaatkan untuk menjana pertumbuhan ekonomi dan membangunkan sosioekonomi rakyatnya. Perhutanan pada masa kini bukan lagi berasaskan pengeluaran kayu-kayan semata-mata, tetapi telah merangkumi segala aspek samada barangan atau perkhidmatan. Tanggapan sesetengah pihak sebelum ini bahawa perhutanan adalah berkaitan dengan pengusahasilan kayu kayan semata-mata adalah tidak wajar kerana manfaat dari hutan adalah menjangkaui lebih daripada itu. Cabaran kita pada masa kini adalah untuk mengoptimumkan nilai tambah hutan dari pengeluaran hasil secara *single-product* dikembangkan kepada pengeluaran hasil hutan secara *multi-product.*

6. Hutan-hutan di negara ini perlu diurus secara mampan bagi memastikan kawasan hutan dapat terus dikekalkan dan diwarisi untuk generasi yang akan datang. Banyak lagi bidang dalam sektor perhutanan yang boleh diterokai untuk menjana kekayaan negara. Sebagai contoh sektor pelancongan berasaskan hutan asli masih belum dieksploitasi sepenuhnya. Konsep pelancongan berasaskan alam sekitar atau eko-pelancongan wajar diketengahkan. Usaha-usaha memajukan kawasan hutan sebagai destinasi pelancongan melalui Hutan Lipur dan Taman Negeri perlu dipergiatkan lagi untuk menarik kedatangan pelancong dari dalam dan luar negara.

7. Telah tiba masanya kita mengenakan bayaran yang berpatutan, contohnya kadar yang nominal RM120 seorang untuk masuk ke Hutan Lipur dan Taman Negeri. Nilai ini bukanlah tinggi jika dibandingkan dengan bayaran masuk ke Taman Tema yang menyediakan perkhidmatan air kitar semula. Untuk itu, kita juga perlu kreatif dalam menyediakan bidang baru di Hutan-hutan Lipur dan Taman Negeri. Kita perlu mensasarkan matlamat untuk menyediakan perkhidmatan yang akan menarik pelancong-pelancong untuk mendapatkan perkhidmatan alam semulajadi yang eksklusif dan bernilai tinggi. Saya yakin, kita mampu menerajui dalam menyediakan pengembaraan eko-pelancongan yang lestari dan mempunyai permintaan yang amat tinggi di kalangan negara maju.

Dato’ Seri-Dato’ Seri, Dato’-Dato’, Tuan-tuan dan Puan-puan yang saya hormati sekalian,

8. Hutan kita juga berpotensi untuk menjadi pembekal utama produk herba daripada kepelbagaian biologi negara yang bernilai berbillion ringgit. Industri herba wajar diterokai dan dibangunkan melalui pendekatan saintifik yang mampu menghasilkan produk komersial serta bakal menjana pendapatan negara. Pembangunan bioteknologi daripada kepelbagaian biologi negara boleh menghasilkan produk-produk yang bernilai komersial seperti farmaseutikal, antibiotik, vaksin dan florikultur. Ini akan memperkasa kualiti produk yang dikeluarkan dari sumber hutan dalam usaha menembusi pasaran global. Justeru itu, penyelidikan dan pembangunan (R&D) yang menyeluruh dalam aspek pengeluaran dan pembangunan produk yang selamat serta berkualiti perlu diberi penekanan. Sementara itu pengetahuan tradisional mengenai kepelbagaian biologi hutan juga perlu dipatenkan bagi manfaat ekonomi negara.

9. Pada masa kini bumi kita juga sedang menghadapi kesan yang membimbangkan. Ini termasuk peningkatan penduduk dunia yang drastik, penambahan bilangan bandar mega (mega city) yang tidak terkawal serta laporan *Intergovernmental Panel on Climate Change*, Bangsa-bangsa Bersatu (IPCC PBB), yang mana purata suhu dunia dijangka akan meningkat pada penghujung abad ke-21. Perdana Menteri dalam Persidangan Perubahan Iklim Bangsa-bangsa Bersatu di Copenhagen pada 2009 (COP15), telah menyatakan komitmen untuk mengurangkan 40% intensiti karbon menjelang tahun 2020, bagi menyumbang kepada usaha menstabilkan suhu dunia. Dalam hubungan itu, kita perlu mengambil masalah ini sebagai satu peluang untuk menjanakan pendapatan melalui perdagangan karbon memandangkan hutan berperanan sebagai tabung / tadahan yang berupaya untuk menyerap karbon dan mengurangkan impak perubahan iklim.

10. Kita di Malaysia mempunyai hutan yang agak luas jika dibandingkan dengan kebanyakan negara-negara maju. Kawasan hutan ini telah mewujudkan stok simpanan karbon yang boleh menjadikan sumber pendapatan negara sekiranya dapat dipasarkan di peringkat antarabangsa bagi tujuan pemeliharaan iklim global. Justeru itu, usaha-usaha perlu dipertingkatkan supaya sumber hutan negara dapat dipasarkan melalui perdagangan karbon.

11. Selain itu, mekanisme kutipan hasil yang dijanakan melalui perkhidmatan hutan perlu juga diberi penekanan. Ini dapat meningkatkan sumber kewangan untuk menampung kos melaksanakan program pemeliharaan dan pemuliharaan hutan ke arah mencapai matlamat pengurusan hutan secara berkekalan dan menambah kawasan litupan pokok. Kajian juga perlu dilakukan bagi melaksanakan mekanisme yang sesuai untuk pembayaran Perkhidmatan Ekosistem (*Payment for Ecosystem Services*), instrumen bayaran awam dan insentif pengurangan pengeluaran karbon.

Dato’ Seri-Dato’ Seri, Dato’-Dato’, Tuan-tuan dan Puan-puan yang saya hormati sekalian,

12. Saya berharap agar Jabatan Perhutanan akan terus berusaha melaksanakan tugas dan tanggungjawab mereka dengan lebih cekap dan berkesan dalam mengurus Hutan Simpanan Kekal di negara ini berteraskan kepada prinsip Pengurusan Hutan Secara

Berkekalan. Kementerian akan terus menyokong usaha yang sedang dan akan diterajui oleh Jabatan Perhutanan dalam meneroka serta menjana sumber ekonomi hasil bukan kayu di negara ini. Kebergantungan terhadap hasil kayu-kayan semata-mata seharusnya dikembangkan kepada lain-lain sumber hutan samada barangan atau perkhidmatan untuk dimanfaatkan secara berterusan oleh generasi masa kini dan akan datang.

13. Saya juga amat mengalu-alukan penubuhan Pusat Penilaian dan Perakaunan Sumber Hutan oleh Jabatan Perhutanan Semenanjung Malaysia yang bertujuan untuk memberi perkhidmatan bagi menilai khazanah hutan kita dengan menggunakan maklumat terkini menepati masa dan boleh dicapai. Adalah diharap Pusat Penilaian dan Perakaunan Sumber Hutan ini akan menjadi pusat khidmat nasihat, latihan perkhidmatan yang terunggul dalam bidang penilaian dan perakaunan sumber hutan tropika.

14. Sebelum saya mengundur diri, besarlah harapan saya agar persidangan kali ini mencapai matlamat dan objektifnya. Kehadiran pakar-pakar dalam bidang ekonomi serta pengurusan hutan pada hari ini diharap akan dapat mencapai satu resolusi yang bernas dan bermanfaat pada penghujung persidangan ini. Saya juga berharap pihak penganjur akan terus mengadakan sesi pencambahan fikiran di peringkat kebangsaan secara berkala untuk mengkaji nilai ekonomi sumber kayu dan bukan kayu pada masa hadapan.

15. Akhir sekali, saya ingin merakamkan setinggi-tinggi ucapan terima kasih kepada pihak penganjur Persidangan di atas jemputan pada pagi ini. Dengan ini, saya dengan sukacitanya merasmikan, Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan tahun 2014.

Sekian, terima kasih.

UCAPTAMA

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SEMPENA PERSIDANGAN KEBANGSAAN PENILAIAN EKONOMI SUMBER HUTAN 2014

PADA 4 SEPTEMBER 2014 (KHAMIS) DI HOTEL THE EVERLY PUTRAJAYA

VALUING AND CAPTURING ENVIRONMENTAL GOODS & SERVICES FROM SUSTAINABLE FOREST MANAGEMENT

Prof. Dr. Mohd Shahwahid bin Haji Othman

ABSTRACT

The Millenium Development Goals (MDG) followed by Rio+20 Sustainable Development Goals (SDG) have the mission to work with Governments, civil society and other partners to shape an ambitious sustainable development framework to meet the needs of protecting the environment. The State Governments have been able to manage the forest resources for timber production and to capture sufficient rent. The challenge is the management of the environmental services from forest while at the same time capturing the due rent for the benefit of society. This would necessitate embarking on the valuation of the stocks and flows of these services and where possible enacting appropriate economic instruments to capture them. Forest values have to be mainstreamed into decision-making by Government, industry and members of society. Towards this end, setting a centre tasked at valuing the stocks and flows of goods and services from forests would go a long way at establishing the Forestry Department Peninsular Malaysia as centre of excellence for forest auditing and valuation as well as feeder of information in decision-making concerning forest resources. The Forestry Departments could not act alone but need the support from all levels of society. A strategy of greater inclusivity would help in attaining sustainable forest management.

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1.0 INTRODUCTION

The United Nations Conference on Sustainable Development (RIO+20) was held in Rio from June 20 – 22, 2012. The RIO+20 adopted an outcome document, "*The future we want"* mandating:

- To develop a set of SDGs for integration into the UN development agenda post 2015; and
- "The UN is working with governments, civil society and other partners to shape an ambitious sustainable development framework to meet the needs of both people and planet, providing economic transformation and opportunity to lift people out of poverty, advancing social justice and protecting the environment."

These SDGs strive and reaffirm:

- For a just, equitable with inclusive economic growth, social development and environmental protection;
- The principles of common but differentiated responsibilities; and
- Poverty eradication, changing unsustainable and promoting sustainable patterns of consumption and production and protecting and managing the natural resource base of economic and social development are the overarching objectives and requirements for SD.

Sustainable development implies that development decisions must integrate economic, social and environmental principles. In response to these calls, the forestry sector in Peninsular Malaysia has already contributed towards Malaysia's development & income. The Forestry Department Peninsular Malaysia (FDPM) contributed various sources of Government revenues (Table 1). FDPM has implemented various development projects including on tree plantings, involving RM15.79 million under the 10th Malaysia Plan.

Table 1: Contribution of government revenues to the Malaysian economy

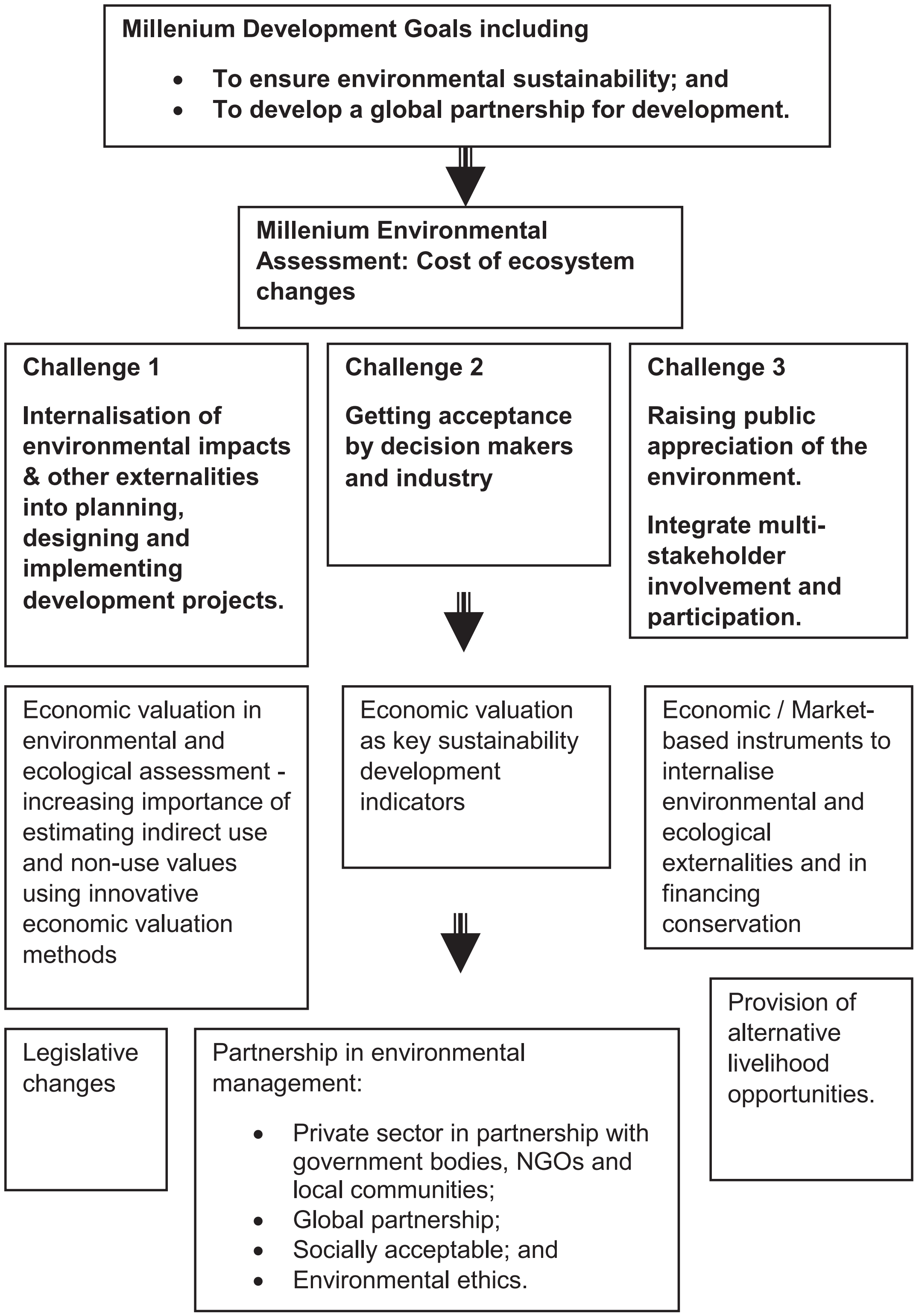
Source	Revenues (RM Million)
Royalty	107.6
Cess	42.1
Premium	166.3
Others	17.5
Total	**333.7**

Source: FDPM (2014)

The FDPM and State governments have succeeded at capturing the revenues from commodity resources such as timber. In the 1970s and 80s there were claims of rent capture failure in the logging licensing allocation system in Peninsular Malaysia (Sulaiman, 1977; Gillis, 1988a; Vincent, 1990; Awang Noor et al., 1992; and Vincent et al., 1993). Rent capture was as low as 12.1% in Peninsular Malaysia (Vincent, 1990). Through the tender system supported by determination of reservation prices valued using the residual method has assured of greater rent capture (Mohd Shahwahid and Awang Nor, 1998).

2.0 CHALLENGES TO THE FORESTRY SECTOR

The challenges to the Forestry Sector are many and the key in ensuring its success is the maintenance of a healthy environment. The environment is a key determinant of growth and poverty reduction. Environmental issues, including those that have long-term global impacts need to be integrated into mainstream planning processes particularly those which affect development objectives (Mohd Shahwahid, 2008). As Malaysia prods its way towards a developed nation, it has to embrace the above principles. The MDG and SDG stipulated the need to 'ensure environmental sustainability' and to 'develop a global partnership for development' with the target of integrating the principles of sustainable development into government policies and programs and of reversing the loss of environmental resources. The nation has to place the environment high in its development agenda. It has to have the will to internalise environmental impacts into planning, designing and implementing of economic development projects. This would include incorporating environmental costs into pricing mechanisms for more accountable decision-making. The environmental impacts from development projects have to be valued and their quantum should serve as one of several key indicators used to help protect and manage unique and important environmental and natural resources. The management of protected areas may see increased private sector and community participation in a socially inclusive and highly ethical manner, in partnership with government bodies, NGOs and local communities (Mohd Shahwahid, 2014). Market-based instruments (MBIs) or economic instruments (EIs) have to be increasingly used to assist in environmental and natural resource management and in financing their conservation and protection. This concept is depicted in Figure 1.



Source: Mohd Shahwahid 2008

Figure 1: Mechanism for incorporating sustainability in national development

For the above principles to be implemented several conditions have to be in place. Sustainable use of the environment and its functional attributes would have to be better understood, articulated and incorporated in decision-making. Greater efforts needed on valuing and capturing benefits from environmental goods and services from the forests. Information on environmental goods and services from the forests has to be mainstreamed and disseminated to society. Strategies and actions to fulfill SDG can be approached at various levels of Governance and Stakeholders. Greater inclusivity involving society namely the private and local community are required.

Environmental services from forests are still not well captured. Currently, there are more success in valuing and capturing ecotourism services, and watershed functions in regulating water resources. There have been attempts at capturing Carbon Footprints of Air Travel for Peat Swamp Forest Conservation (Malaysia Airlines, 2011).

Empowering Resource Management to Local Community as a Strategy of Sustainable Development

An approach of resource management empowerment is encouraging greater effective community-based resource management that can fulfil:

- Natural Resource and Environmental Conservation;
- Economic growth that is equitable, and inclusive;
- Continuous sustained financing of employment opportunities through the offering of services; and
- Responsible governance.

A case example is what happens to the community of Batu Putih, Sandakan, Sabah (Figure 2). The Forestry Department of Sabah (FDS) signed a memorandum of understanding (MOU) with Kopersasi Pelancungan of Batu Putih (KOPEL) empowering the local community to be:

- The caretaker of the Supu Forest Reserve with a RM1.3 million budget allocated by FDS for a three year silviculture and reforestation project;
- Construction of the Tungog Rainforest Eco Camp (TREC) and Ecotourism accommodation;
- The undertaking of the Wetland Lake Rehabilitation project to remove the invasive water weed species, *Salvinia molesta,* which was endangering the freshwater aquatic ecosystems throughout the Kinabatangan; and
- The opportunity to offer unique eco-tourism, culture & homestay to incoming tourists.

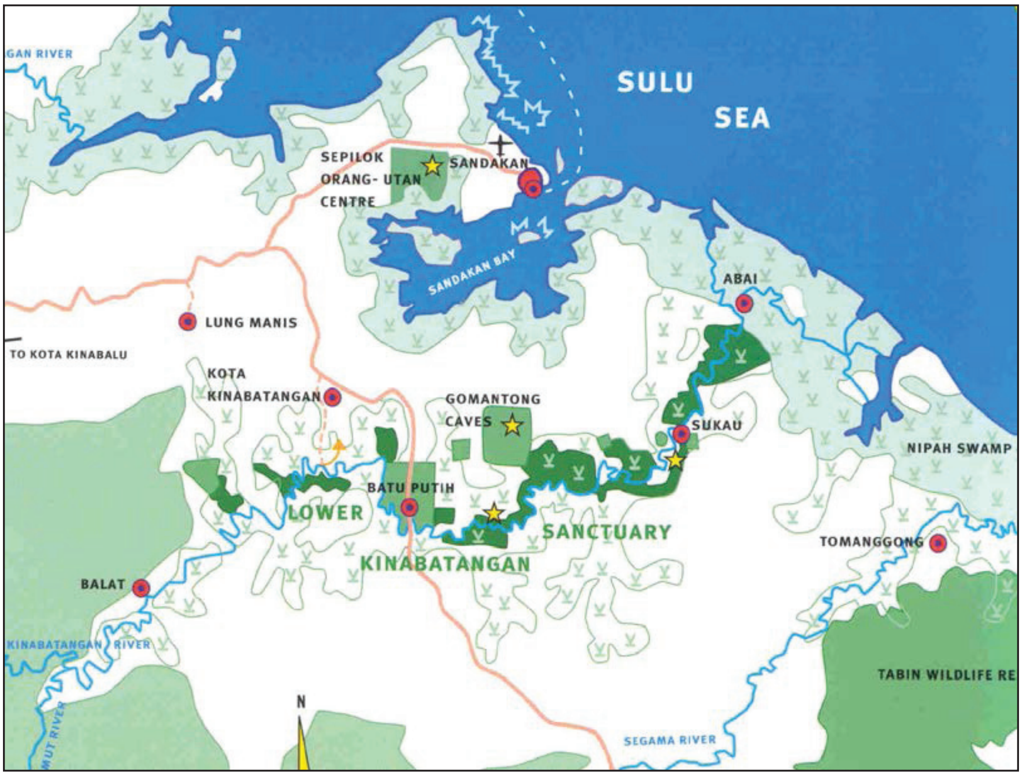


Figure 2: Location of Batu Putih along the Kinabatangan River

In 2002, FDS gave permission and funded RM900,000 for the construction of an ecolodge (TREC) by local community with the aid of tourist volunteers in Pin Supu Forest Reserve. It took five years to complete the ecolodge because KOPEL decided to build using its members' workforce with the help of volunteers coming from international tourists. The endeavour fostered a strong sense of pride and ownership among the local community and the international volunteers that attracted further revisits.

KOPEL was able to contribute towards sustainable forest management as the trustee to conserve the forest reserves of Pin Supu while at the same time maintain commitment among its members to the cooperative. KOPEL offers employment opportunities for its members in the forest and lake rehabilitation activities and in the construction of TREC. TREC has attracted rising interests from tourists, both international and domestic to have the experience in lodging inside the rainforest. KOPEL provides a lodging package with a requirement of staying at both TREC and homestay in members' homes. In this manner members automatically gain from the increased arrivals of tourists.

The inclusivity of local community with sustainable forest management illustrated in Sabah above is an eye opener indicating that we already have good examples in place within the country that other states can follow.

Figure 3: Tungog Ecolodge located by the lake that has been restored from the invasive water weed

Figure 4: A chalet at TREC

Forest Rehabilitation Initiatives via Mas Voluntary Carbon Offset Scheme (VCOS)

MAS approached the Ministry of Natural Resources and Environment (NRE) to explore a collaboration whereby funds collected from such a voluntary carbon offset scheme could be channelled into a trust fund. The trust fund would be used for activities that either sequester or reduce carbon emissions in a measurable, reportable, and verifiable manner.

The intention is for the scheme to be voluntary so as not to affect the competitiveness of the airlines vis-a-vis their competitors. The scheme gives travelers the opportunity to reduce their carbon footprint. This is an entirely voluntary scheme; passengers wishing to participate are invited to either use cash to offset the carbon dioxide emissions of their flight or to make a one time contribution. MAS provide in its web-site a Carbon Offset calculator to enable travelers to make a one-off contribution (Figure 5). Proceeds will help fund selected programs sanctioned by the United Nations to protect the rainforests in Malaysia. These rainforests serve as natural carbon sinks that reduce greenhouse gases and curb the onset of climate change.

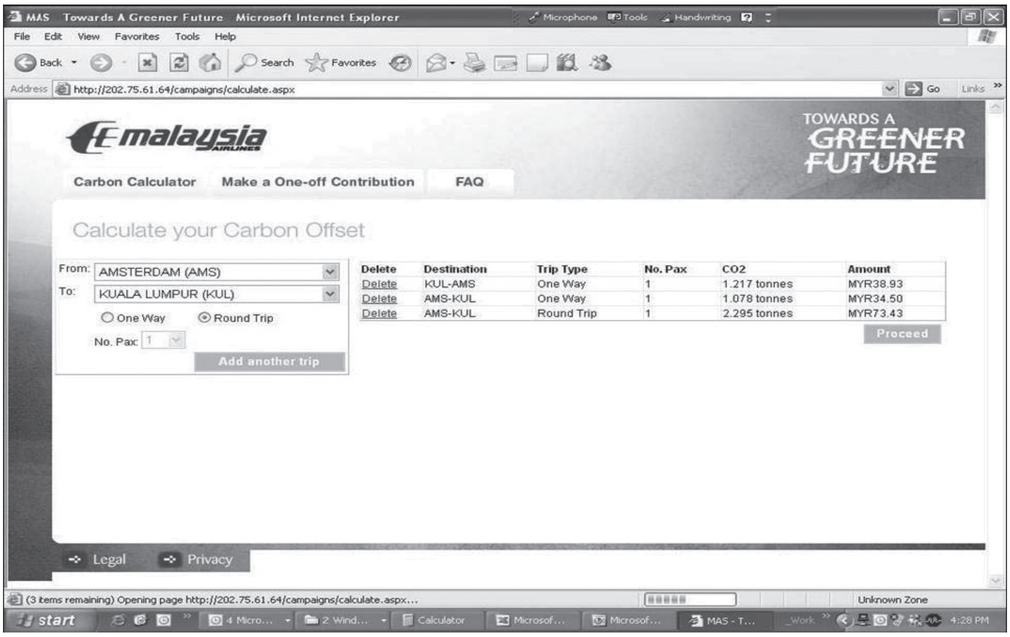
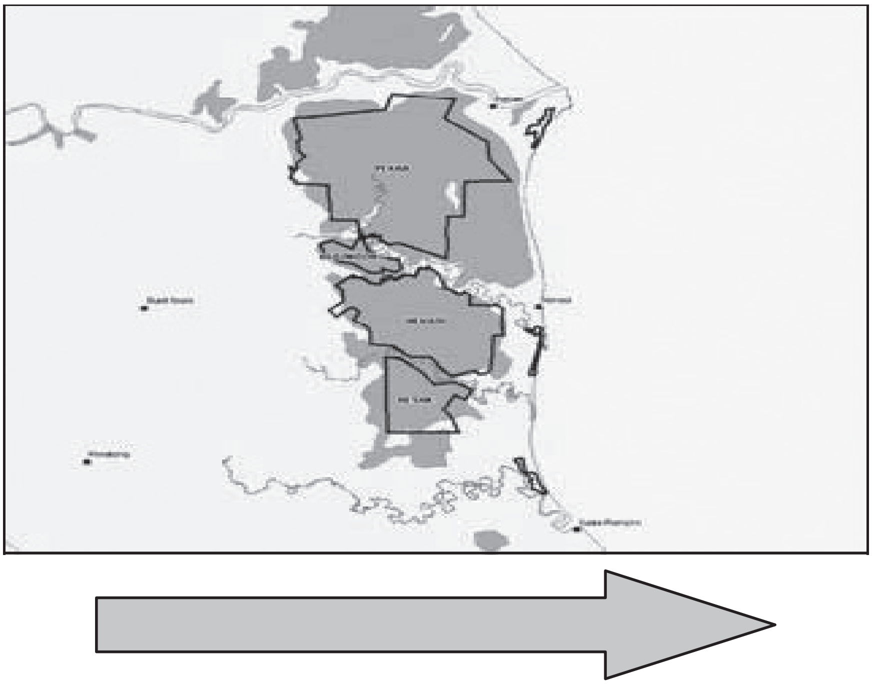


Figure 5: Carbon offset calculator adopted by MAS



South-East Pahang (87,045 ha)

Figure 6: Proceeds will help fund selected programs such as rehabilitating the peat swamp forest at Pekan

Potentials Exist for Capturing Other Environmental Services

The Perak State Government with the help of the State Forestry Department is working towards capturing a portion of the rent from the use of stored water to turn turbines in mini-hydro electric generation in the state. The role of Forestry Departments in setting forest reserves for watershed functions are beginning to be acknowledged financially. Other states may also be finding other opportunities at capturing the values of goods and services from forests.

Innovative programmes to capture the value of environmental services provided by natural forests have to create. However, several issues have to be resolved such as:

- How to finance the programme? Is it by government or private channels? Who is going to pay?;
- How to avoid leakages of the fund?;
- How to make it simple enough to be implemented in developing countries where social and political issues are often very complex? How to make it fair for forest dwellers and other stakeholders?; and
- How to make it competitive compared to utilising the forest land for other land uses which can be much more profitable?

The answers to the above sets of questions would go a long way towards capturing the values of these environmental services provided by the natural forests.

But central to the above initiative, is the need for obtaining appropriate values of the services being provided by the forests. The creation of a pool of economic values of environmental services would be necessary. The Forestry Department could provide leadership by directly or indirectly supporting the valuation of goods and services of the forests. Indirectly the department could fund more research activities on forest valuation to be undertaken by researchers. Directly, the department could act in-house by setting a centre tasked at valuing the stocks and flows of goods and services from forests. This would go a long way at establishing the Forestry Department Peninsular Malaysia as centre of excellence of forest auditing and valuation as feeder of information in decision-making concerning forest resources.

Pre Requisites for Incorporation of EV into Decision-making by Government, Industry and Society

Another challenge befacing the forestry sector is on the ability to incorporate economic valuation into decision-making involving forest land by either the government, industry or the society at large. Efforts have to be taken to overcome the following matters:

- Overcome the failure of current market forces that ignore social and environmental impact especially “externalities”;
- Value the non-marketed environmental and social impacts, using economic valuation techniques, and incorporating them within economic CBA (Pearce and Barbier, 2000);
- Make Valuation a routine part of investment planning and appraisal, policy analysis and land use decision-making;
- Wider involvement of State and local governments, private sector and the public in environmental protection and management; and
- Greater implementation of policy instruments is needed.

Challenges to Incorporating Economic Valuation and Policy Instruments in Decision-making

The challenge for mainstreaming economic valuation in land use decision-making is to assess the economic values of the change in individual forest environmental and ecosystem functions cause by development, and to introduce policy instruments to internalise these impacts caused by developers and to make them accountable.

A further setback is that economic valuation is devoid of judicial sanction. There is no clear mandate for government agencies:

- To demand a valuation of the external impacts from a proposed projects and to conduct an economic cost benefit analysis whereby the value of the externalities are incorporated in the cash flow analysis prior to project approval. In this manner, a wider welfare criterion in development project appraisal is adopted; and
- To impose a developer to internalise the damage of its project upon members of society by establishing mitigation measures and incorporating good environmental practices in its project implementations or to compensate the aggrieved parties.

An exception exists in that if a project falls under a 'prescribed activity' as stipulated in the Environmental Quality Act (EQA), then either an Environmental Impact Assessment (EIA) or a Detailed Environmental Impact Assessment (DEIA) is required. In the latter, an economic valuation of significant environmental impacts is required.

To meet the above challenges requires proper policy environment, legal and planning mechanisms, as well as, buy-in by all levels of society, agencies and institutions, and the private sector in adopting tools for valuing the environment and in implementing the policy instruments. The case study on Batu Putih above suggests that the economic values of the environmental and ecological functions are real and not merely intangibles. Society does suffer a loss from a degradation of these functions or do obtain a gain from any improvement. Various members of society need to raise their awareness of the functions of the environment and to take appropriate actions towards conservation. Governments, industry, non-governmental organizations (NGOs) and local communities have to play a crucial role in replacing unsustainable development patterns with environmentally sound and sustainable one through genuine social partnership.

3.0 CONCLUSION

Sustainable development implies that development decisions must integrate economic, social and environmental principles. The forestry sector in Peninsular Malaysia has already contributed towards Malaysia's development and income. The challenge is the management of the environmental services from forest, while at the same time capturing the due rent for the benefit of society. The case examples of local community empowerment in forest resource management at Batu Putih and MAS voluntary Carbon Offset project were provided. Forest values have to be mainstreamed into decision-making by Government, industry and members of society.

To move forward necessitates embarking on a comprehensive valuation of the stocks and flows of the environmental goods and services and where possible enacting appropriate economic instruments to capture them. Towards this end, setting a centre tasked at valuing the stocks and flows of goods and services from forests would go a long way at establishing the Forestry Department Peninsular Malaysia as centre of excellence of forest auditing and valuation. The centre could serve as a repository and feeder of information in decision-making concerning forest resources. There is also a need to create and design innovative economic instruments and payment for environmental service mechanisms to raise capacity of capturing the economic rent from the use of forest resources.

The Forestry Departments could not act alone but need the support from all levels of society. A strategy of greater inclusivity would help in attaining sustainable forest management. Collaborative management arrangements among agencies, professional bodies, NGOs and local communities is needed to implement good environmental management practices.

REFERENCES

Amran Hamzah & Nor Haniza Mohamad. (2012). Critical Success Factors of Community Based Ecotourism: Case Study of Miso Walaihomestay, Kinabatangan, Sabah. *The Malaysian Forester 75* (1): 29-42.

Awang Noor Abd. Ghani, J.R. Vincent, & Yusuf H. (1992). *Comparative Economic Analysis of Forest Revenue Systems in Peninsular Malaysia*. Final report submitted to Osborn Center Forestry Policy Grants Program, Washington D.C.

Forestry Department Peninsular Malaysia (2014). *Annual Report 2013*. Ministry of Natural Resources and Environment, Putrajaya.

Gillis, M. (1988). *Malaysia Public Policies, Resource Management and the Tropical Forest*. In Public Policies and the Misuse of Forest Resources, edited by R. Repetto and M. Gillis, 115-153. Cambridge: Cambridge University Press.

Malaysian Airlines. *Malaysia Airlines Launches Passenger Carbon Offset Program and Shows Interest in Using Jet Biofuels*. Retrieved from http://www.greenaironline.com/news.php?viewStory=195

Mohd Ihsan M.S., Mohd Iqbal M.N., Farah M.S. & Mohd Shahwahid H.O. (2011). *Assessing Community Based Nature Resource Management (CBNRM) Practices in Tourism: A Case Study from Penang National Park*. In Zaiton Samdin, Norfaryanti Kamaruddin, Nor Azizah Haron (editors) Page 131-157

Mohd Shahwahid H.O. & Awang Noor A.G. (1998). Economic Rent from Hardwood Timber Extraction in the West Coast of Peninsular Malaysia. *Malaysian Journal of Agricultural Economics (MJAE) Vol 12*:1-15.

Mohd Shahwahid H.O. (2008). *Mainstreaming the Environment: Incorporating Economic Valuation and Market-Based Instruments in Decision-making*. Universiti Putra Malaysia Inaugural Professorial Series. UPM Press. Serdang

Mohd Shahwahid H.O. (2012). *Empowering Local Communities in Forest Ecotourism*. 207-210. In Forest for People. International Year of Forests, 2011. Published by Tudor Rose on behalf of the United Nations Dept of Economic and Social Affairs. House, Leicester. England. ISBN 978-0-9568561-1-

Mohd Shahwahid H.O. (2014). Empowering Resource Management for Sustainable Future. Keynote Paper, *Universiti Malaysia Terengganu Conference on Empowering Resource Management for Sustainable Future*, August 2014. Kuala Trengganu

Mohd Shahwahid H.O. Ihsan M.S., Farah M.S. and Mohd Iqbal M.N. (2012). *Critical Success Factors for an Effective Community-based Eco-tourism Project in Malaysia*. P 55-64. In Zuraina Dato' mansor, Zahira Mohd Ishan, Jo Ann Ho and Wong Foong Yee (eds.). Research Issues in Management and Marketing. McGraw Hill. Kuala Lumpur134 p.

Outcome Document – Open Working Group on Sustainable Development Goals. Retrieved from http://sustainabledevelopment.un.org/focussdgs.html

Vincent, J.R. (1990). Rent Capture and the Feasibility of Tropical Forest Management. *Land Economics 66*(2):212-223.

Vincent, J.R., Wan L.F., Chang Y. T., Nooriha M., & G.W.H. Davison. (1993). *Malaysian National Conservation Sstrategy Towards Sustainable Development. Volume 4: Natural resource Accounting.* Economic Planning Unit, Prime Minister's Department, Kuala Lumpur.

PEMBENTANGAN KERTAS KERJA

Bunga Pakma (*Rafflesia cantleyi*)

SESI PEMBENTANGAN I:

Dasar dan Rangka Kerja Penilaian Ekonomi Sumber Hutan

CONTRIBUTION OF THE FORESTRY SECTOR IN PENINSULAR MALAYSIA TOWARDS MALAYSIA'S HIGH INCOME ECONOMY STATUS

Dato' Sri Dr. Hj. Abd. Rahman bin Hj. Abd. Rahim
Poh Lye Yong

ABSTRACT

Forest is a renewable resource and the nation's most valuable natural asset. It contains valuable biological resources that have significant role in ecological, social, environmental and economic functions. Forest provides a wide array of goods and services, from timber and non-timber forest resources; ecological function as forests harbour biological diversity; to playing an important role in mitigating climate change, protects watershed and their vegetation, controls water flows, soil erosion; and tourism, recreation, pharmaceutical and nutritional products; at the same time providing livelihood to people. Realising the importance of forest as warehouse of biological resources, Peninsular Malaysia continues to place great emphasis on Sustainable Forest Management (SFM). Of the total forested area in 2013, about 4.93 million hectares (ha) or 37.4% of the total land area (13.18 million ha) has been designated as Permanent Reserved Forests (PRFs) and be managed sustainably for the benefit of present and future generations. Forestry has evolved from producing a single product that is timber to multiple products that include services. The wood-based industries also grew from merely producing primary products; such as saw logs, sawn timber and plywood/veneer, to manufacturing high value-added products; such as mouldings, flooring, laminated veneer lumber, furniture, builders' joinery and carpentry. Development occurred not only in the wood-based industries but also a shift to forest-based industries which used forest produce such as canes, bamboos, medicinal plants and herbs as raw materials. To-date, there's also a shift from producing forest goods to forest services such as ecological functions and biodiversity.This shift from solely sustained yield timber production to multi-functions forestry indicates the Department's commitment to manage the forest in a holistic and balance manner. Forestry is not only the domain of the foresters but also the non-foresters such as the industries, local communities, non-governmental organisations (NGOs) and the public at large involved in decision-making. Forest also creates employment through the various activities derived from forest products and industries, contributes to foreign exchange earnings and regional development. The forestry sector has significantly contributed to the socio-economic development in the country with RM5.56 billion or 0.7% of the country's Gross Domestic Product (GDP) of RM786.70 billion at constant 2005 prices in 2013. The total export of timber and timber products was valued at RM19.33 billion or 2.7% of the total gross export earnings at RM719.82 billion. Malaysia is classified as an upper middle income nation. To achieve World Bank's classification of high income at USD12,746 in GNI per capita by 2020, Malaysia would need to grow at 6.8% annually from 2011-2020 to sustain a per capita income growth of 5.4% annually. The country's high income would be crucially driven by the effective development of human capital, sufficient investment in R&D, balance equitable sharing of forest benefits and effective coordination and implementation of integrated sector-wide policies and strategies. This paper therefore concluded by proposing several future forestry strategies to enhance effective future economic contribution of forestry to community livelihood.

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1.0 BACKGROUND

Malaysia is one of the 12 mega-biodiversity countries in the world that enjoys the highest percentages of forested land among developing countries such as Brazil, Indonesia, Philippines and Thailand (FAO, 2005).The country's tropical forests inhabit 15,000 species of flowering plants, of which only about 2,800 species are tree species. The forest is also the home to about 300 species of mammals, 700 species of birds, 300 species of reptiles, 165 species of amphibians, 300 species of freshwater fish and millions of invertebrates.

Malaysia's forests also provide valuable timber species, a main source of food to local people, a wide variety of materials used in medicine, a source of eco-tourism and recreation opportunities, and helps maintain favourable environmental conditions. In the past, however, the forest has been viewed mainly as a source of timber, which can be converted to other wood products to meet the demand from overseas and domestic markets. Among major wood products are sawn timber, plywood, mouldings, furniture, laminated veneer lumber and medium density fibreboard. Other non-timber forest products (NTFPs) such as rattan, bamboo, medicinal plants and herbs as well as forest services like water, recreation, eco-tourism, wildlife and carbon sequestration, however are not given much emphasis, until recently. As such, the full potential of the biologically diverse tropical forests has never been fully quantified from the economic perspective. Majority of the forest resources, especially its ecological and environmental functions which have no market price are largely ignored in the decision-making process or given low priority when the forest land is to be converted to other land uses. As such, the policy makers tend to put high priority for other land use options compared to that of forest conservation or protection.

The richness of Malaysia's forest thus can be harnessed to generate economic benefits from tourism, recreation, pharmaceutical applications and nutritional products. Although a shift away from reliance on heavy resource consumptive industries for economic growth is essential, Malaysia's natural resource endowment, therefore, can be used in creative and sustainable ways as base to build new, diverse, high value, high tech industries and services.

2.0 AN OVERVIEW OF GROSS NATIONAL INCOME (GNI)

Gross National Income (GNI) is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. In calculating GNI, formerly referred to as Gross National Product (GNP), the World Bank uses the *Atlas* conversion factor instead of simple exchange rates divided by the mid-year population. The purpose of the *Atlas* conversion factor is to reduce the impact of exchange rate fluctuations in the cross-country comparison of national incomes. The *Atlas* conversion factor for any year is the average of a country's exchange rate for that year and its exchange rates for the two preceding years, adjusted for the difference between the rate of inflation in the country and international inflation. The objective of the adjustment is to reduce any changes to the exchange rate caused by inflation.

The World Bank revises analytical classification of the world's economies each year on July 1 based on estimates of per capita for the previous calendar year. The World Bank groups economies of the world into four (4) categories based on 2013 GNI per capita estimates as shown in Table 1. The classification tables include all World Bank members, plus all other economies with populations of more than 30,000.

Table 1: World Bank income classifications, 2014

No.	Cateogries	GNI per capita (USD)
1.	Low income	≤ 1,045
2.	Lower middle income	>1,045 < 5,170
3.	Upper middle income	> 5,170 < 12,746
4.	High income	≥ 12,746

Source: World Bank, 2014

Among the ASEAN countries, Malaysia is classified as an upper middle income with GDP nominal of USD303.53 billion or per capita of USD10, 304 as shown in Table 2. It shares the same income category as Thailand (USD5, 678) but with a higher GDP nominal per capita. To achieve World Bank's classification of high income at USD12,746 in GNI per capita by 2020, Malaysia would need to grow at 6.8% annually from 2011-2020 to sustain a per capita income growth of 5.4% annually.

Table 2: List of ASEAN countries by GDP, 2012

No.	Country	Population (million)		GDP Nominal		Income Category
		(million)	(%)	(million USD)	Per capita (USD)	
1.	Indonesia	244.46	39.6	878,198	3,592	Lower middle
2.	Thailand	64.38	10.5	365,564	5,678	Upper middle
3.	**Malaysia**	**29.46**	**4.8**	**303,527**	**10,304**	**Upper middle**
4.	Singapore	5.41	0.9	276,520	51,162	High
5.	Philippines	95.80	15.6	250,436	2,614	Lower middle
6.	Vietnam	90.39	14.7	138,071	1,528	Lower middle
7.	Myanmar	63.67	10.3	53,140	835	Low
8.	Brunei	0.40	0.1	16,628	41,703	High
9.	Cambodia	15.25	2.5	14,241	934	Low
10.	Laos	6.38	1.0	9,217	1,446	Lower middle
ASEAN		**615.60**	**100.0**	**2,305,542**	**3,745**	

Source: IMF 2012 estimates

Income level does not necessarily reflect development status. Other criteria used to measure a nation's progress include Human Poverty Index (HPI) and the Human Development Index (HDI) developed by the United Nations Development Programme (UNDP). More recently, global development initiatives such as the Millennium Declaration adopted by 189 nations in September 2000 have included environmental sustainability as one of the Millennium Development Goals (MDG 7). One of the targets under this goal includes the integration of the principles of sustainable development into country policies and programs and the reversal of the loss of environmental resources. In this regard, the current forestry sector has its role and contribution to play for the future prosperity of Malaysia's socio-economic development.

3.0 THE CURRENT STATUS ON ROLE AND CONTRIBUTION OF FOREST RESOURCES IN PENINSULAR MALAYSIA

Malaysia is fortunate to be endowed with relatively large tracts of rich and diverse forest. In 2013, 55.0% (18.07 million ha) of the total land area is under forest with 5.83 (32.3%) million hectares in Peninsular Malaysia, 4.43 (24.5%) million hectares in Sabah and 7.81 (43.2%) million hectares in Sarawak. The tree cover increases to 74.2% (24.47 million ha) if perennial crops such as crops such as rubber, oil palm, cocoa and coconut are taken in consideration.

The total forested areas in Peninsular Malaysia stood at 5.83 million hectares or 44.2% of Peninsular Malaysia's total land area of 13.18 million hectares in 2013. Of this total, about 4.93 million hectares or 84.5 % have been gazetted as Permanent Reserved Forests (PRFs) under the National Forestry Act, 1984 to be managed under the sustainable forest management principles practices for economic, social and environmental benefits. Within the PRF, 2.98 (60.3%) million hectares are production forests with the remaining 1.95 (39.7%) million hectares being protection forests. Protection forest is reserved for its many ecological and environmental services such as the maintenance of climate conditions, water resources, soil fertility, biological diversity conservation, flood mitigation, soil erosion and river siltation. Production forest is reserved for timber production and other non-timber forest products such as rattan and bamboo.

In Peninsular Malaysia, under the 30-year cutting cycle of the Selective Management System (SMS), the cutting limits prescribed for the group of dipterocarp species would range from 50-65 cm dbh, while those prescribed for the group of non-dipterocarp species would range from 45-55 cm dbh, with the maximum volume allowed to be harvested being 85 m^3/ha. Concerted efforts are intensified currently to ensure that the forest resources are also conserved and their functions to produce other forest goods and services are sustained and their benefits realised in perpetuity.

Based on the Fourth National Forest Inventory (NFI4) conducted from 2002-2004, the total number of standing trees in the forest of Peninsular Malaysia is 2.34 billion, with 0.22 billion dipterocarp species and 2.12 billion non-dipterocarp species as shown in Table 6. With the supply of high value timber from the natural forests expected to decline over the next few decades, the potential cultivation of high value timber species should continue to be a key thrust in enhancing the contribution of the forestry sector to the country's high income growth strategy. The country's total growing stock could be enhanced considerably through the establishment of high-yield plantation forests. Under NATIP, the Federal Government has developed plans to establish 375,000 ha of forest plantation in the next 15 years (2006-2020) at an annual planting target of 25,000 ha to produce 75 million m^3 of logs.

The Malaysian timber industry is characterised by both upstream and downstream activities. Currently, upstream activities involve the systematic and sustainable harvesting of natural forests and forest plantations. Downstream activities cover primary, secondary and tertiary operations, and finished timber products. In 2008, about 60% of the export value is derived from primary activities which include harvesting of logs, and the processing of sawn timber, plywood, veneer, fibreboard and particleboard. Meanwhile the remaining 40% of the export value is derived from secondary and tertiary activities related to the manufacture and exports of mouldings, flooring, laminated veneer lumber, laminated timber, furniture, builders' joinery and carpentry. This scenario changes in 2013, where the export earnings from primary products decreased to 55.7%, while the percentage share from secondary products increased to 44.3%. The main contributor to the export earnings from secondary products is furniture with RM5.97 billion or 30.8% of the total export of timber and timber-based products as shown in Table 3.

Table 3: Export earnings from timber and timber-based products Malaysia, 2013

Timber Products	Unit	Quantity	FOB value (RM million)	% share of total FOB value
Primary products				
Saw logs	('000 m^3)	3,142.28	1,870.42	9.68
Sawn timber	('000 m^3)	1,963.53	2,516.38	13.02
Fibreboard	('000 m^3)	1,082.91	1,054.75	5.46
Plywood	('000 m^3)	3,399.70	5,323.47	27.54
Total primary products		**9,588.42**	**10,765.02**	**55.70**
Secondary products				
Mouldings	('000 m^3)	227.18	626.30	3.24
BCJ	kg	-	957.19	4.95
Furniture*	unit	-	5,969.90	30.89
Others	-	-	1,010.47	5.22
Total secondary products		**227.18**	**8,563.86**	**44.30**
TOTAL		**9,815.60**	**19,328.88**	**100.00**
Total Export of Commodities and Commodity-Based Products			**114,526.91**	**16.88**

* = includes rattan furniture
Source: DOSM

The timber-based industry in Peninsular Malaysia comprises sawmills, plywood/veneer mills, moulding mills, chipboard mills, medium density fibreboard mills, woodchip mills, laminated board plants, kiln drying plants, wood preservation plants and furniture/ woodworking/ joinery mills. The most significant increase in the number of timber processing mills in Peninsular Malaysia is the furniture mill which is tipped to be the main contributor to export earnings.

These export oriented wooden furniture mills increase from 1,678 in 2010 to 1,829 in 2013, registering an increase of 9.0% and majority utilise Malaysian Rubberwood as raw material. About 80% of the furniture exports are manufactured from Malaysian Rubberwood.

Other than timber, non-timber forest products (NTFP) also play an important role and contribution to Malaysia's economy. These NTFPs include plant-part used (roots, leaves, barks); edible plants (wild vegetables, fruits, mushrooms, nuts); exudates (resins, gums and oleoresins); medicinal and aromatic plants; perfumes and cosmetics (essential oils and incenses); tans and dyes; honey and beeswax; fibre; rattan and bamboo for handicrafts and construction materials; and wildlife products. The value of non-timber forest benefits – many of them non-marketed-may be increasing faster than the prices of wood products. Due to variation in measurement units, the small quantities harvested and the low transaction rates, in NTFP production volumes are not available. Currently, production can only be estimated by examining royalties collected by the States. On average (2004-2013), NTFPs contributed 27.0% of the total royalty collected in Peninsular Malaysia.

The forest-based industries such as pharmaceutical, nutritional, herbal and perfume industries in Peninsular Malaysia obtain their raw material supply from three main sources, namely the natural forest, plantation and import. In general, the dependency of the industries on local medicinal and herbal plants is less as compared with import in terms of total percentage usages. However, some local medicinal plants such as Tongkat ali (*Eurycoma longifolia*), Kacip fatimah (*Labisia pumila*) dan Rancang besi (*Artaboltrys spp*.) are important for some industries, especially the Malay traditional medicine manufacturers.

The herbal and the bird's nest industries are considered as priority industry under the New Economic Model (NEM) and Economic Transformation Programme (ETP). Their production is one of the Entry Point Project (EPP) because of its potential to contribute to the economy. In Malaysia, the local herbal industry had a market value of RM7.97 billion in 2005 and is growing at a rate of 10% per annum (Zainal Azman, 2007). The growth of the herbal industry is affected by changes in household economic condition, lifestyle, emphasis on health and increasing cost of synthetic medicines (Norani *et al*., 2008). Malaysia's herbal trade grew from RM7 billion in 2006 to RM9 billion in 2007 (Bernama, 2008), a rise of 29% within a year. Malaysians export of edible bird's nest (EBN) increased from 108.9 tonne in 2010 to 121.7 tonne in 2011, registering a growth rate of about 12% (Zulnaidah Manan & Mohd Shahwahid H.O., 2012). In 2011, 3,379 edible bird's nest premises were registered under the Department of Veterinary Services (DVS).

4.0 THE FUTURE PROPSPECT OF THE FORESTRY SECTOR IN THE MALAYSIA'S ECONOMY

Forest resources contribute to Gross Domestic Product (GDP) via the marketed benefits of timber and non-timber products. The traditional measure of GDP does not take into account the non-marketed benefits of forestry services such as the influences on local and regional climate, preservation of soil cover, and protection of downstream soils. The net value added in the forestry sector does not reflect the macro sustainability of forest resources use and allocation because it ignores entirely the changes in the stock of natural capital that ensued when forest resources are harvested or converted to other competing uses.

The only costs associated to resource depletion are the extraction costs and the potential loss of forest wealth that have no effect on GDP. While income from forest extraction has contributed markedly to national welfare, there are fears that it might lead to a major resource and environmental problem, especially in the long run.

The forestry sector which includes logging and the wood products contributed RM9.72 billion or 1.2% of the country's GDP of RM786.70 billion at constant 2005 prices in 2013. This contribution declined from 2.3% in 2005 to 1.2% in 2013, registering a decrease of 47.9% as shown in Table 4. Meanwhile, the contribution of the logging sector to GDP declined from 1.5% in 2005 to 0.7% in 2013, a decline of 53.3% as a result of the decline in log production from 22.4 million m^3 to 14.3 million m^3 over the same period.The decline in GDP share however is not due to the contraction of the forestry sector but attributable to the faster pace of expansion in the non-timber manufacturing and service industries.

Table 4: Trends in the contribution of the forestry sector to GDP*, Malaysia, 2005-2013

Year	Forestry and logging		Wood Products	
	GDP (RM million)	% share of GDP	GDP (RM million)	% share of GDP
2005	7,947	1.5	4,344	0.8
2006	7,898	1.4	4,527	0.8
2007	7,926	1.3	4,582	0.8
2008	7,526	1.2	4,029	0.6
2009	7,140	1.1	3,775	0.6
2010	6,923	1.0	4,230	0.6
2011	6,451	0.9	4,021	0.6
2012	6,030	0.8	4,070	0.5
2013	5,555	0.7	4,166	0.5

* = constant 2005 prices
Source: DOSM

In terms of employment, the forestry sector provided employment to 137,443 (31.1%) persons, the second largest employer after oil palm, amongst the six primary commodity sectors which employed 441,704 persons in 2013. The breakdown being 127,399 persons in the logging and timber-based industries, while 10,044 persons in the public sector. Employment provided by this sector recorded a decreasing trend from 195,524 persons in 2004, registering a decrease of 29.7%.

Malaysia's total export of timber and timber products in 2013 was valued at RM19.33 billion. This accounted for 2.7% of the total gross export earnings at RM719.82 billion. The share of timber exports in the country's total exports has declined steadily over the years from 4.1% in 2004 to 2.7% in 2013, largely due to the more rapid growth of the other exports, especially electrical and electronic products.

The contribution of log and sawn timber exports to the country's total exports has declined significantly from 0.5% and 0.7% in 2005 to 0.3% and 0.4% in 2013 respectively. Meanwhile, the contribution of other manufactured wood products including furniture decrease from 2.9% in 2005 to 2.1% in 2013 over the same period.

Starting as a low income country in 1957, Malaysia briskly climbed the ladder to attain upper middle income status in 1992. In the 1970s, the country successfully shifted from dependence on the primary sector and diversified to manufacturing. Exports of manufactured goods were soon fuelling the country's growth. But since becoming an upper middle income country, like many others, Malaysia has largely stayed where it is. Historically, it has been much easier for a low income country to make the transition to middle income status when they made good use of their natural resources or low cost advantage to attract investment. Although Malaysia's income continues to exhibit a gradual upward trend, it remains far below the 'high income' boundary. Based on 2014 data, the World Bank classifies upper middle income countries as those with Gross National Income (GNI) per capita in the range of USD5,170 to USD12,746.

Table 5: GDP by industry origin, 2010-2020

Sectors	RM million (in 2000 prices)			% of GDP			Average annual growth rate (%)	
	2010*	2015	2020	2010	2015	2020	2011-15	2016-20
Agriculture, forestry & fishing	40,172	46,706	53,153	7.5	6.4	5.2	3.1	2.6
Forestry &logging	**15,113**	**19,308**	**24,895**	**2.8**	**2.6**	**2.4**	**5.6**	**5.8**
Minning and quarrying	41,867	44,309	46,165	7.8	6.1	4.6	1.1	1.0
Manufacturing	138,852	181,465	245,140	25.8	24.9	24.2	5.5	6.2
Sawmills	**3,817**	**4,696**	**5,626**	**0.7**	**0.6**	**0.5**	**4.6**	**4.0**
Plywood &other wood products	**874**	**1,337**	**1,971**	**0.2**	**0.2**	**0.2**	**10.6**	**9.5**
Furniture	**3,123**	**4,296**	**6,001**	**0.6**	**0.6**	**0.6**	**5.5**	**7.9**
Paper & board industries	**2,865**	**3,942**	**5,506**	**0.5**	**0.5**	**0.5**	**7.5**	**7.9**
Construction	16,963	20,559	24,019	3.2	2.8	2.4	3.9	3.2
Services	317,010	453,831	682,401	58.9	62.4	67.3	7.4	8.5
GDP at 2000 constant prices	538,069	727,510	682,401	100.0	100.0	100.0	6.1	6.9
Forestry & forest products	**25,793**	**33,578**	**43,999**	**4.7**	**4.8**	**4.5**	**6.0**	**6.1**

* = based on EPU estimates
Sources: MOF, BNM & EPU

In Malaysian context, forestry is lumped together with the agriculture and fishing sector. The contribution of the forestry and forest products sector is projected to decline gradually from 4.7% of GDP in 2010 to 4.5% in 2020. Its growth is forecast to average 6.0% per annum during the 2011-20 period as shown in Table 5. The services sector, the main contributor for the country to achieve high income status needs to sustain a growth of 8% annually. By 2020, the services sector is projected to account for 67.3% share of GDP.

Despite the immense importance of NTFPs, their values and services are rarely taken into account in land-use planning or taken into account in assessing GDP. These omissions need to be corrected, as NTFPs contribute significantly to household incomes of the rural people. The average monthly income derived from gaharu harvesting is RM809 or 62% (M. Mohd Parid & Lim H.F., 2002). Wild ornamental plants collection constituted 88.3%-98.3% of the monthly incomes of the Orang Asli collectors (Zulnaidah Manan & Mohd Shahwahid H.O., 2011).

The average monthly income earned from wild honey collection on a part-time basis ranged from as low as RM100 per month to as high as RM800 per month. For the full-time collectors, wild honey collection generated an average monthly income ranging from RM1,000-RM4,000 per season, usually about three months (Poh & Mohd Shahwahid H.O., 2007).

In terms of Rattan, there are 106 species and six varieties of rattan found in Peninsular Malaysia with 25 species having commercial value. The most important rattans are Rotan manau (*Calamus manan*), Rotan dok (*C. ornatus*), Rotan dahan (*Korthalsia spp.*), Rotan sega (*C. caesius*) and Rotan semambu (*C. scipionum*). The results from NFI4 indicated that Peninsular Malaysia rattan resources stood about 2.31 billion clumps excluding Rotan manau (21.54 million stems) and Rotan manau tikus (14.06 million stems) where the unit of measurement used is stems.

In terms of Bamboo, there are about 50 species in 10 genera but only 13 species of bamboo are being utilised by the industries and local people. Most of these bamboo species are found in disturbed areas such as logged-over forest and along riverine areas fringing the forests. Bamboo can also be found in hill slopes. The main bamboo species found are Buluh semantan (*Gigantochloa scortechenii*), Buluh beti (*Gigantochloa wrayi*), Buluh beting (*Gigantochloa levis*), Buluh betong (*Dendrocalamusasper*), Buluh semeliang (*Schizostachyum grande*), Buluh nipis (*Schizostachyum zollingeri)* and Buluh akar (*Dendrocalamus pendulus)*. Based on NFI4, the bamboo stock in Peninsular Malaysia is 57.79 million clumps as shown in Table 6.

Table 6: Timber and NTF resources according to NFI4, Peninsular Malaysia

Resource	No./ha	Percentage (%)	Total
Trees (no. of trees/ha)	**408.07**	**100.00**	**2,338,246,812.70**
• Dipterocarp	38.98	9.55	223,355,945.70
• Non Dipterocarp	369.09	90.45	2,114,890,867.00
Rattan (no. of stems*/clumps)	**403.92**	**100.00**	**2,314,543,112.60**
• Manau*	3.76*	-	21,540,363.30*
• Manau Tikus*	2.45*	-	14,064,297.70*
• Dok	2.84	0.70	16,294,059.50
• Dahan	8.81	2.18	50,502,981.90
• Sega	3.61	0.89	20,701,581.70
• Semambu	0.79	0.20	4,546,252.90
• Others	387.87	96.00	2,222,498,236.60
Bamboo (no. of clumps)	**10.084**	100.00	57,789,161.89
• Semantan	0.028	0.28	163,009.66
• Beti	0.004	0.04	25,020.35
• Beting	0.159	1.58	911,956.01
• Betong	0.044	0.44	252,186.94
• Semeliang	0.068	0.68	391,850.14
• Dinding	9.781	96.98	56,045,138.79
Medicinal Plants (no. of plants)	**156.06**	**100.00**	**894,164,914.00**
• Tongkat Ali	18.55	11.89	106,290,589.00
• Tongkat Haji Samad	2.18	1.39	12,470,729.00
• Akar Dawai	10.41	6.67	59,654,735.00
• Sedayan	60.72	38.91	347,899,547.00
• Kacip Fatimah	47.50	30.44	272,192,523.00
• Medang Kemangi	5.58	3.57	31,947,603.00
• Ubi Jaga	8.36	5.36	47,907,527.00
• Semambung	2.54	1.63	14,539,230.00
• Sarang Semut	0.22	0.14	1,262,431.00
Palms (no. of clumps)	**372.06**	**100.00**	**2,131,911,566.10**
• Bertam	67.38	18.10	386,068,128.70
• Bayas/Nibung	26.89	7.23	154,079,489.10
• Nipah	0.06	0.02	356,749.80
• Others	277.73	74.65	1,591,407,198.50

* = no. of stems/ha
NTF = Non-Timber Forest
Source: NFI4, 2002-2004, FDPM

In terms of herbs and medicinal plants, more than 7,000 species of angiosperms and 600 species of ferns in Malaysia, about 1,082 species (15%) and 76 species (13%) respectively are reported to have medicinal properties (Kanta Kumari, 1995). The NFI4 results indicated that Tongkat ali (*Eurycoma logifolia*), Kacip fatimah (*Labisia pumila*), Akar dawai (*Smilax myotosilora*), Medang kemangi (*Cinnamomum porretum*) and Sendayan (*Mapania sp.*) are commonly found in all types of forests and also distributed in either poor or superior virgin forests, logged over forests and protected forests (Saharuddin, 2006). Peninsular Malaysia's medicinal plants stok is 0.89 billion plants. Malaysia has one of the highest diversity of palm species with about 40 species of the world’s 2,600. The NFI4 inventories three main palm species namely Bertam, Nipah and Nibung. The total stock of palms is 2.13 billion clumps (Table 6).

The karas tree is distributed throughout Peninsular Malaysia except in the states of Perlis and Kedah. It is confined mainly to plains, hill slopes and ridges up to 750 m in both primary and secondary lowland and hill forests (Whitmore, 1972) and is known to produce gaharu (Burkill, 1966). Its distribution was estimated at 2.5 individuals per hectare (Soehartono, citied in WCMC 1997). Another important NTFP extracted from the forest is Petai (*Parkia spp.*). Based on a study by Woon and Poh (1998), the estimated number of *Parkia* trees in Peninsular Malaysia is 1.46 million trees. Meanwhile, the estimated ornamental plant species found in the forests are 520, namely wild orchids, pitcher plants (Nepenthes), ferns (Staghorns), wild flowers and keladi (Aroid). These wild ornamental plants grow naturally in the forest and have unique shapes and colours.

The forest is also a complex association between communities of living organisms and the non-living parts of their surroundings. Living organisms include plants, animals, fungi, bacteria and other micro-organisms while water, soil and air make up the non-living parts of the ecosystem. The environment and the natural habitat in the forest support all forms of life within them.

Continuous conservation and management of the environment must be made to ensure the continual availability of such life supporting products and services. There are 131 forest recreational areas scattered throughout Peninsular Malaysia. Majority of these areas have special features that attract many local people as well as foreign tourist to visit the site. Demand for forest recreational areas is expected to increase as population grows, urbanisation, high level of income and education. The total number of visitors to these areas increased from 1.83 million visitors in 2004 to 5.31 million visitors in 2013.

Table 7: Economic value of timber resources and NTFPs

Resource/Products	Value (RM)
Timber (ha)	
• Hill dipterocarp forest	4,200.00 - 27,000.00
• Wetlands {Mangrove & Peat swamps}	187.00 - 9,086.00
• Plantation	3,378.00
Bamboo (ha)	
• Virgin forest	23,175.00
• Logged-over forest	155,099.00
• Bamboo sticks	471.39
• Rattan (ha)	942.52
• Petai (ha)	77.20
• Keranji (ha)	373.26
• Medicinal Plants (ha)	40.21
• Gaharu (*Aquilaria malaccensis*) (ha)	19.00
• Cinnamomum bark (*Cinnamomum mollissimum*) (ha)	4.50
• Wild honey bees (hive)	24.90
Fauna	
• Milky stok (bird)	246,000.00
• Spotted dove (bird)	10.00
• Long-tailed macaque (animal)	1,650.00
• Elephant (animal)	244,000.00
Recreation (trip)	
• Sport Fishing in Sg Karang Peat Swamp Forest	15.90
• Ecotourism services offered by NECC	30.80
• Recreational angling along the Pahang River	83.20
• River cruise at the Kg. Kuantan Fireflies Park	62.00 - 120.00
Carbon stock (ha)	
• HS Piah, Kuala Kangsar, Perak	9,175.72
• Matang Mangrove Forest, Perak	12,485.66

NECC = National Elephant Conservation Centre, Kuala Gandah, Pahang
Source: Various studies conducted in Peninsular Malaysia

Water catchments are defined as areas which contain river basins originating from rainfall and have a natural topographical border. These areas need to be protected and conserved to ensure that water yields in terms of both quantity and quality are sustained. The total water catchment area in Peninsular Malaysia's PRF for 2013 is 723,459 hectares. Forest ecosystems are the most important providers of carbon sequestration services. Through photosynthesis, trees and plants absorb CO_2 and release oxygen. The multi-storey forest vegetation also serve as a natural pollution control agent filtering the air borne and water borne toxic material through the phototropic activities of the vegetation and the entire ecosystem.

The following Table 7 shows the economic value of various timber and non-timber forest resources from studies being conducted by researchers using the different economic valuation methods.

5.0 THE POTENTIAL CONTRIBUTION OF THE FORESTRY SECTOR IN PENINSULAR MALAYSIA TOWARDS MALAYSIA'S HIGH INCOME ECONOMY STATUS

Malaysia aspires to become a developed and high income nation by year 2020. To achieve this, it requires achieving an average GDP growth of 6% per annum during the Tenth Malaysia Plan (2011-2015). This target is expected to be achieved with a comprehensive economic transformation in the various sectors. For the agriculture National Key Economic Area (NKEA) under the 10th Malaysia Plan, the herbal industry is one the 19 entry point projects under the ETP. The government has identified medicinal plants as among the main commodities to make Malaysia a centre for herbal product development in the coming years. Besides the herbal industry, the bird's nest industry is also considered as a priority industry that has potential in contributing towards the country's high income status.

Of late, the global economic importance of forests has shifted to non-timber products, especially in their ecological or biodiversity value and environmental functions. The imminent threat of climate change, the increased frequency and intensity of extreme weather and natural disasters such as heat waves, droughts, typhoons, and floods have triggered alarm on the destructive and irreversible effects of climate change, thereby spotlighting the increasing value of environmental services provided by the forest.

The products and services provided by the forest come in many forms such as:

- Food production;
- Forestry materials;
- Recreation and tourism activities;
- Environmental services;
- Biotechnology products and biodiversity; and
- Minerals and energy.

Food Production

The forest biome has been a natural source of food supply to mankind especially to those living in or around the forest. The range of edible foods extend from animal, reptile, birds, eggs, fishes, shrimps, crabs, frogs and other aqua life, insects, worms, plants, fungi, algae, honey and bird nest.

There are vast opportunities for research on these sources of food so that ultimately new techniques could be introduced to produce such alternative high quality foods on a commercial scale. Cultivation and cross breeding of plants and fungi with the indigenous species found in the forest and the existing food crops and other exotic species could be done within and outside the forest environment to create new sources and enhance food production.

Forestry materials

Promotion on the greater use of forest residues for production of decorative, ornamental and souvenir products by the cottage industry or forest community to complement the tourism industry. Similar effort should also be made on the reuse and recycle of old timber buildings and construction materials. Small decorative or ornamental products of high value which could be crafted from plant parts such as roots, stumps, stems, barks, leaves, fruits and seeds could be promoted as products of community forestry or cottage industry.

The emergence of bio-composite materials that could be substituted for wood raw materials, mixture of bio-materials or natural fibres and resins are new alternatives to manufacturers of timber products as resources from natural forests are declining. These materials have good potential for Malaysian manufacturers, as there is an abundance of such natural fibres from forests and agriculture residues. These include oil palm trunks, coconut trunks, empty fruit brunches (EFB), kenaf and rice husks, than can be used to produce bio-composite materials.

Recreational and Tourism Activities

Scenic location within the forest environment with presence of attractive physical land formation and other special features like river system and water bodies, caves and unique geographical terrain and geological formations together with the dense and diverse vegetation could be developed into sites for recreational and tourism activities. More innovative and high value tourism products such as extreme sports could be introduced with the diverse natural setting as the back drop to further develop tourism up the value chain. Documentary filming of adventure and recreational activities within the nature forest will help to expose the secrets and complexity of the forest biome and create more interest among the local and foreign tourists hence yielding higher earnings for the operators.

Environmental Services

The environment and the natural habitat in the forest support all forms of life within them. Continuous conservation and management of the environment must be made to ensure the continual availability of such life supporting products and services. The proper utilisation of underground water will help to alleviate the pressure of ever-increasing demand of water from the surface sources. The multi-storey forest vegetation also serve as a natural pollution control agent filtering the air borne and water borne toxic material through the phototropic activities of the vegetation and the entire ecosystem.

