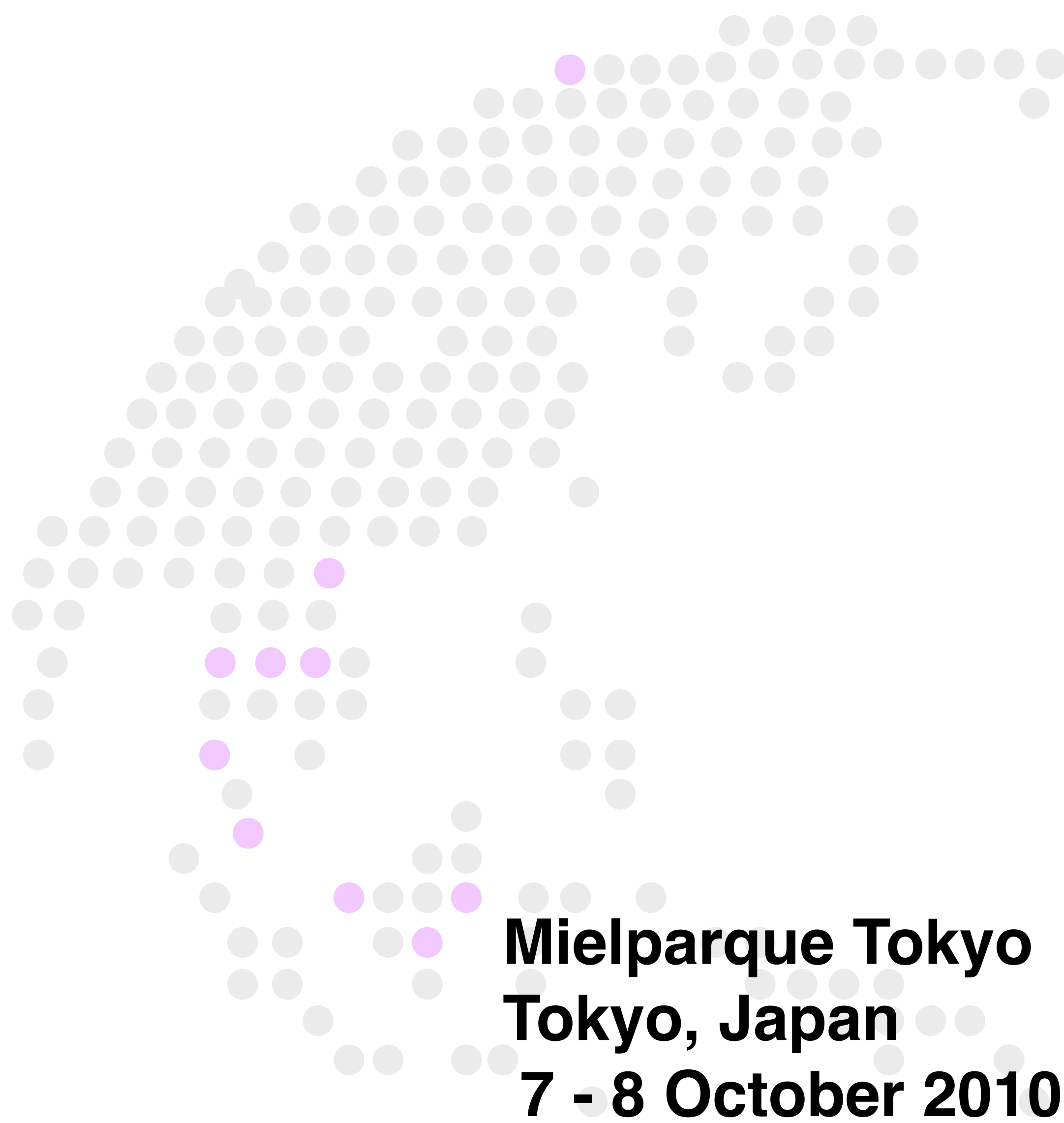
International Workshop

Forest Dynamics and Carbon Monitoring in Forest Ecosystems in East Asia ~ Findings from Forest Dynamics Network~

Abstracts



Mielparque Tokyo
Tokyo, Japan
7 - 8 October 2010

独立行政法人
森林総合研究所

Forestry and Forest Products Research Institute

International Workshop

Forest Dynamics and Carbon Monitoring in Forest Ecosystems in East Asia ~ Findings from Forest Dynamics Network~

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Forestry and Forest Products Research Institute

Hosted by

Forestry and Forest Products Research Institute (FFPRI)

Sponsored by

Ministry of the Environment, Japan (MOEJ)

Forest Agency

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Hiroshi Tanaka: Director, Department of Forest Vegetation, FFPRI

Takeshi Toma: Head, Bureau of International Partnership, FFPRI

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"Advancement of East Asia Forest Dynamics Plots Network -Monitoring forest carbon cycling for the development of climate change adaptation-" [GERANI, MOEJ: FY2009-2013; PL: Dr Tamotsu Sato]

"Development of the forest degradation index and the carbon emission estimation method using PALSAR data" [A-0802, GERF, MOEJ: FY2008-2010 PL: Dr Yoshiyuki Kiyono]

"The conservation measures of swamp forest through sustainable use of ecological resources by local communities" [D-0902, GERF, MOEJ: FY2009-2011 PL: Dr Ryuichi Tabuchi]

Program of Workshop

Day 1 (Thursday 7 October 2010): Room Botan (牡丹) 3F

0900 - 0920 Opening Session

Tamotsu Sato (FFPRI)

Background & Scope of WS

0920 - 1040 **Session 1**_Forest and Carbon Dynamics

Boreal Forest [Tura]

Takuya Kajimoto (FFPRI)

Carbon accumulation and allocation patterns of Gmelin larch forests on the continuous permafrost region in Central Siberia

Takuya Kajimoto, Y. Matsuura, Akira Osawa, Tomoaki Morishita, Yuichiro Nakai, A.S. Prokushkin & O.A. Zyryanova

Yojiro Matsuura (FFPRI)

Soil carbon storage of permafrost larch ecosystems in Central and Eastern Siberia

Yojiro Matsuura, Takuya Kajimoto, Anatoly S. Prokushkin, Alexander P. Iasev & Akira Osawa

Anatoly S. Prokushkin (V.N. Sukachev Institute of Forest, Russian Academy of Sciences)

Hydrological pathway of terrestrial C loss from permafrost affected watersheds of Central Siberia

Anatoly S. Prokushkin, O.S. Pokrovsky, I.V. Tokareva, S.G. Prokushkin, A.A. Onuchin, Y. Matsuura & Takuya Kajimoto

1040 - 1140 **Session 1**_Forest and Carbon Dynamics

Tropical Dry Forest [Mae Klong]

Hiroshi Tanaka (FFPRI)

Contribution of forest floor bamboos to carbon dynamics: population dynamics of four bamboo species in a tropical seasonal forest, Thailand

Hiroshi Tanaka, Dokrak Marod, Utis Kutintara, Samroeng Panuthai, Masamichi, Takahashi, Tomoyuki Saitoh & Tohru Nakashizuka

Dokrak Marod (Kasetsart University)

Regeneration dynamics of a tropical seasonal forest after the simultaneous death of bamboos, western Thailand

D. Marod, H. Tanaka, M. Takahashi, A. Ishida, S. Panuthai, T. Saito & T. Nakashizuka

1140 - 1240 Lunch

1240 - 1340 **Session 1**_Forest and Carbon Dynamics

Tropical Rain Forests [Pasoh & Semangkok]

Abd Rahman bin Kassim (FRIM)

Comparative Assessment of Carbon Stock of Malaysian Forests

Abd Rahman bin Kassim

Kaoru Niiyama (FFPRI)

Root biomass estimation in a dipterocarp forest, Pasoh Forest Reserve, Peninsular Malaysia

Kaoru Niiyama, Tamon Yamashita, Kenzo Tanaka, Azizi Ripin & Abd. Rahman bin Kassim

1340 - 1440 **Session 1**_Forest and Carbon Dynamics

Tropical Rain Forest [Bukit Soeharto]

Takeshi Toma (FFPRI)

Changes in aboveground biomass of a lowland dipterocarp forest following the 1982-83 fires in East Kalimantan, Indonesia.

Takeshi Toma, Sutedjo & Warsudi

Sutedjo (Mulawarman University)

Species Composition and Population Dynamics at Secondary Stands in Bukit Soeharto Education Forest

Sutedjo, Takeshi Toma & Warsudi

1440 - 1540 Tea Break [Poster Presentations]

Akira Osawa (Kyoto University)

Re-evaluation of fine root ingrowth and net primary production in northern boreal forests

A. Osawa, N. Kurachi, T. Kajimoto & Y. Matsuura

Tomoaki Morishita (FFPRI)

Estimation of annual soil respiration rate in a larch forest in Central Siberia

Tomoaki Morishita, Yojiro Matsuura, Yuichiro Nakai, Takuya Kajimoto, Akira Osawa & Olga A. Zyryanova

Keizo Hirai (FFPRI)

Soil carbon stock of tropical monsoon forest in western Thailand

Keizo Hirai, Masamichi Takahashi, Pitayakorn Limtong, Sontam Sukusawang, Junpei Toriyama & Yoshiyuki Kiyono

Tamotsu Sato (FFPRI)

Preliminary survey of coarse woody debris (CWD) stocks in a hill dipterocarp forest, Semangkok Forest Reserve, Malaysia

Tamotsu Sato, Tsutomu Yagihashi, Kaoru Niiyama, Abd. Rahman bin Kassim & Azizi Ripin

Tsutomu Yagihashi (FFPRI)

Habitats suitable for the establishment of *Shorea curtisii* seedlings in the Semangkok hill forest, Malaysia

Tsutomu Yagihashi, Tatsuya Otani, Naoki Tani, Tomoki Nakaya, Abd Rahman bin Kassim, Tetsuya Matsui & Hiroyuki Tanouchi

Tran Van Con (FSIV)

The importance of permanent sample plots in studying forest dynamics and carbon sequestration in Vietnam

Tran Van Con

Tran Van Do (Kyoto University / FSIV)

Can abandoned land after shifting cultivation return to original forest?: A case study in Northwestern Vietnam

Tran Van Do, Akira Osawa & Nguyen Toan Thang

Reiji Yoneda (FFPRI)

Forest structure and dynamics of seasonal flood forest along the Lam Se River, Northeast Thailand

Reiji Yoneda, Sasitorn Poungparn, Makoto Sano, Ryuichi Tabuchi & Pipat Patanaponpaiboon

Moriyoshi Ishizuka (FFPRI)

DBH-height relationship for estimating biomass along a topographic gradient in a Central Amazonian forest

Rempei Suwa, Roseana P. Silva, Takeshi Sakai, Adriano J.N. Lima, Takuya Kajimoto, Francisco G. Higuchi, Hideyuki Noguchi, Niro Higuchi & Moriyoshi Ishizuka

