AsiaFlux training & seminar on tropical ecosystem monitoring

1-5 December, 2014
Cat Tien National Park,
Vietnam

APN
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on tropical ecosystem monitoring

1-5 December, 2014
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Welcome to AsiaFlux training & seminar on tropical ecosystem monitoring!

The number of tower flux sites in Southeast and South Asian countries has been increasing with growing attention of the society to carbon and water cycles in Asian tropical ecosystem. AsiaFlux has been collaborating with and supporting scientists and study sites in those countries. As one of those activities, AsiaFlux will have a training and seminar on tropical ecosystem in Vietnam in December 2014. In the training sponsored by LI-COR, we provide a three-day technical training course on fundamentals of measuring biosphere-atmosphere exchange including eddy covariance flux and soil chamber flux. The seminar consists of a few lectures by invited scientists and presentations of participants on their own studies in respective sites. The prime target of this training and seminar is "beginners" of biosphere-atmosphere fluxes in Southeast Asian countries, but we welcome anyone who is interested in our program.

Organizer: AsiaFlux

Local Organizing Committee

- Juliya Kurbatova (Vietnam Russia Tropical Centre (VRTC), Vietnam; A.N. Severtsov Institute of ecology and evolution RAS, Moscow, Russia)
- Akira Miyata (National Institute for Agro-Environmental Sciences (NIAES), Japan)
- Nobuko Saigusa (National Institute for Environmental Studies (NIES), Japan)
- Sawako Tanaka (National Institute for Environmental Studies (NIES), Japan)
- Nguyen Van Khue (Vietnam Russia Tropical Centre (VRTC), Vietnam)
- Nguyen Van Dien (Director of Cat Tien National Park, Vietnam)
- Nguyen Dang Hoi (Institute for Tropical Ecology, Vietnam)
- Pham Huu Khanh (Department of science and International Cooperation of Cat Tien National Park, Vietnam)
- Dinh Ba Duy (Vietnam Russia Tropical Centre (VRTC), Vietnam)

Sponsors (in alphabetical order)

- APN (Asia-Pacific Network for Global Change Research)
- Cat Tien National Park
- LI-COR
- National Institute for Agro-Environmental Sciences (NIAES), Japan
- National Institute for Environmental Studies (NIES), Japan
- iLEAPS

Program of the AsiaFlux training on tropical ecosystem monitoring
(1-3 December 2014; Cat Tien National Park, Vietnam)

Monday, 1 December: LI-COR Training Course (Day 1)

(**Morning session**)

- Eddy covariance theory
  Eddy covariance theory and principles, Long-term flux measurement example
- Eddy covariance applications and experimental design
  Flux footprint and fetch requirement concepts, Designing and implementing an eddy covariance experiment

(**Afternoon session**)

-Theory of operation for gas analyzers and sonic anemometers
  LI-7500A and LI-7200 CO_2/H_2O analyzers, LI-7700 CH_4 analyzer, Sonic anemometers
- Biomet (biological and meteorological) measurements and sensors
  Biomet data requirements, Energy balance closure, Sensors and stations

Tuesday, 2 December: LI-COR Training Course (Day 2)

(**Morning session**)

- Overview of setup procedures for gas analyzers and eddy covariance systems equipped with the SMARTFlux™ system
- Hands-on installation of eddy covariance systems
  Sensor deployment and positioning, Instrument configuration, including SMARTFlux™ and remote access, Wiring and system integration

(Afternoon session)

- Software configuration and operation of LI-7500A/LI-7200/LI-7700, Biomet, cellular communication, and SMARTFlux™ systems
  Software installation and tour, Configuration, operation and data collection
- Instrument maintenance and calibration
  LI-7500A, LI-7200, LI-7700

Wednesday, 3 December: LI-COR Training Course (Day 3)

(**Morning session**)

- Overview of data processing
  Principles and procedures, Software overview, SMARTFlux™
- EddyPro and File Viewer software installation and sample data
  Preparing data, Demonstration of File Viewer software
- Hands-on GHG data processing
- Explanation of EddyPro and SMARTFlux™ outputs

(**Afternoon session**)

- LAI and Soil Flux measurement

Program of the AsiaFlux seminar on tropical ecosystem monitoring

(Thursday, 4 December 2014; Cat Tien National Park, Vietnam)

Opening		***Chair: Akira Miyata (NIAES, Japan)***
08:00-08:10	Opening address	Juliya Kurbatova (IPEE RAS, Russia)
	Welcome address	Nguyen Van Khue (VRTC, Vietnam)

Session I Tropical/subtropical forest	***Chair: Nobuko Saigusa (NIES, Japan)***
08:10-08:40	Juliya Kurbatova and Aviolov Vitaly (IPEE RAS, Russia)
08:40-09:00	Joseph W. Waili (Tropical Peat Research Lab., Malaysia)
09:00-09:20	Rakesh (ISRO, India)
09:20-09:40	Cheng Yu Lan (National Central University, Taiwan)

Coffee/tea break

10:00-10:30	Koji Tamai (FFPRI, Japan)
10:30-10:50	Robert Sandlerskiy (IPEE RAS, Russia)
10:50-11:10	Hukum Singh (ICFRE, India)
11:10-11:40	*Discussion*