Biotechnology products and Biodiversity

The genetic pool and germplasm could be established to cater for the future development of the plant and animal world. With more break-through in biotechnology, more chemicals, drugs and pharmaceutical products would be obtained from the forest biodiversity. Such products usually are of high economic value.

Mineral and Energy

More research should be done in the area of urban forestry and the greater use of plants and vegetation in buildings and environment to create cooling effects, lower energy consumption and mitigate the effects of climate change. Research to develop renewable energy projects based on the resources available in the forest also to be conducted. Examples of such efforts include the development of hydroelectric power, the production of ethanol from cellulose waste, biodiesel developed from biomass and bio-fuel produced from algae.

6.0 CONCLUSION

As the forest is not only a warehouse for the sustainable production of forest goods but also forest services, forest management practices would therefore need a paradigm shift from the current purely sustained yield timber management to wide range of sustainable forest ecosystem management. There is also a need to expand the spatial scope of forest management from individual forest stands to entire holistic forest ecosystems and forest landscapes. In this endeavour, the conventional system of sustained yield management will also be approached by a new paradigm of multi-resources of forest management.

Multi-resource forest management by definition is the deliberate application or withholding of labour / capital inputs to or from a biophysical forest system for the simultaneous production of several socially desirable outputs. The maintenance of ecosystem, habitats and species diversity is not only for the current and potential economic value of the forest, but also for the undervalued role in maintaining necessary ecological processes such as soil and water regulation. Unfortunately, these benefits are not been fully exploited in the current market economy as researches on environmental and ecological services are still limited. The loss of these functions as a cause of development is passed on to society general or left for future generations to pay. All development plans and policies should inevitably be included with economic valuation that fully reflects the sociological, ecological and environmental costs of resource use, physical developments and pollution, if forestry would desired to contribute towards Malaysia' high income economy status.

The country's high income would be crucially driven by the effective development of human capital, sufficient investment in R&D, balance equitable sharing of forest benefits and effective coordination and implementation of integrated sector-wide policies and strategies. The availability of skilled manpower and development of human-capital are therefore essential for intensifying R&D on technology, products and services derived from the existing vast natural forest resources. Adequate investment in R&D is required for technology development in productivity improvements and research into products and services which could be derived from the biodiversity of the forest through microbial and biotechnology.

Several future forestry strategies to enhance effective future economic contribution of forestry to community livelihood in the country may include the followings:-

- Effective development and implementation of national inventories on forest resources and identification of appropriate inventory methods for NTFPs;
- Intensifying R&D works on technology, products and services derived from the natural forest resources, such as research into alternative food sources from the forests and improvement in food production through cultivation and breeding;
- Availability of sufficient fiscal and attractive financial incentives to encourage the private sector to invest in R&D works, including nursery techniques, tree breeding, plant pathology, soil fertility and genetic engineering, forest conservation and environmental protection;
- Attractive formulation of a system and mechanism for the distribution of benefits and potential returns to the respective stakeholders;
- Effective development and implementation of forest valuation standard for valuing different forest goods and services;
- Integrating the economic value forest resources and development at the policy, planning and management levels for setting the national project priorities;
- Development of one-stop internet-based data centre on economic value of forest resource from different species, ecosystem and geographical regions;
- Creation of interaction and linkages amongst the various government agencies as well as closer co-operation between the public and private sector; and
- Engagement of more multi-disciplinary and cross-sectional professional inputs in the planning and management process.

The adoption of these proposed strategies requires strong commitment and hard work from all interested as well as committed parties and stakeholders between government and private sectors. In this regard, the establishment of the **"Pusat Penilaian dan Perakaunan Sumber Hutan (*Center for Forest Resource Accounting and Valuation*)"** in the Forestry Department Peninsular Malaysia is very timely and important. The proposed organizational structure of this Centre is as shown in Appendix 1. This centre with the various supporting divisions will not only act as the focal point or one-stop centre for information, data, publications related economic valuation of forest goods and services but also accounting, valuation methods as well as identifying, promotion and commercialisation of bio-technology, bio-energy and enhancement of international relations.

REFERENCES

A.R. Rohana, B., Ainu Shuhadah, H.F. Lim & A. Ismariah. (2012). *Herbal Cultivation for Wealth Creation in Peninsular Malaysia*.

Awang Noor Abdul Ghani. (2009). Economic Valuation of Forest Resources: Current Status and the Way Forward. *Paper presented at the Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan, Hotel Best Western Premier Seri Pacific, Kuala Lumpur*, 11-13 November 2009.

Burkill, I.H. (1966). *A Dictionary of the Economic Products of the Malay Peninsular.Vol. 1*. Ministry of Agriculture, Kuala Lumpur.

Chakrabarty, K., Kumar, A. & Menon, V. (1994). *Trade in Agarwood*. TRAFFIC India and WWF-India, New Delhi.

Forestry Department Peninsular Malaysia. (2007). *Laporan Inventori Hutan Nasional Ke Empat Semanjung Malaysia*.

Forestry Department Peninsular Malaysia. (2013). *Forestry Statistics Peninsular Malaysia 2013.*

Ministry of Plantation Industries and Commodities Malaysia. (2009). *National Timber Industry Policy (NATIP) 2009-2020*.

Ministry of Plantation Industries and Commodities Malaysia. (2013). *Statistics on Commodities 2013*.

National Economic Advisory Council. (2010). *New Economic Model for Malaysia*.

Poh Lye Yong & Mohd Shahwahid H.O. (2007). *Economic Value of Honey Bees, Peninsular Malaysia.*

Universiti Kebangsaan Malaysia. (2013). *Facets of Sustainability.*

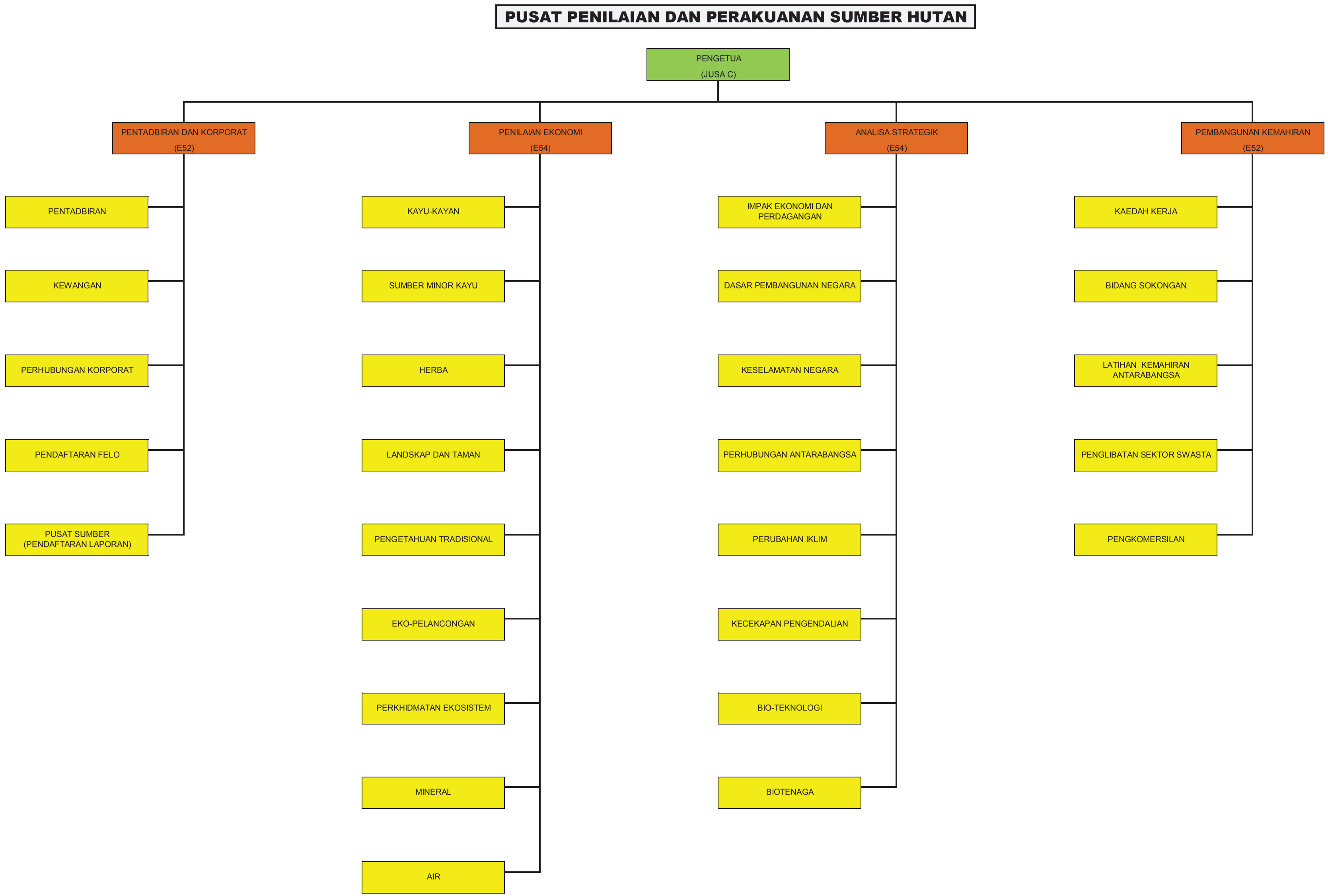
WCMC. (1997). *Conservation and Sustainable Management of Trees Project*. Report on the Third Regional Workshop held at Hanoi, Vietnam. 18-21 August 1997.

Yeah Kim Leng & Tee Choon Hwa. (2009). *The Potential Role, Contribution and Value of Forest Resources to Malaysia's High Income Drive*. Paper presented at the Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan, Hotel Best Western Premier Seri Pacific, Kuala Lumpur, 11-13 November 2009.

Zulnaidah Manan & Mohd Shahwahid H.O. (2012). *Economic Valuation of Ornamental Plants in Peninsular Malaysia.*

Zulnaidah Manan & Mohd Shahwahid H.O. (2012). *An Economic Analysis of Swiftlet Edible Bird's Nest Industry.*

Appendix 1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(E52)
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ANTARABANGSA
PENGLIBATAN SEKTOR SWASTA
PENGKOMERSILAN

ETHNOBOTANICAL AND FOREST VALUATION IMPORTANCE OF MANGROVES FOR CONSERVATION AND POLICY PURPOSES

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ABSTRACT

Mangrove Forests are common and widespread as well as highly threatened ecosystem in Peninsular Malaysia. Local societies about the mangrove ecosystem are endangered. This is an area of research that is represented as a scientific research topic. This study envisages documenting local utilisation pattern and perception of ecosystem change. Through this study, information generated by ethnobiological research can be utilised to strengthen the management policies of the mangrove ecosystem. The proposed study site is in Kampung Sungai Timun, Linggi, Negeri Sembilan that has an established community-mangrove forest relationship. Interviews will be carried out among the local population present in mangrove zones in the study area. The ethnobiological constructs that would be of importance to this study includes timber, non-timber, edible, ethnomedicinal and ecotourism products. The present research gap of ethnobiology that is under represented in existing policy paves way for the development of a comprehensive guideline in conservation and management of the mangrove ecosystem. This will enhance the compatibility and harmony between local people and sustainable resource utilisation. To achieve this, a Total Economic Value (TEV) that addresses a comprehensive ethnobiological framework shall be developed. Appropriate techniques such as CVM, market pricing, hedonic pricing, and replacement costs will be employed upon non-marketable and marketable products respectively. The findings will be able to illustrate how data on ethnobotanical traditions and local people's perceptions can point out contradictions and discrepancies with the current management policy, and can therefore be used to improve the policy.

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1.0 INTRODUCTION

In many developing countries, the utilisation and development of the ecosystem is considered as a vital process to support the transformation of the rural communities from the poverty stricken environment to a higher socio-economic living standard. However, it is also evidenced that many developing countries choose to exploit the ecosystem in order to maximise revenue generating from the ecosystems. Still, the true values of the ecosystems have not been properly identified simply because the benefits of the development of ecosystem resources are not easily quantified explicitly. As the natural resources in the rural setting, like the natural scenery of a village, are not traded in the market place; the benefits from consuming the natural resources cannot be evaluated in the market place, in other words, the natural resources do not get market prices attached to them as values.

Mangrove Forest in Malaysia

It has been proven that mangrove forests provide both ecological and economic benefits and many people depend on the mangrove resources for their livelihood. Yet mangrove forests are being destroyed and resources being over exploited. According to the United Nation Environment Programme report on World's Mangrove Forest, although conservation efforts have slowed down the rates of clearance, however, mangroves are still being cleared at three to four times faster than the rate of other forests (McDermott, 2010).

Mangrove ecosystems occur worldwide on tropical and sub-tropical coastlines (Chapman, 1976; Tomlinson, 1986). For centuries, mangrove ecosystems have provided goods and services both to the community, as well as national and global levels (Dahdouh-Guebas and Koedam, 2001).

Table 1: Mangrove forest area in Malaysia

State	Hectare (ha)	Percentage	Protected Area	Percentage (%)
Johor	25,079	3.9	17,029	68
Kedah	7,949	1.2	7,949	100
Malacca	438	0.1	338	77
Negeri Sembilan	1,267	0.2	540	43
Pahang	11,473	1.8	2,483	22
Penang	451	0.1	451	100
Perak	43,502	6.8	43,502	100
Selangor	15,090	2.4	15,090	100
Terengganu	1,295	0.2	1,295	100
Sabah	367,350	57.2	317,423	86
Sarawak	167,992	26.2	34,992	21
Total	**641,886**		**441,092**	**68.7**

Source: Shukor& Hamid 2004

Mangrove forests have been estimated to have occupied 75% of the tropical coasts worldwide (McGill, 1959; Chapman, 1976), but anthropogenic pressures have reduced the global range of these forests to less than 50% of the original total cover (Spalding et al., 1997).

These losses have largely been attributed to anthropogenic pressures such as over-harvesting for timber and fuel-wood production (Semesi, 1998), reclamation for aquaculture and salt-pond construction (Primavera, 1994), mining, pollution and damming of rivers that alter water salinity levels (Wolanski, 1992). Oil spills have impacted mangroves dramatically in the Caribbean (Ellison and Farnsworth, 1996), but little documentation exists for other parts of the world.

In Malaysia mangrove forests occupy the coastal lowland of the Peninsular with Perak having the largest mangrove forest area. In Sarawak, the mangrove forests cover about 60% of the 740km long coastline mainly along the sheltered shores and estuaries within the major bays of Kuching, Sri Aman and Limbang Division (Sarawak Timber Industry Development Corporation (STIDC, 2008). The state of Sabah has the biggest mangrove forest area covering 367,350 ha. (Table 1). The total mangrove forest area in Malaysia is estimated at 641,886 hectares; however, only 68.7% of the mangrove forests are protected.

Uses of Mangrove Resources

The importance of mangrove is immense. Under a sustainable management regime, mangrove can provide tremendous economic benefits, through the support of fisheries, agriculture, maintenance of water tables, production of timber and plant matter, protection against storms, pollution buffering, provision of wildlife resources, transport, recreation and tourism opportunities (Shuib, 2008). In addition to these economic values, mangroves form part of the cultural heritage of humanity. Some of these economic values are quantifiable and others are totally ignored. The conversion of the mangrove forests into agriculture or industrial uses makes total economic value of the benefits derived from mangrove a top priority (Batagoda, 2003). Agriculture development in mangrove habitats requires the application of appropriate technologies and correct soil and water management.

Table 2: Lists some of the uses of the mangrove ecosystem

Community level	National level	Global level
• Timber and firewood • Fodder for animals • Traditional medicine • Food • Local employment • Recreation • Shell collection • Erosion control • Protection from storm damage	• Timber production • Charcoal production • Shrimp and crab industries • Mangrove silviculture • Trade • Ecotourism • Education • Water quality • Coastal and estuary protection	• Conservation • Education • Preservation of biodiversity • Indicator of climate change

Sources: Dahdouh-Guebas et al., 2000

2.0 OBJECTIVE OF STUDY

The main objective of the present study is to acquire information on traditional uses of the mangrove ecosystem from the communities living in the periphery of the mangroves, to acquire information on local perception of change, and to show how these ethnobiological data in sites should be valued to improve conservation and management of the area. The benefits from the mangrove forest will be evaluated using the Total Economic Value concept.

Study Area: Sungai Timun Village (STV), Kuala Linggi, Negeri Sembilan

Sungai Timun Village in Rembau, Negeri Sembilan is one of the villages, which has a rural eco-tourism potential. The river which has its beginning in the foothills of the Titiwangsa Mountain Range runs through the village and ends in the Strait of Melaka. The rivers form the boundary between the State of Melaka and Negeri Sembilan. The village is located in the district of Rembau which has been gazetted as the legendary and historical path of Raja Melewar, the Yam Tuan Negeri Sembilan who first established the track from Kuala Linggi, the rivermouth, to the hinterland to lay the foundation for the creation of the royal homestead of the Astana Rembau.

The majority of the villagers are Malays who are involved in fishing and shrimping as the main source of income. There are also villagers who do farm works in the oil palm and rubber plantations, especially Indians and Chinese. In general, the communities in the villages in the district are categorized as low-income population; for those working in the plantations the average income is about RM 750 and below. Among those who depend on the fishing activities, the average income is around RM500 a month.

The riverine area is covered with the mangrove forest, which has been gazetted as a protected area by the Department of Forestry. The mangrove forest area is rich in various resources. The river itself is a popular ground for *‘udang galah’* (king prawns) fishing. The villagers are proud of the *‘udang galah’* from the river, which they say is the best because the river is not contaminated, thus being a clean habitat for the *‘udang galah’* to grow. The mangrove forest has become a habitat for the cranes, which have formed the nesting place among the mangrove trees. The river is also the habitat for reptilians such as crocodiles and water lizards.

STV offers a good public facility especially for fishing activities such as boats and fishing equipment at only RM70 per km. It provides lodging for the tourist at only RM50.00 per day. Other facilities provided include food stalls, stage, open hall, Games Park, prayer room and benches.

Ethnobiology of Mangroves

Scholars have found that local ecological knowledge (LEK) or traditional ecological knowledge (TEK) is seen as closely related concepts. They broadly include of various types of ecological relevant knowledge that ranges from traditional use of specific plants, animals and essential knowledge which is critical to harvesting of natural resources by understanding the complexity of the local ecosystem functions, to the cultural beliefs and religious interpretation of human environment relations (Berkes, 1999; Davis and Wagner, 2003).

There is a suggested assumption that a large percentage of LEK is collected via experiences of close contact with the natural environment. As a result, being within the local vicinity plays a crucial role in acquiring this knowledge (Davis and Wagner, 2003). The local sale has proved to be an important pattern in resource extraction, resulting in the impacts of mangroves (Tomlinson 1986; Ewel et al., 1998; Kovacs, 1999; Dahdouh-Guebas et al., 2000; Walters, 2005a; Lopez-Hoffman et al., 2006). The role of LEK becomes an area of great interest amongst managements, unfolding great opportunities to integrate indigenous knowledge into contemporary frameworks for conservation and sustainable management. This, in the context of a priori understanding of forest dynamics and local dependency uses ethno scientific approaches (Rist and Dahdouh-Guebas, 2006) and modelling (Berger et al., 2008).

Previous research of mangrove through LEK and ethnobiology can be generalised into two categories: firstly, emphasis on the ecosystem together with the knowledge of ecological processes of various ecological component interact with each other, and secondly focusing on specific species or taxa and the use for anthropocentric purposes. This is frequently called ethnotaxonomy or ethnobotany (Berlin, 1973).

However, there were instances where mangrove users were not acting in ways that were consistent with their knowledge and beliefs. This can be seen through over-cutting and clearing of mangroves that they would normally see as important to protect (Vayda and Walters, 1999; Lopez-Hoffman et al., 2006). The gap between knowledge and behaviour also referred to as 'cognitive dissonance' (Festinger, 1957), is considered a human behaviour that is displayed when there is conflict of interest or lack of incentives. This is not a validation of LEK per se, but such example should not be assumed to always guide the behaviour of local users in terms of resources (Bart, 2006). Cognitive dissonance in this case is likely to be caused by economic incentives, property rights and participation in the management process.

Total Economic Value

Mangrove forest has both market and non-market values. Market values include products such as timber woods, aquatic products and non-timber forest products (Walters 2004). The CO_2 sink, flood protection, habitat for marine life and wildlife and biodiversity components are not bought and sold in the market place and thus represent non-market values. Most project appraisals are based on the returns of mangrove use market values. This has made conservation of mangrove forest for environmental benefits to be viewed less favourable compared to alternative uses such as agricultural production and industrial development (Ahmad, Bon Sin Yii, and Salbiah, 2012). In addition, the environmental benefits arising from conservation of mangrove forests are usually not taken into account in calculating financial Internal Rate of Return (IRR) for project appraisal.

The implementation of a project will often affect the environment. Since environmental impacts are related to the social objective of increasing people's welfare, environmental values should be weighed in the objectives. These impacts include services that are not free and have values in the same sense as marketed goods. Although the impacts are often characterised by an absence of observable prices on which to base in the cost–benefit analysis (CBA), their values must not be disguised.

Various methods can be introduced to measure these impacts. Stanton (1995) states that there is a need to consider the ecological reasons in agroforestry, and that the remarkable feature of mangrove systems lies in their comparative freedom from the problems besetting the winning of other renewable natural resources; and it is these ecological items that must be debited in the environmental accounting for the true cost of production. One of the methods of measurement of the true cost is the total economic value.

Batagoda (2003) agreed that when the total economic value of a wetland's ecological functions is properly measured, its services and its resources may exceed the economic gains of converting the area to an alternative use. In calculating the Internal Rate of Return (IRR), investors use the stumpage value of tree. The use of tree stumpage value alone to determine investment worth is in fact a purely commercial criterion. Efforts should be made to distinguish between commercial rates of return and economic rates of return in today's situation of scarcity and greenhouse effect. Hence quantification of the benefits of mangrove timber and mangrove agroforestry towards the economy is in order.

The TEV is calculated by summing the total benefits derive from a particular resource. TEV is the sum of use and non-use economic values. The components TEV that need to be estimated in mangrove agroforestry are the non-mangrove timber products: fishes, hydrology, carbon sequestration, and wildlife.

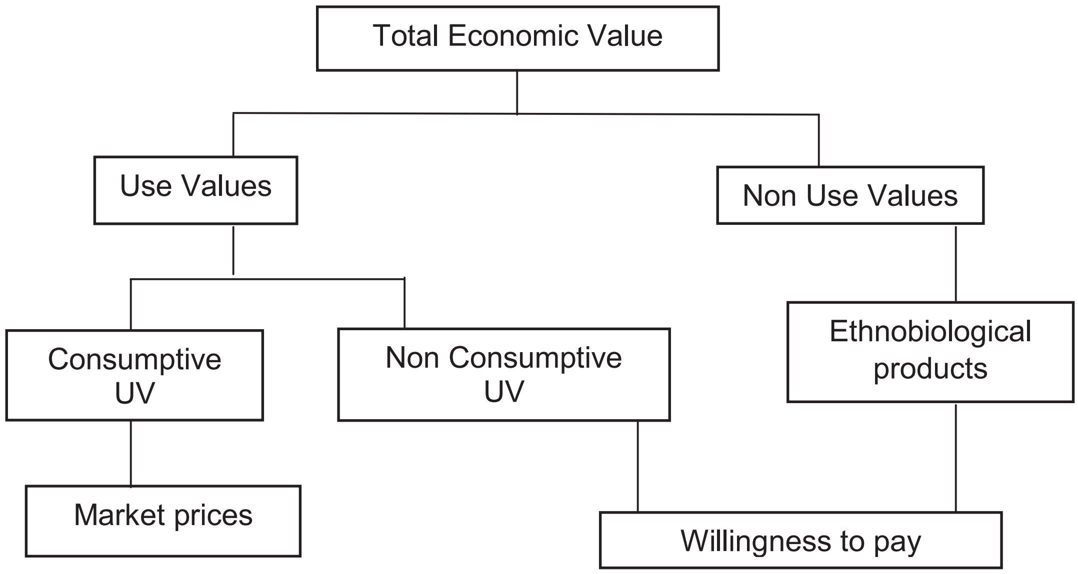

Figure 1: Total economic value of natural resources

3.0 DATA COLLECTION

The knowledge of respondents on mangroves is assessed with ethnobotanical questions, to be aided by a botanical photographic catalogue showing the tree physiognomies, leaves, fruits, flowers and seeds of each mangrove species. The rest of the semi-structured questionnaire contain both multiple choice and open-ended questions, which cover ethnobotanical and fishery-related issues, local perception of change in the mangroves, as well as personal socio-economic questions for each household. The survey will be complemented with visual observations, and the collection of secondary data from both governmental organisations and NGOs.

In the data collection process, a few villages in the periphery of the mangrove forests in Kampung Sungai Timun, Linggi, Negeri Sembilan are selected as the focal point of the research. The sample of the study will come from the population of the village of Kg. Sg. Timun, Kg. Sungai Radin, Tanah Arab and Bukit Bertam Estate which are managed by Jawatankuasa Kemajuan & Keselamatan Kampung (JKKK). Only residents from these localities will be included in the study. The questionnaire used to elicit the data is divided into three parts. These parts included public attitude and behavior toward mangrove forests, uses of mangrove resources, and willingness to pay for conservation of mangroves. Socio-demographic information is asked through open-ended questions such as the age, gender, education level and income. In part B, to obtain the use value, open-ended questions are used to obtain the necessary data from the respondents. Quantity of harvesting per day and the number of days per month that they are harvesting the marine products (fishes, prawns, crabs, and cockles) and forest timber products (mangrove woods) are obtained from the respondents. Ethnobiological data will be collected based on assessment of the local residents' knowledge using ethnobiological questions and aided by a botanical photographic catalogue showing physiognomies, leaves, fruits, flowers and seeds of the mangrove species found in the area.

In part C, to obtain the willingness to pay (WTP) for conservation of the mangrove resources, a modified dichotomous choice technique is used. Firstly, several levels of bid price (RM5, RM10, RM15….etc) are selected and presented to respondents to see whether they are willing to pay for the conservation of mangrove forests. If the respondent gives an answer of "Yes", an open-ended approach is used to obtain the maximum amount of willingness to pay which is higher than the bid price. On the other hand, if respondent gives a "No", the maximum amount of willingness to pay which is lower than the bid price will be asked. This is a modified dichotomous choice method where the lower bound (RM0) and upper bound of WTP will be obtained (Rusli et al., 2007). The TEV will be measured by summing up all the use value (UV) and non-use value (NUV) of each respondent.

4.0 DATA ANALYSIS

To analyse the questionnaire data statistically the X^2-test or the related G-test are used. These tests are most preferable as these test used qualitative response classes. Comparisons of means using t-tests between villages will also be conducted. Combinatory statistical analyses involving age by splitting the age classes in two equal groups and by confronting the upper with the lower age classes will be used. A multiple regression estimation will be done to determine the mean WTP and factors influencing the WTP of the communities for the protection of the mangrove resources.

REFERENCES

Ahmad, S., Bon Sin Yii, A., & Salbiah, E. (2012). Conservation of Deltaic Mangrove Forest Resources in Kuching, Sarawak: Local Communities' Willingness to Pay*. The Malaysian Forester 75* (1): 65-72 (2012) 65

Bart, D. (2006). Integrating local ecological knowledge and manipulative experience to find the causes of environmental change. *Front. Ecol. Environ. 4*, 541-546

Batagoda, B. M. (2003). The Economic Valuation of Alternative Uses of Mangrove Forests in Sri Lanka.*United Nations Environment Programme*, 1-84.

Berger, U., Rivera-Monroy, V. H., Doyle, T. W., Dahdouh-Guebas, F., & Duke, N. C. (n/a) Analyze and Predict Dynamics of Mangrove Forests: *A review. Aquat. Bot. 89*, 260–274.

Berkes, F. (1999). *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*. Taylor & Francis, Philadelphia.

Berlin, B. (1973). Folk Systematic in Relation to Biological Classification and Nomenclature. *Ann Rev. Ecol. Syst. 4*, 259-271.

Davis, A., & Wagner, J. R. (2003). Who Knows? On the Importance of Identifying 'Experts' When Researching Local Ecological Knowledge. *Hum. Ecol. 31*, 463–489.

Dahdouh-Guebas, F., Mathenge, C., Kairo, J.G., & Koedam, N. (2000b). Utilization of Mangrove Wood Products Around Mida Creek (Kenya) amongst Subsistence and Commercial Users. *Econ. Bot. 54*, 513–527.

Ewel, K. C., Zheng, S., Pinzon, Z., & Bourgeois, J. A. (1998). Environmental Effects of Canopy Gap Formation in High-Rainfall Mangrove Forests. *Biotrop. 30*, 510–518.

Festinger, L. A. (1957). Theory of Cognitive Dissonance. Row, Peterson, New York.

Kovacs, J. M. (1999). Assessing Mangrove Use at the Local Scale. *Landsc.Urban Plann. 43*, 201–208.

Lopez-Hoffman, L., Monroe, I. E., Narvaez, E., Martinez-Ramos, M., & Ackerly, D. D. (2006). Sustainability of Mangrove Harvesting: How Do Harvesters' Perceptions Differ from Ecological Analysis? *Ecol. Soc. 11* (2) art 14.

Rist, S., & Dahdouh-Guebas, F. (2006). Ethnosciences - A Step towards the Integration of Scientific and Traditional Forms of Knowledge in the Management of Natural Resources for the Future. *Env. Dev. Sustain. 8*, 467–493.

Rusli, M. Y., Ahmad, S., Mamat, F. M., & Alias, R. (2007). Local Economic Benefits of Ecotourism Development in Malaysia: The Case of Redang Island Marine Park. *International Journal of Economics and Management 1*(3): 365-386.

Shukor, A., & Hamid, A. (2004). *The Use of Mangroves in Malaysia.* In: Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia (pp. 136-144). Tigbauan, Iloilo, Philippines: Aquaculture Department, Southeast Asian Fisheries Development Center.

Stanton, R. W. (1995). *Climate Change: Sago Agro-Forestry and Food Security*. In Subhadrabandhu, S. and Sdoodee, S. (Eds). Proceedings of Fifth International Sago Symposium, pp. 91 – 106. Hat Yai, Thailand.

Tomlinson, P. B. (1986). *The Botany of Mangroves*. Cambridge University Press, Cambridge

Vayda, A. P., and Walters, B. B. (1999). Against Political Ecology. *Human Ecol. 27*, 167–179.

Walters, B. B. (2005). Patterns of Local Wood Use and Cutting of Philippine Mangrove Forests. *Econ. Bot. 59*, 66–76.

Walters, B. B. (2004). Local Management of Mangrove Forests: Effective Conservation Efficient Resource Exploitation? *Hum. Ecol. 32*, 177–195.

ECONOMIC BENEFIT OF REDD+ IN KEDAH: A PRELIMINARY STEPS IN THE ANALYSIS

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ABSTRACT

REDD+ in Malaysia is a theoretical tool, whose practical implementation is yet to be demonstrated. The basic of REDD+ is to provide positive incentive to stakeholders and to reduce emissions of greenhouse gas from the forest. In Malaysia, REDD+ was tackled through reducing logging activities but the issue is whether the scheme is more attractive than the logging revenue. This paper estimates the opportunity cost of REDD+ in Kedah, particularly in terms of the land expectation value (LEV), carbon sequestration and biodiversity conservation value. An opportunity cost analysis of REDD+ from primary data on visitors' willingness to pay (WTP) for biodiversity conservation using Choice Experiment is conducted. Residual value method is used to estimate land expection value by analysing secondary data of Pre-Felling inventory. The study shows that the loss due to logging activities in aggregate amounted to RM23 million affecting the values of land, carbon and biodiversity conservation. This valuation provides the opportunity cost of REDD+ showing the trade off between forest conservation values and logging revenue. From the results, it is observed that in aggregate the estimated total value of Kedah forest is lower than state timber revenue for 2012. When comparing the Kedah state timber revenue of RM40 million in the year 2012, the compensation value/opportunity cost of forest conservation for REDD+ is still relatively low than what logging revenue can provide.

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1.0 INTRODUCTION

Tropical forests are important sources and sinks of carbon. When forests are cleared or degraded they contribute about one-sixth of global carbon emissions. Conserving tropical forest is an important step in adaptation to climate change, as forests maintain a balance between the biomass of its vegetation and CO_2 in the atmosphere. Stern Report (2006) identified deforestation being the second major source of greenhouse gases emissions driving global warming and climate change.

Stopping deforestation must be a part of society's solution to climate change, and REDD+ can be a part of the solution to deforestation. REDD+ was formally introduced in the United Nations Framework Convention on Climate Change (UNFCCC) 13^{th} Conference of the Parties (COP 13) in Bali, Indonesia in 2007. After 2 years, the concept of REDD+ emerged. REDD+ or Reducing Emissions from Deforestation and Forest Degradation is a mechanism that includes forest conservation and protection in tackling climate change.

The REDD+ concept aims to create incentive for developing countries to reduce emissions from deforestation and forest degradation, as well as to promote conservation, sustainable management of forest and enhancement of carbon stock. Therefore, in order to receive REDD+ funding, countries must reduce deforestation and forest degradation activities. However, this incurs costs. Forest degradation, for example generates benefits from selective logging and non-timber forest product (NTFP) collection. Avoiding forest degradation implies forgoing these benefits. The costs of forgone benefits are known as opportunity cost, the cost that country would incur while reducing rate of forest loss within REDD+. This study examines the opportunity cost analysis showing the trade-off between forest business as usual which is logging activities, with forest conservation for REDD+.

2.0 METHODOLOGY

The opportunity cost of forest conservation for REDD+ refers to the value of forgone timber revenue and the corresponding value of other ecosystem services following deforestation and degradation activities. In this study the economic valuation was carried out for the following forest good and services:

- Timber resources value;
- Land expectation value;
- Carbon storage value; and
- Recreational value.

This method depends on two elements, information on pre-felling inventory of forest compartments and visitors' willingness to pay for the conservation recreational forest. It should be noted that the total economic valuation of Kedah forest is still on-going, and the results presented here is not comprehensive due to lack of data and other constraints.

Calculation of Stumpage Value

The first part of the study calculates the value of stumpage and forest land in Kedah. Information on the pre-felling inventory from by the Kedah Forestry Department is collected to determine the value of standing tree and land. The economic value of stumpage is calculated using residual value method based on pre-felling inventory data, log price and logging cost. The pre-felling inventory data were used to estimate timber volume for each species group in the compartments. Data on timber prices were obtained from MTIB (2012). The average logging cost used in this analysis was RM284.93 per cubic meter (2009), then adjusted to real value of RM191 per cubic meter in 2012. Stumpage value is calculated by taking the difference between the selling value of timber and the stump-to-market processing cost. The following formula is used to calculate stumpage value for each tree inventoried (Awang Noor et al., 2007):

$$SVi,j = (Pi, j - C - PMi,j) \; {}^*Vi,j \text{ where,}$$

SV = stumpage value per hectare (RM)
P = ex-forest log price (RM/m^3)
C = logging cost (RM/m^3), PM is profit margin (RM/m^3)
V = volume of standing tree (m^3)
i = index of species
j = the index of diameter class

The margin for profit and risk (PM) is computed as follows:

$$PMij = (Pij * PR) / (1+PR),$$

where PR is profit ratio.

Calculation of land expectation value (LEV)

The second part of the study is the calculation of land expectation value. Land expectation value (LEV) was derived from the previous calculated stumpage value as above using following formula;

$$LEV= SV + SV *(\underline{[\quad 1 \quad] / [}1tr]^{30}-1)$$

where, SV is stumpage value, r is discount rate (10%) and n is year (30 year).

Calculation of carbon storage value

The third part of the study calculates the value of carbon storage in Kedah Forest Reserve using the same pre-felling inventory data used to calculate stumpage and land expectation value. Determination of the amount of carbon stored in a site is done by quantifying the amount of biomass, necromass such as dead plant materials and soil organic matter. To measure the carbon stored, we calculate their biomass volume by taking the diameter at breast height (dbh) measurements and using the conversion formula to estimate the biomass. Many biomass estimates are based on the Kato's *et al.* (1978) equations.

$$Ws = 0.313*(DBH^2H)^{0.9733} \qquad \text{……….. (1)}$$

where;
Ws = Stem biomass (kg)
DBH = Diameter breast height (dm)
H = height (dm)

$$Wb = 0.0390*(DBH^2H)^{1.041} \qquad \text{……….. (2)}$$

where;
Wb = Branch biomass (kg)

$$1/W_L = 1/0.124*(Ws^{0.794}) + 1/125 \quad \ldots\ldots\ldots. (3)$$

where;

W_L = Leaf biomass (kg)

Ws = Stem biomass (kg)

After quantifying the total biomass stored in the tree stand, a conversion factor is applied to express it in terms of carbon.

$$C = 0.5\ W \quad \ldots\ldots\ldots. (4)$$

where;

W is total biomass and C is carbon (Chan, 1982)

The conversion of carbon to carbon equivalent should take into account the attached oxygen atoms by multiplying the ratios of molecular weights with 44/12 or 3.67.

$$CO_2e = C*44/12 \quad \ldots\ldots\ldots. (5)$$

To value the carbon stored, the amount of carbon then multiply by the current prices of carbon published.

Calculation of Biodiversity Conservation (Recreational) Value

The final part calculates the biodiversity conservation value in Kedah Recreational Forest. Recreational forest areas are one element of a forestry strategy directed towards the sustainable use of forest reserve. The economic value of forest as recreational provider could be estimated from public's willingness to pay (WTP) for biodiversity conservation. In this study, visitors to 9 recreational forests in Kedah were surveyed using the Choice Experiment Method. A total of 400 visitors were asked which attribute they would prefer to conserve among choice sets in each individual's survey. Each choice set included alternative types of hypothetical forest improvement with five levels of conservation charge (price). Four attributes that were presented to visitors were (1) forest as a place to protect wildlife, (2) aesthetic value of forest, (3) forest as source for medicinal plants (4) forest as ecosystem service provider.

3.0 RESULTS AND DISCUSSION

The results show that stumpage value varied by compartments, ranged between RM49,996.28 and RM378,097.36 while total estimated stumpage value for Kedah forest in year 2012 was RM2,476,903.68. In turn, land expectation value was estimated at RM3,222,959.01 (Table 1). According to the analysis, the stumpage and land expectation value were considered as comparatively low compared to value in other states in the Peninsular (eg. Terengganu, Kelantan) due to several reasons. First, the data on pre-felling inventory for Kedah state was incomplete for some compartments. Second, the species in the Pre F is recorded in category of species instead of by each species, thus it was not possible to match timber prices by species as in the MASKAYU. Third, compartments have comparatively low commercial timber species. We observed that for Kedah state, the former two factors are the likely reasons for the lower stumpage value. The total carbon storage value based on the same estimated timber volume in stumpage and land expectation value was RM491,485.

Table 1: Estimated stumpage, land expectation and carbon storage value in Kedah Forest Reserve in 2012

Compartment	Forest Reserve	Area (ha)	Stumpage value (RM)	LEV (RM)	Carbon storage value (RM)
11	Bukit Enggang	160	231,759.03	301,565.97	43,850.99
35	Bukit Perak	50	202,891.37	264,003.23	9,905.95
39	Bukit Perak	135	183,794.30	239,154.03	28,914.75
44	Bukit Perak	110	49,996.28	65,055.40	24,728.48
46B2	Bukit Perak	100	378,097.36	491,982.11	35,463.24
46I	Bukit Perak	100	283,325.53	368,664.54	37,491.39
28	Bukit Perangin	90	126,703.22	164,866.84	44,393.27
83B	Rimba Teloi	71	214,263.05	278,800.12	26,147.77
17A	Ulu Muda	200	209,054.56	272,022.80	39,374.88
35A	Ulu Muda	80	108,429.01	141,088.35	71,745.54
35F	Ulu Muda	100	179,736.23	233,873.65	50,186.72
41A	Ulu Muda	221	174,233.90	226,713.98	40,900.65
42A	Ulu Muda	120	134,619.85	175,168.00	38,381.42
Total		**1537**	**2,476,903.68**	**3,222,959.01**	**491,485.05**

In the case of Kedah Recreational Forest, visitors willing to pay (WTP) amounted RM21.21 per hectare per year for all the listed conservation attributes. The highest willingness to pay was observed on forest as ecosystem service provider (RM7.53/ha), followed by the aesthetic value of forest (RM5.83/ha), forest as a place to protect the wildlife (RM4.67/ha) and forest as a source of medicinal plants (RM3.18/ha). The result implies, visitors place greatest concern and willing to pay more for the conservation of forest ecosystem as compared to other attributes. The total willingness to pay for biodiversity conservation of Kedah Recreational Forest per year based on 896,182 average annual visitors were RM19,008,020.

From the results, the opportunity cost of forest conservation for REDD+ in Kedah was estimated closed to RM23 million in the year 2012. The biggest share of the total benefits is observed on forests function as recreational services provider (RM19,008,020), followed by land expectation value (RM3,222,959.01) and carbon storage value (RM491,485.05).

4.0 CONCLUSION

This analysis is limited to a case study in Kedah Forest Reserve, Malaysia. However, the study was carried out with the intention to estimate the opportunity cost of avoiding logging activities, in order to provide information to help in the design of incentives or payment systems under REDD+. Under REDD+, the primary consideration of environmental service is carbon, and the aim is to reduce emissions of carbon that results from forest degradation as well as to enhance the density of biomass landscape in order to sequester more carbon. Logging activities in general, results in forest degradation in which, halting this practice would result in increased carbon stocks. Attempt to reduce logging activities not only will sequester carbon, but other forest services will come along with this efforts.

In this study, it is observed that the estimated total value of Kedah forest is lower than state timber revenue for 2012 (in aggregate). When comparing to the state timber revenue of RM40 million, the compensation value/opportunity cost of REDD+ is relatively lower than logging revenue can provide. However, the value will be higher when considering other forest services such as watershed and non-timber forest product for an attractive conservation value.

In conclusion, when economic returns from timber revenue make it difficult to conserve forests for REDD+, the expansion of existing protected area is a cost effective way to maintain our forest cover.

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REFERENCES

Awang Noor, A. G., Tuan Marina T. I. & Faridah Hanum, I. (2007). *Economic Valuation of Timber Resources in 5-Ha Plot of Tranum Forest Reserve, Pahang.* Paper presented at the Seminar on Economic Valuation of Forest Goods and Services, Hotel Grand Continental, Terengganu, December 15-18, 2007.

Malaysian Timber Industry Board. (2012). *"Monthly Bulletin of Malaysian Timber Industry Board (Maskayu)."* Kuala Lumpur, Malaysia: Malaysian Timber Industry Board

Stern, N., Peters, S., Bakhshi, V., Bowen, A., Cameron, C., Catovsky, S., Crane, D., Cruickshank, S., Dietz, S., Edmonson, N., Garbett, S. L., Hamid, L., Hoffman, G., Ingram, D., Jones, B., Patmore, N., Radcliffe, H., Sathiyarajah, R., Stock, M., Taylor, C., Vernon, T., Wanjie, H., & Zenghelis, D. (2006), *Stern Review: The Economics of Climate Change*, HM Treasury, London.

SESI PEMBENTANGAN II:
Prinsip Kaedah-Kaedah
Penilaian Ekonomi Sumber Hutan

COLLECTION OF ECONOMIC VALUATION RESEARCH OF FOREST GOODS AND SERVICES

Prof. Dr. Mohd Shahwahid bin Hj. Othman

ABSTRACT

Natural forest ecosystem offers various goods and services which in the taxonomy of economic values range from direct and indirect use values, option values and non-use values. Economic valuation helps to place a value to changes in the level of goods, services and functions provided by the forests. This paper provides an overview of the state of research undertaken on the economic valuation of forest in Malaysia. The review covers the different types of economic valuation methods adopted and the goods and services valued ranging from stumpage, non-timber forest products, carbon sequestration and sink, watershed functions and other environmental services. The review also touches on how these values have been incorporated in decision-making processes involving forests. The paper concludes by providing future directions of research on economic valuation of forest resources.

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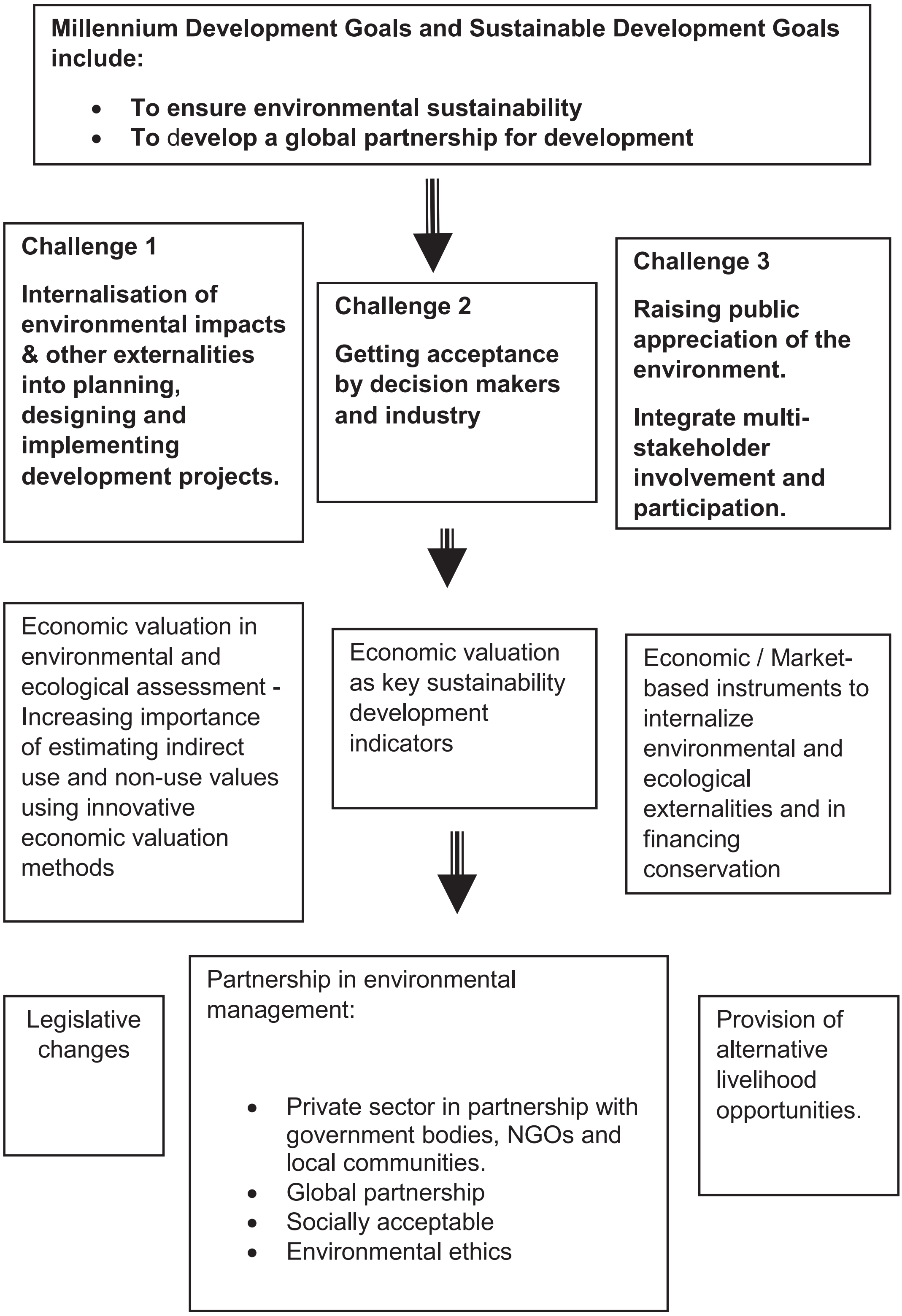
1.0 INTRODUCTION

Sustainable development implies that development decisions must integrate economic, social and environmental principles. This means that sustainable development programs must bring benefits to the entrepreneurs, ensure fairness and inter-generational equity, while at the same time does not cause adverse ecological impacts. Governments can promote sustainable development through broad strategies including improving the quality of life; promoting sustainable consumption and production; protection of the environment; managing the natural resource base sustainability; and enhancing human, institutional and infrastructural capacity.

The challenges to sustainable development are many and the key in ensuring its success is the maintenance of a healthy environment. The environment is a key determinant of growth and poverty reduction. Environmental issues, including those that have long-term global impacts need to be integrated into mainstream planning processes particularly those which affect development objectives. Different countries will respond differently to these challenges, adopting different strategies and choosing different options. However, all require deep structural changes relating to economy, society and politics. Hence, as Malaysia prods its way towards a developed nation, it has to embrace the above principles. Looking at the environmental angle, the Millennium Development Goal (MDG) and Sustainable Development Goal (SDG) stipulated the need to 'ensure environmental sustainability' and to 'develop a global partnership for development' with the target of integrating the principles of sustainable development into government policies and programs and of reversing the loss of environmental resources.

Malaysia has to embrace these principles by making them important tenets in its policies and administration. This tenet has to be well-accepted and made a mainstream culture and the nation has to integrate multi-stakeholder involvement and participation in major development project approval. The nation has to place environment high in its development agenda. It has to have the will to internalise environmental impacts into planning, designing and implementing of economic development projects. This would include incorporating environmental costs into pricing mechanisms for more accountable decision-making. The environmental impacts from development projects have to be valued and their quantum should serve as one of several key indicators used to help protect and manage unique and important environmental and natural resources. Figure 1 shows the goals, the challenges and environmental management prescriptions for sustainable development.



Source: Mohd Shahwahid, 2008

Figure 1: Mechanism for incorporating sustainability in national development

This paper highlights the state of research efforts of evaluating the economic values of environmental goods and services in the nation.

2.0 ECONOMIC VALUATION

The environment and forest resources offer various benefits. Economic valuation helps to place value to changes in the level of goods and services provided by the environment, even if these are not or have not been transacted in formal markets. According to the classification of economic values, these environmental functions offer:

i) direct use values;
ii) indirect use values;
iii) option values; and
iv) non-use values.

This value classification accounts for the manner in which people derive benefits from the consumption of environmental assets. Some of these benefits are derived directly while others are obtained indirectly. In other cases, the benefits are obtained without making any actual consumption. The mere presence and protection of the resource may generate emotional satisfaction. There is also a time dimension to the benefits derived. In most cases people acquire these benefits in the current period, but there are also circumstances where they derive satisfaction from protecting a resource now to ensure that future generations also have the opportunity to use it.

The direct use values provided by natural resource stocks for the production of commodities like timber, fisheries, minerals and petroleum have been well-evaluated by relevant agencies to the extent that the issues of poor rent capture by governments which were predominant up to the eighties, have been rectified. In the case of forestry, stumpage appraisal being exercised by the Forestry Department has allowed the department to determine the reservation prices of the timber stand to serve as the minimum benchmark value for awarding of forest harvesting licenses to any interested logging firm that participated in the tender process. The incorporation of this economic valuation exercise with a tendering process has ensured that state governments fully capture the economic rent from forest resource utilisation (Mohd Shahwahid and Awang Noor, 1998).

But the environment and forest provides ecological functions, much of these provide indirect use values, option and non-use values that are not readily felt by society. Because these benefits do not involved direct payments for their consumption or direct compensations for their loss, much of the environment and forest resources are converted or degraded to give way to development projects.

In accordance to the various forms of environmental functions and services and their corresponding forms of economic values, specific techniques are available to assess their values. These techniques could be selected from various categories of valuation methods ranging from market price and cost-based approaches, and surrogate and constructed market-based approaches. A classification of the valuation techniques, types of values and functions of the environment is given in Table 1 and a short definition of each of the methods in Appendix I.

Table 1: Categories of valuation approaches*

Market Price-Based Approach	Surrogate Market Approach	Constructed Market Approach	Cost-Based Approach
• Residual Method • Shadow Pricing <u>For Evaluating</u> • Natural resource stocks	• Hedonic Prices • Change in Productivity • Travel Cost • Production Function • Related or Substitute Good <u>For Evaluating</u> • Environmental Amenities • Recreation and Ecotourism • Regulatory Ecological and Environmental Functions (flood control, groundwater recharge, micro-climate regulator) • Untraded Natural Resouce Stocks	• Contingent Valuation • Choice Modeling <u>For Evaluating</u> • Recreation and Ecotourism • Ecological and Environmental Functions • Untraded Natural Resource Stocks • Protected and Conservation Areas • Cultural and Religious Values	• Cost of Illness • Opportunity Cost • Restoration Cost • Replacement Cost • Relocation Cost • Preventive / Defensive Expenditure • Damage Costs Avoided <u>For Evaluating</u> • Environmental Impacts • Protected and Conservation Areas • Ecological and Environmental Functions

* Under limitation of time and budget, a fifth category of EV approach is the benefit transfer approach technique that can assess various values of goods and services, as a second best estimate.
Source: McNally and Mohd Shahwahid (2003)

3.0 THE STATE OF ECONOMIC VALUATIONS IN MALAYSIA

A large list of various economic valuation research undertaken in the nation has been compiled by Mohd Shahwahid (2008) and represented in this paper. The list has an emphasis on valuing the environmental functions of forest because of the interest of the author in this area.

Recreational and Eco-Tourism Services

Forest recreation areas (FRAs) provide many benefits to the community, which are difficult to measure unless using economic valuation market approaches. Studies valuing the benefits of FRAs in Malaysia were available as early as 1982 using the travel cost method (Table 2). Among the earliest application of the dichotomous choice contingent valuation method (CVM) was by Nik Mustapha (1993) valuing the outdoor recreational services offered by Taman Tasek Perdana. But a comprehensive study covering 20 FRAs in Malaysia was carried out by Willis et al. (1998) that suggested the benefits derived were valued ranging from RM0.67 to RM3.74 per visit. It should be pointed out that the values estimated from these studies are site specific and are not transferable to other sites, as each site has its own unique characteristic.

Table 2: Summary of economic value recreation and tourism

Forest Reserve/ Conservation area	Project type/ issues of studies (object valued)	Value Estimated	Year of assessment	Source
Kanching FR, Selangor Lowland Forest	Recreation (TCM)	Total value : RM300,000/yr	1982	Abas (1982)
Bako National Park, Sarawak Kerangas Forest	National Park/Recreation (TCM)	Total value: RM990,436/yr	1982	Chung (1982)
Niah National Park, Sarawak Hill Forest	Recreation / Nature uniqueness (TCM)	Total value: RM851,761/yr	1982	Chung (1982)
Lambir National Park, Sarawak Hill Forest	Recreation (TCM)	Total value: RM1,011,611/yr	1982	Chung (1982)
Semenyih Dam, Selangor Lowland – Hill Forest	Recreation (TCM)	CS: RM0.50-RM2.50/visit	1990	Ahmad, Wan Sabri & Rashid (1990)
Taman Tasek Perdana, Kuala Lumpur	Outdoor recreation (CVM)	WTP : RM84-RM106 / person	1993	Nik Mustapha R.A. (1993)
National Parks , Pahang Lowland –Hill Forest	Recreation/nature uniqueness	Total visitor expenditure: RM6,530,044/yr	1994	Ahmad Shuib (1994)
20 Malaysian Lowland Forest Recreation Areas	Recreation (TCM and CVM)	WTP: RM1.03-RM1.46/visit CS: RM0.67-RM3.74/visit Total CS: RM53.06 million (20 FRAs)	1995	Willis et al. (1998)
Ulu Bendul,Negeri Sembilan	Recreation TCM	Total value = RM61,005/year	1995	Mohd. Khidir (1995)
20 Forest Recreation Areas	Recreation TCM	Average value=RM0.67-RM3.74 / visit Total value = RM53.1 million / year (20 FRAs)	1995	Willis et al. (1998)
North Selangor Peat Swamp Forest (Raja Musa and Tg Karang FRs)	Recreation	RM57/ha (8% discount rate)	1995	Kumari (1995)
Kampung Kuantan fireflies attraction	Recreation (CVM)	Total value = RM2.2 million	1997	Jamal (1997)
Kenong Rimba Park	Recreation (CVM)	Average value = RM19/domestic visit and RM30/foreign visit	1997	Gorhan (1997)
Matang Mangrove Forest, Perak Wetland	Sport Fishing Recreation (TCM)	CS: RM16-28/trip Total CS: RM134,000-237,177/yr	1999	Mohd. Shahwahid et al. (1999)
North Selangor Peat Swamp Forest (Raja Musa and Tg Karang FRs)	Recreation (TCM)	RM142,000/yr NPV: RM1.775 million (8% discount rate)	1999	Woon and Mohd. Parid (1999)
Bukit Hijau, Kedah Forest	Recreation (TCM)	WTP: RM1/entrance Total CS: RM1.57million	1999	Lim (1999)
Kuala Selangor Nature Park	Recreation (TCM)	CS: RM126/visit Total CS: RM1.21million (1997) RM5.50 million(2000)	2000	Rusmani (2001)
Kuala Selangor Nature Park, Selangor Wetland	Recreation (TCM) – Fireflies viewing Recreation (TCM) – Kuala Selangor Nature Park	CS: RM225/visit Total CS: RM2.1million RM0.9million	2000	Jamal (2000)
National Parks	Recreation (TCM)	CS : RM120/visitor WTP: RM280/visitor Total CS: RM2.6million	2000	Norlida Hanim (2000)
Manukan Island	Tourism (CVM)	WTP : RM5.02/person Total CS: RM329,865/yr (1998)	2000	Alias Radam (2000) Alias R. and Shazali A.M. 2005

Forest Reserve/ Conservation area	Project type/ issues of studies (object valued)	Value Estimated	Year of assessment	Source
Damai Beach	Tourism (CVM)	WTP : RM11.75-RM15.10/person	2000	Alias Radam (2000)
Malaysian Agro Park	Bukit Cahaya Sri Alam (CVM)	WTP : RM3.61-RM4.87/person	2001	Alias and Ruhana (2003)
Damai recreational site	Recreational services conservation(CVM)	WTP : RM11.64/person	2002	Alias Radam et al 2002
Chemerung FR, Terengganu Lowland Forest	Recreation (TCM)	CS: RM10/visit	2002	Awang Noor et al. (2002)
Sungai Congkak Recreation Forest, Selangor Forest	Recreation (TCM)	RM24.7million	2002	Tee (2002)
Telok Bahang, Bukit Mertajam, Bukit Panchor, Penang Lowland Forest	Recreation (TCM)	WTP : RM1-RM2/person Mean cost of visit : RM10 – RM40/visit	2003	Tuan Marina, et al. (2003)
Bako National Park	Recreation (CVM)	WTP : RM7.77/person	2007	Dayang Affizah etal (2007)
Chamang Recreational Forest, Bentong, Pahang	Recreation (TCM)	WTP : RM67.20 – RM106.40/visit Total CS: RM671,800-RM1.064,000	2007	Awang et al (2007)
Kuala Gandah Elephant Conservation Centre (KGECC), Lanchang, Pahang	Eco-tourism	RM 4.29 / visit for local tourists and RM 57.27 / visit for foreign tourists.	2007	Mohd Shahwahid et al (2007)

CS – consumer surplus, WTP – willingness to pay, TCM – travel cost method, CVM – contingent valuation method
Source: Mohd Shahwahid (2008)

An interesting investigation on valuing eco-tourism attraction of elephants at the Kuala Gandah Elephant Conservation Centre (KGECC) located in Lanchang, Pahang was undertaken in 2007 (Mohd Shahwahid et al., 2007).

This method values the willingness to pay (WTP) of tourists, both domestic and international, if hypothetically an entrance fee to the Pentre is imposed to enjoy activities such as elephant rides, feeding, bathing and taking photographs with elephants.

Besides these activities, a documentary presentation depicting issues, diminishing habitats and translocation of elephants is shown to promote awareness. In comparison, this method is also used to value an eco-tourism safari package of tracking and observing wild elephants in the natural forest, inclusive of transport and food. The estimated willingness to pay (WTP) values of the attractions at the Elephant Centre were RM4.29 per visit for local tourists and RM57.27 for foreign tourists with an overall average of RM30.78 per visit. Meanwhile, the WTP to watch wild elephants in its natural habitat were RM44.83 per visit for locals and RM127.27 for foreigners with an average of RM86.05 per visit.

Local Community Dependence on the Ecosystem

In most cases, the use of non-timber forest products (NTFPs) by the local community, either for their own consumption or for sales, can provide useful information on the implicit value of NTFPs. Mohd Shahwahid (1992) attempted to impute the benefits generated from the utilisation of forest produce in the Tasek Bera ecosystem in Pahang by the Orang Asli community. The study found that the mean imputed economic value per household was RM2,105 per annum. The collection of various rattan species from the genus *Calamus* and *Korthalsia* contributed the most to the total economic value, which was about 68% of the mean household economic value. This was followed by the collection of resins from *Dipterocarpus kerii* (11%), mats and baskets made from *Pandanus sp.* and other species (10%), fragrant wood from *Grewia antidesmaefolia* and *Aquilaria malaccensis* and the rest from plant parts collected for building materials, food and medicinal herbs. But with scarcity of natural resources, the Semelai people's primary economic dependence upon the peat swamp forest has declined from 27% in 1991 to 5.2% in 1996. Nevertheless, as supplementary economic activities the collection of natural resources, fishing and handicraft production are still of considerable importance to the community.

From a survey of the NTFP collection activities in South East Pahang peat swamp forest (SEPPSF), the economic value obtained by local communities living in the vicinity of the forest was estimated at RM1,832/year (Table 3). The main NTFPs collected were fruits (kelubi and petai), rattan and nipah shoots, fisheries (tapah, baung, haruan, crabs, prawns) and a few wild animals.

Forest harvesting has the impacts of increasing accessibility to the collecting sites but with a declining resources and greater intensity of collecting efforts, NTFP yields actually declined at an average rate of 10% per year.

Table 3: Value of NTFP collection from SEPPSF by households

Kinds of NTFP	Total average (RM) / month involved collectors only	Mean value for all households sampled RM/month
Fruits	220.7	23.4
Vegetables	15.0	0.1
Fiber Materials	176.5	72.4
Birds	48.58	14.3
Fishery	172.1	40
Wild Animals	55.0	1.6
Medicinal Herbs	150.0	0.9
Total	**837.88**	**152.7**

Source: Mohd Shahwahid and Awang Noor (2005)

Economic Values of Forest Resources

A listing of the economic value of forest resources have been provided by Awang Noor (2007), while a more detail investigation of the value of honey bees and of *Aquilaria sp*. for gaharu wood have been written by Poh et al. (2007) and Tuan Marina (2007) respectively. The Malaysian forest resources provide stock and flow values of various forest products ranging from stumpage (timber) and NTFPs like rattan, bamboo, wild fruits, petai and honey. Assessing the stock and flow values of these resources provided by the forest could present a justification for the conservation of the Malaysian rainforest.

Timber

Malaysian rainforests are the source of valuable timber that supports the wood-based industry. Species being harvested included the genus *Shorea*, *Dipterocarpus*, *Koompassia*, *Dyrobalanops*, and *Hopea* to name a few. Stumpage appraisal or valuation of potential timber from forest stands, is very essential to both the Forestry Department and timber harvesters. This estimate will influence the forest licensing transaction. The most common valuation method used is the residual value technique to obtain the economic rent estimates. The estimated stumpage value ranges from RM4,218 in Pasoh FR, Negeri Sembilan (Awang Noor and Mohd. Shahwahid, 1999) to RM27,332/ha in Muda FR, Kedah for the Dipterocarp Forest (Table 4).

The total stumpage value for peat swamp forest ranged from RM1,722 to RM2,946/ha both in Sg. Karang FR, Selangor (Awang Noor and Mohd. Shahwahid, 1999) while that for the mangrove forests vary from RM187 in Sungai Pulai FR, Johor, (Mackinna, 1995) to RM9,086/ha in Matang mangrove, Perak (Abd. Hadi, 1994). The total stumpage value for plantations of fast growing timber species was estimated at RM3,378/ha (Hii, 1995). The variation in stumpage values results from differences in forest productivity and composition of growing stock in terms of species, species groups, diameter size, logging costs, log prices, and fair profit margin allocated to the contractor.

Table 4: Estimated total stumpage value of forest reserves in Peninsular Malaysia (RM/ha) (trees with diameters $\geq$ 30 cm)

Forest Type*	Locality	Year of assessment	Stumpage value (RM/ha)	Source
HDF	Kedah, Muda FR	1994	27,332	Awang Noor & Mohd. Shahwahid (1995)
LDF	Negeri Sembilan, Pasoh FR	1995	4,218	Awang Noor & Mohd. Shahwahid (1996)
M	Perak, Matang Mangrove	1994	9,086 (30 years old)	Abd. Hadi (1994)
M	Johor, Sungai Pulai FR	1995	187 (19 years old)	Mackinna (1995)
PSF	Selangor, Sg Karang FR	1999	1,722	Awang Noor and Mohd. Shahwahid (1999)
PSF	Selangor, Sg Karang FR	1999	2,946	Awang Noor and Mohd. Shahwahid (1999)
FP(A)	Selangor, Kemasul FR	1995	3,378 (12 years old)	Hii (1995)

NF – natural forest, hdf – hill dipterocarp forest, ldf (lo) – lowland ddipterocarp forest (logged over), m – mangrove, psf – peat swamp forest and fp (a) – forest plantation (*acacia mangium*)
Source: Mohd Shahwahid (2008)

Non-Timber Forest Products (NTFPs)

Research on the economic values of selected NTFPs are provided below. The significance of conducting the valuation of NTFPs in tropical forests are:

i) In support of multiple use management of forest;
ii) In providing reservation prices for use in determining forest premium payments during licensing process for NTFP extraction from the forest. This will raise forest resource rent capture; and
iii) Socio-economic impact assessment of projects involving forest clearance and degradation.

Rattan

Rattan is one of the major NTFPs harvested from Malaysian forest. The residual value technique is adopted to assess the economic value of rattan stocks (Awang Noor and Mohd. Shahwahid, 1996; Mohd Shahwahid and Awang Noor, 1999). The study was commissioned by the ASEAN Institute of Forest Management and conducted in Negeri Sembilan, as illustration that NTFPs and ecological services have values just like timber trees, and the forest would have to be managed not only for its timber, but also for its NTFPs and ecological functions. The rattan stocks were valued by different rattan species and forest types. The study used data from the National Forest Inventory III to determine the number of rattan clump by species and type of forests. The major rattan species of commercial value are *Calamus manan, Calamus caesius, Calamus ornatus*, *Calamus scipionum*, *Calamus tumidus, Korthalsia rigida* and *Korthalsia lacionos.* A special inventory to identify the number of potential rattan sticks available at various diameter classes was also conducted. A market survey was also conducted to collect information on price, costs, and profit margin. The average stock value per hectare depends on species and forest status. The average stock values for a particular species range from RM0.94 to RM32.52/ha. The appraised value of standing rattans was RM30/ha for the virgin forest reserve and RM16/ha for the logged forest reserve.

Another study conducted in Jengai Forest Reserve, Terengganu in 2000 indicated that the total value of rattan was RM49.54/ha (Awang Noor et al., 2000). The above estimates are based on existing mature rattan stands and have not considered the immature stands that would grow to maturity in the future to continue the sustainable production. In general, a forest stand would only have 30.7% of mature rattan stocks that are marketable while others are still immature. The value will increase if a discounted value is computed over the future streams of mature rattan stands.

Bamboo

Bamboo is an important industrial material used for making chopsticks, joss paper, toothpicks, skewer, blinds and other related items. The National Forest Inventory III conducted in 1990 estimated that there exist 82.2 million clumps of bamboo stocks in the permanent reserved forest. Most bamboo stocks were found either in virgin good and average forests, or in logged-over forests (Poh et al., 1994). The main bamboo species found were *Schizostachyum grande, Schhizostachyum zollingeri,* and *Dendrocalamus pendulus*, *Gigantochloa scortechenii,* and *Gigantochloa wrayi.*

The residual value approach was used in estimating the economic value bamboo stocks in several forest reserves in Negeri Sembilan (Awang Noor and Mohd. Shahwahid, 1996) and in Jengai Forest Reserve, Terengganu (Awang Noor et al., 2000).

Various data were collected to compute the value of the bamboo stocks including the number of clumps per hectare by different bamboo species and forest types, potential number of marketable sticks per clump of bamboo species, ex-mill prices of processed bamboo sticks, costs of collecting raw bamboo, transportation cost, processing cost, and a fair profit margin for the bamboo processing industry. The estimated economic values of bamboo were RM5.64/ha and RM399.18/ha for virgin and logged over forests, respectively with an overall average of RM348.03/ha for all forest in Negeri Sembilan. The low value of bamboo stand in the virgin forest is due to the low bamboo stocks in closed forest. Bamboo is known to dominate in open forest like logged over forests. The estimate in Terengganu was higher with RM471.39/ha. The higher estimate for Terengganu is due to the greater availability of the larger betong bamboo.