1540 - 1640 **Session 1**_Forest and Carbon Dynamics

Tropical Swamp Forest [Lam Se Buy & Ranong]

Tabuchi Ryuichi (JIRCAS)

Change of standing biomass and dead mass of some mangroves over 6 years in Ranong, southern Thailand - before and after Tsunami –

Ryuichi Tabuchi, Yoshimi Fujioka, Reiji Yoneda, Hajime Utsugi, Kyotaro Noguchi, Yasumasa Hirata, Decha Duangnamol, Sasitorn Poungparn & Pipat Patanaponpaiboon

Sasitorn Poungparn (Chulalongkorn University)

Zonal Variation in Dynamics of Leaf Litter in a Secondary Mangrove Forest of Thailand

Sasitorn Poungparn, Vilanee Suchewaboripont & Pipat Patanaponpaiboon

Day 2 (Friday 8 October 2010) : Room Kujaku (孔雀) 4F

0930 - 1000 **Keynote Lecture**

Tsuyoshi Yoneda (Kagoshima University)

Dynamics of stand structure and NEP of a tropical rain forest in Southeast Asia, basing on a long-term research in Padang and Pasoh

1000 - 1200 **Session 2**_Forest Monitoring using Satellites Images and Ground-Based Measurement

Yoshiyuki Kiyono (FFPRI)

Outline of the forest monitoring methods using remote sensing and ground-based measurement

Yoshiyuki Kiyono

Tomoaki Takahashi (FFPRI)

Forest monitoring by PALSAR in Indonesia and Cambodia

Tomoaki Takahashi, Yoshio Awaya, Yoshiyuki Kiyono, Hideki Saito, Tamotsu Sato, Jumpei Toriyama, Yukako Monda, Masanobu Shimada, Suwido H. Limin, I Nengah Surati Jaya & M Buce Saleh

Samreth Vanna (FA, Cambodia)

Monitoring forest biomass carbon stock using permanent sample plots (PSPs) in Cambodia

Samreth Vanna, Chheng Kimsun, Jumpai Toriyama, Satoshi Saito, Yukako Monda, Hideki Saito & Yoshiyuki Kiyono

Junpei Toriyama (FFPRI)

Soil carbon stock in tropical monsoonal forests and rubber plantations in Cambodia

Jumpei Toriyama, Keizo Hirai, Sophal Chann, Seiichi Ohta, Yasuhiro Ohnuki, Eriko Ito, Mamoru Kanzaki, Makoto Araki, Hideki Saito, Yoshiyuki Kiyono & Masamichi Takahashi

Tamotsu Sato (FFPRI)

Relationship between community height and biomass in peatland forests,

central Kalimantan

Tamotsu Sato, Yoshiyuki Kiyono, Tomoaki Takahashi, Sen Nishimura, Hideki Saito, Jumpei Toriyama, Yoshio Awaya, Agung R. Susanto & Suwido H. Limin

Yoshiyuki Kiyono (FFPRI)

Fire impacts on carbon pools in tropical forests: Post-fire succession in peat swamp forest under drainage influence in Central Kalimantan, Indonesia

Yoshiyuki Kiyono, Tamotsu Sato, Jumpei Toriyama, Tomoaki Takahashi, Hideki Saito, Yoshio Awaya, Suwido H. Limin, Agung R.S., Yuda P., F. Darma

1200 - 1300 Lunch

1300- 1500 **Session 3_** Ecosystem Services and Human Activities in swamp forests

Ryuichi Tabuchi (JIRCAS)

Potential resources in swamp forest ecosystem - Change in a riparian swamp in NE Thailand in half century –

Ryuichi Tabuchi, Makoto Sano, Reiji Yoneda, Noriko Hayashi(Tamura), Decha Muangnil, Sasitorn Poungparn & Pipat Patanaponpaiboon

Ong J. Eong (Universiti Sains Malaysia)

Sustainably managing the Matang (Malaysia) Mangroves

Ong J. Eong

Yoshimi Fujioka (NRIA)

Fisheries activities and resources in swamp forests

Yoshimi Fujioka, Junya Higano, Chumpol Srithong, Ryuichi Tabuchi, Hisami Kuwahara, Pipat Patanaponpaiboon & Sasitorn Poungparn

Shinya Takeda (Kyoto University)

Land use history and local conservation of a mangrove forest in Chantaburi Province, Thailand

Shinya Takeda, Ayako Sasaki & Sommai Suppakun

Takayuki Kurashima (FFPRI)

Difficulties of prescriptive tropical forest governance models and their practical function in REDD+: A basis for framing better swamp forest management under the emerging paradigm

Takayuki Kurashima, Takeshi Toma & Ryuichi Tabuchi

1500 - 1530 Tea Break [Poster Presentations]

1530 - 1630 Closing Session

Session 1

Forest and Carbon Dynamics

09:20 – 11:40, 7 October 2010
12:40 – 14:40, 7 October 2010
15:40 – 16:40, 7 October 2010

Room Botan (牡丹) 3F
Mielparque Tokyo

Carbon accumulation and allocation patterns of Gmelin larch forests on the continuous permafrost region in Central Siberia

Takuya Kajimoto[1], Y. Matsuura[2], Akira Osawa[3], Tomoaki Morishita[4], Yuichiro Nakai[5], A.S. Prokushkin[6], O.A. Zyryanova[6]

[1]Department of Plant Ecology, Forestry and Forest Products Research Institute (FFPRI), Tsukuba, Japan; [2]Department of Forest Site Environment, FFPRI, Tsukuba, Japan; [3]Graduate School of Agriculture, Kyoto University, Kyoto, Japan; [4]Shikoku Research Center, FFPRI, Kochi, Japan; [5]Department of Meteorological Environment, FFPRI, Tsukuba, Japan; [6] V.N. Sukachev Institute of Forest SB RAS, Krasnoyarsk, Russia.

Gmelin larch (*Larix gmelinii*) dominates in Central Siberia where permafrost is continuously underlying. The larch often regenerates intensively due to fire disturbance, resulting in re-establishment of almost even-aged stand. Tree density of larch stand is extremely high during early growth stage (< 10 years old). However, old larch stand (> 100 years-old) generally becomes very sparse (i.e., open forest): canopy closure index is much smaller than unity (0.2-0.6 ha ha^{-1}), or crowns of individuals rarely overlap to one another. To understand carbon dynamics following such a stand development, we assessed both above- and below-ground biomass in some larch stands with different ages (10, 14, 27, 105, and > 200 years old) selected near the settlement of Tura. Biomass of each component was estimated by developing site-specific DBH-based allometric equations. Above-ground net primary production (ANPP) was also assessed as the sum of biomass increment and mortality (litterfall).

Aboveground total biomass increased sharply with the stand age at early growth stage (< 30 years-old), then reached stable level (ca. 30 Mg ha^{-1}) at mature stage (> 100 years-old). Belowground biomass also increased with aging at such a younger stage, but still tended to increase gradually (ca. 10 Mg ha^{-1}) as the stand aged further. Consequently, above-/below-total biomass ratios (T/R) of the old stands were reduced to 2-3, indicating that the larch trees shifted carbon allocation from above- to root-oriented pattern as they aged certainly. These values of T/R of the old larch stands were apparently lower as compared to those of the other forest ecosystems (e.g., 4-5 for boreal forests in non-permafrost regions), suggesting that rather root-oriented carbon allocation was a phenomena endemic to the permafrost region. ANPP peaked (ca. 4 Mg ha^{-1} y^{-1}) at younger stage (ca. 30 years-old), then declined substantially (< 1 Mg ha^{-1} y^{-1}) as the stand matured (> 100 years-old). The peak of ANPP occurred at the period when needle biomass was the largest.

Our findings suggest that potential carbon stock and productivity (ANPP) of Siberian *Larix* taiga are the lowest among the boreal forest ecosystems worldwide. This feature may be associated with the attributes due to deciduous species (i.e., short growing season, or needle life span) and the presence of permafrost (i.e., low soil temperature). The age-related reduction of productivity (or tree growth) and shift of carbon allocation are likely to be explained by the constraint of available soil nutrients, especially nitrogen. The root-oriented carbon investment (smaller T/R ratio) implies that roots (mainly coarse roots) function as important carbon sink in the Siberian permafrost *Larix* taiga.

Soil carbon storage of permafrost larch ecosystems in Central and Eastern Siberia

Yojiro Matsuura[1], Takuya Kajimoto[1], Anatoly S. Prokushkin[2], Alexander P. Iasev[3], Akira Osawa[4]

[1] Forestry and Forest Products Research Institute (FFPRI), Tsukuba, Ibaraki, Japan, [2] VN Sukachev Institute of forest SB RAS, Krasnoyarsk, Russia, [3] Institute for Biological Problems of Cryolithozone, Yakutsk, Russia, [4] Division of Forest & Biomaterials Sciences, Kyoto University, Kyoto

Deciduous coniferous taiga, larch (genus *Larix*) ecosystem is one of largest biomes in northeastern Eurasian Continent, where vast area of larch forest exists on continuous permafrost. We selected three representative sites for ecosystem research: 1) a forest near Yakutsk in Yakutian Basin, eastern Siberia (62N-129E), 2) a forest near Tura in central Siberian Plateau (64N-100E), and 3) a forest tundra transition near Chersky in Kolyma lowland (69N-160E). We estimated C storage in both aboveground and belowground biomass, in forest floor, and in active layer as soil organic C. We also estimated inorganic-C accumulated as carbonate-carbon. Soil organic C in active layer was the largest component in each site. Soils in Yakutsk and Tura showed carbonate-C accumulation in active layer, which resulted from extreme continental climate with low annual precipitation. C storage in aboveground and belowground biomass varied among sites; however, ratios of above/belowground biomass C had a relatively narrow range from 1.1 to 1.5. High allocation rate of C to belowground part resulted from a kind of adaptation to effective nutrient acquisition under nutrient limited environment due to low soil temperature.

Hydrological pathway of terrestrial C loss from permafrost affected watersheds of Central Siberia

Anatoly S. Prokushkin [1], O.S. Pokrovsky [2], I.V. Tokareva [1], S.G. Prokushkin [1], A.A. Onuchin [1], Y. Matsuura [3], Takuya Kajimoto [3]

1 VN Sukachev Institute of forest SB RAS, Krasnoyarsk, Russia; *2 LMTG-CNRS, Toulouse, France; 3 Forestry and Forest Products Research Institute (FFPRI), Tsukuba, Ibaraki, Japan*

Subarctic permafrost-dominated basins have the great potential to increase hydrologic carbon release under projected climate warming. Losses of carbon (C) assimilated in terrestrial ecosystems as dissolved organic (DOC), inorganic (DIC), particulate organic (POC) and $aqCO_2$ are likely to increase through temperature-related processes like northward shift of vegetation, enhanced NPP, increased soil respiration and release of C liberated as permafrost thaws.

