Environmental Conservation and Land Use Management of Wetland Ecosystem in Southeast Asia

Annual Report
for
April 1999 - March 2000

Core University Program
between
Hokkaido University, Japan and R & D Center for Biology, LIPI, Indonesia
Sponsored by
Japan Society for Promotion on Science

March 2000

Preface

Three years have already passed since the core university program supported by JSPS, between Hokkaido University, Japan and the Research and Development Center of Biology, LIPI, Indonesia started in April 1997. This first term of three years have been decisive to give the project its direction and to organize scientists who are deeply interested in the project and have been conducting excellent researches.

Fortunately, many scientists attended the workshop in Palangka Raya in 1997 and the International Symposium in Bogor in 1999. To this two events, not only scientists from Japan and Indonesia attended but also scientist from Malaysia, Thailand, U.K. and Germany.

During this first term, four collaborative research groups have been organized and have carried out their research programs very actively.

The research groups are divided as follows,

Group 1. Ecosystem function of wetland forests in Central Kalimantan.

Group 2. Studies on the sustainability of ecological system of bio-production in Central Kalimantan.

Group 3. River and peatland technology.

Group 4. Aquatic ecosystem in Central Kalimantan.

The result of their excellent research works for this first term of three years is reported in the proceedings of the International Symposium on Tropical Peatland Management, TroPeat 99 and the annual report of the core university program.

March 2000

Norio Nishi

Dr. Norio Nishi, Professor
Leader of the core university program
Dean of the Graduate School of Environmental
Earth Science, Hokkaido University

Content

1. Outline of the project

Objective

Researches with collaboration by Japanese and Indonesian scientists into the environmental conservation, management and regional utilization of wetland ecosystems including peat land in Southeast Asia from the view point of environmental earth science.

Organization

This project consist of two core universities, Graduate School of Environmental Earth Science, Hokkaido University, Japan and Research and Development Center for Biology, LIPI, Indonesia. Fourteen universities and institutes in both countries also collaborate to this project. Eighty four Japanese scientists and seventy-two Indonesian scientists are registered in the project.

Leader of the project and Japanese coordinator is Dr. Norio Nishi, Professor, Dean of Graduate School of Environmental Earth Science, Hokkaido University and Indonesian coordinator is Dr. Arie Budiman, Head of Research and Development Centre for Biology, LIPI.

Research and exchange plans of the project are discussed and decided by the steering committee which consist of twenty four members from the core and cooperative universities.

The planning and executive committee being composed by twelve members from the core university proposes the draft of plan to the steering committee and carries the plan into executive after the plan being authorized by the steering committee. The office of Graduate School of Environmental Earth Science, Hokkaido University, supports the project by conducting affairs.

List of the cooperative universities and institutes in Japan and Indonesia

Kwansei University	Hokkaido Institute of Technology
Kyoto University	Hokkaido University of Education
Kagoshima University	R&D Centre for Geotechnology, LIPI
Tottori University	R&D Centre for Limnology, LIPI
Tokyo University of Agriculture and Technology	Bogor Agricultural University
	Institute of Technology Bandung
Hokusei Gakuen University	University of Palangka Raya

2. Chronology

21 March, 1997: The final agreement of the core university project between Graduate School of Environmental Earth Science and Research and Development Centre for Biology, LIPI was concluded by Mr. Jiro Inomata of JSPS and Dr. Soetikno Wirjoatmdjo of R & D Centre for Biology, LIPI in Bogor.

1997th fiscal year

Leader of the project, Coordinator in Japan: Seiichi Tokura, Professor, Dean, Graduate School of Environmental Earth Science, Hokkaido University

Coordinator in Indonesia: Dedy Darnaedi, Head, Scientific Service and Information Division, R& D Centre, LIPI

Number of cooperative universities	Japan: 8	Indonesia: 5
Number of scientists:	Japan: 44	Indonesia: 19

9 June, 1997: The first steering committee was held in Hokkaido University. The plans for scientist exchange between two countries and the international workshop in Palangka Raya were discussed and decided.

6 – 9 August, 1997: The international workshop titled "Environmental Conservation and Land Use Management of Wetland Ecosystem in Southeast Asia" was held in Palangka Raya as *the seminar program*. Thirty three reports were presented by scientists from Japan, Indonesia and U.K. in two days. The discussion in the field continued in the post congress excursion for two days. Four research groups for Forest Ecology, Agriculture, River and Peatland Technology, and Limnology were organized on the end of the workshop.

July – August, 1997: *Collaborative research* "Study on agro-forest ecology of tropical peat swamp area" was carried out in Central Kalimantan.

March 1998: Annual report including the proceedings for the international workshop in Palangka Raya, 6 –9 August, 1997 was published.

Short term exchange program

Japan to Indonesia: Seiichi Tokura, Yoji Mitsuyama (7 days in December, 1997), Hidenori Takahashi (6 days, in December, 1997)

Indonesia to Japan: Herwint Simbolon, Ir. Sulastri, Kamarddin Abdullah, Spiandi Sabiham, Suprihanto Notodarmojo, Suwido Limin (14 days in February,1998),

Long term exchange program

Indonesia to Japan: Basuki Sumawinata (6 months from August, 1997)

1998th fiscal year

Leader of the project, Coordinator in Japan: Norio Nishi, Professor, Dean, Graduate School of Environmental Earth Science, Hokkaido University

Coordinator in Indonesia: Arie Budiman, Head, R& D Centre for Biology, LIPI

Number of cooperative universities	Japan: 9	Indonesia: 5
Number of scientists:	Japan: 68	Indonesia: 36

9 June, 1998: The steering committee was held in Hokkaido University. The plan for scientist exchange between two countries and the research plans of four research groups which were organized during the workshop in Palangka Raya, were discussed and decided.

August – September, 1998: *Collaborative research group #1* "Ecosystem function of wetland forests in Central Kalimantan" was carried out.

August, 1998 – February, 1999: : *Collaborative research group #2* "Study on the sustainability of ecological system of bio-production in Central Kalimantan" was carried out.

August, 1998: *Collaborative research group #3* "River and peatland technology" was carried out.

September – December, 1998: *Collaborative research group #4* "Function of aqua ecosystem in Central Kalimantan" was carried out.

Short term exchange program

Japan to Indonesia: Seiichi Tokura (7 days in November, 1998) , Norio Nishi and Kenichi Takeda (8days in December), Seigo Higashi (8 days in February, 1999)

Indonesia to Japan: Arie Budiman, Hanny Wijaya, Peter E. Hehanussa, Nyoman Sumawijaya (10 days in October,1998) and Muhamad Rahman Djuwansah (10 days in January-February, 1999)

Long term exchange program

Indonesia to Japan: Bismart Ferry Ibie (6 months from September, 1998), Typuk Artingsih (6 months from July, 1998)

1999th fiscal year

Leader of the project, Coordinator in Japan: Norio Nishi, Professor, Dean, Graduate School of Environmental Earth Science, Hokkaido University

Coordinatorin Indonesia: Arie Budiman, Head, R& D Centre for Biology, LIPI

Number of cooperative universities	Japan: 9	Indonesia: 5
Number of scientists:	Japan: 84	Indonesia: 72

22 June, 1999: The steering committee was held in Hokkaido University. The plan for scientist exchange between two countries, the research plans of four research groups and the outline of the seminar in Bogor were discussed and decided.

21 –27 November, 1999: *The seminar* "Intentional Symposium on Tropical Peatland Management, TroPeat99" was held in Cilto-Bogor. Forty three reports were presented in the aural session and seventeen reports in the poster session. Total number of participant was more than one hundred and seventy. The excursion and field discussion also continuously carried out in Central Kalimantan.

November, 1999 – January 2000: *Collaborative research group #1* "Ecosystem function of wetland forests in Central Kalimantan" was carried out.

June, 1999 – December, 1999: *Collaborative research group #2* "Study on the sustainability of ecological system of bio-production in Central Kalimantan" was carried out.

November - December, 1999: *Collaborative research group #3* "River and peatland technology" was carried out.

November, 1999 – March, 2000 *Collaborative research group #4* "Function of aqua ecosystem in Central Kalimantan" was carried out.

Short term exchange program

Japan to Indonesia: Norio Nishi and Kazuo Wada (9days in November), Seigo Higashi (13 days in November, 1999)

Indonesia to Japan: Jan Sopaheluwakan (10 days in October,1999)

Long term exchange program

Indonesia to Japan: Salampak Dohon (6 months from September, 1999),

Collaborative study

(1)

Ecosystem function of wetland forests in Central Kalimantan

JSPS-LIPI Core University Program - Report for the Activity in 1999

Research Project:
Ecosystem Function of Wetland Forests in Central Kalimantan

Biomass and turnover rate of a kerangas forest in Central Kalimantan

Project leader:

Takashi Kohyama
Graduate School of Environmental Earth Science
Hokkaido University
Sapporo, Japan

&

Edi Mirmanto
Research and Development Centre for Biology
Indonesian Institute of Sciences
Bogor, Indonesia

February 2000

Abstract

We studied primary productivity and the tree form of various tree species of a kerangas forest by cutting several trees in two 1-ha plots established in Lahei, Central Kalimantan. Biomass of kerangas forest was about 200 t/ha, which corresponded to 1/2 - 1/3 of that of a lowland rain forest. Biomass turn over time calculated by using the relative growth rate (RGR) of tree diameter was 30 years. This was about three times faster than that of the lowland rain forest and remarkably short turn over. Interspecific differences were also found in allometric relation between various pair of plant dimensions. The acidic and nutrient poor-sandy soils probably affect these unique characteristics of kerangas forests, however, more detailed studies will be needed to clarify the factors.

(1) Introduction

Kerangas forests are one of the most distinctive formation in Central Kalimantan, which occurs on highly acidic- and nutrient-poor sandy soils. Previous studies reported flora, soil characteristics and secondary succession about these forests. However, little is known about primary productivity and architectural characteristics of the forests so far. We attempted to reveal those characteristics of kerangas forests in terms of biomass, biomass allocation, growth and turn over by cutting various sized trees and using allometric relations between various pair of plant dimensions.

(2) Research objectives

The present research aimed at following points: 1) to detect the productivity of kerangas forests in Central Kalimantan and to compared with the other type of forests, especially tropical lowland rain forests, 2) to detect difference of tree form among trees in kerangas forests, 3) to reveal the factors determining the productivity and architectural characteristics of kerangas forests.

(3) Implementation

We carried out field survey in two different sites. The one is in the area about 3-4 km east from Kampong Babugus, Desa Lahei, Kacamatan Metagai, Kabupaten Kapuas. This area is characterized by peat swamp forests and kerangas forests. We have already established three 1-ha plots in this area (two in a kerangas forest and one in a peat swamp forest). To observe annual growth of the forest, we measured girth at breast height (g.b.h.) for all trees with more than 15 cm g.b.h. in one kerangas plot (called P4). We collected specimens of unidentified tree species in the plot. For detecting primary productivity and the analysis of allometric relations, we carried out destructive sampling for in the other plot (P1). We cut various sized trees (from saplings with 4 m high to adults with 30 m high), then, measured and weighed above ground parts of these sample trees divided into three fractions (trunks, branches and leaves). In order to calculate dry weight of each sample tree, we collected small samples to be dried at 80 C in electric oven.
We visited the other site in Gunung Berui area, Serimbu, Kacamatan Air Besar, Kabupaten Pontianak. This area represents well developed lowland dipterocarp forests around Gunung Niut Nature Reserve. We have already established two 1-ha plots on this site. We carried out a preliminary survey for the comparative study between kerangas forests and lowland rain forests (for example, measurement of g.b.h. of trees in plots).

(4) Results and Discussion

Biomass and turn over in a kerangas forest

Biomass (t/ha) of two 1-ha plots were 245 (P1 in 1997) and 208 (P4 in 1998), respectively (Table 1). These biomass levels corresponded to 1/2 - 1/3 of those of mixed dipterocarp forests (Table 2). Turn over (years) of the kerangas forest defined by relative growth rate (RGR) of biomass (i.e. reciprocal of RGR) were 26 (P1) and 31 (P4), respectively (Table 1). These turn over levels were remarkably short compared with those of a mixed dipterocarp forest in Serimbu, West Kalimantan (turn over was more than 100 years; Kohyama, unpubulished data). High density and high growth rate of small-sized trees in the forest seemed to affect to such a short turn over time.

Interspecific differences in architectural characteristics

We compared interspecific difference of allometry between various pair of plant dimensions. Tree species selected were as follows: *Calophyllum* sp. (Guttiferae), *Canarium* sp. (Burseraceae), *Cotylelobium lanceolatum* (Dipterocarpaceae), *Sageraea.elliptica* (Annonaceae), *Hopea dryobalanoides* (Dipterocarpaceae), *Shorea platycarpa* (Dipterocarpaceae), *Palaquium leiocarpus* (Sapotaceae), *Ternstroemia aneura* (Theaceae), *Tetractomia* sp (Rutaceae). So far, we have finished statistical analyses for the first five species. Here, we report the results of allometires of the five species. In five cases of ten pairs of dimensions, significant difference was only seen in intercepts, whereas differences in slopes were also significant for four allometries (Table 3). These results suggest that each tree species in kerangas forests have its own specific characteristics (such as wood density and leaf area), which reflect different niche in the forest. To clarify more details, we need to finish the analyses for all nine species.

(5) Conclusion

From the present study, we concluded the followings: 1) Biomass of the kerangas forest was 1/2 - 1/3 of that of the tropical lowland rain forest. Such a small biomass seemed to be due to nutrient poor soils in the forest. 2) Nevertheless such a small biomass, growth rate of trees in kerangas forests was almost the same as that of tropical lowland rain forests. As the result of that, biomass turn over of the kerangas forest was very short (about 30 years). 3) Tree species in the kerangas forest differed in architectural characteristics each other as previously reported in several lowland rain forests. This indicates that kerangas forests develop the similar stratification of trees as seen in lowland rain forests. Probably, one of the most important factors for above mentioned characteristics of kerangas forests is nutrient poor and acidic soil. Various approaches will be needed for understanding this unique forest ecosystems.

Table 1

	Stem	Branch	Stem+ Branch	Leaf	Total	BA (m^2/ha)	LAI (ha/ha)
P1							
Biomass Jul. 1997 (t/ha)	194.4	44.0	238.4	7.0	245.4	30.5	4.1
Biomass Aug. 1998 (t/ha)	177.2	39.7	216.9	6.4	223.3	28.0	3.8
Increment rate (t/ha/yr)	-15.9	-4.0	-19.9	-0.5	-20.4	-2.3	-0.3
P1 (After clear cut in F07)							
Biomass Aug. 1998 (t/ha)	170.6	38.1	208.7	6.2	214.9	26.9	3.7
Biomass Aug. 1999 (t/ha)	158.3	35.5	193.8	5.7	199.5	24.9	3.4
Increment rate (t/ha/yr)	-12.3	-2.7	-15.0	-0.5	-15.5	-2.0	-0.3
P4							
Biomass Aug. 1998 (t/ha)	166.2	36.6	202.8	6.0	208.8	26.5	3.6
Biomass May 1999 (t/ha)	161.9	35.6	197.5	5.9	203.4	25.9	3.5
Increment rate(t/ha/yr)	-6.3	-1.4	-7.7	-0.2	-7.9	-0.9	-0.1

Table 2

	Loss (t/ha/yr)	RGR (/yr)	Net growth (t/ha/yr)	Net production (t/ha/yr)	Turn over (yr)
P1 (Aug.1997 - Aug.1998)	19.5	-0.004	-0.9	18.6	–
After clear cut in F07					
P1 (Aug.1998 - Aug.1999)	22.1	0.038	7.2	29.3	26
P4 (May1998 - Aug.1999)	14.3	0.032	6.3	20.6	31

Table 3 The difference among 5 tree species in allometric relationships, Ln Y = b1LnX + b0, between various pairs of measures.