Fruit Trees

Of the many fruit trees available in the forest, *Parkia speciosa* (petai) remains a major commercial resource. Petai seeds and pods are widely consumed both by rural and urban people. Petai is an excellent appetizer as well as having some medicinal value. Woon et al. (1995) have conducted an extensive study on the economic value of petai. A market price approach was used to derive the economic value of petai. The benefit derived from petai is the value accrued when it is traded in the local market. The Net Present Value (NPV) of petai production under the three management options was estimated. The results indicate that the petai and durian management option or combination provided the highest NPV per ha (RM42,461) and IRR of 22.4 percent. Petai production and banana combination ranked second in value (NPV RM2,401 per ha, IRR 3.25%) followed by petai and timber production option. (NPV RM1,179 per ha). This shows that inclusion of economic value of petai in analysing land use option will favour fruit trees than timber production.

Two other studies were undertaken in the virgin Pasoh Forest Reserve, Negeri Sembilan (Woon and Poh, 1998) and in Jengai Forest Reserve, Terengganu (Awang Noor et al., 2000). It was estimated that the net value of petai (net of harvesting cost) under primary forest conditions in Pasoh Forest Reserve was RM22.04 per ha and using a discount rate of 7 percent, it was calculated that the NPV that could be derived from pod production in perpetuity is RM314.86 per ha. While the economic value of petai (*P.speciosa*) and keranji (*D. indum*) in Jengai Forest Reserve was estimated at RM77.20 and RM373.26/ha, respectively.

Medicinal Plants

Traditional medicine is important to all ethnic groups in Malaysia. The forest provides valuable medicinal plants and the estimates show that the forest supports more than 200 potential important medicinal plants (Sabariah, 1989). However, it is difficult and almost impossible to estimate the economic value of all medicinal plants as a source of medicinal products. Even though tropical forest has yield several important drugs which are vital in the treatment of related diseases, the economic value derived from these plants have to be assessed in terms of its potential earnings, costs of prospecting, research and development, and cultural practices.

Two studies undertaken on valuing medicinal plants are those by Kumari (1995 and 1998) involving the peninsular and the other by Awang et al. (2000) for the state of Terengganu. The value of medicinal plants is influenced by several critical assumptions, such as the assignment of the level of earnings from plant drugs whether low, medium or high; the level of appropriations to resource owners whether at the 10, 50 and 100 percent rates; and the types of forest area where valuation is undertaken (protected area and production forest, effective protected area). For instance, at a 50% appropriation rate, and calculated on the basis of the effective protected area for Peninsular Malaysia, the annual medicinal plant value per hectare was estimated to range from RM24-RM386/ha per year from the low to the high earnings from drugs (Kumari, 1995). Awang Noor et al. (2000)'s estimates were found to be RM40.21/ha which is at the lower bound range.

4.0 CARBON STORAGE AND SEQUESTRATION VALUES

Previous studies have estimated the role of Malaysian forests in carbon storage and sequestration (Table 5). Vincent et al. (1993) estimated the economic value of carbon storage. The value of carbon storage was RM500 million in 1989, a reduction of RM300 million from 1971. Roslan (1995) also conducted a study on the role of forest in carbon sequestration based on three management systems, viz. protective management system, production forestry system, and plantation forestry system under various assumptions such as different interest rates (0%, 1%, 3%), different business activities (usual business and improved situation), timber quality situation (quality timber and fast growing species). These assumptions were used for different forest management systems. Different interest rates, however, were present in all management systems. The main conclusion was that the forests provide significant impacts in carbon sequestration with some of the situations examined showing positive net present values (NPVs).

But a more thorough study was undertaken by Awang Mohdar et al., 1999 in Sabah on the carbon savings obtained when Innoprise Corporation Sdn Bhd (ICSB) opted to implement reduced impact logging over conventional logging on 1,400 ha of virgin forest in 1992 with of 120 tonnes ha^{-1}. The potential carbon savings from RIL is at least 90-94 tonnes/ha or 328-343 tonnes/ha of carbon dioxide over the next 40 years. The value of the role of Malaysian forest in sequestrating carbon ranges from RM8.5-9.00 tonne carbon.

Table 5: Summary of economic value of carbon, Malaysia

Project type/ issues of studies (object valued)	Forest Reserve/ Conservation area	Value Estimated	Year of assessment	Source
Carbon	Malaysian forest	NPV:RM500 million	1993	Vincent et al. (1993)
Carbon (above ground)	North Selangor Peat Swamp Forest (Raja Musa and Tg. Karang FRs)	NPV:RM9,096/ha (0% logging damage) NPV:RM8,677/ha (20% logging damage) NPV:RM8,049/ha (50% logging damage) (8% discount rate at RM14/tonne)	1995	Kumari (1995)
Carbon (above ground)	North Selangor Peat Swamp Forest (Raja Musa and Tg. Karang FRs)	NPV:RM583.33 million (8% discount rate at RM14/tonne)	1999	Woon and Mohd. Parid (1999)
Carbon (below ground)	North Selangor Peat Swamp Forest (Raja Musa and Tg Karang FRs)	NPV:RM1,360/ha NPV: RM99million (8% discount rate at RM14/tonne)	1999	Woon and Mohd. Parid (1999)
Carbon	Sabah hill forest	RM8.5-9.00 $tonne^{-1}$ C	1999	Awang Mohdar (1999)

Source: Mohd Shahwahid (2008)

Conservation, Wildlife, Biodiversity Values and Other Non-Use Values

Conservation and protected areas (PAs) provide sanctuary for wildlife, a habitat for plant biodiversity, eco-tourism opportunities and are essential for maintaining ecological stability. The economic values of these areas accrued through fulfilling the various functions mentioned above. But economists have not been able to thoroughly understand these non-tangible roles and that conservation or protection involves economic trade-offs. However, a number of studies have attempted to address this question.

A study on the incremental economic cost of managing wetlands for biodiversity conservation was undertaken by using the Kuala Selangor Nature Park (KSNP) as an illustration (Mohd Shahwahid, 1997). This Park is a highly modified mangrove forest of approximately 320 ha, situated 65 km from Kuala Lumpur. The park was established in 1987 and is being managed by the Malayan Nature Society (MNS) following an agreement with the State Government of Selangor. The park is gazetted as a town/public park under the Local Government Act 1976. The KSNP was established to promote conservation of the mangrove and mudflats in the site and re-establishment of indigenous plant species. There is considerable public interest on the park, which is a well-known site for observing mangroves, water birds and other wildlife such as silvered leaf monkeys. Of global interest, is the site's importance for migratory birds. Kuala Selangor is a link in the migratory chain through South East Asia for waders. There is a potential for introducing a milky stork population into the KSNP, which is being bred at Zoo Negara with sponsorship from the Malaysian Wildlife Conservation Foundation. The milky stork is a CITES I bird. The captive management programme has been successful at Zoo Negara and by September 1995, there are 48 milky storks and about five chicks at the aviary. These stocks were transferred to an open aviary constructed at the KSNP site to breed the second generation. The present value incremental costs for these conservation activities was US$ 3.6 million

Table 6: Summary of economic value of conservation, wildlife, biodiversity values and other non-use values of forests

Forest Function	Forest Reserve/ Conservation area	Project type/ issues of studies (object valued)	Value Estimated	Unit Value	Year of assessment	Source
Ecological and local use	Tasek Bera Wetland	Plant diversity and its utilisation by local communities	RM50-RM8,142 Mean: 275/ household	RM/ household /yr	1990	Mohd Shahwahid (1995)
Bird conservation	Fraser's Hill Forest	Bird Watching (CVM)	WTP: RM22.48 – RM66.60/ person	RM/ person	2004	Puan et al. (2004)
Conservation	South East Pahang Peat Swamp Forest	Social benefit	RM199-RM402 million	RM million	1999	Woon et al., 1999
Nature Park	Taman Negara Forest	Non-use value (CVM)	WTP : RM12.32/ household	RM/ household	2000	Norlida Hanim (2000)
Wetlands,	Paya Indah, Kuala Langat	Non-use value (CVM)	WTP: RM28-31/year/ household	RM/ household	2003	Jamal and Shahariah (2003)
Habitat for Wildlie	Maran forests	Habitat function losses using • replacement cost • change in productivity • contingent valuation	RM22,850/ household affected	RM/ household affected	2007	Mohd Shahwahid et al (2007)

Source: Mohd Shahwahid (2008)

The KSNP generates economic value of on-site recreational benefits. Jamal (1997) used the travel cost method (TCM) and contingent valuation method (CVM) to obtain a consumer's surplus ranging between RM62.00 to RM120.00/user trip. This estimate yields a gross economic value in the range of RM1.1 million to RM1.68 million per annum. The list of economic values of environmental conservation is given in Table 6.

An approach to value the elephant habitat function provided by forests is to assess the losses that would occur if these habitat functions are jeopardised. The source of this decline in function could be timber harvesting or forest clearance for agricultural and development projects. The impact of this habitat disturbance would have an effect encouraging the elephant herds to leave their habitat in the forest into agricultural farms or orchards and human villages. This situation would create human elephant conflicts such as elephants damaging the fences of farms and feeding on young rubber tree shoots, fruit trees and oil palm young pith/core and shoots. Substantial losses would be incurred by rural farmers and folks. Using the replacement cost and changes in productivity valuation approaches the economic values of the damages on agricultural crops that were imposed on villagers in Maran, allow the estimation of:

i) Present values of reduced productivities from stunted growth of crops not destroyed;
ii) Present values of foregone revenues from crops destroyed that require replacement;
iii) Replacement cost of destroyed crops; and
iv) Present values of foregone revenues from crops destroyed that do not require replacement.

These damage losses and that of tranquality and trauma suggested an annual loss of RM22,850 per affected household (Mohd Shahwahid et al., 2007).

Figure 1: Pith of a 1.5 year old oil palm trunk eaten by wild elephants

Catchment and Hydrological Functions of Forest

The economic values of catchment and hydrological functions played by natural forests are provided in Table 7. Forest catchments play an important soil conservation and protection role. The rate of sedimentation from the undisturbed forest is 0.67m^3/ha/year while under reduced impact logging it is 27.3m^3/ha/yr which will revert back to pre-logging phase on the sixth year.

Table 7: Economic values of catchment and hydrological functions

Project Type/ Issues of Studies (Object Valued)	Forest Reserve/ Conservation Area	Value Estimated	Year Of Assessment	Source
Hydrological value	North Selangor Peat Swamp Forest (Raja Musa and Tg Karang FRs)	RM319-999/ha of forest (8% discount rate)	1995	Kumari (1997)
Cost saving of water treatment by Public Work Department	North Selangor Peat Swamp Forest (Raja Musa and Tg Karang FRs)	RM0.48 million	1995	Kumari (1997)
Domestic water supplies	North Selangor Peat Swamp Forest (Raja Musa and Tg Karang FRs)	RM30/ha of forest (8% discount rate)	1995	Kumari (1997)
Protection value of forest for water production	Hulu Langat FR, Selangor Lowland –Hill Forest	NPV : RM16.78 million under protective forest and RM11.79million under RIL (at 10% discount rate)	1996	Mohd. Shahwahid et. al (1999)
Hydrological value	North Selangor Peat Swamp Forest (Raja Musa and Tg Karang FRs)	NPV: RM109.56 million (8% discount rate)	1999	Woon and Mohd. Parid (1999)
Total watershed protection	Ulu Muda FR, Kedah Hill Forest	NPV: RM128.8 million (10% discount rate)	2002	Mohd. Rusli (2002)
Water supply (CVM) Forest conservation for water supply (CVM)	Jengai FR, Terengganu Lowland – Hill Forest	WTP: RM9-12/month WTP: RM16-51/year	2002	Awang Noor et al. (2002)
Irrigation water supply	Muda Irrigation Scheme	RM0.01/m^3	2008	Mohd Shahwahid (2008)
Raw water supply to treated water plants	Raw water abstraction by Malacca treated water plant from Muar River	RM0.12/m^3	2008	Mohd Shahwahid (2008)

Source: Mohd Shahwahid (2008)

Using the findings from Mohd Shahwahid et al. 1999, it is estimated that net present value provided by the forest declined from RM59,020 per ha in protected forest to RM41,445 per ha when sustainable forest production using reduced impact technique over a 30 year cutting cycle. The reduction in catchment function value (NPV) when forest harvesting is undertaken is estimated to be RM17,575/ha.

Economic Values of Geo Hazards

Of recent interest amongst international and Malaysian government agencies, is the monetary accounting of impacts of geo hazards beyond their physical quantum. Recent disasters and calamities are no longer just quantified in terms of physical numbers but in terms of their pecuniary effects. For instance, the impacts of floods, landslides, forest fires and tsunamis are not just measured in terms of homes and properties inundated or number of residents evacuated and hospitalised, but in terms of the economic value of the property and human losses. These new attention could be illustrated in a number of post-mortem impact investigations of these geo hazard events, and in the planning and design of new development concepts and projects.

Table 8: Summary of economic values of selected geo-hazards incidents in Malaysia

Area	Project Type/ Issues of Studies (Object Valued)	Value Estimated	Year Of Assessment	Source
Malaysia	Trans boundary haze impacts	RM801.9 million	1997	Mohd Shahwahid and Jamal (1999)
Kota Tinggi, Johor	Flood	RM4.15 billion	2006	Department of Urban and Rural Planning (2008a)
Acacia plantations and peat swamp forest in Peninsular Malaysia	Forest fires	RM618,578/year	2002-04	Department of Urban and Rural Planning (2008a)
Kampung Sungei Pusu, Gombak, Selangor	Hill slope housing development	RM7,305/ household/ year	2007/08	Department of Urban and Rural Planning (2008b)

Source: Mohd Shahwahid (2008)

In recent preparation of spatial planning reports to implement the National Infrastructural Plan, the Department of Urban and Rural Planning has provided sections on:

i) The economic values of flood and forest fires, and its influence on the framing of guidelines and action plans for preventing and regulating disasters (Department of Urban and Rural Planning 2008a);
ii) The economic costs of real estate development on steep slopes and nearby quarrying activities as illustration on the need to incorporate economic costs and market-based instruments in framing of guidelines and action plans for development projects neighbouring environmental sensitive areas (ESA) (Department of Urban and Rural Planning 2008b); and
iii) The economic values of establishing or setting aside of ecological corridors to join islands of natural forest in a bid to establish connectivity for wildlife and bio-diversity as stipulated in the central forest spine (CFS) project (Department of Urban and Rural Planning 2008c).

The Department of Environment (DOE) has been in the forefront of requiring economic valuation of impacts of new projects that fall under the ‘prescribed projects’ be conducted as a section of the Environmental Impact Assessment (EIA). This requirement to carry out an EIA is stipulated in the Environmental Quality Act 1974 amended 1985.

Incorporating Valuation in Decision-Making Concerning Forests

Economic valuation helps to place a value to changes in the level of functions and services provided by the environment. Much of these functions and services are indirect use values and non-use values which are not readily available. One important reason is the failure of current market forces to take into account the wider economic implications of social and environmental impacts that result from existing and new development projects. Many of these impacts are “externalities”, because they are external to the conventional economic values often considered in decision-making, particularly by the private sector.

With rising capacity to evaluate environmental functions and services in the nation, economic valuation could influence the outcomes of decision-making. Valuation could be made a routine part of investment planning and appraisal, policy analysis and land use decision-making.

5.0 CONCLUSION

Natural forest ecosystem offers various goods and services which in the taxonomy of economic values range from direct and indirect use values, option values and non-use values. Economic valuation helps to place a value to changes in the level of goods, services and functions provided by the forests. This paper provides an overview of the state of research undertaken on the economic valuation of forest in Malaysia. The review covers the different types of economic valuation methods adopted and the goods and services valued ranging from stumpage, non-timber forest products, carbon sequestration and sink, watershed functions and other environmental services. The review also touches on the way forward for valuation in particular how these values have to be incorporated in decision-making processes involving forests.

REFERENCES

Abas Said. (1983). Economic *Evaluation of Recreation Area Usage in Selangor*. B.S. Project. Faculty of Forestry, Universiti Pertanian Malaysia. Serdang, Selangor.

Abd. Hadi Nas. (1994). *Optimal Rotation Length of Matang Mangrove Forest*. B.For.Sc. Thesis. Faculty of Forestry, Universiti Pertanian Malaysia. Serdang, Selangor.

Abdullah Mohd. (1995). *Recreation Use Valuation, Management and Policy Implications of Taman Negara*, *The National Park in Peninsular Malaysia*. Ph.D. Thesis. University of Aberdeen, Aberdeen.

Ahmad Fauzi, P., Salleh, M., Mohd Shahwahid, H. O. & Abdul Rahim, N. (2002). Chapter 3: *Cost of Harvesting Operations in Compliance with ITTO Guidelines for SFM*. In Rahim, N. A. (editor): A Model Project for Cost Analysis to Achieve Sustainable Forest Management VOLUME II – Main Report Forest Research Institute Malaysia and International Tropical Timber Organization. Page 63-84. ISBN 983-2181-25-9 (v2)

Ahmad Shuib. (1994). The Total Economic Impact of Tourism Development in Taman Negara National Park. *Dept. of Natural Resource Economics Staff paper No. 2/94*. Faculty of Economics and Management, Universiti Pertanian Malaysia.

Ahmad Shuib, Wan Sabri W. A., & Rashid, R. M. (1990). *Benefit Vvaluation of Outdoor Recreation Resources.* In Research and Publications 1988/89. Faculty of Forestry, Universiti Pertanian Malaysia. Serdang, Selangor.

Alias, R., Shazali, A. M., Abas, S. & Afizah, M. (2002). Willingness of Local Tourists to Pay for Conservation of Tourism Spots in the Damai District Sarawak. ASEAN *Jornal on Hospitality and Tourism 1* (1): 53-62.

Alias, R. & Ruhana, B. (2003). *Consumer Perception and Willingness to Pay toward Facilities in Malaysian Agro Park, Bukit Cahaya, Shah Alam, Selangor*. Seminar FEP 2001. Serdang.

Alias, R. & Shazali, A. M. (2005). Use of Dichotomous Choice Contingent Valuation Method to Value the Manukan Island, Sabah. *Pertanika J. Soc. Sci & Hum.13*(1):1-8.

Awang Noor Abd. Ghani & Mohd. Shahwahid, H. O. (1995). *Estimation of Stumpage Values in Three Concession Compartments of MUDA/PEDU Watershed Area*. Paper presented at the First Workshop on "Kajian Kesan Pembalakan Terhadap Waduk Di Hutan Simpan Ulu Muda", 23 January, 1995, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia.

Awang Noor Abd. Ghani & Mohd. Shahwahid H. O. (1996). *Forest Valuation: Malaysia-AIFM Pilot Project*. Final Report Submitted to ASEAN Institute of Forest Management and Forestry Department Peninsular Malaysia, Kuala Lumpur.

Awang Noor Abd. Ghani & Mohd. Shahwahid, H. O. (1999). *Price-Based Valuation Methods: Stumpage Appraisal of Timber Resources from Peat Swamp Forest*. In Mohd Shahwahid H.O. (ed) Chapter 4 Manual on Economic Valuation of Environmental Goods and Services of Peat Swamp Forests. Pg 47-55. Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forests, Peninsular Malaysia. Forestry Department, Peninsular Malaysia and Danish Cooperation on Environmental Development (DANCED)

Awang Noor, A. G., Jamal, O., Mohd Shahwahid, H. O., Redzuan, O., & Nik Hashim, N. M. (1999). *The Value of Timber Resources from the Matang Mangrove Forest Reserves, Malaysia*. Paper circulated at the United Nations Environmental Program (UNEP) and Malaysian-Thai Training in Environmental Management (THAITREM-MATREM) Meeting. Phuket, Thailand. 28-30 August 1999.

Awang Noor Abd. Ghani, Mohd Azmi Mohamed Idris, Mohd. Shahwahid Hj. Othman, Salleh Mat, Abd. Rahim Hj. Nik & Ahmad Fauzi Puasa. (2000*). Costs Incurred for the Management of NTFPs and Environmental Services*. Paper Prepared for the Workshop 4 on ITTO Project PD 31/95 Rev.3(F): A Model Project for Cost Analysis to Achieve Sustainable Forest Management, 21 September, 2000, Palace of Golden Horses, Seri Kembangan, Selangor.

Awang Noor A. G. (2007). *Overview of Forest Valuation Studies in Malaysia*. Paper presented at the "Seminar on Economic Valuation of Forest Goods and Services 2007", Hotel Grand Continental, Terengganu from December 15 - 18, 2007.

Awang Noor A. G., Mohd Yusrizal H., Tuan Marina T. I. & Mohd Syauki M. S. (2007). *Economic Valuation of Recreation Benefits in Chamang Forest Recreation Area, Bentong, Pahang*. Paper presented at the "Seminar On Economic Valuation of Forest Goods and Services 2007", Hotel Grand Continental, Terengganu from December 15 - 18, 2007.

Chew Y. F. (1996). *The Potential for Peat Swamp Forests to Support the Aquarium Fish Industry*. Wetlands International – Asia Pacific publication.

Chung, K. S. (1982). *Estimating the Demand Curves of Bako, Niah and Lambir National Park in Sarawak*. Sarawak Forest Department Headquarters Publication. Kuching.

Dayang Affizah A. M., Alias R. & Siti Baizura J. Z. (2007). The Economics of Recreational Park Conservation: A Case Study of Bako National Park. *The ICFAI Journal of Environmental Economics V*(1):44-56.

Duraitah Likit. (2007). *Valuation of Recreation Benefits Using Travel Cost Method in Leantang Forest Recreation Area, Pahang*. B.For.Sc. Thesis. Faculty of Forestry, Universiti Putra Malaysia. Serdang, Selangor.

Forestry Department Headquarters Peninsular Malaysia. (2007). Forestry Statistics Peninsular Malaysia.2006. Kuala Lumpur Gianno, R., 1990. Semelai Culture and Resin Technology. *Memoirs of the Connecticut Academy of Arts and Sciences, Vol. XXII*. New Haven, Connecticut.

Gorhan. (1997). *Economic Issues of Ecotourism in Malaysia, With Special Reference to Kenong Rimba Park WWF*, Report 1997

Hii, Y.F. (1995). *The Optimal Rotation Length of Acacia Mangium Plantation.* B.For.Sc. Thesis. Faculty of Forestry, Universiti Pertanian Malaysia. Serdang, Selangor.

Jabatan Hal Ehwal Orang Asli 2005. Status of Orang Asli in Pahang.

Jamal O. (1997). *Market Forces VS Policies in Wetlands Management: The Case of Firefly's Recreation in Kg. Kuantan, Malaysia Can Economic Valuation Sheds Some Light?*. Paper presented at the Beijer Research Seminar, Kota Kinablau, Sabah. 23-25 May, 1997.

Jamal O. & Redzuan O. (1998). Economic Benefits from Wetland Biodiversity: Case of Fireflies Recreation, Malaysia. *Tropical Biodiversity 5*(1):65-74.

Jamal O., Mohd Shahwahid H. O., Awang Noor A. G., Redzuan O. & Nik Hashim N. M. (1999). *Application Of Choice Modeling to Assess the Economic Value of the Conservation of Matang Mangrove Forests, Malaysia*. Paper circulated at the United Nations Environmental Program (UNEP) and Malaysian-Thai Training in Environmental Management (THAITREM-MATREM) Meeting. Phuket, Thailand. 28-30 August 1999.

Jamal O. & Shahariah A. (2003). *The Economics of Wetlands Conservation: Case of Paya Indah Wetlands, Malaysia.* International Ecotourism Conference organized by SEAMEO-SEARCA and UPM, Bangi, Malaysia.

Kumari, K. (1995). An Environmental and Economic Assessment of Forest Management Options: A Case Study in Malaysia. Environment Department*, Environmental Economics Paper No. 026*. World Bank. Washington, D.C.

Kumari, K. (1995). Mainstreaming Biodiversity Conservation: A Peninsular Malaysia Case. Int. J. Sustain. *Dev. World Ecol. 2*:182-198.

Kumari, K, Dan Y. May & Tuan Marina T. I. (1998). *Economic Significance of Medicinal Plants in Peninsular Malaysia*. Department of Forestry Peninsular Malaysia Publication. Kuala Lumpur.

Lim Hin Fui & Mohd Parid Mamat, (1999). *The Socio-conomic Impacts of North Selangor Peat Swamp Forests Utilisation on Local Communities*. In Mohd Shahwahid (ed) Manual on Economic Valuation of Environmental Goods and Services of Peat Swamp Forest. Malaysian–DANCED Project on Sustainable Management of Peat Swamp Forests. Forestry Department Headquarters, Peninsular Malaysia.

Lim Hin Fui, Woon Weng Chuen & Mohd Parid Mamat, (1999a). *The Socio-economic Impacts of North Selangor Peat Swamp Forests Utilisation on Local Communities*. In Chin Tuck Yuan and Palle Havmoller (ed), *Sustainable Management of Peat Swamp Forest in Peninsular Malaysia: Volume II*. Forestry Department Peninsular Malaysia.

Lim Hin Fui, Woon Weng Chuen & Mohd Parid Mamat, (1999b). *The Socio-economic Impacts of Southeast Pahang Peat Swamp Forests Utilisation on Local Communities*. In Chin Tuck Yuan and Palle Havmoller (ed), *Sustainable Management of Peat Swamp Forest in Peninsular Malaysia: Volume* II. Forestry Department Peninsular Malaysia.

Mackinna. (1995). B.For.Sc. Thesis. Faculty of Forestry, Universiti Pertanian Malaysia. Serdang, Selangor.

McNally R., & Mohd Shahwahid H. O. (2003). *Practical Economics: A Guide to Valuing the Environment and Influencing Policy*. World Wide Fund for Nature United Kingdom (WWF, UK) and Universiti Putra Malaysia. Second edition. Serdang. 120 p.

Mohd Akbar J. & Rusnah R. (1997). *Water Quality: What Its Worth*. Paper presented at World Water Day 1997, Kuching, Sarawak.

Mohd. Khidir Majid. (1995). *Economic Valuation of Ulu Bendul Recreational Forest in Negeri Sembilan*. B.S. Project. Faculty of Forestry, Universiti Pertanian Malaysia. Serdang, Selangor.

Mohd Parid Mamat. (2008). *Economic Valuation of Nature Tourism Area of Pulau Redang Marine Park, Terengganu.* M.S. Thesis Faculty of Forestry, Universiti Putra Malaysia, Serdang, Selangor

Mohd Shahwahid H. O. & Nik Mustapha R. A., (1991). Economic Valuation of Wetland Plant, Animal, and Fish Species of Tasek Bera and Residents' Perceptions on Development and Conservation. *AWB Publication No. 77*.

Mohd. Shahwahid H. O. (1992). Economic Valuation of Forest Species utilisation. MPTS Research Notes 2(4*). Bulletins on Multipurpose Tree Species and Their Management, Forestry/Fuelwood Reserach and Development (F/FRED), Bangkok, Thailand*.

Mohd Shahwahid H. O. (1995). *The Incremental Costs of Biodiversity Conservation in the Kuala Selangor Wetlands, Malaysia*. International Conference on Wetlands and Development. 8-14 October. 1995. Kuala Lumpur.

Mohd Shahwahid H. O. (1996). Community Profile Survey of the Semelai Population at Tasek Bera. Integrated Management of Tasek Bera. *Technical Report Series No. 1*, Wetlands International - Asia Pacific. K.L

Mohd Shahwahid H.O. (1997). *Valuation of Recreational Forest: The Case for Air Hitam Forest Reserve*. Manuscript Prepared for IRPA Research Grant No. 01-02-04-0183: Economic Valuation of Forestry Goods and Services, Faculty of Forestry, Universiti Putra Malaysia, Serdang, Selangor.

Mohd Shahwahid H. O. (1997). Chapter 6 "Conservation and Land Use in Kuala Selangor Wetlands, Malaysia." In Giesen W. & King, K. (eds.) 1997. *Incremental costs of Wetland Conservation*. Pp 109-120. Global Environment Facility, Washington D.C. and Wetlands International, Kuala Lumpur.

Mohd Shahwahid H. O. (1998). *Economics of Fishing, Natural Product Exploitation and Shifting Cultivation at Tasek Bera.* Integrated Management of Tasek Bera Technical Report Series No. 2 Wetlands International - Asia Pacific. K.L.

Mohd Shahwahid H.O. (1998). *Valuation of Forest Collecting and Shifting Cultivation Activities at Tasek Bera RAMSAR Sanctuary*. Report submitted to Wetlands International – Asia Pacific. K.L.

Mohd. Shahwahid Hj. Othman, Awang Noor Abd. Ghani, Rusli Mohd, Shukri Mohamed, Faridah Hanum Ibrahim & Mohamed Zakaria Hussin. (1998). Valuing the Recreational Benefits of the Air Hitam Forest Reserve, Selangor. *The Malaysian Forester. 61*(1):38-48.

Mohd Shahwahid H.O. & Awang Noor A.G. (1999). 'Estimating The Non-Timber Value of Forest: Beginning with Natural Stands of Rattan'. *Tropical Biodiversity 6* (3):161-177.

Mohd Shahwahid H. O. & Awang Noor A. G. (1999). Rent Capture in Rattan Production in Peninsular Malaysia*. Journal of Tropical Forest Products 5* (1):10-19.

Mohd Shahwahid H. O.& Jamal O. (1999). Malaysia. In Glover D. and Jessup T. (1999) *Chapter 3 of Indonesia's Fires and Haze: The Cost of Catastrophe*. Institute of Southeast Asian Studies, Singapore.

Mohd Shahwahid H. O., Awang Noor A. G. & Chew C. G. (1999). *On-site and Off-site Losses of Soil Erosion from Crop Cultivation in Highland Catchments: Case of Cameron Highlands, Malaysia*. Paper presented at the Environmental Economics Seminar Series, Department of Economics, Goteborg University, Sweden. October 21, 1999.

Mohd Shahwahid H. O., Jamal O. Awang Noor A. G., Redzuan O. & Nik Hashim N. M. (1999). *Application of Travel Cost Method to Assess the Economic Value of Sport Fishing Recreation at the Matang Mangrove Forest Reserves, Malaysia*. Paper circulated at the United Nations Environmental Program (UNEP) and Malaysian-Thai Training in Environmental Management (THAITREM-MATREM) Meeting. Phuket, Thailand. 28-30 August 1999.

Mohd Shahwahid H. O. & Awang Noor A. G. (1998). Economic Rent from Hardwood Timber Extraction in the West Coast of Peninsular Malaysia. *Malaysian Journal of Agricultural Economics (MJAE) Vol 12*: 1-15.

Mohd Shahwahid H. O., Awang Noor A. G., Ahmad Fauzi, P., Abdul Rahim N., Salleh M., Muhammad Farid, A. R., Mohammad Azmi, M. I. & Amir S. (2002). *Incremental Cost of Complying with Criteria & Indicators for Achieving Sustainable Forest Management*. In Enters, P., Durst, P. B., Applegate, G. B., Kho, P. C. S. and Man, G. (ed.) Proc. Applying reduced impact logging to advance sustainable forest management. *International Conf. Organized by Food and Agricultural Organization of the United Nations, Regional Office for Asia and the Pacific.* Kucing 26/2-1/3 2001. Pg 282-294. RAP Publication 2002/14

Mohd Shahwahid. (2005). *Paper presented at the Third Stakeholder Workshop on The Project Towards the Establishment of the Selangor State Park*. Pan Pacific Hotel, Glenmarie Shah Alam.

Mohd Shahwahid H. O. & Awang Noor A. G. (2005). *Socio-economics of the Non-Timber Forest Products (NTFP) Dependence of the South East Pahang Peat Swamp Forest for Local Communities*. Conservation and Sustainable Use of Tropical Peat Swamp Forests and Associated Wetland Ecosystems. UNDP/GEF funded project

Mohd Shahwahid H. O., Suhaimi A. R., Rasyikah & Farah M. S. (2007). *Rainwater Utilization in Malaysia: Development of Policy, Incentives and By-Law*. Report submitted to the National Hydraulic Research Institute Malaysia. Seri Kembangan.

Mohd Shahwahid H. O. Poh Lye Yong & Teddy Sius @ Lawrencius. (2007). *Economics of Tourism in Kuala Gandah Elephant Conservation Centre.* Paper presented at the "Seminar on Economic Valuation of Forest Goods and Services 2007", Hotel Grand Continental, Terengganu from December 15 - 18, 2007.

Mohd Shahwahid. (2008). *Valuing the Environmental Ecosystem Services of the Malaysian Forest and the Potential Impacts of Deforestation on Water Availability in Malaysia*. Report submitted to Global Canopy Programme, Oxford.

Mohd Shahwahid (2008). *Mainstreaming the Environment: Incorporating Economic Valuation and Market-Based Instruments in Decision Making*. Universiti Putra Malaysia Inaugural Professorial Series. UPM Press. Serdang

Muhd Rusli Yaacob. (2002). *Economic Valuation of the Externality from Logging in Muda & Pedu Water Catchment, Kedah*. M.S. Thesis. Faculty of Economics and Management. UPM. Serdang

Nik Mustapha, R. A. (1993). Valuing outdoor recreational resources in Tasik Perdana using dichotomous choice contingent valuation method. *Malaysian Journal of Agricultural Economics* 10 (December):39-50.

Norlida Hanim Mohd. Salleh & Jamal Othman. (2000). *Evaluation of Forest Recreational Resource: Case of Taman Negara, Malaysia*. Paper Present at the First Conference of Resource and Environmental Economics 29-31 July, 2000, Ayer Keroh, Malacca.

Pahang State Forestry Department. (2007). *Pahang State Forest Management Plan. Kuantan Pearce*, D. W. and E. Barbier., 2000. Blueprint for a sustainable economy. Earthscan, London, U.K.

Pearce, D. W. & E. Barbier., (2000). Blueprint for a sustainable economy. Earthscan, London, Pinard, M. Putz, F. Tay, J. and Sullivan, T. 1995. Creating Timber Harvest Guidelines for a Reduced Impact Logging Project in Malaysia. *Journal of Forestry*, 1995 October.

Poh L. Y. & Mohd Shahwahid H. O. (2007). *Economic Value of Honey Bees, Peninsular Malaysia*. Forestry Department Peninsular Malaysia Publication. Kuala Lumpur.

Poh L. Y., Mohd Shahwahid H. O. & Teddy Sius @ Lawrencius. (2008) (in print). *Economic Valuation of Forest and Elephant Conservation*. Forestry Department Peninsular Malaysia Publication. Kuala Lumpur.

Redzuan O., Jamal O., Mohd Shahwahid H. O., Awang Noor A. G. & Nik Hashim N. M. (1999). *The Recreational Value of Migratory Bird Viewing at the Matang Mangrove Forest Reserves, Malaysia*. Paper circulated at the United Nations Environmental Program (UNEP) and Malaysian-Thai Training in Environmental Management (THAITREM-MATREM) Meeting. Phuket, Thailand. 28-30 August 1999.

Roslan I. (1995). An Economic Evaluation of Carbon Emission and Carbon Sequestration for the Forestry Sector in Malaysia. *Biomass and Bioenergy 8*(5):281-292.

Rusmani M. (2001). *Penilaian Khidmat Persekitaran: Kes Rekreasi Kelip-Kelip Kg. Kuantan, Kuala Selangor, Selangor*. M.S. thesis. Faculty of Economics, Universiti Kebangsaan Malaysia, Bangi.

Sabariah, Z. (1989). *Kajian Ethnobotani di Tiga Kampung, Daerah Sering, Kota Baru, Kelantan*. In Soepadmo, E. Goh, S.H., Wong, W.H., Laily, D., and Chuah, C.H. (eds). Malaysian Traditional Medicine. Proceedings of the Seminar on Malaysia Traditional Medicine, 10-11 June, 1988. Institute of Advanced Stiudies, University of Malaysia and Malaysian Institute of Chemistry, Kuala Lumpur

Tee Shy Shan. (2002). *Economic Valuation Of Forest Recreation Benefit Of Sungai Congkak Recreation Forest, Selangor Using Travel Cost Method.* BSC. Thesis. Faculty of Forestry, Universiti Putra Malaysia, Serdang.

Terengganu State Forestry Department. (2002). Comments to Forest Management Audit Report by SGS (Malaysia) Sdn Bhd.

United Nations. (2005). Millenium Development Goals. Retrieved from http: //www.un.org/ millenniumgoals/

Vincent, J. R. (1990). Rent Capture and the Feasibility of Tropical Forest Management. *Land Economics 66*(2):212-223.

Vincent, J. R., Wan L. F., Chang Y. T., Nooriha M., & G. W. H. Davison. (1993). *Malaysian National Conservation Strategy-towards Sustainable Development. Volume 4: Natural resource Accounting*. Economic Planning Unit, Prime Minister's Department, Kuala Lumpur.

Willis, K.G., G.D. Garrod & Chee Tong Yiew. (1998). *Valuation and Analysis of Consumer Demand for Recreation Areas in Peninsular Malaysia*. In Pp: 300-319. Conservation, Management and Development of Forest Resources, Proceedings of the Malaysia-United Kingdom Programme Workshop, 21-24 October 1996. Forest Research Institute Malaysia, Kuala Lumpur.

Woon, W. C., & Poh, L. Y. (1998). *The Economic Value of Parkia Specioca (Petai) in Peninsular Malaysia*. Forestry Department Peninsular Malaysia, Kuala Lumpur.

Woon Weng Chuen & Mohd. Parid Mamat. (1999). *Economic Valuation of Protective and Productive Functions of the North Selangor Peat Swamp Forest (NSPF).* In Mohd Shahwahid (ed) Manual on Economic Valuation of Environmental Goods and Services of Peat Swamp Forest. Malaysian–DANCED Project on Sustainable Management of Peat Swamp Forests. Forestry Department Headquarters, Peninsular Malaysia.

Woon Weng Chuen, Lim Hin Fui & Mohd. Parid Mamat. (1999). *The Economic Valuation of Protective and Productive Functions of the North Selangor Peat Swamp Forest (NSPF).* In Chin Tuck Yuan and Palle Havmoller (ed) Sustainable Management of Peat Swamp Forest in Peninsular Malaysia: Volume II. Forestry Department Peninsular Malaysia

Woon Weng Chuen, Lim Hin Fui & Mohd. Parid Mamat. (1999). *The Economic Valuation of Protective and Productive Functions of the Southeast Pahang Peat Swamp Forest (SEPPSF).* In Chin Tuck Yuan and Palle Havmoller (ed) Sustainable Management of Peat Swamp Forest in Peninsular Malaysia: Volume II. Forestry Department Peninsular Malaysia

WWF Malaysia 2003a. WWF Malaysia Position Statement. 29 May 2003.

WWF Malaysia 2003b. WWF Malaysia Position Statement. 10 October 2003.

THE STATUS OF FOREST IN WATERSHEDS OF PAHANG: A SPATIAL APPROACH

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Dr. Ismariah binti Ahmad

ABSTRACT

Maintaining supplies of clean water and protecting watersheds were major reasons for conserving the forest areas as forests are keys to clean water. The demand for water gradually increases as the population grows. However, the sources of raw water have been steadily decreasing due to the destruction of the catchments areas and pollution of rivers as well as the incidence of drought and illegal logging activities. Consequently, it turns out that the quality of raw water seems to decline and has caused the costs of water treatment to escalate. This study examines the status of forest area in Pahang's watersheds over 40 years. The process is a ground work to assess the impacts of forest cover on the raw water treatment costs. The water catchments were delineated based on the 82 Water Treatment Plants (WTP) located in Pahang using Geographic Information System (GIS). The National Forest Inventory (NFI) I, II, III and IV were used as the basis of forest cover information for each water catchment. Preliminary results show that forest areas in the superior, good, moderate, poor and mountain forest categories in Pahang's watershed had gradually decreased by 46% between NFI I and NFI IV due to deforestation. The results are useful to estimate the economics of water supply for Pahang State.

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1.0 INTRODUCTION

Water is one of the most important resources we obtain from forests. It is vital for all living things where much of the world's drinking water comes from watersheds that are naturally forested.

Forest resource have been one the major sources of revenue for Malaysia economy, however it is decreasing every year. Factors responsible for forest degradation in Malaysia are shifting cultivation, commercial logging and forest encroachment. As such it is important to monitor the extent and pattern of changes in forest cover over the years in Malaysia. Forest cover changes or deforestation have an effect on degradation of the watershed. When forest mountains are denuded, watersheds are degraded and this leads to the loss of sustained water supplies for lowland communities.

Beside the importance of forest for sustaining water supply, the protection of forest in a catchment helps to reduce the cost for water treatment. Forests in a catchment determine the quantity, rate and the quality of the water which flows into streams and hence into dams. Logged and forest activities would tremendously effects the forest condition such as increase sediments and soil erosion. Additionally, the areas that have been logged could not sustain water as compared to the area with forest. Thus, the logging or forest conversion activities possibly will affect the quality and quantity of water supply.

Although the forests are managed as a water catchment, they also have a number of other values such as wildlife and nature conservation, timber production, education, tourism, recreation and research. Careful management is necessary to ensure that our present and future water needs can be met. The sustainable management practices for watershed and land use have to be applied in order to fulfill the demand between watershed and land use, where protecting water resources is communities demand and land use is a priority to local needs in relation to regional issues.

The objective of this paper is to present information on forest changes in water catchments areas of Pahang. The results provide preliminary physical information of the status of forest in water catchment area in order to assess the impacts of forest to water treatment cost.

2.0 MATERIALS AND METHODOLOGY

Material used in this study comprises of a complete set of National Forest Inventory I, II, III and IV for Pahang provided by the Forestry Department, the Water Treatment Plant's locations and other supporting spatial data to develop the catchment for each WTP such as a river layer and the Digital Elevation Model (DEM). The WTP information was gathered from the Pengurusan Air Pahang Berhad (PAIP), the authoritative agency for water supply in Pahang and the Department of Water Supply (JBA).

The state of Pahang can be subdivided into five major river systems namely Sg. Pahang, Sg. Kuantan, Sg. Besar, Sg. Rompin and Sg. Endau. Within Pahang, due to the large area and distance between townships and villages, most of the water supply is generally abstracted from nearby rivers and streams and being distributed on the district basis. The majority of schemes draws from single river intakes and therefore depended on the sufficiency of flows under drought conditions (National Water Resources Study 2000-2050, 2000). There are about 82 WTP widely dispersed throughout the state that supply treated water to consumers in urban and rural areas of Pahang.

Geographic Information System (GIS) is the main analysis used for this study. The processing of data involved the digitisation of each WTP locations, delineation of catchment area for each WTP and the analysis of forest changes in the catchments. All 82 WTP locations (Figure 1) were digitised based on the coordinates. The summary of number of WTPs is listed in Table 1. The information was used to derive several data sets that collectively describe the drainage patterns of the catchments. Raster analysis was performed to generate data on flow direction, flow accumulation, stream definition and watershed delineation.

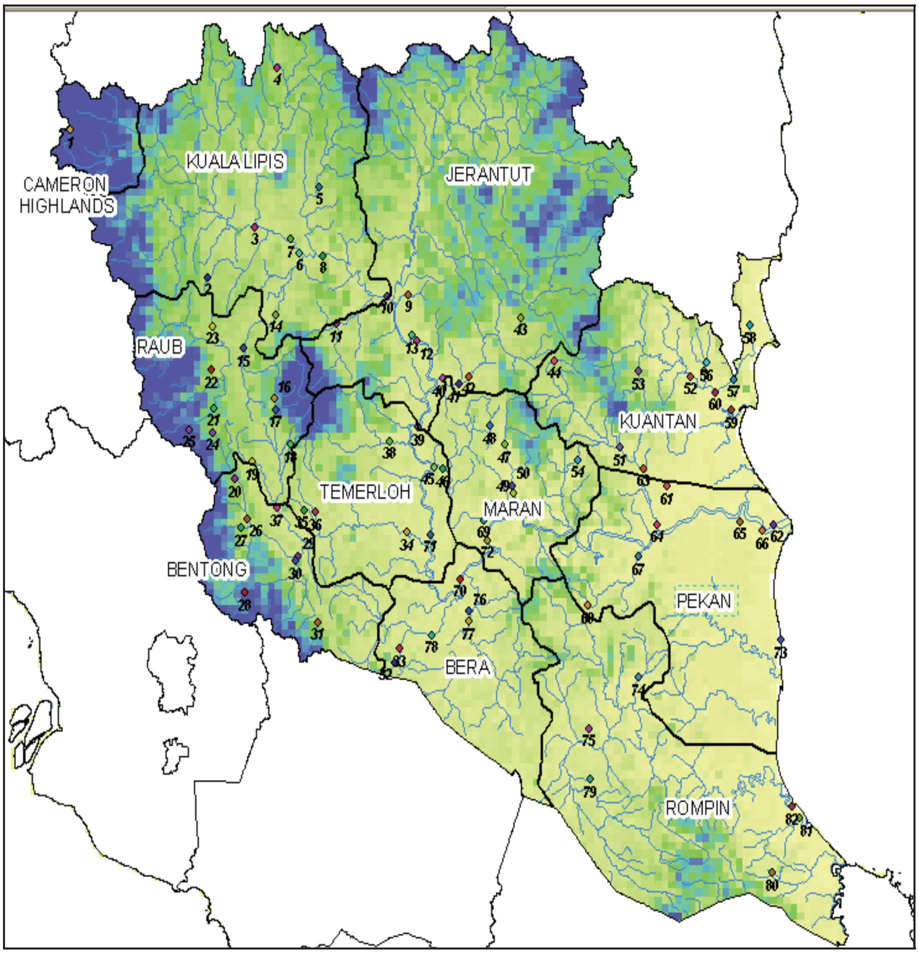

Figure 1: WTP distribution

Table 1: Number of WTPs by district

District	No. of WTP
Cameron Higland	1
Temerloh	8
Kuantan	11
Pekan	9
Maran	6
Bera	4
Bentong	11
Raub	9
Rompin	6
Kuala Lipis	8
Jerantut	9
Total	**82**

The catchments were then overlaid with the NFI information to obtain the area of forested area in a catchment. All four NFI I, II, III and IV (Figure 2) information were analysded to assess the changes of forest area per catchments unit. The based year for each NFI are 1972 (NFI I), 1982 (NFI II), 1991 (NFI III) and 2002 (NFI IV).

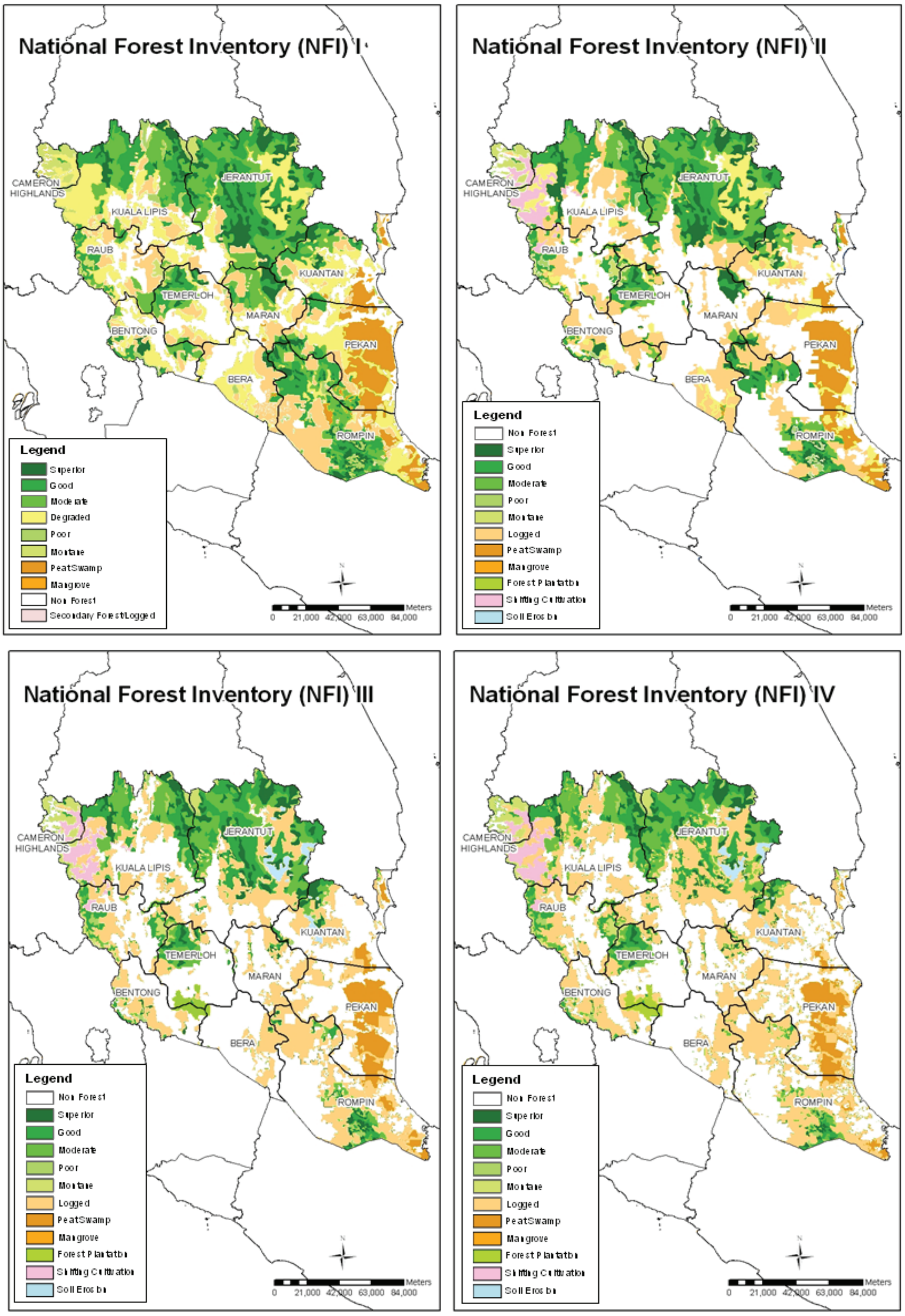

Figure 2: National Forest Inventory (NFI) I, II, III, IV for Pahang

3.0 RESULTS AND DISCUSSION

Forest offers a range of option for water provision and often provide basis for integrated management of water resources. The effects although vary from place to place and it is important for us to analyse by each catchment to gain information and knowledge of the types and age of trees, soil condition and user need that can help to design the forest management policies will be most beneficial for each site.

A total of 82 WTP has generated about 2,801,519 hectares of catchments. Most of the catchments are distributed along the main river of Pahang. There are also two catchments located in Negeri Sembilan as the river network shares the boundaries. Result of delineated catchments is shown in Figure 3. The largest catchment recorded is 431,125.34 ha. The results presented in this paper will cover all 82 WTP catchments being delineated.

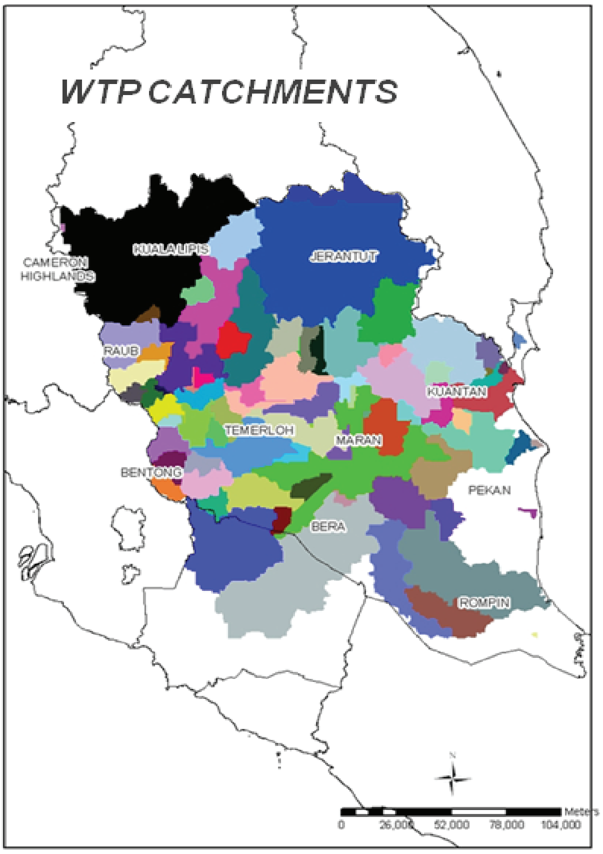

Figure 3: Catchments delineated from WTPs in Pahang

The analysis of forest types by National Forest Inventory shown in Figure 4. There are five major inland forest namely superior, good, moderate, poor and mountain forests. Overall changes of each forest type for 82 catchments are shown in Table 2.

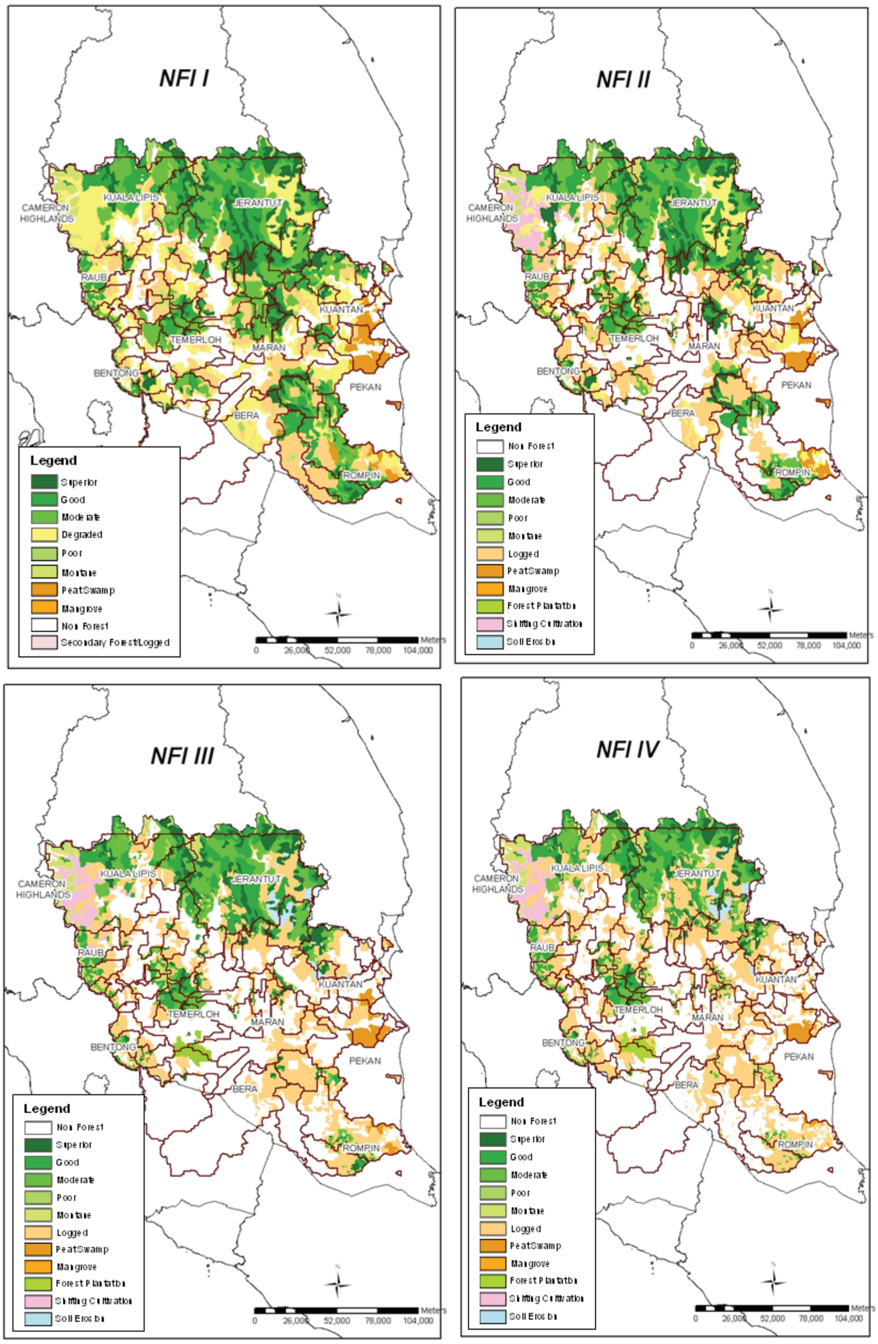

Figure 4: NFI I-IV per catchments in Pahang

The changes of forest for NFI IV in comparison to NFI I recorded are about 119 thousand ha for superior, 221 thousand ha, 226 thousand ha, 17 thousand ha and 5 thousand ha for good, moderate, poor and mountain forests respectively. The huge forest changes experienced for poor and moderate forest reduced as much as 51%, followed by the superior and good forest which recorded 46%. A 6% change occured in mountain forest, which is acceptable because logging activities are prohibited in highland areas plus most of the mountain forests area gazetted as Forest Reserve.

Other two lowland forests are peat swamp and mangrove. Pahang has quite large areas of peat swamp forest mainly in Pekan. Over 82 catchments, there were about 55 thousand ha peat swamp and declined to only 26 thousand ha or 52%. However, Mangroves show improvement in terms of the area planted from 230 ha to 10 thousand ha recorded in NFI IV for all the catchments. The increase of mangrove was about 376.4%.

Other important forest land uses listed in NFI are shifting cultivation, soil erosion and forest plantation (for NFI III and NFI IV). Based on the analysis of 82 catchments, the area of shifting cultivation and soil erosion declined to 19 thousand ha and 15 thousand ha equivalent to 22% and 34% respectively. The condition of area declining for shifting cultivation and soil erosion verify a good sign which show that our forest are less degraded compare when it in early 80's. Forest plantation started in NFI III and no changes are recorded in between both NFI III and IV.

Results show that most of Pahang's forested area been reduced up to an average of 50% due to logging activities and conversion to other land uses. The information of forest cover in a catchment unit are important to see the impact of the forest changes and conversions to water quality and quantity thus affecting the cost of water treatment. This study provides preliminary information of forest status for water supply catchments.

Table 2: Area of forest cover for 82 catchments by NFI I-IV (in hectares)

	Forest Cover Type									
NFI	**Superior**	**Good**	**Moderate**	**Poor**	**Montane**	**Peat Swamp**	**Mangrove**	**Shifting Cultivation**	**Soil Erosion**	**Forest Plantation**
NFI I	258,129.99	477,732.33	443,446.65	33,911.46	80,599.05	55,643.76	230.04	86,551.74	45,374.58	NA
NFI II	258,856.56	391,386.33	296,360.37	21,417.21	74,776.77	50,603.13	0.00	73,785.33	40,824.00	NA
NFI III	173,465.55	294,949.35	240,914.25	19,120.05	77,482.98	36,295.29	68.04	69,832.53	34,733.61	20,403.09
NFI IV	138,987.9	256,625.01	217,054.89	16,518.33	75,559.23	26,452.98	1,095.93	67,502.16	29,909.25	20,246.76
Changes (NFI I-IV)	-119,142.09	-221,107.32	-226,391.76	-17,393.13	-5,039.82	-29,190.78	865.89	-19,049.58	-15,465.33	-156.33
% Changes	-46.2	-46.3	-51.1	-51.3	-6.3	-52.5	376.4	-22.0	-34.1	-0.8

4.0 CONCLUSION

The analysis shows that forested area in Pahang's water supply catchments decreased to 46% for superior and good forest, 50% for moderate, poor and peat swamp forest. However, mountain and forest plantation recorded less changes and mangrove increased greatly. Shifting cultivation and soil erosion showed better results such as 22% and 34% respectively. The results by catchments unit provide information for catchment scale basis. There reported that, scale of a catchments have impacts on the quality and quantity dimension of water supply. This study will further investigate the impacts of scale to water quality and quantity thus affecting the treatment cost.

Forests play an important role in protecting and sustaining the water supply in catchments. It provides benefits in term of quality and quantity of the water delivered to the users. Therefore, the best management practices of forest in the catchments area need to be applied. For responsible water supply and forest management the real benefits of forested area in offering the good water supply should be identified. Once the potential benefits of forested watershed are recognised, a number of different option management exists such as protection, sustainable management and restoration. The decisions will need to take into consideration the competing demands on land, so that management for water will have to be balanced and traded off with other uses.

REFERENCES

Pattanayak, S. K. & Kramer, R. A. 2001. "Worth of Watersheds." *Environment and Development Economics* 6:123-146.

Review of the National Water Resources Study (2000-2050) and formulation of National Water Resources Policy, 2011.

William N. (2000). *Agricultural and Small Watershed Hydrology: Watershed Characteristic*. Retrieved from http://www.egr.msu.edu/~northco2/WshedChar.html (assessed February 2010)

ECONOMIC VALUE OF CONSERVATION OF TOTALLY PROTECTED AREAS: SPECIAL REFERENCE TO ECONOMIC VALUE OF WATER FOR HYDRO ELECTRICITY GENERATION, BATANG AI NATIONAL PARK SARAWAK*

Abd. Wahab bin Bujang
Abg Ahmad bin Abg Morni
Happysupina bin Sait

ABSTRACT

Conservation and management of Totally Protected Areas (TPAs) is one of the core activities of the Forest Department of Sarawak. There are various justifications put forth, among others are the sustainable management and preservation of the ecological functions of TPAs. Batang Ai National Park serves as the domain for the various headwaters and the supplier of water resource for the operation of hydroelectric power (HEP) generation at the Batang Ai HEP of Sarawak Energy Berhad. The study attempts to estimate the economic value of water used for generating electricity at Batang Ai HEP applying the Residual Imputation Approach which entails the identification of incremental contribution of each input to the total value of output or the residual value of water whereby "profit maximizing producer" is assumed to add productive inputs until the point when the Value Marginal Products (VMPs) are equal to opportunity costs of the inputs. Findings of the study shall provide indicative economic parameters for more informed decision-makings as regard to the allocation of land-based resources such as forests among major land-uses.

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WILLINGNESS TO PAY BY UPSTREAM HOUSEHOLD FOR WATERSHED PROTECTION IN LANGAT BASIN, SELANGOR

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Prof. Emeritus Chamhuri Siwar[2]

ABSTRACT

Watersheds provide ample environmental services to water users including provision of aquatic foods, flood prevention, watershed protection, soil formation, nutrient cycling, landscape beauty, carbon sequestration and as habitat for biodiversity. However, watershed degradation appeared as one of the most serious natural resource predicament with long term disturbance to the environment and socioeconomic of the communities. The Malaysian watersheds are in alarming stage. Furthermore, river basin water qualities are being subjected to pollution caused by industries and land development activities. Moreover, the needs for economic valuation in the decision-making process are still lacking. Together with this, failure to measure environmental loss in current market price causes overexploitation of environmental services and free rider dilemma. Therefore, implementation of payment mechanism for environmental services secures sustainable use of natural resources. PES can provide an incentive for landowners to maintain upstream ecosystems using effective land management while providing new revenue option for protection of environmental services and that, through the use of market mechanisms. Using Contingent Valuation Method (CVM) upstream households were asked to state their willingness to pay (WTP) for conserving watershed protection service in Langat Basin, Selangor. A worthy goal of this study can contribute for decision makers to set up sustainable payment mechanism of environmental services for watershed protection.

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1.0 INTRODUCTION

Watersheds provide ample environmental services to water users including provision of aquatic foods, flood prevention, watershed protection, soil formation, nutrient cycling, landscape beauty, carbon sequestration and as habitat for biodiversity. However, watershed degradation appeared as one of the most serious natural resource predicament with long term disturbance to the environment and socio-economic of local communities. The Malaysian watersheds are in alarming stage. Furthermore, river basin water qualities are being subjected to pollution caused by industries and land development activities. Based on Department of Environment (DOE), river water quality report in 2008, out of 143 river basins monitored 58% considered clean, 38% considered slightly polluted and 4% considered polluted. Langat Basin as slightly polluted river basin with 75 Water Quality Index (WQI) which potential to become polluter river basin.

Table 1: Langat River Basin qualities in Malaysia, 2008

State	River Basin	Number of station	Overall WQI	River	River Status	Class
Selangor	Langat	28	75	AnakChuau	SP	II
				Balak	SP	III
				BatangBenar	SP	III
				BatangLabu	SP	II
				BatangNilai	P	III
				Beranang	C	II
				Buan	SP	II
				Chuau	C	II
				Jijan	C	II
				Langat	SP	III
				LimauManis	SP	III
				Lui	C	II
				Pajam	SP	II
				Rinching	SP	III
				Semenyih	C	II

Source: Department of Environment Malaysia, 2008
*C: Clean, SP: Slightly Polluted, P: Polluted

Research Purpose and Objectives

The purpose of this study is to assess the willingness to pay (WTP) of upstream household for conserving watershed protection service in Langat Basin, Selangor. Environmental economic tools were used to quantify economic values of watershed protection function. The valuation and evaluation of watersheds in Malaysia are very important consecutively to ensure Malaysians today do their part for future Malaysians through prudent management and conservation of existing resources. Besides, it is crucial to do economic valuation exercise for effective implementation of sustainable market mechanism. Development of environmental valuation in Malaysia has been rapid and it is increasingly used not only focusing on forest and recreational benefits but also on other sector such as waste management and wetland benefits (Jamal, 2002).

Valuation can assist the government to allocate scarce resources to achieve economic, environmental and social goals. Decision makers constantly operate within restricted time frames, their windows of opportunity are limited by the election cycle and they often have to take decisions in situations where not all of the information is available. Economic valuation studies are critical to assist decision makers in making fair and transparent decisions.

In order to achieve the purpose explained above, the following primary objective of this research is:

- To assess economical valuation of forested watershed services;
- To analyse the condition of existing forested watershed services in Langat Basin; and
- To identify demographic factors influencing WTP of Langat Basin upstream households'.

Research Question

In the process of valuing watershed protection of upstream Langat Basin, the research questions that need to be answered are:

- What are the issues and problems watershed services in Langat Basin?
- What are the economic values of forest watershed services in Langat Basin?
- What are the upstream households' demographic factors influencing WTP of Langat Basin?

2.0 THE SIGNIFICANCE OF THE RESEARCH

Valuation Method Perspective

Valuation of non-marketed goods divided into revealed preference methods and stated preference methods. Revealed preference method infers that the value of non-marketed good by studying actual (revealed) behavior on a closely related market, (Mohd Rusli et al., 2008). Meanwhile, stated preference methods include Contingent Valuation Method (CVM), Choice Experiment (CE) and this study will provide a full range of the economic value for watershed protection function. The measurement of economic value of Langat Basin undertaken through stated preference method.

Valuation of ecosystem services can be used to set charges for the use of those goods and services. Setting value plays a double role in terms of environmental management. It help to control the exploitation of environmental resources, for example the more a resource costs the less it is used and simultaneously generate revenue that can be used to pay for management, protection and restoration of the ecosystem. Valuation results can be used to set charges at the most desirable level.

3.0 STUDY AREA

River basins are therefore based on natural, hydrological boundaries rather than on administrative or political divisions, and are the most appropriate units for the planning, conservation and sustainable use of freshwater resources and ecosystems. Because river basins comprise of every square meter of land or water in the catchment of a given river system, their sustainable management depends on suitable approaches to agriculture, forestry, land use planning and other uses from mountain areas to floodplains, to coastal zones. By their very nature, river basins require management that is integrated at all levels, namely Integrated Water Resources Management (IWRM) and Integrated River Basin Management (IRBM), (WWF Living Waters Programme, 2002).

