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Contents

Workshop on Carbon Cycle and Management in China Held in Beijing

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The Workshop on Carbon Cycle and Management in China was held in Beijing on 13-14 November, 2004, which was sponsored by the Chinese Academy of Sciences (CAS) and organized by the Synthesis Research Center of Chinese Ecosystem Research Network (CERN). The objectives of the meeting were to promote the study on global change and carbon cycling in China and address the key scientific issues concerning carbon cycle and management in this country. More than 200 participants from the institutions and universities including CAS, State Forestry Administration, Chinese Academy of Forestry, Chinese Academy of Agricultural Sciences, Beijing University, China Agricultural University, Nanjing Forestry University and Central South Forestry College attended the workshop. A total of 126 abstracts were received at the meeting.

The meeting was chaired by Gui-rui YU from the Institute of Geographic Sciences and Natural Resources Research, CAS. During the plenary session, 14 speakers made presentations on carbon sink management, carbon flux observation for major terrestrial ecosystems in China and biological carbon fund. On 14 November, 2004, four special sessions were organized, covering the topics of carbon measurement and research, carbon modeling and process, carbon management and policy,

and water-body carbon. More than 70 scientists and students shared their findings and recommendations on carbon cycle and management with other participants.

In recent years, the global change due to rising concentrations of greenhouse gases has been threatening the livelihood and socio-economic sustainable development of humanity, which is of great concern to the government, the public and scientific community. As CO_2 and CH_4 account for over 80% of the total greenhouse gases, it is of critical importance to study the global carbon cycle and management for assessing global carbon budget and conducting international negotiations on climate change.

It was concluded that though the Chinese scientists have achieved great results in this field, we still have a long way to go to meet the needs of the national government. More efforts are needed to facilitate the research on carbon cycle and management and provide more effective service for the national policy-making on ecological and economic development in China.

Development of a Flux Measurement System for Trace Gases by True Eddy Accumulation Technique

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Background and objectives to develop the TEA system

The eddy correlation (EC) method is widely used because it is a direct method for flux measurement of trace gases in the air. This method is, however, applicable to limited kind of trace gases species due to the limitations of response time of sensors. The relaxed eddy accumulation (REA) method and the gradient method have also been used to measure the flux of trace gases. Both methods include theoretical assumptions, although flux measurements were easily carried out since the fluxes were calculated from period average concentration of the trace gases. The true eddy accumulation (TEA) method has been considered to have advantage because it requires least number of theoretical assumptions and the fluxes were calculated from the average concentration of trace gases for the period (e.g. Desjardins, 1977). Practical TEA system has not yet been developed due to the difficulties of taking air samples accurately in proportion to vertical wind velocity with high time resolution.

We have developed an air sampling system based on the TEA with high time resolution and a flux measurement system for a small quantity of trace gases in air (Komori et al., 2004; Komori et al., 2005). We would like to introduce the outline of the new system in this paper.

Theory of the TEA method

A system concept and composition of instruments for TEA are shown in Fig. 1. Theoretically, air should be sampled proportionally to the vertical wind velocity for updraft and downdraft with at least 5 Hz of resolution. It differs from the REA system in which the air is sampled at a constant rate.

The flux (Fc) for a certain period can be obtained from the following equation with the average trace gas absolute concentration of the accumulated air ($C\uparrow$ and $C\downarrow$; $\mu g\ CO_2\ cm^{-3}$ for example). The air should be sampled at least 5 Hz of time resolution. The flux measurement by TEA had not been realized due to the lack of equipment that can sample the air with required time resolution.

$$Fc = (w\uparrow) . (C\uparrow) - (w\downarrow) . (C\downarrow)$$

where ( ) indicates average value of a certain period.

System developed

<u>Development of the air sampling system with high time resolution</u>

The developed sampling system with stepping-motors was shown in Fig. 2 and Photo1-2 (Komori et al., 2004). The system can sample the air continuously using a couple of syringes for each direction of the air sample.