Carbon fluxes in larch ecosystems developed on permafrost soils are analyzed in number of sites located in Central Siberia nearby Tura settlement (64^{o}N, 100^{o}E). Carbon transported via hydrological flow path has been estimated in contrasting habitats (e.g. south- and north-facing slopes), stands affected by wildfires and finally in hydrological network being exported from watersheds. In terrestrial compartment concentrations of dissolved C have been estimated throughout a growing season (May-Sept.) in throughfall, forest floor seepage waters and mineral soils at several depths. To analyze export from watershed, 12 streams in differing size and fire history have been selected for continuous water sampling.

Dissolved C flux in larch stands grown on north- and south-facing slopes clearly demonstrates enhanced production and elevated downward transport of DOC and DIC in warmer and well-drained soils. Nevertheless, those landscape units seemed the minor source of terrestrial organic C in stream waters due to evapotranspirational losses and deeper seepage of water. Latter case causes higher retention and adsorption of organic C on mineral matrices. Most important disturbance factor responsible for decrease of amount of dissolved organic C transported through the soils and exported to streams is periodical ground fires. The key mechanism responsible for such changes is combustion of organic layer, the main source of DOC. In opposite, DIC flux in soils and streams is increasing that suggests enhanced microbial activity in terrestrial ecosystems. Within large scale watersheds (>50 km^2), wildfires may also cause talik formation leading to increased mineralization of stream waters.

Riverine C export is assessed on annual basis for two large rivers draining southern (Nizhyaya Tunguska River, 268000 km^2) and northern (Kochechum River, 96400 km^2) parts of Central Siberian Platform. The key hydrological event for both rivers is the spring flood when up to 80% of annual water and C (as DOC and POC) flux occurred. In wetter years the proportion of spring flood decreases up to 50% of annual value, and summer-to-fall season increases drastically from 20 to 50%. Despite continuous increase of inorganic species concentrations in winter months, overall winter flux is negligible in annual C export as river discharges drops 1000-fold as soil freezes.

Four year observations of dissolved C export by compared rivers suggested that the yield of terrestrial C from southern part of Siberian platform having larger stock of labile C on river basin is water limited, and, vice versa, C export from Northern part is limited by available organic C. In general, Nizhnyaya Tunguska River is characterized by elevated concentrations of all C forms (DOC, POC, DIC and $aqCO_2$) as compared to Kochechum River. If DOC and POC are characteristic of higher C density within the Tunguska basin due to more productive vegetation types (i.e. larch and dark conifer forests cover >80% of Tunguska basin (GLC 2000)), latter species (DIC and $aqCO_2$) are indices of higher decomposition rates of soil organic matter in terrestrial ecosystems.

Contribution of forest floor bamboos to carbon dynamics: population dynamics of four bamboo species in a tropical seasonal forest, Thailand

Hiroshi Tanaka [1], Dokrak Marod [2], Utis Kutintara [2], Samroeng Panuthai [3], Masamichi, Takahashi [4], Tomoyuki Saitoh [1], Tohru Nakashizuka [5]

[1] Department of Forest Vegetation, Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan; [2] Department of Forest Biology, Faculty of Forestry, Kasetsart University, Bangkok, 10900 Thailand; [3] Mae Klong Watershed Research Station, Thong Pha Phum District, Kanchanaburi Province, 71180, Thailand; [4] Research Planning and Coordination Department, Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan; [5] Graduate School of Life Sciences, Tohoku University, Sendai, Miyagi, 980-8578, Japan

The culm and clump dynamics of four co-occurring bamboo species (*Gigantchloa albociliata, G. hasskariana, Bambusa tulda and Cephalostacyum pergracile*) were monitored for 13 y (1993-2005) to investigate the population dynamics, regeneration and carbon sequestration of bamboos. *G. albociliata* and *C. pergracile* flowered and died in 1998 and 2001, respectively, while *B. tulda* did not flower during the study period. *G. hasskarliana* flowered and died three years before the study period (1990). In nine 20 m x 20 m quadrats set in the 4 ha long-term research plot, all the culms > 1 m high in each clump were tagged and their recruitment, survival, and death were monitored annually. Mortalities of the clumps in the mass flowering year were about 90% for G. albociliata and 100% for C. pergracile, suggesting a high synchrony of flowering and death among the individuals in the populations. Thus, the old cohort of *C. pergracile* was completely replaced by a new cohort started from seedlings, but a few of the individuals of the old cohort of *G. albociliata* remained, supplemented with a new cohort from seedlings. After the simultaneous death of *G. albociliata* and *C. pergracile*, suppressed saplings (clumps) of *B. tulda* (which were < 1 m high before the event) started to grow, producing large culms that attained mature size. Although sympatric regeneration is supposed to be one of the adaptive features for monocarpic species, such as bamboo, the occurrence of the saplings of the other bamboo species under the mature individuals prevented the regeneration of the dead bamboo species. This (advanced regeneration of the other bamboo species), however, may have facilitated the recover of aboveground biomass (carbon stock) of bamboos on the forest floor. The aboveground biomass of bamboos was estimated to fluctuate in the range of 23.7-37.1 Mg/ha during the study period according to the population dynamics of the four co-occurring species.

Regeneration dynamics of a tropical seasonal forest after the simultaneous death of bamboos, western Thailand

D. Marod [1], H. Tanaka [2], M. Takahashi [3], A. Ishida [4], S. Panuthai [5], T. Saito [2], T. Nakashizuka [6]

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We studied the regeneration dynamics of a tropical seasonal forest with special reference to the interaction with the simultaneous death of bamboos dominant on the forest floor and occasional occurrences of forest fire. Fourteen years (1992-2006) of monitoring data at a 4 ha permanent plot established in a mixed deciduous forest (MDF) in Mae Klong Watershed Research Station, western Thailand was analyzed. Just before and during the study period (1990, 1998, 2001), three of the 4 dominant bamboo species flowered and died simultaneously in different years. These events resulted in the drastic changes in the biological processes in the forest. Sudden emergence of wild bananas in the forest was the most astonishing one of these changes.

The spatial and temporal recruitment patterns of trees were concentrated in the areas where bamboos died. The relationship between mean recruitment and mortality of tree populations before and after the die-back of bamboo (GA) in 1998 differed among species. The species which had disproportionately higher recruitment than mortality after the death of each bamboo were mostly pioneer species, although the species composition shifted. In contrast, the dominant species showed few changes in stem density unaffected by the bamboo flowering events. Growth and recruitment of the trees were facilitated after the death of bamboos, but the competition with the regenerating bamboos and the occasional occurrences of forest fire strongly impeded the successful regeneration of trees. Other factors such as canopy gaps and limited seed fall with high inter-annual variation also affected the regeneration process of the trees after the death of bamboos.

Changes in aboveground biomass of a lowland dipterocarp forest following the 1982-83 fires in East Kalimantan, Indonesia

Takeshi Toma [1], Sutedjo [2], Warsudi [3]

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Between 1988 and 2009, changes in the aboveground biomass (AGB) of a lowland dipterocap forest, damaged by fires in 1982-83 and 1998, were estimated using allometric functions and an annual inventory of stem diameter for trees equal to or larger than 10 cm in diameter at breast height. A few pioneer species, mainly *Macaranga* spp., dominated a heavily disturbed stand (HDS). Primary tree species that survived the 1982-83 fire dominated a lightly disturbed stand (LDS). A moderately disturbed stand (MDS) contained vegetation intermediate between the HDS and the LDS. In 1997, tree density in the HDS, MDS and LDS was 553, 499 and 356 trees ha^{-1}, respectively. *Macaranga* trees accounted for 70%, 40% and 11% of the total tree densities in the HDS, MDS, and LDS, respectively. In August 1997, the AGB of trees in the HDS, MDS, and LDS was 117, 280, and 315 Mg ha^{-1}, respectively. The proportion of biomass accounted for by *Macaranga* trees for the HDS, MDS, and LDS was 34%, 8% and 1%, respectively. The fire in 1998 again decreased tree density and AGB of the stands. In 2000, the AGB of the trees in the HDS, MDS, and LDS was 27, 106, and 220 Mg ha^{-1}, respectively. Pioneer species, such as *Macaranga gigantea*, *Euodia alba* and *Vernonia arborea* dominated the sites opened up by the 1998 fire. In August 2009, tree density in the HDS, MDS and LDS was 689, 358 and 410 trees ha^{-1}, respectively and pioneer trees accounted for 93%, 79% and 59% of the total tree densities in the HDS, MDS, and LDS, respectively. In August 2009, the AGB of the trees in the HDS, MDS, and LDS was 62, 81, and 234 Mg ha^{-1}, respectively. The fires killed large trees of primary species and the burned site became dominated by pioneer species with a large number of stems per ha, but lowered biomass unlikely to recover to the original forest (>400 Mg ha^{-1}).

Species Composition and Population Dynamics at Secondary Stands in Bukit Soeharto Education Forest

Sutedjo [1], Takeshi Toma [2], Warsudi [3]

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Species composition and population dynamics of secondary Forest stands was described through a -9ha permanent plot. A nine hectares permanent plot was established in Bukit Soeharto Education and Research Forest (BSERF) in the 1997. The 9-ha plots was composed actually of three different conditions namely no felling plots, light felling and heavy felling where each is 3-ha. Unfortunately, one year later (1998) was the plots fallen on to fire. Comparison of the felling effects itself is therefore becoming confused and less relevant any longer. But species change and composition still an important data to recognize and predict the future form of the disturbed forest stands. For those reasons an annually evaluation has been carried out to record the species composition and tree density of individual having diameter equal or greater then 10 cm. However this report focused only to the data in year 1998 and from 2005 up to 2009 to be discussed. Factually, there is 97 species (ha^{-1}) recorded from no felling plot, following by 59 and 68 species for light felling and heavy felling respectively. These mean that species number increased 42.6%, 90.3% and 78.9% compared to the data in1998. Even, tree density increased more drastically, where within ca.11 years (1998 to 2009) rise up to 295%, 1,000% and 873% respectively. Three pioneer species are looked to be consistently population-dominant namely *Macaranga gigantea* Muell.Arch.,, *Euodia alba* and *Vernonia arborea* and triggered the population growth. Mean while *Eusideroxylon zwagery* T.et. B., is the only primary species noted as dominant since observed data in 1998. No other primary species are so far noted as a-ten dominants group.

Keywords: Permanent plots, species composition, population dynamics, pioneer species.