Langat Basin

Langat Basin is macro sized river basin. Ecological boundaries Langat Basin covers of most part of Selangor, a small part of northern NSW and Federal Territories and covers five districts of Hulu Langat, Sepang, Kuala Langat, Klang and Seremban. Langat Basin was chosen as the study area because the basin is experiencing rapid growth and are classified in the group of partially contaminated. The basin is more likely to be contaminated in the future. This is due to the existence of the most advanced infrastructure International Airport (KLIA), KLIA II, Mulitimedia Super Corridor (MSC) and smart and futuristic City Administrative Centre Putrajaya. Langat Basin is an important water catchment area providing raw water supply and other amenities to approximately 1.2 million people within the basin. Important conurbations served include towns such as Cheras, Kajang, Bangi, Government Centre of Putrajaya and others. There are two reservoirs (Semenyih and Hulu Langat) and 8 water treatment plants (4 of which operates 24 hours), which provide clean water to the users after undergoing treatment

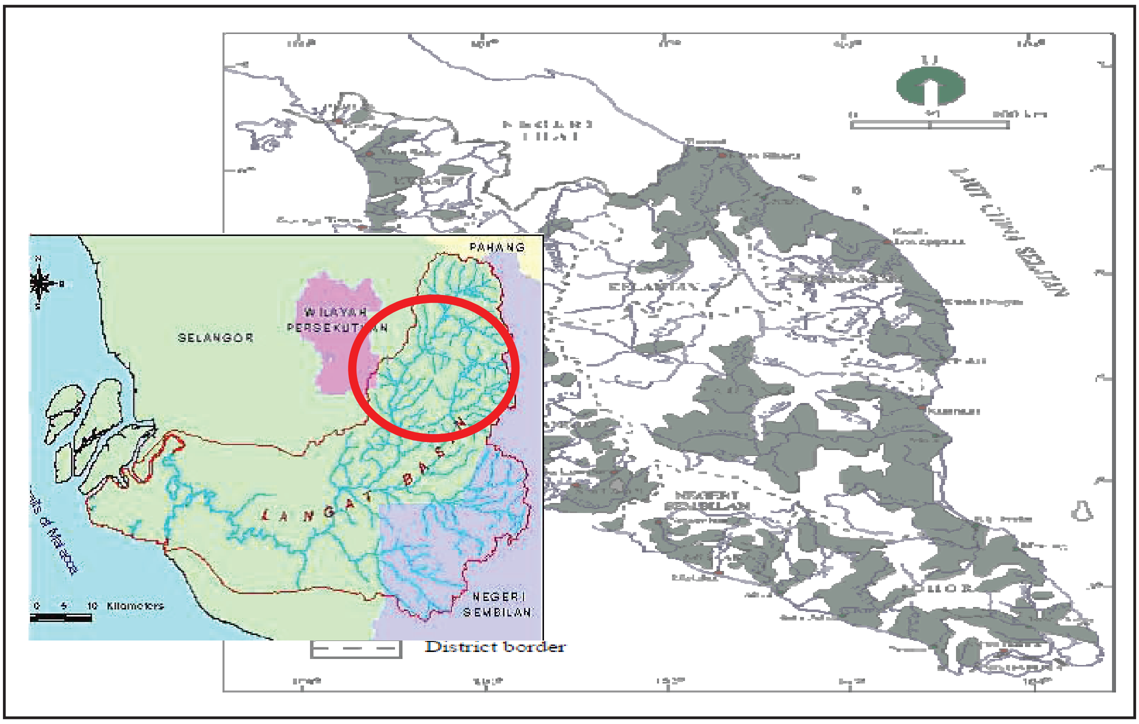

Figure 1: The geographical location of Malaysia and Langat Basin

4.0 RESEARCH METHODOLOGY

Introduction

The double-bounded dichotomous choice format (DBDC) has the advantage of higher statistical efficiency in welfare estimates over the single-bounded dichotomous choice format (SBDC). At the same time, the double-bounded dichotomous choice format help to reveal more information about respondent's WTP than single bounded format (Hanemann et al., 1991; Arrow et al., 1993).This method is the most adequate of the three by the *National Oceanic and Atmospheric Administration* (NOAA) panel. In the DBDC, two sequences of bids are offered to the respondents. First, a respondent is asked whether he would be willing to accept or reject an initial bid; thereafter a second bid is offered; depending on the respondent's answer to the first bid, the second bid could be iterated downwards or upwards. If a respondent willing to pay an initial bid $X for perceived improved watershed protection, so he accepts the initial bid, a second higher bid *hnX (*the double of the first bid) will be offered. If he rejects, a second lower bid *In X* (half of the first bid) will be offered. Therefore there are four possible responses: "yes-yes"; "yes-no"; "no-yes" and "no-no". The double-bounded dichotomous choice format (yes-no, no-yes responses) makes clear bounds on unobservable true WTP. Besides, the yes-yes, no-no response sharpens the true WTP (Haab and McConnell, 2002).

$X^1 \leq$ WTP $< X^2$for the yes no responses
$X^1 >$WTP $\geq X^2$ for the no yes responses
WTP $\geq X^2$ for the yes yes responses
WTP $< X^2$ A for the no no responses

Survey Methodology

Between April and June 2014, a total number of 180 survey questionnaires were used to conduct face to face interview a random sample of residents aged 18 years or older in state of Selangor. Based on results of a pre-test, the sets of 6 bids used in the study were: (5, 3, 10), (10, 5, 15), (15,10,20), and (20, 15, 25), (25, 20, 30), (30, 25, 35), where the first element of each set represents the first bid, the second element corresponds to the lower bid if the respondent answers "no" to the first bid, and the third element corresponds to the higher bid if the response to the first bid is a "yes". The payment vehicle used was a one time lump sum contribution to a trust fund designed for a PES project. The survey questionnaire was split into four sections. The first section dealt with the respondents' water usage, water source and expenditure. The second section is regarding respondents' awareness about watershed. Third section contained the valuation scenario and respondents' willingness to pay for watershed protection, which attempted to provide as much information aspossible about the hypothetical market. Guidelines for a valid contingent valuation analysis suggested by Carson (2000), Carson et al. (2001), and Arrow et al. (1993) were followed as much as possible. The last part of the questionnaire focused on economic and socio-demographic characteristics of the respondents. Besides, follow-up certainty questions were included after the initial bids and the follow-up bids as well.

Model Specification And Estimation Procedures

When the dependent variable in the regression model is continuous the analysis can be conducted using linear regression model (Mezgeboet al., 2013). Conversely, when the dependent variable in a regression model is binary the analysis could be conducted using linear probability or logit or probit models (Pindyck and Rubinfeld, 1981; Mezgeboet al., 2013). However, logit or probit models generate predicted values between 0 and 1, and they fit well to the non-linear relationship between the probabilities and the explanatory variables (Pindyck and Rubinfeld, 1981; Gujarati, 2004). In addition, the probit model works well for bivariate models than logit model (Park 2008). Probit model was used to determine the factors that affecting the WTP of households (Mezgeboet al., 2013). Hence, in this study probit model was used to determine the factors that affecting the WTP of households. Following Cameron and Quiggin (1994), the probit model was specified as:

$$Y_i^* = \beta' x_i + \varepsilon_i$$
$$Y_i = 1 \text{ if } Y_i^* > I_i^*$$
$$Y_i = 0 \text{ if } Y_i^* < I_i^*$$

Where;

β' = *Vector of unknown parameters of the model*
x_i = *Vector of explanatory variables*
Y_i^* = *Unobservabe households' actual WTP for watershed protection*
Y_i = *discrete responses of the respondents for the WTP*
I_i^* = *the offered initial bids assigned arbitraily t the I respondent*
ε_i = *unobservabel random component distributed N(0, σ)*

Bivariate probit model used for the double-bounded models because the bivariate normal density function is appealing to statisticians in the sense that it allows for non-zero correlation, while the logistic distribution does not (Jeanty et al., 2007). In addition, constraining the parameters in the bivariate probit model yields other models such as the interval data model and the random effects probit model (Cameron and Quiggin, 1994; Haab, 1997). Specifically, when the correlation coefficient between the error terms of the two questions is relatively high, more efficient welfare measures can be obtained by constraining the means and the variances to be equal across questions 1. Econometrically modeling data generated by the double-bounded question was specified as (Greene, 2007):

$$Y_1^* = \beta_1 x_1 + \varepsilon_1$$
$$Y_2^* = \beta_2 x_2 + \varepsilon_2$$
$$E(\varepsilon_1 / x_1, x_2) = E(\varepsilon_2 / x_1, x_2) = 0$$
$$Var(\varepsilon_1 / x_1, x_2) = (\varepsilon_2 / x_1, x_2) = 1$$
$$Cov(\varepsilon_1, \varepsilon_2 / x_1, x_2) = \rho$$

Where;

Y_1^* = *i respondent unobservable true WTP at the time of the first bid offered.*
WTP = *1 if $Y_1^* \geq \beta i^o$ (initial bids), 0 otherwise.*
Y_2^* = *i respondent implicit underlying point estimate at the f the second bid offered.*
x_1 and x_2 = *The first and second bids offered t the respondent*
$\varepsilon_1$and ε_2 = *Error terms*
β_1 and β_2 = *Coefficients of the first and second bids offered*

Respondents' WTP is random variable with specified in given cumulative distribution function (cdf) denoted by *G(Yi*, θ),θ,* represents the parameters of this distribution, which are to be estimated on the basis of the responses to the CV survey. The log-likelihood function in the double-bound elicitation method for the responses to a CV survey was also specified as:

$$lnL = \Sigma \{ di^{YY} \ln G(\beta i^{u};\theta) + di^{YN} \ln[G(\beta i^{u};\theta) - \quad G(\beta i^{0};\theta)] + di^{NY} \ln[G[(\beta i^{0};\theta) \quad G(\beta i^{1};\theta)] + di^{NN} \ln[1 - \quad G(\beta i^{1};\theta)] \}$$

Where;

di^{YY} = 1 if the i response is (Yes,Yes) and 0 otherwise;
di^{YN} = 1 if the i response is (Yes,No) and 0 otherwise;
di^{NY} = 1 if the i response is (No,Yes) and 0 otherwise;
di^{NN} = 1 if the i response is (No,No) and 0 otherwise;

5.0 RESULTS AND DISCUSSION

Multiple benefits and water supply problems

All 180 respondents are aware of Langat basin where household getting water for routine activities. The result showed (Table 1) that 35.56% of the respondent indicated that water management is main cause of waters supply problems in upstream of Langat basin. Table 2 showed 63 respondents or 35% of respondents said inconvenience and wasted time is negative effects due to water management problems. This regard to conservation, 180 respondents answered it is important to manage and protect the watershed for the households. At the same time, 36.1% respondents answered reason for protect watersheds is for water absorption on water and makes this available for future use.

Willingness to pay (WTP)

Concerning willingness to pay, 180 respondents agreed to pay for watershed protection. From this portion, 35% of respondents households want more reliable water supply and followed by 34.4% respondents agreed to pay with reason households would like the future generation to have reliable water supply. For initial bid RM5, RM10, RM15, RM20, RM25 and RM30 (Table 3), 95.6% of respondents agreed to pay stated amount compared to 98.9% respondents agreed to pay lower bound amount and about 55.6% of respondents agreed to pay upper bound amount. When bid amount increased the probability of saying yes decreased. Means willingness to pay among 180 respondents in upstream of Langat basin is RM30 per year.

Determinants Demographic

The estimated result on factors that affecting WTP of upstream household is shown in Table 5. Both significant and insignificant variables included in Table. The Probit model in is not indicating the magnitude effect of the explanatory variables on the probability that respondents accept or reject the initial bids marginal effects on the variables affecting WTP been calculated (Mezgebo et al.,2013). Result indicated monthly share, civil status, education attainment and total household have positive and significant relationship with upstream household WTP.

5.0 CONCLUSION

This study used double-bounded elicitation method followed by an additional open ended format contingent valuation technique to elicit households' willingness to pay for water supply in upstream of Langat Basin. Data from 180 households revealed that the main cause for water supply problems are water management, insufficient raw water during dry season, busted pipes and many water users.The willingness to pay by upstream household is RM30 per year and total WTP from the double-bounded dichotomies choice was computed at RM5,401 per year.The empirical findings on the determinants of WTP indicated that largest share in monthly budget, water consumption, gender, civil status and education level are key factors influencing the WTP.

ACKNOWLEDGEMENT

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REFERENCES

Cameron, T. A. & Quiggin, J. (1994). Estimation Using Contingent Valuation Data from a Dichotomous Choice with Follow-up Questionnaire. *Journal of Environmental Economics and Management. 27*(3), 218-234.

Carson, R.T. "Contingent Valuation: A User's Guide." (2000). *Environmental Science and Technology 34*: 1413-1418.

Carson, R. T., Flores, N. E. & Meade. N. F. (2001). "Contingent Valuation: Controversies and Evidence." *Environmental and Resources Economics 19*: 173-210.

Greene, W. H. (2003*). Econometric Analysis (5th ed.)*. Pearson education, Inc., Upper Saddle River, New Jersey, 07458.

Gujarati, D. N. (2004). *Basic Econometrics (4rd Ed.)*. McGraw-Hill, Inc

Haab, Timothy C., & Kenneth E. McConnell. (2002).*Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*. Edward Elgar Publishing,

Hanemann, M., Loomis, J. & Kaninen, B. (1991). Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation. *American Journal of Agricultural Economics, 73*(4), 1255-1263.

Jamal, O. (2002). *Household Preferences for Solid Waste Management in Malaysia*. EEPSEA Research Report.

Jeanty, Pierre Wilner, Tim Haab, & Fred Hitzhusen. "Willingness to Pay for Biodiesel in Diesel Engines: A Stochastic Double-Bounded Contingent Valuation Survey." *American Agricultural Economics Association Annual Meeting*. Portland, Oregon, USA. 2007.

Mezgebo, Alem, Worku Tessema, & Zebene Asfaw. (2013). "Economic Values of Irrigation Water in Wondo Genet District, Ethiopia: An Application of Contingent Valuation method." *Journal of Economics and Sustainable Development 4.2*, 23-36.

Othman, Jamal. (2007). "Economic Valuation of Household Preference for Solid Waste Management in Malaysia: A Choice Modeling Approach." *International Journal of Management Studies (IJMS) 14.1*, 189-212.

Park, H.M. (2008). *Estimating Regression Models for Categorical Dependent Variables Using SAS, STATA, LIMDEP, and SPSS*. The Trustees of Indiana University.

Pindyck, R. S. & Rubinfeld, D. C. (1981*). Econometric Models and Econometric Forecasts (2nd ed.)*. Mcgraw-Hill Book Co. New York

"Report of the NOAA Panel on Contingent Valuation". (1993): 4601-4614.

Arrow, K., R., Solow, P.R., Portney, E. E., Leamer, R., Radner, H., & Schuman. (1993). Report of the NOAA panel on contingent valuation. *Federal Register, 58*, 4601-4614.

Retrieved from http://www.eea.europa.eu/themes/water/wise-help-centre/glossary-definitions/river-basin

River Water Quality Report (2008), Department of Environment.

WWF Living Waters Programme, 2002.

Yacob, Mohd Rusli, Alias Radam, & Ahmad Shuib. (2009). "A Contingent Valuation Study of Marine Parks Ecotourism: The Case of Pulau Payar and Pulau Redang in Malaysia." *Journal of Sustainable Development 2.2*, p95.

APPENDIX

Table 2: Main cause of water supply problems

Problems	No. of Household	Percentage (%)
Busted pipes	38	21.11
Insufficient raw water during the dry season	42	23.33
Deforestation	1	0.5
Water management	64	35.56
Many water users	35	19.44
Total	**180**	**100**

Source: Survey Data

Table 3: Negative effects of the water problems to your household

Problems	No. of Household	Percentage (%)
Health problems	38	21.11
Personal hygiene is affected	28	15.56
Inconvenience or wasted time	63	35.00
Higher expenditures for water	51	28.33
Total	**180**	**100**

Source: Survey Data

Table 4: Reason for maximum WTP

Reason	No. of willing respondent	Percentage (%)
I want more reliable water supply	**62**	**34.4**
It is my duty as a water user	**17**	**9.44**
I would like the future generations to have reliable water supply	**63**	**35.00**
I believe that the council will do a good job in administering the fund	**1**	**0.56**
I want the watersheds to continue producing other environmental services like flood control,carbon sequestration, landscape beauty	**64**	**35.56**

Source: Survey Data

Table 5: Distribution of the amount of the initial bid

Bidi	Frequency	Percent (%)	Cumulative
5	30	16.66	16.66
10	30	16.66	33.32
15	30	16.66	49.98
20	28	16.66	66.64
25	28	16.66	83.3
30	30	16.66	99.96 ≈ 100

Table 6: Probablity of saying "Yes" and "No"

Answer 1	RM5		RM10		RM15		RM20		RM25		RM30	
	No	%	No	%	No	%	No	%	No	%	No	%
No	0	0	0	0	0	0	0	0	6	20	11	36.7
Yes	30	100	30	100	30	100	30	100	24	80	19	63.3
Total	30	100	30	100	30	100	30	100	30	100	30	100

Table 7: Parameter estimates for Bivariate Probit Model

Variable	Coefficient	Standard Error	z
Bid1	-.7557097	0.803844	-3.42
_cons	0.452561	0.254389	1.13
Bid2	-.0545416	0 .7535593	-2.07
_cons	0.218952	0.124459	1.87
Number of obs	= 180		
Wald $X^2(22)$	= 58.72	Prob> chi2	= 0.0000
Log likelihood	= -136.18177	$X^2(1)$	= 17.8908
Likelihood-ratio test of rho	= 0		
Prob> chi2	= 0.0000		
Mean WTP	= RM30 (95%, Confidence Interval= 26.663840-33.34727)		

Source: Model Output

Table 8: Demographic factor affecting WTP

Independent variable	Coefficient	Marginal Effect	Standard Error	Z-Value
monthly_sh~e	-.0017415	-6.50e-06	.0007805	-2.23
water_bill	.0277324	.0001036	.0213608	1.30
age	.0026983	.0000101	.0209092	0.13
gender	-.5600733	-.0023668	.4843059	-1.16
civil	.410395	.0015326	.4594588	0.89
edu	-.0631369	-.0002358	.1418214	-0.45
total_Earner	.5568935	.0020797	.3017919	1.85
gross_income	.1292431	.0004827	.1742002	0.74
_cons	-.1903362		1.288312	-0.15
Number of obs = 180 LR chi2 (8) = 15.45 Prob> chi2 = 0.0509 Prob> chi2 = 0.0509 Log likelihood = -25.000865 Pseudo R2 = 0.2361				

Source: Model Output

SESI PEMBENTANGAN III:

Penyelidikan,

Pembangunan dan Inovasi

REDUCING EMISSIONS FROM THE FORESTS UNDER REDD+: A CASE STUDY OF PAHANG

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ABSTRACT

Forestry has been recognised as an important sector for climate change mitigation. Consequently, Reducing Emissions from Deforestation and Forest Degradation of Tropical Forests in Developing Countries (REDD+) mechanism is being developed under the United Nations Framework Convention on Climate Change (UNFCCC) to provide financial incentives to developing countries that are able to reduce emissions or enhance carbon sequestration above a baseline within the forestry sector. To assist Malaysia's capacity in getting ready to implement REDD+ projects, a project is being conducted with financial support from the International Timber Trade Organization (ITTO) entitled Reducing Forest Degradation and Emissions through Sustainable Forest Management (SFM) in Peninsular Malaysia. The project is jointly conducted by Forest Research Institute Malaysia (FRIM), Forestry Department of Pahang and Forestry Department Peninsular Malaysia. The project site which is located in Pahang will determine emissions from forest degradation in logged forests and assess the value of enhancing forest management practices to reduce emissions from forest degradation. Financial evaluations of the improved management practices will be undertaken to provide avenues for assessing payment for ecosystem services. To date the project has been able to assess the rate and drivers of deforestation through satellite data. It was found that a combination of Landsat and SPOT satellite image with Land use change maps could be used to identify drivers of deforestation. Satellite data was further supported by ground verification. The project is currently assessing emissions from current logging practices (as baseline) as well as through improved logging techniques (reduced emissions). This paper provides an account of the findings of the project in reducing emissions from the forests in Pahang.

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1.0 INTRODUCTION

Malaysia is still relatively well covered with natural forest that amounts to an area of 18.56 million ha – of about 57% of the total land area in year 2007 (JPSM, 2007; Thang, 2007) as shown in Table 1 and Figure 1. A large proportion of this is located in Sabah and Sarawak of about 61% and 67% of forested areas, respectively. The total forest area within the country that is legally designated as Permanent Reserved Forest (PRF) was estimated at 14.3 million ha or about 44% of the total land area (FRA, 2010). Based on the forest regions, there are 4,696,000, 3,605,000 and 6,000,000 ha of PRF in Peninsular Malaysia, Sabah and Sarawak, respectively (FRA, 2010). Forests under the PRF to be managed sustainably for protection, production, amenity, research and education purposes to provide benefit of present and future generation.

Under the present National Forestry Policy (NFP), all remaining forested areas within the country are broadly classified according to productive, protective and amenity purposes so as to balance the needs for timber production and environmental protection (Figure 2). Forests have a vital role to play in the fight against global warming. It is recognised as the largest terrestrial store of carbon, and represent third largest source of carbon emissions. However, Malaysia as in any developing country has converted some of these forests to agricultural, industrial, recreational and urban development uses.

Table 1: Total forested land and distribution of forest cover by major forest types in 2007 (millions of ha)

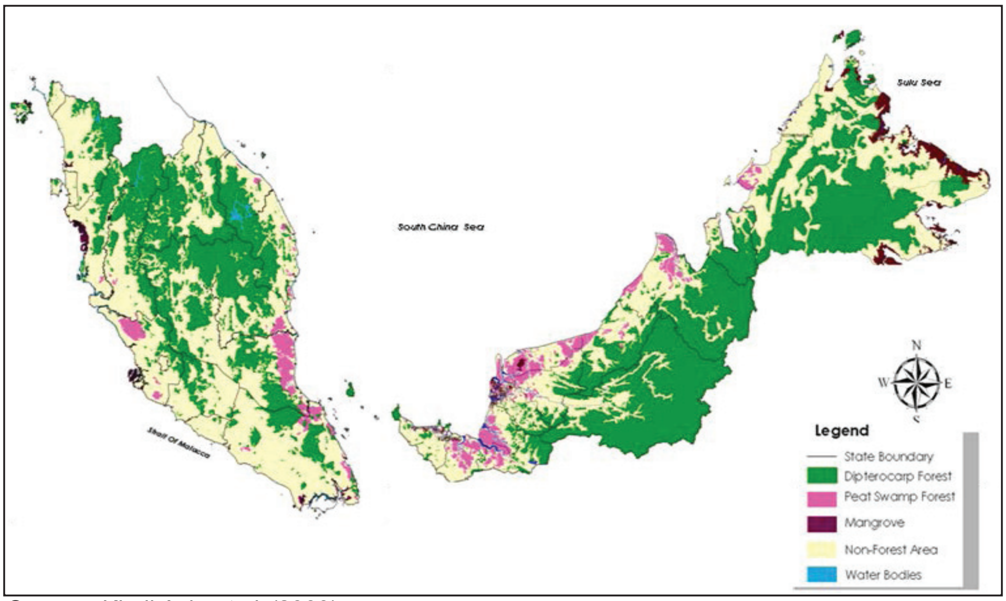
Region	Land area	Dry Inland forest	Swamp forest	Mangrove	Forest plantation	Total forested area	Forested area (%)
Peninsular Malaysia	13.16	5.34	0.30	0.10	0.10	5.84	44.4
Sabah	7.37	3.85	0.12	0.32	0.20	4.49	60.9
Sarawak	12.30	6.76	1.14	0.14	0.19	8.23	66.9
Total	**32.83**	**15.95**	**1.56**	**0.56**	**0.49**	**18.56**	**56.5**

Sources: JPSM (2007); FD Sabah (2007); FD Sarawak (2007)

All inland production forests in Peninsular Malaysia are currently being managed under the Selective Management System (SMS). The system allows trees to be removed based on a flexible cutting regime where all trees above a prescribed cutting limit are removed. The determination of the cutting limit takes into consideration the existing growing stock, its increment and mortality, as well as a specified future crop at the end of a 30-year cutting cycle. However, there are concerns that the assumptions for the above factors in the implementation of SMS are not being met consistently and thus affecting the productivity of the residual stands. In addition traditional ground based harvesting logging practices have been reported to be damaging to the residual stand and the surrounding environment.

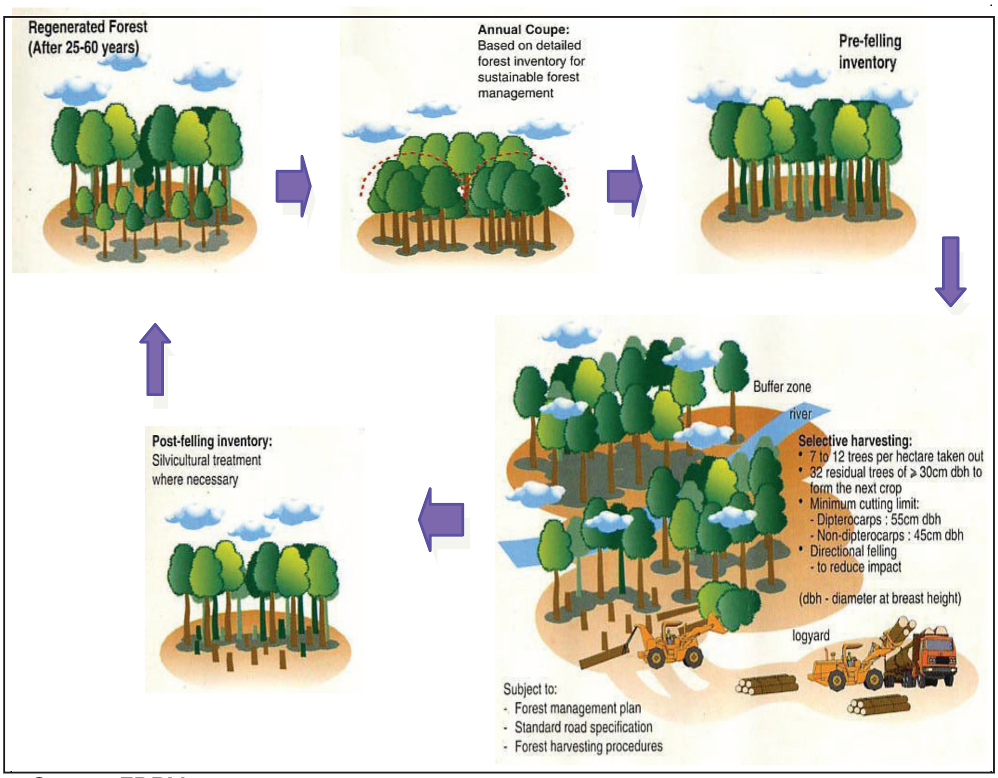
The introduction of Reduced Impact Logging (RIL) systems and practices have indeed reduced the logging damage and improved stand conditions. It is thus opportune that further improvements to the current management practices be implemented to further enhance the productivity of the residual stand and reduce forest degradation in terms of total carbon stocks as well as other ecological factors. However, such sustainable forest management practices may incur significant additional costs both to the logging operators as well as the government.

The Reducing Emissions from Deforestation and Forest Degradation of Tropical Forests in Developing Countries (REDD+) mechanism under the United Nations Framework Convention on Climate Change (UNFCCC) currently being discussed, presents an incentive that may encourage implementation of improved management practices to reduce forest degradation.



Source: Khali Aziz *et al.* (2009)

Figure 1: Forest areas in Malaysia



Source: FDPM

Figure 2: General sequence of SFM practices in Peninsular Malaysia

2.0 THE CASE STUDY

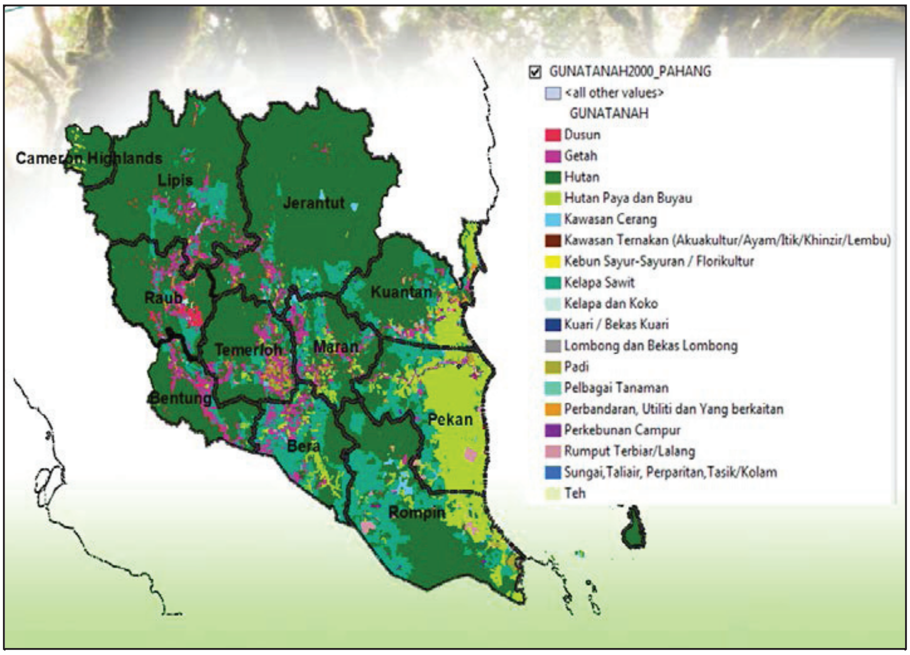
Malaysia has been given funding by International Timber Trade Organization (ITTO) to conduct a project entitled Reducing Forest Degradation and Emissions through Sustainable Forest Management (SFM) in Peninsular Malaysia. Besides Forest Research Institute Malaysia (FRIM) as executing agency, other major players for this project are Ministry of Natural Resources and Environment (NRE) and Forestry Department of Peninsular Malaysia (FDPM) including Pahang State Forestry Department (FD Pahang). Pahang is selected as project site due to significant contribution of forestry sector to its economy and social development. Pahang has largest forest areas in Peninsular Malaysia comprises all major forest types. In addition, there are some communities' dependants to the forest resources, in particular the Orang Asli.

The general objective of this project is to utilise SFM as a mitigation tool in combating climate change. As deforestation rate is stable in Malaysia, the emissions to be accounted for REDD+ mechanism would probably come from the reduction of forest degradation (or enhancement of carbon stock) in Peninsular Malaysia. The specific objective is narrowed down to improve knowledge on reduction of forest degradation (or increase carbon stock) and enhance payments for ecosystem services (PES). Besides, the project will also study the economic aspect of establishing incentives in enhancing the carbon stock and ecosystems services. Opportunity cost for implementing the programme will be evaluated for the purpose, and suitable incentives procedures will be recommended for the enhancement of carbon stock through SFM practices.

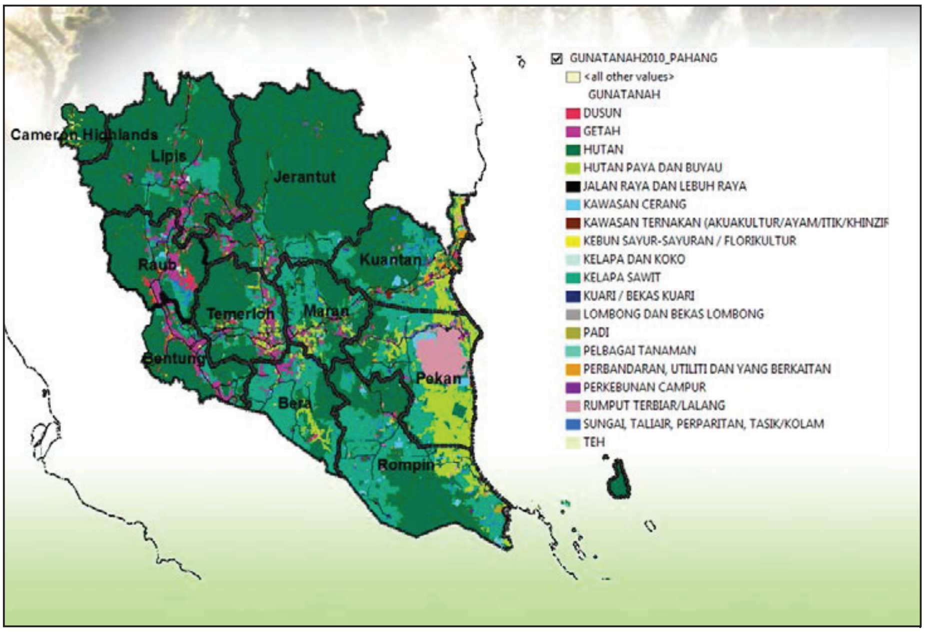
The long-term viability for SFM in Pahang will be one that balances the needs of the economy, environment and ecology. This project is useful as it provides opportunities to enhance value of forests at the forest management unit (FMU) of Pahang, in particular under the REDD+ mechanism. It promotes SFM and supports Malaysia's commitment under the UNFCCC. This project would calculate the amount of carbon stocks and carbon emissions from the forest activities. It is expected that the forests, in particular the PRF are storing more carbon and less emissions due to improvements on the forest management practices such as the use of RIL, replanting activities, etc.

3.0 SOME PRELIMINARY RESULTS

Some preliminary results are as in Figure 3 and Figure 4. As for the being, the project analyses and recorded land use and forest cover for state of Pahang since year of 2000 to 2010. This information will be further analyses to determine the changes (figures & percentages) and drivers of the changes.

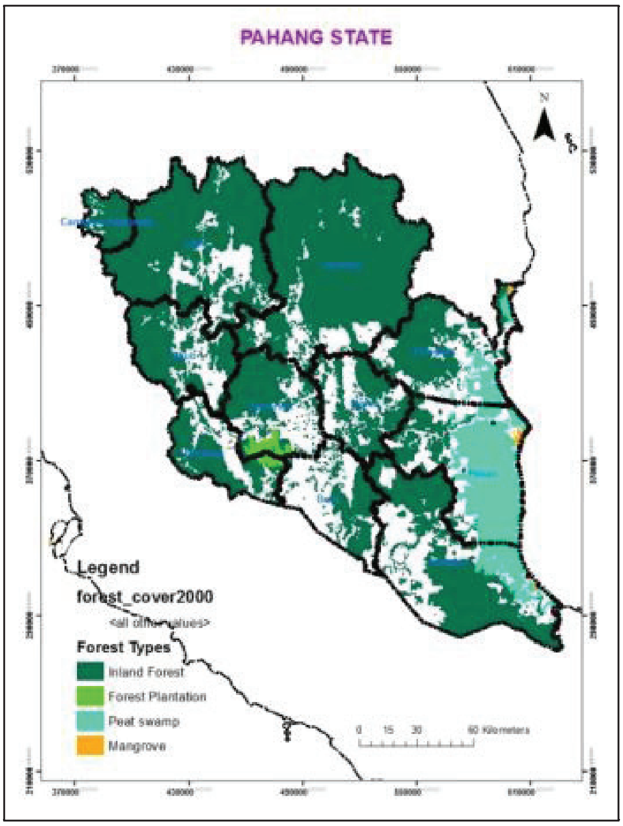


a) Landuse in Pahang (year 2000)

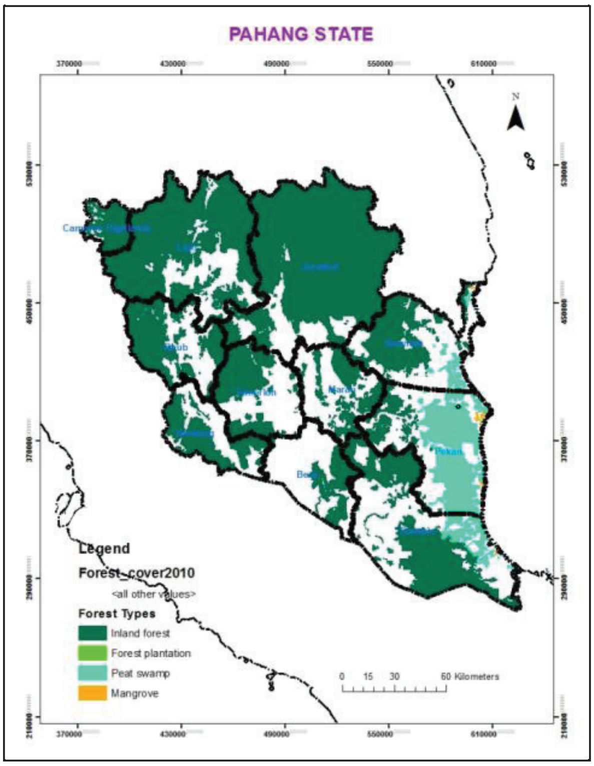


b) Landuse in Pahang (year 2010)

Figure 3: The landuse in Pahang (year 2000 & 2010)



a) Forest cover in Pahang (year 2000)



b) Forest cover in Pahang (year 2010)

Figure 4: The forest cover in Pahang (year 2000 & 2010)

4.0 CONCLUSION

The project is among pilot projects of REDD+ related project order to Malaysia to enhance its readiness to full implementation of REDD+, once the mechanism take place in this country. The implementation of the project is expected to enable better integration climate change requirements into current forest management and practices. In general, the project will assess the current management practices based on the SFM in terms of its total carbon storage. In addition, improved silvicultural and management prescriptions will be introduced to further enhance the total carbon stock. The amount of total carbon stock based on the SFM practices in this country and Pahang in particular is the critical baseline information for incentive calculation under the REDD+ mechanism.

The project will also evaluate the economic aspect for PES such as carbon stock and watershed (including forest dependant community) in the state of Pahang. As the project is still on-going, not much information could be included in this paper. Nonetheless, sufficient data would be available once the projects completed by end 2015. Indeed it is an opportunity for Pahang to have the project in order to have sufficient baseline data on the climate-change related information.

REFERENCES

FD Sabah. (2007). *Annual Report 2007*. Forestry Department of Sabah.

FD Sarawak. (2007). *Annual Report 2007*. Forestry Department of Sarawak.

FRA. (2010). *Forest Resources Assessment for Malaysia of 2010*. Report prepared by Ministry of Natural Resources and Environment (NRE), Malaysia for FAO.

JPSM. (2007).*Annual Report 2007*. Forestry Department Peninsular Malaysia, Kuala Lumpur.

Khali Aziz, H., Ismail, P., Abd Rahman, K., Che Hashim, H., Grippin, A. & Nizam, M. S. (2009). Ecological Characteristics of a *Gonystylus bancanus*-rich Area in Pekan Forest Reserve, Pahang, Malaysia. *Journal of Tropical Life Sciences Research* 20(2): 15-27.

Thang, H. C. (2007). *An Outlook of the Malaysian Forestry Sector in 2020*. Consultancy report to the Asia Pacific Forestry Commission (APFC), FAO. 89 pp.

PENILAIAN EKONOMI UNTUK STOK BIOJISIM (BIOMAS) DAN KARBON BAGI TANAMAN *Rhizophora mucronata poiret* PADA PERINGKAT JUVANA

Dr. Affendi bin Suhaili
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ABSTRAK

Dengan program perubahan iklim seperti REDD+, penekanan yang lebih telah diletakkan dalam menilai status tanaman di tapak penghutanan semula walaupun pada peringkat awal pertumbuhan. Keupayaan untuk menganggarkan biojisim dan stok karbon dalam penilaian status tanaman juvana mempunyai kepentingan yang tinggi untuk pengauditan (seperti kredit karbon) projek perhutanan semula. Dalam kajian ini sebuah persamaan '*allometric*' telah ditubuhkan untuk menganggar biojisim dan stok karbon untuk anak pokok individu *Rhizophora mucronata poiret* berusia tiga tahun berdasarkan struktur kanopi mereka, yang kemudiannya boleh dikaitkan dengan sifat-sifat yang boleh diekstrak dari dataset penderiaan jauh. Anggaran terbaik biomas tumbuhan itu diperoleh dari persamaan $y = 4.418x - 1.656$ ($r^2 = 0.913$; 0.01). Hasil kajian juga menunjukkan kandungan biojisim yang lebih tinggi pada komponen akar bawah tanah untuk menyokong pertumbuhan anak pokok *R. mucronata* di peringkat awal perkembangannya. Kadar peningkatan stok karbon adalah lebih tinggi pada struktur silara yang lebih kecil jika dibandingkan dengan saiz silara yang lebih besar.

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1.0 PENGENALAN

Hutan Simpan Bakau Sarawak asalnya meliputi kira-kira 17,153 ha. Walau bagaimanapun, keluasan hutan persisiran pantai berkenaan semakin berkurang disebabkan faktor yang berkaitan dengan pengambilalihan tanah, baki kawasan bakau hanya 11,651 ha. Oleh yang demikian, kerajaan Negeri Sarawak telah mewartakan dua kawasan yang dilindungi sepenuhnya (Bako Taman Negara; Kuching Wetland National Park) kerana kepentingan sumbangan ekosistem tersebut untuk habitat marin dan untuk perlindungan pantai. Selain daripada itu, pihak kerajaan negeri juga bekerjasama dengan kerajaan pusat bagi menjalankan aktiviti penanaman semula dikawasan persisiran pantai berkenaan. Usaha-usaha penghutanan semula ini dikenalpasti dapat menyumbang ke arah pengurangan dan penstabilan stok karbon untuk hutan paya bakau secara khusus dan hutan tropika secara amnya.

Dengan adanya program perubahan iklim seperti REDD+, keupayaan untuk menganggar biojisim dan stok karbon pada tanaman di peringkat awal pertumbuhan atau juvana (ketinggian kurang dari 3m) memberikan kepentingan yang tinggi untuk menentukan sumbangan projek perhutanan semula tersebut terutama dari aspek pengauditan kredit untuk karbon.

Projek penghutanan semula untuk spesis pokok di hutan bakau ini dipengaruhi oleh beberapa faktor seperti kesesuaian spesis yang ditanam dengan kawasan tanaman tersebut serta ketersediaan (*availability*) anak benih spesis berkenaan. Spesis *Rhizophora* (Bakau Kurap, Bakau Minyak) adalah yang selalu digunakan untuk penanaman semula disebabkan anak benih yang mudah didapati dalam kuantiti yang banyak serta ianya senang dibiak (Sukardjo and Yamada, 1992). Walau bagaimanapun, tumbesaran untuk *R. apiculata* adalah agak perlahan, di mana kadar pembesaran diameternya hanya 0.24 - 0.29cm setahun (Putz and Chan, 1986). Ini menyebabkan kajian semasa yang dijalankan untuk menilai produktiviti pada jenis hutan tersebut hanya tertumpu pada dirian yang telah matang. Ini merupakan kekangan pada masa ini terutama bila penilaian dibuat secara sinoptik menggunakan kaedah cerapan jarak jauh (*Remote Sensing*) di mana sensor sedia ada hanya mampu menilai sifat fisiologi serta struktur pada silara serta tanaman yang bersaiz besar (ketinggian melebihi 5m).

Kajian ini dijalankan bagi menganggar biojisim dan stok karbon untuk setiap anak pokok bakau yang telah ditanam dalam linkungan 3-4 tahun di mana saiz silara adalah dalam linkungan 0.5-1.0m dan ketinggian tidak melebihi 3.0m. Hasil daripada anggaran biojisim serta stok karbon yang diperolehi daripada kajian ini kemudian boleh dikembangkan untuk membuat anggaran pada anak benih serta dirian menggunakan kaedah cerapan hiperspektral (*hyperspectral sensing*) yang berupaya untuk mengesan kanopi renek dan membezakan ianya dari latar belakang.

2.0 METODOLOGI

Kawasan Kajian

Kajian ini telah dijalankan di Kampung Selabat, Muara Tebas yang terletak di muara Sungai Sarawak iaitu kira-kira 30km dari Kuching. Ia adalah salah satu projek penanaman semula hutan bakau yang dijalankan oleh Jabatan Hutan Sarawak yang ditanam dengan anak *benih R. mucronata poiret* pada tahun 2009. Luas keseluruhan kawasan yang telah ditanam adalah 40 hektar yang bersaiz 1 ha untuk setiap kuadrat.

Pengumpulan Data Lapangan

Kerja lapangan dijalankan dari Julai 2012 - Mac 2013. Untuk menghasilkan persamaan *allometric* bagi menganggar biojisim dan stok karbon daripada dirian *R. mucronata poiret* yang ditanam semula, 38 anak pokok yang mempunyai ketinggian diantara 1.5 - 3.0 meter telah dituai. Kaedah Kairo et al. (2008) digunapakai untuk mengklasifikasikan anak pokok tersebut ke dalam kategori juvana berdasarkan ketinggian yang tidak melebihi 3.0 meter .

Anggaran Biojisim dan Stok Karbon

Anggaran biojisim diperoleh daripada kelompok (*pool*) untuk atas (*above ground biomass-AGB*) dan bawah tanah (*below ground biomass-BGB*). Bagi kelompok AGB, pokok-pokok dituai di paras tanah kemudian diasingkan untuk merangkumi batang (stem), daun dan akar. Pengiraan nisbah basah-kering ditentukan dengan mengukur berat segar setiap komponen dan berat kering ketuhar (berat malar pada 85°C selepas 48 jam).

Model *allometric* antara komponen AGB dan jumlah biojisim (*total plant biomass-TPB*) telah ditubuhkan berdasarkan saiz kanopi anak pokok individu yang dirujuk daripada imej dataset berdasarkan transformasi linear (Persamaan 1):

$$Y = a + bx \qquad (1)$$

di mana y mewakili biojisim, a dan b adalah regresi berterusan dan x adalah pemalar (*independent or predictor variable*) yang merujuk kepada saiz kanopi.

Penentuan komponen BGB terdiri daripada kedua-dua akar utama dan sekunder (termasuk akar halus yang bersaiz < 2mm) berdasarkan berat-kering ketuhar. Ini kemudian diterjemahkan ke TPB (t/ ha) dengan menjumlahkan biojisim atas tanah (AGB) dan biojisim bawah tanah (BGB). Kandungan karbon (*vegetative carbon-C*) kemudiannya dikira dari TPB, dengan andaian 48% daripada biomas vegetatif adalah karbon (Martin and Thomas, 2011).

Selaras dengan penilaian karbon dalam konteks perubahan iklim, nilai karbon (C) yang diperolehi ini kemudiannya akan ditukar (C x 3.67) kepada unit *Carbon Dioxide Equivalent* (CDE) yang merupakan ukuran untuk jumlah karbon dioksida yang tidak dilepaskan ke atmosfera disebabkan oleh aktiviti yang dijalankan dalam projek *flexible mechanisms* dimana salah satu merupakan aktiviti penghutanan semula. Unit CDE akan digunapakai dalam perakaunan stok karbon di mana nilai ekonomi akan ditentukan oleh pasaran karbon semasa.

3.0 KEPUTUSAN DAN PERBINCANGAN

Pengukuran Struktur Tumbuhan dan Biojisim

Parameter yang berkenaan dengan struktur dan biojisim dari sampel anak pokok *R. mucronata* adalah seperti yang ditunjukkan dalam Jadual 1. Hasil pemerhatian menunjukkan bahawa pertumbuhan bagi dua kelas pokok juvana pada sampel (n = 38) tersebut adalah lebih dikaitkan dengan saiz diameter (34%) berbanding dengan ketinggian (25%). Bagi kedua-dua kelas ketinggian berkenaan, kandungan biojisim bagi kelompok (*pool*) atas tanah (AGB) adalah lebih tinggi (64% - 66%) bagi penganggaran biojisim keseluruhan (TPB) anak pokok *R. mucronata*. Perbezaan pada biojisim bagi kelas ketinggian yang lebih besar (> 2m) adalah dua kali ganda daripada anak pokok yang bersaiz lebih kecil di mana ini dikaitkan dengan ukur lilit yang lebih tinggi bagi anak pokok bersaiz besar tersebut.

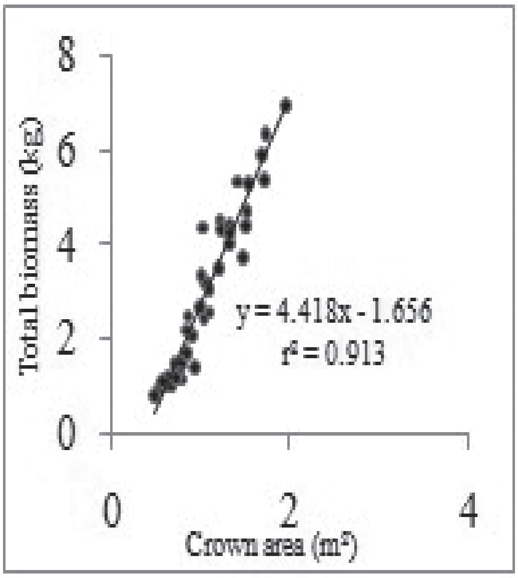
Jadual 1: Ciri-ciri struktur dan biojisim *R. mucronata* peringkat juvana untuk kelas ketinggian berlainan

Tinggi kelas	Parameter struktur (Purata ± SD)			Biomass (kg)	
	Diameter (cm)	Tinggi (m)	Silara (m^2)	AGB	TPB
1.0m-2.0m	3.80±0.64	1.79±0.12	0.91±0.28	1.44 (64%)	2.25
2.1m- 3.0m	5.10±0.70	2.24±0.19	1.47±0.27	3.41 (66%)	5.17

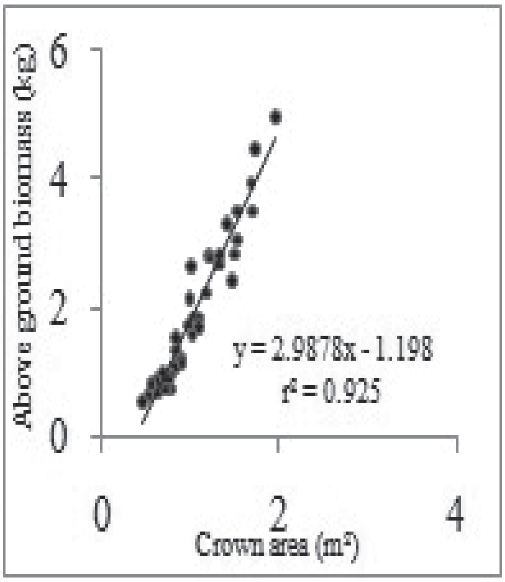
Ketinggian (0.12-0.19 SD) serta luas silara (0.28-0.27 SD) adalah lebih seragam berbanding dengan diameter batang (0.64-0.70 SD) dan variasi pada diameter anak pokok berkenaan adalah lebih tinggi pada kelas ketinggian yang lebih besar (> 2.0 m). Sebaliknya, perubahan pada luas silara adalah sama untuk kedua-dua saiz kelas anak pokok *R. mucronata*. Keseragaman struktur silara tersebut menjadi asas dalam pemilihan pembolehubah untuk dimuatkan ke dalam persamaan *allometric* bagi menganggar biojisim dan stok karbon untuk setiap anak pokok.

Persamaan A*llometric* dalam Penganggaran Biojisim

Hubungan secara linear (Rajah 1) dapat dilihat dalam menganggar biojisim atas tanah bagi *R. mucronata* melalui persamaan y=2.9878x -1.198 (r^2 = 0.925) manakala regresi untuk biojisim keseluruhan diperolehi melalui persamaan y=4.418x -1.656 (r^2 = 0.913). Kedua-dua persamaan secara keseluruhan adalah sangat bererti (P<0.01), yang menunjukkan kekuatan hubungan di antara pembolehubah biojisim (AGB and TPB) dengan struktur silara.



(a)



(b)

Rajah 1: Hubungan linear di antara kawasan silara dengan biojisim atas tanah (a) dan jumlah pokok biojisim (b)

Jadual 2 menunjukkan kesan ke atas anggaran untuk AGB serta TPB untuk *R. mucronata* di peringkat juvana apabila pembolehubah ketinggian pokok ditambah dalam persamaan berkenaan. Nilai R^2 bagi AGB (Jadual 2.a.) didapati meningkat sedikit ($P<0.01$) dari 0.925 hingga 0.931, manakala TPB (Jadual 2.b.), meningkat dari 0.913 hingga 0.919. Hasil kajian menunjukkan kesesuaian bagi menggabungkan sifat-sifat struktur silara dalam menganggarkan biojisim bagi anak pokok *R. mucronata* tersebut. Ia juga menunjukkan bahawa pembolehubah yang berkaitan dengan sifat bio-fizikal anak pokok berkenaan dapat memberikan anggaran yang sama seperti yang diperolehi dari pembolehubah lain (diameter batang) yang biasa digunakan seperti dalam menganggarkan jumlah biojisim pada dirian (*stand biomass*) pokok bakau di peringkat juvana.

Jadual 2 (a) di bawah digunakan untuk meramal biojisim atas tanah, (*above ground biomass* - AGB) *R. mucronata*. Persamaan adalah terpakai pada julat ketinggian di bawah 3 meter (juvana). Pembolehubah tidak bersandar; CA = *Crown Area* dalam m² and h = jumlah ketinggian dalam m.

Jadual 2(a)

Independent variable (x)	Dependent variable (y)	a	b_1	b_2	R^2	Signicant level
CA	AGB	-1.198	2.987	-	0.925	**
CA x h	AGB	-1.883	2.792	0.467	0.931	**

** significant at p<0.01 , n= 38

Jadual 2(b). Regresi digunakan untuk meramal jumlah biojisim, (*predicted total biomass* - TPB) *R. mucronata*. Persamaan adalah terpakai pada julat ketinggian dibawah 3 meter (juvana). Pembolehubah tidak bersandar; CA = *Crown Area* dalam m² and h = jumlah ketinggian dalam m

Jadual 2(b)

Independent variable (x)	Dependent variable (y)	a	b_1	b_2	R^2	Significant level
CA	TB	-1.656	4.418	-	0.913	**
CA x h	TB	-2.774	4.099	0.761	0.919	**

** significant at p<0.01 , n= 38

Penentuan Stok Karbon

Jadual 3 menunjukkan perbandingan saiz silara dengan karbon yang diperolehi daripada komponen atas serta bawah tanah yang dianggarkan pada dirian *R. mucronata*. Berdasarkan jumlah 2,346 anak pokok yang terdapat pada dirian seluas 1 ha, didapati bahawa kelas silara yang bersaiz antara 0.5 – 1.5 m akan menghasilkan antara 0.92 – 4.36 metrik ton karbon sehektar (tC/ha) yang bersamaan dengan 3.36 – 15.98 unit CDE. Kajian yang telah dibuat oleh Chandra et al. (2011) pada dirian *R. apiculata* yang matang memberikan 116.79 ton biojisim sehektar yang boleh menghasilkan 56.06 tC/ha, manakala Kairo et al. (2009) memperolehi 9.72 tC/ha untuk komponen atas tanah pada tanaman *R. mucronata* yang berusia 5 tahun (Jadual 3).

Jadual 3: Struktur silara dan stok karbon

Kelas Saiz Silara	Purata Stok Karbon (t/ha)*	
	Jumlah Karbon	CDE
< 0.5m	0.92	3.36
0.5m -1.0m	1.85	6.80
1.0m – 1.5m	4.36	15.98
>1.5m	6.50	23.84

*Pengiraan berdasarkan 2346 individu yang terdapat pada dirian 1ha

Jika dilihat berdasarkan peningkatan stok karbon, didapati bahawa kadar peningkatan untuk kelas silara berkenaan (0.5 – 1.5 m) adalah secara eksponen jika dibandingkan dengan saiz kelas silara yang melebihi 1.5m yang mula menunjukkan kadar yang menurun.

4.0 KESIMPULAN

Kajian ini telah menunjukkan bahawa anggaran untuk biojisim atas tanah (AGB) serta biojisim keseluruhan (TPB) bagi tanaman pokok bakau *R. mucronata* yang masih dalam peringkat awal pertumbuhan atau juvana adalah sesuai dianggarkan berdasarkan struktur silara berkenaan. Anggaran terbaik untuk AGB diperolehi melalui persamaan y=2.9878x -1.198 (r^2 = 0.925) manakala anggaran bagi TPB diperolehi melalui persamaan y=4.418x -1.656 (r^2 = 0.913). Bagi saiz pokok juvana, didapati bahawa peruntukan biojisim yang lebih tinggi pada komponen akar bawah tanah di mana ini boleh dikaitkan dengan sistem sokongan pada pokok *R. mucronata* tersebut pada peringkat awal perkembangannya. Kadar peningkatan stok karbon adalah lebih tinggi pada struktur silara yang lebih kecil untuk dirian tanaman kuadrat 1 hektar. Hasil dari kajian ini telah memberi peluang untuk menggunakan sifat fizikal kanopi yang boleh diekstrak dari data penderiaan jauh untuk tujuan penganggaran biojisim bagi merangkumi kawasan yang lebih luas.

RUJUKAN

Chandra, L.A., Seca, G. & Abu Hena, M.K. (2011). Above Ground Biomass of *Rhizophora Apiculate Blume* in Sarawak Mangrove forest. *American Journal of Agricultural and Biological Sciences. 6* (4): 469-474

Donato, D. C., Kauffman, J. B., Murdiyarso, D., Kurnianto, S., Stidham, M., & Kanninen, M. (2011). Mangroves among the Most Carbon-rich Forests in the Tropics. *Nature Geosciences 4*:293-297.

Golley, F. B., McGinnis, J. T., Clements, R. G., Child, G. I. & Duever, M. J. (n/a). *Mineral Cycling in a Tropical Moist Forest Ecosystem*. University of Georgia Press, Athens, U.S.A. 248p.

Intergovernmental Panel on Climate Change (IPCC). (2001). The Third Assessment Report: Climate Change 2001. IPCC Geneva. Retrieved from, http://www.grida.no/publications/other/ipcc_tar/ (30 January 2013)

Intergovernmental Panel on Climate Change (IPCC). (2003). *Good Practice Guidance for Land Use, Land Use Change, and Forestry*. Penman, J., Gytarsky, M. Hiraishi, T., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, K., Tanabe, K., & Wagner, F. (eds.) IPCC, Geneva. Retrieved from http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html (13 June 2011).

Intergovernmental Panel on Climate Change (IPCC). (2006). *Guidelines, Volume 1 and Volume 4 (Agriculture, forestry, & other landuse), Annex 2 (Summary of equations).* IPCC, Geneva. Retrieved from http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html (13 June 2011).

Intergovernmental Panel on Climate Change (IPCC). (2007). The Fourth Assessment Report: Climate Change 2007. Pachauri, R.K. and Reisinger, A. (eds.) IPCC, Geneva. http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm (13 June 2011).

Kairo, J. G., Bosire, J., Langat, J., Kirui, B., & Koeda, N. (2009). Allometry and Biomass Distribution in Replanted Mangrove Plantations at Gazi Bay, Kenya. *Aquatic Conservation: Marine and Freshwater Ecosystem 19*(1): S63 – S69

Kauffman, J. B., Heider, C., Cole, T., Dwire, K. A., & Donato, D. C. (2011). Ecosystem C Pools of Micronesian Mangrove Forests: Implications of Land Use and Climate Change. *Wetlands 31*: 343-352.

Komiyama, A., Ogino, K., Aksornkoae, S. & Sabhasri, S. (1987). Root Biomass of a Mangrove Forest in Southern Thailand: Estimation by the Trench Method and the Zonal Structure of Root Biomass. *Journal of Tropical Ecology 3*, 97-108.

Laffoley, D. D. A. & Grimsditch, G. (2009). *The Management of Natural Coastal Carbon Sinks*. International Union for Conservation of Nature, Gland, Switzerland. 53p

Martin, A. R. & Thomas, S.C. (2011). A Reassessment of Carbon Dioxide in Tropical Trees. *PLoS One 6* (8):e23533

Putz. F., & Chan. H. T., (1986). Tree Growth Dynamics and Productivity in a Mature Mangrove Forest in Malaysia. *Forest Ecol. Manage. 17*. 211 230

POTENSI KONSERVASI RAMIN TELUR (*Gonystylus bancanus*) DI ULU MENTAWAI, TAMAN NEGARA MULU

Noorhana binti Mohd Sapawi
Mohizah binti Mohamad
Nur Safinas binti Jelani
Aurelia Dulce Chung
Yahud bin Wat
Yazid bin Kalbi

ABSTRAK

Gonystylus bancanus (Miq.) *Kurz* atau lebih dikenali sebagai Ramin Telur merupakan salah satu spesies balak yang utama di hutan paya dan mempunyai nilai komersial yang tinggi. *Gonystylus bancanus* telah diklasifikasikan sebagai spesies terancam Appendiks II di bawah CITES (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*) yang menghadkan perdagangan antarabangsa bagi spesies ini tanpa permit yang sah. Ini bertujuan untuk memelihara populasi *G. bancanus* yang kian terancam akibat penerokaan secara berlebihan. Bagi tujuan tersebut juga, satu kajian telah dijalankan di Ulu Mentawai, Taman Negara Mulu dimana populasi *G. bancanus* telah dikenalpasti di satu kawasan hutan paya dengan anggaran keluasan 100-150 hektar. Hasil daripada penilaian pada plot seluas 1 hektar, sejumlah 21 pokok *G. bancanus* telah direkodkan dengan mengambil kira batang berdiameter pada paras dada (dbh) ≥ 10cm. Data menunjukkan julat dbh antara 27-73 cm dengan ketinggian 30-50 m. Hampir kesemua pokok yang direkod (66.67%) mempunyai kedudukan silara kelas 5 dimana ia menunjukkan penerimaan cahaya matahari yang mencukupi. Dari segi biojisim pokok, dianggarkan sebanyak 63.72 t ha^{-1} biojisim yang terkumpul pada *G. bancanus* dimana nilai tersebut dianggap tinggi untuk sesuatu dirian spesies. Biojisim adalah bahan organik yang dihasilkan oleh pokok dan ia adalah sumber kepada perkhidmatan hutan yang lain. Antaranya, maklumat biojisim boleh digunakan untuk menganggarkan parameter seperti kandungan simpanan karbon. Selain nilai komersialnya yang tinggi dalam industri kayu-kayan negara, pemuliharaan populasi *G. bancanus* juga penting untuk kestabilan ekosistem serta pembangunan sosioekonomi negara.

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1.0 PENGENALAN

Di Sarawak, hutan paya campur (*mixed swamp forest*) adalah yang terbesar berbanding lima jenis hutan paya yang lain (Lilian, 2008). Salah satu spesies utama di hutan paya adalah *Gonystylus bancanus* (Miq.) *Kurz* daripada famili *Thymelaeaceae*, atau lebih dikenali dengan nama tempatannya Ramin Telur. *Gonystylus bancanus* merupakan spesies yang penting dan paling dominan di hutan paya campur di Sarawak (Tawan, 2004). Habitat bagi *G. bancanus* secara umumnya adalah kawasan paya yang mempunyai kedalaman melebihi 3m, terpengaruh oleh pasang surut tetapi airnya tidak masin serta memerlukan banyak cahaya (Heriyanto dan Garsetiasih, 2006).

Menurut Khali *et al*. (2010), *G. bancanus* merupakan salah satu spesies balak yang utama dan boleh dianggap sebagai *jewel of the peat swamp forest* kerana mempunyai nilai ekonomi yang tinggi. Oleh itu, *G. bancanus* menjadi tumpuan pembalakan bagi tujuan komersial. Namun, eksploitasi berlebihan terhadap spesies ini telah memberi ancaman terhadap kemerosotan populasi serta degradasi pada habitat asalnya (IUCN, 2014). Isu ini telah mendapat perhatian daripada pelbagai pihak dimana ianya amat kritikal pada *G. bancanus* yang hanya tumbuh di habitat tertentu. Sebagai salah satu usaha pemuliharaan, *Gonystylus spp.* telah diklasifikasikan sebagai spesies terancam Appendiks II di bawah CITES (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*) yang bertujuan mengehadkan penebangan serta perdagangan antarabangsa tanpa permit yang sah.

Untuk tujuan konservasi, satu kajian telah dijalankan di Ulu Mentawai, Taman Negara Mulu, Sarawak dimana populasi *G. bancanus* telah dikenalpasti di satu kawasan hutan paya dengan anggaran keluasan 100-150 hektar. Ini merupakan rekod taburan terbaru bagi *G. bancanus* di Ulu Mentawai, Taman Negara Mulu Sarawak, dan memerlukan kajian yang lebih terperinci memandangkan kajian terhadap spesies ini masih lagi terhad. Kajian ini bertujuan untuk menilai potensi pada *G. bancanus* di habitat asalnya iaitu di hutan paya Ulu Mentawai, Taman Negara Mulu agar langkah konservasi dapat diambil untuk kajian yang seterusnya. Langkah konservasi harus diambil dalam usaha memulihara spesies G. *bancanus* di habitat asalnya serta meningkatkan populasi *G. bancanus* agar kemandirian spesies tersebut terjamin disamping meneruskan kepentingannya dalam ekosistem dan potensi terhadap ekonomi negara.

2.0 METODOLOGI KAJIAN

Tapak kajian

Kajian telah dijalankan di Hutan Paya Ulu Mentawai, Taman Negara Mulu, Sarawak pada Mac 2013 lanjutan daripada penemuan spesies *G. bancanus* di Ulu Mentawai semasa ekspedisi yang telah dijalankan pada September 2012. Mengikut kaedah jalur transek, satu plot bersaiz 1 hektar (100m x 100m) telah ditubuhkan dan dibahagikan kepada 16 kuadrat yang bersaiz 25m x 25m setiap satu.

Pengumpulan data

Semua *G. bancanus* yang terdapat dalam plot dan mempunyai diameter paras dada (dbh) ≥ 10cm direkod dan dilabel menggunakan plat aluminium. Setiap *G. bancanus* yang direkod dinilai dengan mengambil kira ukuran diameter, tinggi serta kelas silara pokok. Kedudukan koordinat bagi setiap *G. bancanus* dicatat menggunakan GPS (*Global Positioning System*) untuk merekod taburan spesies tersebut.

Data analisis

Pengiraan bagi keluasan pangkal (*Basal Area*, BA) dan isipadu (*Volume*, V) pokok adalah mengikut formula tersebut (Khali *et al*., 2009):

Keluasan pangkal (BA) = $[\pi \times (dbh^2)/40\ 000]$, dalam unit m^2

Isipadu (V) = $BA \times mht \times 0.65$, dalam unit m^3

Dimana, 'mht' merujuk kepada *merchantable bole height* dalam unit meter, manakala 0.65 adalah bentuk faktor yang boleh diaplikasikan untuk semua jenis pokok.

Biojisim pokok ditakrifkan sebagai jumlah keseluruhan bahan organik yang terdapat pada pokok, dan dirujuk sebagai biojisim kering per unit kawasan (tan ha^{-1}). Dalam kajian ini, pengiraan bagi anggaran biojisim pokok di hutan jenis paya adalah berdasarkan formula Istomo (2006) (Khalil *et al.*, 2009):

Biojisim (atas tanah) = $0.0145\ (dbh^3) - 0.4659\ (dbh^2) + 30.64\ (dbh) - 263.32$

Biojisim (bawah tanah) = 20.1% daripada biojisim (atas tanah)

Jumlah biojisim tumbuhan = biojisim (atas tanah) + biojisim (bawah tanah)

Kandungan karbon kemudian dianggarkan kepada 50% daripada jumlah biojisim (Roland and Lim, 1999; Pearson et al., 2005; Verwer and van der Meer, 2010; Yanto et al., 2010; Liz, 2013)

3.0 DAPATAN KAJIAN

Hasil daripada penilaian plot seluas 1 hektar, sebanyak 21 dirian *G. bancanus* berketinggian 30m – 50 m telah direkod dengan keluasan pangkal 4.94m^2 ha^{-1} dan isipadu 139.35m^3 ha^{-1} (Jadual 1). Diameter kelas 50.0 – 69.9cm menunjukkan kepadatan dirian yang paling tinggi dengan 11 individu iaitu melebihi setengah (52.4 %) daripada keseluruhan rekod. Ini menunjukkan kebanyakan populasi *G. bancanus* di kawasan kajian terdiri daripada pokok-pokok induk. Manakala bagi kedudukan silara (Synnott, 1979), semua pokok yang direkod mempunyai kedudukan silara kelas 3 dan ke atas dengan 66.67% adalah berkelas 5, seterusnya menunjukkan bahawa penerimaan cahaya bagi populasi *G. bancanus* di kawasan kajian adalah baik.

Jadual 1: *Gonystylus bancanus* (dbh ≥ 10 cm) dalam plot 1 hektar di Ulu Mentawai

Kelas diameter	Individu (individu ha^{-1})	Keluasan Pangkal, BA (m^2ha^{-1})	Isipadu, V (m^3ha^{-1})
10.0 – 29.9	1	0.06	1.12
30.0 – 49.9	5	0.57	14.66
50.0 – 69.9	11	2.68	80.89
≥ 70.0	4	1.62	42.68
Jumlah	**21**	**4.94**	**139.35**

Biojisim tumbuhan adalah bahan organik yang dihasilkan oleh pokok dan ia adalah sumber kepada perkhidmatan hutan yang lain, misalnya maklumat biojisim boleh digunakan untuk menganggarkan parameter seperti kandungan simpanan karbon. Secara keseluruhannya, sebanyak 63.72 t ha^{-1} biojisim *G. bancanus* dianggarkan untuk plot 1 hektar (Jadual 2), dimana ianya menyimpan anggaran 31.86 t C ha^{-1}. Diameter kelas 50.0cm – 69.9cm mempunyai kandungan biojisim tertinggi (33.24 tan ha^{-1}) diikuti dengan kelas diameter ≥ 70cm (23.57tan ha^{-1}). Kelas diameter ≥ 70.0 cm menunjukkan kandungan biojisim yang jauh lebih besar daripada kelas diameter 30.0cm – 49.9cm kerana selain daripada kepadatan dirian, biojisim bergantung pada tinggi dan keluasan pangkal pokok tersebut.