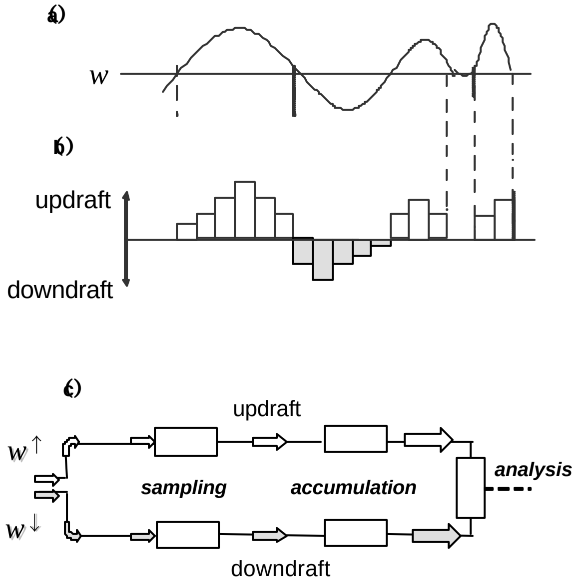

Fig. 1 Schematic diagram of air sampling system based on TEA (a) an exmaple of a signal vertical wind velocity (b) sample air volume for C↑ and C↓ (c) components of sampling system and air flow

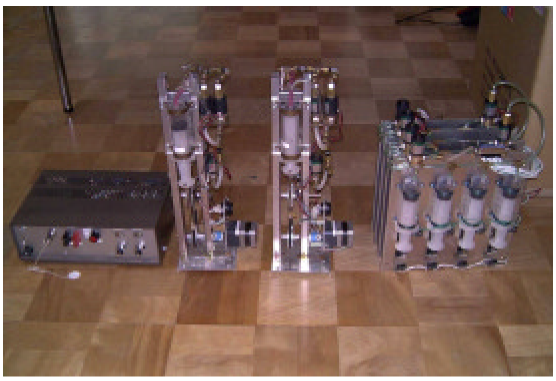

Photo. 1 A developed system. Left: sampling controller unit (SCU); Center: two air sampling systems for upward and downward wind ; Right: reservoir section (RS).

Miyake and McBean (1970) proposed that 5 Hz of time resolution of fluctuation is needed for EC applied CO_2 flux measurement. We have confirmed that the system could precisely sample at about 7 Hz, reflecting a digital signal input to the system. Therefore, this new system is considered to be applicable for TEA.

<u>Development of the automated flux measurement system</u>

We developed automated flux measuring system with the sampling system mentioned above. The diagram is shown in Fig. 3. It is composed of a sampling air section (SAS), a reservoir section (RS) and a sampling controller unit (SCU) (Fig. 3 and Photo 1).

The analog signal of vertical wind velocity obtained

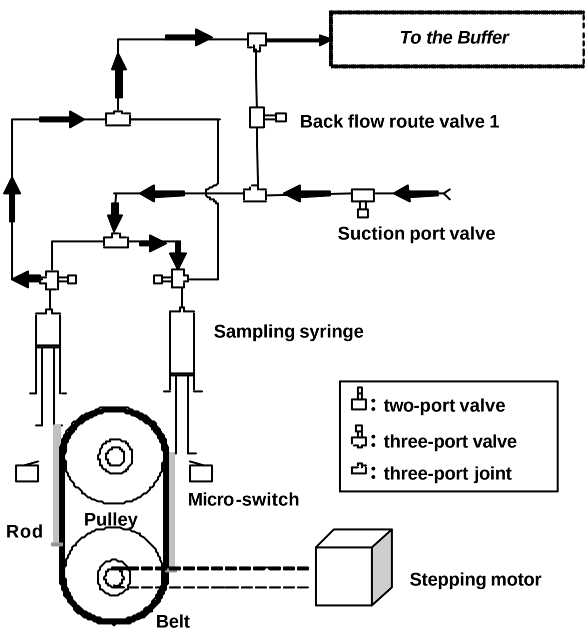

Fig. 2 Schematic diagram of air sampling system

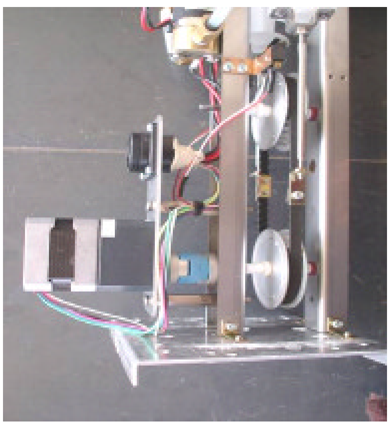

Photo. 2 Photo around stepping motor of air sampling system

from SAT at 10 Hz is divided into two directions, upward and downward, by the signal conditioner in SCU (Fig. 1 and Photo.1). This analog data is then converted to digital data by A/D converter. The SAS, then, samples the air according to the volume, and introduces the sampled air into upward and downward reservoirs.