Comparative Assessment of Carbon Stock of Malaysian Forests

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One of the fundamental tasks in assessing contribution of forest to carbon emission is the quantification of carbon stock and how do they vary within and between the different forest types. The paper presented a comparative assessment of carbon stock in three broadly classified forest types in Peninsular Malaysia (a) peat swamp forest, (b) mangrove forest and (c) inland dipterocarp forest. The findings are presented in two parts. The first part presented the overall stocking, species composition and size structure variation within each forest type. The second part compares the variation in overall stocking, species composition and size structure between forest types of the pristine forests. To quantify the total carbon stocks of standing trees within the forest, we calculated the above-ground and of below-ground carbon using allometric equation developed for the tropical region. The comparative assessment of carbon stock among various forest types indicated that the total stand carbon stock tend to be influenced more by the topography than the forest types. The total carbon stock varies between 188 tonne ha^{-1} to 350 tonne ha^{-1}. The relative proportion of below-ground carbon ranges from 16 to 27 percent of the total standing carbon stock. The results also indicated that carbon stock exhibited mark differences across dbh classes and is associated with species mixture of the forest stand as well as habitat condition. New research direction on the comparative assessment of changes in carbon stock due anthropogenic disturbances such commercial logging is also highlighted.

Root biomass estimation in a dipterocarp forest, Pasoh Forest Reserve, Peninsular Malaysia

Kaoru Niiyama [1], Tamon Yamashita [2], Kenzo Tanaka [3], Azizi Ripin [4] and Abd. Rahman Kassim [4]

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Precise estimation of root biomass is important for understanding carbon stocks and dynamics in tropical rain forests. However, limited information is available on the vertical distributions and spatial heterogeneity of root biomass. We excavated five 2-m depth pits (1 m x 1 m x 2 m) and two 4-m depth pits for root biomass measurements. These seven soil pits showed similar root biomass distribution with soil depth. Most of root biomass, 80%-90% was concentrated on upper 50 cm depth (Fig.1). Root biomass measurements by soil-pits were largely different from allometric estimations (Table 1). A model estimation assuming decreases root biomass with distance from trees is needed to more precise root biomass estimation. This model well estimates spatial heterogeneity of real data from soil-pit measurements. These results mainly depend on coarse root biomass. Spatial distribution of fine root is more homogeneous than that of coarse root mass.

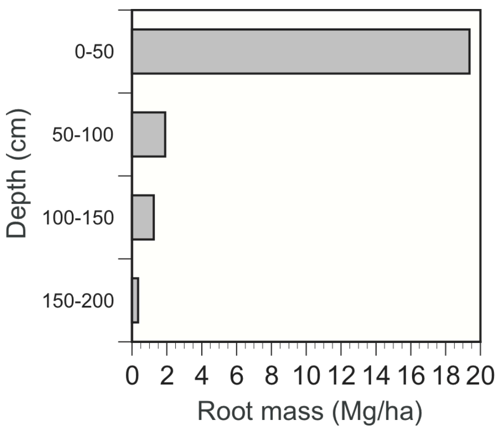

Fig. 1. An example of vertical distribution of root biomass

Table 1. Comparison of root biomass by soil-pit method and other model estimations.

Plot	Soil pit (Mg/ha)	Allometry (Mg/ha)	Model (Allometry + Distance) 8.5m	Model (Allometry + Distance) 4.25m
P1-1	**22.9**	96.3	27.5	18.8
P1-2	**41.7**	96.3	40.6	30.7
P2	**97.5**	111.8	104.0	94.6
P3	**27.5**	157.6	51.8	16.0
P4	**35.1**	231.9	56.8	37.0
Mean	**50.5**	149.4	63.3	44.6

Change of standing biomass and dead mass of some mangroves over 6 years in Ranong, southern Thailand - before and after Tsunami –

Ryuichi Tabuchi[1], Yoshimi Fujioka[2] , Reiji Yoneda[3], Hajime Utsugi[3], Kyotaro Noguchi[3], Yasumasa Hirata[3] Decha Duangnamol[4], Sasitorn Poungparn[5]・Pipat Patanaponpaiboon[5]

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We are monitoring stand structure of mangroves to detect the impact and pattern of Tsunami damage on stand productivity and their recovery processes. We established study plots of mangrove at Sukusamran District, Ranong Province in 2003 to monitor the stand dynamics as the source of nutrition offered to ecosystem. Just after the second census on individual base in November 2004, Tsunami attacked our plots. We fortunately returned to each plot to check the direct impact in March 2005, and started annual re-census again since November 2005 up to present. The last census was made in December 2009. Initial biomass estimates of 4 stands (Plot-A, B, C and D) in 2003 (and in 2009) were varied as 84.8 (96.6), 93.1 (138.9), 202.7 (241.8) and 198.5 (257.9) ton/ha respectively with reflecting dominant species and stand structure. Mangroves of this area have ever experienced clear felling for charcoal production and all stand studying are estimated in around 16 years old in age when began monitoring in 2003. There difference of major species was so significant so that *Rhizopjhora apiculat*a dominated Plot C and Plot D were far higher than those of either Plot A as pure *Avicennia* alba stand or *Avicennia-Rhizophora* mixed Plot B. The dead tree mass during 6 years for Plot A to D were 8.53, 7.88, 12.67 and 15.98 ton/ha, respectively. The damage pattern on mangroves and recovery so far can be classified into three types in the followings. Type-1: Stand shaken by mass Tsunami water with no direct hit by wreckage. This type is observed in the interior of large mangrove zone (Plot D). Type-2: Stand shaken and hit by wreckage. Mangrove at water front is often mown (Plots A, B and C). Type-3: Stand directly attacked by strong Tsunami and covered by thick sand, Mangrove facing to sea near river mouth is entirely mown down and covered by sea sand to 1.5 m at thickest. High mortality was observed within initial two years after Tsunami including trees hit by wreckage in case of type-2 stands but Plot D (type-3) showed the peak of mortality in the third year. Small to middle size trees were majority of dead trees. The pattern of biomass change is the simple increase so far except slight retarding by tsunami damage in Plot A to C. Tsunami impact was supposed as if working to remove trees which would be disappeared by natural competition in advance.

The case of type-3 stand was much different. In spite of our expectation that removal of sand by natural tide current brings mangrove habitat again enough to recover original vegetation, binding power by densely woven root system was rapidly decayed due to mass killing of standing trees and appeared as the loss of habitat by erosion of substratum consequently.

Zonal Variation in Dynamics of Leaf Litter in a Secondary Mangrove Forest of Thailand

Sasitorn Poungparn, Vilanee Suchewaboripont, Pipat Patanaponpaiboon

Department of Botany, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand

A study on dynamics of leaf litter was conducted in 3 vegetation zones of a secondary mangrove forest locating on the estuary of Trat River, eastern Thailand. Classified by the dominant tree species, the vegetation zones were in a series of *Avicennia*, *Rhizophora*, and *Xylocarpus* zones from the river fringe to inland part. We studied the dynamics of leaf litter including the following parts; litter fall production, litter standing crop, litter decomposition, imported/exported litter, and consumed litter (Figure 1). The results showed that amount of litter fall (1.37–2.51 $g/m^2/day$) and litter standing crop on the forest floor (0.14 - 0.58 $g/m^2/day$) were significantly different among zones. *Rhizophora* zone showed the highest amount and followed by *Avicennia* and *Xylocarpus* zone, respectively. Ratio of litter standing crop and litter fall was less than 1.0 in all zones indicating lost of leaf-litter from the forest by decomposition, consumption and export by tide. Imported leaf-litter was observed from the forest floor just under the litter traps. They were in a range of 0.13-0.47 $g/m^2/day$, and differed by zone. We discussed the potential of imported leaf-litter by the environmental and morphological characteristics of each zone, such as frequency of tide and aboveground root system. Rate of leaf-litter decomposition related to the soil temperature, and thus the rate of CO_2 emission from the soil respiration previously studied in this study site by Poungparn *et al*. (2009). The amount of consumed leaf-litter was indirectly estimated by abundance and density of leaf-litter eating crabs. Huge amount of consumed leaf-litter was found in *Xylocarpus* zone, while the consumed leaf-litter by crabs was assumed to be zero in *Avicennia* zone because no leaf-litter eating crab was found. Finally, the exported leaf-litter was calculated by balancing amount of litter fall, imported litter, litter standing crop, consumed leaf-litter, and decomposed leaf-litter. The zonal differences of leaf-litter dynamic by some physical and biological factors were discussed.

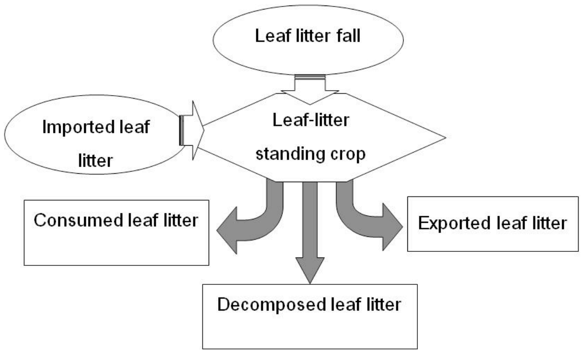

Figure 1 Model of leaf litter dynamics in mangrove ecosystem

Keynote Lecture

09:30 – 10:00, 8 October 2010

Room Kujaku (孔雀) 4F
Mielparque Tokyo

Dynamics of stand structure and NEP of a tropical rain forest in Southeast Asia, basing on a long-term research in Padang and Pasoh

Tsuyoshi Yoneda

Department of Environmental Science and Technology, Faculty of Agriculture, Kagoshima University, Kagoshima, Japan

Negative impacts from drought, fire and a storm have been largely depressing quality and quantity of a forest in Southeast Asia including a tropical forest in northern Australia, though a Neotropical forest showed some increase in biomass owe to some positive influences from climate changes. Drought weather, in particular, would be a harmful factor for humid tropical plants including even the Neotropical plants, in which the event in 2005 decreased biomass in Amazon area as much as about 2% of annual amount of net primary production of global terrestrial ecosystem. It would be a complex problem to grasp a long-term trend of rainfall patterns in the tropics because of wide spatial/temporal variances, however drought weather in Southeast Asia is realized to increase in abundance and extent. Long-term research with large area could provide us variable information about impacts from these natural disasters. I would like to discuss the impacts basing on the research at two sites. One is Padang in West Sumatra. Long-term census of a stand dynamics has been conducted with several permanent plots (0.1 - 1 ha area) at an interval of 1.5 years during the last three decades. Another is Pasoh in Peninsular Malaysia. Dynamics of a forest stand was analyzed through field observation and Dbh data-base at a 50-ha plot during the last two decades (FRIM). Impacts from natural and man-made disturbance on stand dynamics and function will be discussed with the biotic parameters of tree mortality, growth ratio, guild composition and Net Ecosystem Production. Summary of this paper is

1. Mortality of a canopy tree has been increasing in Padang and Pasoh since the latter half of 1990s.
2. A montane forest in Padang showed the similar phenomenon with some delayed phase.
3. Drought weather would be a major factor for this event primarily, and an established gap could accelerate mortality secondarily.
4. The present high variance of monthly rainfall could be a harmful factor for trees under super-humid climate particularly.
5. High turnover of canopy trees would change not only species composition being advantages for trees with soft-wood and high growth rates, and but also NEP because of high CO_2 emission from mass CWD.
6. CWD could cause negative NEP at the initial stage of regeneration process from SMS logging operation.