Jadual 2: Jumlah anggaran biojisim bagi *Gonystylus bancanus* dalam plot 1 hektar di Ulu Mentawai

Kelas diameter	Biojisim (tan ha^{-1})			
	Atas tanah	Bawah tanah	Jumlah	Peratus (%)
10.0 – 29.9	0.51	0.10	**0.61**	0.96
30.0 – 49.9	5.25	1.05	**6.30**	9.89
50.0 – 69.9	27.68	5.56	**33.24**	52.17
≥ 70.0	19.62	3.94	**23.57**	36.99
Jumlah	**53.06**	**10.65**	**63.72**	**100.00**

4.0 PERBINCANGAN

Taburan *G. bancanus* boleh dianggap terhad di kawasan tanah rendah tropika jenis hutan paya. Di Sabah dan Sarawak, spesies ini terdapat di hutan paya campur (Lilian, 2008). Di Ulu Mentawai, Taman Negara Mulu Sarawak terdapat pelbagai jenis hutan termasuk hutan paya dimana sebanyak 21 dirian *G. bancanus* telah direkod di dalam plot 1 hektar. Menurut Khali *et al.* (2009) hasil daripada kajian ke atas plot 1 hektar di Hutan Simpan Pakan, Pahang, *G. bancanus* merupakan antara 3 spesies yang paling dominan, dengan rekod 25 dirian *G. bancanus* berkeluasan pangkal 5.57 m^2 ha^{-1} dan isipadu 72.40 m^3 ha^{-1}. Kedudukan silara bagi *G. bancanus* di Ulu Mentawai menunjukkan kesemua dirian mempunyai kedudukan silara kategori baik iaitu kelas 3 ke atas dimana ia menunjukkan penerimaan cahaya yang baik selain tumbuh subur dan tinggi. Seperti yang dinyatakan oleh Heriyanto dan Garsetiasih (2006), *G. bancanus* merupakan spesies yang selalu menghijau dan memerlukan persekitaran dengan cahaya yang banyak. Kawasan kajian menyediakan persekitaran yang baik bagi habitat *G. bancanus* dan langkah konservasi harus diambil.

Biojisim bergantung pada ketinggian, kepadatan dirian, keluasan pangkal sesuatu pokok (Mardan *et al*., 2013) serta komposisi spesies (Liz, 2013). Perbandingan terhadap kajian oleh Khali *et al.* (2009) menunjukkan jumlah keseluruhan biojisim bagi 376 pokok untuk 49 spesies (dbh ≥10 cm) dalam plot 1 hektar adalah 414.57 t ha^{-1}. Manakala kajian terhadap plot 1 hektar hutan paya di hutan simpan UNIMAS menunjukkan jumlah biojisim atas tanah bagi 1,400 pokok untuk 129 spesies (dbh ≥10cm) adalah 221.38 t ha^{-1} (Ipor *et al.,* 2013). Biojisim atas tanah terdiri daripada tumbuhan yang hidup di atas tanah, termasuk batang, dahan, ranting dan daun (Verwer dan van der Meer, 2010) manakala biojisim bawah tanah merujuk pada akar-akar pokok (Hussin *et al*., 2007). Di Ulu Mentawai, jumlah keseluruhan biojisim bagi 21 dirian *G. bancanus* adalah 63.72 t ha^{-1}, dan nilai tersebut dianggap tinggi untuk sesuatu dirian spesies dimana anggaran jumlah karbon yang tersimpan adalah 31.86 t C ha^{-1}. Biojisim adalah penting bagi menganggarkan jumlah potensi karbon yang tersimpan dalam sesuatu dirian tumbuhan hutan. Kandungan simpanan karbon adalah salah satu sumber perkhidmatan hutan yang penting dimana ia berpotensi mengurangkan pengumpulan gas karbon dioksida di atmosfera melalui pengumpulan biojisim seterusnya berperanan penting menjaga keseimbangan karbon dalam ekosistem.

5.0 KESIMPULAN

Gonystylus bancanus mempunyai potensi yang tinggi dari segi ekonomi dan ekologi. Selain daripada memiliki nilai komersial yang tinggi dalam industri kayu-kayan Negara, *G. bancanus* memberi sumbangan yang besar dalam fungsi simpanan karbon dimana ia adalah penting dalam menjaga keseimbangan ekosistem. Kawasan kajian menunjukkan bahawa habitat *G. bancanus* mempunyai potensi yang besar dan kajian selanjutnya harus dijalankan terutama dalam usaha konservasi dan memperkayakan populasi bagi memastikan habitat dan kemandirian spesies terjaga disamping meneruskan kepentingannya dalam ekosistem dan ekonomi negara.

6.0 CADANGAN KAJIAN

Menubuhkan *Permanent Sample Plots* (PSPs) di kawasan habitat *G. bancanus*. PSPs adalah penting bagi memelihara habitat dan populasi *G. bancanus* dimana kajian jangka panjang dapat dijalankan seperti penilaian terhadap perubahan struktur hutan dan komposisi spesies dari semasa ke semasa, disamping perubahan kepadatan dirian dan keluasan pangkal bagi sesuatu spesies. Bilangan PSPs ditentukan berdasarkan jumlah kajian perimeter terhadap keluasan sebenar hutan paya.

Kajian terhadap tanah adalah penting bagi menilai komposisi tanah, seterusnya mengenalpasti faktor yang mempengaruhi kesuburan kawasan habitat tersebut.

Kajian terhadap fenologi merupakan salah satu elemen penting dalam langkah konservasi. Pemerhatian terhadap fenologi *G. bancanus* dijalankan bagi merekod kitaran produktiviti spesies tersebut di kawasan kajian. Rekod ini adalah penting bagi pengumpulan germplasma untuk pembekalan biji benih.

Langkah pemuliharaan *in-situ* boleh diambil dengan cadangan membina tapak semaian, bertujuan untuk mengekalkan sumber *G. bancanus* di kawasan sekitar Ulu Mentawai Taman Negara Mulu. Penyemaian biji benih dibuat di tapak semaian sebelum proses penanaman semula anak pokok ke habitat asalnya. Untuk kesan jangka panjang, cadangan untuk melibatkan komoditi di kawasan Ulu Mentawai di mana mereka boleh bekerjasama dan menjadi pembekal anak pokok *G. bancanus* kepada pengusaha ladang. Ini secara tidak langsung dapat meningkatkan sosioekonomi penduduk setempat sekaligus membantu memperkayakan populasi *G. bancanus*.

Pemuliharaan secara *ex-situ* merujuk pada penanaman semula *G. bancanus* di kawasan bukan habitat asalnya. Ini melibatkan penanaman semula anak pokok *G. bancanus* di beberapa kawasan kajian yang terpilih, terdiri daripada kawasan paya dan bukan paya. Menurut Khali *et al.* (2010), pihak Forest Research Institute Malaysia (FRIM) telah berjaya menanam *G. bancanus* di tanah bukan gambut pada tahun 1993 dimana ia menunjukkan garis pusat pertumbuhan tahunan kira-kira 0.9 cm/tahun. Merujuk pada Ismail *et al*. (2007), kemandirian *G. bancanus* yang ditanam di kawasan hutan bukan paya adalah sebanyak 52% dengan purata tinggi penuh sebanyak 816 cm dan purata diameter pada paras dada sebanyak 9.1 cm bagi percubaan tanaman *G. bancanus* selama 11 tahun. Penanaman semula merupakan usaha konservasi yang penting kerana selain dapat meningkatkan populasi pokok, ia dapat menyumbang jumlah simpanan karbon yang besar dalam ekosistem.

RUJUKAN

Heriyanto, N. M. & Garsetiasih, R. (2006). Ekologi dan Potensi Ramin (*Gonystylus bancanus* Kurz.) di Kelompok Hutan Sungai Tuan-Sungai Suruk, Kalimantan Barat. *Buletin Plasma Nutfah*, 12 (1): 24-29.

Hussin, Y. A., Samalca, I. K. & de Gier, A. (2007). *Estimation of Tropical Forest Biomass for Assessment of Carbon Sequestration Using Regression Models and Remote Sensing in Berau, East Kalimantan, Indonesia.* In the Proceedings of the 28th Asian Conference on Remote Sensing (ACRS) 2007, Vol. 3 of 3, p. 1603-1608. Kuala Lumpur, Malaysia.

Ipor, I. B., Tawan, C. S., & Earl Roscoe, J. R. (2013). *Tree Diversity and Above Ground Biomass Estimation of Peat Swamp Forest in UNIMAS Forest Reserve*. In 2nd International Conference on Alfred Russel Wallace – His Predecessors and Successors. Naturalists, Explorers and Field Scientists in South-East Asia and Australasia.

Ismail, P., Shamsudin, I., Abdul Rahman, K., Hashim, W. S. & Ismail, H. (2007). Planting of *Gonystylus bancanus* in Non-Peat Swamp Area. *Journal of Tropical Forest Science*, 19 (1): 50 – 56.

IUCN. (2014). Red List of Endangered Species. *International Union for the Conservation of Nature and Natural Resources*. Retrieved from http://www.iucnredlist.org/

Khali, A. H., Ismail, P., Abdul Rahman, K., Che Hashim, H., Grippin, A. & Nizam, M. S. (2009). Ecological Chatacteristics of a Gonystylus bancanus - Rich Area in Pekan Forest Reserve, Pahang, Malaysia. *Tropical Life Sciences Research, 20* (2): 15 – 27.

Khali A.H., Ismail, P., Ani, S., Mohd Azahari, F., Harry, Y. & Ihsan, S.K. (2010). *Gonystylus bancanus: Jewel of Peat Swamp Forest*. Forest Research Institute Malaysia. 83 pp.

Lillian, S. L. C. (2008). *Ramin (Gonystylus bancanus) in Malaysia*. In NDF Workshop Case Studies. p. 1-21. Mexico.

Liz, A. D. C. (2013). *Disturbance Effects on Carbon Content and Tree Species Traits in Tropical Peat Swamp Forest in Central Kalimantan, Indonesia Borneo*. B. Sc Thesis. Dalhousie University, Halifax, Nova Scotia. 108 pp.

Mardan, M. N., Hakeem, K. R., Faridah Hanum, & Saari, N. S. (2013). Tree Species Composition and Diversity in One Ha Forest, Ulu Muda Forest Reserve, Kedah. *Sains Malaysiana, 42* (10): 1409 – 1424.

Pearson, T. R. H., Brown, S. & Ravindranath, N. H. (2005). *Integrating Carbon Benefit Estimates into GEF Projects*. Capacity Development and Adaptation Group Guidelines. United Nations Development Programme (UNDP), Global Environment Facility (GEF), USA. 57 pp.

Roland, K. J. H. & Lim, M. T. (1999). An Estimate of Forest Biomass in Ayer Hitam Forest Reserve. *Pertanika J. Trop Agric.* Sci, 22 (2): 117-123.

Synnott, T. J. (1979). *A Manual of Permanent Plot Procedures for Tropical Rain Forests.* Tropical Forestry Papers no. 14. Department of Forestry Commonwealth Forestry Institute, University of Oxford, UK. 67 pp.

Tawan, C. S. (2004). *Thymelaeaceae*. In Tree Flora in Sabah and Sarawak - Volume Five (Soepadmo, E., Saw, L. G. and Chung, R. C. K., eds.), p. 433 – 484. Forest Research Institute Malaysia, Sabah Forestry Department, Sarawak Forestry Department, Malaysia.

Verwer, C. C. & van der Meer, P. J. (2010). *Carbon Pools in Tropical Peat Forest - Towards a Reference Value for Forest Biomass Carbon in Relatively Undisturbed Peat Swamp Forests in Southeast Asia*. Wageningen, Alterra. Alterra – report 2108. 64 pp.

Yanto, R., Dudung, D., Teddy, R. & Elias. (2010). Perubahan Stok Karbon dan Nilai Ekonominya pada Konversi Hutan Rawa Gambut Menjadi Hutan Tanaman Industri Pulp. *JMHT, XVI* (1): 18-26 p.

SESI PEMBENTANGAN IV:

Penilaian Ekonomi Barangan Hutan

URBAN TREE: THE VALUE OF TREES IN THE CITY OF KUALA LUMPUR USING THYER AND BURNLEY METHODS

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ABSTRACT

Urban trees planted in the city areas generate environmental, economic and social benefits to urban dwellers. However, the economic benefits or values of urban trees are not known due to the non-existence of a market for urban trees. There are some methods to estimate the economic values of urban trees and all these methods have been developed and applied in developed countries. In this study, Thyer and Burnley methods were used to estimate the economic values of ten species of urban trees along five major roads in Kuala Lumpur. A total of 503 urban trees were selected by cluster sampling from these roads for field measurements. The field measurements were conducted to record tree species, age, circumference, height, tree volume, crown diameter and tree characteristics. The results show that the estimated total economic values of 503 urban trees are RM4,358,510 (Thyer method) and RM229,283 (Burnley method). The estimated mean value per tree is RM435,851 and RM22,928 for the Thyer and Burnley methods, respectively. Results also indicate that *Pterocarpus indicus* has the highest value with the estimated mean tree value of RM972,660 (Thyer method) and RM61,454 (Burnley method) per tree. The economic value of urban trees based on tree height class, tree crown diameter class and tree DBH class also differs with respect to physical and qualitative characteristics of the tree. The Thyer method gives higher mean tree value than the Burnley method because of the relative weighting of the key factors such as size and species quality. Potential research areas related to economic valuation of urban trees are also highlighted.

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1.0 INTRODUCTION

Urban trees are part of the urban forest used for the purpose of landscaping an area. The vegetation and urban trees are able to enrich the community living in urban areas in terms of environmental, economic and social aspects. Urban trees are valuable natural capital that contributes to human well-being. A well planned urban trees program will contribute significantly to human well-being in terms of ecosystems services that they provide. These ecosystem services include provisioning (for example air purification), regulating (for example climate regulation), supporting (for example prevention of soil erosion) and cultural services (for example recreational benefits).

Urban trees can be seen along streets, roads and in parks. Whether urban trees are self-seeded or planted, they provide the environment with technical, architectonic, and ecological goods and services. Many factors contribute to the need for urban trees, and these are mainly from the demand side. The presence of trees in an urban setting plays an important role in increasing urban dwellers' environmental awareness and concerns about quality of life. Moreover, the urban trees provide many ecological benefits to people living in the cities.

In Malaysia, the practice of greening urban areas has been focused primarily on beautification programmes. The tree planting development can be divided into three phases: the initiation of greening before independence; a more extensive greening programme in the 1970s, 1980s and 1990s; and the campaign for a Garden Nation ten years ago (Sreetheran *et al.*, 2006). At present, urban tree planting plays an important role in making urban areas greener. In Malaysia, since the eighteenth century up to the recent campaign for Garden Nation, tree planting in urban areas has become the government's priority. Many initiatives such as extra follow-ups for tree planting campaign throughout the country are re-emphasised, since they were launched on March 3, 1997. The campaign aims to combine present efforts with past initiatives to create synergy in making Malaysia a "Garden Nation". Malaysia's current goal is to plant 20 million urban trees by the year 2020 and contribute to Malaysia's vision of holding the title of "Most Beautiful Garden Nation". To date, 19,301,581 of 20 million urban trees, representing 96.51%, have been planted in an effort to fulfil this vision (Jawatankuasa Kempen Penanaman Pokok Kebangsaan, 2013).

Managing and investment of urban trees is one of the main programmes undertaken by local municipalities. The investment in urban trees planting programmes requires a better understanding of the true value of economic value of urban tree benefits and other economic tools that take proper account of this value. The economic value of urban trees is important in order to provide policy makers with the tools they need to incorporate and capture the true value of urban tree benefits into their decision. Such benefits should be internalised in the many strings of the decision process such as providing equal priority in budget allocation for urban tree planting programmes and designing appropriate fiscal policy to bring efficiency in the economy. If the policy makers fail to account the economic value of urban tree benefits and losses, there could be a tendency to make wrong choices and give low priority in urban tree planting programmes in addressing sustainable development of urban city.

Thus, valuation of urban tree benefits is required to arrive at an estimated figure, which will form the basis of allocating public funds in the budget for the annual maintenance costs of urban trees and tree-planting programmes. Therefore, if economic values of urban trees are not taken into account, investment in urban tree plantings cannot be fully justified and complicates decision-making for policy makers.

Moreover, urban tree planting programmes usually entail a large amount of funding, which requires due diligence and justifications.

In the past, researchers in many parts of the world have used various methods to appraise urban tree values. These include Helliwell (Helliwell, 1967) – Great Britain; Burnley (McGarry & Moore, 1988) – Australia; Standard Tree Evaluation Method (STEM) (Flook, 1996) – New Zealand; Norma Granada (Asociación Española de Parques y Jardines Públicos, 1999) – Spain; Council of Landscape and Tree Appraisers (CTLA) (CTLA, 2000) – United States; Thyer Tree Valuation Method (Thyer, 2005) – Australia; and VAT03 Model (Randrup, 2005) – Denmark.

Tree planting programme in Malaysia has been part of the main activities in landscaping programme in urban areas. This is because urban tree planting provides benefits to the community and environment. Hence, the government takes an initiative to increase awareness of the importance of preserving the environment and encourages members of the public to be more involved in the planting and caring of trees. The main objective of this study is to appraise the economic value of urban trees in Kuala Lumpur. In specific, this study aimed: 1) to estimate the economic value of selected urban tree species in selected roadsides in Kuala Lumpur; 2) to compare the economic values of urban trees in terms of tree height, tree crown diameter and diameter at breast height (DBH) by using two methods, namely the Thyer and Burnley methods.

2.0 MATERIAL AND METHODS

Study Site

The study was conducted in Kuala Lumpur, the capital city of Malaysia. The city is situated between 03° 10’ 00’’ N latitude and 101° 42’ 00’’ E longitude. Kuala Lumpur has been earmarked as a primary development area to be awarded the status of a modern city by 2020 (KLCH, 2003 and 2007).

Kuala Lumpur, the capital city of Malaysia was chosen as the study site because it has the potential to become a full-fledged modern city through the programme of Sustainable Tropical Garden City by 2020 (Jusoh & Rashid, 2008). According to Islam (2010), Malaysia is a fast developing country and projected to be a developed country by the year 2020. The vision for the development of Kuala Lumpur is highlighted in the Kuala Lumpur Structure Plan 2020 (KLCH, 2003). Malaysia's future development as envisaged in Vision 2020 implies that the nation will reach the status of a developed country from the economic, social, political and spiritual perspectives. Accordingly, urban trees and landscape assets can most likely contribute to the achievement of the vision through good planning, management and maintenance.

Another reason for choosing Kuala Lumpur as the study area is that an extensive urban tree planting programme has been carried out by the City Hall. The municipality is responsible for managing urban trees for sustainable management in the urban areas. Kuala Lumpur has a good record of urban trees stored in a database to facilitate monitoring by the authorities for urban tree management and tree maintenance. Besides, the easy accessibility to assess the urban trees in Kuala Lumpur is another reason for conducting the study in this city.

Tree Selection

The selection of urban trees included in the study was done in collaboration with the Department of Landscape and Recreation, Kuala Lumpur City Hall. The selected individual urban trees were located along the 5 main roads, namely Jalan Ampang, Jalan Cheras, Jalan Kuching, Jalan Raja Laut and Jalan Sultan Ismail. The criteria of tree selection were based on the locations of trees along the “protocol road” or main road that lead to key administration buildings such as the Kuala Lumpur City Hall, Bank Negara and other important landmarks in Kuala Lumpur (Sharifah Dora, 2009).

Besides, these roads are normally used as the main access to enter the city centre and are part of the longest road in Kuala Lumpur which has mature, large and old trees. The other reasons for this choice include the availability of a database on these trees, as recorded by Kuala Lumpur City Hall and also their accessibility. These roads are also a part of the main roads which are maintained and given special attention by the Kuala Lumpur City Hall.

There are 10 popular species of urban trees planted along Jalan Ampang, Jalan Cheras, Jalan Kuching, Jalan Raja Laut and Jalan Sultan Ismail. The trees are akasia perak (*Acacia holosericea*), tapak kuda (*Bauhinia spp.*), bintangor laut (*Calophyllum inophyllum*), ara (*Ficus benjamina*), merawan siput jantan (*Hopea odorata*), bunga tanjung (*Mimusops elengi*), jemerlang (*Pelthophorum pterocarpum*), angsana (*Pterocarpus indicus*), rain tree (*Samanea saman*) and pink tecoma (*Tabebuia pallida*).

Data Collection Procedure

Data were collected from both primary and secondary sources. Primary data were collected from the study site based on tree measurements on the field. On the other hand, secondary data include information and data available from the Kuala Lumpur City Hall records. Data of the physical characteristics of the trees were supplied by Kuala Lumpur City Hall, which were collected by the staff of Kuala Lumpur City Hall during the development of a database on urban trees for monitoring purposes.

Field measurements were taken using the above-mentioned instruments and were recorded in the field data sheet designed specifically for this study. This data sheet contains information of measurements and observations in relation to the physical characteristics and qualitative features of trees. The measurements include diameter at breast height (DBH), tree height, circumference and crown diameter. The qualitative characteristics of each tree include vigour, condition, structure, health, location, species, quality, special situation, price, and quality conditions of tree, which were all recorded. These qualitative characteristics were measured based on qualitative scores set by the Thyer and Burnley methods. Other information required includes tree inventory reports and planting costs, which were provided by Kuala Lumpur City Hall (Sharifah Dora, 2009).

The study site was divided into 5 roads: Jalan Ampang, Jalan Cheras, Jalan Kuching, Jalan Raja Laut and Jalan Sultan Ismail. Along these roads, urban trees are planted on both sides and have been tagged and meticulously recorded by the staff of Kuala Lumpur City Hall. There are approximately 2,068 urban trees planted along these roads. The percentage of urban tree sample is 24.3% from the total urban trees for this study site. For this study, 503 trees were measured and all the information was recorded in the field sheet.

There are approximately, 46 akasia perak (*Acacia holosericea*); 28 tapak kuda (*Bauhinia spp.*); 62 bintangor laut (*Calophyllum inophyllum*); 28 ara (*Ficus benjamina*); 92 merawan siput jantan (*Hopea odorata*); 26 bunga tanjung (*Mimusops elengi*); 452 jemerlang (*Pelthophorum pterocarpum*); 764 angsana (*Pterocarpus indicus*); 414 rain tree (*Samanea saman*) and 156 pink tecoma (*Tabebuia pallida*) planted along these roads. The percentages of each species of urban tree sample are approximately 24.3% from the total urban trees for each species for this study site. For this study, 11 akasia perak (*Acacia holosericea*); 7 tapak kuda (*Bauhinia spp.*); 15 bintangor laut (*Calophyllum inophyllum*); 9 ara (*Ficus benjamina*); 22 merawan siput jantan (*Hopea odorata*); 6 bunga tanjung (*Mimusops elengi*); 110 jemerlang (*Pelthophorum pterocarpum*); 185 angsana (*Pterocarpus indicus*); 100 rain tree (*Samanea saman*) and 38 pink tecoma (*Tabebuia pallida*) were measured and all the information was recorded in the field sheet.

For each road, different numbers of urban trees were selected and measured by cluster sampling based on tree species and DBH class of urban trees. These include Jalan Ampang (100 urban trees), Jalan Cheras (136 urban trees), Jalan Kuching (148 urban trees), Jalan Raja Laut (44 urban trees) and Jalan Sultan Ismail (75 urban trees). The database on urban trees was supplied by Kuala Lumpur City Hall as reference for urban tree selection of this study.

The Haga altimeter was used to measure and record the total height of the trees. The height recordings were taken at a distance of 15 metres from any standing tree measured by using the meter tape. The reason for this distance is to avoid the trees fronting the tree being measured; they tend to block the reading of tree height. If the measurements are taken at a further distance (> 15 metres), the view of crown height will overlap with the front trees. Additionally, diameter and tree circumference readings were recorded at 1.3 metres above ground at breast height. This is a standard measurement for the diameter of trees in forestry research.

Appraisal Methods

Thyer Method

The Thyer method was developed in Sydney, Australia in 1984 (Thyer, 2005). The valuation reflects the contribution of trees to the landscape, the expression of positive qualities by the tree, and the extent to which these elements are appreciated. According to Thyer, this method of economic valuation includes the measurements of several factors such as the size factor (S), age factor (A), physical and social qualities factor (Q), significant index (SI) and the planting cost (P) of trees in order to obtain the values of urban trees (V).

All attributes of tree measurements were taken, such as size factor (S) measured in metres; it consists of tree height, area of canopy from side view, average diameter to dripline and tree circumference. The Thyer method applies standard parameters in the calculation of the age factor (A) through the assessment of tree age, multiplied by 0.02 and adding 0.5. This is a standard parameter used in Thyer method. The physical and social qualities factors represented by Q, is calculated based on qualitative scores. The indicators for physical qualities factors (Qi) are: the health of the tree; environmental benefits; life expectancy beyond present time; re-establishment potential of same species on site; and rate of growth over the first 10 years. The scales for physical qualities factors (Qi), range from scores of 0, 1, 2, 4 and 8. In addition, indicators for social qualities factors (Qii) are social benefit; form and features; and social significance. The scales for social qualities factors (Qii) scores are

0, 2, 4, 8 and 16. The scores for total Qi scores are then added with total scores of Qii in order to obtain the value of physical and social qualities factors (Q).

The significant index (SI) is calculated through the multiplication of the size factor (S), age factor (A) and physical and social factors (Q). Data on planting cost (P) were obtained based on the average landscape industry rate report as provided by Kuala Lumpur City Hall for various species and tree sizes. For this study, information on planting costs for each species was given by Kuala Lumpur City Hall. All parameters were recorded using the field data sheet.

The following formula was used to calculate the appraised values of urban trees:

Tree value (V) = significance index (SI) [size factor (S) × age factor (A) × physical and social qualities factors (Q)] × planting cost (P)

Burnley Method

The Burnley method is based on tree size and unit monetary value. Tree size is measured as volume of a tree approximated by an inverted cone. The tree volume is multiplied by the cost per cubic meter of retail nursery stock (presumably of the same species). The factors for life expectancy range from 0.5 to 1.0; form and vigour 0.0 to 1.0; location 0.4 to 1.0. To calculate tree volume, the formula for a cone ($1/3\ \Pi r^2 h$) is used, where r is radius in centimetres (cm) and height is measured in metres (m). The base value calculation is expressed as RM/m^3.

All parameters are recorded in the field data sheet. According to the Burnley method, the factors for life expectancy form and vigour, and location are calculated based on qualitative scores given.

The appraised values for the urban trees are calculated using the following formula:

Appraised value = tree volume (TV) × base value (BS) × life expectancy (E) × form and vigour (Fv) × location (L)

Statistical Analysis

Statistical Package for Social Science (SPSS) Version 17 was used for all the analyses conducted. Statistical analysis and descriptions of the urban tree characteristics by species include the mean, variance and standard deviation. The estimated tree values of urban trees (RM) according to species were also analysed using the Thyer and Burnley methods. Besides, the average tree value of urban trees was calculated based on species, tree height class, tree crown diameter class and DBH class using both methods.

The analysis of variance (ANOVA) tests was conducted to determine the significant difference in tree values among different tree species as assessed by the Thyer and Burnley methods. ANOVA tests were also conducted to determine whether trees have significantly different mean tree values for each species according to the tree height class, tree crown diameter class and DBH class.

3.0 RESULTS AND DISCUSSION

Tree Characteristics

The characteristics of the urban trees measured based on a sample size of 503 trees are presented in Table 1. The results are tabulated according to tree height, crown diameter, circumference, diameter at breast height (DBH), tree age, tree volume and significance index (SI). Results from this study show that *Pterocarpus indicus* has the highest mean height of 22.52m, a mean diameter at breast height (DBH) of 66.64cm, a mean crown diameter of 14.51m, a mean circumference of 2.09m, a mean age of 74 years, a mean tree volume of 2.85m3 and a mean significant index (SI) of 1095.34. It can be said that *Pterocarpus indicus* is a fast-growing tree and provides much needed shade within the shortest growth time (Wee & Corlett, 1986).

Overall, the urban trees show the following results: total mean of tree height is 17.74m; total mean of crown diameter is 12.54m; total mean of circumference is 1.68 m; total mean of diameter at breast height (DBH) is 53.54 cm; total mean of age is 59 years; total mean of tree volume is 1.85m3; and total mean of significant index (SI) is 769.11.

Table 1: Descriptive statistics of tree characteristics by species

Tree Species	N		Tree Height (m)	Crown Diameter (m)	Circumference (m)	DBH (cm)	Tree Age (years)	Tree Volume (m^3)	Significance Index (SI)
Acacia holosericea	11	Mean	16.41	12.10	1.30	41.37	46	1.10	510.47
		Std. Deviation	3.47	1.47	0.70	22.20	25	1.37	164.16
		Variance	12.07	2.15	0.49	492.81	607	1.87	26,949.10
Bauhinia spp.	7	Mean	8.66	7.09	0.79	25.17	28	0.13	93.41
		Std. Deviation	2.87	2.86	0.11	3.62	4	0.09	46.61
		Variance	8.23	8.17	0.01	13.13	15	0.01	2,172.67
Calophyllum inophyllum	15	Mean	10.90	8.32	1.21	38.60	43	0.44	187.00
		Std. Deviation	1.11	0.40	0.25	7.88	9	0.18	77.06
		Variance	1.22	0.16	0.06	62.17	75	0.03	5,938.07
Ficus benjamina	9	Mean	14.49	11.87	1.88	59.93	67	2.47	597.93
		Std. Deviation	8.30	8.28	1.56	49.53	55	4.03	591.42
		Variance	68.93	68.58	2.42	2,453.03	3033	16.23	349,780.97
Hopea odorata	22	Mean	14.77	7.59	0.60	19.16	21	0.16	264.88
		Std. Deviation	1.84	1.37	0.21	6.77	7	0.12	116.38
		Variance	3.40	1.89	0.04	45.82	56	0.01	13,544.11
Mimusops elengi	6	Mean	8.27	6.88	0.75	23.93	27	0.14	215.00
		Std. Deviation	0.33	0.73	0.36	11.47	13	0.13	27.77
		Variance	0.11	0.54	0.13	131.54	166	0.02	771.29
Pelthophorum pterocarpum	110	Mean	14.81	11.51	1.35	43.03	48	0.88	441.85
		Std. Deviation	3.73	3.83	0.55	17.54	19	0.81	275.22
		Variance	13.90	14.67	0.30	307.56	380	0.66	75,747.93

Table 1: Descriptive Statistics of Tree Characteristics by Species (Cont')

Tree Species	N		Tree Height (m)	Crown Diameter (m)	Circumference (m)	DBH (cm)	Tree Age (years)	Tree Volume (m^3)	Significance Index (SI)
Pterocarpus indicus	185	Mean	22.52	14.51	2.09	66.64	74	2.85	1,095.34
		Std. Deviation	5.71	3.89	0.59	18.71	21	2.07	976.91
		Variance	32.64	15.12	0.35	350.16	432	4.27	954,349.11
Samanea saman	100	Mean	16.18	13.59	1.85	58.81	65	2.20	918.66
		Std. Deviation	4.76	4.96	1.04	33.20	37	3.12	1,453.68
		Variance	22.66	24.60	1.09	1,101.93	1362	9.71	2,113,172.47
Tabebuia pallida	38	Mean	15.79	9.85	1.38	44.02	49	1.11	583.70
		Std. Deviation	5.87	4.55	0.62	19.86	22	1.50	910.31
		Variance	34.48	20.74	0.39	394.27	487	2.26	828,660.80
Total	**503**	**Mean**	**17.74**	**12.54**	**1.68**	**53.54**	**59**	**1.85**	**769.11**
		Std. Deviation	**6.24**	**4.61**	**0.82**	**26.07**	**29**	**2.24**	**976.72**
		Variance	**38.92**	**21.28**	**0.67**	**679.48**	**838**	**5.01**	**953,983.24**

Estimated Tree Value Using Two Methods

Table 2 presents the overall estimated tree values based on the Thyer and Burnley methods. Results show that *Pterocarpus indicus* has the highest tree value based on both the Thyer and Burnley methods with an estimated mean tree value of RM972,660 and RM61,454 per tree respectively. The tree species that has the lowest tree value is *Bauhinia spp.* with an estimated mean tree value of RM82,953 (Thyer method) and RM 1,975 per tree (Burnley method).

The results also indicate that the average tree values range from RM82,953 to RM972,660 (Thyer method) and from RM1,975 to RM61,454 (Burnley method). Based on the Thyer method, the estimated total value of the 503 urban trees is RM4,358,510 and the mean value per tree is RM435,851. Meanwhile, the estimated total value of urban trees in the area is RM229,283 and the mean value per tree is RM22,928 using the Burnley method.

Based on the above-mentioned results, it is evident that the tree value produced by the Thyer method is higher compared with that of the Burnley method. The reason for the difference in the tree value is that relative weightings of the key factors of size and species quality differ in the formula methods used for this study. This is in line with a study by Watson (2002) who reported wide variations in the range of appraised values for the different urban tree species using different methods. However, unlike the Thyer method, the special factors are not considered in the Burnley method. The Thyer method considers special factors in determining the social qualities factors; hence, these special factors influence the appraised value.

Table 2: Descriptive statistics of tree value using two methods

Tree Species	N	Thyer		Burnley	
		Mean (RM)	Std. Deviation	Mean (RM)	Std. Deviation
Acacia holosericea	11	453,293	145,775	22,795	31,820
Bauhinia spp.	7	82,953	41,392	1,975	1,667
Calophyllum inophyllum	15	166,058	68,428	8,501	5,111
Ficus benjamina	9	530,963	525,184	30,174	33,459
Hopea odorata	22	235,214	103,345	5,013	3,828
Mimusops elengi	6	190,914	24,663	3,708	3,272
Pelthophorum pterocarpum	110	392,364	244,398	19,979	19,404
Pterocarpus indicus	185	972,660	867,494	61,454	57,988
Samanea saman	100	815,766	1,290,864	48,692	75,669
Tabebuia pallida	38	518,324	808,354	26,993	31,330
Average all trees		435,851	411,990	22,928	26,355
Total Value	**503**	**4,358,510**	**4,119,898**	**229,283**	**263,547**

Comparative Study Between The Two Methods

Tree Height Class

Table 3 presents the estimated mean values for each tree species based on tree height class. The five species, namely *Acacia holosericea*, *Bauhinia spp.*, *Hopea odorata*, *Pelthophorum pterocarpum* and *Samanea saman* shows that as tree height class increases, mean tree value increases for both the Thyer and Burnley methods. In the case of *Calophyllum inophyllum*, as tree height class increases, the mean tree value decreases for the Thyer method; in contrast, it increases when using the Burnley method. For the Burnley method, there is a direct relationship between tree height class and mean tree values for all the trees tested except for *Tabebuia pallida*.

Most of the urban trees in the study are planted within good planting distance (6.1 m – 9.1 m) between trees. Thus, the crowns of the trees can grow without being obstructed by adjacent trees, and hence the crown diameter increases accordingly. This condition enables the urban trees to grow well as there is little competition for sunlight and space. As a result, the urban trees exhibited a higher mean tree value and increases with respect to the tree height class.

The results indicated that *Samanea saman* has the highest mean tree value with respect to tree height class (more than 25 m), which amounted to RM5,637,578 (Thyer method) and RM306,150 per tree (Burnley method). The range of the estimated mean tree values for the Thyer method is higher compared with that of the Burnley method; the values range from RM144,870 to RM1,395,182 for the Thyer method and RM5,770 to RM86,604 for the Burnley method. In conclusion, the results indicate that the mean tree value is positively related to tree height class and vice versa.

Table 3: Average tree value by tree height class using two methods

Tree Species	N	Height Class (m)	Thyer		Burnley	
			Mean (RM)	Std. Deviation	Mean (RM)	Std. Deviation
Acacia holosericea	8	10 - 14.99	394,442	91,523	6,015	2,696
	3	20 - 24.99	610,230	161,669	67,540	30,128
Bauhinia spp.	4	< 9.99	59,353	12,536	1,487	1,253
	3	10 - 14.99	114,419	48,010	2,624	2,208
Calophyllum inophyllum	3	< 9.99	175,269	55,016	6,679	1,381
	12	10 - 14.99	163,755	73,350	8,956	5,636
Ficus benjamina	3	< 9.99	247,912	243,240	10,847	17,017
	4	10 - 14.99	357,023	286,950	20,969	12,380
	1	20 - 24.99	1,681,864	-	46,240	-
	1	> 25	924,979	-	108,911	-
Hopea odorata	7	10 - 14.99	135,692	46,410	4,357	4,395
	15	15 - 19.99	281,658	88,508	5,318	3,660
Mimusops elengi	6	< 9.99	190,914	24,663	3,708	3,272
Pelthophorum pterocarpum	12	< 9.99	170,209	90,064	6,375	4,123
	39	10 - 14.99	336,997	189,259	16,007	12,932
	47	15 - 19.99	424,220	214,905	19,408	17,605
	11	20 - 24.99	664,056	353,446	46,690	26,304
	1	> 25	731,653	-	71,197	-
Pterocarpus indicus	8	< 9.99	200,956	15,447	13,039	180
	10	10 - 14.99	370,690	238,237	23,287	23,115
	42	15 - 19.99	877,175	494,874	45,302	28,229
	47	20 - 24.99	747,621	420,600	57,369	36,709
	78	> 25	1,316,001	1,136,362	82,472	75,569

Table 3: Average tree value by tree height class using two methods (Cont’)

Tree Species	N	Height Class (m)	Thyer		Burnley	
			Mean (RM)	Std. Deviation	Mean (RM)	Std. Deviation
Samanea saman	7	< 9.99	49,270	19,692	416	234
	25	10 - 14.99	228,711	120,830	11,092	7,603
	53	15 - 19.99	734,666	473,556	48,979	54,762
	13	20 - 24.99	1,946,269	1,851,692	106,217	72,548
	2	> 25	5,637,578	5,967,934	306,150	345,126
Tabebuia pallida	6	< 9.99	75,190	42,811	3,042	2,545
	9	10 - 14.99	310,114	324,066	15,496	16,350
	16	15 - 19.99	401,226	257,630	26,613	17,142
	4	20 - 24.99	1,755,998	2,137,679	76,519	67,364
	3	> 25	1,003,517	30,763	45,378	18,251
Total	**49**	**< 9.99**	**144,870**	**94,963**	**5,770**	**5,973**
	117	**10 - 14.99**	**283,764**	**191,292**	**13,263**	**12,769**
	173	**15 - 19.99**	**614,806**	**435,932**	**34,198**	**37,967**
	79	**20 - 24.99**	**990,897**	**1,033,845**	**65,135**	**47,624**
	85	**> 25**	**1,395,182**	**1,433,677**	**86,604**	**88,846**

Tree Crown Diameter Class

The estimated tree values for each species based on tree crown diameter class are presented in Table 4. In this study, five species namely *Acacia holosericea*, *Hopea odorata*, *Pelthophorum pterocarpum*, *Pterocarpus indicus* and *Tabebuia pallida* show that the mean tree values increase as tree crown diameter class increases, for both the Thyer and Burnley methods; there is a positive relationship between the two items. For the Thyer method, all trees species except *Bauhinia spp.* show a positive relationship between mean tree values and tree crown diameter class. A reason for this finding is due to the fact that *Bauhinia spp.* is a small tree with its scattered branches. So, the crown shape of trees was not spread very well, thereby affecting the mean tree value.

Most of the urban trees planted in this study area are well maintained. Appropriate tree management procedures are also covered in this study, such as fertiliser application, mulching, watering, pruning, pest and disease control. The care and maintenance given to urban trees help the crown of urban trees to spread very well. In contrast, in cases of poor care and maintenance, the growth of the tree crown can be stunted. In addition, a longer tree planting distance (mean planting distance, 6.1 m – 9.1 m) allows the crown diameter of urban trees to spread very quickly without being disturbed by adjacent urban trees; this is probably because of competition for sunlight and space. Thus, the urban trees show higher mean tree values as the crown diameter class of urban trees increases.

Tabebuia pallida shows the highest mean tree value with respect to tree crown diameter class (more than 20 m), which amounted to RM4,934,000 per tree for the Thyer method. Meanwhile, for the Burnley method, *Samanea saman* indicates the highest mean tree value with respect to tree crown diameter class (more than 20 m), which amounted to RM179,411 per tree. In general, the estimated mean tree value range for the Thyer method is higher compared with that of the Burnley method; the range is from RM120,201 to RM2,439,200 for Thyer method and RM15,003 to RM141,723 for the Burnley method. In conclusion, the results show that the higher tree crown diameter class, the higher the mean tree value.

Table 4: Average tree value by tree crown diameter class using two methods

Tree Species	N	Crown Diameter Class (m)	Thyer		Burnley	
			Mean (RM)	Std. Deviation	Mean (RM)	Std. Deviation
Acacia holosericea	10	10 - 14.99	447,473	152,307	18,505	30,002
	1	15 - 19.99	511,498	-	65,691	-
Bauhinia spp.	1	< 4.99	163,039	-	1,958	-
	4	5 - 9.99	70,910	29,115	1,894	2,235
	2	10 - 14.99	66,996	15,278	2,144	1,266
Calophyllum inophyllum	15	5 - 9.99	166,058	68,428	8,501	5,111
Ficus benjamina	2	< 4.99	107,802	23,397	1,023	239
	3	5 - 9.99	320,459	195,379	26,510	14,588
	2	10 - 14.99	497,422	395,624	17,421	2,764
	2	> 20	1,303,400	535,198	77,576	44,315
Hopea odorata	21	5 - 9.99	220,864	80,358	4,841	3,835
	1	10 - 14.99	536,560	-	8,617	-
Mimusops elengi	6	5 - 9.99	190,914	24,663	3,708	3,272
Pelthophorum pterocarpum	1	< 4.99	77,216	-	3,522	-
	45	5 - 9.99	293,223	146,235	15,226	13,996
	49	10 - 14.99	407,360	228,085	17,141	15,671
	11	15 - 19.99	559,533	221,827	38,552	22,921
	4	> 20	943,072	411,249	61,264	32,069
Pterocarpus indicus	24	5 - 9.99	346,099	278,998	25,304	30,731
	82	10 - 14.99	831,681	390,793	57,174	44,555
	69	15 - 19.99	1,151,900	528,054	66,824	42,553
	10	> 20	2,395,400	2,825,209	146,263	151,394

Table 4: Average tree value by tree crown diameter class using two methods (Cont')

Tree Species	N	Crown Diameter Class (m)	Thyer		Burnley	
			Mean (RM)	Std. Deviation	Mean (RM)	Std. Deviation
Samanea saman	3	< 4.99	176,970	244,222	54,365	93,457
	23	5 - 9.99	221,346	139,943	8,346	9,391
	32	10 - 14.99	590,047	412,194	25,860	19,073
	32	15 - 19.99	827,582	506,608	59,141	58,479
	10	> 20	3,059,100	3,160,233	179,411	149,654
Tabebuia pallida	6	< 4.99	95,973	65,898	4,070	4,526
	18	5 - 9.99	235,387	149,710	22,825	21,623
	8	10 - 14.99	707,975	331,240	30,827	17,498
	5	15 - 19.99	857,138	183,669	34,857	21,814
	1	> 20	4,934,000	-	169,569	-
Total	**13**	**< 4.99**	**120,201**	**115,010**	**15,003**	**44,374**
	159	**5 - 9.99**	**253,766**	**167,513**	**14,049**	**17,888**
	186	**10 - 14.99**	**638,946**	**389,927**	**36,748**	**37,380**
	118	**15 - 19.99**	**990,839**	**527,481**	**60,741**	**46,014**
	27	**> 20**	**2,439,200**	**2,661,210**	**141,723**	**133,331**

Tree Dbh Class

The estimated tree values for each species based on tree DBH class are shown in Table 5. The five species, namely *Bauhinia spp.*, *Calophyllum inophyllum*, *Hopea odorata*, *Pterocarpus indicus* and *Tabebuia pallida* indicate that the mean tree values as assessed by the Thyer and Burnley methods increase with tree DBH class. All urban trees species except *Acacia holosericea,* shows that the mean tree values for the Burnley method increase with tree DBH class.

In this study, different species of trees show different mean tree values as a factor of DBH based on the Thyer and Burnley methods. The urban trees that are in good condition possess higher potential to expand their DBH over time. However, most of the urban trees within the study scope are in poor state. There is probably due to insufficient growing space for root growth, resulting in the stunted growth of the trees' DBH. Research conducted by Ning *et al.* (2008) found that factors such as unhealthy soil (limiting space above and below ground in the urban setting), construction-related stresses, environmental pollution and heavy traffic are the main causes for low survival rate and unhealthy growth of the urban trees along many main roads. As a result, the urban trees show higher mean tree values and increase with the DBH class of urban trees.

Tabebuia pallida shows the highest mean tree values with respect to tree DBH class, which RM4,934,034 per tree (Thyer method) and RM169,569 per tree (Burnley method). The range of estimated mean tree values for the Thyer method is higher compared with that of the Burnley method; the range is from RM231,298 to RM1,647,600 for the Thyer method and RM2,473 to RM125,223 for the Burnley method. In conclusion, the results also show that the higher the DBH class of the tree, the higher the mean tree value. This discovery is consistent with the findings reported by Watson (2002) where the values of urban trees increase rapidly with tree size.

Table 5: Average tree value by tree dbh class using two methods

Tree Species	N	DBH Class (cm)	Thyer		Burnley	
			Mean (RM)	Std. Deviation	Mean (RM)	Std. Deviation
Acacia holosericea	1	< 19.99	347,960	-	2,399	-
	7	20 - 39.99	401,082	96,752	6,532	2,448
	2	60 - 79.99	516,943	7,700	82,121	23,235
	1	> 80	796,803	-	38,380	-
Bauhinia spp.	1	< 19.99	56,193	-	1,249	-
	6	20 - 39.99	87,413	43,461	2,095	1,792
Calophyllum inophyllum	10	20 - 39.99	162,133	69,262	7,054	3,335
	5	40 - 59.99	173,908	74,020	11,395	7,121
Ficus benjamina	2	< 19.99	107,802	23,397	1,023	239
	2	20 - 39.99	458,728	450,345	12,905	3,622
	2	40 - 59.99	949,768	1,035,339	32,808	18,996
	1	60 - 79.99	292,962	-	38,690	-
	2	> 80	726,555	280,615	69,703	55,448
Hopea odorata	14	< 19.99	231,029	53,731	3,099	1,609
	8	20 - 39.99	242,537	163,042	8,362	4,361
Mimusops elengi	3	< 19.99	181,481	23,424	1,612	712
	2	20 - 39.99	206,322	34,581	3,830	1,656
	1	40 - 59.99	188,397	-	9,753	-
Pelthophorum pterocarpum	8	< 19.99	332,765	164,328	3,105	1,920
	42	20 - 39.99	363,783	181,015	7,482	4,302
	41	40 - 59.99	327,743	177,991	20,483	10,155
	15	60 - 79.99	643,305	328,948	51,219	18,288
	4	> 80	533,000	559,292	62,633	15,106

Table 5: Average tree value by tree dbh class using two methods (Cont')

Tree Species	N	DBH Class (cm)	Thyer Mean (RM)	Thyer Std. Deviation	Burnley Mean (RM)	Burnley Std. Deviation
Pterocarpus indicus	7	20 - 39.99	468,904	313,793	10,251	6,656
	59	40 - 59.99	764,166	376,180	31,117	16,519
	78	60 - 79.99	869,004	553,905	57,220	33,082
	41	> 80	1,555,897	1,474,106	121,909	85,798
Samanea saman	3	< 19.99	302,356	212,514	1,727	1,263
	25	20 - 39.99	257,001	214,616	3,843	4,608
	38	40 - 59.99	526,299	364,951	26,083	15,995
	14	60 - 79.99	976,495	457,134	52,322	12,065
	20	> 80	2,028,712	2,455,494	152,214	117,906
Tabebuia pallida	3	< 19.99	42,546	8,657	870	540
	15	20 - 39.99	353,467	336,029	11,748	8,996
	13	40 - 59.99	462,758	330,856	25,892	15,152
	6	60 - 79.99	552,799	360,579	56,791	15,653
	1	> 80	4,934,034	-	169,569	-
Total	**35**	**< 19.99**	**231,298**	**133,426**	**2,473**	**1,630**
	124	**20 - 39.99**	**310,581**	**224,374**	**7,157**	**5,621**
	159	**40 - 59.99**	**550,289**	**380,038**	**26,011**	**15,293**
	116	**60 - 79.99**	**825,400**	**514,072**	**56,100**	**28,730**
	69	**> 80**	**1,647,600**	**1,814,710**	**125,223**	**94,613**

Duncan Multiple Range Test

Results of the Duncan multiple range test for comparison between species of mean tree value using the Thyer and Burnley methods are shown in Tables 6 and 7. Table 6 shows that the mean tree value for *Bauhinia spp.*, *Pterocarpus indicus* and *Samanea saman* is significantly different among species at the 5% level ($p<0.05$) when using the Thyer method. However, the mean value of tree species for the Thyer method is not significantly different for *Acacia holosericea*, *Calophyllum inophyllum*, *Ficus benjamina*, *Hopea odorata*, *Mimusops elengi*, *Pelthophorum pterocarpum* and *Tabebuia pallida* ($p>0.05$).

Based on the foregoing results, it can be said that the best species of urban trees in relation to growth is *Pterocarpus indicus*. The mean tree value for this species is the highest compared with all the other species studied. Seven other species also have the best mean tree values (Table 7), but the results are not consistent. For these species, there are combinations of higher and lower mean tree values of trees, especially for *Ficus benjamina* and *Hopea odorata*. Although these species have the same high value as *Pterocarpus indicus*, they also tend to be similar to the next best group of trees denoted by "b" and "c". It is also found that *Bauhinia spp.* has the lowest mean tree value among the species studied.

Table 6: Results of the Duncan multiple range test for comparison among species in terms of mean tree value using the Thyer method

Tree Species	Total	Mean Value (RM)	Standard Error of Mean	Mean ± CI	
Acacia holosericea	11	453,293	43,953	453293 ± 97927	abc
Bauhinia spp.	7	82,953	15,645	82953 ± 38283	c
Calophyllum inophyllum	15	166,058	17,668	166058 ± 37898	bc
Ficus benjamina	9	530,963	175,061	530963 ± 403692	abc
Hopea odorata	22	235,214	22,033	235214 ± 45829	bc
Mimusops elengi	6	190,914	10,069	190914 ± 25887	bc
Pelthophorum pterocarpum	110	392,364	23,302	392364 ± 46139	abc
Pterocarpus indicus	185	972,660	63,779	972660 ± 126283	a
Samanea saman	100	815,766	129,086	815766 ± 255591	ab
Tabebuia pallida	38	518,324	131,132	518324 ± 265019	abc

Note: Means with the same letters are not significantly different using the multiple Duncan range test at α = 0.05.

Table 7: Results of the Duncan multiple range test for comparison among species in terms of mean tree value using the Burnley method

Tree Species	Total	Mean Value (RM)	Standard Error of Mean	Mean ± CI	
Acacia holosericea	11	22,795	9,594	22795 ± 21376	abc
Bauhinia spp.	7	1,975	630	1975 ± 1542	c
Calophyllum inophyllum	15	8,501	1,320	8501 ± 2831	bc
Ficus benjamina	9	30,174	11,153	30174 ± 25719	abc
Hopea odorata	22	5,013	816	5013 ± 1698	c
Mimusops elengi	6	3,708	1,336	3708 ± 3434	c
Pelthophorum pterocarpum	110	19,979	1,850	19979 ± 3663	abc
Pterocarpus indicus	185	61,454	4,263	61454 ± 8441	a
Samanea saman	100	48,692	7,567	48692 ± 14982	ab
Tabebuia pallida	38	26,993	5,082	26993 ± 10271	abc

Note: Means with the same letters are not significantly different using the multiple Duncan range test at $\alpha = 0.05$.

Table 7 shows that mean tree values for *Calophyllum inophyllum*, *Pterocarpus indicus* and *Samanea saman* are significantly different among species ($p<0.05$) when assessed using the Burnley method. However, the results show that the mean tree values for *Acacia holosericea*, *Bauhinia spp.*, *Ficus benjamina*, *Hopea odorata*, *Mimusops elengi*, *Pelthophorum pterocarpum* and *Tabebuia pallida* are not significantly different among species at the 5% level ($p>0.05$) for the Burnley method.

Based on the Burnley method, the best species is still *Pterocarpus indicus*. The means that all trees of this species have high mean tree values compared with other species. A similar trend appears where seven other species are not statistically significant compared with *Pterocarpus indicus*. For the species of *Ficus benjamina* and *Calophyllum inophyllum*, they are characterised by a combination of higher and lower mean tree values. This situation implies that although these species are comparable to *Pterocarpus indicus*, they also tend to be similar to the next best group of trees denoted by “b” and “c”. It is also found that *Bauhinia spp.*, *Hopea odorata* and *Mimusops elengi* have the lowest mean tree values among the species studied.

4.0 CONCLUSION

In conclusion, urban trees provide multiple benefits to the community in urban areas and these benefits can be estimated in monetary terms. The economic values of urban trees are substantial and can differ according different methods used (Thyer and Burnley methods). This study indicate that the tree values of urban trees based on tree height class, tree crown diameter class and DBH class are different due to the physical and qualitative characteristics of the urban trees. The Thyer method gives higher values than the Burnley method in all analyses conducted. The large difference in values for each species seems to be mainly attributed to difference in the relative weightings of the key factors of size and species quality in the formula of each method. Therefore, the Thyer method is considered the best method to be applied in Malaysia.

There are other potential research areas related to the utilisation and economic valuation of urban trees that need further investigation and discussion and it can help government or policy makers to justify the planting program in the urban areas. The potential of estimating the economic values of urban trees and landscape in Kuala Lumpur and other states can help the authorities for pricing of the landscape and urban trees in investment planning of urban tree planting programme in the future. Other than that, the establishment of database on economic value for landscape resources, urban trees and urban green areas for Kuala Lumpur City Hall for long term planning and management of urban trees. Urban tree management is crucial for improving community health and well-being and also to increase the functional values, as well as maintain environmental quality in towns located in the urban areas.

Future studies could look into other methods that can be used to evaluate or assess the economic values of urban trees as a basis for comparison with the other existing methods. This will help in selecting the best method to value urban trees growing in certain areas of the country or state. If the economic values of urban trees are in question, a better understanding of the economic valuation of urban trees should be developed. This warrants establishing or developing a method to specifically evaluate urban trees in our country without depending on the method developed by other countries to assess their urban trees. Nevertheless, the methods used in other countries can be used as a guideline to develop methods that meet our country's needs.

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REFERENCES

Asociación Española de Parques y Jardines Públicos (AEPJP). (1999). *Metedo Para Valoración de árboles y arbustos ornamentals: Norma Granada: Revision.* Madrid, Spain: Asociación Española de Parques y Jardines Públicos.

Council of Tree & Landscape Appraisers. (2000). *Guide for plant appraisal* (9th ed.). Champaign, IL: International Society of Arboriculture.

Flook, R. (1996). *A Standard Tree Evaluation Method (STEM)*. Nelson, New Zealand: Ron Flook.

Helliwell, D. R. (1967). The Amenity Value of Trees and Woodlands. *Arboricultural Association Journal*, *1*(5), 128-131.

Islam, R. (2010). Critical Success Factors of the Nine Challenges in Malaysia's Vision 2020. *Socio-Economic Planning Sciences*, *44*(4), 199-211.

Jawatankuasa Kempen Penanaman Pokok Kebangsaan. (2013). *Portal kempen Penanaman Pokok Kebangsaan*. Kuala Lumpur, Malaysia: Jabatan Landskap Negara, Kementerian Perumahan dan Kerajaan Tempatan. Retrieved from http://www.treesforlife.gov.my.

Jusoh, H., & Rashid, A. A. (2008). Efficiency in Urban Governance towards Sustainability and Competitiveness of City: A case study of Kuala Lumpur. *World Academy of Science, Engineering and Technology*, *40*, 443-456.

KLCH (Kuala Lumpur City Hall). (2003). *Kuala Lumpur Structure Plan 2020 (KLSP2020)*. Kuala Lumpur, Malaysia: Federal Town and Country Planning Department.

KLCH (Kuala Lumpur City Hall). (2007). *Kuala Lumpur City Plan 2020 (KLCP 2020)*. Kuala Lumpur, Malaysia: Federal Town and Country Planning Department.

McGarry, P. J., & Moore, G. M. (1988). The Burnley Method of Amenity Tree Evaluation. *Australian Journal of Arboriculture*, *1*(1), 19-26.

Ning, Z. H., He, X. Y., Liu, C. F., & Abdollahi, K. K. (2008). Assessing Urban Forest Structure and Health in Shenyang, China. *Arboriculture and Urban Forestry*, *34*(6), 379-385.

Randrup, T. B. (2005). Development of a Danish Model for Plant Appraisal. *Journal of Arboriculture*, *31*(3), 114-123.

Sharifah Dora, S. M. (2009, July 16). Trees Selection and Protocol Road. (M. Fazilah, Interviewer)

Sharifah Dora, S. M. (2009, October 1). Tree Inventory Reports and Planting Costs. (M. Fazilah, Interviewer)

Sreetheran, M., Philip, E., & Zakiah, M. S. (2006). A Historical Perspective of Urban Tree Planting in Malaysia. *Unasylva*, *57*(223), 28-23.

Thyer, P. R. (2005). *The Thyer Tree Valuation Method*. NSW, Australia: Peter Thyer. Retrieved from http://peterthyer.com/

Watson, G. (2002). Comparing Formula Methods of Tree Appraisal. *Journal of Arboriculture*, *28*(1), 11-18.

Wee, Y. C., & Corlett, R. (1986). *The City and the Forest: Plant Life in Urban Singapore*. Singapore: Singapore University Press.

SPECIES DIVERSITY AND ECONOMIC VALUE OF MEDICINAL PLANTS IN ONE-HECTARE PLOT OF BEREMBUN FOREST RESERVE, NEGERI SEMBILAN

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ABSTRACT

Medicinal plants have been used widely in treatment and health improvement in Malaysia. Its resources need to be managed sustainably for long term social benefit. However, the empirical literature on the distribution, species diversity and its economic value are still lacking. Thus, this paper provides species diversity and economic value of medicinal plants in four 50m x 50m plots of Berembun Forest Reserve, Negeri Sembilan. The plots of 50m x 50m were each laid out and traverse according to slope with a distance of 50m between each plot. Twenty-five subplots in each plot measuring 10m x 10m were established to conduct inventory of plants that have medicinal properties. Data on medicinal plants were extracted and analysed to calculate species diversity, richness and economic value. The economic value of medicinal plants was calculated using residual value technique. The result shows that a total of 873 individuals representing 86 species, 71 genera and 47 families were recorded. The most common species are *Rinorea anguifera, Barringtonia macrostachya, Oxyspora bullata, Strychnos ignatii, Baccaurea racemosa, Phyllagathis rotundifolia, Peliosanthes teta Andrews ssp. Humilis, Rennellia elliptica, Donax grandis* and *Mapania cuspidata.*

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1.0 INTRODUCTION

Medicinal plants have been an important component of traditional medicine and culture in Malaysia. They are one of the valuable non-timber forest resources. The earliest record on medicinal plants was a manuscript called “The Medical Book of Malayan Medicine” written in Arabic and translated around 1886 by Ismail Munshi of Penang. The document was later published in Gardens’ Bulletin of Singapore by its editors J.D Gimlette and I.H.Burkill in 1930. At the same time I.H.Burkill and Mohamed Haniff (1930) published a more scientific document called “Malay Village Medicine”. They recorded 1675 plants names covering 434 genera and 109 families. In 1935 I.H.Burkill published a more comprehensive document called “A Dictionary of Economic Products of the Malay Peninsula” in which 1219 species in 699 genera of both local and naturalised plants were recorded as of medicinal use. The Dictionary provided detailed descriptions of plants used for medicinal purposes and formed the basis for future research and studies in Malaysia.

In 2002 Kamarudin Mat-Salleh and Latiff published a book “*Tumbuhan Ubatan Malaysia*” which consists of the ethnobotanical studies undertaken by UKM students from 1982-2001. The book covered about 103 families and 768 dicotyledonous species including 89 introduced or naturalised taxa. These included some important families such as *Euphorbiaceae* (80 species), *Leguminosae* (74 species), *Annonaceae* (61 species), *Rubiaceae* (43 species), *Lauraceae* (27 species), *Apocynaceae* and *Verbenaceae* (19 species each), *Moraceae and Melastomataceae* (18 species each), and *Acantaceae* (16 species). Other species included are from *Zingiberaceae* (21 species) and *Araceae* (18 species).

Even though much has been written on the uses of medicinal plants, very little is known on its distribution pattern, quality and quantity in natural forest. In this regard an attempt was undertaken to estimate the distribution of selected medicinal plant species during the implementation of the Fourth National Forest Inventory (NFI4) from 2002-2004. This was the first time that the NFI4 attempted to enumerate medicinal plants apart from timber trees, palms, rattan and bamboo species. A total of nine species was included in the inventory which is Tongkat Ali (*Eurycoma longifolia*), Aji Samad (*Primatomameris Malaya*), Akar Dawai (*Smilax myosotiflora*), Sendayan (*Mapania sp*), Kacip Fatimah (*Labisia pumila*), Medang kemangi (*cinnamomum porretum*), Ubi Jaga (*smilax calophylla*), Sembong (*blumea balsamifera*) and Sarang Semut (*hydnophytum formicarum)*. The NFI 4 results also indicated that Tongkat Ali (*E.longifolia*), Kacip Fatimah (*L.pumila*), Akar Dawai (*S.myosotiflora*), Medang Kemangi (*C.porretum*) dan Sendayan (*Mapania sp.*) are commonly found in all types of forest and also distributed in either poor or superior virgin forests, logged over forests and protected forests. Meanwhile, Aji Samad (*P.malaya*), Ubi Jaga (*S.calophylla*) and Sarang Semut (*H.formicarum*) were not recorded in Peat Swamp Forests, but elsewhere evenly distributed (Shaharuddin, 2005).

There are a number of publications on medicinal plants have been published. For example, Terengganu Forest Department has produced two books titled ‘*Herba Ubatan Negeri Terengganu (Edisi 1 & 2)*’ recorded a total of 400 medicinal plants species. (Samsuddin et. al., 2006 & 2011). Similarly, Mustaffa and Zanisah (2010) in their book titled *‘Tumbuh-tumbuhan Ubatan Orang Asli’* listed a total of 92 species of medicinal plants used by Orang Asli community in Pahang.

Medicinal plants have been given priority by the government as a source material for pharmaceutical products (3rd National Agricultural Policy, 1998-2010). This is because it provides new opportunities for creation of new wealth to the country in terms of value added product for export and domestic market. Currently, the under Chapter 15: Agriculture of the Economic Transformation Programme (ETP) has provided new entrepoint focusing on unlocking value from Malaysia's biodiversity through high value herbal products (ETP, 2010). This entails sustainable management of medicinal plants for long term social benefits. Intensive inventory of medicinal plants is important in order to assess the extent of its distribution under different forest ecosystems. However, the empirical literature on medicinal plants lacks estimates of the distribution, species diversity and its economic value (T. Marina, Awang Noor & I. Faridah Hanum, 2007).

The local market for traditional medicinal products in Malaysia was estimated at RM4.55 billion (Mardi, 1999) and the market growth rate was estimated at 15 to 20% annually. This shows that the demand for traditional medicinal products is very encouraging resulting in high consumption of the raw materials by the industry.

This paper provides species diversity of medicinal plants in one-hectare plot of Berembun Forest Reserve, Negeri Sembilan.

Site Area

The site chosen for this study is Berembun Forest Reserve, Negeri Sembilan. It is located 8 km from Seremban, the capital of Negeri Sembilan and about 200 km south east of Kuala Lumpur. This study was carried at the compartment 32, which was classified as virgin jungle reserve at 02° 48' 58.8"N and 102° 00' 53.7"E under the jurisdiction of Forestry Department of Negeri Sembilan shown in Figure 1.

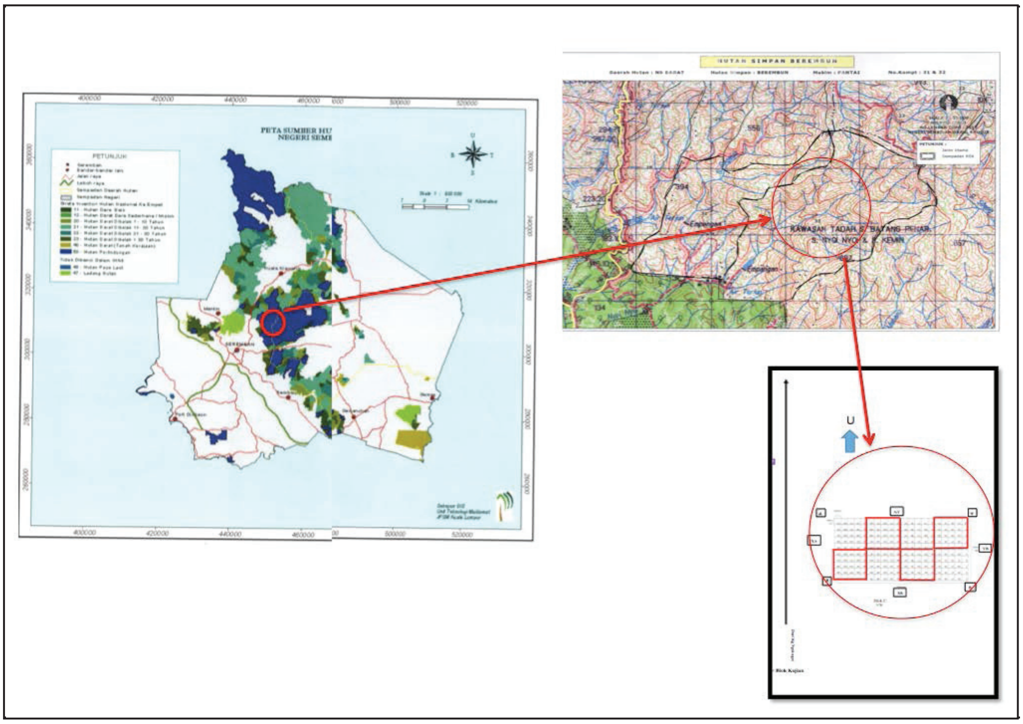

Figure 1: Study site location

2.0 METHODOLOGY

The plots of 50m x 50m were each laid out and traverse according to slope with a distance of 50m between each plot. Twenty-five subplots in each plot measuring 10m x 10m were established to conduct inventory of plants that have medicinal properties. The samples were sent to Herbarium UKM for record. Data on medicinal plants were extracted and analysed to calculate species diversity, richness and economic value.

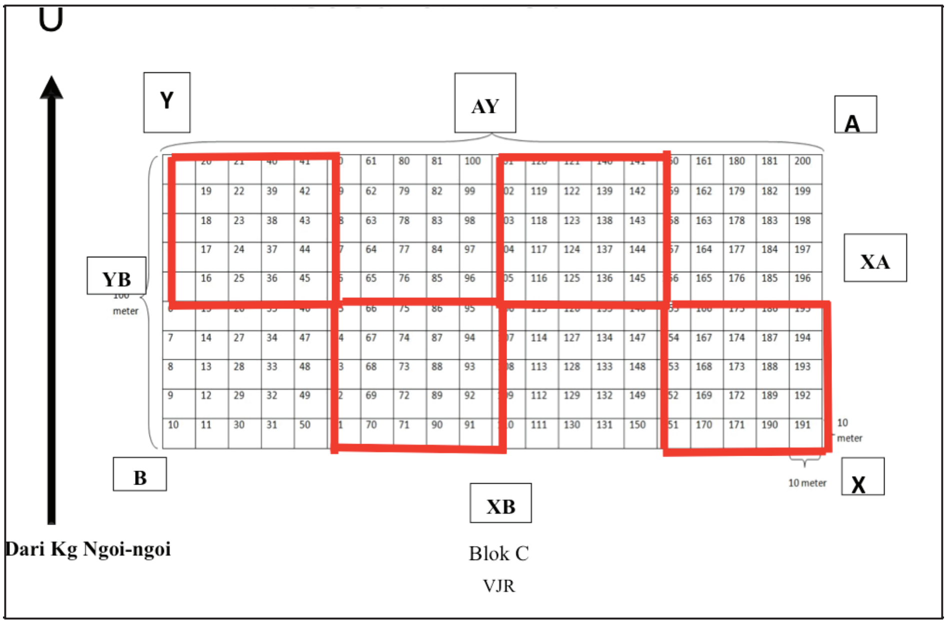

Figure 2: Research plot design

3.0 RESULTS AND DISCUSSION

The study recorded 873 individuals of medicinal plants in 47 families, 71 genera, 86 species in 1 hectare plot at compartment 32, Berembun Forest Reserve. The most abundant species were *Rinorea anguifera* (102). The second most abundant was *Barringtonia macrostachya* (63), followed by *Oxyspora bullata* (43), *Strychnos ignatii* (35), *Baccaurea racemosa* (34), *Phyllagathis rotundifolia* (33), *Peliosanthes teta* (29), *Rennellia elliptica* (25), *Donax grandis* (25) and *Mapania cuspidata* (25). The details are provided in Figure 3 and Table 1.