Accumulated air in the 200 ml syringes of the RS is automatically pumped to the gas analyzer when a micro-switch attached on the bottom of the syringes is turned on. The average absolute concentration of trace gas is, then, measured. One of coupled syringes can sample the air while another syringe drains accumulated air to gas analyzer (Fig. 3). The RS is designed so that it can continuously sample air and measure the concentration of accumulated air automatically. In case when both reservoirs happen to exhaust the sampled air at the same time, SCU controls the RS to avoid the mixing of sampled air.

<ins>The performance test of the system in the field</ins>

The field test was conducted to test the developed air sampling system based on the TEA technique with EC, REA and Bowen ratio method in Betsukai-town, Hokkaido, Japan (Photo 3). Significant linear correlation (r^2=0.84) was recognized with EC and the trend of regression line is nearly 1.0 (Fig, 4). Result indicates that the developed system is able to measure the flux of trace gases.

Prospects of flux measurement by TEA technique

The TEA has theoretical advantages due to less number of assumptions. Since TEA does not require instruments for measuring concentrations of trace gas with high time resolution, this technique can be applied for measuring the fluxes of ozone, methane, terpenoids and peroxides by changing the materials of tubing and

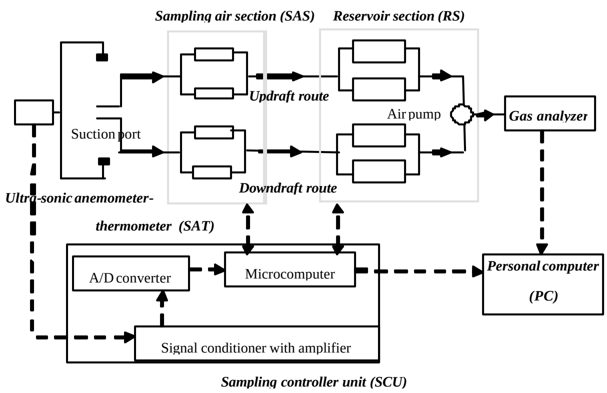

Fig. 3 Schematic diagram of the automated flux measurement system

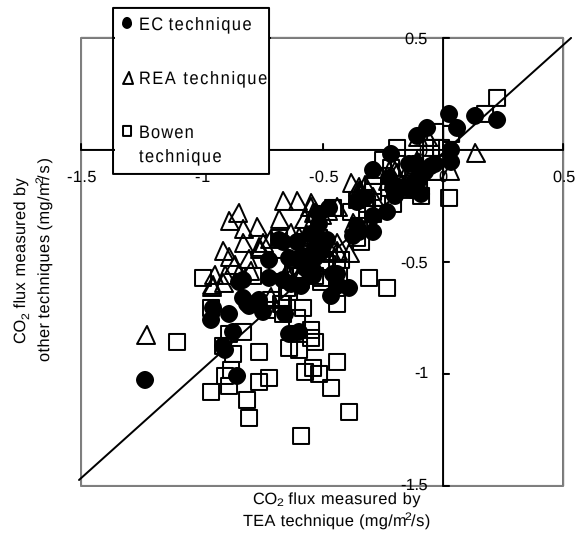

Fig. 4 Comparison of CO_2 flux between TEA and other methods

Photo. 3 Field test of TEA in Betsukai-town, Hokkaido. White tubes are inlets of sampled air (lower photo)

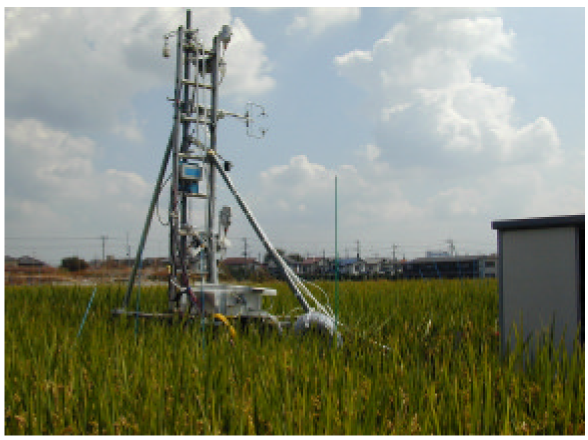

Photo. 4 NO_2 flux measurement by TEA technique in a paddy field

adsorption trap for trace gases. The example of measurement of NO_2 flux in a paddy field is shown in Photo 4.