		Regression for total			Variance ratio F		Regression for each species	
x	y	b1	b0	r	b1	b0	common b1	range of b0
1 D	H	0.693	5.581	0.947	2.384	8.639 ***	0.699	**5.402 to 5.728**
2 H	Ac	1.687	-0.446	0.874	2.486	7.499 ***	1.818	**-1.601 to -0.750**
3 H	D2H	3.586	-14.009	0.971	3.011 *	8.317 ***	3.640	-14.856 to -13.984
4 H	Ws	3.603	-15.393	0.973	2.071	5.717 ***	3.640	**-16.001 to -15.342**
5 D2H	Ws	0.999	-1.262	0.997	3.121 *	16.667 ***	0.999	**-1.415 to -1.103**
6 D2H	W	0.979	-0.745	0.996	3.267 *	5.841 ***	0.983	**-0.941 to -0.698**
7 W	Wl	0.699	0.14	0.94	1.530	6.849 ***	0.725	**-0.472 to 0.350**
8 W	Wb	1.037	-2.209	0.984	6.438 ***	5.409 ***	1.056	-2.669 to -2.117
9 H	Al	2.218	-4.052	0.875	0.441	6.206 ***	2.376	**-5.540 to -4.422**
10 Ac	Al	1.216	-2.349	0.926	1.870	0.602	1.216	-2.475 to -2.192

D, diameter (cm); H, height (m); Ac, crown area (m2); D2H, trunk volume index (cm2*m);
Ws, stem weight (kg); W, above ground total weight (kg); Wl, leaf weight (kg) ;
Wb, branch weight (kg); Al, total leaf area (m2)
*, $P < 0.05$; ***, $P < 0.001$

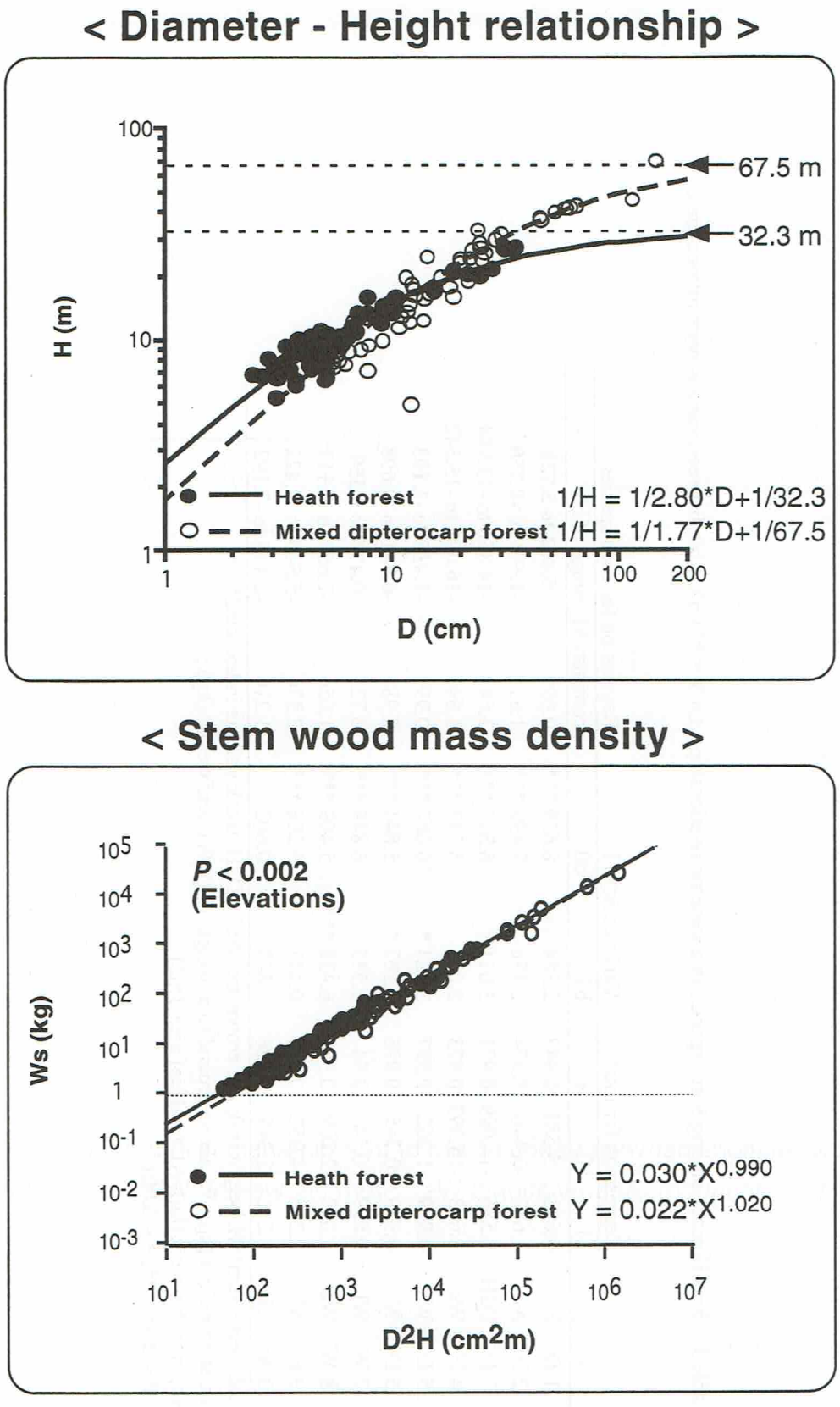

Fig. 1 Allometric relations between various pairs of tree dimensions in a heath forest and a mixed dipterocarp forest. Abbreviations: H, Tree height; D, diameter at 1/10 of tree height; Ws, Stem dry weight; D^2H, Trunk volume index

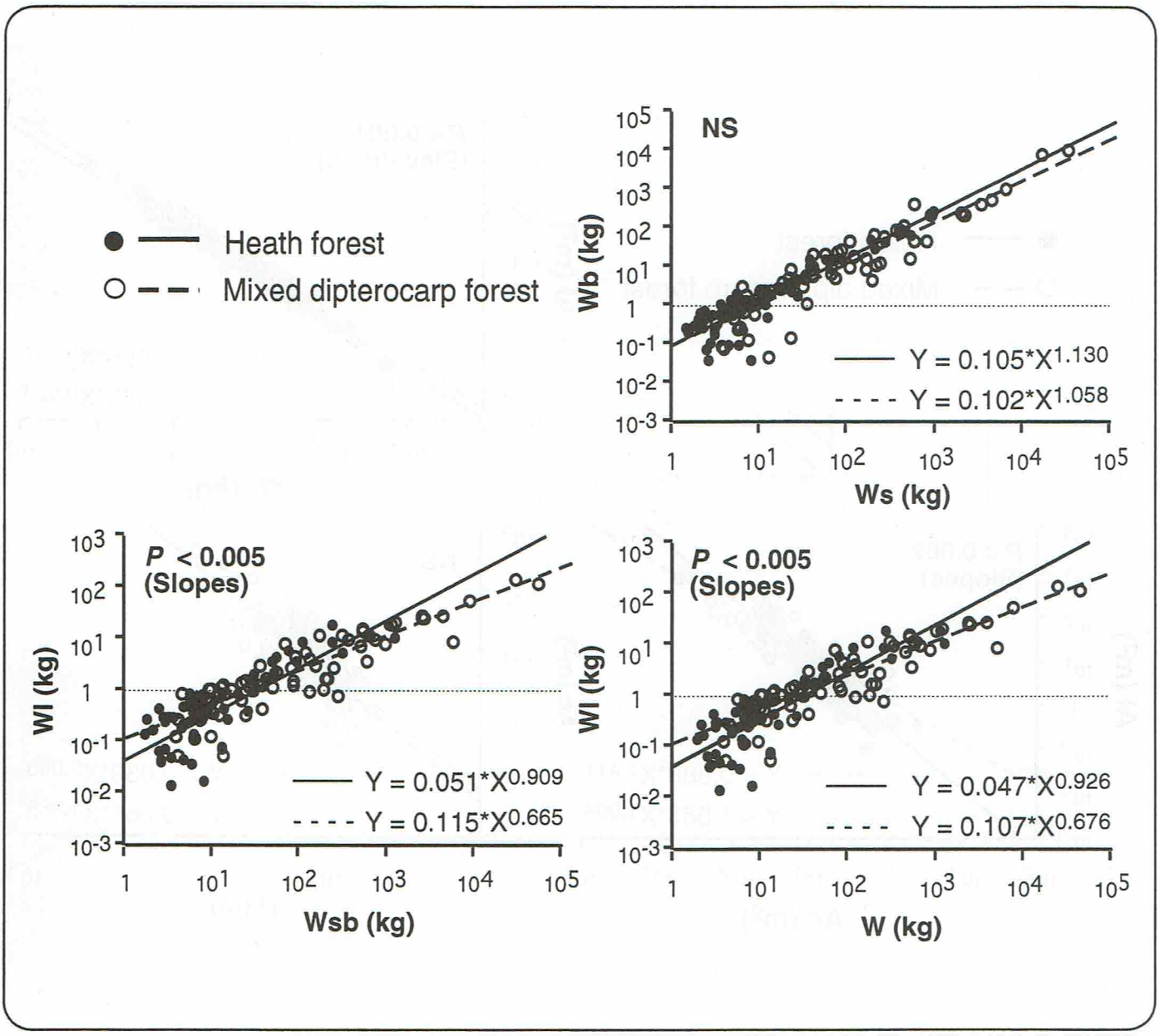

Fig. 2 Allometric relations between various pairs of tree dimensions in a heath forest and a mixed dipterocarp forest (continued). Abbreviations: Ws, Stem dry weight; Wb, Branch dry weight; Wl, Leaf dry weight; Wsb, Sum of stem and branch dry weight; W, Above ground total dry weight

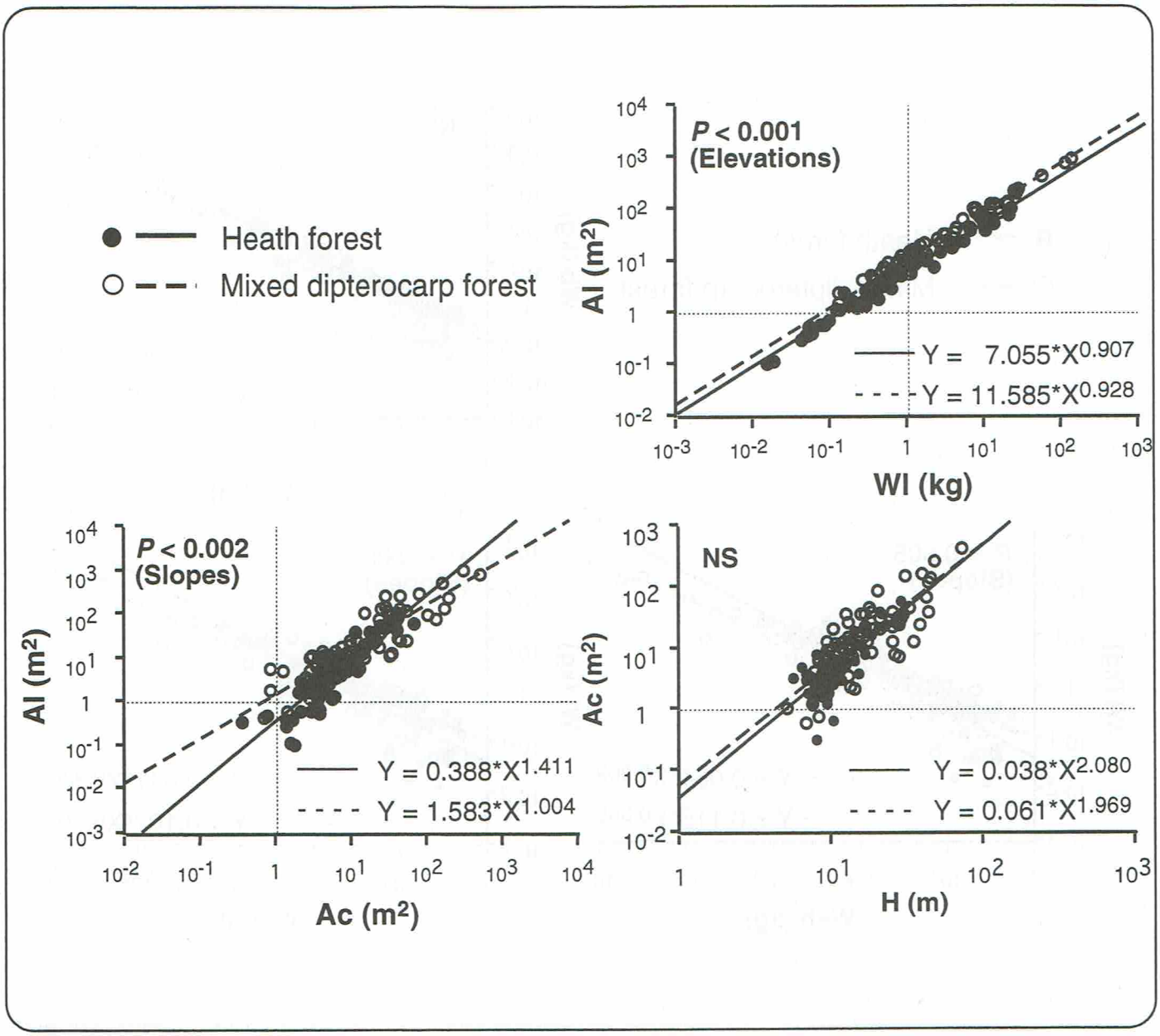

Fig. 3 Allometric relations between various pairs of tree dimensions in a heath forest and a mixed dipterocarp forest (continued). Abbreviations: H, Tree height; Ac, Crown area; Al, Total leaf area;Wl, Leaf dry weight

Collaborative study

(2)

Study on the sustainability of ecological system of bio-production in Central Kalimantan

ACTIVITY REPORT OF AGRONOMY GROUP ON 1999

Study on the Sustainability of Ecological System of Bio-Production in Central Kalimantan

in relation to

LIPI – JSPS Core University Program

"Environmental Management of Tropical Wetland Ecosystems in Southeast Asia"

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General Aspect of Project

In consideration of the susceptibility that inherent with peatland ecosystems of Central Kalimantan, Agricultural Sciences Group proposes a study on the sustainability of ecological system of bio-production. This research project is directed under the umbrella of LIPI-JSPS Core University Program. The issues of rehabilitation and establishment of sustainable agro-systems are to be addressed. The study sites will cover the destroyed, abandoned, and fire-damaged areas over peatlands ecosystem, as well as cultivated areas surrounding the natural or semi-natural peat swamp forests. The main objectives of this project are (1) to conserve peat swamp forests and rehabilitate the destroyed, abandoned, and fire-damaged areas; and (2) to establish the sustainable agro-systems in cultivated areas. Thus, this research project is entirely carried out in Central Kalimantan within two distinct zones of Kalampangan and Pangkoh along the Sebangau-Kahayan water catchment.