Lunch and group photo

Special lecture

13:00-13:30 (*invited*)	Alex Guenther (Pacific Northwest National Laboratory, USA)

Session II. Mangrove forest	***Chair: Juliya Kurbatova***
13:30-14:00 (*invited*)	Yoshiaki Kitaya (Osaka prefecture University, Japan)
14:00-14:20	Truong Van Vinh (Nong Lam University, Vietnam) and Nguyen Thanh Nho (University of Science, Vietnam)
14:20-14:40	Hironori Arai (Chiba University, Japan)
14:40-15:00	*Discussion*

Coffee/tea break

Session III Miscellaneous ecosystems in tropical Asia	***Chair: Alex Guenther***
15:20-15:50	Kazuyuki Inubushi (Chiba University, Japan)
15:50-16:10	Thi Phuong Quynh Le (VAST, Vietnam)
16:10-16:30	Duong Van Hau (Hue University of Agriculture and Forestry, Vietnam)
16:30-16:50	Tassanee Jiaphasuanan (Ubon Ratchathani University, Thailand)
16:50-17:10	Saon Banerjee (AICRP on Agrometeorology, India)
17:10-17:30	Kasturi Kanniah (UTM, Malaysia)
17:30-18:00	*Discussion*

Closing

Field Trip to the Nam Cat Tien Forest site
(Friday, 5 December 2014)

Site name	Nam Cat Tien Forest
AsiaFlux site code	NCT
Location	Vietnam
Position	11°26' 29.9" N, 107°24' 3.8" E
Elevation	156 m above sea level
Slope	Negligible
Terrain type	Flat
Area	38,302 ha (area of Nam Cat Tien)
Fetch	500-700 m
Climate	Tropical monsoon climate (Am)
Mean annual air temperature	26.2 degree C
Mean annual precipitation	2470 mm
Vegetation type	Tropical monsoon valley tall-stand forest
Domestic species (Overstory)	*Lagestroemia caluculata, Afzelia xylocarpa, Sindora siamensis, Tetrameles nudiflora, Hopea odorata, Haldina (syn.Adina) cordifolia, Aglaia sp., Ficus spp., Sterculia cf. cochinchinensis.*
Dominant species (Understory)	*Achasma cf. macrocheilos, Globba cf.pendula, Stachlianthus campanulatus, Zingiber gramineum, Alpinia sp., Zingiber sp.Aglaonema fumeum, Amorphophallus opertus, Pseudodracontium latifolium, Bolbitis annamensis, Dianella nemorosa, Leea cf. rubra, Peliosanthes teta, Pellionia cf. deveauana, Pseuderantemum crenulatum, Strobilanthes sp., Clerodendrum sp., Commelina sp.,Murdannia sp., Pandanus sp., Selaginella spp.*
Canopy height	About 35 m
Age	About 200 years old (the age of the oldest trees is 600-800 years old)
LAI	N/A
Soil type	Dystric Cambisols

Abstract

Heat, water and carbon fluxes in southern Vietnam

Avilov Vitaly[1,3], Kuricheva Olga[1,3], Dinh Ba Duy[2,3], Kurbatova Juliya[1,3]

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Heat, water and carbon ecosystem fluxes were collected for 2011-2014 in Southern Vietnam by eddy covariance methods in primary tropical forest. Forest has 3-5 canopy sub-stages and rich biodiversity (80 tree species), canopy height is ~ 37 m. Predominant spp. on drained plots are Lagerstroemia calyculata (Lythraceae), Haldina cordifolia (Rubiaceae), Tetrameles nudiflora (Datiscaceae), Afzelia xylocarpa (Caesalpiniaceae), Sterculia cf. cochinchinensis (Sterculiaceae). Soils are medium-rich ultisols over basalt rock. Climate is tropical monsoon with 2 seasons: dry winter (each month from December to March has less than 100 mm of rain) with temperature of +24...+28 and rainy summer with +26 on average. Total year precipitation is 2518 mm (Dong Xoai meteorological station, 1981-2010).

Eddy covariance system at 50-m scaffold tower consisted of LI-7500A open-path gas analyzer and CSAT3 sonic anemometer. 10-Hz raw data were processed in EddyPro software (LI-Cor Inc.).

Soil fluxes were measured from November 2010 by chamber method every 10-15 days at 7 plots with differ soils and forest types, mostly in Lagerstroemia - or Dipterocarpus-dominated tree stands. CO_2 concentration was defined with LI-820 gas.

The results of studies have allowed to estimate daily, seasonal and annual variability of CO_2 soil and ecosystem water, heat and carbon fluxes. Generally tropical forest of southern Vietnam was sink of CO_2 for atmosphere.

Eddy Covariance Measurement of Evapotranspiration from a Tropical Peat Swamp Forest in Sarawak, Malaysia

Joseph Wenceslaus Waili[1], Wong Guan Xhuan[1], Edward Baran Aeries[1], Lo Kim San[1], Ryuichi Hirata[2], Lulie Melling[1]

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The co-existence of tropical forest on peatland forms a very unique ecosystem that exists in a high humidity and acidic waterlogged conditions. Over the past decade, considerable attention has been devoted to understand the role of this ecosystem in regulating global climate especially the CO_2 fluxes. However, there still remain great uncertainties in the magnitude and driving force of greenhouse gas such as water vapor, an invisible gaseous form of water in atmosphere. It is the Earth's most significant greenhouse gas, accounting for about 95% of Earth's greenhouse effect.