Session 2

Forest Monitoring using Satellites Images and Ground-Based Measurement

10:00 – 12:00, 8 October 2010

Room Kujaku (孔雀) 4F
Mielparque Tokyo

Outline of the forest monitoring methods using remote sensing and ground-based measurement

Yoshiyuki Kiyono [1]

[1] *Department of Plant Ecology, Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan*

A simplified method for estimating CO_2 emissions from deforestation and forest degradation (DD) is the calculation of carbon stock change by monitoring forest land and periodically summing up the land area and its averaged carbon stock for important forest types. Kiyono et al. (2010) have done a feasibility study for applying this method to a tropical dry-land forest in Cambodia. Based on this method and relating to REDD, a total monitoring scheme was designed for estimating carbon stock per unit land area and 5 types of approaches with relatively high practicalities were selected. Each approach uses different parameter: 1) back scattering coefficients of PALSAR, 2) community-height, 3) tree crown size, and 4) community-age, and data from 5) permanent sampling plots (PSPs). Considering requirements for monitoring methods for REDD; accuracy, large-scale, semi-real time, choices, etc., combination of forest area estimation using mid- to higher resolution remote sensing data and carbon stock estimation by PSP measurement has higher feasibility. Kiyono et al. (2011, accepted) examined non-destructive methods for practicalities in monitoring anthropogenic greenhouse gas (GHG) emissions from tropical dry-land forest under the influence of various forms of human intervention. Compared to non-destructive methodologies for land cover classification, those available for carbon stock estimation have low-level practicalities in monitoring anthropogenic GHG emissions from tropical forests under the influence of human intervention. As for carbon stock, PALSAR is at an advantage by enabling semi-direct measuring using backscattering coefficients although it is limited to forests with medium or low biomass. There are no practical methods for monitoring the amount of carbon loss by forest conversion and logging in high-biomass forests. An inexpensive method available at present is applicable only to monitoring carbon stock in cyclic land use that includes clear-cutting stage, such as in slash-and-burn agriculture. It is suggested that the practical method should be chosen from adaptive options with considerations of available data and resources in the target region. Although the approach using PSP data may cost more than the other methods, the combination of forest area estimation using mid- to higher resolution remote sensing images and carbon stock estimation using PSPs shows the high feasibility under the present circumstances. To compensate for the faults of PALSAR methodologies at present and to enable practical and frequent monitoring of all types of forest vegetation by humans, it is vital to devise a new methodology to detect changes in high-biomass forests. Important human intervention forms that can cause DD may be different among biomes. Provision of choices of methods according to biomes, human intervention forms, data and institutes availability, costs etc. will be a role of researchers in addressing the issue of REDD.

Forest monitoring by PALSAR in Indonesia and Cambodia

Tomoaki Takahashi [1], Yoshio Awaya [2], Yoshiyuki Kiyono [1], Hideki Saito [3], Tamotsu Sato [1], Jumpei Toriyama [1], Yukako Monda [1], Masanobu Shimada [4], Suwido H. Limin [5], I Nengah Surati Jaya [6], M Buce Saleh [6]

[1] Forestry and Forest Products Research Institute; [2] Gifu University; [3] Kyusyu Research Center, Forestry and Forest Products Research Institute; [4]JAXA; [5]Palangkaraya University; [6]Bogor Agricultural University

It has been expected that PALSAR (Phased Array type L-band Synthetic Aperture Radar) sensor using L-band frequency to achieve cloud-free and day-and-night land observation would have a potential for monitoring tropical rain forests. PALSAR provides higher performance than the JERS-1's SAR. In order to assess the potential of PALSAR sensor, we first tried to create land cover classification (LCC) maps in test sites in Indonesia and Cambodia. The results showed that the LCC maps had good agreement with LANDSAT ETM+ images in both test sites. Especially, the rate of coincidence of the PALSAR-derived LCC map with a LANDSAT ETM+-derived LCC map was approximately 92% when setting five types of cover, i.e., high- (>= 170 Mg/ha), middle- (170-10 Mg/ha) and low- (<= 10Mg/ha) above ground biomass (AGB) areas, burnt area, and waters. Next, the relationship between above ground biomass (AGB) and backscattering coefficients of dual polarization data (i.e., σ_{HH} and σ_{HV}) were investigated. Not only field measured AGB was used in the analysis for both test sites, but also Light Detection And Ranging (LiDAR)-AGB in large area (ca. 28 km^2) in the test site of Indonesia was also used to investigate the relations. The results showed σ_{HV} would be superior to σ_{HH} for estimating AGB when using simple nonlinear regression model both in Indonesia and Cambodia, although the residuals of the regression equations seemed to be indispensable for estimating accurate AGB. All results of this study indicate that although PALSAR would be a very powerful tool for forest monitoring in tropical forests, further researches should be conducted to reveal the potential of PALSAR data and suggested more sophisticated methods and modeling to acquire accurate LCC map and AGB estimates in any forests toward practical application of PALSAR-based monitoring.

Monitoring forest biomass carbon stock using permanent sample plots (PSPs) in Cambodia

Samreth Vanna [1], Chheng Kimsun [1], Jumpai Toriyama [2], Satoshi Saito [3], Yukako Monda [3], Hideki Saito [4], Yoshiyuki Kiyono [3]

[1] Forestry Administration, Ministry of Agriculture Forestry and Fishery, Kingdom of Cambodia, [2] Bureau of Climate Change, Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan, [3] Department of Plant Ecology, Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan, [4] Kyushu Regional Research Center, Forestry and Forest Products Research Institute, Kumamoto, Japan

Forest carbon stock by using the permanent sample plots (PSPs) of the Forestry Administration (FA) in Cambodia was estimated. The FA has established one hundred and twelve (112) PSPs representative of three major forest types in the four territorial management zones, viz. Mekong, Gulf, South Tonle Sap, and North Tonle Sap in Cambodia. The PSPs are distributed in the five provinces (Kampong Thom, Siem Reap, Koh Kong, Kratie, and Ratanakiri) of the country in 1998. The PSPs were allocated in evergreen forest (EF), mixed forest (MF), and deciduous forest (DF), and each forest type contains stands with different magnitudes of disturbance. Trees with DBH of 7.5 cm or above in the PSPs have been monitored for 4 times in 1998, 2000-2001, 2004, and 2010. For this study, we used only the data collected in 1998 and 2000-2001 in all five provinces mention above. The PSPs were set in evergreen forest (EF), mixed forest (MF), and deciduous forest (DF). Forest carbon stock in the PSPs was estimated using the datasets of DBH, tree height, and wood density (IPCC's default values were used based on the botanical names of trees) in 1998 and 2000-2001, and a generic equation for tree biomass (Kiyono et al. 2011, accepted). Averaged forest carbon stock was estimated at 124.9 ± 73.7 Mg-C ha^{-1} in 1998 and 127.3 ± 79.4 Mg-C ha^{-1} in 2000-2001 for "EF and MF" (hereafter EF) and at 33.9 ± 24.4 Mg-C ha^{-1} in 1998 and 33.7 ± 23.6 Mg-C ha^{-1} in 2000-2001 for DF. Averaged forest carbon stock did not significantly differ between 1998 and 2000-2001 for both EF and DF, while it significantly ($P < 0.0001$) differed between EF and DF. Consequently, stratifying forest types may be useful to reduce uncertainty in nationwide forest carbon stock estimation. Using default values of forest carbon stock specific to each forest type may be allowable for forest under less pressure of land-use change and forestry activities. Required number of PSPs for reducing uncertainty in estimating forest carbon stock in Cambodia was 46-50 plots for EF and 21 for DF. Since the numbers of existing PSPs are 85 for EF, and 15 for DF, at least six additional PSPs of DF are needed for estimating total forest carbon stock with reasonable accuracy. The nationwide EF and DF forest carbon stock in Cambodia in around 2000-2001 (a temporary figure) was estimated at 625.4 ± 219.5 Tg-C.

Soil carbon stock in tropical monsoonal forests and rubber plantations in Cambodia

Jumpei Toriyama [1], Keizo Hirai [2], Sophal Chann [3], Seiichi Ohta [4], Yasuhiro Ohnuki [5], Eriko Ito [6], Mamoru Kanzaki [4], Makoto Araki [5], Hideki Saito [7], Yoshiyuki Kiyono [5], Masamichi Takahashi [5]

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Tropical monsoonal forests that cover wide areas of the Indochina peninsula are key regions for the Reducing Emissions from Deforestation and Forest Degradation (REDD) project in Southeast Asia. Country-wide data from five major carbon (C) pools in the forest ecosystem (forest aboveground and belowground biomass, deadwood, litter and soil) are required for technical support of the REDD scheme. However, the monsoonal forest C inventory, particularly for soil, is presently inadequate for this purpose. Hence, we studied relationships among soil C stock in tropical monsoonal forests, type of forest, and environmental factors in the lower Mekong basin, Cambodia. We analyzed nine soil profiles in evergreen and deciduous forests growing over sedimentary rock and basalt. Categorization of tropical monsoonal forests into evergreen and deciduous likely reflects intrinsic ecological functions, and this classification has been adopted by some Southeast Asian countries (e.g., Thailand, Cambodia, Laos). Evergreen forest soils tended to have a larger C stock than deciduous forest soils within geological formations. In evergreen and deciduous forest soils, carbon stocks were 57 ± 30 (mean ± SD) and 35 ± 24 Mg C ha^{-1}, respectively, in the 0−30-cm depth range, and 109 ± 53 and 53 ± 30 Mg C ha^{-1}, respectively, in the 0−100-cm depth range. Soil C stocks were comparable to those of similar forests and geological formations in Thailand, and higher than those in Southeast Asian humid tropics (except in Andosols and peat soils). Soil C stock was highly correlated with soil water content in the dry season, which is thought to be related to forest canopy openness and soil clay content, which is likely an indicator of conditions for accumulation of soil organic C in tropical monsoonal regions. We also studied soil C stock in rubber plantations that are rapidly expanding in Cambodia to evaluate the effect of land use change (deforestation) on soil C stock in the region. The soil carbon stock in four rubber plantation sites ranged from 34 to 48 Mg C ha^{-1}. The soil C stock in rubber plantations was correlated with soil clay content. However, soil C stock in rubber plantations was small compared to that in natural forests with similar clay content. It was suggested that soil C stock decreased after the land clearing of natural evergreen forests and plowing for the rubber plantations. In the future study, the soil C change discussed above should be related to the change in aboveground biomass C, the largest C pool in the forest ecosystem for the technical support of REDD scheme.