Table 1: Ten most abundant species of medicinal plant

ID	Botanical Name	Family	Local Name	Quantity
1	**Rinorea anguifera** (Lour.) Kuntze	Violaceae	Pacat kenyang	102
2	**Barringtonia macrostachya** (Jack) Kurz	Lecythidaceae	Putat	63
3	**Oxyspora bullata** (Griff.) J.F. Maxwell	Melastomataceae	Senduduk gajah, senduduk hutan	43
4	**Strychnos ignatii** Berg.	Loganiaceae	Gajah tarik	35
5	**Baccaurea racemosa** (Reinw.) Müll.Arg.	Euphorbiaceae	Rambai hutan (isi ungu)	34
6	**Phyllagathis rotundifolia** (Jack) Blume	Melastomataceae	Tapak sulaiman, hempedu beruang	33
7	**Peliosanthes teta** Andrews ssp. **humilis** (Andrews) Jessop	Convallariaceae	Derhaka mertua, bujang hilir	29
8	**Rennellia elliptica** Korth.	Rubiaceae	Segemuk, mengkudu hutan	25
9	**Donax grandis** (Miq.) K. Schum.	Marantaceae	Bemban	25
10	**Mapania cuspidata** (Miq.) Uittien var. **cuspidata**	Cyperaceae	Pandan serapat	25

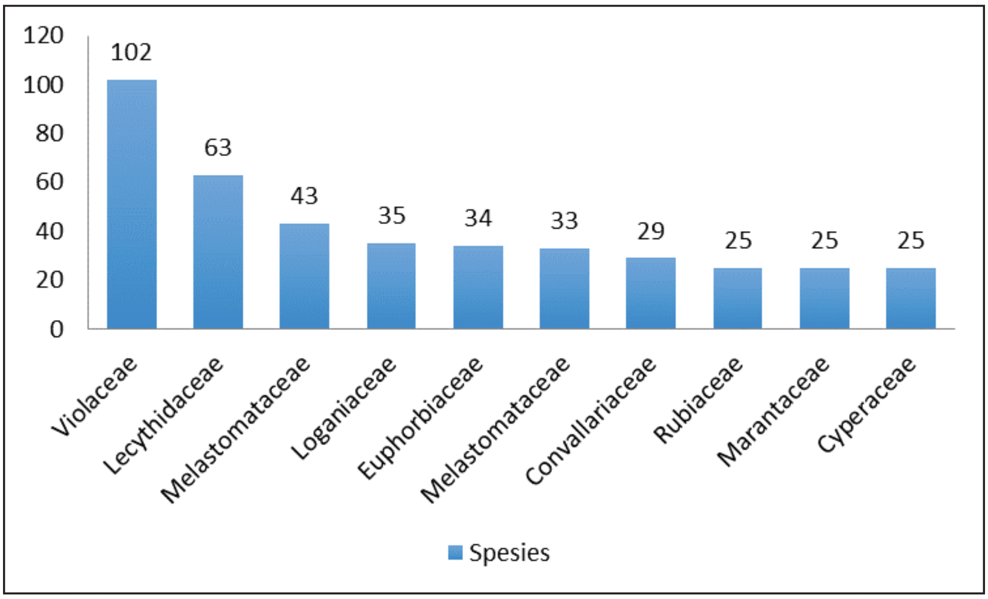

Figure 3: Ten most abundant species of medicinal plant

The diversity of medicinal plants in Berembun Forest Reserve could be considered rich in many medicinal families as compared to the similar study sites conducted by several authors in other forest reserves. However, it can be seen that the 1 hectare plot indicated 86 species in 71 genara and 47 families is among the highest compared to the other study sites as shown in Table 2.

Table 2: Comparison of tree taxa composition of medicinal plants by location

Location	Family	Genus	Species	Reference
Ulu Muda Forest Reserve, Kedah	35	53	56	Shamsul K., A. T. Manap (based on interview)
Gunung Stong Forest Reserve, Kelantan	20	22	24	Shamsul K., A. T. Manap (based on interview)
Bukit Labuan Forest Reserve, Terengganu	40	39	40	Shamsul K., A. T. Manap (based on interview)
Pasir Raja Forest Reserve, Terengganu	53	62	76	Shamsul K., A. T. Manap (based on interview)
Sungai Bebar Forest Reserve, Pahang	38	52	57	Shamsul K., A. T. Manap et. al (based on interview)
Tranum Forest Reserve, Pahang	33	52	66	Awang Noor et. al (5 hectare plots)
Angsi Forest Reserve, Negeri Sembilan	**26**	**-**	**37**	**Shamsul K., A. T. Manap (based on interview)**
Kampung Tering, Negeri Sembilan	**-**	**-**	**35**	**Ong**
Berembun Forest Reserve, Negeri Sembilan (This Study)	**47**	**71**	**86**	**1 hectare plot**

Estimation Total Value of Medicinal Plants

The economic evaluation of medicinal plants in this area is still in preliminary phase. However, we would like to adapt approach from other studies into this study.

Tuan Marina T. I., Awang Noor A. G. & I. Faridah-Hanum (2007),

$$Ev_i = [(P-C-PM)]*[Ni*GW)$$

where;

EV = Economic Value (RM/ha)
P = Price (RM/kg)
C = Cost of Harvesting (RM/ha)
PM = Profit Margin (RM/kg)
N = Number of Individuals per hectare for species
GW = Green weight of species I
i = is index of species

Table 3 provided some estimations of the total value of medicinal plants based on previous studies by several authors. These values will provide the basis and guidance for the preparation of the next phase of this study to be conducted in the study areas which will comprise the Orang Asli communities and the surrounding village communities. The study will be undertaken through questionnaires and discussions with the local communities which will provide the basis for calculating the economic value of medicinal plant in Berembun Forest Reserve Negeri Sembilan.

Table 3: Estimation total value of medicinal plants

Forest Reserve	State	Hectare	Survey of trees	Value of Medicinal Plant (RM)	Source
Jengai Compt 5	Terengganu	7	All trees	40.22	Awang Noor et. al
Tranum	Pahang	5	Below 1 cm	668.00	Awang Noor et. al
Ayer Hitam	Selangor	2	All trees	340.58	Awang Noor et. al
Orang Asli Village	Selangor, Perak and Pahang	-	Medicinal plants	24 - 386	Kanta Kumari
Ayer Hitam	Selangor	-	Medicinal plants	6,500.00	Rusli Mohd et. al

4.0 CONCLUSION

The continued trading of local medicinal plants and products depends much on the available resources. As one of the important non-timber forest products (NTFPs) utilised by local communities, medicinal plants have been used in traditional ways as well as commercially exploited by the industry. The supply of medicinal plants from the natural forest will be exhausted if no conservation measures are taken to overcome the problem. Thus, this study is one of the effort that helps to recognise and estimate the amount of raw materials that are still available in the forest.

Studies are needed to estimate the availability of raw materials (medicinal plants) collected and utilised by the industry.

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REFERENCES

Burkill, I. H. & Muhammad Haniff (1930). *Malay Village Medicine – Garden's Bulletin of Singapore Volume 6*.

Burkill, I.H. (1935). *A Dictionary of the Economic Products of the Malay Peninsula – Volume 1 & 2. Published by Government of Malaysia and Singapore.*

Economic Transformation Plan. (2010).

Gimlette, J.D. & Burkill, I.H. (1930). *The Medical Book of Malayan Medicine – Garden's Bulletin of Singapore Volume 6.*

Kamarudin, M. S. & Latiff, A. (2002). *Tumbuhan Ubatan Malaysia.*

Mustaffa O. & Zanisah M., (2010). *Tumbuh-tumbuhan ubatan orang asli*.

McNally, R. & Mohd. Shahwahid, H. O., (2003). *Environmental Economics*.

Ong, H. C., Norliah A. & Pozi M., (2011). Traditional Medicinal Plants Used by the Temuan Villagers in Kampung Tering, Negeri Sembilan, Malaysia. *Ethno Med, 5*(3): 169-173.

Shaharuddin, M.I. (2006). *Medicinal Plant Resources from the Forests of Peninsular Malaysia: Issues and Challenges in Sustainable Management and Utilisation of Medicinal Plant Resources edited by Azhar Muda et al. UPM and JPSM.*

Shamsul, K. & Manap, T. A. (2003). *Notes on The Medicinal Plants of Gunung Stong Forest Reserve*.

Shamsul, K., Manap, T. A., Nur Saadah, A. H., Siti Shareena, A. S. & Azlin, A. *A Preliminary Survey of Medicinal Plants at Bukit Labohan, Kemaman, Terengganu*.

Shamsul, K., Manap, T. A, Ahmad Fauzi, M., Faridah Hanum, I., Rusea, G. & Latiff, A. (2005). *Ethnobotanical Survey of the Jakun in Sungai Bebar, Pekan, Pahang*. Biodiversity Expedition - Sungai Bebar, Pekan, Pahang.

Shamsul, K., T. Tajuddin, A. M., Hazarini, D. & Roslan H., (2010). *Tinjauan Awal ke Atas Tumbuhan Ubatan dan Hubungkaitnya dengan Komuniti Tempatan di Hutan Simpan Angsi*, *Hutan Simpan Gunung Angsi, Negeri Sembilan* – Pengurusan Hutan, Persekitaran Fizikal dan Kepelbagaian Biologi.

Tuan Marina T. I & Awang Noor A. G. (2007). *Species Diversity and Economic Value of Medicinal Plants in Five-Hectare Plots of Hill Dipterocarp Forest, Pahang*. National Conference on the Management and Conservation of Forest Biodiversity in Malaysia.

ECONOMIC VALUES OF SWIFTLET CAVES IN FORESTS

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ABSTRACT

Natural forest ecosystem containing caves that harbor swiftlet nests is unique and has an economic value. The residual value approach is adopted to estimate the economic rent from the sustainable production of edible bird's nest from a cave hole. The residual appraisal procedure is a direct application of derived demand whereby all costs other than that of the habitat function of the cave for swiftlet nestings are subtracted from the market price of the edible bird's nest. These information are obtained from field surveys of bird's nest collectors and middlemen buyers with the help of the Sarawak Forestry Corporation officer in charge of the Niah Cave Forest Park. The average production of bird's nest during the eight months collecting season was 15kg per month per cave hole during the 2010/11 period. With a market price of RM2,500/kg for raw and uncleaned bird's nest, the average revenue obtained was RM300,000 per year. Allowing a 30% normal profit margin for entrepreneurial efforts of the owners/partners, an annual economic rent of RM109,727 per cave hole is estimated. Overall, the economic rent represented 36.58% of the revenues generated from the EBN production. The economic value of a cave hole located in the forest reflects the economic rent that can be collected by a State Government as forest resource trustee from the licensing of cave holes for EBN collection.

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1.0 INTRODUCTION

Forests which until a few years ago, were only valued for their timber, are suddenly more valuable as intact forests. In some tracts of forests, the value of timber revenues could not match the aggregate value of the loss of NTFPs and the costs of the externalities arising from logging. There is a trend towards acknowledging the importance of NTFPs and their contributions to the livelihood of rural communities and in some cases to the economy via domestic and international trade. Some State Governments are willing to set aside some portions of their forests for protective and conservation purposes so that these contributions could be sustained. This is a positive development. Many of the functions of the forest ecosystem are irreversible once disturbed. In specific cases, the role of NTFPs may be grossly under-valued, in the sense that much of their benefits are ignored and not valued. Methodologies have been formulated by economists to estimate the value of these NTFPs and the costs of the externalities from logging operations. In Malaysia, some attempts at valuing NTFPs have been attempted by Cheng (1994), Mohd Shahwahid and Nik Mustapha (1991), Mohd Shahwahid and Poh (1999), and Mohd Shahwahid and Awang Noor (1999), Woon *et al.* (1998) and Zulnaidah and Mohd Shahwahid (2011). The field of economic valuation is relatively young and techniques are being improved and new techniques introduced.

This paper is an attempt to appraise the value of forest caves harboring swiftlets in the production of edible bird’s nest (EBN). This economic value is based on an extractive goods from the forests. The forest caves are pro viding a direct use value derived from the sustainable harvesting of raw EBN from ceiling of the caves holes.

2.0 ANALYTICAL MODEL

The value of forest caves as a habitat for swiftlets in the EBN production is basically the value of the available stock of raw EBN that can be extracted from the ceilings of cave holes. The residual value approach is adopted. The residual appraisal procedure is a direct application of derived demand: all costs other than that of the function of forest cave habitat for swiftlets are subtracted from the market price of the product. The approach requires first determining the selling price for the product or products potentially generated from the swiftlet breeding activities. The product that has a market price is the raw uncleaned EBN that is based on the price delivered to the middleman. By subtracting all costs from the product’s final sales price – from extracting to transporting, and further deduction for whatever amount is necessary to pay to the entrepreneurs overseeing the cave holes and swiftlet habitat for his or her contribution, one derives the residual value. This residual value is the economic rent or value of the forest cave swiftlet habitat function. Hence, this rent could be allocated as the value of the returns to the resource owner or in Sarawak – the Forestry Corporation as trustee of the natural caves. The process of the valuation exercise is represented in Figure 1.

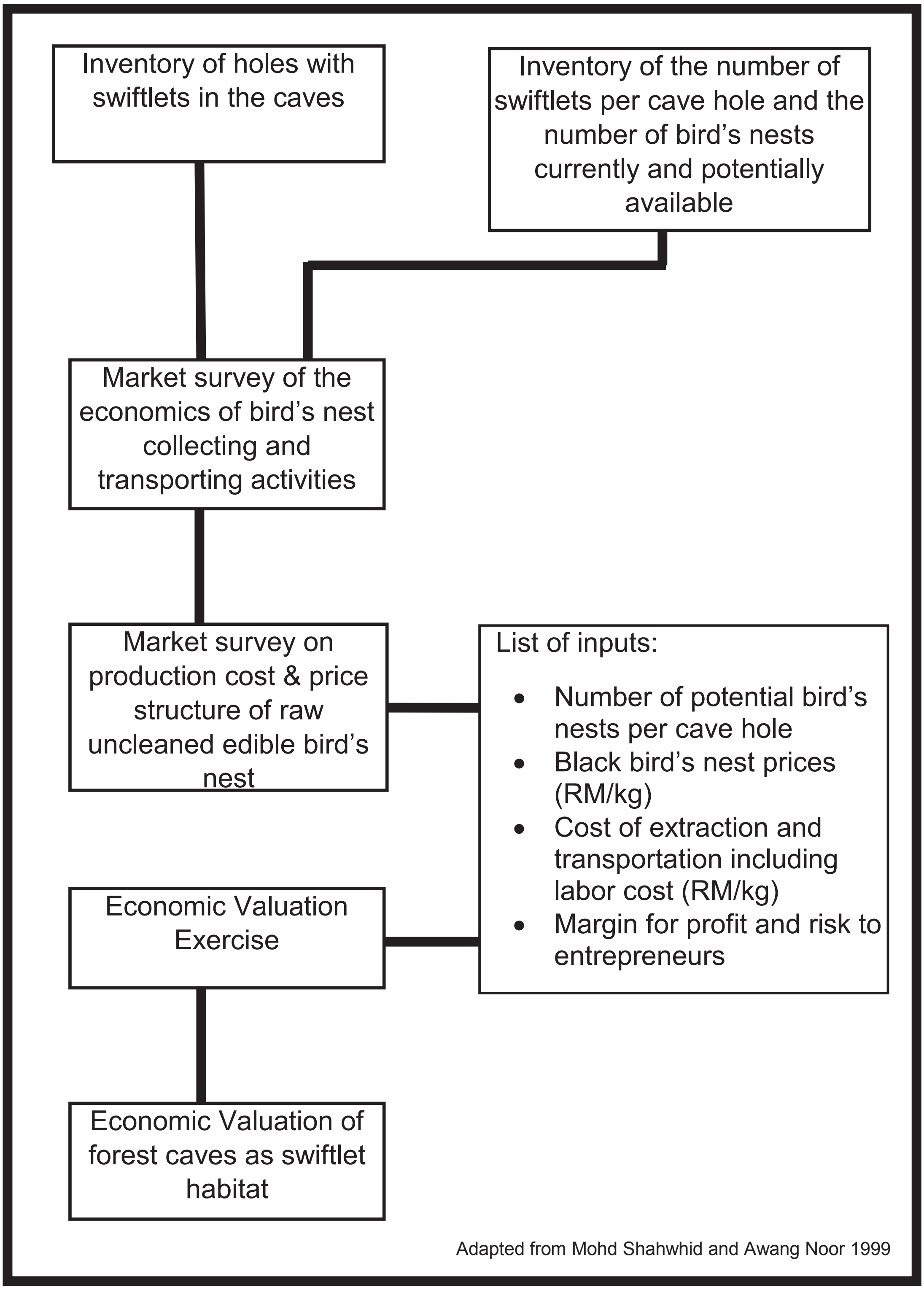

Figure 1: A flow chart for deriving the value of forest caves as swiftlet habitat

3.0 EMPERICAL MODEL

Valuation of forest caves as swiftlet's habitat for EBN production requires two basic sets of information; on prices and costs, and on quantities of bird's nest potentially extractable from the ceilings of cave holes in the forest. The formula for calculating the value for swiftlets in EBN production which is adapted from the formula for stumpage timber value of Davis (1977), and Mohd Shahwahid and Awang Noor (1999) is given below:

$$V = \sum_{j=1}^{k} Q_j \{ BNP_j - (ADC + APM_j) \} \qquad \text{(i)}$$

where;

V is the value of forest caves as swiftlet's habitat in EBN production per cave holes licensed

BNP_j which is the market price of bird's nest j,

Q_j is the quantity (kg) of EBN j per year which is estimated to be equal to

$$Q_j = (n\, c_j\, w_j) \qquad \text{(ii)}$$

where;

n is the number of the male and female pairs of swiftlet bearing bird's nest

c_j is the average number of cycles each male and female pair of swiftlet can potentially build its bird's nest j in that year

w_j is the weight of bird's nest j from the pairs of swiftlet

ADC is the average direct collecting and transporting cost of EBN (not inclusive of entrepreneuring cave hole owner/partner's equitable profit margin).

APM_j is the equitable profit margin allocated to the entrepreneuring cave hole owner/partner's for harvesting bird's nest *j*, which is equal to

$$APM_j = (\pi BNP_j) / (1 + \pi) \qquad \text{(iii)}$$

where;

π is the average profit margin in percent for a resource-base extraction industry but adjusted to reflect the opportunities and risk undertaken by the EBN collection entrepreneur from cave holes. In this analysis a π of 30% is used which is considered quite representative for this industry in general.

From the above equations, it is expected that the variation in the values of swiftlet colonies within cave holes in the forest will result mainly from differences in swiftlet productivity characteristics, bird's nest prices, and cost of extraction, and transportation.

4.0 RESEARCH INVESTIGATION SITE

Various data are needed to compute the value of forest caves as swiftlet's habitat in EBN production, including the number of male and female pairs of swiftlet per cave hole, average number of cycles each male and female pair of swiftlet can potentially build its bird's nest in a year, weight of a bird's nest, ex-middleman prices of raw and uncleaned bird's nest, costs of collecting, transportation and packing of bird's nest from a cave hole, and a fair profit margin for the entrepreneuring cave hole owner/partners. To obtain these, field surveys of bird's nest collectors and middlemen buyers were conducted. Interviews were conducted on two cave hole owners/partners and two middlemen buyers at Niah Caves forest.

The Sarawak Forestry Corporation officer in charge of the Niah Cave Forest Park was contacted and a meeting was arranged with the owners/partners and middlemen at Niah Cave. The objective was to survey as many owners/partners as possible but the number of willing samples was limited.

Findings

Table 1 provides the breakdown of the average revenue from EBN collection and the economic value of forest caves as swiftlet's habitat in EBN production. The average production of bird's nest during the eight months collecting season obtained from respondents surveyed at Niah Cave was 15kg per month during the 2010/11 period. With a market price of RM2,500/kg for raw and uncleaned bird's nest, the average revenue obtained was RM300,000 per year.

Table 1: Breakdown of average revenue from bird's nest activity and the economic value of swiftlets in bird's nest production from cave holes

Parameters	RM/kg	RM/year	Percentage of bird's nest sale (%)
Bird's nest revenue sales	2,500.00	300,000.00	100.00
Average direct production cost	675.35	81,042.00	27.01
Imputed salary for supervisor	333.33	40,000.00	13.33
Average fair profit margin	576.92	69,230.77	23.08
Economic value of swiftlet in production of EBN from cave hole	914.39	109,727.23	36.58

The breakdown of the average revenue structure showed that direct production cost took up 27.01% of annual sales or RM81,042 (Table 1). This cost component refers to the direct expenditures incurred to participate in the bird's nest collection business. This component does not include the operational and export license fees to be paid to the Government. It has also not included the salary to be allocated to the coordinator of the collecting activity involving field supervision, bird's nest marketing and communication between the collecting crew and the owner/partners of the business.

The EBN collecting business from cave holes is unique. In many cases the cave hole license owner does not participate in the activity. He usually sub-contracts the bird's nest collecting activities to a middleman who sets up a collecting team who forms a partnership between the owner and a number of financiers. The construction of the access route to the cave holes and the installation of a system of bridges and climbing platforms involve high investments.

For all these tasks, the middleman who oversees the field work received a remunerative salary which is a certain proportions of the net returns. This salary is estimated to take up 13.33% of the sales revenue or RM40,000 per year or as estimated about 15% of the net sales revenue. Including this imputed salary of the coordinator increassed the production cost to 40.34% of the sales revenue per year. Allowing a 30% normal profit margin for entrepreneurial efforts of the owners/partners, a residual value of RM109,727.23.

This value is allocated as the economic rent of the role of swiftlets in EBN production from cave holes in the forest. Overall, the economic rent represented 36.58% of the revenues generated from the EBN production. This high proportion allocated as the economic rent is due to the low usage of capital since the bird's nests are naturally produced by the swiftlets without any human effort to construct the swiftlet habitat such as in the case of the construction of swiftlet bird house.

Table 2: Effects of increasing the fair profit margin on the economic value of swiftlets in bird's nest production from cave holes

Parameters	Per kg sales basis			Per annual sales basis		
Average fair profit margin	30%	40%	50%	30%	40%	50%
Economic value of swiftlet in production of bird's nest from cave hole (RM)	914.39	777.03	657.98	109,727.23	93,243.71	78,958.00
Economic value as a percentage of sales (%)	36.58	31.08	26.32	36.58	31.08	26.32

The above provides information of the economic value of forest caves as swiftlet's habitat in bird's nest production on the assumption of 30% fair profit margin for the entrepreneurial skill of the cave hole owners/partners. This leads to an economic value of 36.58% of the sales revenue value. If this fair profit margin is increased to reflect the high investment risks undertaken by the financiers to 40% and 50%, then the residual economic value computed would contribute to lower percentages of sales revenue of 31.08% and 26.32% respectively (Table 2).

5.0 CONCLUSION AND POLICY IMPLICATIONS

This chapter has contributed several interesting findings. Firstly, it has demonstrated a simple method to put values on the role of forest caves as swiftlet's habitat in EBN production. The economic value of forest caves as swiftlet's habitat in EBN production takes a large proportion of the sales revenue from the bird's nest production. This occurs since direct production cost incurred by collectors are minimal given that the true work of producing bird's nest is naturally done by the swiftlets. The other cost elements deducted from the revenue are the salary of the bird's nest collecting coordinator. Secondly the role played by swiftlets in caves is considered useful information for biodiversity conservation in that it can add up to the total economic values of forests harbouring many caves. Thirdly, the economic rent of in cave holes in EBN production has been estimated. This latter information would be especially useful to State Government regulators in setting appropriate user fees for the extraction of bird's nest.

The first two sets of information is potentially useful for biodiversity conservation of forests. The ability to appraise the value of forest caves in bird's nest production suggests other NTFPs have a high probability of being valued as well. With the estimation of most of these NTFPs, there would be sufficient monetary-based information to help better land use decision making on forest land. With this information, it is possible to identify the trade-offs involved when forests are opened for timber harvesting or deforested. A more integrated management of land use should be implemented to avoid the loss of these NTFP values. The timber harvesting system can be specified to take into account the multiple uses of the forest resources having many caves so as not to forego this NTFP benefit.

The third piece of information is of potential value for policy makers and analysts, as well as the Government agency responsible for licensing the extraction of non-timber forest products. The economic value of potential bird's nest available in cave holes located in forests reflects the economic rent that can be collected by the State Government as forest resource trustee from the licensing of cave holes for EBN collection.

Currently, the Sarawak Government imposes a minimal renewal license fee of RM100. When the bird's nest is to be exported another RM50 exporting fee is required. These fees that a State Government is obtaining are miniscule when compared to the annual economic rent estimated from a cave hole licensed. A rent capture failure has certainly occurred. There exists a great opportunity for the State Government to raise its rent capture.

A word of caution on the use of these economic value estimates of in caves should be in order. This valuation exercise is site-specific, particularly to the study locations. Its findings are not directly transferable to appraise other forest caves in other locations, owing to variations in swiftlet colonies and the quantities and qualities of the EBN produced by the swiftlets, bird's nest prices across the country, accessibility and cost of extraction and transportation. Further, applying the economic values to computing the total value of all harvestable bird's nest over the whole state can be erroneous. This assumes that the supply of bird's nest is infinitely elastic at these prices. These two problems were: a) it contradicts an implicit assumption of the residual approach (infinitely inelastic supply); and b) the total market in a given area normally exhibits a downward-sloping demand curve with increasing quantity demanded in response to decreasing prices.

REFERENCES

Cheng Heng Kuan, (1994). *The Biodiversity Value, Sustainability and Management of the Matang Mangroves*. WWF Malaysia Project Report.

Davis, K. P., (1977). *Forest Management*. McGraw Hill Publication. N. Y.

Lampietti, J. A. & J. A. Dixon, (1995). To See the Forest for the Trees: A Guide To Non-Timber Forest Benefits. *Environment Department Papers No. 013*. Washington, D.C.: The World Bank.

Mohd Shahwahid H.O. & Nik Mustapha R.A., (1991). Economic Valuation of Wetland Plant, Animal, and Fish Species of Tasek Bera and Residents' Perceptions on Development and Conservation. *AWB Publication No. 77*

Mohd Shahwahid H. O. & Poh L. Y. (2007). Economic Value of Swiftlets in Bird's Nest Collection from the Forest. *Malaysian Forester 70* (2): 95 – 102

Mohd Shahwahid H. O. & Awang Noor A. G., (1999). Estimating the Non-timber Values of Forest: Beginning with Natural Stands of Rattan. *Tropical Biodiversity 6* (3):161-177. 1999

Wong Weng Chuen & Poh Lye Yong (1998). *The Economic Valuation of Parkia speciosa (petai) in Peninsular Malaysia*. Book jointly published by Forestry Department Peninsular Malaysia and FRIM

Zulnaidah M. & Mohd Shahwahid H. (2011). E*conomic Values of Ornamental Plants*. Forestry Department Peninsular Malaysia Publication. Kuala Lumpur. ISBN 978-983-9269-60-5

Zulnaidah M. & Mohd Shahwahid H. (2012). *An Economic Analysis of Swiftlet Edible Bird's Nest Industry*. Forestry Department Peninsular Malaysia Publication. Kuala Lumpur. ISBN 978-983-9269-92-5

VALUE ADDED OF TIMBER IN PRIMARY WOOD-BASED INDUSTRY IN PENINSULAR MALAYSIA

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Dr. Ismariah binti Ahmad
Norliyana binti Adnan
Dr. Lim Hin Fui

ABSTRACT

Timber is a tangible economic product of forest and the supply of timber is highlighted as the key resource-based sector for wood-based industry. The usage of natural forest species (NFS) in producing sawntimber, veneer and plywood as an intermediate goods in primary wood-based industry also creates additional values. This paper identifies the value-added created to the value of NFS and the productivity of primary wood-based industry.The methodology used in this study was field survey on 213 sawmills and plywood mills in primary industry in 2013.The results show that the value added gained in primary wood-based industry that utilised NFS was about RM 1.328 billion, contributing about 99.6% of total value added in primary wood-based industry. The results also show that, the most productive mills are large mills.

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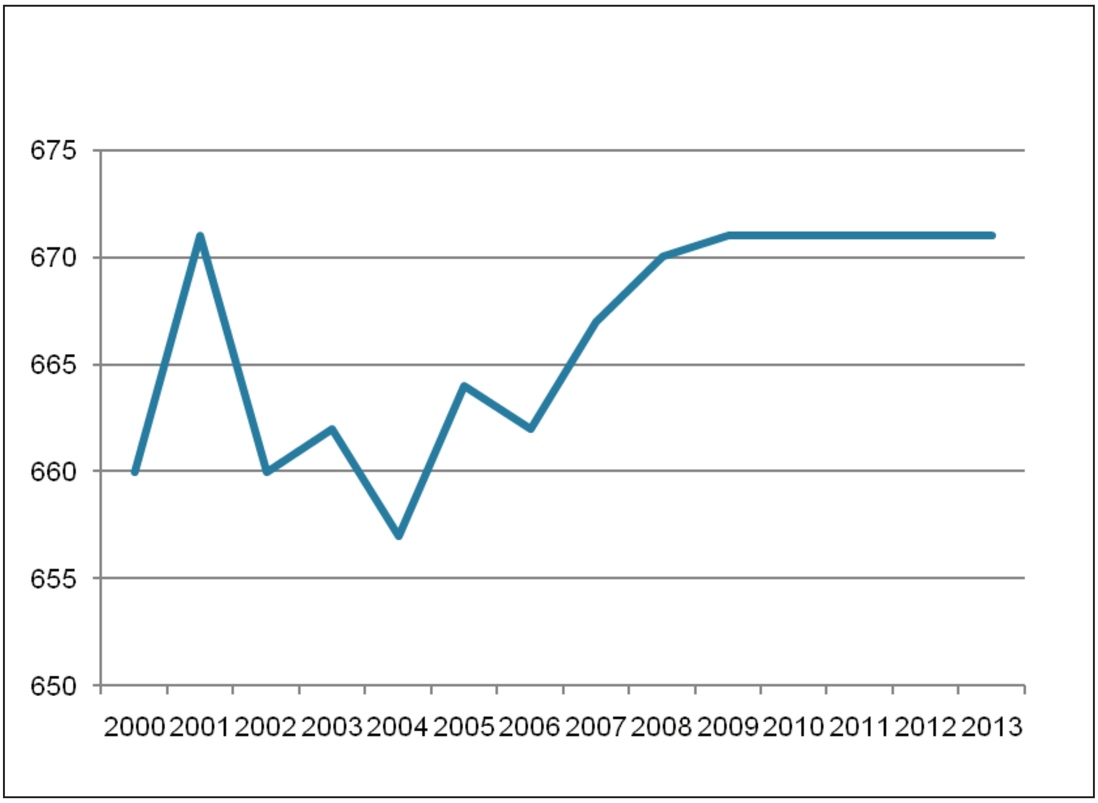
1.0 INTRODUCTION

The main economic product of forest is timber, where by far the most important in term of volume and total value. The supply of timber is highlighted as the key resource-based sector. The contribution of Malaysia's agriculture, forestry and logging was 0.9% of Gross Domestic Product (GDP) in 2013 while wood products 0.5% of GDP (Department of Statistics, 2013). Both contributions have decreased by 40% in last 8 years. This study was a project under 10th Malaysian Plan entitled Socio-economy Study on Labour in Wood Industry. This study was conducted to get the information on current situation of the wood industry which is generally known as labour intensive and low technology industry. The objective of this paper is to assess the value-added gained from NFS and to asses value added productivity and total productivity in primary wood-based industry.

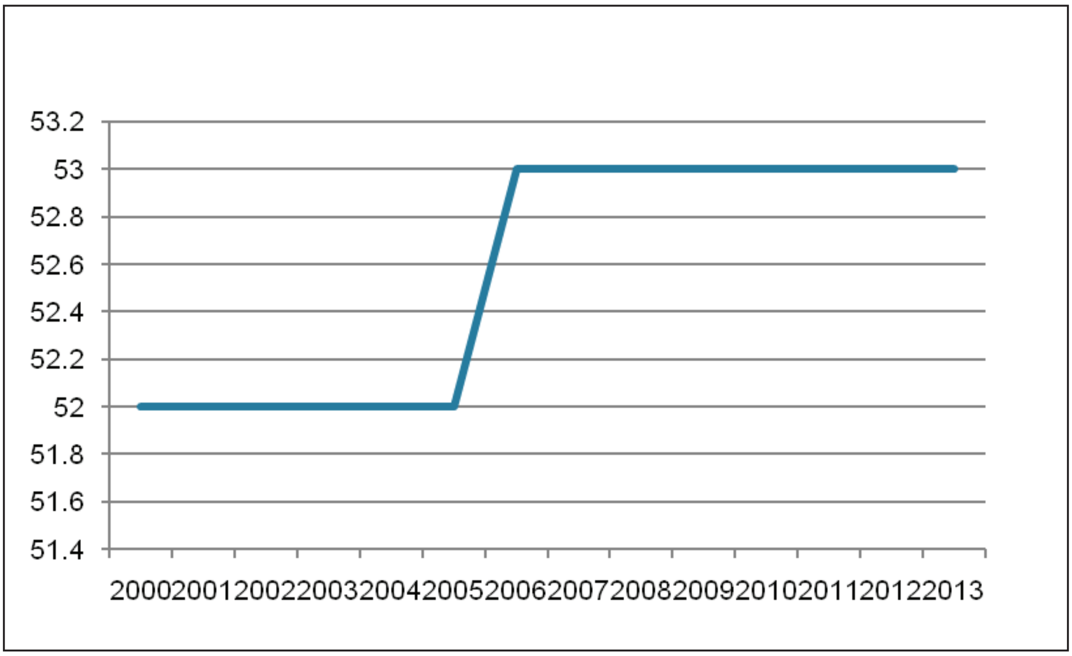
2.0 STUDY BACKGROUND

The number of sawmills increased from 660 sawmills in 2000 to 671 in 2013 while the number of veneer mills increased by additional 1 mill in 2006 making it 53 mills compared to 52 mills in 2000 (Figure 1 and 2). From the total number of sawmills and veneer mills that registered and in process with Forestry Department of Peninsular Malaysia (FDPM), 385 sawmills (57%) and 24 veneer mills (45%) were active in 2013 (Figure 3). The data was collected from the survey conducted to 213 sample companies from population of 409 mills. Based on Sekaran (2003), the sample size is sufficient to ensure a good decision model at 95% level of confident.



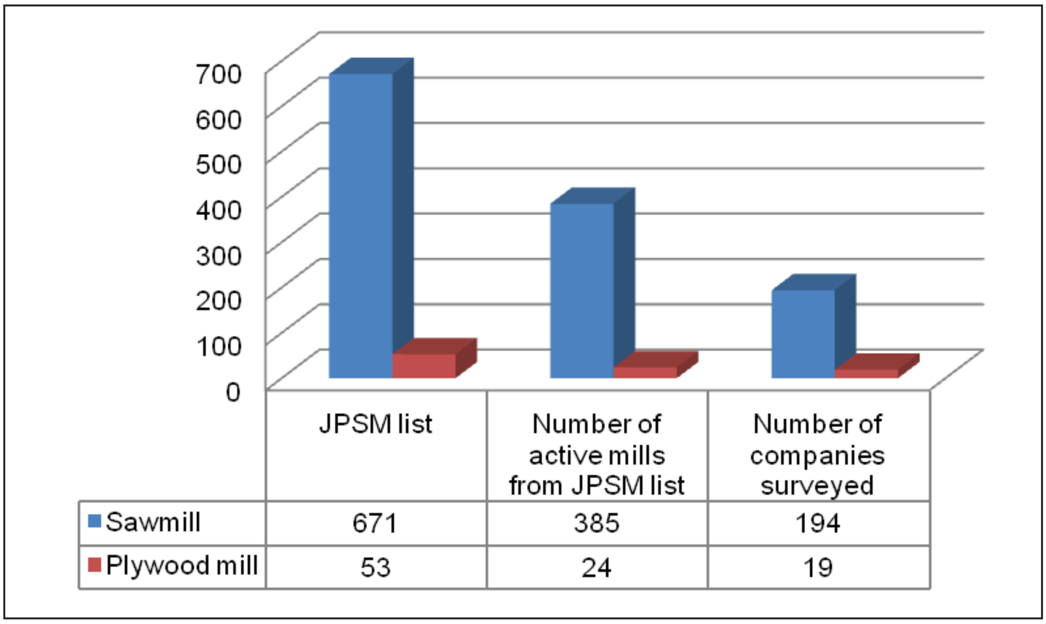
Source: FDPM

Figure 1: Number of sawmills



Source: FDPM

Figure 2: Number of veneer mills



Source: FDPM and actual survey, 2013

Figure 3: Number of mills surveyed

Classification of the Mills

The mills surveyed are classified according to the size based on criteria underlined by Small Medium Industry Development Corporation (SMIDEC), an agency under Ministry of Trade and Industry (MITI) (Table 1) to note if there is any significant difference between size of the company and other variables analysed such as sales, wages and labour productivity.

Table 1: Size classification of the industry

Size of the industry	Annual sales turnover
Micro	< RM 250,000
Small	RM 250,000 - RM 10 million
Medium	> RM 10 million - RM 25 million
Large	> RM 25 million

Source: MITI

Company background

Out of 213 mills surveyed, most mills (18.8%) were located in Pahang, followed by Perak (17.4%). Melaka had the least mills (2.8%) followed by Kedah (5.6%) and Selangor (6.6%). Most of the large (41.7%) and medium (24.3%) mills were located in Pahang, most small mills were located in Perak (21.2%) and the only micro mill was located in Penang (Table 2).

Table 2: Location of mills according to size

State	Large		Medium		Small		Micro		Total	
	Number of mills	%	Number of mills	%	Number of mills	%	Number of mills	%	Number of mills	%
Johor	2	8.3	7	10.0	10	8.5	0	0.0	19	8.9
Kedah	2	8.3	4	5.7	6	5.1	0	0.0	12	5.6
Kelantan	3	12.5	11	15.7	9	7.6	0	0.0	23	10.8
Melaka	0	0.0	1	1.4	5	4.2	0	0.0	6	2.8
N.Sembilan	1	4.2	6	8.6	7	5.9	0	0.0	14	6.6
P.Pinang	1	4.2	2	2.9	13	11.0	1	100.0	17	8.0
Pahang	10	41.7	17	24.3	13	11.0	0	0.0	40	18.8
Perak	2	8.3	10	14.3	25	21.2	0	0.0	37	17.4
Selangor	0	0.0	4	5.7	10	8.5	0	0.0	14	6.6
Terengganu	3	12.5	8	11.4	20	16.9	0	0.0	31	14.6
Grand Total	**24**	**11.3**	**70**	**32.9**	**118**	**55.4**	**1**	**0.5**	**213**	**100.0**

Source: Actual survey, 2013

Table 3 showed that most mills (89.7%) were listed as private limited company and the rest were listed as individual owned mills (6.6%), partnership (2.8%) and public limited company (0.9%). Most individual and private limited mills were small (71.4% and 53.4% respectively) while all partnership mills were small (100%). A total of 23 private limited mills (12%) and 1 public limited mills (50%) were large mills.

Table 3: Status of mills according to size

Status	Large		Medium		Small		Micro		Total	
	Number of mills	%	Number of mills	%	Number of mills	%	Number of mills	%	Number of mills	%
Individual	0	0.0	3	21.4	10	71.4	1	7.1	14	6.6
Partnership	0	0.0	0	0.0	6	100.0	0	0.0	6	2.8
Private Limited Company	23	12.0	66	34.6	102	53.4	0	0.0	191	89.7
Public Limited Company	1	50.	1	50.0	0	0.0	0	0.0	2	0.9
Grand Total	**24**	**11.3**	**70**	**32.9**	**118**	**55.4**	**1**	**0.5**	**213**	**100.0**

Source: Actual survey, 2013

By ownership, as most Bumiputra mills (53.3%) were listed as small, 40% medium and 6.7% large. For non-Bumiputra, 44% were listed small, 32% were large while 24% were medium. Most mix mills (57.2%) were listed as small, 33.5% were medium, while 8.7% were large (Table 4).

Table 4: Ownership of mills according to size

Ownership	Large		Medium		Small		Micro		Total	
Bumiputera	1	6.7%	6	40.0%	8	53.3%		0.0%	15	7.0%
Non-Bumiputra	8	32.0%	6	24.0%	11	44.0%		0.0%	25	11.7%
Mix	15	8.7%	58	33.5%	99	57.2%	1	0.6%	173	81.2%
Total	**24**	11.3%	**70**	32.9%	**118**	55.4%	**1**	0.5%	**213**	100.0%

Source: Actual survey, 2013

Table 5: Number of mills at each state according to year of establishment

Year of establishment	Johor	Kedah	Kelantan	Melaka	N. Sembilan	P. Pinang	Pahang	Perak	Selangor	Terengganu	Total
Before 1950	0	0	1	0	0	3	0	0	0	2	**6**
1951-1960	0	2	0	1	0	2	2	5	0	2	**14**
1961-1970	0	2	1	0	0	2	7	2	1	1	**16**
1971-1980	8	1	3	3	4	2	12	6	3	8	**50**
1981-1990	2	1	6	1	0	3	7	5	1	5	**31**
1991-2000	4	3	4	1	6	3	7	10	6	7	**51**
2001-2010	5	3	8	0	4	2	3	9	3	3	**40**
After 2010	0	0	0	0	0	0	2	0	0	3	**5**
Total	**19**	**12**	**23**	**6**	**14**	**17**	**40**	**37**	**14**	**31**	**213**

Source: Actual survey, 2013

The most mills were established in 1990's and 1970's with 51 and 50 mills established respectively (Table 5).

Table 6: Number of Malaysian and foreign workers according to designation

Management	Malaysian		Total	Foreigner		Total	Total workers		Total
	Male	Female		Male	Female		Male	Female	
Manager	379	45	424	2	1	3	381	46	427
Clerk	189	769	958	0	0	0	189	769	958
Office boy	72	19	91	0	0	0	72	19	91
Others	142	25	167	11	0	11	153	25	178
TOTAL	**782**	**858**	**1640**	**13**	**1**	**14**	**795**	**859**	**1654**
Mill operation									
Loggers	31	0	31	0	0	0	31	0	31
Saw doctors	260	0	260	14	0	14	274	0	274
Lorry driver	211	0	211	0	0	0	211	0	211
Forklift driver	504	0	504	172	0	172	676	0	676
Log loader driver	188	0	188	10	0	10	198	0	198
Security guard	185	3	188	47	0	47	232	3	235
Supervisor	344	3	347	33	0	33	377	3	380
General workers	5252	354	5606	4598	389	4987	9850	743	10593
Others	162	87	249	50	19	69	212	106	318
TOTAL	**7137**	**447**	**7584**	**4924**	**408**	**5332**	**12061**	**855**	**12916**
GRAND TOTAL	**7919**	**1305**	**9224**	**4937**	**409**	**5346**	**12856**	**1714**	**14570**

Source: Actual survey, 2013

Number of workers

The total employees in the mill surveyed in 2013 were 14,570 workers. The proportion of total Malaysian workers in management was 99.2% while in mill operation was 63.3%. Most foreign workers were hired as general workers (47.1%), forklift drivers (25.4%) and as security guards (20%) (Table 6).

Sales generated from the industry

Total sales generated from the industry were RM3,067,679,549 with Pahang generated the most sales (RM 677 million) followed by Kedah (RM 550 million) (Table 7).

Table 7: Number of sawmills and veneer mills, employees and sales by state

State	Number of mills	Employees	Sales (RM '000)
Johor	19	1,340	236,280
Kedah	12	2,015	549,534
Kelantan	23	1,403	375,100
Melaka	6	269	29,952
Negeri Sembilan	14	590	308,906
Pulau Pinang	17	883	143,717
Pahang	40	3,932	676,793
Perak	37	2,065	331,454
Selangor	14	594	110,565
Terengganu	31	1,479	305,380
Total	**213**	**14,570**	**3,067,680**

Source: Actual survey, 2013

Table 8 shows sawntimber generated the highest income (80.9%) in the industry followed by plywood (13.2%) and MDF and laminated veneer (1.8%). Some of the company surveyed provided services such as cutting service, kiln drying and treatment services (0.4%).

Table 8: Sales generated according to type of products

Products	Total sales (RM)
Cable drum	3,108,000
Charcoal	960,000
Cutting services	3,505,622
Door Frame	4,830,000
Kiln Drying and Pressure Treatment	7,444,320
Laminated MDF	28,046,800
Laminated Plywood	3,830,780
Laminated Sawntimber	400,000
MDF and laminated veneer	56,560,000
Moulding	5,345,568
Pallet	13,560,200
Plywood	405,780,920
Plywood and LVL	36,840,000
Sawntimber	2,480,799,496
Treatment Services	768,000
Veneer	15,899,843
Grand Total	**3,067,679,549**

Source: Actual survey, 2013

3.0 METHODOLOGY

Sawmill productivity is measured by total output produced (sales) per employee. Sales are used as a proxy to output since the product in this industry is varying. To estimate the productivity per employee, total output produced is divided by total employee.

$$\frac{\text{Productivity}}{\text{Input}} = \frac{\text{Output}}{\text{Number of employee}}$$

Value added is calculated by subtracting cost of purchased goods and services from sales while value added productivity can be calculated by dividing value added gained by number of employee.

Value added = Sales – Cost of purchased goods and services

$$\text{Value added productivity} = \frac{\text{value added}}{\text{Number of employee}}$$

4.0 RESULTS AND DISCUSSION

Based on the survey the most productive mills per man days were located in Negeri Sembilan (RM1,818) while the least productive mills were located in Melaka (RM386.60). The productivity was also measured for mills' operation employees and the result shows that mills with highest productivity in mills' operation is located in Negeri Sembilan (RM2,090.80) followed by Kelantan (RM1,058.90) (Table 9).Table 10 showed that most productive mills were large mills indicate that size of mills influence productivity.

Table 9: Productivity of sawmills and veneer mills by state

State	Number of mills	Sales (RM '000)	Employees	Sales per employee (man days)	Employees in mill operation	Sales per employee in mill operation (man days)
Johor	19	236,280	1,340	612.3	1,135	722.8
Kedah	12	549,534	2,015	946.9	1,915	996.4
Kelantan	23	375,100	1,403	928.3	1,230	1058.9
Melaka	6	29,952	269	386.6	234	444.4
N. Sembilan	14	308,906	590	1818	513	2090.8
Pulau Pinang	17	143,717	883	565.1	801	623
Pahang	40	676,793	3,932	597.7	3,497	672
Perak	37	331,454	2,065	557.3	1,842	624.8
Selangor	14	110,565	594	646.3	531	723
Terengganu	31	305,380	1,479	716.9	1,218	870.6
Total	**213**	**3,067,680**	**14,570**	**731.1**	**12,916**	**824.7**

Source: Actual survey, 2013

Table 10: Productivity of sawmills and veneer mills by state

Size	Total mill	Total Sales (RM)	Total workers	Productivity
Large	24	1,425,347,280	4,945	288,240
Medium	70	1,098,245,088	4,182	262,612
Small	118	544,051,181	5,434	100,120
Micro	1	36,000	9	4,000
Grand Total	**213**	**3,067,679,549**	**14,570**	**654,972**

Source: Actual survey, 2013

From the total of 213 mills surveyed, 208 companies (97.7%) use NFS as raw material and the other 3.3% use Rubberwood. The value added gained in primary wood-based industry that utilised NFS was about RM1.33 billion, contributing about 99.8% of total value added in primary wood-based industry (Table 11).

Table 11: Estimate value added in primary wood-based industry and mills using NFS

	Primary industry	Mills using NFS
Number of mills surveyed	213	208
%		97.7%
Sales (RM '000)	3,067,679.50	3,010,978.70
Cost of purchased goods and services (RM '000)	1,734,632.70	1,680,892.18
Value added (RM '000)	1,333,046.80	1,330,086.52
%		99.8%
Employees	14,570	13,875
Employees in mill operation	12,916	12,267
Value added productivity (RM '000)	91.5	96.0
Value added productivity per month (RM '000)	7.6	8.0
Value added productivity per man days (RM)	317.7	332.9
Value added productivity of labour in mill operation per man days (RM)	103.21	108.43

Source: Actual survey, 2013

Table 12: Estimate value added by state

State	Number of mills	Sales (RM '000)	Cost of purchased goods and services (RM '000)	Employees	Value added (RM '000)	Value added productivity (RM '000)
Johor	19	236,279.88	146,322.95	1340	89,956.9	67.1
Kedah	12	549,533.92	222,672.04	2015	326,861.9	162.2
Kelantan	23	375,099.51	249,712.72	1403	125,386.8	89.4
Melaka	6	29,951.84	28,506.70	269	1,445.1	5.4
N. Sembilan	14	308,906.26	63,550.50	590	245,355.8	415.9
Pulau Pinang	17	143,716.92	76,840.98	883	66,875.9	75.7
Pahang	40	676,792.95	461,376.35	3932	215,416.6	54.8
Perak	37	331,454.05	246,771.09	2065	84,683.0	41.0
Selangor	14	110,564.50	24,011.15	594	86,553.4	145.7
Terengganu	31	305,379.72	214,868.25	1479	90,511.5	61.2
Total	**213**	**3,067,679.55**	**1,734,632.73**	**14570**	**1,333,046.8**	**91.5**

Source: Actual survey, 2013

The estimate value added per state shows that mills located in Kedah had highest value added (RM 327 million) however mills with highest value added productivity were located in Negeri Sembilan (RM420 thousand) while the lowest value added productivity mills were located in Melaka (RM 5 thousand) (Table 12). High percentage of export and mixed oriented for Kedah (94.2%) and Negeri Sembilan (69.5%) indicate that market oriented is one of the factors affecting value added productivity (Table 13).

Table 13: Estimate value added by market orientation

State	100% export market	100% local market	Mixed-oriented market	Value added (RM '000)	Value added productivity (RM '000)	Percentage of export and mixed oriented market
Johor	57,119.2	115,572.0	63,588.7	89,956.9	67.1	51.1%
Kedah	-	31,683.2	517,850.7	326,861.9	162.2	94.2%
Kelantan	-	194,949.5	180,150.0	125,386.8	89.4	48.0%
Melaka	12,845.8	9,152.0	7,954.0	1,445.1	5.4	69.4%
N.Sembilan	-	94,342.3	214,564.0	245,355.8	415.9	69.5%
P.Pinang	-	56,097.7	87,619.2	66,875.9	75.7	61.0%
Pahang	-	257,682.2	419,110.7	215,416.6	54.8	61.9%
Perak	-	273,402.4	58,051.7	84,683.0	41.0	17.5%
Selangor	-	76,862.5	33,702.0	86,553.4	145.7	30.5%
Terengganu	-	121,506.3	183,873.4	90,511.5	61.2	60.2%
Total	**69,965.0**	**1,231,250.1**	**1,766,464.4**	**1,333,046.8**	**91.5**	**59.9%**

5.0 CONCLUSION

Increasing number of mills indicate that the industry is growing and NFS is the main source of raw material for primary wood based industry with 97.7% mills surveyed use NFS as raw material. 3.3% contribution of Rubberwood in primary industry is allied to the proportion of Rubberwood in total exports of sawn timber from Malaysia in 2012 which is 5% (FDPM).

The survey results also show that the value added gained in primary wood-based industry that utilised NFS was about RM1.328 billion, contributing about 99.6% of total value added in primary wood-based industry. High productivity in large companies and mix-oriented markets show that these factors have significant effects on total productivity.

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REFERENCES

Department of Statistics Malaysia. Retrieved from www.statistics.gov.my

Forestry Department Peninsular Malaysia.*Forestry Statistics Peninsular Malaysia, various issues*, Kuala Lumpur: Author

Malaysian Industrial Development Authority (MIDA) 2008. *Industries in Malaysia: Wood-based Industry*. Retrieved from www.mida.gov.my

Sekaran, U. (2003). *Research Methods for Business (4th Ed.).* USA: John Wiley & Sons, Inc.

SESI PEMBENTANGAN V:

Penilaian Ekonomi Perkhidmatan Hutan

DEVELOPMENT OF COMMUNITY-BASED FOREST ECOTOURISM: THE CASE OF ULU GEROH IN PENINSULAR MALAYSIA

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ABSTRACT

Amidst declining availability of forest resources for the indigenous people worldwide, alternative economic opportunity need to be made available for the forest dependent communities. One of the means in raising their living standard is the development of community-based forest ecotourism. The study among the indigenous Orang Asli Semai at Ulu Geroh in Peninsular Malaysia shows that given adequate assistance they are capable of managing the 136-ha of Bukit Kinta Forest Reserve (Perak) which is rich in *Rafflesia cantleyi*. With the assistance of Malaysian Nature Society (an NGO) and Perak State Forestry Department, the Orang Asli Semai youth in Kampong Ulu Geroh were trained to manage the area rich in *Rafflesia cantleyi*. The case demonstrates the application of traditional knowledge in modern forest resource management in the form of community-based forest ecotourism. This provides an additional source of income to the local communities. In the meantime, plant and animal species in the managed areas are also protected and conserved. By 2014, there are 18 Orang Asli guides (11 females and 7 males) in Kampong Ulu Geroh and each earns average monthly cash income of about RM100-150. The development of ecotourism has brought about capacity building among the indigenous forest dependent community.

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1.0 INTRODUCTION

Since the Earth Summit in 1992, over the last 3 decades, there is increasing concerns at international and national levels for preservation of biological diversity and sequestration of carbon in countering global warming and climate change. Forest management has taken an obvious change from obtaining “sustained timber yield” to multiple functions (Panayatou & Ashton, 1992). However, such change to sustainable forest management does not necessarily include the concerns of local community (Trosper & Parrotta, 2012).

During the past few decades, there is a wide call at international level for increasing the involvement of the indigenous peoples in forest management activities. This is based on the belief that establishing harmony between forests and the local people is the key to sustainable management of forests. Among the model suggested are community forest, joint forest management, partnership (between governments, rural and indigenous communities, the private sector and civil society), model forests, co-operatives for forest management and operation, participation and consultation mechanisms for forest management.

In the case of Peninsular Malaysia, a question was raised whether the relatively less educated Orang Asli communities could be entrusted the responsibility to manage a special forest area. This case study on the Orang Asli Semai of Ulu Geroh shed some light on this matter.

2.0 BRIEF HISTORY ON VILLAGE DEVELOPMENT

The Orang Asli in Ulu Geroh (Kinta district, Perak) belongs to the Semai people, one of the 18 sub-ethnic groups of Orang Asli community in Peninsular Malaysia. The village is located in the lowland forest area of Bukit Kinta Forest Reserve, about 12 km from the nearest town, Gopeng. The village is accessible by 4-wheel vehicles and motorcycles.

Orang Asli Semai community in Ulu Geroh has been living in the area for many generations. In the past, the forest resources practically met all the subsistence needs of the Orang Asli community (Lim, 1997). Hill paddy cultivation was a common practice to provide rice for the households. Villagers obtained their vegetables and meat needs through harvesting of wild vegetables and hunting. The forest provides resources such as building and handicraft making materials and medicinal plants. The Semai live in small groups, normally of 15 to 40 households each. In the 1930s, the Semai began to cultivate rubber trees as they needed cash income (Gomes, 1986) to buy materials such as sugar, tea, coffee salt and clothes.

In the late 1960s, with increased population, part of the former hill paddy area and forest land was opened for rubber cultivation.

In the 1980s, when the rubber prices declined, the Semai in Ulu Geroh also followed some rural Malaysians to switch from rubber to oil palm cultivation which was viewed more productive and could fetch better prices. Unlike rubber which takes 7 years to mature before harvesting, the oil palm trees produce yield after 3 years. Oil palm fruit harvesting is done once every two week, rain or shine while rubber tapping is not possible during rainy days.

By 2011, all 242 hectares (686 acres) of rubber land cultivated by the Semai in Ulu Geroh were planted with oil palm. Over the years, the Semai in Ulu Geroh has developed into four small settlements with a population of about 415 villagers in 2011 (Table 1). Today, villagers are animists, Christians and Muslims. Wooden or brick houses were built by Jabatan Kemajuan Orang Asli (JAKOA). All four settlements are located within the Bukit Kinta Forest Reserve, while their cultivated areas fall within and outside this forest reserve.

Today, the villagers practice both traditional and modern economic activities. Many have chosen to purchase rice from the modern market while some households continue to cultivate hill paddy. As sweeden farmers, the Semai practice slash and burn agriculture which involves opening a new area after a few years of cultivating hill paddy. In general, they also carry out hunting, gathering of forest produces and trading in durian, petai, rattan, bamboo, honey, resins, insects and Rafflesia buds for cash. Oil palm yield now provides a more regular source of income. Since late 1990s, the Orang Asli in Ulu Geroh found a new source of income from the development of forest ecotourism.

Table 1: Semai villages and population in Ulu Geroh, 2011

Village	Estimated households	Estimated population	Facility
Kampung Padang	30	120	-
Kampung Ta Kek	35	140	Community hall has been turned into a Semai Community Centre Conservation project; chapel
Kampung Ki Og	17	85	-
Kampung Kandang Kambing	15	70	Clinic and nursery
Total	**97**	**415**	

3.0 A NEW ECOTOURISM PROJECT

Bukit Kinta Forest Reserve (Perak) is known to be rich in flora and fauna. In particular, the 136-ha of Bukit Kinta Forest Reserve near Ulu Geroh area is rich in *Rafflesia cantleyi* the home of the famed Rafflesia. This is the world's largest flower and can only be found in the tropical rainforests of Southeast Asian countries such as Malaysia, Thailand and Indonesia. It is noted that the Ulu Geroh area is a site rich in two rare species, the *Rafflesia cantleyi* and Rajah Brooke Birdwing butterfly (*Trogonoptera brookiana*).

The Rafflesia is listed by Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as an endangered plant, facing high risk of extinction while the Rajah Brooke butterfly is listed as threatened. In the now famous Rafflesia sanctuary in Ulu Geroh, there were eight small population of this species (Wong & Gan, 2008).

Ulu Geroh area would not have developed into a forest ecotourism area without the assistance of outside organisation. In 1980s, members of Malaysian Nature Society (MNS) found the Rafflesia flower at Ulu Geroh area. Moreover, there were also over 60 species of butterflies identified in Ulu Geroh of which 53 are common, six uncommon and three are rare according to Malaysian Nature Society (Foong. 2004). The Rajah Brooke Birdwing butterfly is a protected insect under Malaysia's Protection of Wild Life Act 1972. Due to its beauty, the Rajah Brooke Birdwing butterfly is highly sought after by collectors.

In the 1990s, the existence of the Rafflesia flower and butterflies was threatened by rampant collection by the Orang Asli for sale to obtain cash income. The Rajah Brooke Birdwing Butterfly and other butterflies were collected for sale to local traders at a low price of RM0.10 each. It meant villagers had to collect many butterflies to earn a reasonable amount of cash income to sustain livelihood. Each butterfly was mounted by the middlemen and sold for RM15. The Orang Asli in Ulu Geroh also brought visitors to see the Rafflesia flowers from time to time (Randhawa, 2004).

In 1998, MNS members visiting the areas found the declining Rafflesia flower population due to over harvesting by the Semai people. To prevent further loss in biodiversity, in 2000, MNS carried out a 6-month study on the Rafflesia flower, a project sponsored by International Union for Conservation of Nature (IUCN). The study showed that there were healthy colonies of the Rafflesia in several compartments within the Ulu Kinta Forest Reserve easily accessible and thus justifiable to conserve the area.

It was realised that conservation program needed to involve the local Orang Asli community. In 2002, with the assistance of MNS, a grant was obtained from the United Nations Development Programme (UNDP) Small Grants Programme to start a conservation and training programme at Ulu Geroh which was completed in 2004. The project focused on community development and capacity building in ecotourism and conservation. It was aimed to prepare the Semai to play a specific role as stewards and a local support group while simultaneously helping to support the local community. The project trained the villagers to appreciate the natural resources and to act as nature guides with the ultimate aim of becoming the stewards of the nearby forests. The project was supported by the JAKOA and Perak Forestry Department. MNS taught the locals to mount the butterflies themselves. The effort was to enable locals to earn more income from fewer butterflies thus uplifting their economic well-being and conserving the butterflies (Randhawa, 2004).

The training resulted in Orang Asli community getting more committed to engage themselves in conservation program. In 2004, a group of 20 Semai Orang Asli organised themselves with a collective name of *Sahabat Eko-Pelancongan dan Memulihara* (SEMAI) or Friends of Ecotourism and Nature Conservation (Anon, 2004) under the MNS Rafflesia Conservation project. This conservation project is a working partnership with the Perak Forestry Department, Perak, JAKOA and MNS. Under this project, MNS's project aims to develop a site for conservation of the Rafflesia and Raja Brooke Birdwing.

To enhance local capacity, local guides were given a two-week nature guide course in Kuala Gula, Perak, organised by the National Parks and Wildlife Department (Perhilitan), Tourism Ministry, Danish International Development Agencies (Danida) and Wetlands International. The Orang Asli guides bring tourists to see the rafflesia flower, Raja Brooke butterflies and a scenic waterfall in the jungle. Visitors pay a fee to visit the selected sites (Table 2).

Table 2: Fee for visiting sites in Ulu Geroh

	Package 1	Package 2	Package 3
Site	Rafflesia only	Rafflesia & butterfly	Rafflesia, butterfly and waterfall
Fee per pax	RM22	RM44	RM55
Group of 3 adults and 1 child* under age of 12	4	4	4
Number of guide	1	1	2
Total fee	RM77	RM154	RM192**
Sharing of benefit (a) Guide fee (b) Admin assistant (c) Identify flower (d) Community fund	 RM30 RM17 RM20 RM10	 RM50 RM17 RM20 RM67	 RM100 RM17 RM20 RM55

*Half price. **May be discounted to RM150

The community-based forest ecotourism development in Ulu Geroh has long-term implication and impact. The Semai community has learnt to apply their traditional knowledge in managing *Rafflesia cantleyi* and developing ecotourism project that create employment for youths as well as generate income. This form of forest based ecotourism development enhances their confidence besides gaining more experience in guiding the tourists. The process of empowerment also helps to inspire new ideas to improve their nature tour package offering.

This case of the Orang Asli Semai in Ulu Geroh shows that the local villagers have learnt to apply their traditional knowledge in managing *Rafflesia cantleyi* and developing ecotourism project with the assistance of government agency and a national NGO. It is through this collaborative project that a formerly abandoned community hall was converted into an educational centre, focusing on biodiversity, conservation and sustainable use. The project has turned the Orang Asli Semai into stewards for the rare and endangered Rafflesia, protected Rajah Brooke Birdwing butterfly besides generating supplementary income from ecotourism.

By 2014, there are 18 Orang Asli guides (11 females and 7 males, part and full time) in Kampong Ulu Geroh and each earns average monthly cash income of about RM100-150. The over impact is in line with sustainable development which is defined in Brundtland Report (1987) as “meeting the needs of current generations without compromising the ability of future generation to meet theirs”. The impacts could be summarised in Table 3.

Table 3: Impacts of managing a FR area, 2010

Local organisation	Before involvement None	After involvement Formation of SEMAI
Harvesting of plant resources	Free to harvest bamboo and medicinal plants for own use.	• Free to harvest bamboo and medicinal plants for own use.
Harvesting of butterfly	Free to harvest and sold at RM0.005 each.	• Raja Brooke can no longer be harvested.
Capacity building	Occasional briefings by government agencies	• Proper and specific training by MNS. • 18 guides available. • Better communication skills. • More confidence interacting with others. • Some guides can communicate in simple English.
Income	Irregular income from harvesting butterflies	• More regular income from guiding tourists. • Working closely with hotels and resorts. • RM100-150 per guide per month.

The Ulu Geroh ecotourism initiative now managed well by SEMAI has received recognitions in the last decade:

a) On the Earth Day (8 July 2009), Dow Chemical Company Malaysia celebrated the Ulu Geroh Ecotourism Park in Malaysia, a project supported by Dow Malaysia coordinated and implemented by MNS; and

b) In December 2009, SEMAI was awarded the President's Award in the Perak Tourism Appreciation Awards. This was the outstanding achievement of SEMAI, MNS and various donors and supporters between 2000 and 2010 demonstrating an excellent example of community participation in conserving Malaysia's natural resources and its sustainable use.

4.0 CONCLUSION

This case study on the involvement of local community in managing a 136-ha of Bukit Kinta Forest Reserve which is rich in *Rafflesia cantleyi* shows that indigenous people could play a role in sustainable forest management. With the assistance of Malaysian Nature Society (an NGO) and Perak State Forestry Department, the Orang Asli youth in Kampong Ulu Geroh were trained to manage the area rich in *Rafflesia cantleyi*. The capacity building resulted in local communities playing a key role in conserving *Rafflesia cantleyi* in the area. Visitors are guided by villagers to see the flowering of *Rafflesia cantleyi* from time to time. This provides an additional source of income to the local communities. In the meantime, plant and animal species in the managed areas are also protected and conserved.

The involvement of indigenous peoples in forest management raises further food for thought. It appears that given opportunity and external supports, the indigenous community could play a role in sustainable forest management. Community-based forest ecotourism development in this case study clearly demonstrates that local traditional knowledge and practices could be applied in sustainable forest management activities. Perhaps, the forest managers could consider this and entrust more local community the appropriate responsibility of managing the local forest areas. A wise partnership between the forest managers and local communities would ensure long-term successful implementation of sustainable forest management.

REFERENCES

Brundtland Report. (1987). *Report of the World Commission on Environment and Development – Our Common Future*. Oxford: Oxford University Press.

Convention on Biological Diversity. (1992). Retrieved from http://www.cbd.int/convention/convention.shtml

Department of Orang Asli Affairs (JHEOA). (2005). *Data Maklumat Asas JHEOA Malaysia*. JHEOA.

Foong, T.L. (2004). *Home of the Famed Rafflesia*. The Star, 30 December 2004.

Gomes, A. G. (1986). *Looking for Money: Simple Commodity Production in the Economy of the Tapah Semai of Malaysia*. Ph. D. Thesis, Australian National University.

Lim Hin Fui. (2007). Orang Asli, Forest and Development. *Malayan Forest Records No. 43*. Forest Research Institute Malaysia.

Panayotou, T. & Ashton, P. (1992). *Not by Timber Alone: Sustaining Tropical Forest through Multiple Use Management*. Island Press, Covelo, California, USA.

Randhawa, S. (2004). *Fortunes Bloom for Biodiversity Guardians*. The Sun, 8 April, 2004.

Sobrevila, C. (2008). *The Role of Indigenous People in Biodiversity Conservation*. The International Bank for Reconstruction and Development/World Bank.

Trosper, R. L. & Parrotta, J. A. (2012). *"Introduction: The Growing Importance of Traditional Forest-Related Knowledge"*. Pp 1-36 in John A. Parrota and Ronald L. Trosper (Ed.). Traditional Forest-Related Knowledge: Sustaining communities, ecosystems and Biocultural Diversity. Springer Science+Business Media B.V. (outside the USA).

Wong, M. & Gan, F. (2008). "Lidah-Lidah, a Potentially New Species of Rafflesia". *Malaysian Naturalist, Volume 62* (2): 40-42.

ESTIMATING THE RECREATION VALUE OF PENANG HILL USING TRAVEL COST METHOD

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ABSTRACT

Penang Hill is known for its history for being a hill station established by the British during their time in Malaysia. The hill also offers recreational activities attracting various types of visitors to this location. Despite its long history of development, the historical value and recreational benefit obtained from visiting Penang Hill is still unidentified. In order to understand the allocation for recreational development in Penang Hill, an assessment of the estimated economic value of benefits from recreation and history must be made. Thus, the aim of this study is to determine the benefit attained by visitors by estimating the consumer surplus value of a recreational demand model. The study adopted the Travel Cost Method in constructing recreational the demand model. A survey was conducted for two months in 2013 and obtained a total of 204 usable questionnaires. A multiple regression analysis was employed to determine the explanatory variables which were total travel cost, length of stay, perception mean score for facilities, perception mean score for conditions, visitors' nationality, age and marital status. The study has estimated the annual consumer surplus per individual at RM108.24 per visit for the year 2012. From this, the recreational value of Penang Hill was estimated at RM83,065,293.85 for the year 2013. This value demonstrated the amount of benefit attained by visitors resulted from the current management approach. If the management decides to change its style, it might affect the recreational value of Penang Hill. There is also a possibility of overestimation, hence a thorough study is needed in observing multi-destination effects.