One of the dominant factors that governs water entering atmosphere is evapotranspiration. To date, little is known about the pattern and rate of evapotranspiration from tropical peat swamp forest and even less is known about the factors that influence evapotranspiration in this area. Thus, the present paper reports the preliminary findings from our research effort to quantify the magnitude of evapotranspiration from a tropical peat swamp forest in Sarawak, Malaysia. Continuous measurement of evapotranspiration was carried out using eddy covariance method. In addition, we also incorporate meteorological instruments to access the effect of environmental variables on evapotranspiration.

Eddy covariance method is the most commonly used micrometeorological method which provides in situ measurements of evapotranspiration, continuous long term measurement in an ecosystem scale and spatially averaged over a large area. It adopts a sonic anemometer to measure high-frequency vertical wind speed fluctuations about the mean and an infrared gas analyser LI-7500A to measure high frequency water concentration fluctuations. LI-7500A is ideally suited for eddy covariance application with low power consumption, high precision and high speed output. The outcomes from this research will lay a fundamental foundation which enables us to have a better insight for the function of tropical peat swamp forest in hydrological cycle. Hence, the hydrological behaviour will be defined and contribute to a better prediction of hydrological response from this area in future.

Carbon flux and biomass density over central Indian deciduous forests.

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In order to understand the global carbon cycle, it is necessary to study the carbon pools (places where carbon is stored) and carbon fluxes (processes that transfer it from one pool to another). Carbon pools and fluxes of a particular ecosystem are correlated with each other and net ecosystem exchange could be considered as indicator of forest health. This study is an attempt to establish a relation between net ecosystem exchange (NEE) and biomass density.

Eddy covariance carbon fluxes, leaf area index, and tree biomass were monitored for successive 2 years at Betul Flux Tower (BFT) in Teak mixed deciduous forest of Madhya Pradesh, central India. During the study period, continuous fast response measurements of CO_2, H_2O and heat fluxes above the canopy were carried out at 10 Hz and averaged for 30 minutes. 9 plots of size 0.1 ha were inventoried for two successive years 2011 and 2012 at tower site. 8 plots were distributed symmetrically around tower location and 1 plot was located at tower site. Tree parameters like DBH (diameter at breast height), height recorded during field inventory were converted to tree biomass using allometric equations and wood densities. Field measured biomass density ranged between 53.16 to 121.58 t ha^{-1} .

The flux footprint described as the upwind area seen by the instrument measuring vertical turbulent fluxes has been estimated using the crosswind integrated footprint model by Kljun et al (2004). Wind direction and footprint were used to divide the fluxes recorded from all directions into 8 segments of 45 degree each, NEE of particular segment were correlated with corresponding plots biomass density. On an annual time scale, net ecosystem exchange for day and night showed good correlation with biomass density. A significant correlation of 0.37 and 0.80 were observed for day and night NEE and biomass for 2012 year. Season integrated daytime NEE was related to biomass density to understand phenological behavior of deciduous forests in carbon sequestration. Correlation between day time NEE and biomass showed a seasonal variation, however night time NEE showed similar correlation over all seasons.

Surface fluxes of a subtropical broadleaf forest at the Lien-Hua-Chih experimental watershed in central Taiwan

Cheng-Yu Lan, Ming-Hsu Li, Yi-Ying Chen, Shinh-Chi Hsu

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Subtropical evergreen forests represent the transition between temperate and tropical forest. Warming and changed precipitation pattern at subtropical forest may alter evapotranspiration and carbon sequestration in a different way than that at temperate or tropical forests. The Lien-Hua-Chih (LHC) study site, a subtropical broadleaf forest, is located inside an experimental watershed in central Taiwan. Long-term micrometeorological observations were established since summer 2004. Flux tower for studying energy fluxes was operated since summer 2006 and carbon flux observation was available since 2011. Surface energy fluxes were measured by the Eddy Covariance (EC) techniques. However, the cost of fast response equipment required for EC measurement is very expensive for some trace gases. Recently, Relaxed Eddy Accumulation method (REA) measurement, without the need of fast response equipment, is widely applied to measure greenhouse gas flux. Nevertheless, this method requires setting parameters before estimating, and has not yet been commercialized. The development of REA technique is currently under testing at the LHC. Investigation of raw EC data will provide great help in future setting of REA instruments.

Keywords: Surface Fluxes, Carbon Fluxes, Eddy Covariance, Relaxed Eddy Accumulation Method

Role of Tower observation in the development of CO_2/H_2O cycle simulation model for forest ecosystem

Koji Tamai

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The tower flux monitoring for H_2O and CO_2 flux has been enhanced in Asian forests. Their data are utilized in various ways. The parameterization or verification is one of them in the development of CO_2/H_2O cycle simulation model for forest ecosystem. I shall introduce the case studies of 1) Water discharge model for Japanese forest and 2) Carbon stock model for Asian tropical forest.