We are grateful to Tomoyasu ISHIDA of Utsunomiya Univ. and Satoru SUZUKI of the Forestry and Forest Products Research Institute for their support. This research was funded by Grant-in-Aid for Scientific Research (13556041; PI: Masatoshi AOKI)

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Effects of Habitat Fragmentation on Regeneration Resilience and Tree Floristic Richness in a Degraded Bornean Rain Forest：

An Application of Findings from Large-scale Forest Dynamics Plot Database

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In 1993 a large-scale (52 ha) forest dynamics plot was established in a lowland mixed Dipterocarp forest (LMDF) in Lambir Hills National Park (area 6823 ha), Sarawak, Malaysia, as a collaborative project among Sarawak Forest Department, Japanese Basic Creative Research team (Leader : Saburo TAMURA, The University of Tokyo) and CTFS/STRI (Center for Tropical Forest Science of the Smithsonian Tropical Research Institute) (Lee et al., 2002, 2003). The plot is located near the boundary of the park, and the area has been affected by two forms of deforestation, logging and shifting cultivation, since the park was gazetted in 1975. Using satellite images, aerial photographs, and tree demographic census data, we analyzed the fragmentation processes and the effects of these two practices on LMDF at the park border and also evaluated the resilience of remnant forests in a fragmented LMDF at the Bakam Forest Experimental Reserve (243.9 ha), Sarawak Forest Department, located 10 km north of the 52 ha plot (Fig.1). The 52 ha plot is designated as the target model forest for rehabilitation, and the tree demographic data can be compared with that of the remnant forests.

To clarify the processes and causes of forest fragmentation, we address the following specific questions: 1) How quickly has the forested landscape become fragmented? 2) What causes the forest fragmentation and what processes are involved? In addition, to compare the effects of the two practices of deforestation, logging and shifting cultivation, on LMDF, we also asked that 3) what are the differences in forest structure and tree floristic composition resulting from the two forms of deforestation? Finally, we propose a scheme for the rehabilitation of degraded logged-over forest ecosystems.

The overall 8550 ha of the forest remnants in Bakam rapidly decreased from 89.6 % to 36 % from 1977 to 1997. The shift of mode of forest area loss from logging to shifting cultivation occurred, within the last 10 years. The timing of increase of the forest area used for shifting cultivation (rate changed in area: 2.7 to 4.4 %/yr) along logging roads coincides with the decrease of log-

Table 1 Tree species richness index (Fisher's alpha) in 52 ha plot in Lambir and the adjacent degraded area in Bakam Experimental Forest Reserve. (Ohkubo et al., unpublished data)

Site	Plot	Fisher's alpha	
		mean	range
52 ha plot	whole plot (52 ha)	106.1	(13.1-358.3)
in Lambir	ridge (0.88 ha)	49.2	(31.6-89.9)
Bakam	Logged over forest area		
Experimental	remnant A (0.16 ha)	24.7	(20.6-29.0)
Forest Reserve	remnant B (0.13 ha)	17.5	(7.8-37.8)
	The forest after shifting cultivation (0.53 ha)	9.0	(3.5-17.3)

Sub plot size: 20 x 20m, Trees measured: DBH>1cm

ging operations (4.1 % to 2.7 %/yr in area). The shifting cultivators are able to enter the logged-over forest via logging roads after logging operations decrease, and use fire for their own shifting cultivation. At the regional scale, shifting cultivation after logging is a more intense and more direct cause of forest fragmentation than logging alone.