Several field surveys have been conducted on this selected research sites, and its progress has also been reported. However, current field survey is another series of observation, which mainly focussed on the promoting of teamwork between principal and co-operative scientists who involved in this project, as well as intended to establish study plots at Kalampangan Zone and find out details information on animal husbandry aspects.

Project Principal:

Under the slogan of sustainable development, forests on the peat swamp and wetland areas have been destroyed in tropical area. Needless to say, since it is very difficult to develop peat swamp and wetland, those huge areas still remain in natural or semi-natural conditions. Those areas have been considering as the key ecosystem for not only reserving bio-resources and biodiversity, but also stocking of carbon in forests and peat, or controlling water resource. However, nowadays, the peat swamp and wetland in tropical area face to the crisis of disappearance due to human impact, which is accelerated by recent abnormal and unusual global climate changes. Therefore, this current project is focussed on rehabilitation of peatlands and establishment of sustainable agro-systems in the destroyed, abandoned, and fire-

damaged areas in peat lands including cultivated areas, where locate surrounding natural or semi-natural peat swamp forests.

Project Objectives:

We have two main objectives in this project.

1) To conserve peat forest lands and rehabilitates the destroyed, abandoned, and fire-damaged areas in peat lands
2) To establish the sustainable agro-systems including cultivated areas

Experimental sites:

Peatlands area in Central Kalimantan are classified into three areas according to intensity of human activities; 1) the native peat swamp forest, 2) the destroyed, abandoned, and fire-damaged area and 3) cultivated areas. Referring to these peatlands characteristics in Central Kalimantan (surrounding Palangka Raya), the native peat swamp forest locates mainly between Sebangau River and Katingan River (Sebangau-Katingan catchment). Meanwhile, the abandoned, destroyed and fire-damaged area locate mainly between Sebangau River and Kahayan River (Sebangau-Kahayan catchment), and intensive cultivated areas locate mainly between Kahayan River and Barito River (Kahayan-Barito catchment).

Since our project is mostly taking special account on the rehabilitation of peatlands in the abandoned, destroyed and fire-damaged areas, as well as the establishment of sustainable production systems in cultivated areas, Sebangau-Kahayan catchment is proposed as the experimental sites. This is mainly because the Sebangau-Katingan catchment includes not only the abandoned, destroyed, and fire-damaged areas, but also cultivated areas (Figure 1).

Along the Sebangau-Kahayan catchment, there are three types of peat soils formation found such as inland peat, transitional peat, and coastal peat. However, since agricultural activity of coastal peat is quite different to inland peat and transitional peat, at first this project starts to study in inland peat and transitional peat. To this end, the following area are proposed as permanent research belt zones:

1. Kalampangan zone (Inland peat area with sandy material sub-layer) lies between both rivers of 7 km long and 25 km wide (Figure 2).
2. Pangkoh zone (Transitional peat with clay material sub-layer) lies between both

rivers of 40 km long and 30 km wide (Figure 3).

In these zones, 4 monitoring plots will be established which including reforestation plot, agro-system experimental plot, 2 observatory stations, as well as education and training center. These four monitoring plots locate in Kalampangan upon native-deep peat (plot I) and burn-deep peat (plot II); whereas in Pangkoh locates upon a secondary forest cover of native-shallow peat (plot III), and burn-shallow peat (IV).

I. Report on activities during the field visit to Central Kalimantan

Mitsuru Osaki[1)], Hiroshi Hata[1)], Sehat Jaya[1)], Suwarno[2)], Darobin Lubis[2)], Sri Purwaningsih[3)], Suwido Hester Limin[4)], and Robertho Aden[4)]

[1)] Graduate School of Agriculture, Hokkaido University,

[2)] Bogor Agricultural University (IPB),

[3)] Indonesian Institute of Sciences (LIPI), and

[4)] Palangka Raya University (UNPAR).

1. Itinerary

DATE	*ACTIVITY*
26 June 1999 (Sat.)	▪ Departs from Chitose Airport-SAPPORO and Kansai International Airport-OSAKA to Jakarta-INDONESIA. ▪ Arrive at Jakarta International Airport "Soekarno-Hatta". ▪ Travel to Bogor and stay at LIPI-Kebun Raya Guest House.
27June 1999 (Sun.)	▪ Visiting some areas in "Puncak" Bogor to look at the landscape and agricultural practices on the region. ▪ Visiting Lembang District-West Java to find out information on the animal husbandry programs.
28 June 1999 (Mon.)	▪ Preparing proposal and paper for meeting at Research and Development Center for Biology of LIPI. ▪ Meeting with scientists from Bogor Agricultural University and Research and Development Center for Biology, Indonesian Science Institute.
29 June 1999 (Tue.)	▪ Departs from Jakarta to Palangka Raya ▪ All team members stay in Palangka Raya ▪ Meeting with colleagues from UNPAR at CIMTROP's office to discussing detail plans and field visits schedule.
30 June 1999 (Wed.)	▪ Visiting Livestock Agency of Central Kalimantan Province. ▪ Visiting Transmigration Settlement at Sungai Gohong Village.

- Visiting a temporary livestock industry site at Km 7 of Palangka Raya – Sampit main road.

1 July 1999 (Thu.)
- Departs from Palangka Raya to Bahaur District (a trip along Kahayan River by speedboat).
- Taking soil samples and collecting some mushroom strains at Muara Bahaur and Bahaur Hilir village.
- Continuing trip to Pangkoh IX of transmigration settlement, then collecting soil and grass samples as well as visiting traditional livestock or animal production hold by the farmers.
- Returning backs to Pulang Pisau and stay over night.

2 July 1999 (Fri.)
- Continuing trip to Pangkoh III of transmigration settlement.
- Visiting the edge of drainage canal nearby Pangkoh V, then taking soil and mushroom strain samples upon a fire damaged area, under "*Melaleuca sp.*" association and over an abandoned area (dominated by *Imperata cylindrica*).
- Visiting Basarang river channel to look at a traditional farming system.
- Continuing trip to Garong village nearby drainage canal of one million hectares project, then taking soil and mushroom samples.
- Returning back to Palangka Raya.

3 July 1999 (Sat.)
- Dr. Hata, Mr. Suwarno, Mr. Darobin and Mrs. Purwaningsih depart from Palangka Raya to Jakarta and Bogor.
- Dr. Osaki and Mr. Sehat Jaya visiting site along Kalampangan drainage canal about 8.5 km long.

4 July 1999 (Sun.)
- Dr. Osaki and Mr. Sehat Jaya visiting an area at Kalampangan zone, which is nominated as study site and experimental plot.

5 July 1999 (Mon.)
- Meetings at the University of Palangka Raya to discuss further programs and to decide where the study plots should be established.
- Preparing proposal for further meeting at Bogor Agricultural University.

6 July 1999 (Tue.)
- Dr. Osaki departs Palangka Raya to Banjarmasin and Banjarbaru.
- Dr. Osaki visiting Faculty of Agriculture, Lambung Mangkurat University and has a chance to meet some scientists there.
- Mr. Sehat Jaya keeps continue working in the field until 22 July 1999. This fieldwork aimed to establish the study plots, to set up several field instruments for continuously

- Visiting a temporary livestock industry site at Km 7 of Palangka Raya – Sampit main road.

1 July 1999 (Thu.)
- Departs from Palangka Raya to Bahaur District (a trip along Kahayan River by speedboat).
- Taking soil samples and collecting some mushroom strains at Muara Bahaur and Bahaur Hilir village.
- Continuing trip to Pangkoh IX of transmigration settlement, then collecting soil and grass samples as well as visiting traditional livestock or animal production hold by the farmers.
- Returning backs to Pulang Pisau and stay over night.

2 July 1999 (Fri.)
- Continuing trip to Pangkoh III of transmigration settlement.
- Visiting the edge of drainage canal nearby Pangkoh V, then taking soil and mushroom strain samples upon a fire damaged area, under "*Melaleuca sp.*" association and over an abandoned area (dominated by *Imperata cylindrica*).
- Visiting Basarang river channel to look at a traditional farming system.
- Continuing trip to Garong village nearby drainage canal of one million hectares project, then taking soil and mushroom samples.
- Returning back to Palangka Raya.

3 July 1999 (Sat.)
- Dr. Hata, Mr. Suwarno, Mr. Darobin and Mrs. Purwaningsih depart from Palangka Raya to Jakarta and Bogor.
- Dr. Osaki and Mr. Sehat Jaya visiting site along Kalampangan drainage canal about 8.5 km long.

4 July 1999 (Sun.)
- Dr. Osaki and Mr. Sehat Jaya visiting an area at Kalampangan zone, which is nominated as study site and experimental plot.

5 July 1999 (Mon.)
- Meetings at the University of Palangka Raya to discuss further programs and to decide where the study plots should be established.
- Preparing proposal for further meeting at Bogor Agricultural University.

6 July 1999 (Tue.)
- Dr. Osaki departs Palangka Raya to Banjarmasin and Banjarbaru.
- Dr. Osaki visiting Faculty of Agriculture, Lambung Mangkurat University and has a chance to meet some scientists there.
- Mr. Sehat Jaya keeps continue working in the field until 22 July 1999. This fieldwork aimed to establish the study plots, to set up several field instruments for continuously

monitoring, to collect leaf and bark sample of trees, to determine peat and water table depths, as well as to collect peat soil samples.

7 July 1999 (Wed.)
- Dr. Osaki visiting the Center for Swampland Research in Banjarbaru (South Kalimantan), with paid due regard to the information on Acid Sulfate Soils.

8 July 1999 (Thu.)
- Dr. Osaki departs from Banjarmasin to Jakarta and Bogor.
- Visiting Bogor Agricultural University.

9 July 1999 (Fri.)
- Meeting with principal and collaborative scientists from Bogor Agricultural University at Darmaga Campus.
- Leaving for Japan.

23 July 1999 (Fri.)
- Mr. Sehat Jaya departs from Palangka Raya to Jakarta and Bogor.
- Delivering fresh peat soil samples to Mrs. Typuk Artiningsih at Research and Development Center of Biology-LIPI, Bogor.

24 July 1999 (Sat.)
- Mr. Sehat Jaya departs from Jakarta to Japan
- Arrived at Sapporo on 25 July 1999.

2. Introduction

Central Kalimantan is the second largest province in Kalimantan Island, which total area of 153,564 km^2. This province is characterized by one of the largest areas of pristine peat swamp forest in the tropics, resources that represent a highly sensitive ecosystem. However, the peat swamp forests are nowadays a greatly endangered ecosystem due to the increasing deforestation and conversion rates that resulted of fast economic as well as population growth. Only has it been recognized that sustainable development and rational exploitation of natural resources is essential to assure future prosperity. Nevertheless, the significant role of tropical peatlands for the global ecosystem and as a natural resource is still widely underestimated. It is, therefore, many people regard peat swamp forests simply as a huge timber stock, whereas others consider to remove the forest cover completely in order to establish plantations and

agricultural fields. These views are wrong, as many studies have been highlighted that tropical peatlands are the natural habitat for many important and endemic plant and animal species.

As a wetland ecosystem, peatland is often identified as a marginal and fragile ecosystem. Therefore, aim to develop the peatlands for agriculture of high productivity in the framework of sustainable development and environmental-based, it is required a careful planning, proper utilization and application of technology, land development in a proportional manner, as well as appropriate management of peat soils and water. Thereby, in order to manage the peatland ecosystem it is necessary to consider a conservation approach. This approach is intended to manage the utilization of biosphere by human in obvious ways so that it can provide a maximum sustainable benefit to today generations of human beings while conserving its potential to grant the needs of future generations. In essence, any attempts to manage peatland ecosystem should be directed to the activities to protect, preserve and enhance its ecological and environmental importance.

Based on the proposed land use planning of Central Kalimantan, most of the peatland areas have been designated particularly into uni-sectoral forms, which including production forest, agricultural and protected areas. These areas consist of a great ecological functions and attributes which could be utilized by various economic sectors simultaneously on a sustainable basis. In order to achieve this purpose, it would require the development of integrated management and therefore a close co-operation of the various parties involved must be promoted and enhanced. In addition, integrated management of peatland ecosystems should be placed in the framework of spatial planning, aimed at optimizing the use of the complete range of functions and attributes provided, balancing economic productivity with maintenance of life support systems and conservation of biodiversity.

Considering the susceptibility that inherent with the peatland ecosystems of Central Kalimantan, Agricultural Sciences Group proposes a research project on rehabilitation of peatlands and establishment of sustainable agro-systems. This research project is directed under the umbrella of LIPI-JSPS Core University Program. The rehabilitation and the establishment of sustainable agro-systems projects are addressed to the destroyed, abandoned, and fire-damaged areas over peatlands

ecosystem including cultivated areas, where locate surrounding natural or semi-natural peat swamp forests. The main objectives of this project are (1) to conserve peat swamp forests and rehabilitate the destroyed, abandoned, and fire-damaged areas; and (2) to establish the sustainable agro-systems in cultivated areas. Thus, this research project is entirely carried out in Central Kalimantan within two distinct zones of Kalampangan and Pangkoh along the Sebangau-Kahayan water catchment.

There have been several field surveys conducted on this selected research sites, and its progress has also been reported. However, current field survey is another series of observation, which mainly focussed on the promoting of teamwork between principal and co-operative scientists who involved in this project, also the establishment of study plots, as well as details information on animal husbandry aspects. Additionally, co-ordinate positions of the visited sites were also recorded using GPS as given in ***Appendix-1*** of this activity report.

3. Activities during the Visit

3.1. Visits to Puncak-Bogor and Lembang District-West Java

It was almost half day spent to travel around Puncak and Lembang District. Attractive scenery of agriculture lands and tea plantation appeared to be outstanding and widely spread out over the high altitude and mountainous area of Puncak, Bogor. The lands for agriculture practice are managed following the contour line so called "*sengkedan*". This method has been applied to protect the soil from heavy erosion and also to control the water discharge on the land. The association of Andosol and Inceptisol in where farmers mostly cultivate wetland rice using both local and IR-64 varieties is the dominant soils found in this area. Meanwhile vegetables such as carrot, tomato, celery, chili, sweet corn, long-bean, cabbage, etc., as well as some fruit trees such as banana, guava, "*talas*", etc. are also grown well in this area.