Moreover, I shall report some findings derived from the tower flux monitoring, such as the stable activities of Cambodian dry evergreen forest in spite of the interannual variations of climate conditions.

LAI measurements in boreal forest ecosystems

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For flux-tower "Russia-Fedorovskoje - drained spruce stand") environs in the Central Forest Reserve (56^{o} N, 32^{o} E), in the bilberry spruce-sphagnum forest, leaf area index was measured. Measurements were carried out on a transect of nearly 6 km length, with a regular step of 20 meters, 295 points total. For measurements a digital camera with a 180 degrees lens aperture was used (Nikon Coolpix 4900 with FC-E9 Fish-eye lens). For each point photos of the crown projection were made. Each photo is treated with specialized software (Hemisfer, author – Patrick Schleppi), which allows to calculate the transmittance of sunlight and proper leaf index. It is a cheap way that does not require comparison of the flux of incoming radiation over the canopy and the forest canopy, unlike most current devices (Li-Cor LAI-2200C, Decagon AccuPAR LP-80). Thus, the LAI estimates were obtained for the different ecosystems of the southern taiga. In the future, these estimates will be compared with data from remote multispectral (Landsat TM, ETM +, OLI / TIRS) and hyperspectral data (Hyperion HIS) for various periods of time to assess their relations and interpolation on the entire Reserve area. As leaf area index estimates will be compared with the thermodynamic characteristics of ecosystems (absorbed solar radiation, energy, bound energy, entropy ect.), calculated by the original method using the Landsat data (Puzachenko et al., 2013). In principle, a similar research program can be implemented in the vicinity of flux-tower in Cat Tien.

References

Hemisfer is a software designed to estimate the leaf area index (LAI) and the light regime from hemispherical photographs // Swiss Federal Institute for Forest, Snow and Landscape Research WSL http://www.wsl.ch/dienstleistungen/produkte/software/hemisfer/index_EN

Puzachenko Y., Sandlersky R., Sankovski A. Methods of evaluating thermodynamic properties of landscape cover using multispectral reflected radiation measurements by the Landsat satellite // Entropy. 2013. V. 15. 3970-3982 pp. doi:10.3390/e15093970

Study on carbon, water and energy dynamics in Himalayan forests ecosystem - an initiative on forest micrometeorology taken by forest research institute, Dehradun, India

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Forests play an important role in biosphere-atmosphere mass (carbon and water) and energy exchanges that occupy about 30% portion of the land surface. Forests influence the regional climate by affecting the changes in the quanta of carbon dioxide, energy and water fluxes in the atmosphere. The potential changes in carbon, water and energy fluxes are of particular Importance for functioning of Himalayan ecosystems because of their large extent and presumed sensitivity to climatic variability, anthropogenic manipulations and disturbances. Forests ecosystem in Himalayan region exchanges huge amounts of carbon, water and energy with the atmosphere and exhibits distinct seasonal trend and are thought to be important in controlling local as well as regional climates. The subtropical environment in Himalayan ecosystem and semi-arid regions of India are expected to be sensitive to greater climate variability such as changes in temperature, rainfall and seasonality. In present time, large part of our knowledge on the complex multi-scale interactions between the climate and vegetation is based on models, whose major source of uncertainty can be traced back to the terrestrial biosphere and its processes. Therefore, characterizing the forest's atmosphere transfer processes are thus important to understand the global exchanges including research on the forest ecosystem processes in context of carbon, water and energy exchanges which are required to establish the protocols for monitoring response, feedback to atmosphere and also predicting the impacts of climate change. Further, long-term observations on carbon, water and energy dynamics in Himalayan forests ecosystems are not available by which changes in biodiversity might be detected due to changes in climate. Keeping this view, the study on seasonal, annual and inter as well as intra-annual dynamics of carbon, water and energy in Himalayan chir pine forests was initiated at Forest Research Institute Dehradun, in Doon valley of India. The process based methodology or micrometeorological observations coupled to eco-physiological studies are being used to understand the role of terrestrial biosphere in global climate change. The Automatic Micrometeorological Station (AMS) has been established in experimental site (30°20′4″ N, 78°01″ E with an elevation of 640 m a.m.s.l.) and regular observations are being carried out at various seasons/intervals. This study could also generate the data to predict the climate change impacts on chir pine forest of Himalayan ecosystems as stressed by IPCC 2007. Besides, the AMS will have a contribution in the flux measurement or monitoring network of AsiaFlux particularly in chir pine forest ecosystems of Himalayan region/ subtropical environment of India.

Keywords: AsiaFlux; carbon, water and energy dynamics; forest micrometeorology; flux; Himalayan forest ecosystems; research initiative.