Logging effects on the two studied remnant forests (800, 1700 m^2) in Bakam were limited to the canopy layers (trees with diameter >40 cm were removed). Elevated levels of disturbance regime from the remnant forests to the forests after shifting cultivation may result in the decrease of total stand biomass, maximum size of trees, and loss of Dipterocarp species (36.4 m^2 ha^{-1} of basal area (BA), with 17.1 % of *Dipterocarpaceae* and Maximum diameter at breast height (DBH) of 73.6 cm in a remnant forest; 4.56 m^2 ha^{-1} of BA, with 4.56 % of *Dipterocarpaceae*, Max. DBH of 31.9 cm in the forest after shifting cultivation). Potential resilience of the remnant forests was still maintained on the basis of understory pole and sapling structure, even in a micro sized remnant (25 m^2). But in the forests after shifting cultivation the regeneration response is weak judging from the measurement of recruitment and tree species composition. Tree floristic richness of the remnant forests evaluated by Fisher's alpha diversity index was inferior to that of the 52 ha plot in Lambir. The value of the forests after shifting cultivation was lowest (Table 1). Sub-plots in the 52 ha plot in Lambir showing low values of the diversity index were spatially distributed on the ridge-tops. Also, slopes and intercepts of the species-area curves in the remnant forests in Bakam were lower than that of 52 ha plot in Lambir, and the forests after shifting cultivation were lowest. Higher similarity of species composition between the two remnant forests in Bakam and the 52 ha plot than expected values of similarity calculated from the species-area curves can be explained by the preservation of common flora in both forests.

In conclusion, the remnant forests fragmented by logging are characterized by low degradation, high resilience, low tree floristic richness, and presence of

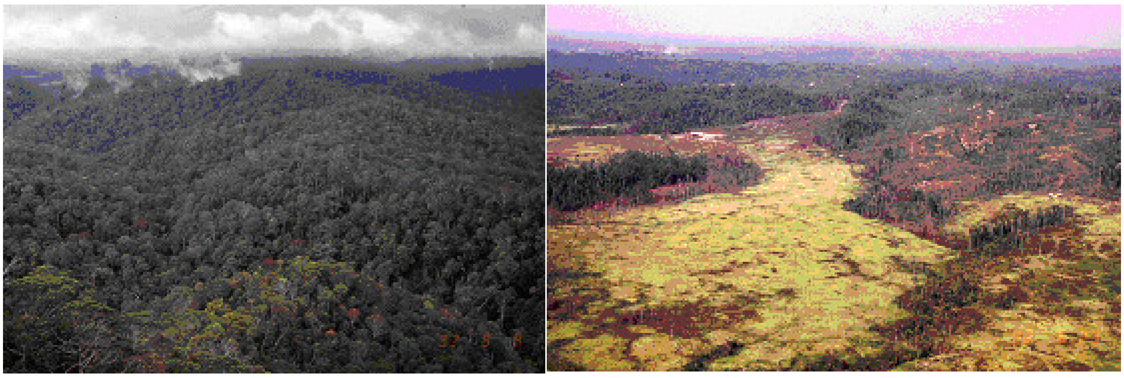

Fig. 1 Lowland mixed Dipterocarp forest in Lambir Hills National Park (left) and small forest fragments surrounded by abandoned shifting cultivation area in Bakam Experimental Forest Reserve near Lambir (right) in Sarawak, Malaysia.

tree species in common with the 52 ha plot. For future management, preventing tree species loss by successive disturbance and receding forest edges is required. The forests after shifting cultivation are characterized by high degradation, low responsiveness, and lowest tree floristic richness. Planting is an indispensable option for the ecosystem rehabilitation. The study of the 52 ha plot in Lambir Hills National Park provides relevant information as the reference model forest for degraded forests with regard to selecting species for plantings and clarifying their habitat preferences.

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Flux Observation at Haibei Alpine Grassland Site

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The Haibei flux site is located at the alpine grassland on the northeast of the Qinghai-Tibetan Plateau in northwestern China (37°35 '- 37° 40' N, 101°18' - 101°20' E). The terrain is shown as large-area flat plains with mild hills around, elevation ranging from 3100-3400 m . The topographic map of the area shows a gentle southward inclination. Wind flows mainly from the south during the day and from the north at night. The site has a highland continental climate due to its hinterland location and high elevation. The annual mean temperature is only −1.7°C; and annual precipitation is about 580 mm, with most occurring from May to September. The solar radiation is strong and the annual global solar radiation is up to 6000-7000 MJ m^{-2}.

The research area covers 15 km^2. The differences of local microclimate and soil drainage property lead to various vegetation types over this area, covered by alpine Kobresia humilis meadow, Kobresia tibetica swamp and bush cinquefoil (Potentilla fruticisa L.) (Table 1). Seasonal leafing period is from mid-May to mid-October. The maximum leaf area index (LAI) was in August, with leaves were sampled and measured by the LI-3000A leaf area meter in 2004.