Due to its distinctive features as agricultural lands and tea plantation, this region has been promoted as a preferred site for agro-tourism. It is, therefore, every-time during the weekend many visitors, mainly from Jakarta, Bogor and Bandung gathering together to this area and causing long line traffic jam on the main road that connecting Bogor to Bandung the capital of West Java Province.

Our visit to Lembang District at this time was not so satisfied in obtaining information on animal husbandry and other related activities owing to most of the farming areas are closed down during the weekend. However, a general figure of the animal husbandry aspects upon this area can be described as follows:

- The animal husbandry farming is managed under large and small scale farming by a co-operative manner.
- Cows and sheeps are the foremost animal farms found in this area. The cows are maintained to produce milk, whereas the sheeps domesticated to produce body hair as the row material for making wool.
- Large-scale farming governed by private company, which commonly established a clinic for artificial insemination. Results gained from this clinic, then, disseminated to small-scale farming under the co-operative link.

3.2. Meeting at Research and Development Center for Biology, LIPI

The meeting was held and organized by Agricultural Sciences Group. The main purpose of the meeting is to disseminate information on the research projects to all members who actively involved, as well as determining the working schedule and expected outputs that should be achieved. This meeting was attended by many scientists under the Agricultural Sciences Group such as Dr. Misuru Osaki, Dr. Hiroshi Hata and Sehat Jaya from Hokkaido University; Dr. Hanny Wijaya and Mr. Darobin Lubis from Bogor Agricultural University; and Dr. Kartini, Dr. Paul Naiola, Typuk Artiningsih and Hidayati from Indonesian Institute of Sciences (LIPI).

At the end of the meeting, all participants agreed to give a responsibility to each sub group to work out with their own research proposal and submitting the result immediately to Dr. Mitsuru OSAKI. The meeting has also considered defining the project members who are classified as principal scientists and co-operative scientists.

3.3. Meeting at the University of Palangka Raya

The topics discussed in this meeting are also emphasized for Agricultural Sciences Group. Apart from the aim to disseminate all information regarding the project, this meeting is also to invite as many as possible scientists from the University of Palangka Raya to be involved in the project as a whole. It is important

to bear in mind that the research-base of this project is located in Central Kalimantan of where a significant contribution expected more from Unpar's scientists. Some critical aspects of the research project were also highlighted in this meeting, particularly deciding the research sites, convincing local government relating to the importance of the project, and promoting link and collaborative means to the related parties. Meanwhile, schedule of our field visits this time was also discussed.

The attended scientist were Dr. Mitsuru Osaki, Dr. Hiroshi Hata, and Sehat Jaya from Hokkaido University; Suwarno and Darobin Lubis from Bogor Agricultural University; Suwido Limin, Adi Jaya, Patrisia Erosa Putir, and Robertho Aden form Palangka Raya University; as well as Sri Purwaningsih from RDC for Biology of LIPI.

3.4. Visits to the Livestock Agency of Central Kalimantan

During this visit we were scheduled to meet Mr. Sudiman, Head of Livestock Agency of Central Kalimantan Province. This meeting is intended to earn information on the current state and prospect of animal husbandry development in this province. The followings are explanations of Mr. Sudiman regarding the facts and prospects of animal husbandry in Central Kalimantan:

- To date the Livestock Agency of Central Kalimantan still maintaining animal husbandry projects which the sources of scheme mainly from Asian Development Bank, Central Government Budgets, Presidential Grants, and Local Government Budgets.
- To some extent, different schemes may provide different kind of livestock animals to be domesticated. For instance, Cows and Buffaloes are distributed to the farmers under the ADB schemes, cows and chickens under the state and local government budgets, whilst cows and pigs are provided under the presidential grants. It is estimated about 10,000 cows imported from Java and Bali every year.
- In terms of the potential of Central Kalimantan areas to be developed for animal husbandry, on one hand it is argued that this province consists of 4 main rivers of where some association of water grass (locally called "*kumpai*") grown on water surface around the river bank. This wild grass is ascertained has about 12 percent of protein content, and it has been widely used as one type of forage. On the other hand, waste of oil palm plantations is also potential converted to be the forage.

Local government of Central Kalimantan has been projected to develop about 2 million hectares of oil palm plantations, particularly in the area of Kotarwaringin Timur and Kotawaringin Barat Regencies.

- In 1995, the Livestock Agency of Central Kalimantan was initiated a transmigration program with special pattern that so called "animal husbandry pattern". This program is directed under Memorandum of Understanding between Local Government of Jakarta and Central Kalimantan.
- In effort to develop animal husbandry in Central Kalimantan, the Livestock Agency encountered several problems such as:
  - ❖ Small population and very low production of livestock that could not fulfilled the needs on the region;
  - ❖ Availability of the livestock at the initial stage are limited in both quality and quantity;
  - ❖ The farmers are often perform lack of knowledge, awareness and skills; and
  - ❖ Facilities and infrastructures are also very limited; therefore it is too hard to convince investments to develop business in animal husbandry over this region.

3.5. Visits to Sei Gohong Transmigration Settlement

This site is located adjacent Sei Gohong village, at km 37 of the main road that connecting Palangka Raya-Tangkiling-Kasongan-Sampit. This area was initiated for transmigration settlement in 1995 and at the same time land clearing is also conducted. The transmigrants were settled on September 1997. Total population of the transmigrants was proposed about 250 families, where 75 families are from DKI Jakarta and the rests are from Java and local dwellers.

The transmigrants are given a total 1.25 ha land, which is divided into 0.25 ha for housing and homeyard, 0.50 ha for pasture and other forage crops, and 0.50 ha for cultivation, cattle-ranch and training in animal husbandry. Each family of the transmigrants receiving 3 cows and 100 of non-broiler chickens. In addition, during the first 12 months of settlement period, the transmigrants receiving subsistence

subsidiary from the government, including rice, salty fish, cooking oil, mungbean, soap, detergent and kerosene.

Upon their homeyard, the transmigrants are expected to cultivate vegetable for fulfill their daily subsistence, meanwhile in the pastureland they expected to cultivate elephant grass (*Setaria* sp.) as the main forage for cattle. However, since the soils in this area are very poor in nutrients which commonly found in sandy soil covered by a shallow peat layer, it was not easy to the dwellers to develop agricultural practice in general including pasture or forage cultivation. Therefore, recently only about 50 families of the transmigrants remain and most of them already return back to Jakarta and Java. As explained by Mr. Asep, one of the co-ordinator of the farmer group, that after two year this program was launched only about 2 to 3 cows found in this area. It was very hard to the farmers to stand and pretending they do not know the "agreement", most of them just selling the cattle and all facilities, then disappeared. However, the remaining transmigrants are still try to survive with focussing on the cultivation of fruits and vegetables such as banana, eggplant, chili, cucumber, etc. This attempt seems to be promising, but required very high input in terms of liming, composting, as well as the availability of Urea, TSP and KCl fertilizers.

3.6. Visits to Bahaur down stream

A visit to Bahaur down stream has taken about 4 to 5 hours by speedboat, a common transport used on the rivers of Central Kalimantan. During this visit, our first destination is a site adjoining to the Java Sea, which dominated by mangrove formation. In this area, some strains of mushroom and soil samples were collected. Soil samples are taken from different depths, from 0-10 cm, 10-30 cm, 30-50 cm and 50-60 cm.

The next site visited around Bahaur district is a small village of Bahaur Hilir. This site is about 200 meters far from the Kahayan riverside, which is firstly pass through the *sungai Rungun* to get into. Some fruit trees, coconuts and wetland rice are found growing well in this area, and some farmers have been introduced a high yielding variety of rice (e.g. IR-64) in addition to the local variety that already well adapted. At the time, we also found species of grass (*Brachiaria briganta*) that grown well on this site.

3.7. Visits to Pangkoh III and IX of Transmigration Settlement

Pangkoh III and IX are an old transmigration settlement situated in the western side of the Kahayan down river, which was initiated in 1986. Previously, these sites are included in the One Million Hectares Peatland Development Project (Block-C). Therefore a drainage canal of 25 meters wide was constructed through some parts of these sites, which connecting Kahayan and Sebangau river catchments. However, the existing drainage canals within the sites have also revived on 1996 resulting in a deeper canal dimension. One of the settlers explained that in the past most of the lands of Pangkoh III and IX are covered by peat of about 1.0 meter thick. Yet, after the settlement period occupied these sites for several years, the peat has gradually disappeared. It was also exacerbated by the implication of slash and burn cultivation practice over these areas.

Our visit to Purwodadi village at Pangkoh IX found that in this area rice cultivation was very disappointed due to the persistent attack of pests. The farmers in this area then changing their cultivation commodities from food crops to fruits (e.g. jack fruit, pineapple, guava) and estate crops (e.g. coffee), as well as combined with vegetables such as longbean, eggplant, cassava, chili, etc. Since 1988 the farmers in this area received grant from Asian Development Bank in form of farm animals supports such as cows and non-broiler chickens. To date the animal husbandry program in this area seems encouraging and event some of the farmers own 8 of the cows. In addition, there are 2 families the transmigrants using the cows to plowing up their lands prior to cultivation. To this effort they consider to use the cows from Bali because it was ascertained fit to the characteristics of the site. Then, the forage used to feeding the cattle is some grass found over the cultivation land and also from grass field planted by the farmers. There are two kinds of grass cultivated in this site: *Brachiaria humidicola* tuly and *Brachiaria humidicola* 1369. The last grass species is growing faster than the first one. Meanwhile, elephant grass is also growing well in this area, but the farmers were not so enthusiastic in promoting it owing to very high fertilizer inputs and require more cautious maintenance. Although these BH are widely used as the main forage in this area, it has been recognized that these grasses

may produce an alelophatic substance which deteriorating the growth of other plants if planted at the same land under an alley cropping system.

During our visit to Kantan Muara village at Pangkoh III, we found the animal husbandry system applied similar to Pangkoh IX. At present, the farmers hold more than 800 cows of Bali origin and about 200 cows of "*onggol*" hybrid. The forage that widely developed in this area is also *Brachiaria humidicola* grass. Apart from cattle, the farmers also promoted non-boiler chickens as additional livestock commodity, and it has been significantly contribute to the farmer income, as well as to fulfill the protein consumption. In terms of agricultural aspect, this area has been well developed for rain-feed paddy field. However, most of the farmers cultivated rice originated from local varieties that argued already well adapted to the site conditions.

3.8 Visits to the areas nearby drainage canal adjacent Pangkoh V settlement

It was about 35 minutes trip by motorbike from Pangkoh III to get into the drainage canal edge adjacent the forested area of Pangkoh Zone. The access roads are through the center of Pangkoh V settlement and the land road to Pulang Pisau. This drainage canal is about 13 km in length which connecting the primary canals between Sebangau and Kahayan river catchments.

The areas encircling the canals perform various types of land use. Close to the settlement area are mostly already converted for cultivation purposes, however some parts found as abandoned areas where covered by *alang-alang* and bush. Upon this area, there was no peat discovered.

Then, moving further ahead close to the forested areas where we can see a dense association of *Melaleluca leucadendron*. This woody plant is found growing quite dense on shallow peat, which performs a cluster distribution. Behind the *Melaleuca leucadendron* association we can reach the mixed forest of peat swamp. Some economically important species such as *ramin*, *swamp meranti*, *bintangor, cratoxylon*, *etc.* are found predominantly governing the top canopy layer of this forest. Nevertheless, some areas have been damaged especially during 1997 wildfire disaster and even exacerbated by persistent illegal logging or timber extractions. Thickness of peat around the junction of the canal was measured about 4 m in depth.

3.9. Establishment of study plots at Kalampangan Zone

In order to find out a comprehensive and meaningful information on ecological and ecosystem functional of tropical peatlands, it is essential to establish a secure field-based research site including some field station facilities. The selected study plots are representing a relatively unlogged or native peat swamp forest; fire damaged, as well as abandoned areas.

Two research sites are being established under this study. One is located in Kalampangan Zone and the other located in Pangkoh Zone. The Kalampangan Zone is representing inland peat soils, whereas the Pangkoh Zone characterizing transitional peat soils.

During this visit, 4 of 1-hectare study plots were established at Kalampangan Zone. Two of the study plots placed on deep peat, but different in land covers that representing a relatively undisturbed peat swamp forest and fire damaged area. Meanwhile, the other two plots located on shallow peat which representing the same land cover types as explained previously.

Following a grid system, each of the 1-hectare study plots divided into 100-sub plots of 10 m X 10 m in size. 20-sub plots out of 100 then selected systematically in where sampling, all field measurements and monitoring are employed. Samplings are conducted toward leaf and bark of predominant trees and also peat soils with different depth; whereas field measurements and monitoring applied to obtain data on peat depth, peat water table, tree biomass, plant root systems, forest profile diagram, litter fall and litter decomposition. To this purpose, sets of necessary instruments are installed upon the selected plots. Schematic map and distribution of the selected sub-plots for each of 1-hectare study plots that already established at Kalampangan Zone given in ***Appendix-2*** and ***3***.

3.10. Meeting at Bogor Agricultural University

It was the last meeting held by Agricultural Sciences Group during this visit to Bogor and Central Kalimantan. Aim of the meeting is to discuss in deep all aspects related to the framework and proposed research project in Central Kalimantan, and also to finalize the members of each sub group. Member of scientists who participated on the meeting were Dr. Mitsuru Osaki from Hokkaido University; Dr. Paul Naiola,

Hidayati, Typuk Artiningsih and Sri Purwaningsih from LIPI; Dr. Hanny Wijaya, Istomo, Tapa Darma, Hartoyo, Rizaldi Boer, Suwarno, and Untung from IPB.

Working proposals that already agreed in this meeting separated into general project proposal and specific project proposal for each sub group (see ***Appendix-4***). This complete proposal will be submitted to the Local Government of Central Kalimantan. Whilst, the more detail proposal for the next stage of this project was prepared after meeting.

II. Field Survey Report with reference to Rice Production

Toshihiro Hasegawa

(Crop Science Lab. Graduate School of Agriculture, Hokkaido University)

Firstly, I participated in the International Symposium on Tropical Peatland Management on 22-23 of November, 1999 held at Ciloto-Punchak, Indonesia.
Scientists of various fields of study gathered and exchanged the conditions of the peat land in Kalimanta.

During the visit to Kalimantan from Nov.24th to 30th, our group made a field trip to six research sites in South and Central Kalimantan. We interviewed farmers who grow mainly rice using both local cultivars and improved cultivars. Here, I report on the aspect of crop production, with special reference to rice cultivation.

Paddy fields in South Kalimantan generally have relatively favorable conditions in terms of soil and water availability, compared with Central Kalimantan. The coastal areas are influenced by the high tide that can drain the adverse substances in the sub-soil layer. Recently, the canal irrigation system has been built for the inland areas. The adequate use of water resources would be needed, but, in general, these would allow more stable rice production in South Kalimantan.