Ecosystem-atmosphere exchange of biogenic volatile organic compounds

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The AsiaFlux community has made substantial progress in advancing our understanding of carbon dioxide, water vapor and energy fluxes between terrestrial ecosystems and the atmosphere. There is now increasing interest in extending this successful approach to include other important ecosystem-atmosphere exchanges. One of the greatest challenges with respect to predicting regional air quality and climate change is quantifying ozone and secondary organic aerosol (SOA) formation from Biogenic Volatile Organic Compounds (BVOCs) emitted from and deposited to terrestrial ecosystems and the associated feedbacks in biogeochemical cycles. There is growing evidence that changes in atmospheric composition, driven primarily by fossil fuel combustion, have greatly enhanced the production of ozone and SOA from natural sources resulting in degraded air quality and potentially strong feedbacks on climate. BVOC play a key role in both the "climate penalty" on air quality, leading to increased ozone pollution in a warmer climate, and the "air quality penalty" on climate, resulting in warming associated with improved air quality. Our current understanding of the processes linking air quality, climate and biogenic organics will be presented and potential feedbacks will be discussed. The need for long-term, canopy-scale BVOC flux observations will be discussed and measurement techniques will be described. The major gaps in our knowledge of BVOC sources and sinks will be described including the biological diversity of emission capacity, the chemical diversity including unknown and unidentified BVOC, and the response of BVOC emissions and uptake to stress.

Mangroves and coastal ecosystems

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Tropical coastal zones have recently been damaged by increasing of population pressures, food production and industrial and urban development in many parts of the world. Especially excess cutting of mangroves and conversion of mangrove forests to agricultural lands and aquaculture ponds for commercial production have caused environmental problems. The coastlines where the mangroves disappeared easily suffer erosion by rough waves of sea water. Mangroves and their associated ecosystems are also important components not only for tropical coasts but also the global environment. The values of mangrove ecosystems are in terms of goods, such as timber and charcoals derived directly from the mangroves themselves, and fish, shrimp and other aquatic resources indirectly supported by the mangrove ecosystem, but also from a series of less tangible services which mangroves provide, such as shoreline protection and sediment and nutrient trapping. Recently, the function of below ground carbon sequestration by mangrove peat accumulation has also been identified which emphasized the role in mitigation of atmospheric carbon dioxide accumulation. In spite of their importance, mangrove forests and ecosystems in Southeastern Asia have been disturbed and destroyed by urbanization, timber cutting, shrimp farming etc. In addition, the mangrove ecosystem faces serious threats from global environmental change, especially a rapid sea-level rise. On the other hand the conservation of mangrove environments and restoration forestry have become popular in many countries recently. The development of comprehensive awareness of the ecosystem functions and improvement in skills of ecosystem restoration are useful for local people and also offer a solution to some global environmental problems.

Vietnam coast was widely covered by natural mangrove forests in the 19th century. The area was quickly reduced following growth in other land uses such as agricultural development, shrimp farming, charcoal production and destruction during the two Indochina wars. Can Gio area covered with 40,000 ha natural or semi-natural mangrove forests before the war was completely destroyed by herbicide spray by 1971. After many years of herbicide spraying, the degraded land still remains degraded and bushy or bare. After the end of the war, great efforts have been made towards the rehabilitation of mangroves. An extensive plantation project was started in 1986 by local government and 54 % of the area was recovered by 1998.

The mangroves in Can Gio are amongst the richest in the world, with more than 72 species of mangrove flora and 440 species of fauna, constituting an environment of high biodiversity. Common mangrove species found in Can Gio are *Avicenia alba, A. officinalis, Bruguiera cylindrical, B. parviflora, B. gymnarrhiza, Ceriops tagal, C. decandra, Kandelia candel, Rhizophora apiculata, R. mucronata, Sonneratia alba, S. caseolaris, Xylocarpus granatum, X. moluccansis, Phenix paludosa, Lumnitzera racemosa, Excoecaria agallocha, Acrosticum aureum, Acanthus ilicifolius*, etc. The area was appointed as a mangrove nature reserve by UNSCO/MAB in 2000.

As a result of the reforestation, there are again large areas covered by mangrove forests and ecosystems. The main species of planted mangroves are *Rhizophora spp., Avicennia spp.* and *Sonneratia spp.*, which are 10-20 meters high. During the plantation, many remarkable environmental changes have become apparent. For example, a significant effect of the mangrove plantation was reported on fishery production as a socio-economic impact of mangrove restoration. However, some parts of the reforested mangrove forests have been destroyed again by new economic factors such as shrimp farming.

We must know the importance and present situation of mangrove ecosystems and consider about and the future outlook of mangroves.

Ability of mangroves to fix atmospheric greenhouse gas Can gio, Mekong river, Vietnam

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In Vietnam, mangrove forests provide many products for economies and local people, in addition it is also habitat to many animals. Because of its high productivity, global distribution, and its position at the interface between land and ocean, the mangrove forest is considered important, having the dual skills of being a sink for atmospheric CO_2 and a source of organic and inorganic carbon for adjacent ecosystems. However, the latest estimates of carbon balance in the mangroves show numerous uncertainties. The main objective of this project is to establish a quantified model of carbon dynamics in the Can Gio mangrove (north of the Mekong Delta, Vietnam), which is a UNESCO Biosphere. Can Gio Mangrove Biosphere Reserve (CGMBR), is located in Southeast of HCMC and known as the "Green lung and kidney" for the people of HCMC. This study aims at: (1) Quantifying carbon stock in sediment and biomass; (2) Quantifying mangrove productivity; (3) Quantifying CO_2 and CH_4 fluxes from sediments and river, (4) Quantifying CO_2 fluxes at the canopy level using an eddy-covariance system, and (5) Understanding the fluxes variability, the influence of tide, mangrove species, seasons. To estimate net aboveground primary productivity, tree allometry and light attenuation methods will be used. Total organic content of sediments will be determined as well as sediment density to assess the sedimentary stock per hectare of the different mangrove states studied. To determine the balance between source and sink of atmospheric carbon, measurements of net carbon flux at large spatial scales can be performed continuously and without disruption of the ecosystem through the system of Eddy-Covariance. This system will be installed at the canopy level but also on a boat on the river crossing the mangrove. These measurements will be linked to ad-hoc analysis of fluxes (with incubation chambers) of CO_2 from mangroves soils, which are lowest than other forest soils because it is waterlogged and decomposition processes of OM are slow. Within the tidal creek, pCO_2 will be monitored and the export of DIC, DOC, and POC will be determined by combining flow data and concentrations of the different species. 13C of dissolved species will also be determined to understand the contribution of pore water seepage.