Flux towers with eddy covariance systems were set up over the shrub and swamp ecosystems in 2002 by Chinese Academy of Sciences (Fig. 1). The tower over the alpine meadow was installed in 2001 by the National Institute for Environmental Studies, Japan. Fluxes of momentum, sensible heat, latent heat, water vapor and CO_2 were measured by eddy covariance methods at heights of 2.2-2.5 m. A 3-D sonic anemometer (model CSAT3, Campbell Scientific, USA) measured three-dimensional wind speeds and air temperature, and a fast-response, open-path infrared gas analyzer (IRGA, model LI-7500, LI-COR Inc., USA) measured water vapor and CO_2 concentrations. Micrometeorological components above canopy were also monitored, including net radiation, PAR, rainfall, the vertical distributions of wind speed, humidity and air temperature. The ecophysiological measurements were also taken during the growing season. The above- and below-ground biomasses were measured once every two weeks. The temporal variation of soil respiration is measured by the static chamber method from 2003.

Haibei station was originally established in 1980 by the Synthesis Research Center of Chinese Ecosystem

Table 1 Basic information of the three ecosystems at Haibei flux site

Vegetation type	Meadow	Swamp	Shrub
Dominant species	*Kobresia humilis*	*Kobresia tibetica*	*Potentilla fruticisa* L.
Elevation(m a.s.l)	3148	3160	3293
Canopy height(m)	0.2	0.4	0.5
Maximum LAI	3.4	2.8	3.5
Soil type	Alpine meadow soil	Alpine swamp soil	Alpine scrubby meadow soil
Tower location	101°19´37"E, 37°36´31"N	101°18´18"E, 37°36´48"N	101°19´52"E, 37°39´55"N
Flux observation period	From Aug. 2001	From Sep. 2002	From Sep. 2002

Research Network (CERN) for meteorological and environmental monitoring on the Tibet Plateau. More and more scientists were attracted to carry out their researches at this area since the 1990s because of the unique climate and environmental conditions on the Tibet Plateau, aiming at not only quantifying the carbon and nutrient dynamics in soil and vegetation, but also evaluating the effects of grazing intensity and management activities on grass yield and livestock. Haibei station also has a long research history on the restoring of degenerated grassland.

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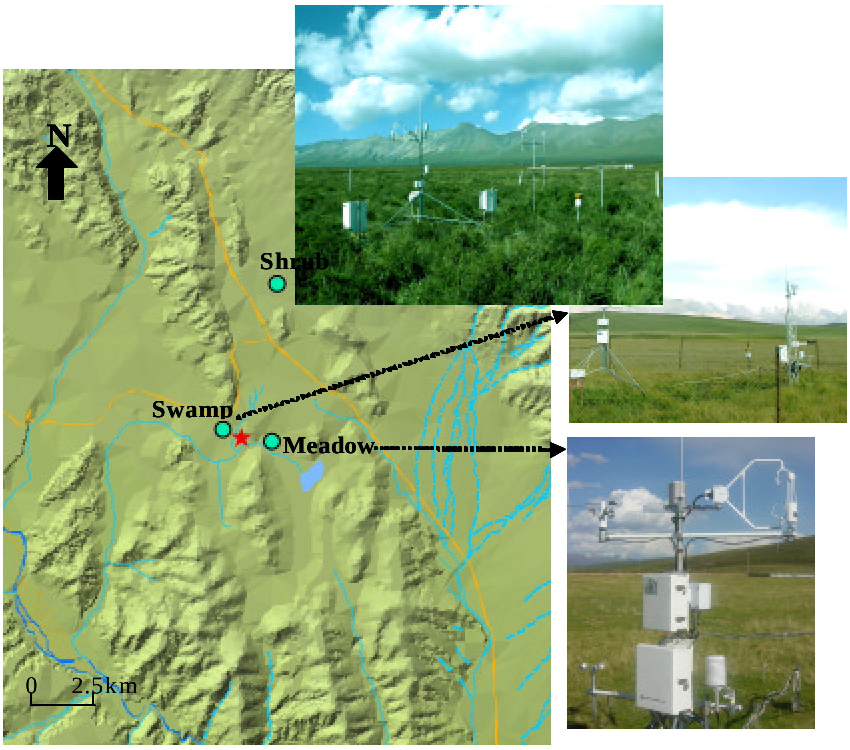

Fig. 1 The location of the three studied ecosystems at Haibei flux site, with the pictures of flux observation tower installed.