Farms that we visited include irrigated paddies and rain-fed paddies near Banjarbaru and Banjarmasin. Traditionally, farmers used local varieties with long growth duration. The unique cropping system was employed with multiple transplanting. Namely, seeds were sown on the upland nurseries in October-November. The seedlings were raised for ca 40d, after which they were transplanted on the paddies with a dense spacing (one hill had more than 50 seedlings). Approximately 60 d later, the seedlings with multiple tillers in the paddy were transplanted again on the wider paddies with much less dense spacing. Harvesting generally occurred in September.

Since new improved varieties, including ones bred at IRRI, were

introduced from the government another cropping system has been commenced. Different nurseries with submerged conditions are prepared for the improved varieties, just as the Javanese style, where improved varieties are seeded. At the same time, seedlings for local varieties are grown on the upland nurseries in the traditional manner. Both varieties are transplanted on the paddy field at almost the same time. New varieties (with short duration) are grown and harvested in February, after which local varieties are transplanted again on the paddies previously planted with new varieties. The yield level ranges widely for both varieties, with generally higher yield for improved varieties, but the reliable data are lacking to evaluate the cropping system. Although improved varieties are strongly recommended by the government, local varieties are preferred for its high eating quality. Therefore, the evaluation of the productivity under rice cropping system will be necessary to meet both the demand for higher yield and higher income for the farmers.

We are selecting a few experimental paddies with and without irrigation in collaboration with the staff at the University of Lambung Mangkurat in Banjarubaru. Possible candidates for the research sites include the irrigation experiment station of the University of Lambung Mangkurat and the farmers' paddy field near the coast without irrigation. At the experimental station, different levels of lime are applied so as to evaluate the effect of soil acidity on the rice growth. The growth of rice will be traced to evaluate the productivity of rice cropping system. At the same time, irrigation management will be assessed in collaboration with Dr. T. Inoue of Hokkaido University.

In conclusion, the field survey yielded a concrete research plan in the next year with a help of the staff of the University of Lambung Mangkurat. We start with the study on the rice productivity under relatively favorable condition in South Kalimanta. The next stage would be to apply the results to Central Kalimantan, which has more severe conditions for rice production.

III. Performance situation and result of the expected purpose.

KoyoYONEBAYASHI

(Kyoto Prefectural University)

November 22nd-23rd : "International Symposium on Tropical Peatland Management" was held in Bogor/Ciloto of Indonesia. I attended this symposium, and lectured on the following: "Boron contents of tropical peat soils in southeast asia."

November 24th : The seminar on the tropical peatland management was opened in Lambung Mangkurat University of Banjarmasin. Attended this seminar, and it lectured on the ditto.

November 25th : Banjar Baru suburb irrigation project area and rice paddy area around Rantau were inspected.

November 26th : Tidal Irrigation Area in peatland at the right bank of the Barito river was inspected.

November 27th : Kapuas river and Kahayan river were ascended by the speed boat, and arrived at Palangka Raya. Talked with Prof. Sweed at University of Palangka Raya (UNPA).

November 28th : In Kalampangan (Belenbenker) region, the plowed field of peanut and longbean, paddy field, and non-cultivated field of UNPA were inspected, and the soil samples were collected.

November 29th : In Tangkiling district, the soil was collected in the farmhouse plowed fields in Tumbang Tahai, transmigration area (shallow peat-Kerangas sand zone). Sand soil dressing was observed in the surface layer. Kerangas sand sample was collected in the mining road head. The arboritum was inspected .

November 30th : Future research direction was discussed with Prof. Supiandi in Bogor Agricultural University.

The reasoning based on the field study.

1. The management of latent acid sulfate soil area.

In the paddy field of peat area at the right bank of the Barito river, the peat has already disappeared almost, and the clay layer in lower layer has been exposed. Though this region was said as the acid sulfate soil area, pH of the soil was 5 to 6. However, paddy water and irrigation water pH were low with 3 to 4. It seemed to expose the deep clay layer in the embankment surface, when it drilled the irrigation and drainage channel or ditch, and when it built the embankment. It was guessed that the pyrite which was included in the clay layer was oxidized and that the sulfuric acid was formed on the surface of the embankment, and that it had made the irrigation water the acidity. Though present paddy soil is the latent acid sulfate soil, it is hard to be predicated as an acid sulfate soil. Therefore, let's must accurately grasp the vertical distribution of pyrite content which is included in clay layer of lower layer of peat soil. And, it is necessary to cover the surface of the embankment with the other soils such as Laterite, when the embankment is built with the subsoil of clay layer including the pyrite. For environmental preservation of the latent acid sulfate soil zone, this fact is very important.

2. Trace element deficiency in the tropical peat area.

To the various crop of the deep peat area of Kalampangan district, there were various deficiency symptom. These deficiencies seemed to be the symptoms in which potassium, copper, boron lack were combined. The farmers in this region prepare the compost from cattle excrement and crop residue, and it has been fertilized in the field. And, the ash which incinerated weed and crop residue is used for the field. In spite of them, there is a deficiency to the crop. It is asked that the element, especially the trace element, is insufficient. I have recognized that trace element contents in the peat soils of Sarawak compare it with other soils and that these are remarkably low. Trace element contents in the peat soils of Kalimantan are also anticipated with that these are very low. The fertilizer level necessary for crop growth can be calculated, if trace element contents of peat soils of Kalimantan are compared in no-tillage and plowed field. This fact is to be the most necessary for the sustainable agriculture of the peatland.

3. Why is Kerangas sand snow-white ?

In the Kerangas sand zone, the sand color which was exposed on the surface is snow-white. But, the sand color is the pale yellow in profile inside of the mining road head of Kerangas sand. Therefore, it seemed to change in the whiteness, when the sand of the pale yellow of the underground is exposed on surface, and when it is exposed to the solar light. It is well known that the iron was removed from Kerangasu sand by the podzolization and seemed to whiten it. The sand color of the profile inside is the pale yellow, when it is well observed. Probably soil organic matter and the chelate of fulvic acid and iron seems to remain on the sand surface. This organic acid and iron chelate are reduced to the bivalent iron by the photoreduction, and the sand will become the snow-white, if it is leached out by the heavy rain. By verifying this idea, the way of the effective utilization of Kerangas sand may be opened.

VI. Report of filed survey in Central Kalimantan.

Dr. Masanori Okazaki

Graduate School of Bio-applications and Systems Engineering, Tokyo University of Agriculture & Technology

Nov. 22 and 23, 1999

I attended the International Symposium on Tropical Peatland Management and discussed the peatland management with the researchers in Cilot, Indonesia.

Nov. 24

The areas of which surface soils were taken by a large bulldozer followed by hardening during dry season are quite difficult to manage as upland field. Meanwhile some farmers in Kalampangan have performed the good management of upland field, vegetables and tropical fruits. Kalampangan village holds an advantage to be the suburbs of Palankaraya, so that it is necessary to establish the sustainable farm management.

Nov. 25

We had a chance to see the permanent plots, which Mr. Sehat Jaya Tuah settled up, in the natural tropical lowland forest in Nature Reserve which located in the area facing to Kahayan river and Sebangan river (S 2° 17´ 18", E 114° 1´ 53"). From the permanent plots Dipterocarp species had been cut off and stolen by illegal logging. We hope the monitoring will be continued to elucidate the changes in tropical lowland tree species and tree community structure. Soil survey in this area hasd been carried out in each grid of 10 m by 10 m by Mr. Sehat Jaya Tuah. The woody peat horizons were present from 3 to 5 m in thickness. The dryness of tropical peat soil had started by burning of the forest in 1997. The our study site in this area will set as a reference of the sustainability in bio-production systems.

Nov. 26

We went to Paduran from Banfanan by a speed boat and saw potential acid sulfate soils in Kereng Bangkirai village . The canal construction in this area started in

1980/81 and established in 1985. Local farmers introduced paddy rice IR64 from 1986. However, the production of paddy rice has decreased and continued to decrease until the present time. The burning of tropical peat soil invites the appearance of actual acid sulfate soil. We had have an improved method of acid sulfate soils. it is needed to support the improvement of actual acid sulfate soils from the aspect of budget and education.

Nov. 27

In the morning we went to Kalampangan village to see and ask the farm management and economic condition of farmers. The farmers cultivate the soft leaves vegetation. Afternoon we went to Forest Reserve in Tumbangtahai to see Forest Reserve of natural vegetation.

Nov. 28

We discussed our future study programme in Bogor Agricultural University. I will study the compounds emitted from the burning of tropical peat soils.

V. Report of filed survey in Central Kalimantan.

Dr. Osamu Nakahara

(Graduate School of Agriculture, Hokkaido University)

Nov 22, 23

We participated in the international symposium on the management of tropical peatland soils. There was a hot discussion on the utilization of peatlands. Some presentations discussed the water management in peatlans to prevent the peat from being lost by oxidation reaction and to maintain the crop yield. But I felt that enough discussion was not given to the chemical aspects of peatland soils, especially, the nature and origin of acidic toxicity, the relationship between acidic properties and oxidative-reductive properties. In general, however, the basic problems in agriculture on peatland soils were clarified in this symposium. The reports of the present situations of the research of peatland in Thailand and Malaysia were gave useful information.

Nov 24

We participated in the seminar on the management of peatland soils held in Lambung Mangkurat University. Lots of questions and comments were given to the presentation by researchers from Japan. Unfortunately, my presentation was not understood by the most of audience. This is partly because the acidic properties in peatland soils dominated by COO- group (not complexed with aluminum cationic species) and non-allophanic Andisols dominated by active surface hydroxyl groups like Al-OH and Fe-OH. Although the gypsum application might not reduce the Al toxicity in peatland, we have to develop alternative amendment materials to reduce acidic toxicity and to increase the crop yield in peat soil.

Nov 25, 26

We observed the paddy fields developed on acid-sulfate soils, irrigation systems, and rice production in paddy fields near Banjarmasin in central Kalimantan. In most of paddy fields in this investigation pH of water in canals and paddy fields was very low (< 4.0). But in most cases, the pH of soil supension was higher than 4.0, indicating

that in reductive conditions the oxidation of potential acidic materials, e.g., pyrite, was inhibited. In most cases, low pH of water samples seemed to arise from the dissociation of proton from humic and fulvic acids dissolved from peat layers and the oxidation of reductive Fe2+ cation to Fe3+ cation that immediately precipitate to oxyhydroxides, e.g., lepidocrosite and ferrihydrite, leaveng proton in solutions. From these observations, we learned that we cannot decide the acid-sulfate soils by its water pH values alone, and we need further testing to decide the study sites of the typical acid-sulfate soils.

Nov 28, 29

We observed the crop management on peatland soils near Palangkaraya in central Kalimantan. Main fertilizer in this area is the ash of weeds and there were lots of streaks of smoke in farm. And some farmers applied homemade manure. In general, however, shortage of fertilizer seemed to be the main cause of the poor crop yield in this area. In my opinion, this problem should be recognized as the economic or social problems, and we have to clarify the limit and possibility of the contribution by the agricultural science and technology. In addition, we observed a lots of soil types near Palangkaraya, which indicate that this diversity of soils in this region will give difficulty to our further study. At least, we need precise soil maps in this region to conduct a investigation on soil chemical properties.

Nov 30

We discussed about the future study with the researchers in Indonesia, especially on the possibility of joint research project.

VI. Study on mycorrhiza colonisation of plants grown in Central Kalimantan

Keitaro Tawaraya and Yuichiro Takaya

(Faculty of Agriculture, Yamagata University)

Mycorrhizas help nutrient uptake of plants grown in low fertility soil. Mycorrhiza should play an important role in nutrients cycle of peat swamp forest where soils are infertile. Therefore role of mycorrhiza in nutrients cycle in those soils must be clarified. Purposes of our research in 1999 were 1) to collect peat soils and plants grown in Central Kalimantan and 2) to discuss mycorrhizal research plan in this project with researchers in the University of Parangka Raya (UNPAR), Bogor Agricultural University (IPB) and the Indonesian Institute of Sciences (LIPI).

According to our preliminary survey of 1998, we collected peat soils, Kelangas and acid sulfate soils from 32 sites in Central Kalimantan and South Kalimantan from 25 Nov 1999 to 29 Nov (Table 1). We also collected plants grown in those soils. Those plants were grains, vegetables and native glasses.

Various kinds of crop plants were grown in farmer's field in Central Kalimantan. Nodules were formed in some legume plants. Some farmer were carrying out the mixed cropping where mycorrhizal symbiosis can play important role in nitrogen nutrition. Some vegetables showed symptons of nutrients deficiency in the leaves. There were pioneer plant species in disturbed area. Plant roots were stained and arbuscular mycorrhizal colonisation was observed with microscope. There was a difference in mycorrhizal colonisation among plant species. Some plants were nonmycorrhizal. Propagules of arbuscular mycorrhizal fungi in those soils will be propagated and isolated with the trap culture method.

We visited the Forest Research and Development Agency and the Bogor Agricultural University. We discussed mycorrhizal research and made mycorrhizal research plan in this project with Maman Turjaman, Ricksy Prematuri, Ragil SB Iranto and Erdy Santoso.

Table 1 Soil type, plant species and arbuscular mycorrhizal colonisation

Site No.	Date	Soil type	Plant name	Mycorrhizal colonisation
1	25.Nov	sandy		N. D.

2		Peat	*Oryza sativa*	N. D.
3	26.Nov	Peat	*Melastoma*	+
4		Peat	*Manihot esculenta*	+
5			*Panicum repens*	+
6		Acid sulfate	(Kalakai)	N. D.
7		Acid sulfate	*Imperata cylindrica*	+
8	28.Nov	Peat	*Purun sp.*	+
9		Peat	*Ficus sp.*	N. D.
10		Peat	(Kalakai)	N. D.
11		Peat	*Melastoma melabathricum*	+
12		Peat	*Allium cepa*	+
13		Peat	(rumput teki)	-
14		Peat	*Imperata cylindrica*	+
15		Peat	*Vigna sesquipedalis*	+
16		Peat	*Capsicum annuum*	+
17		Peat	*Cucurbita moschata*	+
18		Peat	*Ananas comosus*	+
19		Peat	*Oryza sativa*	+
20		Peat	*Zea mays*	+
21		Peat	*Vigna sesquipedalis*	+
22		Peat	*Arachis hypogaea*	+
23		Peat	*Manihot esculenta*	+
24		Peat	*Solanum melongena*	-
25	29.Nov	Kelangas	(orok-orok)	+
26		Kelangas	*Clotaraia*	N. D.
27		Peat	*Arachis hypogaea*	N. D.
28		Peat	*Zea mays*	N. D.
29		Mineral	*Vigna sesquipedalis*	N. D.
30		Mineral	*Zea mays*	N. D.
31		Kelangas	(masisin)	N. D.
32		Forest	*Kompassia malceasis*	N. D.