Keywords: Mangrove forests; CO_2; CH_4

Methane emission and soil-microbiological properties in mangrove forest soils
- A preliminary report-

Hironori Arai[1], Ryo Yoshioka[1], Syunsuke Hanazawa[1], Vo Quang Minh[2], Vo Quoc Tuan[2], Tran Kim Tinh[3], Truong Quoc Phu[4], Chandra Shekhar Jha[5], Suraj Reddy Redda[5], Masayoshi Mano[1] and Kazuyuki Inubushi[1]

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l. Background and objectives

The rates of blue carbon sequestration and storage capacities in coastal ecosystems are regarded comparable to those in other terrestrial high carbon reservoirs such as wetlands/peatlands. Above all, mangrove ecosystem in many wet tropical areas represents one of the most productive of natural ecosystems. Although this ecosystem has potential of further sources of a greenhouse gas, methane, the quantification results have been reported only partially. So as to establish proper observing system to estimate baseline of the methane emission in this ecosystem and understand controlling factors of methane emission, methane emission and related microbial properties in mangrove forest soils as affected by climate change and anthropogenic activity were researched preliminary in this study.

2. Research methodology and techniques

Soil and gas samples were collected at several points with different distance from seashores in Ca Mau (N8^{o}37', E104^{o}43') and Soc Trang (N9^{o}21', E106^{o}05'), Vietnam on 24th June 2014 and in Sundarbans (N21^{o}49', E88^{o}38'), India on 6th and 7th August 2014 (2-4 replications each). Three grams of soil samples were incubated under 30oC condition anaerobically with 30-ml test tubes (3 replications each). In addition, properties of each soils sample were analyzed with microbiological methods.

As results, especially high methane emissions were detected at a seashore in Ca Mau-mangrove forest, Vietnam. Regarding the methane emissions from interior mangrove forest soils, methane emission became larger as density of pneumatophore aerial roots was larger. Soil incubation experiment showed significant positive relationships among soil organic carbon content, population of methanogens and methane producing activity of soils. Methane producing activity of the soil was significantly enhanced by applying 10ml of 4 times-diluted seawater although application of undiluted-seawater or 2times-diluted seawater inhibited the methane producing activities.

These results indicated that high methane emission might be occurred temporary with drastic tidal motion even in soils exposed to seawater. Even in interior mangrove forest soils unaffected by tidal motion, the accelerated carbon reserving condition with high density of pneumatophore aerial roots and high organic-carbon content could cause high methane emission. Because the addition of 10ml-diluted seawater intensely enhanced the methane producing activity, fresh water intrusion to the mangrove forests or dyke-construction for aquaculture in the coasts, which eases the soils-immersion with seawater could cause the emission of considerable amount of methane.

Effect of topography on N_2O and CO_2 emissions and dissolved N_2O in oil palm plantation in Riau, Indonesia

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The oil palm plantations in Indonesia have been focused concerning emission of greenhouse gases, through its association with deforestation. It was reported that greenhouse gases into the atmosphere which linked to nitrogen fertilizer use. However the interactions of soil properties and topography influencing soil N_2O and CO_2 fluxes are still poorly understood particularly in the tropical region. In the agriculture land, topography affects the movement of surface and subsurface water and caused the variability of soil processes, which makes the accurate estimation on N_2O and CO_2 fluxes more difficult. In tropical ecosystem such as in Indonesia, oil palm plantation is located in the different land pattern or slope variation. Therefore, this study aimed to assess the N_2O and CO_2 emissions at different landscape positions, and to assess the dissolved N_2O concentration as source of indirect emission from oil palm plantation to the atmosphere.

N_2O and CO_2 were measured in upper, middle, and lower slope positions for a year from June 2012 to May 2013 along the sloping from 1.3 to 2.2%, in Tunggal sandy loam soil, Indonesia. N_2O and CO_2 fluxes were determined by placing a 20.8 cm diameter and 14.2 cm high PVC pipe chamber to soil depth of 5 cm. Gas samples were taken after it had been sealed for approximately 5 minutes, by connecting a 30 ml gas syringe with tubes to the chamber. Gas samples were collected at 0-, 10-, and 20-minute intervals and were injected into a glass vial that had been evacuated and closed tightly with butyl rubber seals. The filled vials were transported to the laboratory, and the gas fluxes were measured by gas chromatograph. Dissolved N_2O concentrations were measured in puddle, drains, and wells for 3 times, in June and October 2012, and January 2013. Dissolved N_2O concentrations were analyzed by headspace methods.