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1.0 INTRODUCTION

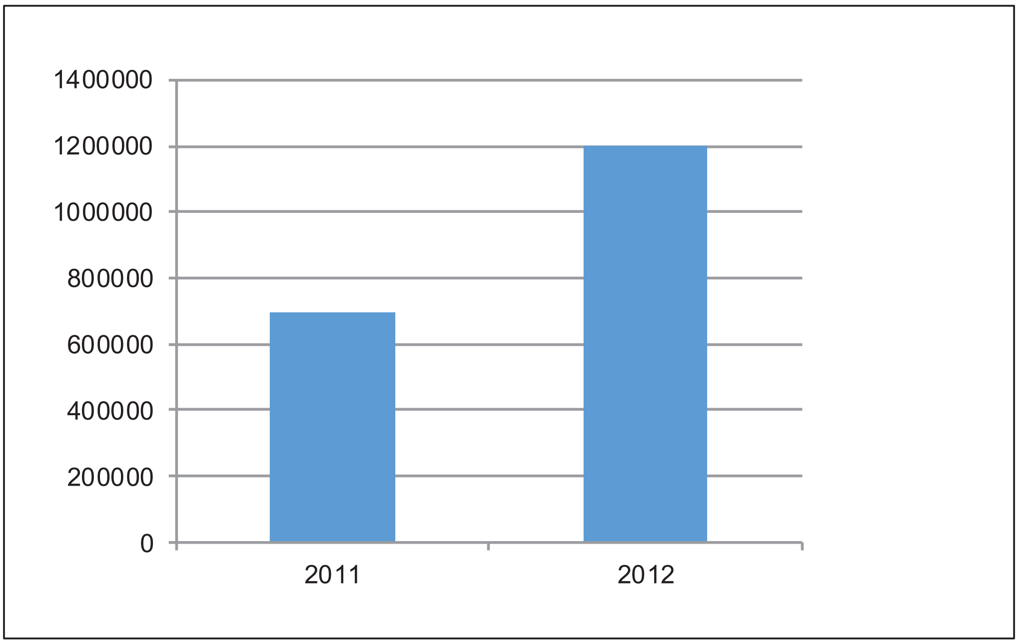
Penang Hill (PH) is one of the oldest colonial hill station establish by the British during their time in Malaysia. PH is located in Ayer Itam, Penang, Malaysia which is about 6 kilometers away from the city center of George Town. PH is also known by the Malay name Bukit Bendera, which translates to Flagstaff Hill, the most developed peak. The PH Railway is a one section funicular railway which climbs PH from Air Itam.

PH is one of the hill stations that had originated in the uplands tropics during the colonial era (Aiken, 1987). Aiken (1987) states that the functional composition and landscape characteristics of PH during the early nineteenth century are described in the context of contemporary medical concepts, perceived health hazards, leisure pursuits, and culture transfers. PH increasingly resembled an ideal model of “home”. The impact of the opening during British colonial times, PH changes into the initial parcel of a value in history. The concept of the building and the early hill station remains as a remnant of British history in PH, which is an attraction tourism site for local and foreign visitors. In the aspect of physical condition, PH is a granitic massif that forms a chain, with a series of slopes and valleys at a range of elevations (Aiken, 2002). Its highest point is 823m above sea level and the northern region differs prominently lowlands. The climate is seasonal, the wet season occurring between April – November and the dry season between December – March. In the wet season rainfall occurs on most days and humidity is relatively high (70-90%); the mean annual rainfall is 2670mm. The core summit area has a daily temperature ranging from 20 – 27 ^{0}C, and the overall mean monthly minimum temperature is consistently below 21 ^{0}C (Addo-Fordjour *et al*., 2013).

The main attraction of PH was the funicular railway from Air Itam to the top Flagstaff. This is the most convenient way to travel up PH; i.e. by using funicular train of the PH Railway. On 2011, the PH Corporation took over the PH Railway Service until present and new coaches are used until now to give the best service for visitors.) Alternatively, there is a 5.1km tarmac road, beginning at the quarry at the entrance of the Penang Botanical Gardens.

PH provides a variety of recreational activities, ranging from passive activities to vigorously active recreational pursuit. Sightseeing is one of the most popular due to the high altitude, historical colonial buildings, greenery and scenery of Penang Island. The main tarmac road from Penang Botanical Gardens to the summit of PH is used usually used as trail for trekkers and cyclists. The popularity of the hill is increasing as it shown by the increasing trend of tourists’ arrivals (Figure 1).

These natural resources of PH are rich with features that have value especially in terms of recreational and historical. These recreational visits, either directly or indirectly, have impacts on PH economy. From economic perspectives the economic impact comprised of market value and non-market value. While tourist expenditure can be observed contributes directly to the state economy, the non-market economic value of PH justifies the value gained by the public through its recreational and historical aspect. This is especially imperative as the PH is operated and maintained by public fund. With huge expenditure by the Government, it is a good idea to assess the effort undertaken by the authorities has its impact. One of the ways is by assessing by the means of a benefit-cost analysis (Syamsul et al., 2012). As non-market value provides the monetary measurement of the recreational and historical value of PH, this assessment could be used in determining the current use of PH as oppose to other type of land use. The estimation of recreational benefits can also provide information to the Penang Hill and the State Government, to use for future planning and development since the study was based on actual visitors' expenditures. With the projection of economic value, it helps the managing agency to generate prospective funds from various sources, either government, private or non-profit organisations.



Source: Penang Hill Corporation, 2013

Figure 1: Visitors statistic at Penang Hill

2.0 METHODOLOGY

The survey was conducted at Penang Hill every weekend during the duration of the study, in the morning and evening to ensure enough variation in the respondent's preferences. Surveys were conducted for a period of 3 months in 2013. Respondents were selected from the leaders of the groups. It is assumed that the information given by the leader of the group reflects the information for the entire family or group and not merely his/her own (Ahmad, 1994). Respondents were interviewed personally to ensure a complete questionnaire returned. Following Kuosmanen et al. (2004), only respondents with the purpose of recreation are interviewed to resolve multi-destination trip visitors. In avoiding an overestimated consumer surplus (CS), international visitor were excluded in the survey.

Travel Cost Method

This study has employed the travel cost method (TCM) in achieving its objectives. TCM is based on the notion that the money and time that people spend traveling to an outdoor recreation area indicates the economic value of the recreational resources (Hackett, 2000). TCM recognises that the total cost each individual pays for his or her trip depends on the cost of travel to the site; this will affects an individual's frequency of the visitation. The demand model is then constructed by regressing visitation and the travelling cost. Based on the estimated demand curve for outdoor recreation at the site, benefits to visitors could be estimated by calculating the area under the demand curve that measures the CS of recreational resources to users. In this study, other related independent variables were also included in the regression analysis, which were traveling cost to alternative site, time cost and socio-demographic variables.

The specific model can be written as follows:

$$V = \beta_0 + \beta_1 TTC_{ij} + \beta_2 ARITC_{ij} + \beta_3 OST_{ij} + \beta_4 OSC_{ij} + \beta_5 AGE_{ij} + \beta_6 EDU_{ij} + \beta_7 INC_{ij} + \beta_8 MS_{ij} + \beta_9 SI_{c\,ij} + \beta_{10} SI_{f\,ij} + \beta_{11} SI_{b\,ij} + \varepsilon_i$$

where;

V = Frequency Number of Individual Visit for Recreation per Year
TTC = Total Travel Cost (RM per visit)
ARITC = Alternative Recreation Individual Travel Cost (RM)
OST = On Site Time (Hours)
OSC = On Site Cost (RM)
AGE = Age (years)
EDU = Education (years in school)
INC = Income per Month (RM per month)
MS = Marital Status
SI_c = Satisfaction Index Condition
SI_f = Satisfaction Index Facilities
SI_b = Satisfaction Index Benefits
ε_i = Error Terms
$\beta_{0,}\ \beta_{1,\ldots\ldots}\beta_6$ are parameters to be estimated and ε is random error, $_i$ is index of observation.

3.0 RESULTS AND DISCUSSION

Respondents Background and Travel Characteristics

The average age was found to be 33.4 years old, which is close to the median (30 years old). Percentage of male visitors (52%) is more than female visitors (48%) with Malay as the majority (63%). One possible explanation for this it is may relate to the way that data was collected. Most of the visitors (54.4%) in Penang Hill were married, while 45.6% of them were single status. The highest percentage of education level attained was STPM, diploma and degree (72.5%), the mean of the visitors monthly income was RM3,721.2. that most of the visitors (72.5%) were first timer to Penang Hill. majority of the visitors (45.1%) visit to Penang Hill came with family. Sightseeing activities shows the highest percentage rate compare to other activities in Penang Hill (83.3%), 9.3% of visitors for tracking activities, 1% of visitors for mountain biking activities, while 4.4% of visitors visit the nearest place and the rest were other activities (2%). most of the visitors (38.2%) spend their time at Penang Hill about two hours. Most of the visitors (75.5%) came to Penang Hill by car. 14.7% of the visitors came to Penang Hill by bus, 6.9% of visitors came to Penang Hill by taxi and only 2.9% of the visitors came to Penang Hill by motorcycle.

Multiple Regression Result

The multiple regression indicates that travel cost is inversely associated with the dependent variable. The negative relationship is expected as it is consistent with demand theory. It can be explained that total visitation decreases as the distance increases (since the travel cost increases as well). As shown in Table 1, the relationship between mean facilities and the visit of the visitors is indicated as directly proportional (0.681). This means that the higher the satisfaction on facilities, the more the visitors will visit Penang Hill. This finding is beneficial to Penang Hill Corporation as it shows the importance of visitor satisfaction on facilities. In this case, there are facilities valued lower than the satisfactory level such as the parking lot and food stalls. Hence, more attention should be given to these two facilities by the authorities.

Table 1: Regression analysis result

Variables	B	Beta	P-Value
(Constant)	-0.658		0.62
Total Travel Cost	**-0.002**	**-0.195**	**0.017**
On Site Time	**0.199**	**0.2**	**0.004**
Age	**0.024**	**0.193**	**0.037**
Nationality	**1.004**	**0.26**	**0.002**
Marital Status	**-0.525**	**-0.193**	**0.029**
Mean Facilities	**0.681**	**0.278**	**0.004**
Years of Education	0.021	0.029	0.689
Alternative Recreation individual Travel Cost	-2.87E-05	-0.004	0.956
On Site Cost	0.002	0.02	0.772
Monthly Income	1.28E-05	0.044	0.62
Mean Benefits	0.341	0.116	0.103

F= 4.273, R^2 = 0.213
*significant at 0.05 confident level

The on-site time of visitors and the frequency of visit are directly proportional (0.199) as per shown in Table 1. The relationships explain that visit per year increases if the visitors spend more time at the location. This is because visitor the time spent on the activity that they participated such as sightseeing (83.3%) and jungle trekking (9.3%). This suggests the importance of recreational activities such to prolong visitors stay on-site. In general, pleasant experiences during the stay have positive effects towards length of stay and frequency of future visits.

Table 1 also shows that the relationship between age and visit are directly proportional. This explains that the older visitors tend to have frequent visits to PH. In general, participation in vigorous activities is inversely related with age. As people grow older, they decrease their engagement in active outdoor recreation but prefer more relaxing activities. This can be seen in PH where the most frequent activity is sightseeing (83.3%), that can be considered as relaxing activity rather vigorous activity.

Marital status is found to have inverse relationship with visit. This suggests that shows that single visitors would have a lesser visits compared to married visitors. It can be assumed that married visitors (54.4%) like to come with their family (45.1%). The relaxing environment of Penang Hill made it preferable for visitors to spend their quality time with family members. It is also supported by the fact that the highest rank of satisfaction to PH is "spending time with family and friends" (68.6%).

Estimating CS of Penang Hill

In this study, the benefit gained by visitors is estimated by calculating the CS area. The CS in economic terms can be measured in the form of the area underneath the demand curve (Figure 5). The Total Travel Cost (TTC) is used as a proxy for the price of using the resources in the site and the Frequency of Visit (V) per year to Penang Hill. The value of this integration measures the area below the demand curve (Figure 5).

The Equation 1 function of TCM in this study was:

$$V = -0.02 \text{ Total Travel Cost} + 0.681 \text{ mean facilities} + 0.199 \text{ OST} + 0.024 \text{ Age} + 1.004 \text{ Nationality} - 0.525 \text{ marital status} - 0.658 \text{ constant} \quad \ldots\ldots \text{(Eq.1)}$$

by assuming other variables, expected TTC (Total Travel Cost), are constant, *ceteris paribus* the demand function is then derived :

$$V = -0.002TTC - 0.658 \quad \ldots\ldots \text{(Eq. 2)}$$

Taking the integration of Eq. 2, the CS of PH demand is estimated at RM 108.24 per visit for the year 2012. The estimation of recreational value of PH is then calculated by multiplying CS and total visitation to PH in 2012. From this, the recreational value of Penang Hill is estimated at RM83,065,293.85 for the year 2013.

In comparison with another study by Awang *et al.* (2007), the economic value of Chamang Recreational Forest was estimated to be between RM 6.7 to RM10.6 million in 2007. Based on this study, the economic value of PH is higher compared to Chamang Recreational Forest. This is probably due overestimation issue. In the trip to PH, visitors might have visited other locations. Therefore, the expenditure of other locations might have affected the calculation of the total cost to PH.

4.0 CONCLUSION

From the study, there is a need for the management to have strategies to increase visitation, as this will also increase the economic value. This study has also identified the factors that affected visitation rates, which were the travel cost, age, marital status, nationality, on-site time, and mean facilities. The value estimated for PH is derived from current management approach. If there is change to the management style, it might change the value. Hence, it is important to understand the effect towards the value prior to any change made. Further research on historical value should be continued at PH to understand the significant of cultural and heritage into the whole economic value.

REFERENCES

Aiken, S. R. (1987). Early Penang Hill station. *Geographical Review*, 421-439.

Aiken, S. R. (2002). Penang Hill: Landscape Evolution, Heritage Conservation and Sustainable Tourism. *Malaysian Journal of Tropical Geography*, *33*(1/2), 77-92.

Awang Noor, A. G., Mohd Yusrizal, H., Tuan Marina, T.I., & Mohd Syauki, M. S. (2007). *Economic valuation of recreation benefit in Chamang Forest Recreation Area, Bentong, Pahang*. Paper presented at the Seminar on Economic Valuation of Forest Goods and Services, Terengganu, December 15-18, 2007.

Kuosmanen, T., Nillesen, E., & Wesseler, J. (2004). Does Ignoring Multidestination Trips in the Travel Cost Method Cause a Systematic Bias. *The Australian Journal of Agricultural and Resource Economic , 48* (4), 629-651.

Syamsul Herman M. A., Ahmad Shuib, Ramachandran, S., Mohd. Rusli Y. & Aldrich Richards. (2012). The Need for Recreational Economic Valuation at Perlis State Park. *Malaysian Forester 75(1).* 73-80

PES MECHANISMS THROUGH MINI HYDRO PROJECTS IN THE FOREST RESERVES OF PERAK STATE, MALAYSIA*

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ABSTRACT

Our natural environment, particularly water, provides a variety of services to the well-being and economic prosperity. Hydroelectric developers tend to neglect that the conservation and protection of watershed forests by the Forestry Department played an essential part in their business. Water, which is sourced from a dedicated watershed forest area, has been undervalued as compared to the value of timber because of the lack of formal market. Hydro power generation from watershed forest often compromise the income derived from timber in the same productive forest as hydroelectric developers pay taxes to the Government. The income from government taxes is not directly channeled to the Forestry Department to enable them to finance Sustainable Forest Management (SFM). In order to supply sustainable flow of water, both in terms of quality and quantity to the hydroelectric plant, the watershed areas situated in productive forest becomes opportunity cost to the Forestry Department. Nevertheless, PES Mechanisms implemented by the Perak State Forestry Department (SFD) and Perak Hydro Renewable Energy Corporation (PHREC) is a win-win situation for both parties. Perak SFD will ensure water quality (evenness of stream flow and quantity) to generate PHREC’s mini hydro turbine, while generating sustainable and predictable income from the protection and conservation of river.

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IMPERATIVES FOR SOIL CARBON VALUATION IN MALAYSIAN FOREST ECOSYSTEMS

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ABSTRACT

Valuation of forest environmental services is important for sustainable utilisation and conservation of forest resources. It also aids decision-making by equipping policy makers with options on best ways of putting forestry goods and services to use. Various studies have estimated the total economic value of forest ecosystems in Malaysia and some have even estimated the value of carbon in biomass; but majority of these studies have failed to include soil carbon in the valuation. Forest soils render a number of environmental services such as carbon sequestration, water purification, provision and recycling of nutrients, flood and erosion control. On the other hand, poor management of soil resources also creates dis-services such as carbon emission, loss of nutrients and flooding. This paper examines the role of soil environmental services in the Malaysian forest ecosystem with a particular reference to soil carbon and sequestration services. A number of approaches to valuation of soil carbon have been reviewed. It is concluded that, soil carbon valuation may likely increase the value of Malaysian forest's contribution to the World and may also make the carbon markets under the REDD+ or A/R CDM economically realistic.

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1.0 INTRODUCTION

The soil is a principal component of the forest ecosystem that is often neglected in forestry research, management and policy decisions. The soil provides a number of environmental services such as provision and recycling of nutrients, water purification, flood and erosion control. Perhaps one of the most important roles of soil is carbon storage and sequestration. Globally, the soil contains 1550 Pg C carbon which is two times higher than what is found in the atmosphere (760 Pg C) and three times higher than biotic carbon pool (560Pg C) (Lal, 2004). In the forest ecosystem, the soil is believed to account for an average of 85% total carbon in boreal forests, 60% in temperate forests and 50% in tropical forests (Dixon et al., 1994). The forest ecosystem makes significant contribution to the Malaysian economy over the years. However, most of the research conducted to assess and estimate the economic value of carbon in the Malaysian forest sector concentrate on the above ground biomass and tend to overlook the contribution of soil despite the significant amount of carbon held in the soil (Kato et.al., 1978; Abdulrashid et. al., 2009; Kumari, 1995).

It has been reported that the Malaysian forest ecosystem contains an estimated 23.48 Million tonnes of Carbon (C) (or 86.17M tonnes CO_2 equivalent) and have the potential of sequestering 4 tonnes of Carbon ha^{-1} Yr^{-1}(Shamsudin, *et.al.*, 2009). However, this estimate does not include the carbon in soil. Considering the significant amount of carbon held in forest soil, the carbon stock and sequestration capacity of the Malaysian forest ecosystem is probably under-estimated and undervalued. This situation can have a far reaching policy implication as the country under-reports its national carbon inventory in National communications thereby downplaying its carbon sequestration contribution to the global ecosystem. This paper attempts to highlight the imperative for valuing soil carbon stock and sequestration services in the Malaysian forest sector.

Carbon Stock in Forest Soils

In the forest ecosystem, carbon is stored mainly in biomass and soil. The carbon found in soil plays a significant role in the global carbon cycle owing to the large expanse of the forest ecosystem estimated to cover 4.1 billion hectares (Dixon and Wisniewski, 1995). Globally, the forest ecosystem contains about 1,240 Pg C (Dixon et al., 1994). Out of this amount, the vegetation contains about 536 Pg C while the soil is believed to contain up to 704 Pg of C. This clearly indicates that there is more carbon in soil than in the vegetation at the global scale.

Table 1: Percentage organic carbon in soil in forest ecosystems as reported by different authors

S/N	Source	Percentage organic carbon in soil of forest ecosystems
1	FAO, 2001	36% (Tropics)
2	Dixon et al., 1994	40% (Global)
2	Jobaggy and Jackson, 2000	43% (Global)
3	FAO, 2006	45.6% (Tropics)
4	Saner *et al.,* 2012	23.5% (Sabah, Malaysia)
5	Neto*et al.,* 2012	52% (Selangor, Malaysia)
	Average	40.625%

Source: Abdullahi, A.C et al (forthcoming)

The soil contains two thirds of the total terrestrial carbon pool estimated at 1500 Gt C at the global level (Lal, 2004). In Malaysia, Saner et al. (2012) reported that the soil contains 23.5% of the carbon in Malua Forest Reserve, Sabah Malaysia. Neto et al. (2012) also reported that the soil contains 17% (at 30cm depth) to 52% (at 3m depth) of total carbon in Ayer Hitam Forest, Selangor, Peninsular Malaysia. Table 1 below shows the percentage organic carbon in soils of forest ecosystems as reported by different authors.

Although found in abundance, soil carbon in natural forests is highly susceptible to depletion due to natural and anthropogenic factors. Naturally, a reduction in biomass (above and below ground) returned to the soil, changes in soil moisture and temperature regimes and degree of decomposability of soil organic matter will markedly deplete soil carbon stock (Post and Kwon, 2001). Also, converting natural forests to agriculture depletes the soil organic carbon by as much as 20-25% (Lal, 2005). Deforestation is reported to emit about 1.6-1.7 Pg C/year (about 20% of anthropogenic emission) (Watson et al., 1995; IPCC, 2000).

The Role of Soil Carbon in Forest Ecosystem

The carbon in soil plays significant roles in the forest ecosystems by mitigating climate change and enhancing forest health and productivity. The soil is believed to posses the ability to sequester carbon in long-lived pools thereby reducing the amount that is present in the atmosphere (Stockmann, et. al., 2013; Lal, 2004; Post and Kwon, 2000; Guo and Gifford, 2002; Smith, 2008 etc).

Apart from reducing the concentration of greenhouse gases (GHGs) in the atmosphere, soil carbon sequestration also improves forest health and productivity. Organic matter improves soil's structural stability, water-holding capacity, nutrients availability and favourable environment to soil organisms (Lal, 2004). Enhancing the carbon storage and sequestration ability of forest soils creates a win-win opportunity for the forest owner. This is because all strategies that sequester carbon in soil also improve soil quality and land productivity by increasing the organic matter content of the soil. The organic matter (>50% of which is organic carbon) is responsible for improving the structural stability of the soil, richest source of plants nutrients, energy to soil organisms, and pH regulation (Lal, 2004; UNEP, 2012; Batjes, 2013; Ravindranath and Ostwald, 2008).

Carbon sequestration activities offer an opportunity for regaining lost productivity especially under agricultural systems. It has been reported that managed ecosystems such as agriculture have lost 30-55% of their original soil organic carbon stock since conversion (Batjes, 2013). The lost productivity of agricultural and degraded lands together offers an opportunity for recovering 50-60% of the original carbon content through adoption of carbon sequestration strategies (Lal, 2004). About 11% of the land mass (which mainly consist of degraded land and abandoned mine fields) in Peninsular Malaysia has been found to be eligible for establishment of new forest plantation for the purpose of carbon sequestration (Theseira, 2009).

Anthropogenic activities such as forest conversion, draining of peat soils and unsustainable silvicultural practices depletes soil organic carbon stock and increase emission of carbon dioxide to the atmosphere. Forest management decisions seldom factor soil health priorities leading to situations where a favourable silvicultural practice may actually be detrimental to soil health and productivity. The soil being an important component of the forest ecosystem, if ignored or mis-managed, may affect the sustainability of the forest ecosystem.

Importance of Soil Carbon in National Carbon Inventories

Countries that are parties to the United Nations Framework Convention on Climate Change (UNFCCC) are required to periodically report their national greenhouse inventory. Article 3.3 of the Kyoto Protocol provides that:

'GHG emissions by sources and removal by sinks associated with those actvities shall be reported in a transparent and verifiable manner and reviewed in accordance with Article 7 and 8'.

Carbon inventory is a process of estimating changes in the stocks (emission and removals) of carbon in soil and biomass periodically for various reasons (Ravindranath and Ostwald, 2008). In order to render a comprehensive report, therefore, it is necessary to estimate and value all carbon sink and sources in the terrestrial and other sectors (which includes the forest soil).

Malaysia had so far rendered two carbon inventory reports (national communcations to the UNFCCC) so far in 2000 and in 2009 (Ministry of Natural Resources and Environment, 2011). However, the carbon inventory rendered in the two submissions reported only the carbon in the above ground biomass while ignoring the soil component. Ignoring the estimated 40% of the carbon stock contributed by the soil means that the reports have under estimated and devalued the country's actual carbon contribution to the World. This underscores the importance of soil carbon assessment and valuation, alongside the above ground component, in terrestrial ecosystems such as forestry.

Economic benefits of the forest ecosystem

Malaysia has 57% of its land mass still covered with forest as at 2007 (Thang, 2007). The forestry sector has therefore been a major pillar in the country's economic growth. Some of these benefits include: foreign exchange earnings, employment, ecotourism and recreation, regional development, NTFPs, medicinal plants, water supply and carbon sequestration among others (Awang Noor, 2010; 2008).

Table 2: Economic values of some forest goods and services in Malaysia

S/N	Forest Resource	Economic Value
1	Timber Stumpage value-Dipterocarp Forest	4,200-42,000/ha
2	Mangrove Forest	187,-9,086/ha
3	Plantation	3,378/ha
4	Peat swamp forest	1,722-15,765/ha
5	Rattan	942.52/ha
6	Bamboo	471.39-155,099/ha
7	Wild fruits	892/ha
8	Medicinal plants	4,832
9	Watershed protection	128,841,265
10	Protected Areas	WTP 62-120/visitor/trip
11	Wildlife	Milky stork-246,000 per bird
12	Carbon benefits	500 million (1989)

Source: Awang Noor (2008)

2.0 VALUATION OF ENVIRONMENTAL GOODS AND SERVICES

Environmental valuation is the process of assigning monetary values on environmental goods and services (EGS), many of which have no easily observed market prices. Many EGS are considered public goods with positive externalities (Cornes and Sandler, 1996). Valuation helps in assigning monetary values to EGS with non-existent market prices.

Various valuation approaches and techniques on assigning monetary values to EGS have been developed by environmental economists over the years (Pearce, 1993; McNally and Shahwahid, 2002). Economic valuation of environmental goods and services is important for ensuring evidence-based policy decisions. It gives forest managers and policy makers options for alternative course of actions (in conservation or utilisation of forest goods and services). Valuation is also one of the best ways ensuring efficient allocation of scarce public resources for conservation (Awang Noor, 2010). There are various approaches and techniques used in valuing environmental goods and services.

In situations where the EGS have existing market prices as in the case of timber and edible forest products, for instance, the respective market prices can simply be taken as proxies to their economic values. In such instances, the economic values are normally the difference between the market price and the cost of production (including entrepreneurial risks and profits) (McNally and Shahwahid, 2002:25). Examples of techniques based on the market price approach include the residual and shadow price methods.

Table 3 below provides a summary of these approaches based on a review by McNally and Shahwahid (2002).

Table 3: Valuation Approaches and Techniques

S/N	Approach	Technique/Method
1	Market price-based	Residual method, Shadow price method
2	Revealed preference (Surrogate market-based) approach	Hedonic pricing method, travel cost method, Change in productivity approach
3	Stated preference	Contingent valuation method, Choice modelling technique
4	Cost-based	Damage cost avoidance method, replacement cost method
5	Benefit transfer	
6	Participatory Appraisal Techniques	Semi-structured interviews, Mapping and modelling, Time-line and trends etc

(Based on Mc Nally and Shahwahid, 2003)

However, for EGS without formal markets, the revealed or stated preference approaches could be used. Under the surrogate market or revealed preference approach, the values are deduced from observing consumer expenditure or behaviour in related markets, observing the prices of marketed goods and services or the level of productivity of certain market activities (Bishop, 1999). Examples include Hedonic Pricing Method, Travel Cost Method and Change in Productivity technique etc. Constructed, hypothetical or stated preference approach entails constructing a hypothetical market to derive the values of EGS with no market or surrogate markets. The Contingent Valuation Method is one example of the stated preference approach. (McNally and Shahwahid, 2002). Others include cost-based approaches, which are based on actual or potential cost of avoiding or mitigating the damage caused by losing the EGS. Examples include the preventative technique and the replacement cost technique; damage cost and damage cost avoided methods (McNally and Shahwahid, 2002).

Conceptual basis for economic valuation of EGS:

Economic values of environmental goods and services are hinged on their roles in sustaining human health and well-being. Therefore by measuring the effects of withdrawal of these services to human welfare the economic values can be derived. Economic value of sequestered carbon is based on the role of carbon in climate change regulation, sustainable land management etc.

Most EGS such as carbon sequestrationare considered public goods with positive externalities (also described as non-rival and non-excludable) – meaning that they do not have alternatives and beneficiaries cannot be excluded from enjoying them (Cornes and Sandler, 1996). Positive externalities are uncompensated benefits due to absence of market value and legal means of enforcement (Landell-Mills and Porras, 2002).As a result of these attributes, most environmental goods and services are presumed to have no economic value. This scenario creates disincentives for natural resource owners to conserve or otherwise sustainably manage these resources for the benefit of society.

There are several valuation approaches for estimating the economic value of soil services including soil carbon. The choice of which approach or technique to use will depend however on the research context and the environmental good or service under consideration.

Generally, valuation methods are based on consumer demands as they attempt to elicit consumer’s willingness to pay or willingness to accept for gaining or losing environmental goods and services as the case may be.

Valuation of Soil Environmental Goods and Services

The soil, being an important component of the forest ecosystem, generates a number of ecosystem services that include provision and recycling of nutrients vital for plant growth, flood and erosion control, water purification, substrate for soil organisms and carbon sequestration. However, the soil also generates dis-services if handled improperly. Some of these dis-services include: loss of nutrients, flooding, and carbon emission amongst others.The economic benefits of these services and costs of the dis-services are realised or appreciated through economic valuation. The soil generated ES and EDS have different types of economic values and therefore different techniques are requiredto value them.

Previous research in valuation of soil services were largely focused on determination of the cost of erosion (Ribauch and Young, 1989; Dragovich, 1990; Whitby and Adgers, 1996). The cost estimates are believed to be true reflection of the values of ‘soil quality’ (Harris, et al 2006). However, specific valuation of soil EGS (such as nutrient, water and carbon cycling) are few in the literature (Bateman, 2000), although some studies provided hints of values of some soil ecosystem services as part of global ecosystem services (such as Constanza, 1997; Nunen, 2001 in Harris, et al., 1996).

Considering the fact that, globally, there is more carbon in the soil than in the atmosphere and terrestrial biomass, there is a compelling need for estimating the value of soil carbon stock and sequestration services for proper management of the soil resource and for policy decisions.

The economic value of soil is determined by the benefits it provides to the society. These benefits can be captured in people's willingness to pay for enjoying the soil's EGS. However, some of these benefits are not traded in formal markets because they do not have market prices. Examples include landscape and biodiversity services. The values of these services are difficult to measure due to absence of market prices. To get their values therefore, different types of techniques are used in valuing them depending on the situation (Garrod and Willis, 1999; Pearce et al., 2006; Harris, et al., 2006).

Valuation of Carbon Stock and Sequestration in Forest Soil

Carbon dioxide is a major GHG that damage the global environment. Carbon storage and sequestration in soil therefore benefit the society by reducing the amount of carbon in the atmosphere. The economic value arises from the role of the soil in storing significant quantity of carbon thereby reducing the amount that could be found in the atmosphere. Conversely, the release of carbon held in the soil through mineralization and decomposition as a result of anthropogenic activities such as deforestation increase the atmospheric carbon dioxide exacerbating climatic changes. The resulting damage from climate change causes tremendous economic (cost) losses on individuals and societies. The quantification or valuation of these consequences has therefore become necessary for finding sustainable solution to the underlying causes of the problem.

In estimating the economic value of soil carbon storage and sequestration, a number of methods have been used in different studies found in the literature. The most commonly used methods include: Damage cost approach, the cost of damage avoidance method, market price method, shadow price of carbon, choice modelling and land rental methods. The next section provides an overview of some few studies that have attempted to estimate the economic value of carbon.

The Damage Cost Approach

Carbon storage and sequestration in soil can be valued by using the damage cost approach based on the fact that benefit and cost to the society is tied to the effect of carbon in the soil or in the atmosphere. In this approach, the welfare loss resulting from damage caused by climate change is estimated and considered as the economic value of carbon.

There are two variants to this approach, namely: the enumerative and statistical approach. The enumerative approach (Nordhaus, 1994a; Fankhauser, 1994; Tol, 1995, 2002) use climate impact models and laboratory experiments to ascertain the physical effects of climate change and then assign prices to these effects. Under the statistical approach, variations in prices and expenditures of environmental goods and services over space and time is measured and used in estimating the effects climatic changes on human welfare (Tol, 2009).

The valuation is carried out by determining the marginal damage cost, which is defined as the net present value of incremental damage caused by small increase in CO_2 emission (Tol, 2006).The marginal increase in emission is regarded as equivalent to the damage caused by emission to the environment or society (Jerath, 2012).

The marginal damage cost, is calculated by using a family of models jointly referred to as integrated assessment models (IAMs). These include: MERGE (Model for Estimating the Regional and Global Effects of GHG Policies), IMAGE (Integrated Model to Assess the Greenhouse Effect), CASES (Cost Assessment for Sustainable Energy Systems), FUND (Climate Framework for Uncertainty Negotiation and Distribution Model) and DICE (Dynamic Integrated Climate Economy Model) (Jerath, 2012). These IAMs use socio-economic and geophysical data to assess the different policy options for controlling climate change (Ding et al, 2010). Some estimated values of marginal damage costs obtained using some of these models are provided in Table 4 below.

The cost of damage avoidance method

This approach is based on estimating the opportunity cost of preventing negative impacts of carbon emission on the environment and the society (Dietar and Elasser, 2002). The opportunity cost is the net benefit forgone in order to avoid the negative environmental impact from carbon emission.

The cost of damage avoidance is calculated by determining the marginal abatement cost (MAC). MAC measures welfare benefits drivable from emission trading (Jerath, 2012). Estimates of MAC depend on the type of models and assumptions used. Kuik (2008), using a target emission range of 550-350 ppmv, estimated an 'idealised global MAC' at €13-119/tCO_2 in 2025 to €212/tCO_2 in 2050 with an average of €204/tCO_2 in 2010. Additional examples of MAC estimates are provided in Table four.

Market price method

The economic value of carbon can also be captured in the prevailing market price of carbon in the carbon markets. Carbon prices are set in the various markets based on current demand and supply of carbon credits. The market price of carbon represents the price investors are willing to pay in order to offset one tonne of carbon from the atmosphere (Yee, 2010). The trading takes place in both compliance (regulatory) and voluntary markets. Examples of compliance markets include the clean development mechanism (CDM), joint implementation, the EU ETS, AFOLU, LULUCF, REDD+ each with different types of trading units. Some voluntary markets include the European Climate Exchange (ECX) and the defunct Chicago climate exchange (CCX).

According to the forest trend report (of ecosystem market place), the average price of carbon in 2012 at the compliance (regulatory) market was USD 10.5/ tCO_2e and USD7.7/tCO_2e at the voluntary markets (Peter-Stanley et al., 2013).

Shadow Price of Carbon

Shadow Price of Carbon (SPC) is the price adopted by governments used in policy appraisal and evaluation. It is based on estimates of the life time damage costs associated with green house gas emissions known as social cost of carbon. The SPC is a reflection of climate change commitment goals set by a country's environmental policy. The SPC helps governments to evaluate the cost-effectiveness of their policies that affect the general welfare of the society (Jerath, 2012). The SPC for United Kingdom in 2007 was set at ₤25.5/tCO_2 based on Stern Review (2007) (Price et al., 2007). Although now abolished, the Australian government also instituted a carbon tax of $87/tC ($23/tCO_2) based on the SPC in 2012.

Table 4: Economic values of carbon from different studies

S/N	Cost (Value) of Carbon	Study	Method	Approach
1	$133/tC	(Ding et al., 2010)	Social cost of carbon	Damage cost method
	$50/tC	(Tol, 2005)		
	$28/tC	(Nordhaus, 2007)		
	$9-32.4/tC	(Chiabai, et.al., 2009)		
	$177/tC	(Tol, 2011)		
2	$204/tC	(Kuik et al., 2008	Marginal abatement cost	Damage cost avoidance approach
	$95.2/tC	(Tol, 2006)		
	$125/tC	(Fisher &Nakicenovic et al., 2007)		
3	USD 10.5/ tCO_2e (Compliance Market)	(Peter-Stanley, et al, 2013)	Carbon Price	Market Price
	USD7.7/tCO_2e (Voluntary Market)	(Peter-Stanley, et al. 2013)		
4	$6/t$CO_2$e in 2010	(Jerath, 2012)	REDD+	Market Price
5	GBP25.5/tCO2 (2007 prices)	(Price et al, 2007; in Jerath, 2012)	Shadow price of carbon	Market Price

3.0 IMPERATIVES FOR SOIL CARBON VALUATION IN MALAYSIAN FOREST ECOSYSTEM

Valuation of soil carbon storage and sequestration is necessary in order to meet international commitment by accurately accounting and reporting of GHGs inventory in Malaysia. This will enable the country to get proper recognition and reward for the carbon sequestration services rendered to the World. Including the stock and economic value of soil carbon may likely enhance carbon trading through (either AR/CDM or REDD+ markets) more feasible. Tables five and six below illustrates how a 40% (representing contribution from soil carbon missing from the estimation) increase in forest carbon stock and value will reduce the shortfall in potential carbon payment derivable from two scenarios of reducing forest conversion and increasing forest cover.

Table 5: Comparison of potential revenue from oil palm production and carbon payment with and without soil value included (Modified from Ministry of Natural Resources and Environment, 2011)

Reducing Forest Conversion (%)	Potential revenue from Oil Palm (net opportunity cost in MYR Million)	Potential carbon revenue excluding soil carbon (in Million of MYR estimated at MYR16 per Tonne of CO_2eq)	Deficit (million of MYR)	Potential Carbon Revenue with contribution of soil carbon (millions of MYR	New deficit (with soil carbon included)
1% Scenario	99.3	53.4	45.9	89.0 (60%)	10.3
5% Scenario	496.6	266.9	229.7	444.8 (60%)	51.8

Source: Second Malaysia National Communication to the UNFCC by Ministry of Natural Resources and Environment (2011) as modified in Abdullahi, et al (Forthcoming)

Table 6: Opportunity cost of two scenarios of increasing forest cover compared with potential carbon revenue with and without soil carbon contribution (Modified from Ministry of Natural Resources and Environment, 2011)

Planting rate (ha/yr)	Net opportunity costs (million MYR)	Cost of establishment (million MYR)	Carbon revenue (million MYR)	Deficit (million MYR)	Carbon revenue with soil value included	New deficit with soil carbon value
50,000	3,820	2,500	457.6	5,862.4	762.7	5,557.3
100,000	7,640	5,000	915.2	11,724.8	1,525.3	11,114.7

Source: Second Malaysia National Communication to the UNFCC by Ministry of Natural Resources and Environment (2011) as modified in Abdullahi, et al. (Forthcoming)

Adopting strategies to sequester and store carbon in forest soil will also enhance forest health and productivity thereby making it a win-win scenario for the forest sector in Malaysia.

4.0 CONCLUSION

Forest soils contain up to 40% of the carbon stock in the forest ecosystem in Malaysia Soil carbon plays significant role in climate change mitigation and sustainable land management. The carbon stock and sequestration services of forest soils are grossly under-estimated and under-valued by previous studies thereby downplaying the contribution of Malaysia's forest ecosystem to the World. A number of methods of valuing soil carbon were reviewed. It is highly recommended that future forest carbon studies must also undertake to assess the soil carbon in the forest ecosystems to better represent the actual situation on ground.

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REFERENCES

Abdul Rashid, A. M., Shamsudin, O., Ismail, P., & Fletcher, S. C. (2009).The Role of FRIM in Addressing Climate Change Issues. *Research Pamphlet No. 128*. Forestry Research Institute of Malaysia

Awang Noor Abd. Ghani. (2008). *Economic Valuation of Forest Ecosystem Services in Malaysia.* ASTS Seminar, Penang. 10-14 March 2006.

Awang Noor Abdul Ghani. (2010). *Economic Valuation of Forest Resources: Current Status and the Way Forward.* Prosiding Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan. Kuala Lumpur11-13 November 2009. Pp 2-18

Bateman, I.J. & A. A. Lovett. "Estimating and Valuing the Carbon Sequestered in Softwood and Hardwood Trees, Timber Products and Forest Soils in Wales". *Journal of Environmental Management 60*, 301-323, 2000

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, & M. van den Belt. (1997). *The Value of the World's Ecosystem Services and Natural Capital, Nature 387*, 253-260.

Cornes, R. & T. Sandler. (1996). *The Theory of Externalities, Public Goods and Club Goods* (Second Edition). Cambridge: Cambridge University Press. 590pp.

Chiabai, A., Travisi, C., Ding, H., Markandya, A., & Nunes, P. A. (2009*). Economic Valuation of Forest Ecosystem Services: Methodology and Monetary Estimates*. 11th Annual BIOECON Conference on Economic Instruments to Enhance the Conservation and Sustainable use of Biodiversity.

Dieter, M., & Elsasser, P. (2002). *Quantification and Monetary Valuation of Carbon Storage in the Forests of Germany in the Framework of National Accounting*. (Institute for Economics Working Paper 2002 / 8). Hamburg, Germany: Federal Research Centre for Forestry and Forest Products; University of Hamburg.

Dietz, S., & Fankhauser, S. (2009). Environmental Prices, Uncertainty and Learning. (*Working Paper No. 12*). Centre for Climate Change Economics and Policy.

Ding, H., Dias Nunes, P. A., & Teelucksingh, S. S. (2010). *European Forests and Carbon Sequestration Services: An Economic Assessment of Climate Change Impacts*.

Rochester Dixon, R. K., Brown, S., Houghton, R. A., Solomon, A.M., Trexler, M.C., & Wisniewski, J. (1994). Carbon Pools and Flux of Global Forest Ecosystems. *Science 263*:185–190

Dragovich, D. (1990). `Does Soil Erosion Matter to People in Metropolitan Sydney?'. Australian *Journal of Soil and Water Conservation, 3*(1): 29-32.

Fankhauser, S. (1994). *Valuing Climate Change - The Economics of the Greenhouse*. London: EarthScan.

Garrod, G. & Willis, K. (1999). Economic Valuation of the Environment. Edward Elgar, Cheltenham.

Guo, L. B., & Gifford, R. M. (2002). Soil Carbon Stocks and Land Use Change. *Global Change Biol. 8*, 345–360.Helm, D. 2005 (ed.). Climate-change Policy. OUP, Oxford.

Hope, C. W. (2006). The Marginal Impact of CO^2 from PAGE 2002: An Integrated Assessment Model Incorporating the IPCC's Five Reasons For Concern*. Integrated Assessment Journal, 6*(1), 19-56.

Jerath, Meenakshi. (2012) "An Economic Analysis of Carbon Sequestration and Storage Service by Mangrove Forests in Everglades National Park, Florida" (2012). *FIU Electronic Theses and Dissertations.* Paper 702.http://digitalcommons.fiu.edu/etd/702

Jan.-Feb.Ribaudo, Marc O. & C. Edwin Young, (1989). Estimating the Water Quality Benefits from Soil Erosion Control. *Water Resources Bulletin Vol. 25*, no. 1, 71-78.

Kato, R., Tadaki, Y & Ogawa, H. (1978). Plant Biomass and Growth Increment Studies in Pasoh Forest. *Malayan Nature Journal 30*: 211-224

Kuik, O., Brander, L., & Tol, R. S. J. (2008). *Marginal Abatement Costs of Carbon-Dioxideemissions: A Meta-Analysis*. Economic and Social Research Institute,

Kumari, K. (1995). An Environmental and Economic Assessment of Forest Management Options: A Case Study in Malaysia. *Environment Department, Environmental Economics Paper No. 026*. World Bank. Washington, D.C

Lal, R. (2004b). Soil Carbon Sequestration to Mitigate Climate Change. *Geoderma 123*, 1–22

Landell-Mills, N., Porras, I. (2002). *Silver Bullet or Fool's Gold? A Global Review of Markets for Forest Environmental Services and their Impact on the Poor*. IIED, London

Lasco, R. D., Macdicken, K. G., Pulhin, F. B., Guillermo, I. Q., Sales, R. F. & Cruz. R. V. O. (2006). Carbon Stocks Assessment of a Selectively Logged Dipterocarp Forest and Wood Processing Mill in The Philippines. *J. Trop. For. Sci., 18*: 166-172.

MNRE. (2011). *Malaysia Second National Communication to the UNFCC. Ministry for Natural Resources and Environment (MNRE), Putrajaya, Malaysia*, ISBN: 13-9789834429492, Pages: 115.

Neto, V., N. Ahmad Ainuddin, M.Y. Wong & H.L. Ting.(2012). Contributions of Forest Biomass and Organic Matter to Above and Below Ground Carbon Contents At Ayer Hitam Forest Reserve, Malaysia. *J. Trop. For. Sci., 24*: 217-230.

Nordhaus, W. D. (1994). Expert Opinion on Climate Change. *American Scientist, 82*(1), 45-51.

Nordhaus, W. D. (1994). Managing the Global Commons: The Economics of Climate Change. Cambridge, *MA: MIT Press*.

Nordhaus, W. D. (2006). *Geography and Macroeconomic: New Data and New Findings*. Proceedings of the National Academy of Sciences, USA, 103(10), 3510-3517.doi:10.1073/pnas.0509842103.

Nordhaus, W. D. (2010). Economic Aspects of Global Warming in a Pots-Copenhagen Environment. Proceedings of the National Academy of Sciences, USA, 107(26), 11721-11726. doi:10.1073/pnas.1005985107148

Nordhaus, W. D., & Yang, Z. (1996). RICE: A Regional Dynamic General Equilibrium Model of Optimal Climate-Change Policy. *American Economic Review, 64*(1-2), 195-225.

Nunes, P.A.L.D., J.C.J.M. & van den Bergh. (2001). Economic Valuation of Biodiversity: Sense or Nonsense.*Ecological Economics 39*, no. 2 203-222.

Pearce, David, Atkinson, Giles & Mourato, Susana. (2006). *Cost-Benefit Analysis andthe Environment*. OECD, Paris.

Pearce David W., Cline, W. R., Achanta, A. N., Fankhauser, S., Pachauri, R. K., Tol, R.S. J., & Vellinga, P. (1996). *The Social Costs of Climate Change: Greenhouse Damage and the Benefits of Control*. In J. P. Bruce, H. Lee &E. F. Haites (Eds.), Climate change 1995: Economic and social dimensions- contribution of working group III to the second assessment report of the intergovernmental panel on climate change (pp. 179-224). Cambridge, MA: Cambridge University Press.

Peters-Stanley, M; Gonzalez, G. & Yin, D. (2013). *Covering New Ground: State of the Forest Carbon Markets.* Forest Trend Report by Ecosystem Marketplace. Available: http://www.forest-trends.org/documents/files/SOFCM-full-report.pdf Accessed: 25th September 2014

Post, W. M., & Kwon, K. C. (2000). Soil Carbon Sequestration and Land-Use Change: Processes and Potential. *Global Change Biol. 6*, 317–327.

Price, R., Thornton, S., & Nelson, S. (2007). *The Social Cost of Carbon and the Shadow Price of Carbon: What They Are, and How to Use Them in Economic Appraisal in the UK*. London, U.K.: Economics Group, Department for Environment, Food and Rural Affairs.

Ribaudo, M. O., D. Colacicco, A. Barbarika & C. E. Young. (1989). The Economic Efficiency of Voluntary Soil Conservation Programs. *Journal of Soil and Water Conservation*.

Roslan, Ismail. (1995). An Economic Evaluation of Carbon Emission and Carbon Sequestration for the Forestry Sector in Malaysia. *Biomass and Bioenergy 8*(5): 281-292.

Saner, P., Y.Y. Loh, R.C. Ong & A. Hector, 2012. Carbon Stocks and Fluxes in Tropical Lowland Dipterocarp Rainforests in Sabah, Malaysian Borneo. *PloS One, Vol. 7*

Shamsudin, I., Ismail, P., & Samsudin, M. (2009). Introductory Chapter in Abdul Rashid, A. M., Shamsudin, O., Ismail, P., & Fletcher, S. C. (2009). The Role of FRIM in Addressing Climate Change Issues. *Research Pamphlet No. 128*. Forestry Research Institute of Malaysia

Shamsudin, O.; Ismail, P.; Fletcher, S.C (2009) The Role of FRIM in Addressing Climate Change Issues. Research Pamphlet No. 128. Forestry Research Institute of Malaysia. Abd Rahman, K. and Philip, E. (2009) Past, Current and Future R&D on Climate Change. Pp 73-100 in Abdul Rashid, A.M; Shamsudin, O.; Ismail, P.; Fletcher, S.C (2009) The Role of FRIM in Addressing Climate Change Issues. *Research Pamphlet No. 128*. Forestry Research Institute of Malaysia

Stockmann, U; Adams, M.; Crawford, J.W; Field, D.J; Henakaarchchia, N.; Jenkins, M.; Minasnya, B.; McBratneya, A.B.; de Courcelles, V.D.; Singha, K.; Wheeler, I.; Abbott, L.; Angers, D.A.; Baldock, J; Birde, M.; Brookes, P.C; , Claire Chenug, Julie D. Jastrow, J.D.; Vincent, J.R, wan L.F, Chang, Y.T., Nooriha, M & Davison, G.W.H. (1993). *Malaysian National Conservation Strategy-towards Sustainable Development. Volume 4*: Natural resource Accounting. Economic Planning Unit, Prime Minister's Department, Kuala Lumpur.

Thang, H.C. (2007). An Outlook of the Malaysian Forestry Sector in 2020. Consultancy report to the Asia Pacific Forestry Commission (APFC). *FAO.89 pp*.

Theseira, G.W. (2009). *Adaptation and Mitigation Options*. Pp 36-45 in Abdul Rashid, A.M;

Tol, R. S. J. (2002). New Estimates of the Damage Costs of Climate Change: Part II. Dynamic estimates*. Environmental and Resource Economics, 21*(1)

Tol, R. S. J. (2005). The Marginal Damage Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties. *Energy Policy, 33*, 2064 - 2074. doi:10.1016/j.enpol.2004.04.002

Tol, R. S. J. (2009). The Economic Effects of Climate Change. *The Journal of Economic Perspectives, 23*(2), 29-29-51. doi:10.1257/jep.23.2.29

Tol, R. S. J. (2011). The Social Cost of Carbon. *Annual Review of Resource Economics, 3*(1), 419-443.

Tsang, F., & Burge, P. (2011). Paying for Carbon Emissions Reduction. (No. OP12). Santa Monica, CA: RAND Corporation. Retrieved from http://www.rand.org/pubs/occasional_papers/OP312

Watson, R. T., Noble, I. R., Bolin, B., Ravindranath, N. H., Verardo, D. J., & Dokken, D. J. (2000). *Intergovernmental Panel on Climate Change. Special Report on Land Use, Land-Use Change and Forestry*. Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N.H., Verardo, D.J., and Dokken, D.J (Eds). Cambridge University Press, Cambridge pp.375

Whitby, M & Adger, N. (1996). Natural and Reproducible Capital and the Sustainability of Land Use. *Journal of Agricultural Economics 47*, 50-65.

Yee, S. M. (2010). *REDD and BLUE Carbon: Carbon Payments for Mangrove Conservation. (MAS Marine Biodiversity and Conservation Capstone Project.)*. San Diego, CA: University of California, San Diego.

QUANTIFYING ABOVEGROUND CARBON STOCK OF 30-YEAR-OLD MANGROVE FOREST AND ITS ECONOMIC VALUE

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ABSTRACT

Mangrove forests have been recognised to have potential for inclusion in climate change mitigation strategies such as the Reduced Emissions from Deforestation and Degradation (REDD+) programme. Participation of developing countries in REDD+ will require them to derive robust estimates of forest aboveground biomass (AGB) and subsequently determine carbon storage. Because of the monetary value attached to C stock, there is increased scrutiny of techniques for estimating AGB. Generic equations stratified by ecological zones for estimating AGB exist, but they may not accurately reflect the tree biomass in a specific forest-type. Forest biomass differs significantly among forest groups. Hence, specific volume and allometric equations need to be expanded to other forest types.

In this study, the total AGB of two matured mangrove forests (30 years old) located in Matang Mangrove Forest Reserve is estimated by developing local allometric equations in order to reduce the uncertainty of estimation. Fifteen trees from each location were destructively sampled; comprising trees from three diameter classes after the forest census was carried out. Specific and combined models were then established between observed AGB and D and D^2H. Simulations of uncertainty were also done before these models can be used for calculating total AGB. Sub-samples from each treecomponent were taken and analysed for C content. Other AGBs such as shrubs and dwarf mangroves, litter, dead and downed wood were also sampled and total AGB were determined by summing all the components. Total C stock was then calculated from total AGB and C contents. Economic valuation of C stock was carried out by multiplying total C stock with current market values based on price is equal to USD15 per Mg C and also based on trading price of t CO^2 equivalent in the Carbon Trade Exchange; €5 (€1=MYR4.40).

There were huge differences in tree density for tree with diameter above and below 5cm between both sites. Similar results were also found for dead and downed wood. For litter, there was a slight difference between these two sites. The values of C stock derived from this study were found to be within the range of high C level even though the age of stand is about 30 years old. The economic value of carbon is MYR12,485.66 ha^{-1} and MYR7,475.87 ha^{-1} respectively. This research depicts the vital role of mangrove forest in improving carbon stock. A better understanding of carbon valuation can act as a guideline for policy makers for good management practices and to increase the economic value of mangrove forests.

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1.0 INTRODUCTION

Recently, biomass and carbon sequestration function of forests is of great concern due to the global warming phenomenon, and hence managing forests with a proper system would play a vital role in mitigating global warming in the future. Estimation of biomass in stands provides the basic data for forest ecosystem management. Research on biomass not only focuses on trees, but it also extends to other strata, such as understory vegetation, the litter layer, and soils, which can affect nutrient cycling (André and Ponette, 2003; Huet et al., 2004; Le Goff et al., 2004; Ponette et al., 2001). From this, scientists can estimate the total of carbon pool from different land cover types. Previous studies had estimated the carbon stored in forests on local and large scales within a single continent, but no systematic way of looking at all tropical forests existed. Scientists typically use a ground-based technique (tree census) to measure the size of the trees, which gives a good estimate of how much carbon they contain.

The estimation of the carbon storage or stocks mostly comes from the biomass estimation of the forests by using allometric equations both for above ground and below ground biomass. Some generic equations stratified by ecological zones for estimating aboveground biomass exist (e.g. Brown et al., 1989; Brown and Iverson, 1992; Brown et al., 1997; Chave et al., 2005), but they may not accurately reflect the tree biomass in a specific forest-type or region (Chave et al., 2009; Kenzo et al., 2009; Segura and Kanninen, 2005). Hence, it is better to develop specific equations due to the fact that measurement accuracy is crucial to ensure that volume, biomass and carbon stocks are not over or under-estimated and payments for carbon are made appropriately.

The carbon numbers, along with information about the uncertainty of the measurements, are important for countries planning to participate in the Reducing Emissions from Deforestation and Degradation (REDD+) program. REDD+ is an international effort to create a financial value for the carbon stored in forests including mangrove forest. It offers incentives for countries to preserve their forestland in the interest of reducing carbon emissions and investing in low-carbon paths of development.

From the total ecosystem carbon pools (above ground and below ground), mangrove carbon pools are the highest of any other major land cover types. Ecosystem carbon pools of mangrove in Indo-Pacific region are more than double those of most upland tropical and temperate forests (Donato et al., 2012; Kauffman et al., 2011; Laffoley and Grimsditch, 2009). Mangrove forests are keystone for coastal ecosystems serving numerous environmental services and ecological functions. Mangrove forests are also among the major carbon sinks of the tropics (Bouillon et al., 2008; Cahoon et al., 2003). The published data on biomass production of mangrove forests in Malaysia were done by Gong and Ong (1990) and Putz and Chan (1986) on *Rhizophora apiculata* and by Juliana and Nizam (2004) on *Rhizophora mucronata.* Those studies were carried out in Larut Matang Forest Reserve but none of them include carbon measurement.

Hence, this study was carried out to quantify the aboveground carbon stock by determining the aboveground biomass production and other necromass in mature age of mangrove forests located in Kuala Sepetang and Kuala Trong Forest Reserves as well as valuing the economic potential of the carbon stock. Furthermore, this research is important to demonstrate that these environmental resources are not free and that each carries a value as a marketed product.

2.0 MATERIALS AND METHODS

Study Area

Study areas were identified in two locations, which are in Compartment 37 Pulau Sangga Besar Permanent Forest Reserve and in Compartment 69, Pulau Trong Selatan Permanent Forest Reserve. Both study areas represent mixed mangrove species stands. Since biomass and carbon are being assessed, similar stand age at 30 year-old was selected in order to reduce spatial variability and also to better estimate the carbon stock and value the economic potential.

Plot Setting and Census

Trees

One hectare plot was established at each range of Kuala Sepetang in Pulau Sangga Besar Permanent Forest Reserve and Kuala Trong in Pulau Trong Selatan Permanent Forest Reserve. Stem diameter at breast height (D; 1.3 above grounds or just above the highest stilt root especially *Rhizophora spp.*) and tree height (H) of all trees with diameter > 5cm in the plots were measured to evaluate tree growth characteristics and to estimate the total stand biomass. This is due to the fact that smaller trees often constitute a relatively insignificant proportion of total ecosystem carbon stocks (Cummings et al., 2002; Hughes et al., 2000). However, to maximise sampling efficiency, smaller trees were also measured in smaller nested subplots. Trees that are dead and standing were also measured as for live trees.

Shrubs and Dwarf Mangroves

Small plots include 2-m radius, circle plots were established in a nested plot design. An average of dry mass per seedling/sapling/dwarf/shrubs was utilised to determine their plot-level biomass. About 5 to 10 samples were collected in small plots and oven dried to obtain dry mass. Samples biomass was then calculated as the product of sample density multiplied by average mass.

Dead and Downed Wood

These components can be a significant component of aboveground biomass. A series of a vertical sampling plane (transect) was established to measure this component. Any downed dead woody materials such as detached trunk, branches, prop roots or stem of trees and shrubs that have fallen and lies within 2m of the ground surface were measured using the non-destructive line intersect technique (Waddell, 2002).

Litter

Litter in most biomass studies was destructively sampled through collection from microplots. A common microplot sized 50cm X 50cm was used. The samples were collected and mixed in a bag, and wet weight was determined in the field. The subsamples were extracted and dried to a constant weight in the laboratory. The ratio between the wet and dry mass of the subsample was determined. Whole litter samples were then calculated by multiplying with the ratio value obtained.

Soil

Soil samples were also taken for preliminary assessment of carbon in the laboratory. Carbon assessment of this forest will follow the upland forests, which have limited sampling to the top 30cm even though the best sampling depth for mangrove area is up to 2m. However, the data may provide useful information in mangrove forest management perspective. Basic data on soil properties in both sites are presented in Table 1.

Table 1: Basic soil properties in both study sites

Site	Point	%Clay	%Silt	%Fine Sand	%Coarse Sand	%C	%N
Kuala Sepetang	1	30	31	0.4	2.6	28.64	0.55
	2	28	35	0.4	2.9	26.34	0.60
	3	29	38	0.3	3.1	24.74	0.47
	4	34	32	0.5	2.3	25.44	0.51
	5	32	33	0.3	3.4	21.74	0.51
	6	25	40	0.2	3.7	22.44	0.58
	7	30	38	0.5	2.5	26.24	0.55
	8	22	41	0.3	2.9	26.24	0.59
	9	31	36	0.7	2.1	25.34	0.52
	10	25	43	0.2	3.7	22.94	0.43
	11	23	41	0.3	3.1	22.04	0.47
	12	21	44	0.4	2.2	19.64	0.52
	13	35	39	0.3	2.5	21.34	0.44
	14	31	35	0.6	2.0	22.34	0.48
	15	27	40	0.2	3.9	23.14	0.50
	16	24	42	0.4	2.2	24.64	0.49
	Average	**28**	**38**	**0.4**	**2.8**	**23.94**	**0.51**
Site	**Point**	**%Clay**	**%Silt**	**%Fine Sand**	**%Coarse Sand**	**%C**	**%N**
Kuala Trong	1	33	31	0.3	3.1	14.84	0.62
	2	35	32	0.2	3.3	12.55	0.61
	3	34	31	0.4	3.0	10.12	0.59
	4	37	35	0.4	3.2	12.21	0.55
	5	36	36	0.3	2.8	15.14	0.59
	6	29	38	0.3	3.5	13.49	0.54
	7	38	32	0.4	2.6	14.12	0.62
	8	29	43	0.6	2.4	13.93	0.53
	9	29	39	0.5	2.3	13.42	0.52
	10	27	40	0.5	2.4	14.47	0.51
	11	28	43	0.7	2.2	13.84	0.49
	12	32	37	0.3	3.6	16.74	0.60
	13	30	39	0.4	3.3	13.18	0.53
	14	35	36	0.5	2.8	13.04	0.43
	15	29	43	0.3	2.7	15.54	0.50
	16	25	45	0.4	3.1	17.34	0.52
	Average	**32**	**38**	**0.4**	**2.9**	**13.99**	**0.55**

Above Ground Biomass Allometry

The total above ground biomass was calculated based on allometric equation developed locally. The destructive sampling was carried out based on the optimised sampling technique in order to reduce the number of trees to be felled or to be selected for biomass allometry. Optimising the sampling plan has therefore "saved" us measuring more trees compared to the plan that consisted in selecting trees at random.

An estimate of 30 trees from various species and sizes based on DBH distribution were selected for destructive measurements to formulate allometric equations. Plots are chosen from all class of coverage evenly. After felling a sample tree, height and diameter of stem at 0m 0.3m, 1.3m (DBH), 3.3m (diameter at every 2 meter), and diameter of stem at the joint of the lowest living branch (Db) were measured. Branches and twigs were separated from the stem, and the stem was cut into logs. Each log was numbered properly and weighed using platform balance. The samples from each component as follows; logs: 0-0.3m, 0.3-1.3m, 1.3-3.3m, 3.3-5.3m, and subsequently every 2m length, living branches and twigs, dead branches and twigs, and leaves. After weighing and recording required data in tally sheets, samples were kept inside plastic bags with written labels to help it distinguish from each other for the next processes. Overall, there were five parameters measured in the field for each log (from each sample tree): 1) Diameter and fresh weight for disks at lower, middle and upper in centimeters (cm), 2) Log fresh weight- using weighing balance, in kilograms (kg), 3) Sample fresh weight for each log, in grams (g), 4) Fresh weight for whole living branch and twigs, dead branch and dead twigs, and foliage, all in grams (g), 5) Fresh weight for samples for living branch and twigs, dead branch and twigs, and foliage, collected. Samples collected from each selected trees are: 1) Disks separated from sample tree, 2) Living branch and twigs, 3) Dead branch and twigs and 4) Foliage and were brought back to laboratory and later oven-dried at 75°C to constant weight to calculate dry weight conversions. The total dry weights of each of the components of every tree were then tabulated against its DBH.

All the data obtained from both destructive felling and laboratory were then combined in one tally sheet in order to calculate these parameters: 1) Biomass calculation for sample disks for each destructed trees, and 2) total dry weight for whole living branch and twigs, dead branch and twigs and lastly foliage.

Statistical Analyses

Diameters at breast height (D) and tree height (H) were tested as independent variables. Preliminary analyses of alternative equations were carried out to determine the best equations fit for this study. Then, all regressions were determined using SPSS ver. 12, followed by Sigma Plot for plotting the graphs.

Tree above ground biomass was estimated by summing the data obtained from the calculation of each biomass component and total component using the equations derived from the allometric relationship either by using diameter or both diameter and height data as presented below:

Total aboveground biomass:

$$Y \text{ or } W = a(D)^b \text{ or } a(D^2H)^b \qquad (1)$$

where a (intercept) and b (slope) are the regression constants, D is the diameter at breast height, and H is the total height.

$$W_{total} = W_{leaf} + W_{branches} + W_{stem/trunk} \quad (2)$$

Carbon Stock Quantification and Economic Valuation

Total carbon content was determined in dried sediments and total organic carbon was determined in dried and acidified sediments using a LECO CR-412 Carbon Analyzer. Sediment was combusted in an oxygen atmosphere and any carbon present was converted to CO_2. The sample gas flows into a non-dispersive infrared (NDIR) detection cell. The NDIR measures the mass of CO_2 present. The mass was then converted to percent carbon based on the dry sample weight. The total organic carbon content was subtracted from the total carbon content to determine the total inorganic carbon content of a given sample.

Instrument-LECO CR-412 Carbon Analyser

The LECO CR-412 Carbon Analyzer was calibrated prior to the analysis of samples. Different amounts of high purity calcium carbonate standard (99.95% purity, carbon content of 12.0%) were used to calibrate the instrument. The approximate amounts of calcium carbonate used for the six-point calibration are; 0.01g, 0.05g, 0.10g, 0.25g and 0.50g. An empty carbon-free combustion boat was analysed as a blank for the calibration curve. The calibration curve provides an analysis range of approximately 0.0 to 0.06g total carbon. Each calibration standard must fall within 3% of the known percent carbon value to meet acceptance criteria. A continuing calibration check standard (mid-level standard) was analysed every ten samples and must be within 5% of the known value of the standard.

Step of Analysis

Total carbon was analysed by placing approximately 0.35g of dried, ground and homogenized sample into a clean, carbon-free combustion boat. Once the sample is ready, it is placed on the auto-sampler rack assembly and loaded onto the LECO carbon analyser.

Calibration Verification

The calibration verification standard, also called the QC check standard, was run with each analytical batch and contains ~0.6 – 0.7g of BBOT *(2,5 –BIS (5-ter-butyl – 2 benzo-oxazol-2-yl thiophene*). To analyse for precision on this system, a standard (sulfamethazine, sulfanilamide, BBOT, or aspartic acid) was run in duplicate or triplicate and the standard deviation of the results calculated for each element:

$$s.d. = SQR\ [(x1 – xm)2 + (x2 – xm)2 + (x3 – xm)2] / (n – 1),$$

where;

*x*m = average of results and *n* = number of data points.

Calculation

Treated samples result calculation:

Result (% Carbon) = Sample Result (% Carbon) x Correction Factor

where;

$$\text{Correction factor} = \frac{\text{Final weight of crucible and soil} - \text{Weight of crucible}}{\text{Initial weight of crucible and soil} - \text{Weight of crucible}}$$

Relative Percent Difference (RPD) for Duplicate:

$$\text{RPD (\%)} = \frac{\text{Sample Result} - \text{Duplicate Result}}{\left[\frac{\text{Sample Result} - \text{Duplicate Result}}{2}\right]} \times 100$$

Percent Recovery for Matrix Spike:

$$\text{Matrix Spike Recovery (\%)} = \frac{\text{\% Carbon Found}}{\text{Calculated \% Carbon}} \times 100$$

$$\text{Calculated \%Carbon} = \frac{(\text{Weight of Sample} \times \text{\% Carbon}) + (\text{Weight of Spike} \times \text{\% Carbon})}{\text{Total weight}}$$

Spike sample analysis (or known addition) was used to test the method at varying concentrations of analyte. Known amounts of analyte are added to a sample and the percent recovery is calculated. If interferences are present in the sample, results may be obtained which are significantly higher or lower than the actual concentration. The percent recovery is calculated by dividing the sample result by the expected result as follows:

Expected spike result = sample result + standard concentration

Finally, the total carbon content was then calculated by multiplying the carbon values from each aboveground component with biomass values, and the total above ground carbon stock was then determined by summing all the aboveground carbon pools.

The quantified carbon from protocol mentioned above was used for valuing the economic for carbon in this area by using current market value discussed before.

3.0 RESULTS AND DISCUSSION

Tree census above than 5 cm diameter

Table 2 shows the descriptive statistics of tree inventory carried out in Kuala Sepatang and Kuala Trong for trees with diameter above than 5cm. The diameter measurement was taken at 1.3m above the ground (DBH) or 30cm above the highest stilt roots. The total of five species were found in both study plots with only one individual of *Xylocarpus moluccensis* was found in Kuala Trong study plot. The total number of trees (stems) in both study plots were 1802 and 1084 respectively. The data of the total trees were also comprised multiple leader stems counted at 1.3 m height. *Rhizophora apiculata* species was found to dominate the area with the total number of trees were 1073 and 1072 in Kuala Sepetang and Kuala Trong plots respectively.

Table 2: Summary of descriptive statistic for both study areas for trees above than 5 cm DBH.