Relationship between community height and biomass in peatland forests, central Kalimantan

Tamotsu Sato [1], Yoshiyuki Kiyono [2], Tomoaki Takahashi [3], Sen Nishimura [4], Hideki Saito [5], Yoshio Awaya [6], Jumpei Toriyama [7], Agung R. Susanto [8], Suwido H. Limin [8]

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Despite the importance of estimation of national-level forest biomass carbon stocks under the REDD scheme, scientific tools and models that can scale up point data to large-scale data are insufficient. Besides stand age and crown diameter, community height data is one of the important parameter to connect between ground-base and remote-sensing measurement in degradation forests. The aim of this study is to evaluate possibility of estimation of carbon storage (i.e. aboveground biomass) using community height data in degradation forests, especially peatland forests. In this study, we used 18 plots which were established near Palangka Raya, Central Kalimantangin in early 2009. Area of each plot was 0.12 ha (30m x 40m). We defined "community height" as following two ways: "maximum height" and "average height". Maximum height was defined as tallest tree height in the plot. Average height was defined as mean value of the maximum tree height of each quadrat (n=4). Because there were no trees in lower biomass plots and shrub dominated plots, we focused biomass estimation at high biomass plots only (more than 50 Mg ha^{-1}). We made simple equations between community height (maximum height and average height) and aboveground biomass in the plots. We also compared estimated (equation derived) and measured (ground data derived) biomass in the plot. We concluded the following points from this study:

- Biomass in peatland forests could be estimated using community heights.
- Maximum height would be better parameter for biomass estimation in stands with wide range biomass. However uncertainty still remain for degraded forest and monitoring of biomass changes.
- As compared with measured biomass, estimated biomass tended to underestimate in extremely high biomass stands (more than 300 Mg ha^{-1}) and overestimate in middle and high biomass stands (less than 300 Mg ha^{-1}).
- We need more data about peatland forest biomass (i.e., different stand type, belowground biomass, etc.).

Fire impacts on carbon pools in tropical forests: Post-fire succession in peat swamp forest under drainage influence in Central Kalimantan, Indonesia

Yoshiyuki Kiyono [1], Tamotsu Sato [2], Jumpei Toriyama [3], Tomoaki Takahashi [4], Hideki Saito [5], Yoshio Awaya [6], Suwido H Limin [7], Agung RS [7], Yuda P [7], F Darma [7]

[1] Department of Plant Ecology, Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan, [2] Department of Forest Vegetation, Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan, [3] Bureau of Climate Change, Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan, [4] Department of Forest Management, Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan, [5] Kyushu Regional Research Center, Forestry and Forest Products Research Institute, Kumamoto, Japan, [6] River Basin Research Center, Gifu University, Gifu, Japan [7] Center for International Cooperation in Sustainable Management of Tropical Peatland (CIMTROP), University of Palangka Raya, Palangka Raya, Indonesia

Fire can seriously impact on forests with trees vulnerable to fire. Peat swamp forest is one of such forests and once drained for exploitation, can easily catch fire in dry weather. Studies of post-fire succession in drained peat swamp forest were less as compared to those in dry-land forest and therefore, predicting secondary succession after peat fire remains difficult. We aimed to obtain post-fire data useful for people living on the peat land miss-managed and under serious ecosystem degradation caused by fire. We set over 20 of 30 m x 40 m permanent sampling plots (PSPs) in December 2008-February 2009 to monitor peat swamp forest under influence of drainage as a whole near Palangkaraya, Central Kalimantan. Trees with DBH ≥ 5 cm in the PSPs were recorded their vernacular names and tagged to monitor changes in DBH and for some trees, tree height. For plants with DBH below 5 cm, understory vegetation, a mean surface height was measured in each PSP. Biomass was estimated by generic equations for trees and understory vegetation respectively. By November 2009, about two-third of the PSPs have been suffered with fire. We measured the PSPs again in December 2009-February 2010 for biomass and deadwood stock. We here showed only initial results. The existing forest was classified into four types corresponding to stand development and also biomass classes. Both land cover classifications by Landsat/ETM+ and ALOS/PALSAR corresponded well to the classifications by ground-based measurement. 1. "The high biomass forest" (around 200 Mg ha^{-1}) is a logged over primary forest and at the old-growth stage. 2. "The low biomass forest 2" (less than 10 Mg ha^{-1}) is considered to be at the stand initiation stage derived from the newly-burnt primary forest. A small number of standing and abundant fallen primary trees exist. 3. "The middle biomass forest" (around 50 Mg ha^{-1}) is secondary forest at the young stage derived from "the low biomass forest 2". Fallen trees have decomposed and *Combretocarpus torundatus* and *Cratoxylon arborescens*, primary forest pyrophytic trees, and exotic *Acacia* trees are often dominant. 4. "The low biomass forest 1" (less than 10 Mg ha^{-1}) is considered to be at another stand initiation stage derived from the forest at-least-twice burnt. This forest has distinctively less deadwood stock. As a conclusion, drainage and fire may cause plagiosere succession of peat swamp forest through impacts on water and carbon circulations and floristic composition. Redesigning of land use including rewetting, fire prevention, land reallocation to agriculture and forestry is indispensable for mitigating permanent degradation of peat land forest ecosystem, as livelihood resources for human being.

Session 3

Ecosystem Services and Human Activities in Swamp Forests

13:00 – 15:00, 8 October 2010

Room Kujaku (孔雀) 4F
Mielparque Tokyo

Potential resources in swamp forest ecosystem - Change in a riparian swamp in NE Thailand in half century -

Tabuchi Ryuichi [1], Sano Makoto [2], Yoneda Reiji [2], Hayashi(Tabura) Noriko [3], Decha Muangnil [4], Sasitorn Poungparn [5], Pipat Patanaponpaiboon [5]

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The incentives with which local community initiates to conserves swamp forests for livelihood are studied on their potential and acceptance by community as well as the problems which participatory forest management project held and solutions for them to accelerate swamp conservation through community forestry.

In the present paper, we focus initially on the land use types and their area in around the riparian swamp forest in Na Kae, Yasothon province, NE Thailand. We found obvious fragmentation and shrinkage of forests within half century by landscape analysis of GIS data in last half century. And the structure and standing biomass are monitored as the agents reflecting the potential resource from swamp forest ecosystem to present productivity for further determination of allowable resource harvest. There was apparent difference in tree size and species composition by the relative ground elevation which determines the frequency and duration of water logging so that the higher site is rich in large trees while the lower site is covered by small shrubby trees densely. The difference in biomass estimates between them arose more than 3 times as 52.1 in low site and 192.9 ton/ha in the high site, respectively. The annual biomass increment also varied as 2.53 in low site and 1.56 ton/ha/yr in high site..

The biodiversity of small mammal became low due to frequent use of swamp forest by local people so that 10 mammal species out of 18 ever sighted during 50 years were already disappeared.

Sustainably managing the Matang (Malaysia) Mangroves

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The 40,000 hectare Matang Mangrove in Peninsular Malaysia which was originally managed for the extraction of timber to fuel steam locomotives that ferried tin ore from Taiping to Port Weld. Charcoal then became the main timber product of the forest. With the introduction of kerosene and then petroleum gas as alternative cooking fuel, local demand for charcoal fell. Presently, most of the charcoal produced is exported. We look at the management system based on a 30-year rotation with commercial thinnings at 15 and 20 years.

From just the timber extraction point of view, the mangroves, having been managed for a century, are arguably managed on a sustained yield basis. However, more holistically and in particular from the ecological, economical and community involvement points of view, we ask if the Matang mangrove is truly sustainably managed.

Whilst mangroves do occur naturally in mono-specific stands, these stands are restricted to particular tidal inundation zones [e.g. *Rhizophora apiculata* do well in Watson's (1928) Inundation Classes 3 and 4]. The current practice of planting *Rhizophora apiculata* in the other tidal inundation zones not only results in ecological inefficiencies but also in the reduction of biological species diversity. However, even though the mangroves are used for charcoal (which eventually returns carbon dioxide to the atmosphere), litter sequestered in the soil still makes the mangroves a carbon sink. Use of mangroves for aquaculture ponds, on the other hand, releases carbon that has been sequestered over the past hundreds of years.

It is shown that whilst charcoal production returns some MYR 27 (~US$8.2) million per annum, the industry is significantly subsidized by the government through the services of the forestry department. This is the result of the low price of charcoal probably caused by "rent seeking". Whilst it generally makes sense for governments to provide equity when there is economic market failure, whether this subsidy is justifiable in this particular situation, when much of the charcoal produced is now exported, is certainly not moot.

Management is based on a "top down" approach but there has been a recent attempt by non-governmental organizations to involve local community participation in the management system. Thus, the take home message is that, no matter how successful a management system may be, it is not wise to just follow blindly. There must be constant and critical review based on good science and a holistic approach.

Fisheries activities and resources in swamp forests

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Wetlands such as riparian freshwater swamps and mangrove swamps are important for nursing fisheries resources with supplying potential source of food and breeding sites or shelter. We demonstrated in this study the biological diversity and the productivity of fisheries resources supported by swamp forests in tropical Southeast Asia. Two main study sites, riparian swamp forests in floodplain along Lam Se Bai, Yasothon province, northeastern Thailand and mangrove swamp forests and the adjacent coastal areas of Kamphuan, Ranong province, southern Thailand, were selected in the Kingdom of Thailand. We studied the following subjects from the viewpoint of biological, fisheries and social scientific aspects, respectively; (1) aquatic organisms and environment in riparian freshwater swamps and mangrove swamps, (2) fishery activities in swamps to utilize sustainably natural resources and (3) livelihood of fishermen and other local inhabitants. The original data were obtained by means of ecological field survey and interviews, and the secondary data were analyzed from statistical data and monitoring data of government office, village office and international organizations. In both study sites, traditional fishery activities were established to support relationships between livelihood of local inhabitants and ecological services in swamp ecosystem. In Na Kae village, Yasothon province, approximately 70 inhabitants used several different kinds of fishing gears including traditional branch stake traps "luan loub" and "pon paan" along the river stream of Lam Se Bai, which is a small branch of Mekong river. Species of cat fishes and cyprinid fishes dominated in this areas and a total of 45 fish species belonging to 33 genera and 14 families were collected by means of these fishing gears and/or sold at local fish market of Yasothon. Water level of Mekong-Mun-Chi basin was controlled by 22 dams in the northwestern Thailand, and the river often flooded during rainy season on the floodplain of Lam Se Bai and some other branches. While, in the coast of Kamphuan sub-district, Ranong province, more than 200 local fishermen operated 13 different kinds of characteristic fishing gears by sharing the fisheries resources such as fish, shrimp, crab, cuttlefish, squid, jellyfish and so on. They might utilize sustainably fisheries resources by being avoid competition each other. On December 26th, 2004, the impact of Tsunami waves caused by an undersea earthquake off Sumatra Island generated severe damage to artificial constructions and natural ecosystems on coastal area along the Andaman Sea. On damaged areas, biomass and diversity of macrobenthos decreased significantly after the Tsunami. Three dominant macrobenthic communities, polychaetes, mollusks and arthropods, on the mangrove swamps were changed by the Tsunami; endobenthic organisms such as polychaetes and bivalves decreased significantly due to be buried in sand, while epibenthic organisms such as gastropods and crustaceans decreased at once but recovered immediately, and terrestrial organisms such as insects increased on dried sandy substratum.