N_2O and CO_2 fluxes showed variability with seasons and slope positions. Cumulative N_2O fluxes were 460, 560, and 697 g N $h^{-1}y^{-1}$, and cumulative CO_2 fluxes were 6266, 7374, and 7595 kg C $h^{-1}y^{-1}$ in the upper, middle and lower slope, respectively. Cumulative N_2O fluxes was significantly higher in the lower position, however upper and middle slope showed no significant difference, while cumulative CO_2 fluxes have no significant difference among the slope positions. Dissolved N_2O concentrations varied by water sources and sampling time. It ranged 0.12 – 10.52 μg N L^{-1}. Dissolved N_2O were supersaturated (1.48–39.1 times higher) than ambient equilibrated concentration as leading possibility to be source of indirect emission. These results show that topography even in a short slope affected variability in the spatial on N_2O and CO_2 emission, which may need to be taken into account in field measurements and modelling including the indirect emissions.

Carbon transfer and emission of the Red River (Vietnam and China)

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Riverine carbon fluxes and emission (or outgassing or evasion) are an important part of carbon exchange between terrestrial, oceanic and atmospheric environment. Rivers and streams not only transfer various forms of carbon (dissolved and particular) to oceans, but also evade a significant amount of carbon to atmosphere and thus must be considered in strategies to mitigate climate change. Carbon fluxes and emission of the river are impacted by both natural and anthropogenic. To obtain a good understanding of the global natural and human impact to global carbon cycle, it has to be examined at a regional scale, where the various climatic and socio-economical constraints can be taken into account.

The Red River (Vietnam and China) is a good example of a South-East Asian river system, strongly affected by climate and human activities. The paper presents the preliminary results on carbon transfer (organic and inorganic forms) of the Red River system during the period January 2008 to January 2010. The results showed that total carbon contents (including POC, DOC and DIC) at all sampling sites were in the range of 13.0 – 28.5 mgC/l. Of which, dissolved inorganic carbon (DIC) occupied a large proportion with the mean value of 82.5% in relation to the abundance of carbonate rocks in the Red River basin. The organic carbon contents represented a smaller part, with the mean value of 17.5%. The POC concentrations (0.2 – 6.6mgC/l) at all monitoring stations showed the positive correlation with the river flow and the total suspended solids concentrations. The ratio POC/Chl a fluctuated in the wide range, from 34 to 5670 mgC/mg Chl a with an average value of 802 mgC/mg Chl a for the whole system of the Red River, depending on river flows and turbidity. All that introduced the strong erosion and leaching processes in the watershed and its impacts to the POC content in the Red River system.

Carbon emission from the Red River is estimated by two ways: 1) estimate via C partial pressure change pCO_2; 2) synthesize the results obtained from field measurement using equipments (float chamber); We try to yield carbon emission through two various means which assure our estimates and measurements more reliable.

Keywords: carbon transfer, carbon emission, Red River, Vietnam

Effects of water management on the growth, development, yield of rice and green house gas emission in Thua Thien Hue province, Central Vietnam

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With the clearly defined goal of reducing greenhouse gas (GHG) emissions from the agricultural sector by 20% until 2020, Vietnam aims to quickly disseminate mitigation technologies in rice production. One such technology is alternate wetting and drying (AWD) in which a rice field encompasses several dry phases during the growth period. In order to fine-tune this water-management practice regime, field experiments were conducted with irrigation regimes different treatments in Winter – Spring 2013 – 2014 in Thua Thien Hue Province, Central Vietnam. The closed chamber technique was used for emission measurements. The results showed that AWD did not affect the growth, development and yield of rice, but reduced GHG emissions as compared to continuous flooding (CF). The total emissions CH_4 from AWD treatment decreased by 22%, did not affect the total emission N_2O. AWD also saved about 27 % of irrigation water as compared to CF. It is necessary to set up field demonstrations on AWD in order to raise awareness of this technology.

Key words: Climate change, fertilization, GHG emission, water management, rice

Methane and nitrous oxide emission from irrigated rice field with different cultivation practices

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Rice cultivation in flooded ecosystems emits approximately 13 percent of the national total of greenhouses gases (GHG) in Thailand. Common cultivation practices often deal with field burning of rice straw to ease land preparation before tillage. In order to abate the air pollution occurred from straw burning, Thai government has launched the policy to prohibit rice straw burning while promote incorporated rice straw as the alternative. It is known that high organic amendment in the field increases methane emission. However, long term impact on soil carbon storage of these straw management is still an unclear issue. The objective of this study is to quantify greenhouse gas emissions as affected by rice straw incorporation in comparison with rice straw burning under mid-season drainage and local drainage in order to find the compromised conditions. The experiment was conducted in rice fields located in Samutsakorn province, in the central part Thailand, throughout the first and the second crop seasons in 2007. This experiment consisted of burnt (B) and stubble incorporated or un-burnt (S) treatments of rice straw applied with two different water drainage schemes, local and mid-season drainage. It was found that incorporated rice straw increased CH_4 emission during the vegetative phase while mid-season drainage showed effective reduction during reproductive phase in un-burnt field. Water drainage showed stronger impact on methane reduction in un-burnt treatment (50% and 23% in wet and dry season) than burnt treatment (8% and 3% in wet and dry season). The results using net global warming potentials (GWPs) suggest that the combination of un-burnt practice and mid-season drainage showed the smallest emission and can reduce air pollution from field burning.