Kahoku Experimental Watershed
– The Southernmost Observation Site of FFPRI FLUXNET –

Takanori SHIMIZU

Forestry and Forest Products Research Institute, Japan

Kahoku Experimental Watershed, one site of our institutional observation network of Forestry and Forest Products Research Institute (FFPRI FLUXNET), is the southernmost continuous monitoring site of forest CO_2 flux in Japan. The site is located in northern Kumamoto Prefecture (33°08'N, 130°43'E) in Kyushu Island, southeastern Japan (Fig. 1). The dominant species are planted evergreen conifers of 50-year-old Japanese cedar (*Cryptomeria Japonica*, "Sugi" in Japanese) and 27- to 50-year-old Japanese cypress (*Chamaecyparis obtusa*, "Hinoki" in Japanese). The two species are the most important planted trees in Japan, especially in Kyushu Island. Total area of the two species dominated plantations cover about 18% of the land surface of the country, and about 34% of Kyushu Island. The geology of the site is the crystalline schist. The observation field consists of three small watersheds (WS1-3 in Fig. 2) with each covering 2.3 to 3.7 ha, and the elevations range from 140 to 250 m. The terrain is not flat, similar to most of the forests in Japan. The canopy height is 14 to 32 m and the year-round vegetation area index (VAI) measured at 3 plots using a plant-canopy analyzer (LAI-2000, LI-COR, USA) varies between 4 and 6, with the peak in middle autumn. Mean annual temperature between 2000 and 2002 was 15.2°C, with the minimum mean monthly temperature of about 4°C between January and February and the maximum temperature of 26°C in August, respectively. The central-southern part of Kyushu area, where the site located, is characterized by the highest rate precipitation of the temperate region. Mean annual precipitation for 5 years (1999-2003) was 2150 mm, with a relatively low rate of 1538 mm in 2002. The weather varied over a 5- to 10-day cycle through the year, except in the rainy season from the middle of June to early July.

The site was established in 1991 to investigate and quantify the hydrological factors for a coniferous plantation on the basis of precipitation and runoff observa-