N.D: not determined

2		Peat	*Oryza sativa*	N. D.
3	26.Nov	Peat	*Melastoma*	+
4		Peat	*Manihot esculenta*	+
5			*Panicum repens*	+
6		Acid sulfate	(Kalakai)	N. D.
7		Acid sulfate	*Imperata cylindrica*	+
8	28.Nov	Peat	*Purun sp.*	+
9		Peat	*Ficus sp.*	N. D.
10		Peat	(Kalakai)	N. D.
11		Peat	*Melastoma melabathricum*	+
12		Peat	*Allium cepa*	+
13		Peat	(rumput teki)	-
14		Peat	*Imperata cylindrica*	+
15		Peat	*Vigna sesquipedalis*	+
16		Peat	*Capsicum annuum*	+
17		Peat	*Cucurbita moschata*	+
18		Peat	*Ananas comosus*	+
19		Peat	*Oryza sativa*	+
20		Peat	*Zea mays*	+
21		Peat	*Vigna sesquipedalis*	+
22		Peat	*Arachis hypogaea*	+
23		Peat	*Manihot esculenta*	+
24		Peat	*Solanum melongena*	-
25	29.Nov	Kelangas	(orok-orok)	+
26		Kelangas	*Clotaraia*	N. D.
27		Peat	*Arachis hypogaea*	N. D.
28		Peat	*Zea mays*	N. D.
29		Mineral	*Vigna sesquipedalis*	N. D.
30		Mineral	*Zea mays*	N. D.
31		Kelangas	(masisin)	N. D.
32		Forest	*Kompassia malceasis*	N. D.

N.D: not determined

VII. Species composition and density of tree saplings, situation of ectomycorrhizal formation and occurrence of mushrooms in undisturbed and burnt sites of tropical peat swamp forest

Masato Shibuya, Yutaka Tamai, Joo Young Cha, Sehat Jaya (Graduate School of Agriculture, Hokkaido University), Yu Adachi (Faculty of Agriculture, Hokkaido University) and Istomo (Bogor Agricultural University)

We conducted surveys on species composition and density of naturally regenerated tree saplings (less than 2 m in height), situation of ectomycorrhizal formation on saplings of major tree species and occurrence of mushrooms in undisturbed and burnt sites of tropical peat swamp forest in Kalampangan region in southern Kalimantan to examine the effect of wild fire on dynamics of the peat swamp forest. A wild fire occurred in 1997 in our burnt site. The surveys were carried out from 17 to 20 Nov. 1999.

Survey plots of 75 m^2 in area were established in undisturbed and burnt sites, respectively. We identified tree saplings and counted sapling numbers for every tree species in each plot. Two to five saplings of major tree species were sampled around the plots to examine the situation of ectomycorrhizal formation on their roots. Sampled saplings were measured for sizes (diameter at ground surface, stem length and root length) and fresh masses of leaves, aboveground woody parts and root in the laboratory. Fine roots with ectomycorrhizas of the sampled saplings were observed macro- and microscopically for characteristics of ectomycorrhizas. Mushrooms appeared in the plots were sampled after the description of their habitat and identified to genus or species level.

In the undisturbed stand where we established the undisturbed plot, canopy height was 25-30 m, and canopy tree density and DBH were 0.03 trees m^{-2} and 30-60 cm, respectively. Woody plant density of more than 1.3 m in height, including shrub and vine species, was very dense and estimated approximately 15 plants m^{-2}. Canopy closure was moderate and around 75 %. Major tree species in the canopy layer were *Gonystylus bancanus*, *Callophylum inophylum*, *Shorea* sp., *Tetramerestra glabra*,

Combretocarpus rotundatus, *Mangifera* sp. and *Tristania* sp., and those in the shrub layer were *Pandanus* sp. and *Macaranga* sp.. No apparent signs of recent disturbances could be recognized in and around the plot.

In contrast, the stand where the burnt plot located was burned intensively in 1997 and lost many canopy trees. Canopy height was 20-25 m and the density of residual canopy trees was less than 0.01 trees m^{-2} in the stand. Canopy closure was very sparse and around 30 %. However, woody plant density of more than 1.3 m in height was dense and estimated around 12-13 plants m^{-2} because of many saplings regenerated naturally after the fire. Major tree species in the stand were *Gonystylus bancanus*, *Shorea* sp., *Cratoxylon* sp., *Tetrameristra glabra*, *Callophylum* sp. and *Dyera* sp.. Ferns occurred very frequently as the forest floor vegetation. Pioneer and/or resistant tree species to wild fire, such as *Cratoxylon* and *Dyera* species, were more abundant in the burned stand than in the undisturbed stand.

Table 1 shows sapling inventory in the two plots. The numbers of tree species were 12 and 13 in the undisturbed and burnt plots, respectively. Total density of saplings was 1.71 saplings m^{-2}, and *Ilex macrophylla*, *Callophyllum inophyllum*, *Baccaurea bracteata*, *Mangifera* sp. and *Tetramerista glabra* were dominant in the undisturbed plot. In the burnt plot, the density was 1.43 saplings m^{-2}, and *Cratoxylon arborescens*, *Antidesma bunius*, *Baccaurea bracteata* and *Tristania maingayi* were dominant. Common species to the plots were five. Simpson's indices of species diversity were 7.62 and 4.55 in the undisturbed and burnt plots, respectively. Species diversity was higher in the undisturbed plot than in the burnt plot. *Cratoxylon arborescens* was accounted for 40 % of sapling density in number in the burnt plot, whereas *Ilex macrophylla* was accounted for 21 % of the density in the unditurbed plot. Species composition of tree saplings in the burnt plot was different from that in the undisturbed plot, and was less diverse than that in the undisturbed plot.

Table 1 Sapling inventories in the undisturbed and burnt plots

a) Undisturbed plot

Species	Family	Density of saplings* (m^{-2})
Ilex macrophylla	Aquifiliaceae	0.36
Callophyllim inophyllum	Guttiferae	0.32

Baccaurea bracteata	Euphorbiaceae	0.23
Mangifera sp.	Anacardiaceae	0.21
Tetramerista glabra	Theaceae	0.16
Eugenia sp.	Myrtaceae	0.09
Shorea teysmanniana	Dipterocarpacea e	0.08
Camnosperma coreaceum	Anacardiaceae	0.07
Tristania maingayi	Myrtaceae	0.07
Gonystylus bancanus	Thymeliaceae	0.05
Diospyros maingayi	Ebenaceae	0.04
Macaranga semiglobosa	Euphorbiaceae	0.03
Occurring species: 12 species		1.71

* Number of individuals of tree species less than 2 m in height.

b) Bunrt plot

Species	Family	Density of saplings* (m^{-2})
Cratoxylon arborescens	Hypericaceae	0.57
Antidesma bunius	Euphorbiaceae	0.27
Baccaurea bracteata	Euphorbiaceae	0.13
Tristania maingayi	Myrtaceae	0.13
Palaquium leucocarpum	Sapotaceae	0.07
Tetramerista glabra	Theaceae	0.07
Mangifera sp.	Anacardiaceae	0.07
Garcinia sp.	Guttiferae	0.04
Eugenia sp.	Myrtaceae	0.03
Macaranga semiglobosa	Euphorbiaceae	0.01
Litsea sp.	Lauraceae	0.01
Santiria laevigata	Myristicaceae	0.01
Annona sp.	Annonaceae	0.01
Occurring species: 13 species		1.43

* Number of individuals of tree species less than 2 m in height.

Table 2 shows the general description of sampled saplings to examine the ectomycorrhizal situation. Saplings of five tree species were collected in each plot; *Camnosperma auriculata*, *Callophyllum inophyllum*, *Gonystylus bancanus*, *Mangifera* sp. and *Shorea teysmanniana* in the undisturbed plot, and *Camnosperma auriculata*, *Callophyllum inophyllum*, *Gonystylus bancanus*, *Shorea teysmanniana*, and *Crutoxylon arborescens* in the burnt plot.

Table 2 General description of sampled tree saplings

a) Undisturbed plot

Species	Diameter*(cm)	Stem length (cm)	Root length (cm)	Fresh mass (g)
Camnosperma auriculata	0.6±0.2	36.0±14.5	41.1±19.5	20.5±12.8
Callophyllum inophyllum	0.4±0.1	31.5±10.8	18.8±10.2	6.5± 6.8
Gonystylus baneanus	0.9±0.3	63.9±13.5	66.8±30.0	56.5±24.8
Shorea teysmanniana	0.6±0.1	80.9±22.9	75.2±11.5	37.3±15.1
Mangifera sp.	0.6±0.04	46.5± 7.2	68.4± 9.1	52.7±13.2

b) Burnt plot

Species	Diameter* (cm)	Stem length (cm)	Root length (cm)	Fresh mass (g)
*Camnosperma auriculata***	0.9±0.2	45.2±15.3	54.4±19.2	46.7±27.3
Callophyllum inophyllum	0.8±0.3	85.7±20.4	60.5±12.8	48.1±27.0
*Gonystylus baneanus****	1.5±0.5	96.1±31.1	70.0±10.4	163.5± 9.7
*Shorea teysmanniana***	0.8±0.1	105.0±27.0	66.5± 5.7	79.6±24.8
Crutoxylon arborescens	0.7±0.3	61.6±15.7	30.4± 5.6	23.6± 9.8

Values indicate mean±standard deviation.
* Diameter at ground surface.
** The number of saplings is three.
*** The number of saplings is two.
The numbers of saplings of the other species are five.

Ectomycorrhizas on fine roots were found in 17 out of 25 saplings (68 %) sampled in the undisturbed stand. Total number of etomycorrhizal types classified by macro- and microscopic characteristics was 56 (3.35±1.37 types per sapling: mean±SD). All of *Shorea teysmanniana* saplings formed ectomycorrhizal roots in the stand. In the burned stand, ectomycorrhizas were observed in most of sampled saplings (16 out of 17 saplings: 94 %). Total number of the types was 44, and mean was 2.95 types per sapling with 1.31 of SD. Although the means of the number of ectomycorrhizal types per sapling did not differ significantly (t-test, p=0.68) between the stands, the ratio of saplings with ectomycorrhizas was larger in the burned stand than in the undisturbed stand.

Twenty-three species of mushrooms were sampled in the undisturbed plot (Table 3). Only two fungi are considered to be ectomycorrhizal fungi (IN 1 and IN 15), and the

others to be decaying or decomposing fungi. Twelve mushrooms were also sampled in the burnt plot (Table 3). All of them are considered to be decaying or decomposing fungi. It may be characteristic that mushrooms of decaying or decomposing fungi are abundant in the peat swamp forest. Ten out of 12 species of mushrooms in the burnt plot are not common to those in the undisturbed plot. According to results of the present surveys, species composition in tree saplings and mushrooms in the peat swamp forest may be affected and altered by the wild fire.

Table 3 List of mushroom from the natural forest in Kalimantan, Indonesia

a) Undisturbed plot

No. of specimen	Name of species	Date of collection	Habitat
IN 1	*Russula* sp.	17 Nov. 1999	on decaying litter
IN 2	*Amauroderma* sp.	17 Nov. 1999	on decaying trunk of *Shorea teysmanniana*
IN 3	*Lentinus* sp.	18 Nov. 1999	on decaying stem of broad-leaved tree
IN 4	*Amauroderma* sp.	18 Nov. 1999	on decaying trunk of broad-leaved tree
IN 6	Clitopilus sp.	18 Nov. 1999	on decaying wood
IN 7	*Marasmius* sp.	18 Nov. 1999	on decaying branch
IN 8	*Russula* sp.	18 Nov. 1999	on decaying litter (same species to IN1)
IN 9	*Hohenbuehelia* sp.	18 Nov. 1999	on decaying wood
IN10	*Polyporus* sp.	18 Nov. 1999	on decaying trunk
IN11	*Polyporus* sp.	18 Nov. 1999	on decaying wood
IN12	*Coriolopsis* sp.	18 Nov. 1999	on decaying wood
IN13	*Skeletocutis* sp.	18 Nov. 1999	on decaying branch
IN14	*Marasmiellus* sp.	18 Nov. 1999	on decaying branch
IN15	*Scleroderma* sp.	18 Nov. 1999	on soil
IN16	*Marasmius* sp.	18 Nov. 1999	on decaying branch
IN17	*Xeromphalina* sp.	18 Nov. 1999	on decaying trunk
IN18	*Russula* sp.	18 Nov. 1999	on decaying litter (same species to IN1)
IN19	Unidentified	18 Nov. 1999	on decaying leaf
IN20	*Trametes* sp.	18 Nov. 1999	on decaying stem
IN21	*Xylaria* sp.	18 Nov. 1999	on decaying stem
IN22	Unidentified	18 Nov. 1999	on decaying branch
IN23	*Pluteus* sp.	18 Nov. 1999	on decaying trunk
IN24	*Inonotus* sp.	18 Nov. 1999	on decaying stem
IN25	*Xylaria* sp.	18 Nov. 1999	on decaying stem

IN47	*Daedalea dickinsii*	20 Nov. 1999	on decaying trunk

b) Burnt plot

No. of specimen	Name of species	Date of collection	Habitat
IN29	*Pycnoporus coccineus*	18 Nov. 1999	on decaying wood
IN30	*Coriolopsis* sp.	18 Nov. 1999	on decaying trunk
IN31	*Fomitopsis* sp.	18 Nov. 1999	on decaying wood
IN32	*Rigidoporus* sp	18 Nov. 1999	on decaying wood
IN33	*Guepinia spathularia*	18 Nov. 1999	on decaying wood
IN34	*Daedaleopsis tricolor*	18 Nov. 1999	on decaying wood
IN35	*Polyporus* sp.	18 Nov. 1999	on soil (same to IN10)
IN36	*Panellus* sp.	18 Nov. 1999	on decaying wood
IN37	*Daedaleopsis purpurea*	18 Nov. 1999	on decaying stem
IN38	*Nigroporus* sp.	18 Nov. 1999	on decaying wood
IN39	*Gloeophyllum odoratum*	18 Nov. 1999	on decaying wood
IN40	*Lentinus jawaensis*	18 Nov. 1999	on decaying wood

VIII. Study on Natural Product Chemist in Peat lands

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a) Pesticides

In the agricultural region of Kalampangan, two farmlands, one of which was successfully managed because of a good maintenance of the peat layer while the other was abandaned due to low soil productivity, were compared. It was estimated that the soil productivity is dependent on preserved top soil of the peat layer brought by farmer's efforts. In the successful farmland, the farmers put ash (phosphorus and alkali) as a pin-point fertilization to keep better soil around the rhizosphere, so that the peat soil around the root system is rich in soil microorganisms. On the contrary, abandoned farmland is obviously poor in nutrients and soil microorganisms.

However, successful farmers periodically spray powerful pesticides and insecticides over crops and vegetables. Because such disordered chemical use often results in accumulation of these man-made chemicals in the soil without decomposing, there is certain fear that such accumulated chemicals bring qualitative and quantitative decrease of population of the soil microorganisms in the top soil. Then, it may bring to farmlands decrease the soil productivity on a mid or a long term basis. To avoid this sort of risks from the abuse of such synthetic chemicals, it is necessary to propel the local farmers to substitute moderate natural product chemicals for pest control. It will also be a support to push forwards low cost and sustainable agriculture.