Land use history and local conservation of a mangrove forest in Chantaburi Province, Thailand

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In the past several decades, mangrove forest areas in Thailand have experienced rapid destruction and/or degradation. Among the many reasons for this, land use conversion for aquaculture, especially shrimp farming, has been the main factor in recent years. This case study in the Welu Wetland of Chantaburi Province, Thailand, investigated land use history and local conservation of mangrove forests in relation to the rise and fall of shrimp farming.

Mangrove forests are found in coastal areas along the Gulf of Thailand and have been an important source of firewood and charcoal for local people's kitchens in the fuel-poor delta. Areas with mangrove forests have also acted as centers for salt production. In former times, shrimp was a byproduct of salt pens. Since the late 1940s, when salt prices declined, local people began to engage in shrimp farming. In this early era, shrimp farms relied solely on the natural larvae of Peneaus merguiensis. The stocking density of P. merguiensis was less than $1/m^2$ at that time. In Thailand, extensive and semi-intensive farms were commercially established in the 1970s. The stocking density of Penaeus monodon was $2\text{-}5/m^2$ in extensive and semi-intensive farms. An intensive shrimp farming system was introduced from the 1980s. Encouraged by extremely high prices on the Japanese market, Thailand became the world's leading producer of farm-raised P. monodon in 1988. Its high profitability fuelled a rapid spread of shrimp farming into mangrove forests along the Gulf of Thailand. In the 1990s, shrimp farming areas began to decline in number due to outbreaks of shrimp disease. Penaeus vannamei was introduced into Asia in the 1990s. Due to a number of favorable factors in the 2000s, commercial production of P. vannamei overtook the production of P. monodon in Thailand. In present-day Thailand, shrimp farming systems have diverged into two groups: 'natural systems' (i.e. extensive aquaculture) and 'developed systems' (i.e. intensive).

The land use history of Welu Wetland has been affected by these changes in shrimp farming. If mangrove forests were owned and managed by the state, communities would have limited or no rights to access. However, even under the 'exclusive' state management, coastal communities do in fact access and manage the mangrove forests. Although the entire area of Welu Wetland is national reserved forest, community participation in mangrove forest management is quite important. In contrast to other areas, 'resource scarcity' was not the driving force for the recent recovery of mangrove and its conservation in Welu Wetland. After the collapse of the shrimp farming, caused by a viral disease outbreak in 1990s, many villagers gave up shrimp farming, reduced their farm size and returned to extensive aquaculture. Those changes made room for reforestation in areas disturbed by shrimp farming. Today, the Welu Wetland of Chantaburi is attracting visitors through ecotourism based around its mangrove fireflies, a successful case of local mangrove management.

Difficulties of prescriptive tropical forest governance models and their practical function in REDD+: A basis for framing better swamp forest management under the emerging paradigm

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Illegal loggings and REDD (Reducing Emission from Deforestation and forest Degradation) have raised international interest in forest governance in tropical countries. Over the past decade, international authorities, nongovernmental organizations (NGOs), and academic institutes have held many workshops and presented prescriptive forest governance models. Such models have been devised to be progressive, and it has resulted in building them into operational frameworks of both illegal logging and REDD+. This study aimed to show what functions forest governance models fulfill under the coming REDD+ order. The concrete mechanism of the REDD+ order is more difficult to determine than that of illegal loggings. An approach composed of three phases, which is now the most dominant approach of the REDD+ operational framework, is used here as an example; the more likely function of the forest governance model is presented together with several other functions. We found that forest governance models possibly act as the control gears for braking, rather than accelerating, the transitions in the phased approach. One reason for this perspective is that passing the criterion for phase transitions imposed by prescriptive forest governance models is likely very difficult for many countries because extremely wide gaps exist between such models and real situations. Another reason is the precedence of many empirical examples of difficulties encountered in improving governance in the field of developmental assistance. This study addresses the following: the definition of and typical model of forest governance, the background of the growing interest in forest governance, the position and functions of forest governance models under the REDD+ operational framework, the more likely function of forest governance models under the REDD+ operational framework, and the difficulties of forest governance models compared to real situations.

Poster Session

14:40 – 15:40, 7 October 2010

Room Botan (牡丹) 3F
Mielparque Tokyo

Estimation of annual soil respiration rate in a larch forest in Central Siberia

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Soil is a major carbon pool in terrestrial ecosystems. Soil respiration (SR) is an important component process of carbon cycle. Boreal forest in Russia plays an important role in carbon storage. The purpose of this study was to elucidate the effect of soil temperature and moisture on the SR related to the difference of forest floor vegetation in a larch forest in Central Siberia, and to estimate annual SR there. The study was conducted in Tura (64^o 12’ N, 100^o 27’ E), Central Siberia from 2005 to 2007. The annual mean temperature and precipitation are –9.2 ^{o}C and 334 mm, respectively. Soil type is Gelisol with permafrost below the depth of 70 to 100 cm from the surface and poor drainage. The forest consists mainly of Larch (*Larix gmelinii*) trees about 100 years old. Patches of lichens and mosses, mainly *Cladina* sp., *Pleurozium* sp., and *Aulacomnium* sp., cover the forest floor with depth of 10 to 20 cm. SR was measured by using a closed chamber technique. Each two chambers were set on patches of *Cladina stellaris*, *Pleurozium shreberi*, and *Aulacomnium palustre*. Soil temperature and moisture as a volumetric water content moisture by TDR were measured at a depth of 10 cm and 0–12 cm below the surface near the chambers, respectively. Soil temperature in the *Aulacomnium* patch was significantly lower than that in other patches in July (6.4 ^{o}C) and September (4.4 ^{o}C). Soil moisture in the *Aulacomnium* patch was significantly higher than that in other patches in both July (0.31 m^3 m$^{–3}$) and September (0.38 m^3 m^{-3}). Highest SR (mg C m$^{–2}$ h$^{–1}$) was observed in *Pleurozium* patch in July (181). There were significant differences among the mean SR of different patches. SR for each patch was in the following order: *Pleurozium* (44 ± 28) > *Cladina* (34 ± 21) > *Aulacomnium* (26 ± 18). SR in winter was negligible small, but was observed (max: 1.0). SR was positively correlated with soil temperature (r = 0.71 P < 0.01) and negatively correlated with soil moisture (r = –0.57 P < 0.01). It is considered that SR in *Aulacomnium* patch was smaller than other patches due to low soil temperature and high soil moisture. The relationship between the SR and soil temperature was somewhat different depending on the month. The difference suggests that yearly difference in permafrost thawing would affect the soil respiration. SR in growing season (113 g C m^{-2}) and winter season (11.9 g C m^{-2}) was calculated separately from each relationship between SR and soil temperature. The contribution of SR in winter season to annual SR estimated 9.5%. Annual SR of 125 g C m^{-2} was smaller than review value of 322 ± 31 g C m^{-2}. The value in this study was similar to that of 94 ± 16 g C m^{-2} in Northern bogs and mires.

Soil carbon stock of tropical monsoon forest in western Thailand

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Forest soil is one of the big reservoirs of carbon in the forest ecosystem. It is important to reduce carbon emission from the forest sector to prevent climate change in most tropical countries. The changes of soil carbon stock following forest decrease and degradation in the forest ecosystem was necessary to promote REDD activity in these developing countries. In this study, we aim to clear the soil carbon stock of each forest type in the tropical monsoon forest in Thailand. A study site was located in Mea Klong Watershed Research Station (MWRS), Kanchanaburi province, western Thailand. Mixed deciduous forest (MDF) was dominant in this site. Fifteen soil profiles were selected to analyze soil carbon stock in dry evergreen forest (DEF), MDF, dry dipterocarp forest (DDF), teak (*Tectona grandis*) plantation, grassland at MWRS. Soil carbon stock in 0-30cm depth following Tier 1 of IPCC-GPG were estimated from the soil carbon content and bulk density of fine soil. We discussed the difference between soil carbon stock between in Thai and in Cambodian forests (Toriyama *et al.*, 2007; 2010) under same climatic zone in SE Asia. To discuss the factors controlling soil carbon stock in forest soil, clay contents in forest soil was also determined. Soil carbon stock (kgC m^{-2}) was 11.5 in DEF and 4.6 in DDF. Average soil carbon stock in MDF dominant in this area was 6.8, and ranging from 5.5-8.7. In MDF, average soil carbon stock of secondary and degraded forest was 5.9, and this of primary forest was 7.3. Average soil carbon stock in grassland after shifting cultivation was 7.4, and ranged 6.0-9.1 and in teak plantation was 5.3. Soil carbon stock was the highest in DEF and the lowest in DDF. In Cambodian forest, the average soil carbon stock in MDF was close to the Thai forest, but that of DEF was lower than the Thai forest. To clear the difference of soil carbon stock between the Thai and Cambodian forests, the factor to control soil carbon stock was discussed. Soil carbon stock has a positive relationship with clay contents of soil, but different trend was observed between MDF, and DEF and DDF. It was also observed that soil carbon stock was higher in the soil of the Thai forest than those of the Cambodian forest when clay contents were equal. It means the capacity of carbon adsorption were different between Thai and Cambodian forest soils. Our results indicate that soil carbon stock of the tropical monsoon forest was different among forest types, and forest degradation could be a possible cause of decrease in the soil carbon stock. It was suggested that clay contents in the soil regulates soil carbon stock from the comparative study of Thai and Cambodian forests.

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Preliminary survey of coarse woody debris (CWD) stocks in a hill dipterocarp forest, Semangkok Forest Reserve, Malaysia

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Coarse woody debris (CWD) is major pathway of carbon flux in forest ecosystems. Because CWD is a large and labile pool of carbon with significant impact on the net carbon budget of forest ecosystems, surveys of live biomass alone are insufficient to determine carbon budgets. In this study we investigated the stocks of CWD in a hill dipterocarp forest in peninsular Malaysia. The study was conducted in an old-growth hill dipterocarp forest in the Semangkok Forest Reserve, Selamgor, Malaysia. The study plot is dominated by *Shorea curtisii.* To estimate the CWD mass, we used a sample plot inventory method using twenty 20-m × 20-m quadrats. In each quadrat, all CWD with an end diameter ≥ 10 cm was measured in September 2009 and classified as snaps, standing dead, uprooted logs, or fallen logs. The total mass of CWD averaged 92.68±106.64 (SD) Mg ha^{-1} (range, 4.98–341.01 Mg ha^{-1}). This average values is greater than that estimated in a lowland dipterocarp forest at Pasoh (49 Mg ha^{-1}). The CWD mass accounted for about 15% of AGB. This percentage is higher than that in other tropical forests. In the plot, fallen logs were the major form of CWD: 42%. About 27% of CWD was uprooted and 17% was snaps. The CWD mass differed markedly throughout the topographic positions in the plot. The headmost wall slope position had a higher CWD mass than that in other slope positions. In the Semangkok Forest Reserve, many *Shorea curtisii* trees are distributed around ridge, and are dominated within top canopy layer (e.g. 40-50 m in height). This specific stand structure is one of the reasons why the plot tends to have a high CWD stock.