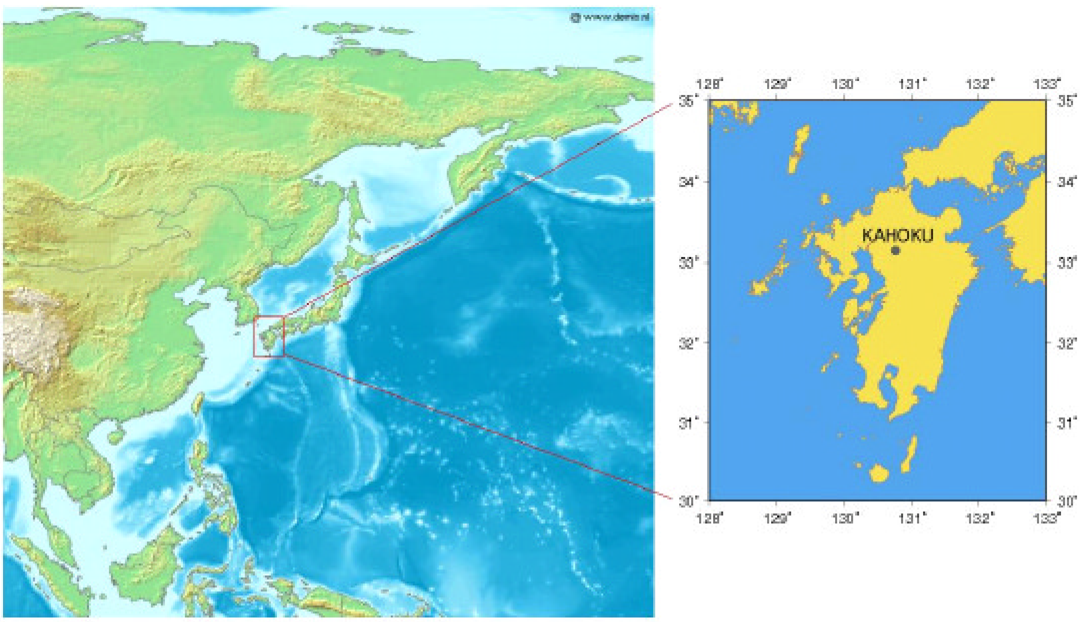

Fig. 1 Kahoku experimental watershed, in Kyushu Island, Japan

tion. Additionally, throughfall and stemflow have been measured at 3 plots since 2002. Net radiation and gradients of air temperature and humidity had been measured at the top of the canopy in WS3 until 1999, and evapotranspiration (ET) was calculated by the Bowen ratio method. Results were examined with the hydrological data for the estimation of ET from the site and its characteristics (Shimizu et al., 2003).

In 1999, a 50-m height of meteorological observation tower (Photo. 1) was built in the middle of WS2 at 165 m above sea level, and the CO_2 flux measurement was started with the eddy covariance method. Continuous data acquisition system has been operated since November 1999, using a three-dimensional sonic anemometer (DAT600, probe: TR-61C, KAIJO, Japan) that was installed at 51 m above the ground. Air sample near the sonic anemometer was drawn into a closed-path infrared CO_2 analyzer (IRGA, LI-6262 (until January 2005) or LI-7000 (from January 2005), LI-COR, USA) through a 60 m length and 6 mm inner-diameter of Teflon tube at a flow rate of 8 L min^{-1}. All the turbulence data were recorded at 10 Hz using an analog datalogger (DR-M3b, TEAC, Japan). CO_2 storage flux was observed every 20 minutes by drawing air samples from 8 levels into an IRGA (LI-6262). The zero and span drifts of the IRGA were manually calibrated at least once a week. Other sensors were also attached to the tower to measure the micrometeorological components: Air temperature and humidity sensors were attached at 6 levels above, within and beneath the canopy; Solar radiation and infrared radiation were measured near the top of the tower both upward and downward factors. Moreover, soil respiration has been measured once a month since April 2000 with three closed chambers, and annual soil respiration was derived from continuous measurements of soil temperature at a depth of 5 cm and a soil temperature-dependent function.

Beside the hydro-meteorological observations, recently individual studies on stable isotopes in rainfall and runoff water and measurement of sap flow with Granier sensors have been started since 2004. We are now preparing for output of the accumulated data, and concurrently seeking the ways to extend and connect these investigations for more accurate and effective estimation of carbon and water dynamics within and over the cedar and cypress forests in Japan.

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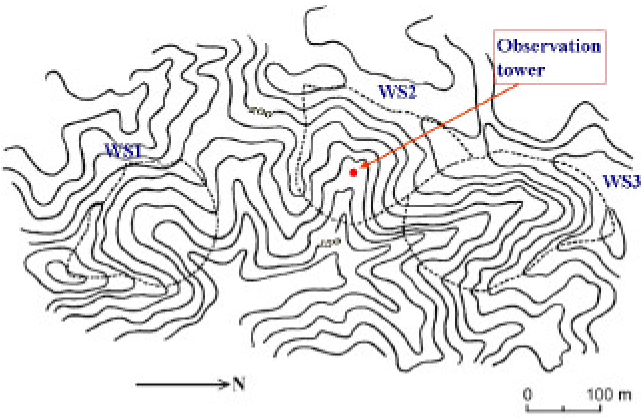

Fig. 2 Topographical map around the site

Photo. 1 A 50-meter observation tower

The 4th AsiaFlux WS Postponed

The 4th AsiaFlux WS, which was scheduled on 11-12 May 2005, was postponed due to (1) abrupt change of funding and (2) lack of time to decide the schedules particularly concerning invited speakers. We are sorry that you might have to cancel your travel plan. We will inform you the new schedule of the WS after it is fixed.

We apologize for its postponement and hope you will understand our situation and give us your further cooperation.

Editor's Note

The towers of Sapporo-site damaged by typhoon will be reconstructed soon.(see Newsletter No.11 and 12)
We are thankful to the persons concerned and are glad to be able to carry out observation again.

The editor of AsiaFlux Newsletter No.13:
Satoru SUZUKI
(Hokkaido Research Center, Forestry and Forest Products Research Institute)

The editor of AsiaFlux Newsletter No.14 will be Nobuko SAIGUSA (National Institute of Advanced Industrial Science and Technology).

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