Natural Product Chemistry Team therefore tried to search agricultural wastes which is candidates of such substituted natural product sources. Our initial concept was to list up any "easily obtained", "easily cultivated", "easily extracted" and "clearly effective" materials. According to this investigation around Central Kalimantan, we have listed up some candidate crops. What seemed to be a promised plants were the herbs of Zingiberaceae, which are mainly utilized their tubers. In Indonesia, several species of Zingiberaceae herbs are cultivated and widely used, and over 5 species of the family Zingiberaceae were also seen in the farmland area in Center Kalimantan. Among them, tubers of two species of Zingiberaceae plants were commonly seen in the free market in Palangka Raya. The fact that most of the aerial parts of the harvested Zingiberaceae herbs are discarded is also an advantage for their secondary utilization, because cost for the purpose is nearly free.

Discussing on this matter with Dr. Hanny Wijaya, we agreed on starting a small project of Zingiberaceae herbs. We are going to collect some samples near Kalampangan, extract their natural compounds, and test their anti-insect and anti-fungal effects. When we found clear activity from the preliminary bioassay, easy method to process for obtaining active aqueous extracts from the aerial part is further examined.

b) Screening of Functional Rhizospheric Microorganisms from Peat Land.

In the investigation in destroyed forest area, we collected roots of some under-growth plants which was common in two sites. One is the site where top soil of the peat land is well preserved and the growth of the young tree in next generation is observed. The other is the site where top soil layer had been artificially off to prevent regeneration of the spring-off of the forest trees. The roots of plants thus sampled were washed with pure mineral water to remove the attaching soil and then cut off from the stems to be soaked in the sterilized water. After this was retained in half day, only the water phase was transferred into the clean vial. Thus, suspension of rhizospheric microorganisms in sterile water was obtained from each plant in respective sites. Plants sampled are carper grass, a fern locally known as edible and young tree of genus Ficus. Moreover, Melastoma malabathricum known as a bush plant resistant to acid sulfate soil was also collected from both of the sites.

Agricultural farmlands including rice field in Paduran near coast have widely shown crop damage due to acid sulfate soil. Rice plant (IR64) took a serious damage from the acid soil to be insufficient growth with yellowing and stunting. Whereas a grass weed grow very well in the same rice field and produced off-springs. In abundant farmlands in this area, M. malabathricum is most abundant shurab. We therefore sampled rhizosphere microorganisms attaching on the roots of those plants.

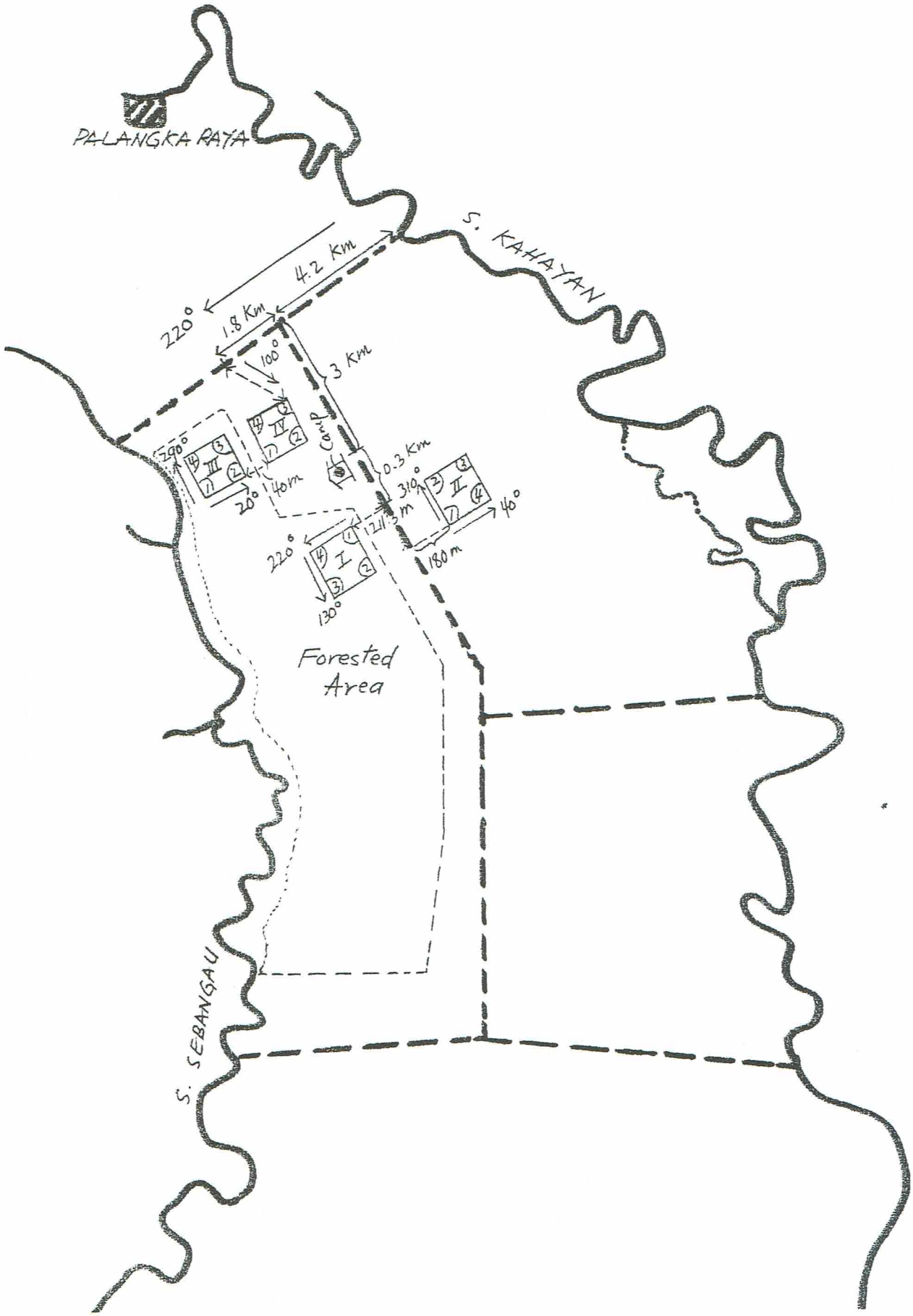
The sampled microorganism suspension is respectively going to do screening for 6 items of properties as follows: 1) acid-resistant, 2) ability to fix nitrogen, 3) ability to reduce sulfate anion, 4) capacity to neutralize sulfuric acid, 5) ability to solubilize hardly soluble organic phosphorus, 6) oxidation of the bivalent iron, at present. Present investigation is positioned as a preliminary screening. From the next year, we further focuse on some rhizospheric systems of the selected plants.

APPENDICES

Appendix-1. Co-ordinate positions of the visited sites recorded using GPS

Date	*Location*	*Latitude (South)*	*Longitude (East)*	*Route*
99/07/01	Bahaur Hilir (paddy field)	03-16.259'	114-06.028'	1
99/07/01	Bahaur Muara (sampling point)	03-20.810'	114-02.710'	1
99/07/01	Muara Bahaur (sea shore)	03-20.820'	114-02.732'	1
99/07/01	Pangkoh IX	02-53.175'	114-09.608'	1
99/07/01	Pangkoh IX-E	02-53.341'	114-09.427'	1
99/07/01	Pulang Pisau village	02-44.034'	114-15.851'	1
99/07/02	Basarang river channel	02-53.932'	114-16.962'	1
99/07/02	Maliku village	02-58.538'	114-09.596'	1
99/07/02	Pangkoh district	03-04.650'	114-09.162'	1
99/07/02	Pangkoh III-1	02-57.865'	114-02.351'	1
99/07/02	Pangkoh III-2	02-58.494'	114-04.293'	1
99/07/02	Pangkoh III-3	02-58.813'	114-05.599'	1
99/07/02	Pangkoh III-C	03-00.062'	114-05.208'	1
99/07/02	Bereng Bengkel village (river bank)	02-14.938'	114-02.018'	2
99/07/02	Garong canal (nearby Kahayan river bank)	02-38.040'	114-12.956'	2
99/07/02	Gohong village (under the bridge)	02-40.967'	114-16.741'	2
99/07/02	Jabiren village	02-31.349'	114-11.610'	2
99/07/02	Palangka Raya, Rambang's Port	02-11.114'	113-57.346'	2
99/07/02	Pilang village	02-28.909'	114-12.459'	2
99/07/02	Tumbang Nusa village	02-21.213'	114-08.320'	2
99/07/03	Canal edge (nearby S. Sebangau)	02-19.414'	114-00.930'	3
99/07/03	Canal edge (nearby T-shape)	02-18.101'	114-01.547'	3
99/07/03	Kalampangan bridge (landroad)	02-17.341'	114-01.921'	3
99/07/03	Kalampangan-1	02-21.170'	114-00.074'	3
99/07/03	Kalampangan-2	02-20.321'	114-00.502'	3
99/07/04	Border of forested area (at Kalampangan canal	02-20.606'	114-02.241'	3
99/07/04	Forested area along Kalampangan canal	02-20.696'	114-02.222'	3
99/07/04	Inoue sensei's pipe line across the Pilang canal	02-20.115'	114-01.749'	3
99/07/12	Starting point, study plot-1	02-20.625'	114-02.314'	4
99/07/13	Camp (nearby plot-1)	02-20.581'	114-02.183'	4
99/07/14	Entrance gate to plot-1	02-20.541'	114-02.197'	4
99/07/14	Study Plot-1 (KZNDP)-origin point	02-20.660'	114-02.110'	4
99/07/14	Reference point, study plot-1	02-20.644'	114-02.271'	4
99/07/14	Reference point-3	02-20.753'	114-02.242'	4
99/07/16	Canal edge at 3.3 km of T-shape to Pilang	02-20.611'	114-02.314'	4
99/07/16	Study Plot-2 (KZBDP)-origin point	02-20.519'	114-02.345'	4
99/07/17	Canal edge (access to plot-3)	02-20.494'	114-00.451'	5
99/07/17	Canal edge (exit gate from plot-4)	02-20.311'	114-00.536'	5
99/07/17	Study Plot-3	02-20.513'	114-00.674'	5
99/07/17	Study Plot-3, corner point-3	02-20.425'	114-00.596'	5
99/07/17	Study Plot-4, corner point-1	02-20.438'	114-00.675'	5
99/07/17	Study Plot-4, corner point-3	02-20.339'	114-00.693'	5
99/07/17	Study Plot-4, corner point-4	02-20.395'	114-00.613'	5

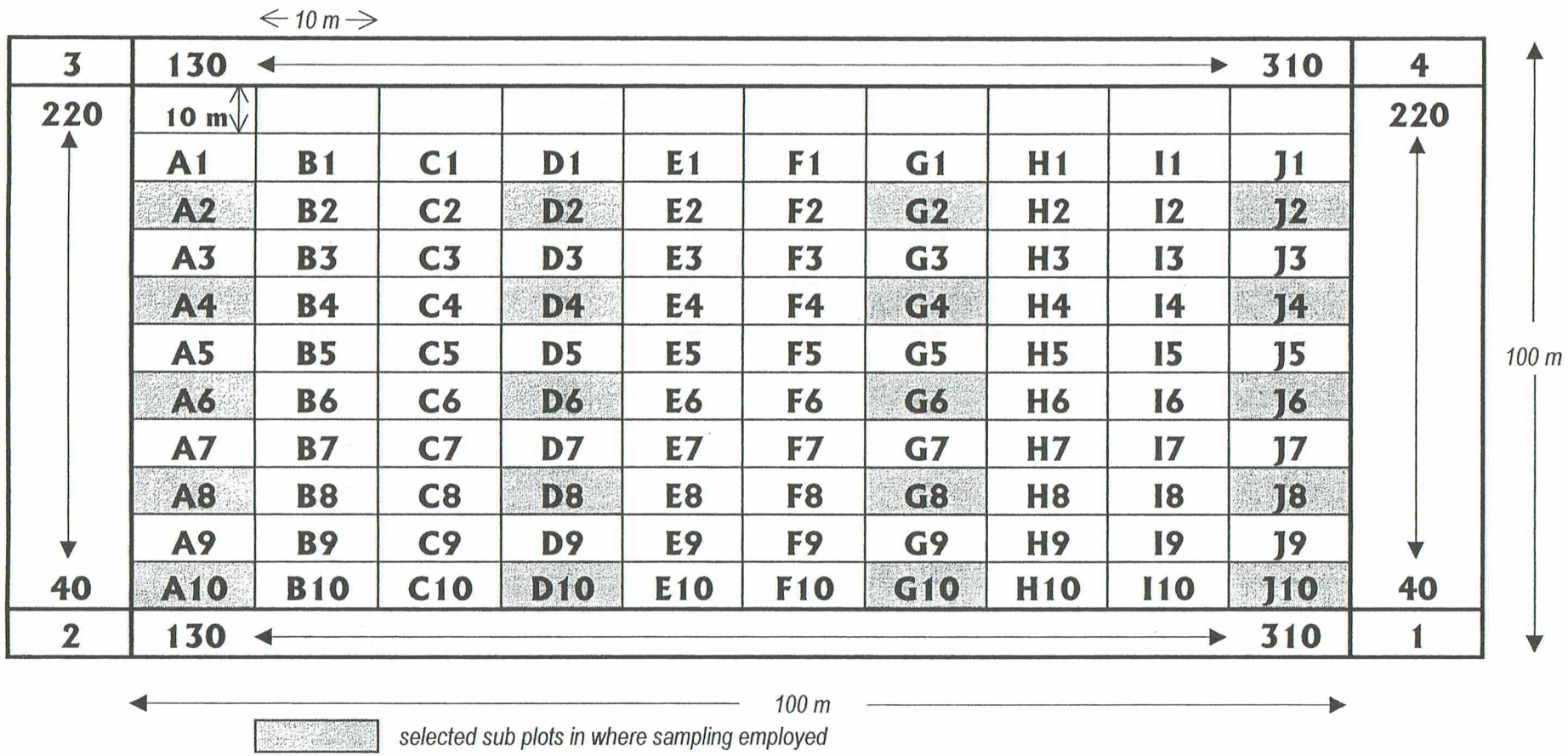
Appendix-2. Schematic map describing the location of study plots at Kalampangan Zone



LAY OUT OF STUDY PLOTS AND SUBPLOTS

SITE LOCATION	Kalampangan Zone
PLOT ID CODE	Plot-1, Native Deep Peat [KZNDP-1]
GRID REFERENCE	South-West [bearing 220 degree] and East-South [bearing 130 degree]

Appendix-3. Lay out of study plots and sub plots at Kalampangan Zone



SITE LOCATION	Kalampangan Zone
PLOT ID CODE	Plot-2, Burn Deep Peat [KZBDP-2]
GRID REFERENCE	North-East [bearing 40 degree], East-South [bearing 310 degree]