Species	DBH (cm)	Height (m)	DBH (cm)		Height (m)		Count	
			Min	Max	Min	Max	DBH	Height
KUALA SEPETANG								
Bruguiera gymnorrhiza	11.95±0.88	8.57±0.52	6	20	4	14.1	26	26
Bruguiera parviflora	7.73±0.16	7.38±0.09	3.6	28.9	3	20.84	544	544
Rhizophora apiculata	14.90±0.15	11.25±0.09	4.1	28.6	2	21.77	1073	1073
Rhizophora mucronata	16.28±0.28	12.28±0.24	5.8	30.9	2	23.85	159	159
KUALA TRONG								
Bruguiera gymnorrhiza	8.80±1.27	8.45±1.00	5.3	16.2	5	13	11	11
Rhizophora apiculata	18.43±0.19	12.81±0.09	5	35.3	2	24.8	1072	1072
Xylocarpus moluccensis	5.2	4.5					1	1

Note: 1. ± represents standard error.
2. the minimum value for *Bruguiera parviflora* and *Rhizophora apiculata* below than 5 cm diameter due to the data taken from multiple leader trees.

The mean values of DBH and height of mangrove trees in Kuala Sepetang plot ranged from 7.73cm to 16.28cm and 7.38m to 12.28m. Meanwhile, these mean values ranged from 5.2cm to 18.43cm and 4.5m to 12.81m in Kuala Trong plot. However, the minimum values given in Table 2 were found below than 5cm for *Bruguiera parviflora* and *Rhizophora apiculata* species. These were due to the measurement taken for stem with multiple leader growth habit.

The histograms of DBH and height are shown in Figure 1. Higher skewness value was recorded in Kuala Sepetang compared to Kuala Trong indicating that higher number of DBH distributed towards lower values. Similar patterns were also recorded for height. This finding is parallel with the results observed for stand density which is Kuala Sepetang plot is higher than Kuala Trong plot.

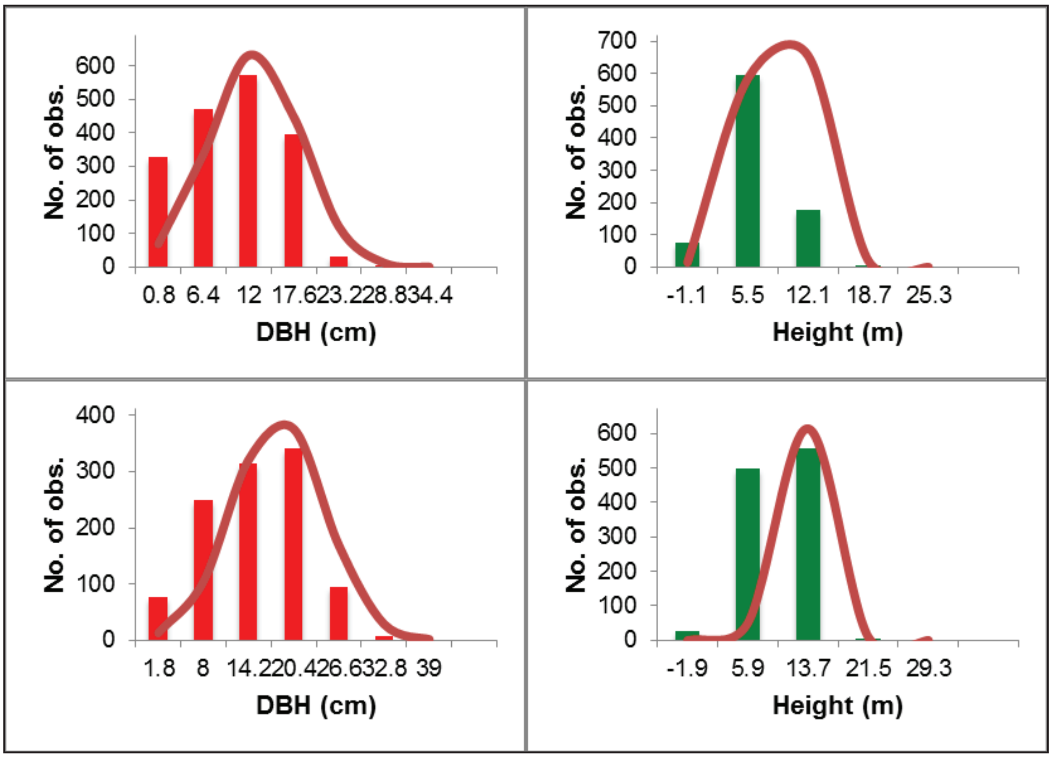

Figure 1: Histogram of DBH and Height in 1 ha plot in Kuala Sepetang (top) and Kuala Trong (bottom)

Tree census below than 5cm diameter

Sixteen subplots with the total area sized 200.96m^2 were established in 1 ha study plot in both Kuala Sepetang and Kuala Trong areas for measuring shrubs, dwarf mangroves including sapling and seedling with sized below than 5cm diameter. These subplots were separated about 25m each other from the radius center. The results were summarised in Table 3. In contrast with trees with diameter above 5cm, the majority of trees below than 5cm were dominated by *Bruguiera parvifolia*, followed by *Rhizophora apiculata*, *Rhizophora mucronata* and *Bruguiera gymnorrhiza* in Compartment 37, Kuala Sepetang with total of 237 individuals. Meanwhile, only 22 individuals from two species were found in 200.96m^2 area of subplot established in Kuala Trong.

From the results, an estimate about 11,793 and 1,095 of individuals comprising majority sapling and seedling found in a hectare area in both Kuala Sepetang and Kuala Trong plots. This huge difference in the number of individual between these two areas might be due to the tree density factor. Kuala Sepetang plot was more dense with 1,802 trees (stems) compared to Kuala Trong with 1,084 trees (stems).

Table 3: Summary of descriptive statistic for both study areas for trees below than 5 cm diameter in 16 two-meter-radius subplots.

Species	Diam (cm)	Height (m)	Diam (cm)		Height (m)		Count	
			Min	Max	Min	Max	Diam	Height
KUALA SEPETANG								
Bruguiera gymnorrhiza	2.13±0.14	2.69±0.37	0.5	4.1	0.5	11	39	39
Bruguiera parviflora	2.54±0.11	4.58±0.23	0.3	4.8	0.5	12	103	103
Rhizophora apiculata	1.76±0.09	2.46±0.21	0.3	4.1	0.8	8	54	54
Rhizophora mucronata	2.53±0.11	3.11±0.19	1.1	4.5	0.7	5.1	40	40
Xylocarpus granatum	3.9	4.2					1	1
KUALA TRONG								
Bruguiera gymnorrhiza	0.3	0.3					1	1
Rhizophora apiculata	0.61±0.18	0.64±0.17	0.2	2.8	0.15	3	21	21

Stand Biomass Production

Biomass Proportion

Table 4 shows the biomass values measured destructively in both sites. Total aboveground biomass for selected trees (N=30) ranged from 23.37 kg to 523.98 kg and 11.95 kg to 1069.94 kg in Kuala Sepetang and Kuala Trong sampling plots respectively. The biomass storage in different tree components of mixed mangrove species calculated from destructive sampling measurement from both sites was shown in Figure 2. The proportion of stem and branch biomass were found higher in Kuala Trong compared to Kuala Sepetang except for leaf biomass. The values contributed to the total above ground biomass in the order of stem>branch>leaf.

Table 4: Biomass values for each tree component and total above ground measured in both sites (N=30)

No	Species	Height (m)	DBH (cm)	Stem Biomass (kg)	Branch Biomass (kg)	Leaf Biomass (kg)	Total Aboveground Biomass (kg)
Kuala Sepetang							
1	*RM*	13.2	10.1	47.69	5.99	1.67	55.35
2	*RM*	15.3	12	71.93	6.10	2.99	81.02
3	*BP*	10.2	6.4	22.6	1.68	0.59	24.87
4	*RA*	9.2	6.8	17.51	4.20	1.65	23.37
5	*RA*	11.5	7.9	31.77	6.50	1.75	40.02
6	*RM*	9.65	6.6	24.76	1.66	1.18	27.60
7	*RA*	17.1	12.8	104.02	10.35	3.93	118.30
8	*RA*	19.52	15.8	150.61	25.87	14.45	190.93
9	*RA*	20	17.3	190.56	31.03	17.01	238.60
10	*BP*	16.8	16.2	143.67	33.03	12.45	189.15
11	*RM*	18.1	16.8	146.26	25.61	6.24	178.11
12	*RA*	19.9	20.2	281.79	55.03	21.23	358.04
13	*RA*	22.7	22	381.59	105.00	36.09	522.68
14	*RA*	24.3	21	319.89	76.88	28.35	425.12
15	*RA*	24.2	23.5	432.06	75.60	16.32	523.98

Note: *RA - Rhizophora apiculata, RM - Rhizophora mucronata, BP - Bruguirea parviflora*

Table 4: Biomass values for each tree component and total above ground measured in both sites (N=30) (cont')

No	Species	Height (m)	DBH (cm)	Stem Biomass (kg)	Branch Biomass (kg)	Leaf Biomass (kg)	Total Aboveground Biomass (kg)
Kuala Trong							
1	*RA*	25.6	22.3	238.62	41.44	2.59	282.65
2	*RA*	24.6	18.1	184.8	34.41	1.03	35.44
3	*RA*	26.3	20.1	261.97	35.37	3.43	300.77
4	*RA*	6.65	5.1	6.64	3.34	1.96	11.95
5	*RA*	25.8	27.1	505.7	146.34	26.79	678.83
6	*RA*	12.4	8.4	27.3	10.08	3.74	41.13
7	*RA*	25.45	17.6	204.02	19.27	1.19	224.48
8	*RA*	27.4	19.3	274.05	25.88	3.43	303.36
9	*RA*	22.1	16.9	169.06	24.30	3.20	196.56
10	*BP*	12.7	9.2	38.89	6.95	3.50	49.34
11	*BP*	16.7	10	59.76	6.71	3.51	69.98
12	*RA*	29.3	35	785.14	240.61	44.19	1069.94
13	*RA*	19.85	14.5	147.35	17.15	5.84	170.34
14	*RA*	18.75	10.5	80.52	11.52	3.63	95.67
15	*RA*	29.3	24	463.89	70.16	9.28	543.33

Note: *RA - Rhizophora apiculata, RM - Rhizophora mucronata, BP - Bruguirea parviflora*

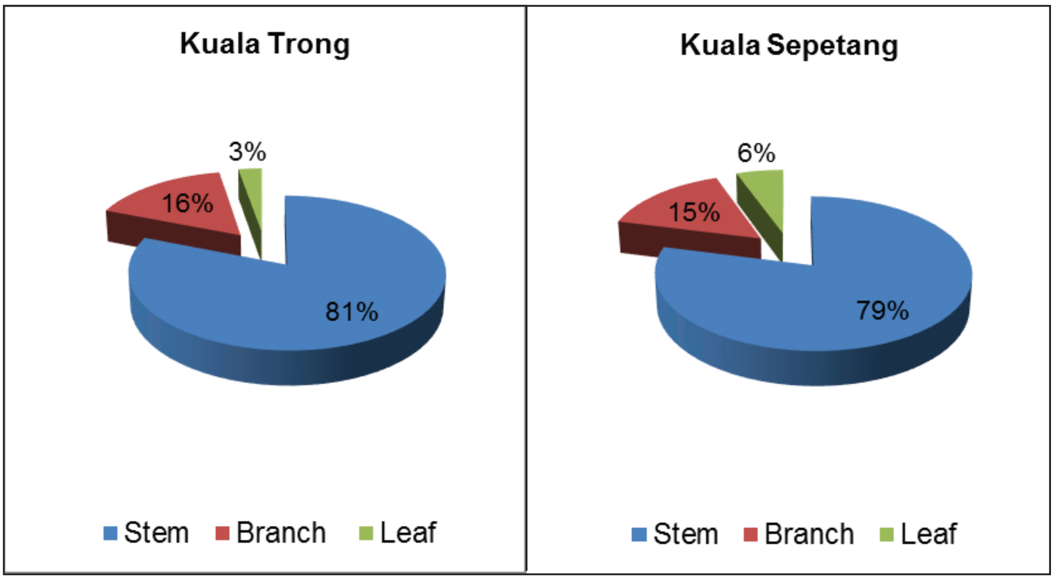

Figure 2: Biomass proportion calculated in both sites

Allometric Equations

Allometric equations were derived from analyses of the regression between tree growth parameters and tree biomass components. The relationships between these parameters were illustrated in Figure 3 and 4, and were regressed using power function to fit the values based on two models, i.e. D and D^2H. Coefficient of determination (R^2) ranged between 0.9035 to 0.9862 for model using D and 0.8979 to 0.988 for model using D^2H recorded in Kuala Sepetang. Meanwhile R^2 values ranged between 0.2656 to 0.9862 for model using D and 0.2145 to 0.988 for model using D^2H recorded in Kuala Trong. Lower values of this coefficient were recorded for leaf biomass especially in Kuala Trong showing that stand density plays an important role in biomass allocation. However, each formulation was well fitted and model using D was generally found to be a better model for estimating above ground biomass.

The generic equations combining sampled trees (N=30) in both sites were also developed for better estimation of above ground biomass in Larut Matang area (Figure 5). The highest coefficient of determination (0.9842) was found for model using total above ground biomass and DBH (D).

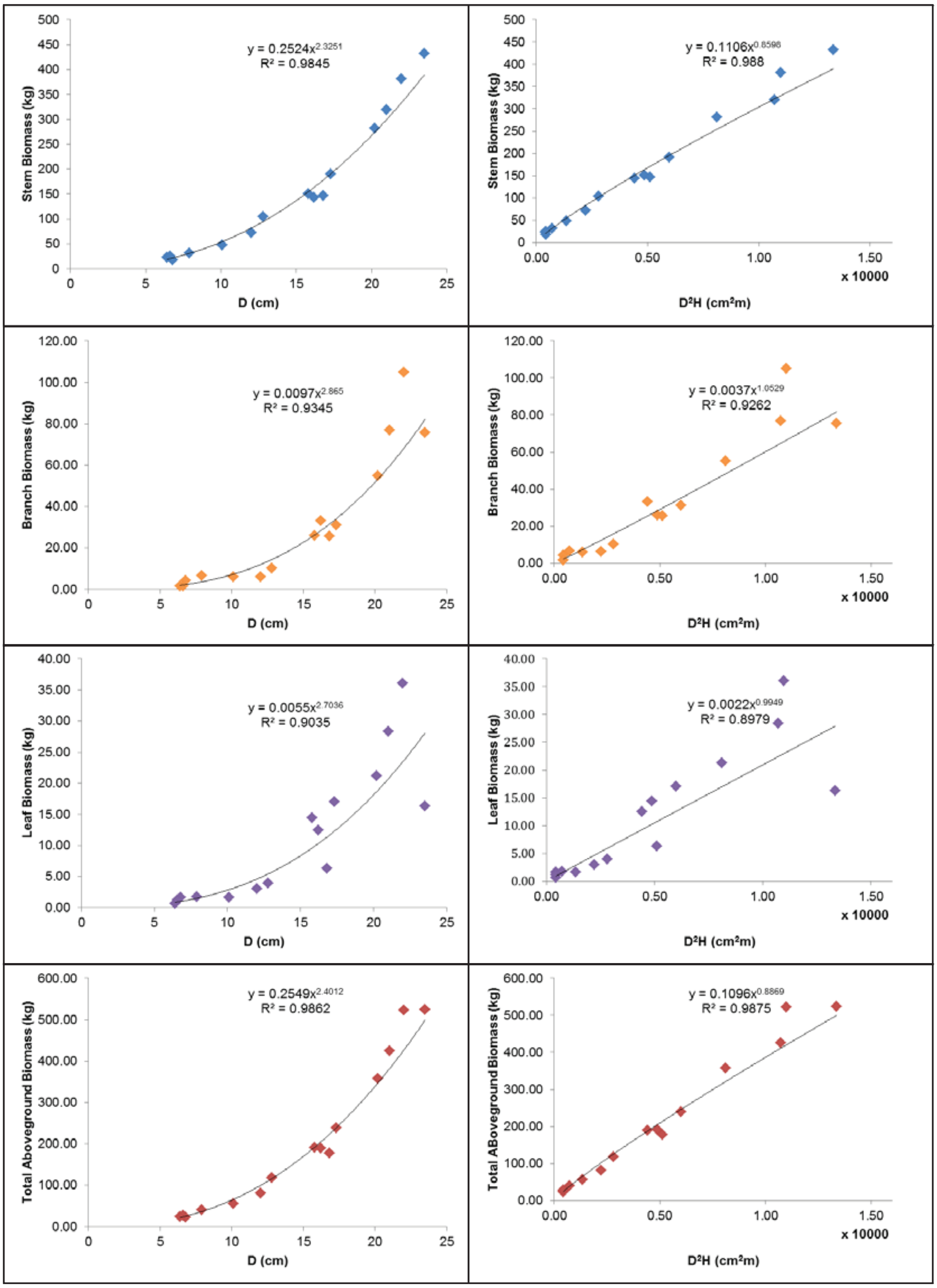

Figure 3: Comparison between using *D* and *D^2H* in determining the biomass equations for different tree components in Kuala Sepetang

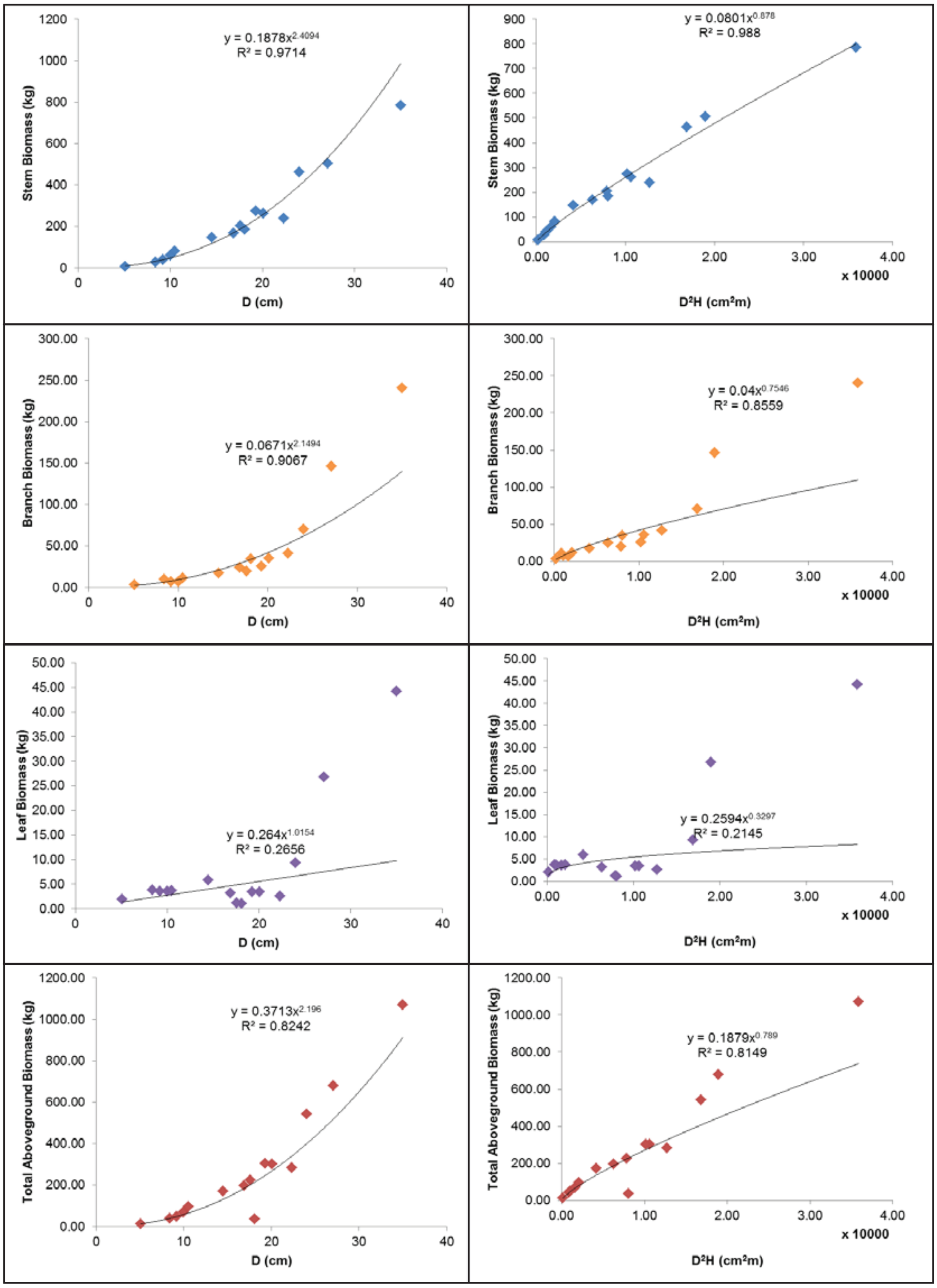

Figure 4: Comparison between using *D* and *D*^{2}*H* in determining the biomass equations for different tree components in Kuala Trong

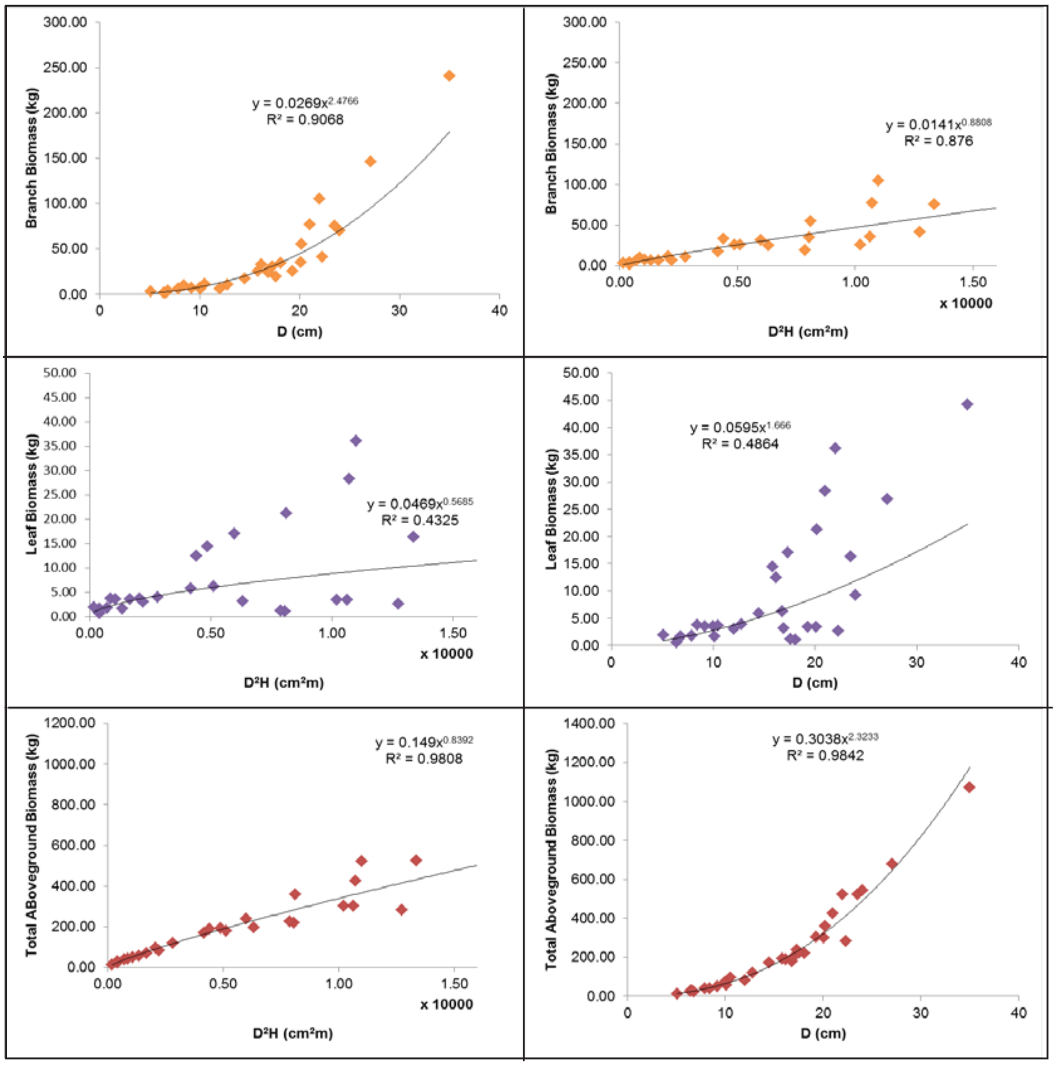

Figure 5: Generic equations derived from combined data of Kuala Sepetang and Kuala Trong

Tree Biomass Production and Tree Carbon Stock

Tree components biomass was calculated from established allometric equations using *D* based on the inventory data (trees >5cm diameter). These values were then summed to determine the total standing above ground biomass (Model A). Total standing above ground biomass was also estimated directly from total allometric equations (Model B) and combined equations (Model C). Total above ground biomass was found higher in Kuala Trong compared to Kuala Sepetang when estimated using tree component equations (Model A) and combined equations (Model C) but the values were about similar when using total above ground equations (Table 5). However, there was no significant difference found between models used for estimating total standing biomass in both sites (Table 6). Moreover, these values were found within the range recorded by Putz and Chan (1986) in Matang as well as Komiyama et al. (1987) in Ranong.

Biomass production was also calculated for trees below than 5cm including seedlings by using average dry mass. A total of 20 samples were selected randomly and the average of dry mass was found at about 1.557 kg tree^{-1}. This value was then multiplied with the number of trees below than 5 cm found in both sites. The results show that the biomass production was found higher in Kuala Sepetang due to the fact that the trees density below than 5cm is higher than Kuala Trong.

Table 5: Tree component and total aboveground biomass production in Kuala Sepetang and Kuala Trong using parameter DBH (*D*)

Component	Kuala Sepetang			Kuala Trong		
	Mass (t ha^{-1})	CC (%)	CS (t ha^{-1})	Mass (t ha^{-1})	CC (%)	CS (t ha^{-1})
Trees > 5cm						
Stem (1)	223.11	55.25	123.27	269.85	53.49	144.34
Branch (2)	40.00	45.29	18.11	43.23	46.23	19.99
Leaf (3)	14.28	46.70	6.67	5.49	45.14	2.48
(A) Total aboveground (1+2+3)	**277.39**	**-**	**148.05**	**318.57**	**-**	**166.81**
(B) Total aboveground	**279.53**	49.08^{a}	**137.19**	**276.13**	48.29^{a}	**133.33**
(C) Total aboveground	**267.18**	48.68^{b}	**130.06**	**334.54**	48.68^{b}	**162.85**
Trees < 5cm	**18.36**	47.21	**8.67**	**1.70**	45.33	**0.77**

Note: Values of (A) calculated from tree component biomass equations (1, 2 and 3), (B) values calculated directly from total aboveground biomass equations (Figure 5 and 6), and (C) values calculated from total aboveground biomass using combined equation. CC – carbon content where ^{a} was an average of CC of (1), (2) and (3), and ^{b} was an average of all CC obtained for all sampled trees, CS – carbon storage. Biomass for trees<5cm was calculated by multiplying the average value (1.557 kg tree^{-1}) of selected samples with number of trees.

Table 6: Summary of analysis of variance (ANOVA) between models

Site	Source of Variation	df	SS	MS	F	P-value
Kuala Sepetang	Model	2	48344.5	24172.25	1.316	0.268
Kuala Trong			6719882	3359941	0.038	0.963

Higher values of carbon content were found for stem component compared to branch and leaf in both study sites (Table 5). These values were calculated from each subsample and averaged from 15 destructed trees for each study site, and were then used for calculating the total above ground carbon stock / density for each site. Higher carbon stock at 166.81 t C ha^{-1} was observed in Kuala Trong site compared to Kuala Sepetang (148.05 t C ha^{-1}) when using tree component biomass separately (Model A) but the value of carbon stock was found slightly higher at 137.19 t C ha^{-1} in Kuala Sepetang compared to Kuala Trong (133.33 t C ha^{-1}) when the total above ground biomass (Model B) was multiplying with the average of carbon content from each component biomass. The values of carbon stock were once again found higher in Kuala Trong (162.85 t C ha^{-1}) compared to Kuala Sepetang (130.06 t C ha^{-1}) when using combined equations (Model C).

Dead and Downed Wood

Table 7 and 8 show the data of dead and downed wood collected in 200.96m^2 of total subplot area (16 subplots) in both study sites. The overall total of dead and downed wood was found higher in Kuala Sepetang plot (8.46 t ha^{-1}) compared to Kuala Trong plot (5.74 t ha^{-1}). These results were found parallel with the results obtained for tree density which were found higher in Kuala Sepetang compared to Kuala Trong. The values of carbon content of dead and downed woody ranged from 43.34% to 49.44% and 43.44% to 49.24% with an average of 46.25% and 46.52% in both sites respectively. These values have made up the carbon storage in dead and downed woody with a total of 4.04 t C ha^{-1} and 2.68 t C ha^{-1}.

Table 7: Total dry weight and carbon storage of dead and downed wood obtained in Compartment 37 Kuala Sepetang

No. of Plot	Dead and downed woody										
	Point				SFW (g)	SDW (g)	TFW (kg)	TDW (kg)	Total (kg ha^{-1})	C content (%)	C Stock (kg ha^{-1})
	A	B	C	D							
1	3.00	2.50	2.00	4.45	170.00	66.80	11.95	4.70	233.66	45.94	107.33
2	1.00	4.25	1.50	2.50	110.00	42.65	9.25	3.59	178.47	45.44	81.09
3	1.50	2.50	1.50	2.75	180.00	82.20	8.25	3.77	187.48	45.24	84.81
4	0.50	60.50	2.00	1.00	210.00	147.05	64.00	44.82	2230.06	49.44	1102.43
5	2.00	51.50	5.65	0.46	160.00	108.80	59.61	40.53	2017.06	48.84	985.03
6	0.29	4.50	2.00	1.16	150.00	36.05	7.95	1.91	95.08	45.54	43.29
7	13.50	0.14	2.60	7.20	140.00	74.45	23.44	12.46	620.14	47.84	296.64
8	5.50	10.00	1.00	12.50	110.00	49.05	29.00	12.93	643.48	46.44	298.80
9	2.00	6.00	5.50	1.00	140.00	90.60	14.50	9.38	466.94	48.24	225.23
10	2.50	2.00	3.00	3.00	190.00	90.75	10.50	5.02	249.56	48.64	121.37
11	3.00	3.70	2.50	3.00	250.00	63.80	12.20	3.11	154.93	44.84	69.46
12	2.00	1.50	2.50	6.00	150.00	39.20	12.00	3.14	156.05	43.94	68.56
13	1.50	2.50	0.45	0.30	110.00	45.45	4.75	1.96	97.66	43.34	42.32
14	10.00	1.00	2.50	0.50	130.00	87.50	14.00	9.42	468.90	47.24	221.48
15	4.00	2.50	3.50	3.50	160.00	75.15	13.50	6.34	315.52	45.04	142.09
16	7.00	5.50	1.00	2.50	140.00	60.30	16.00	6.89	342.93	44.14	151.35
TOTAL								**169.97**	**8457.91**		**4041.30**

Note: TFW-Total fresh weight, TDW-Total dry weight, SFW-Sample fresh weight, SDW-Sample dry weight

Table 8: Total dry weight and carbon storage of dead and downed wood obtained in Compartment 69 Kuala Trong

No. of Plot	Dead and downed woody										
	Point				SFW (g)	SDW (g)	TFW (kg)	TDW (kg)	Total (kg ha^{-1})	C content (%)	C Stock (kg ha^{-1})
	A	B	C	D							
1	1.50	1.00	4.00	2.50	110.00	63.70	9.00	5.21	259.35	47.34	122.76
2	2.00	4.50	0.50	7.00	140.00	74.15	14.00	7.42	368.98	49.24	181.67
3	9.50	6.00	2.50	0.19	190.00	70.85	18.19	6.78	337.53	45.34	153.02
4	2.50	3.00	1.50	1.00	150.00	73.25	8.00	3.91	194.40	46.64	90.66
5	5.00	2.50	3.50	8.00	140.00	73.45	19.00	9.97	496.03	47.44	235.29
6	5.00	2.00	2.50	6.50	150.00	60.80	16.00	6.49	322.72	47.04	151.79
7	3.00	5.00	2.00	3.50	210.00	79.25	13.50	5.09	253.52	46.74	118.48
8	3.50	6.00	3.50	7.00	120.00	37.50	20.00	6.25	311.01	47.54	147.84
9	3.50	10.00	3.00	18.00	160.00	86.90	34.50	18.74	932.42	44.74	417.12
10	1.50	0.50	0.00	5.00	150.00	58.40	7.00	2.73	135.62	45.84	62.16
11	4.00	5.00	3.50	4.00	150.00	64.05	16.50	7.05	350.59	45.94	161.04
12	6.00	8.00	16.0 0	0.50	160.00	62.25	30.50	11.87	590.49	47.64	281.28
13	2.50	1.00	0.00	0.00	150.00	30.30	3.50	0.71	35.18	43.44	15.28
14	3.50	5.00	7.00	4.50	150.00	65.05	20.00	8.67	431.60	45.64	196.96
15	3.00	7.00	5.00	5.50	150.00	80.95	20.50	11.06	550.52	48.24	265.54
16	3.50	0.30	3.00	1.50	150.00	62.45	8.30	3.46	171.95	45.64	78.47
							TOTAL		**5741.88**		**2679.37**

Note: TFW-Total fresh weight, TDW-Total dry weight, SFW-Sample fresh weight, SDW-Sample dry weight

Litter

Table 9 and 10 show the data of litter collected in 200.96m^2 of total subplot area (16 subplots) in both study sites. Total dry weight per hectare for each subplot ranged from 8.96 kg to 63.07 kg and 21.80 kg to 56.22 kg in Kuala Sepetang and Kuala Trong plots respectively. The overall total of dry weight was found slightly higher in Kuala Trong (0.57 t ha^{-1}) compared to Kuala Sepetang (0.5 t ha^{-1}). For carbon content, the values were found ranging from 34.74% to 48.04% in Kuala Sepetang plot and 40.04% to 47.54% in Kuala Trong. The total carbon stocks for litter were 0.21 t C ha^{-1} and 0.26 t C ha^{-1} in both sites respectively.

Table 9: Total dry weight and carbon storage of litter obtained in Compartment 37 Kuala Sepetang

No. of Plot	Litter										
	Point				SFW (g)	SDW (g)	TFW (kg)	TDW (kg)	Total (kg ha^{-1})	C content (%)	C Stock (kg ha^{-1})
	A	B	C	D							
1	0.50	1.00	0.71	1.00	135.00	51.00	3.21	1.21	60.34	35.44	21.38
2	1.00	0.70	0.66	0.71	100.00	33.90	3.07	1.04	51.79	34.74	17.99
3	0.40	0.25	0.53	0.60	110.00	46.90	1.78	0.76	37.77	38.14	14.40
4	0.75	0.34	0.26	0.70	120.00	53.65	2.05	0.92	45.61	41.14	18.76
5	0.82	0.35	0.74	0.37	150.00	46.10	2.28	0.70	34.87	35.94	12.53
6	0.68	1.16	0.81	0.62	105.00	40.70	3.27	1.27	63.07	48.04	30.30
7	0.45	0.40	0.37	0.35	190.00	58.55	1.57	0.48	24.07	42.34	10.19
8	0.15	0.30	0.27	0.43	110.00	51.20	1.15	0.54	26.64	37.14	9.89
9	0.43	0.15	0.37	0.23	160.00	53.60	1.18	0.40	19.67	42.94	8.45
10	0.28	0.18	0.20	0.43	110.00	32.20	1.09	0.32	15.88	43.64	6.93
11	0.20	0.50	0.55	0.45	110.00	31.75	1.70	0.49	24.42	45.94	11.22
12	0.23	0.22	0.32	0.37	110.00	29.85	1.14	0.31	15.39	45.04	6.93
13	0.25	0.16	0.22	0.27	180.00	36.00	0.90	0.18	8.96	39.94	3.58
14	0.30	0.42	0.34	0.28	130.00	51.40	1.34	0.53	26.36	47.64	12.56
15	0.45	0.28	0.37	0.32	150.00	49.70	1.42	0.47	23.41	39.34	9.21
16	0.37	0.47	0.27	0.42	140.00	46.10	1.53	0.50	25.07	42.14	10.56
						TOTAL		**10.11**	**503.32**		**204.87**

Note: TFW-Total fresh weight, TDW-Total dry weight, SFW-Sample fresh weight, SDW-Sample dry weight

Table 10: Total dry weight and carbon storage of litter obtained in Compartment 69 Kuala Trong

No. of Plot	Litter										
	Point				SFW (g)	SDW (g)	TFW (kg)	TDW (kg)	Total (kg ha^{-1})	C content (%)	C Stock (kg ha^{-1})
	A	B	C	D							
1	0.87	0.65	0.55	0.72	180.00	38.35	2.79	0.59	29.58	42.84	12.67
2	0.58	0.47	0.69	0.58	140.00	33.95	2.32	0.56	28.00	43.64	12.22
3	0.50	0.44	0.67	0.48	130.00	27.4	2.09	0.44	21.92	40.04	8.78
4	0.57	0.45	0.60	0.53	120.00	26.8	2.15	0.48	23.89	41.94	10.02
5	0.62	0.55	0.58	0.65	120.00	35.1	2.40	0.70	34.93	45.54	15.91
6	0.62	0.52	0.58	0.47	120.00	41.9	2.19	0.76	38.05	46.04	17.52
7	0.54	0.65	0.49	0.62	130.00	43.1	2.30	0.76	37.94	46.44	17.62
8	0.54	0.66	0.67	0.72	130.00	52.45	2.59	1.04	52.00	45.64	23.73
9	0.67	0.72	0.68	0.74	130.00	44.35	2.81	0.96	47.70	46.54	22.20
10	0.74	0.69	0.72	0.82	130.00	49.45	2.97	1.13	56.22	47.14	26.50
11	0.66	0.68	0.69	0.73	120.00	46.6	2.76	1.07	53.33	44.44	23.70
12	0.59	0.56	0.44	0.33	140.00	40.45	1.92	0.55	27.60	46.64	12.87
13	0.74	0.42	0.28	0.22	150.00	41.9	1.66	0.46	23.07	45.14	10.41
14	0.64	0.58	0.49	0.67	160.00	29.45	2.38	0.44	21.80	46.64	10.17
15	0.64	0.54	0.66	0.74	140.00	48.4	2.58	0.89	44.38	47.54	21.10
16	0.72	0.67	0.58	0.69	170.00	42.4	2.66	0.66	33.01	45.34	14.97
						TOTAL		**11.52**	**573.44**		**260.36**

Note: TFW-Total fresh weight, TDW-Total dry weight, SFW-Sample fresh weight, SDW-Sample dry weight

Total Above Ground Carbon

The total above ground carbon comprising each above ground component where values from Model C were used for standing biomass is shown in Table 11. The total mean value is 154.78 t C ha^{-1} and it is within the range values reported by Donato et al. (2012) for islands in Micronesia.

Table 11: Total aboveground carbon stock in both sites

Component	Kuala Sepetang	Kuala Trong	Mean
	CS (t C ha^{-1})	CS (t C ha^{-1})	CS (t C ha^{-1})
Trees > 5 cm	130.06	162.85	**146.46**
Trees < 5 cm	8.67	0.77	**4.72**
Dead and downed woody	4.04	2.68	**3.36**
Litter	0.21	0.26	**0.24**
		TOTAL	**154.78**

Note: Value of trees > 5 cm were taken from Model C (see Table 5).

Estimated Economic Value of Carbon

Importance of Valuation

Tropical forests in the form of mangrove forests, offer numerous benefits to society. The benefits drawn from mangrove forests can be directly or indirectly attained. Mangrove forests can act as important carbon sinks by storing carbon over extensive periods of time. As carbon sinks, it plays an important role in reducing climate change by taking carbon dioxide (CO_2) out of the atmosphere. It also ensures the continuous flow of ecosystem services by maintaining water quality and acting as natural buffer zones from strong currents.

Although forests provide various benefits to society (which may include carbon sequestration, mitigating climate change, recreational opportunities, and beautiful landscapes), the monetary value these resources are not economically evaluated. According to Daily et al. (2000), the economic evaluation for environmental resources is controversial, however, if this value is not estimated, it is considered as free in economic markets. For this reason, and also to overcome the problem of undervalued resources, valuation is important.

Valuation is important for pricing decisions and leads to increased efficiency in budget allocations, especially in weighing benefits and costs. The economic value of carbon is important to policy makers, especially for future planning, which requires policy makers to take into account the value of these resources and also the effects of policy deliberations. Since conflict exists in the usage of mangrove forests - between the utilisation of the mangrove forests for products (e.g. charcoal) and the conservation of mangrove forest, economic valuation of carbon can highlight their importance and guide government authority towards the appropriate conservation mechanisms. In addition, some of these products and services are critical for economic activities and also for the survival of the human kind.

Carbon Valuation

As discussed before, there are few techniques to value carbon including social value and market value of carbon. The selection of a single carbon valuation technique is a daunting task for any researcher while it is also reported that the value of carbon are varies from region also from country to country.

Suren et al. (2000) estimated the average value of carbon based on the replacement and substitute cost method. They found that the cost of carbon was \$17.50 per tonne using the replacement cost method. Meanwhile, cost using the substitute method is \$16.25 per tonne. Using the total carbon stored of 488 Mt C, economic value of stored carbon in Saskatchewan, Canada is equal to \$8,540 (Mill \$) and \$7,930 (Mill \$). In this study, two estimation of carbon value were used. The first estimation is based on studies by Tschakert (2002); estimated the price of carbon is equal to \$15 per Mg C. This study applied the price of carbon \$15 per Mg C and it is based on the scenarios in Southeast Asian countries with the same socio-economics condition. The second estimation uses the current price of carbon based on the trading price of t CO_2 equivalent in the Carbon TradeXchange, Golden Standard CER prices at €5 (MYR22.00).

The Kuala Sepetang and Kuala Trong Mangrove Forest Reserves store a total of 154.78 t C ha^{-1} on average or equivalent to 567.53 t CO_2 ha^{-1} (refer Table 11). Based on this estimated amount, the economic value of carbon is MYR7,475.87 per ha using the price of carbon MYR48.30 (Table 12). On the other hand, by using the market price of MYR22.00, the value of CO_2 equivalent is estimated at MYR12,485.66 per ha.

Table 12: Estimated value of stored carbon for Kuala Sepetang and Kuala Trong Mangrove Forest Reserves

Value of Carbon based on Carbon TradeXchange, Golden Standard CER trading price at MYR22.00 (€5) for 154.78 t C ha^{-1}/ 567.53 t CO_2 ha^{-1}	Value of Carbon based on estimated price by Tschakert (2002) at MYR48.30 (\$15 per Mg C) for 154.78 t ha^{-1}
567.53 t CO_2 ha^{-1} x MYR22.00 = MYR12,485.66 per ha	**154.78 t C ha^{-1} x MYR48.30 = MYR7,475.87 per ha**

Note: Exhange rate for Euro1=MYR4.40, USD1=RM3.22

4.0 CONCLUSION

A better understanding of valuation of environmental resources such as carbon storage in the Matang Mangrove Forest Reserve will lead to good management pratice and better revenue for the economy. The quantification of carbon also acts as a guideline to the government and other policy makers who emphasise the ability of natural resources in generating carbon credits and also reducing the problem of global warming. In addition, it is essential to sustain the health, diversity, and productivity of the nation's forests to meet the needs of present and future generations.

Gathering a complete data of forest structure through forest inventory is essential for accurately estimating forest productivity especially in quantifying biomass production and carbon stock / storage. Among the major carbon pools in a forest ecosystem include above ground carbon from standing live and dead trees, below ground carbon (soil and root), dead and downed wood, and also litter.

In our inventory works carried out in Compartment 37 Kuala Sepetang, and Compartment 69 Kuala Trong, there were huge differences in tree density for tree with diameter above and below 5cm between both sites. Most of individual found below than 5cm were sapling and seedling. Similar result was also found for dead and downed wood. For litter, there was slightly difference between these two sites.

Total standing biomass production was successfully estimated by using locally established equations through destructive sampling measurements. Even though, the values were slightly different between three developed models, these values were found still within the range reported by other researchers. Overall, the standing biomass production (tree biomass) was found higher in Kuala Trong compared to Kuala Sepetang reflecting the size of trees but for Kuala Sepetang, the value was found to be compensated by stand density. Higher biomass production was found for shrubs and dwarf mangrove (dominated by seedling and sapling) in Kuala Sepetang. However, contrasting patterns were observed for above ground carbon stock by using total above ground biomass component values (Model A) and total aboveground biomass values (Model B and C). Nevertheless, the values of carbon stock derived from this study was found to be within the range of higher carbon level even though the age of stand is about 30 year-old.

Meanwhile, the economic valuations based on the carbon stock values of this mangrove forest were estimated around MYR12,485.66 per ha and MYR7,475.87 per ha using both estimation methods respectively which include social and non-social factors.

Overall, this research finding can be a useful tool for forest and plantation managers towards the establishment and managing natural and planted forest in the future. The fundamental knowledge gained is this study might be useful in depicting the vital role of planted mangrove forest in improving carbon stocking as well as increasing economic and environmental values. Furthermore, the allometric models derived in this study can be potential equations for estimating standing biomass production as well as carbon sequestration in this specific mangrove area of Larut Matang. General equation can also be established by combining destructive data from both sites in the future.

REFERENCES

André, F., & Ponette, Q. (2003). Comparison of Biomass and Nutrient Content Between Oak (*Quercus Petraea*) and Hornbeam (*Carpinus Betulus*) Trees in a Coppice-With-Standards Stand an Chimay (Belgium). *Annal Forest Science 60*, 489-502.

Bouillon, S., Borges, A. V., Castañeda-Moya, E., Diele, K., Dittmar, T., Duke, N. C., Kristensen, E., Lee, S. Y., Marchand, C., & Middelburg, J. J. (2008). Mangrove Production and Carbon Sinks: A Revision of Global Budget Estimates. *Global Biogeochemical Cycles 22*, GB2013.

Brown, S., Gillespie, A. J., & Lugo, A. E. (1989). Biomass Estimation Methods for Tropical Forests with Applications to Forest Inventory Data. *Forest Science 35*, 881-902.

Brown, S., & Iverson, L. R. (1992). Biomass Estimates for Tropical Forests. *World Resources Review 4*, 366-383.

Brown, S., Schroeder, P., & Birdsey, R. (1997). Aboveground Biomass Distribution of US Eastern Hardwood Forests and the Use of Large Trees as an Indicator of Forest Development. *Forest Ecology and Management 96*, 37-47.

Cahoon, D. R., Hensel, P., Rybczyk, J., McKee, K. L., Proffitt, C. E., & Perez, B. C. (2003). Mass Tree Mortality Leads to Mangrove Peat Collapse at Bay Islands, Honduras after Hurricane Mitch. *Journal of Ecology 91*, 1093-1105.

Chave, J., Andalo, C., Brown, S., Cairns, M. A., Chambers, J. Q., Eamus, D., Fölster, H., Fromard, F., Higuchi, N., Kira, T., Lescure, J. P., Nelson, B. W., Ogawa, H., Puig, H., Riéra, B., & Yamakura, T. (2005). Tree Allometry and Improved Estimation of Carbon Stocks and Balance in Tropical Forests. *Oecologia 145*, 87-99.

Chave, J., Coomes, D., Jansen, S., Lewis, S. L., Swenson, N. G., & Zanne, A. E. (2009). Towards a Worldwide Wood Economics Spectrum. *Ecology Letters 12*, 351-366.

Cummings, D. L., Kauffman, J. B., Perry, D. A., & Hughes, R. F. (2002). Aboveground Biomass and Structure of Rainforests in the Southwestern Brazilian Amazon. *Forest Ecology and Management 163*, 293-307.

Daily, G. C., Söderqvist, T., Aniyar, S., Arrow, K., Dasgupta, P., Ehrlich, P. R., Folke, C., Jansson, A. M., Jansson, B. O., Kautsky, N., Levin, S., Lubchenco, J., Mäler, K. G., Simpson, D., Starrett, D., Tilman, D., & Walker, B. (2000). The Value of Nature and the Nature of Value. *Science 289*, 395-396.

Donato, D. C., Kauffman, J. B., Mackenzie, R. A., Ainsworth, A., & Pfleeger, A. Z. (2012). Whole-Island Carbon Stocks in the Tropical Pacific: Implications for Mangrove Conservation and Upland Restoration. *Journal of Environmental Management 97*, 89-96.

Gong, W. K., & Ong, J. E. (1990). Plant Biomass and Nutrient Flux in a Managed Mangrove Forest in Malaysia. *Estuarine, Coastal and Shelf Science 31*, 519-530.

Huet, S., Forgeard, F., & Nys, C. (2004). Above and Belowground Distribution of Dry Matter and Carbon Biomass of Atlantic Beech (*Fagus Sylvatica* L.) in a Time Sequence. *Annal Forest Science 61*, 683-694.

Hughes, R. F., Kauffman, J. B., & Jaramillo, V. J. (2000). Ecosystem-Scale Impacts of Deforestation and Land Use in a Humid Tropical Region of Mexico. *Ecological Applications 10*, 515-527.

Juliana, W. A., & Nizam, M. S. (2004). *Forest Structure and Above-Ground Biomass of Two Mangrove Forest Communities in Matang*. In "National Conference on Sustainable Management of the Matang Mangroves-100 Years and Beyond" (M. I. Shaharuddin, A. Muda, R. Ujang, A. B. Kamaruzaman, K. L. Lim, S. Rosli, J. M. Som & A. Latiff, eds.), pp. 235-244, Ipoh, Perak, Malaysia.

Kauffman, J. B., Heider, C., Cole, T. G., Dwire, K. A., & Donato, D. C. (2011). Ecosystem Carbon Stocks of Micronesian Mangrove Forests. *Wetlands 31*, 343-352.

Kenzo, T., Furutani, R., Hattori, D., Kendawang, J., Tanaka, S., Sakurai, K., & Ninomiya, I. (2009). Allometric Equations for Accurate Estimation of Above-Ground Biomass in Logged-Over Tropical Rainforests in Sarawak, Malaysia. *Journal of Forest Research 14*, 365-372.

Komiyama, A., Ogino, K., Aksornkoae, S., & Sabhasri, S. (1987). Root Biomass of a Mangrove Forest in Southern Thailand. 1. Estimation by the Trench Method and the Zonal Structure of Root Biomass. *Journal of Tropical Ecology 3*, 97-108.

Laffoley, D., & Grimsditch, G. D. (2009). *"The Management of Natural Coastal Carbon Sinks*," Iucn.

Le Goff, N., Granier, A., Ottorini, J. M., & Peiffer, M. (2004). Biomass Increment and Carbon Balance of Ash (*Fraxinus Excelsior*) Trees in an Experimental Stand in Northeastern France. *Annal Forest Science 61*, 577-588.

Ponette, Q., Ranger, J., Ottorini, J.-M., & Ulrich, E. (2001). Aboveground Biomass and Nutrient Content of Five Douglas-Fir Stands in France. *Forest Ecology and Management 142*, 109-127.

Putz, F. E., & Chan, H. T. (1986). Tree Growth, Dynamics, and Productivity in a Mature Mangrove Forest in Malaysia. *Forest Ecology and Management 17*, 211-230.

Segura, M., & Kanninen, M. (2005). Allometric Models for Tree Volume and Total Aboveground Biomass in a Tropical Humid Forest in Costa Rica. *Biotropica 37*, 2-8.

Suren, N. K., Lac, S., Johnston, M., & Kinar, C. (2000). *"Carbon Sequestration in Protected Areas of Canada: An Economic Valuation".* Canadian Parks Council.

Tschakert, P. (2002). Linking Global Climate Change with Local Fertility Management: Results from a Carbon Sequestration Pilot Project in Senegal. In "*The International Workshop on Quantifying Terrestrial Carbon Sinks: Science,Technology, and Policy*, 25–27 September ", Wengen, Switzerland.

Waddell, K. L. (2002). Sampling Coarse Woody Debris for Multiple Attributes in Extensive Resource Inventories. *Ecological Indicators 1*, 139-153.

RESOLUSI

Buluh Betong (*Dendrocalamus asper*)

RESOLUSI PERSIDANGAN KEBANGSAAN PENILAIAN EKONOMI SUMBER HUTAN 2014

Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014 telah bersidang di Hotel The Everly Putrajaya pada 2-5 September 2014 dengan tema persidangan 'Penjanaan Kekayaan Baru Barangan Dan Perkhidmatan Hutan Ke Arah Negara Maju Berpendapatan Tinggi'. Persidangan ini telah dirasmikan oleh YB. Datuk Seri G. Palanivel, Menteri Sumber Asli dan Alam Sekitar Malaysia dan dihadiri oleh sejumlah 110 peserta dari pelbagai agensi kerajaan, institut pengajian tinggi, institusi penyelidikan dan badan-badan bukan kerajaan. YBhg. Prof Dr. Mohd Shahwahid bin Hj. Othman, Dekan Fakulti Ekonomi dan Pengurusan, Universiti Putra Malaysia telah menyampaikan ucaptama Persidangan yang bertajuk "*Valuing and Capturing Environmental Goods and Services from Sustainable Forest Management*".

Sejumlah 19 kertas kerja telah dibentangkan di bawah lima (5) sesi seperti berikut:

1. Dasar dan Rangka Kerja Penilaian Ekonomi Sumber Hutan;
2. Prinsip Kaedah-Kaedah Penilaian Ekonomi Sumber Hutan;
3. Penyelidikan, Pembangunan dan Inovasi;
4. Penilaian Ekonomi Barangan Hutan; dan
5. Penilaian Ekonomi Perkhidmatan Hutan.

Sementara itu, objektif Persidangan adalah seperti berikut:

1. Menterjemahkan Barangan dan Perkhidmatan Sumber Hutan yang Berpasaran dan Bukan Berpasaran Dalam Bentuk Nilai Ekonomi Agar Nilai Keseluruhan (Total Economic Valuation) Hutan Dapat Ditentukan;

2. Mengenalpasti Kaedah-Kaedah Pengiraan Penilaian Ekonomi Barangan dan Perkhidmatan Sumber Hutan Ke Arah Penentuan Kos dan Faedah (Cost Benefit Analysis) Sesuatu Projek Perhutanan;

3. Menyediakan Platfom Kepada Jabatan Dan Agensi Kerajaan, Pihak Swasta, Institusi Penyelidikan, Pusat Pengajian Tinggi dan Badan Bukan Kerajaan (Ngos) Untuk Berkongsi Maklumat Mengenai Penilaian Ekonomi Sumber Hutan; dan

4. Mengenalpasti Dasar dan Strategi Bagi Mengarusperdanakan Penilaian Sumber Hutan Dalam Perancangan dan Pembangunan Sumber Tanah Negara.

Berdasarkan pembentangan kertas kerja dan perbincangan yang diadakan, Persidangan telah merumuskan resoluasi-resolusi seperti berikut:

1. Menyedari akan kepentingan untuk meningkatkan keberkesanan pengumpulan dan penyebaran maklumat penilaian barangan dan perkhidmatan sumber hutan bagi membantu penggubalan dasar dan membuat keputusan, Persidangan merumuskan supaya:

    a. Sebuah pusat yang dikenali sebagai Pusat Penilaian dan Perakaunan Sumber Hutan ditubuhkan di bawah kelolaan Jabatan Perhutanan Semenanjung Malaysia;

    b. Kerajaan Malaysia menyediakan peruntukan yang mencukupi untuk tujuan penubuhan dan operasi Pusat ini;

c. Modal insan yang mencukupi dan berkemahiran tinggi disediakan untuk mengendalikan pusat ini; dan

d. Satu program *Fellowship* yang dianggotai oleh pakar-pakar dalam pelbagai bidang / disiplin diwujudkan bagi memberi nasihat teknikal penilaian ekonomi dan meningkatkan rangkaian di antara pihak berkepentingan bagi mempromosi barangan dan perkhidmatan hutan.

2. Menyedari akan kepentingan untuk mengarusperdanakan penilaian barangan dan perkhidmatan sumber hutan bagi membantu dalam penggubalan dasar dan membuat keputusan berkaitan guna tanah hutan, Persidangan merumuskan supaya:

a. Satu Program Penilaian dan Perakaunan Sumber Hutan diwujudkan dibawah Rancangan Malaysia Ke-11; dan

b. Pengajian penilaian dan perakaunan sumber hutan dijadikan sebagai salah satu program dalam pendidikan di institut pengajian tinggi.

3. Menyedari kepentingan untuk meningkatkan hasil Kerajaan Negeri dan kutipan hasil hutan yang lebih holistik, persidangan merumuskan supaya:

a. Potensi kekayaan baru sumber hutan seperti *bio-medicine* dan *bio-energy* perlu diteroka dan dikembangkan;

b. Peruntukan dalam Akta Perhutanan Negara dan Kaedah-kaedah Hutan dikaji semula bagi membolehkan nilai-nilai ekonomi hutan dapat dijadikan sebagai hasil hutan; dan

c. Prosedur kutipan hasil hutan diperkemas, ditambahbaik dan dilaksanakan.

4. Menyedari akan kepentingan peranan Orang Asli dan masyarakat setempat dalam menjayakan matlamat pengurusan hutan secara berkekalan, persidangan merumuskan supaya:

a. *Traditional Ecological Knowledge* (TEK) dan *Local Ecological Knowledge* (LEK) diberi perhatian khusus dalam pengemaskinian dasar dan Rancangan Pengurusan Hutan di semua negeri di Semenanjung Malaysia;

b. Aktiviti pengurusan hutan secara berkekalan yang dilaksanakan hendaklah mengutamakan penglibatan orang asli dan masyarakat setempat; dan

c. Aktiviti pengurusan hutan secara berkekalan yang dilaksanakan hendaklah memberi faedah kepada Orang Asli/masyarakat setempat.

LAMPIRAN

Pokok Bisa Ular (*Barleria lupulina*)

ATURCARA PERSIDANGAN

2 SEPTEMBER 2014 (SELASA)		
4.00 petang – 6.00 petang	:	Pendaftaran Peserta Persidangan
3 SEPTEMBER 2014 (RABU)		
8.00 pagi	:	Pendaftaran Peserta Persidangan
8.30 pagi	:	Ucaptama Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014 oleh Prof. Dr. Mohd Shahwahid bin Hj. Othman, Dekan Fakulti Ekonomi & Pengurusan, UPM
SESI 1: DASAR DAN RANGKA KERJA PENILAIAN EKONOMI SUMBER HUTAN		
Pengerusi Sesi: YBhg. Dato' Hj. Nik Mohammad Shah bin Nik Mustafa **Rapporteur:** En. Mohd. Jinis bin Abdullah Cik Rosaizan Haryani binti Rosli		
8.50 pagi	:	**Contribution of the Forestry Sector in Peninsular Malaysia Towards Malaysia's High Income Economy Status** YBhg. Dato' Sri Dr. Hj. Abd. Rahman bin Hj. Abd. Rahim, Ketua Pengarah Perhutanan Semenanjung Malaysia dan Poh Lye Yong, JPSM
9.10 pagi	:	**Ethnobotanical and Forest Valuation Importance of Mangroves for Conservation and Policy Purposes** Prof. Dr. Ahmad bin Shuib, Prof. Madya Dr. Sridar Ramachandran, Dr. Syamsul Herman bin Mohammad Afandi, Prof. Madya Dr. Zaiton binti Samdin dan Dr. Siow May Ling, INTROP, UPM.
9.30 pagi	:	**Economic Benefit of REDD+: A Preliminary Steps in the Analysis** Juliana binti Ahmad, Dr. Ismariah binti Ahmad, Noor Aini binti Zakaria, Norliyana binti Adnan dan Norcahaya Khairani binti Mohamad Azmi, FRIM
9.50 pagi	:	Sesi Soal Jawab
10.30 pagi	:	Minum Pagi

SESI 2: PRINSIP KAEDAH-KAEDAH PENILAIAN EKONOMI SUMBER HUTAN		
Pengerusi Sesi: Pn. Shashiah binti Abdul Karim **Rapporteur:** En. Hamidi bin Abd Halim En. Mohd Zuhir bin Ahmad Mustafa Khalili		
11.00 pagi	:	**Collection of Economic Valuation Research of Forest Goods and Services** Prof. Dr. Mohd Shahwahid bin Hj. Othman, UPM
11.20 pagi	:	**The Status of Forest in Watersheds of Pahang: A Spatial Approach** Norliyana binti Adnan dan Dr. Ismariah binti Ahmad, FRIM
11.40 pagi	:	**Economic Value of Conservation of Totally Protected Areas: Special Reference to Economic Value of Water for Hydro Electricity Generation, Batang Ai National Park Sarawak** Abd. Wahab bin Bujang, Abg Ahmad bin Abg Morni dan Happysupina bin Sait, JH Sarawak
12.00 tengahari	:	**Willingness to Pay by Upstream Household for Watershed Protection in Langat Basin, Selangor** Devika Krishnan, Shaharuddin bin Mohamad Ismail dan Prof. Emeritus Chamhuri Siwar, LESTARI, UKM
12.20 tengahari	:	Sesi Soal Jawab
1.00 petang	:	Makan Tengahari

SESI 3: PENYELIDIKAN, PEMBANGUNAN DAN INOVASI		
Pengerusi Sesi: En. Ridza bin Awang **Rapporteur:** En. Sulahi@Suhaili bin Hj. Rosli Cik Nur Afzan binti Anuar		
2.00 petang	:	**Reducing Emissions From the Forests under REDD+: A Case Study of Pahang** Abdul Khalim bin Abu Samah, Mohd Paiz bin Kamaruzaman, Dr. Ismail bin Parlan, Dr. Samsudin bin Musa, Norhaidi bin Yunus, Edevaldo J.Yap, Nurul hidayah binti Hadzuha dan Norulhuda binti Ali, JPN Pahang
2.20 petang	:	**Penilaian Ekonomi untuk Stok Biojisim (Biomas) dan Karbon Bagi Tanaman *Rhizophora Mucronata Poiret* pada Peringkat Juvana** Dr. Affendi bin Suhaili dan Jayneeca Lawen, JH Sarawak

2.40 petang	:	**Potensi Konservasi Ramin Telur (*Gonystylus bancanus*) di Ulu Mentawai, Taman Negara Mulu** Noorhana binti Mohd Sapawi, Mohizah binti Mohamad, Nur Safinas binti Jelani, Aurelia Dulce Chung, Yahud bin Wat dan Yazid bin Kalbi, JH Sarawak
3.00 petang	:	Sesi SoalJawab

SESI 4: PENILAIAN EKONOMI BARANGAN HUTAN

Pengerusi Sesi:
Dr. Mohd Hizamri bin Mohd Yasin

Rapporteur:
Tn. Hj. Ramli bin Mat
Cik Jennifer anak Francis

3.40 petang	:	**Urban Tree: The Value of Trees in the City of Kuala Lumpur Using Thyer and Burnley Methods** Fazilah binti Musa, Prof. Madya Dr. Awang Noor bin Abd. Ghani, Abdullah bin Mohd dan Mustafa Kamal bin Mohd Shariff, UPM
4.00 petang	:	**Species Diversity and Economic Value of Medicinal Plants in One-Hectare Plot of Berembun Forest Reserve, Negeri Sembilan** Faten Naseha binti Tuan Hussain, Shaharuddin bin Mohamad Ismail, Nicolai bin Sidek, LESTARI, UKM, Shamsul bin Khamis dan Tajjudin bin Abd Manap., UPM
4.20 petang	:	**Economic Values of Swiftlet Caves in Forests** Zulnaidah binti Manan, JPSM dan Prof. Dr. Mohd Shahwahid bin Hj. Othman, UPM
4.40 petang	:	Minum Petang
5.00 petang	:	Bersurai

4 SEPTEMBER 2014 (KHAMIS)

8.30 pagi	:	Majlis Perasmian Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014
10.30 pagi	:	MinumPagi
11.00 pagi	:	**Value Added of Timber in Primary Wood-Based Industry in Peninsular Malaysia** Noor Hazmira binti Merous, Dr. Ismariah binti Ahmad, Norliyana binti Adnan, dan Dr. Lim Hin Fui, FRIM
11.20 pagi	:	Sesi Soal Jawab

SESI 5: PENILAIAN EKONOMI PERKHIDMATAN HUTAN

Pengerusi Sesi:
Tn. Hj. Zahari bin Ibrahim

Rapporteur:
En. Grippin anak Akeng
En. Azhar bin Ahmad

12.00 tengahari	:	**Development of Community-Based Forest Ecotourism: The Case of Ulu Geroh in Peninsular Malaysia** Dr. Lim Hin Fui, Norshakila binti Yusof dan Intan Nurulhani binti Baharuddin, FRIM
12.20 tengahari	:	**Estimating the Recreation Value of Penang Hill Using Travel Cost Method** Dr. Syamsul Herman bin Mohamad Afandi, Mohd Adli bin Ahmad, Prof. Madya Dr. Zaiton binti Samdin, Prof. Madya Dr. Sridar Ramachandran, dan Prof. Dr. Ahmad bin Shuib, INTROP, UPM
12.40 tengahari	:	Sesi Soal Jawab
1.00 petang	:	Makan Tengahari
2.00 petang	:	**PES Mechanisms through Mini Hydro Projects in the Forest Reserves of Perak State, Malaysia** Dr. Mohd Hizamri bin Mohd Yasin dan Roslan bin Ariffin, JPN Perak
2.20 petang	:	**Imperatives for Soil Carbon Valuation in Malaysian Forest Ecosystems** Abdullahi Ahmed Chinade, Shaharuddin bin Mohamad Ismail, Prof. Emeritus Chamhuri Siwar dan Isahak bin Anizan, LESTARI, UKM
2.40 petang	:	**Quantifying Aboveground Carbon Stock of 30-Year-Old Mangrove Forest and its Economic Value** Prof. Madya Dr. Hazandy bin Abdul Hamid, Prof. Madya Dr. Ahmad Ainuddin bin Nuruddin, Prof. Madya Dr. Zaiton binti Samdin, Dr. Arifin bin Abdu, INTROP, UPM; Tuan Marina binti Tuan Ibrahim dan Lydia Suzieana binti Mohammad, JPSM
3.00 petang	:	Sesi Soal Jawab
4.30 petang	:	Minum Petang
5.00 petang	:	Bersurai

5 SEPTEMBER 2014 (JUMAAT)		
8.30 pagi	:	Rumusan Persidangan Kebangsaan Penilaian Ekonomi Sumber Hutan 2014

Pengerusi Sesi:
YBhg. Dato’ Hj. Nor Akhirrudin bin Mahmud,
Timbalan Ketua Pengarah Perhutanan (Dasar dan Perancangan)

Pembentang:
En. Lim Kee Leng (Ketua Rapportuer)

10.00 pagi	:	Minum Pagi
10.30 pagi	:	Majlis Penutup
12.00 tengahari	:	Makan Tengahari dan Bersurai

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Hutan Lipur Lubuk Yu, Pahang

MAJLIS PERASMIAN PERSIDANGAN

Dato' Sri Dr. KPPSM mengiringi
Menteri NRE ke Majlis Perasmian

Menteri NRE bersalaman
dengan para jemputan

Majlis Perasmian Persidangan Kebangsaan
Penilaian Ekonomi Sumber Hutan 2014

Bacaan doa oleh En. Abd. Halim bin Sanui

Ucapan Aluan oleh Dato' Sri Dr. KPPSM

MAJLIS PERASMIAN PERSIDANGAN

Ucapan perasmian oleh
Menteri NRE

Perasmian dimulakan
dengan pukulan gong

Gimik Perasmian

Dato' Sri Dr. KPPSM
menyampaikan cenderahati kepada TKSU II, NRE

Dato' Sri Dr. KPPSM
menyampaikan cenderahati kepada Menteri NRE

PAMERAN PERSIDANGAN

Lawatan ke pameran persidangan

Menteri NRE menandatangan buku pelawat

Menteri NRE dan TKSU II, NRE diberi penerangan mengenai gaharu

Menteri NRE mencuba minuman Tongkat Ali

Urusetia pameran

SESI PEMBENTANGAN KERTAS KERJA

Peserta persidangan mengajukan
soalan kepada pembentang

Ucaptama yang disampaikan oleh
Prof Dr. Mohd Shahwahid bin Hj. Othman

Pembentangan oleh
Dr. Lim Hin Fui

Peserta Persidangan

Pembentang dan Peserta Persidangan

MAJLIS PENUTUP PERSIDANGAN

Pembentangan resolusi oleh
Ketua Rapportuer

Majlis penutup yang dipengerusikan
oleh TKP (DP)

Ucapan Penutup oleh
Dato' Sri Dr. KPPSM

TPB (PE) menyampaikan cenderahati
kepada Dato' Sri Dr. KPPSM

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