Habitats suitable for the establishment of *Shorea curtisii* seedlings in the Semangkok hill forest, Malaysia

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Shorea curtisii is the most common tree species in the hill dipterocarp forests of Peninsular Malaysia, and is considered a key species for the dynamics of such forests. Therefore, investigations were conducted in the Semangkok Forest Reserve to determine what constitutes suitable habitat for the establishment of seedlings of the species. In the 4ha plot examined, there were 738 seedlings, and 97.6% of these grew within 40m of the mother tree. A random-effect Poisson regression model was fitted using the Markov Chain Monte Carlo (MCMC) procedure in the OpenBUGS software. 'Number of seedlings' was used as the dependent variable, and four environmental factors as the predictor variables, namely: distance from the mother tree (m), diffuse transmittance of light (%), Topographic Index (TI), and angle of slope (degree). Statistically significant coefficients in the fitted model were the distance from the mother tree, diffuse transmittance, and TI; the coefficient of the angle of slope was not significant. Distance from the mother tree and TI had a greater influence on seedling density than diffuse transmittance. Both of the former coefficients were negative, thus, seedling density was higher closer to the mother tree and in locations with small TI values (i.e. on the ridges). We conclude that microsites suitable for the establishment of *S. curtisii* seedlings are limited by topography, distance from the mother tree and light conditions; the first two factors are most important. Seedling density was high at locations within 40 m of the mother trees on the ridge. Hence, if logging is carried out in *S. curtisii* dominated forests, seed trees should be retained at intervals of a maximum of 40 m, and felling in valleys should be avoided unless the species is abundant. Moreover, it might be better for forest managers to avoid creating large canopy gaps, which may reduce the density of *S. curtisii* seedlings.

The importance of permanent sample plots in studying forest dynamics and carbon sequestration in Vietnam

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Successful implementation of sustainable forest management in the operational level relies on the understanding of process which occurs in natural forest ecosystems and the response of them due to intervention. The natural forests in Vietnam have been managed for over than three decades but the knowledge of such process is still limited due to lack of data derived from permanent sample plots (PSP). There are three things resulted from PSP, mainly diameter increment using to determine the cutting cycle and cutting diameter limit; volume increment using to determine the sustainable annual allowable cut; and stand structure dynamics to know the stand structure condition in the future. Stem analyses do not provide reliable data for many tropical tree species, so data must be obtained from remeasurements on PSP.

In Vietnam, 58 PSP of 1 ha each were established by the Forest Science Institute of Vietnam from 2004 to 2007. These PSP have been designed for studies on: (i) Vegetation analyses including forest structure, floristic composition and biodiversity; (ii) Forest dynamic processes such as growth, mortality and recruitment; (iii) Nutrient cycling such as litter fall, nutrient content, decomposition; (iv) Species ecology; and (v) Other dynamic properties of four tropical natural forest ecosystems (forest types) in of Vietnam, namely: evergreen broad-leaved forest (34 SPS), dry dipterocarp forest (6 SPS), mangrove forest (10 SPS) and melaleuca forest (8 SPS). Remeasurements on PSP have been done periodically 3-5 years. A summary of basic silvicultural parameters from four forest types is given in table 1.

Table 1: Summary of basic silvicultural parameters from different forest types.

Forest type	Evergreen broad-leaved forest	Dry dipterocarp forest	Mangrove forest	Melaleuca forest
Number of PSP	34	6	10	8
Number of species (spec./ha)	20-80	12-27	1-12	1-6
Number of stems.(1/ha)	560±350	470±150	780±250	640±300
Ratio of individuals/species	1/82-1/4	1/137-1/36	1/530-1/65	1/360-1/140
Basal area (sqm/ha)	28±19	16±5	22±10	20±8
Stand volume (cbm/ha)	250±150	80±50	150±80	145±95
Volume increment (cbm/ha/y)	5±3	3±2	4±2	4±1,5
Diameter increment (cm/y)	0,42±0,20	0,34±0,15	0,40±0,22	0,38±0,15
Total Litter fall (t/ha)	12,5±3,5	8,6±1,5	7,6±1,8	8,2±1,6

Based on the IUFRO classification scheme of the vertical structure distinguishing: upperstory (tree height > 2/3 top height), middle story (<2/3, <1/3) and understory (<1/3 of top height) (Leibundgut 1958), an analysis of the vertical structure of evergreen broad-leaved forest has been done. The results shows that the total individuals of all tree species were in average of 150.000 stems per ha (±30%), of which the upper story shows the smallest stem number (only approx. 0,1% of total), accounting, however, 60-61% of the total stand basal area; stem number of middle story accounts round 0,4% with 35-36% of basal area while the highest stem numbers found in the lower story accounts only 4-5% of basal area. The analysis based on data from 10 PSP of evergreen broad-leaved forest measured in 2004 and 2009 shows following findings on forest dynamic properties: (i) The mortality rate of trees with DBH ≥10cm were 23 ±5 and the recruitments were 24 ±5 during 5 years; (ii) The average diameter increment of all species is 0,41 cm/year. There are significant diameter increment differences between tree of different forest stories, species of the lower stories shows the lowest growth, but can nevertheless live to a very old age, despite their small final dimensions.

Data sets from PSP are very useful for silvicultural purposes and PSP will become important in the future to be used in measures to indicate forest services such as the provision of water and carbon storage. Currently research allows only stem volume estimates, so research on biomass expansion factors for conversion to biomass and carbon are needed.

Forest structure and dynamics of seasonal flood forest along the Lam Se River, Northeast Thailand

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The structure and topography of seasonal flood forest, where was completely inundated from August to October, was studied in Yasothon Province, Northeast Thailand. One research plot (30m × 150m) was established from river side to inland, and the topography was surveyed. Tree census has been conducted since 2005. Five hundred ninety three trees and climbers were recorded and seventy species were identified in the plot. Stand density, total basal area and the mean diameter at breast height (DBH) were 1318 trees/ha, 23.6m^2/ha and 11.3cm, respectively. *Mallotus thorelii* (Euphorbiaceae), *Garcinia schomburgkiana* (Guttiferae), *Hymenocardia wallichii* (Euphorbiaceae), *Dipterocarpus alatus* (Dipterocarpaceae) and *Vatica harmandiana* (Dipterocarpaceae) were the dominant species in the plot. Almost of *M. thorelii*, *G. schomburgkiana* and *H. wallichii* were observed in riparian zone (0 to 3m in the elevation). In riparian zone, 373 trees which mean 63 % of total tree number were recorded and the mean DBH was 9.5cm. On the contrary, 128 trees (22% of the total trees) were recorded in inland zone (more than 6m in the elevation) and the mean DBH was 14.6cm. Riparian zone forest was consisted by small DBH trees and the density was high. The inland zone forest consisted by large DBH trees and the density was low. For Dipterocarpaceae, six species were observed. The distribution of dipterocarp trees was different among the species. *V. harmandiana* distributed from 0 to 3m in the elevation where was flooded for two months. *D. alatus* and *Hopea odorata* distributed from 3 to 7.5m, 4 to 5m in the elevation, respectively. These zones were flooded about one month. *Shorea roxburghii*, *Dipterocarpus intricatus* and *Anisoptera costata* distributed more than 6.9m in the elevation where was not effected from flooding. During five years, 54 recruit trees have been recorded and 80.4% of recruit trees distributed from 0 to 1m in elevation. The recruit trees were mainly *M. thorelii*, *Melodorum siamensis* (Anonaceae), and *G. schomburgkiana*. Seventy nine trees were dead and 63.4% of dead trees distributed from 0 to 1m in the elevation. Dead trees were mainly *H. wallichii* and *M. thorelii*. The riparian forest of 0 to 1m in the elevation where was flooded about 3 months, was high mortality and recruitment. Thus, elevation and flooding period would affect the species composition and the dynamics in seasonal flood forest.

DBH-height relationship for estimating biomass along a topographic gradient in a Central Amazonian forest

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Accurate estimation of forest biomass in Amazon basin is one of the most important issues for evaluating the global carbon dynamics since the Amazon forest occupies a substantial portion of net primary productivity and carbon stores in global terrestrial ecosystems. The basin's main topographical features are gently undulating hills called terra-firme (solid ground), composed of layers of alluvial soil that were deposited as much as 2.5 million years ago. Forest structure within a terra-firme rainforest varies depending on the soil conditions along the topographic gradient (plateau – valley). In particular, the clay contents influences on forest structure (Laurence et al. 1999) and depends strongly on altitude (de Castilho et al. 2006). In previous studies, the biomass of terra-firme forest was estimated using the allometric equation having a variable D, the diameter at breast height. Meanwhile, the tree height H also can be incorporated into the variable. The D - H relationship often changes with environmental conditions such as climate, topography and soil. In this study, we have developed the D - H allometry depending on topography, for better biomass estimation of terra-firme forest. Especially, we focus on the relative altitude with which clay contents change in parallel. The study site is ZF-2 Experimental Station of the National Institute for Research in the Amazon (INPA). Two belt transects (2500 m x 20 m) were established in 1996 by INPA and FFPRI as a part of "Jacaranda Project" supported by JICA. The belt transect was divided by 20 x 20-m sub plots. In this transect belt, 14,922 individuals (DBH > 10 cm) and 409 different tree species, 206 genera and 51 families have been recorded (Higuchi et al., 1985). In this study, the analysis was done on the basis of the data taken from a single belt transect in 2000. Diameter at breast height D was measured for all trees whose D > 10 cm. For evaluating the D - H relationship, 1309 trees (D >1 cm) were sampled from a part of the belt transect. The tree height was measured using a scale hypsometer. The sampling area was selected considering the wide range of the amount of clay (3 % - 36 %) following Ferraz et al. (1998). The D - H relationship model was successfully established and revealed that the potential tree height increased from ca. 33 m at a low altitude plot to ca. 41 m at a high altitude plot. As a result, by combining the D - H relationship model and the allometric equation having D^2H as a variable (D^2H model, unpublished data of Niro et al.), the average biomass including aboveground and belowground parts was estimated as 314 t d.m. ha^{-1}. Ignoring the change in the D - H relationship, brought 10 % overestimation at a low altitude plot and 7 % underestimation at a high altitude plot as a maximum overestimation and underestimation, respectively. However, the average biomass within the belt transect did not differ between the two models since the overestimations at high altitude plots were balanced with the underestimations at low altitude plots. On the other hand, following the allometric equation having D alone as a variable, the average biomass was estimated as 361 t d.m. ha^{-1} which was 115 % of that based on the D^2H model.