Latent energy flux over rice field: A comparison between Bowen ratio energy balance and aerodynamic methods

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Under the pressure of population growth and climate change, all the agricultural inputs including water should be used in such a way so that maximum input-efficiency can be obtained. Efficient use of irrigation water becomes a real need in modern agriculture, which in turn requires proper estimation of evapotranspiration (ET). Thus, with an aim to determine the energy flux components and ET from a large area, field experiment was conducted in Ghetugachi, Nadia, West Bengal, India (2301' N latitude, 88035' E longitude and 9m altitude). The experiment was conducted over rice field, where rice was grown in summer season (January to May) followed by wet-season (July to November).

The sensible heat flux (H) was calculated by standard bulk aerodynamic transfer equation and latent heat flux (LE) was calculated as residual of energy balance equation. The Bowen ratio (β) was calculated from difference in the air potential temperature and moisture contents for a specific height interval and thereafter the computed β was used to measure the LE. As net radiation (Rn) is one of the prime factors in determining different surface energy flux components, variation of Rn over different crop growth stages were studied first. In case of summer season, the diurnal variation of net radiation followed a definite pattern, the magnitude of Rn increased from 9 hours to 12 hours and then a decreasing trend was observed. On the contrary, greater fluctuation of Rn was observed during wet-season. Due to high specific heat of water (here, stagnant water over rice field), it was found that throughout the day Rn was the dominant contributor and LE is the main receiver from the surface. LE calculated by aerodynamic method was compared with the LE calculated by Bowen ratio technique. It was observed that 5/8th of the calculated value falls on 1 : 1 line. It indicated that the LE calculated by two methods was well in agreement. The calculated LE provides estimation of actual ET from the crop field, which can further be used for irrigation water management.

Keywords: Latent energy, aerodynamic method, Bowen ratio, rice, evapotranspiration

Instrumenting eddy covariance based flux tower to study carbon, energy and water fluxes and air quality in an urban ecosystem in Malaysia

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United nation's survey found that more than half of world's population now living in urban areas and an additional 2.5 billion people are predicted to live in urban areas by 2050. Malaysia is a rapidly developing country and the major economy changes for the past 20 years have contributed to high rates of urbanization. Urban population in Malaysia is increasing with the projection of 75 % by the year 2020 (Department of Statistics Malaysia, 2009). Three main city regions that dominate the urbanization in Malaysia are Kuala Lumpur, George Town and Johor Bahru, around which conurbations are being, formed (Mustafa, 2009). The most important impacts of urbanization are the emissions of greenhouse gases (especially CO_2) and particulate matters associated with the combustion of fossil fuels, transportation and industrial activities and changes in land use. This has caused considerable issues including that of assimilative capacity and environmental quality. Data and studies have shown that the level of air pollution is increasing in some large cities in Malaysia at an unacceptable levels set by the national ambient air quality standards (Awang et al., 2000; Afroz et al., 2003; Juneng et al., 2009). CO_2 is particularly shown to be higher in cities in Malaysia (Hashim et al., 2004). However, knowledge of the magnitude and temporal variability of surface-atmosphere CO_2 exchange and pollution in cities has been limited. In Malaysia there is no eddy covariance based flux tower available to understand the exchange of CO_2, energy and water cycles and high temporal variation of pollution characteristics in cities. As of 2014 there are only 4 eddy covariance systems measuring CO_2, energy, and water vapour fluxes of tropical forest (Pasoh Forest Reserve), Oil Palm plantation (Sibu), and Secondary peat swamp forest (station in Betong and Maludam National Park station in Sawarak). So, there is a need to make continuous CO_2 exchange measurements over urban surfaces. Data and information obtained from the measurements can be used for monitoring CO2 emissions and for making policies to curb excessive CO_2 levels in the urban environment. So, the aim of this presentation is to find the feasibility of instrumenting an eddy covariance based flux tower in an urban environment in Malaysia to continuously monitor and quantify the sources and sinks of CO_2. The proposed study site is within the Iskandar Development Region (IDR) or Iskandar Malaysia (IM- Figure 1) in the Johor state (southern part of Peninsular Malaysia).

IM is a visionary economic region in Southern Peninsular Malaysia (LCS, 2013) with the size of 2,216.3km² and it was established in 2006 as one of the catalyst development to spur growth of the Malaysian economy (LCS, 2013). Environmental pollution and emission of CO_2 is expected to increase in this region. Based on the simulation result from the ExSS model, the GHGs emission of Iskandar Malaysia in year 2005 is estimated to be 11.4 MtCO2eq and the value is projected to double into 31.3 $MtCO_2eq$ in year 2025 BaU scenario (LCS, 2013). Therefore, instrumenting a flux tower to measure the CO_2 and energy fluxes will greatly help to formulate appropriate policies to control CO_2 emissions in this region.

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