3	310 ◄									130 ►	4
40											40
▲	A1	B1	C1	D1	E1	F1	G1	H1	I1	J1	▲
	A2	B2	C2	D2	E2	F2	G2	H2	I2	J2	
	A3	B3	C3	D3	E3	F3	G3	H3	I3	J3	
	A4	B4	C4	D4	E4	F4	G4	H4	I4	J4	
	A5	B5	C5	D5	E5	F5	G5	H5	I5	J5	
	A6	B6	C6	D6	E6	F6	G6	H6	I6	J6	
	A7	B7	C7	D7	E7	F7	G7	H7	I7	J7	
	A8	B8	C8	D8	E8	F8	G8	H8	I8	J8	
▼	A9	B9	C9	D9	E9	F9	G9	H9	I9	J9	▼
220	A10	B10	C10	D10	E10	F10	G10	H10	I10	J10	220
2	◄									130 ►	1

selected sub plots in where sampling employed

SITE LOCATION	Kalampangan Zone
PLOT ID CODE	Plot-3, Native Shallow Peat [KZNSP-3]
GRID REFERENCE	North-East [bearing 40 degree], West-North [bearing 290 degree]

3	290 ◄									► 110	2
20 ▲											20 ▲
	A1	B1	C1	D1	E1	F1	G1	H1	I1	J1	
	A2	B2	C2	D2	E2	F2	G2	H2	I2	J2	
	A3	B3	C3	D3	E3	F3	G3	H3	I3	J3	
	A4	B4	C4	D4	E4	F4	G4	H4	I4	J4	
	A5	B5	C5	D5	E5	F5	G5	H5	I5	J5	
	A6	B6	C6	D6	E6	F6	G6	H6	I6	J6	
	A7	B7	C7	D7	E7	F7	G7	H7	I7	J7	
	A8	B8	C8	D8	E8	F8	G8	H8	I8	J8	
	A9	B9	C9	D9	E9	F9	G9	H9	I9	J9	
200 ▼	A10	B10	C10	D10	E10	F10	G10	H10	I10	J10	200 ▼
4	◄									► 110	1

selected sub plots in where sampling employed

SITE LOCATION	Kalampangan Zone
PLOT ID CODE	Plot-4, Burn Shallow Peat [KZBSP-4]
GRID REFERENCE	North-East [bearing 40 degree], West-North [bearing 290 degree]

3	290 ◄								► 110	2
20										20
▲	A1	B1	C1	D1	E1	F1	G1	H1	I1	J1	▲
	A2	B2	C2	D2	E2	F2	G2	H2	I2	J2	
	A3	B3	C3	D3	E3	F3	G3	H3	I3	J3	
	A4	B4	C4	D4	E4	F4	G4	H4	I4	J4	
	A5	B5	C5	D5	E5	F5	G5	H5	I5	J5	
	A6	B6	C6	D6	E6	F6	G6	H6	I6	J6	
	A7	B7	C7	D7	E7	F7	G7	H7	I7	J7	
	A8	B8	C8	D8	E8	F8	G8	H8	I8	J8	
▼	A9	B9	C9	D9	E9	F9	G9	H9	I9	J9	▼
200	A10	B10	C10	D10	E10	F10	G10	H10	I10	J10	200
4	◄								► 110	1

selected sub plots in where sampling employed

Appendix-4. **Proposal for Local Government of Central Kalimantan prepared by the Agricultural Sciences Group**

GREEN WALL ON PEATLANDS IN CENTRAL KALIMANTAN

A. General Introduction

Central Kalimantan is the second largest province of the four Kalimantan provinces. This province possesses an area of 15.3 million hectares, of which 12.023 million hectares were classified as production forests that managed under forest concession rights (HPH). Whilst, the rest area of 729,419 hectares were classified as nature reserve/recreational forest; 800,000 hectares as protection forest, and 4,302,581 hectares as conversion forest, respectively.

Kalimantan island contains about one third of the peatlands in Indonesia (estimated 6.8 million hectares), of which about 2.25 million hectares are found in Central Kalimantan province. This province contains some of the largest remaining areas of undisturbed Peat Swamp Forests (PSFs), for instance in the catchments of the rivers Sebangau, Kapuas, Barito, Katingan, Mentaya, Seruyan and Kotawaringin.

In tropical lowland, peat swamp forests have also an important role in land stabilization processes. They develop inland of the coastal mangrove swamps and are the second line of defense against coastal erosion. They are important to local economies as a source of wood, food, shelter and firewood. At the present time large areas of tropical peat swamp forest are being drained, settled with people, and converted to agriculture. In Central Kalimantan this is being carried out as part of the Indonesian Government policy to develop one million hectares peatland for agriculture, and to promote transmigration program (population translocation) to reduce the population of Java by persuading people to move to undeveloped and under populated parts of the country.

B. Project Principal

Under the slogan of sustainable development, forests on the peat swamp and wetland areas have been destroyed in tropical area. Needless to say, since it is very difficult to develop peat swamp and wetland, those huge areas still remain in natural or semi-natural conditions. Those areas have been considering as the key ecosystem for not only reserving bio-resources and biodiversity, but also stocking of carbon in forests and peat, or controlling water resource. However, nowadays, the peat swamp and wetland in tropical area face to the crisis of disappearance due to human impact, which is accelerated by recent abnormal and unusual global climate changes. Therefore, this current project is focussed on rehabilitation of peatlands and establishment of sustainable agro-systems in the

destroyed, abandoned, and fire-damaged areas in peat lands including cultivated areas, where locate surrounding natural or semi-natural peat swamp forests.

C. Objectives

1) To conserve peat forest lands and rehabilitates the destroyed, abandoned, and fire-damaged areas in peat lands
2) To establish the sustainable agro-systems in cultivated areas

D. Experimental sites

Peatlands area in Central Kalimantan are classified into three areas according to intensity of human activities; 1) the native peat swamp forest, 2) the destroyed, abandoned, and fire-damaged area and 3) cultivated areas. Referring to these peatlands characteristics in Central Kalimantan (surrounding Palangka Raya), the native peat swamp forest locates mainly between Sebangau River and Katingan River (Sebangau-Katingan catchment). Meanwhile, the abandoned, destroyed and fire-damaged area locate mainly between Sebangau River and Kahayan River (Sebangau-Kahayan catchment), and intensive cultivated areas locate mainly between Kahayan River and Barito River (Kahayan-Barito catchment).

Since our project is mostly taking special account on the rehabilitation of peatlands in the abandoned, destroyed and fire-damaged areas, as well as the establishment of sustainable production systems in cultivated areas, Sebangau-Kahayan catchment is proposed as the experimental sites. This is mainly because the Sebangau-Katingan catchment includes not only the abandoned, destroyed, and fire-damaged areas, but also cultivated areas (Figure 1).

Along the Sebangau-Kahayan catchment, there are three types of peat soils formation found such as inland peat, transitional peat, and coastal peat. However, since agricultural activity of coastal peat is quite different to inland peat and transitional peat, at first this project starts to study in inland peat and transitional peat. To this end, the following area are proposed as permanent research belt zones:

1. Kalampangan zone (Inland peat area with sandy material sub-layer) lies between both rivers of 7 km long and 25 km wide (Figure 2).
2. Pangkoh zone (Transitional peat with clay material sub-layer) lies between both rivers of 40 km long and 30 km wide (Figure 3).

In these zones, 4 monitoring plots will be established which including reforestation plot, agro-system experimental plot, 2 observatory stations, as well as education and training center. These four monitoring plots locate in Kalampangan upon native-deep peat (plot I) and burn-deep peat (plot II);

whereas in Pangkoh locates upon a secondary forest cover of native-shallow peat (plot III), and burn-shallow peat (IV).

E. Specific objectives and activities

(1) Reforestation Program

1) Natural forestry monitoring
2) Reforestation of dominant, native, and commercial tree species
3) Silviculture of useful trees such as medical or chemical substances produced-trees species
4) Silviculture system and silviculture of dominant and native tree species

(2) Establishment of sustainable agro-system

1) Establishment of integrated agro-ecosystem in peatlands including traditional farming, agro-forestry, combination of animal husbandry
2) Socio economic and culture

(3) Stabilization and destabilization processes of peat soil

1) Carbon budget and nutrients cycle
2) Chemical and physical properties of peat soils
3) Water and heat flux
4) Controlling organic acid reactivity
5) Vegetation types as indicator of soil types
6) Water relation of tropical peatland plants

(4) Hydrological monitoring and investigation on water management

1) Monitoring of shallow ground water level and its fluctuation in peat lands with various land uses
2) Study on relation between farmer's water management and changes in peat subsidence rate on peatland
3) Study on hydrological influence of canal construction

(5) Studies on bio-product utilization of plants

1) Chemical studies in nature such as:
   a) Survey on local traditional agro-system benefit value,
   b) Survey on various phenomena related to plant physiology and pathology, and
   c) Isolation and utilization of bioactive compounds for sustainable agro-system
2) Non timber products such as: gum and fat
3) Bio-fiber utilization

(6) Studies on micro-organisms activity and its utilization in peatlands

1) Conservation, study, and use of wild Polyporaceae fungi from peat swamp forests
2) Mycorrhizal colonization of several plant species grown in Central Kalimantan and its isolation from their rhizosphere soil
3) Studies of wild fungi isolated from peat swamp for new medicine
4) Nitrogen fixing and phosphate solubilizing microorganisms and plant growth
5) Studies of cultivation of wild mushroom
6) Microbial diversity and activity in peatland
7) Biodegradation studies in peatland

F. Experimental plots design and supporting facilities

(1) Monitoring plots

The selected research sites will include a primary or native peat swamp forest and abandoned or burnt areas of both transitional and inland peatlands, which representing different magnitude of human interference upon them. To allow a continuously monitoring of water table fluctuation, pH, Electric Conductivity, Redox Potential (Eh), heat flux, peat subsidence, litter fall and litter decomposition process over the peatlands area, 4 of 1 ha permanent plots for each selected zone (Kalampangan and Pangkoh zones) will be established. Then, these 1 ha permanent plots will be divided into 100 sub plots of 10m x 10m for further detail measurements.

(2) Observatory stations

Tropical peatlands, in particular, transitional and inland peat have been recognized as nutrient-poor environment. Nevertheless, native plants that grown over the peatlands area indicated an inherent mechanism to allow them to be tolerant to the harsh environment. Therefore, in order to collect as much as information concerning the possible environmental changes upon the sites in the long-term basis, it is necessary to establish 2 of observatory stations within each zone. These observatory stations are aimed to collect and record weather data, to measure microclimate and determine CO_2 flux by using a canopy tower.

(3) Education and training center

As one of the principal outputs of this research program is the possibility to disseminate the results gained to the community, to train students and others related parties. To this end, an education and training center should be established and promoted.

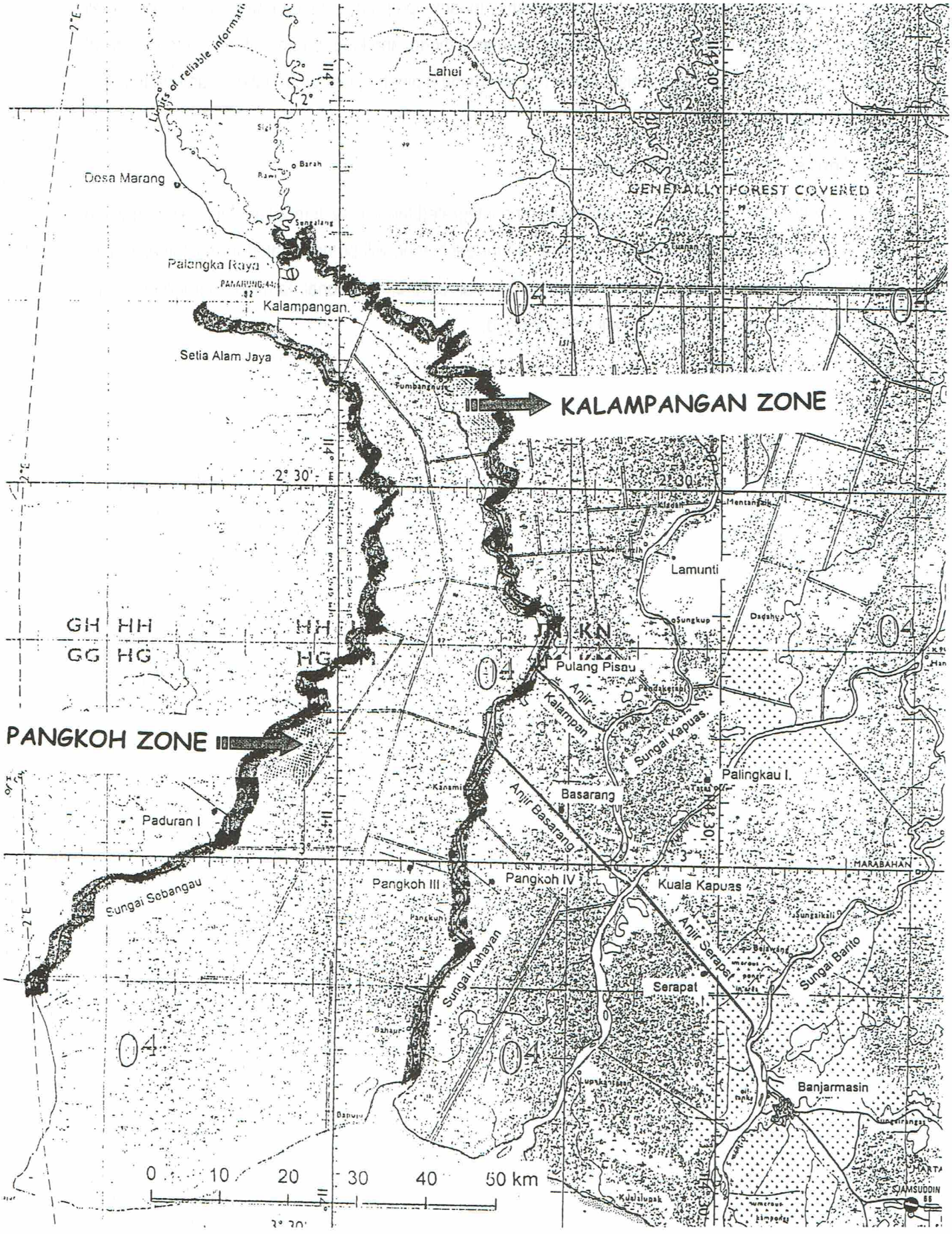
(4) Reforestation site

Since reforestation and other rehabilitative means upon a degraded peatlands area are remain important, it is urgently required to establish a site as a model and long-term monitoring of forest growth and development. This site will also support by designing a plot for plant propagation, nursery and other related aspects.

(5) Agro-system experimental plot

Attempt to conduct a comprehensive and integrated farming system will be the main purpose of this long-term research project. At least one plot for each zone will be designated for sustainable agro-system experimental plot. A detail study on social culture, traditional farming, agro-forestry and combination of animal husbandry will be addressed.

Figure 1. Proposed research sites within the Kahayan-Sebangau river catchment



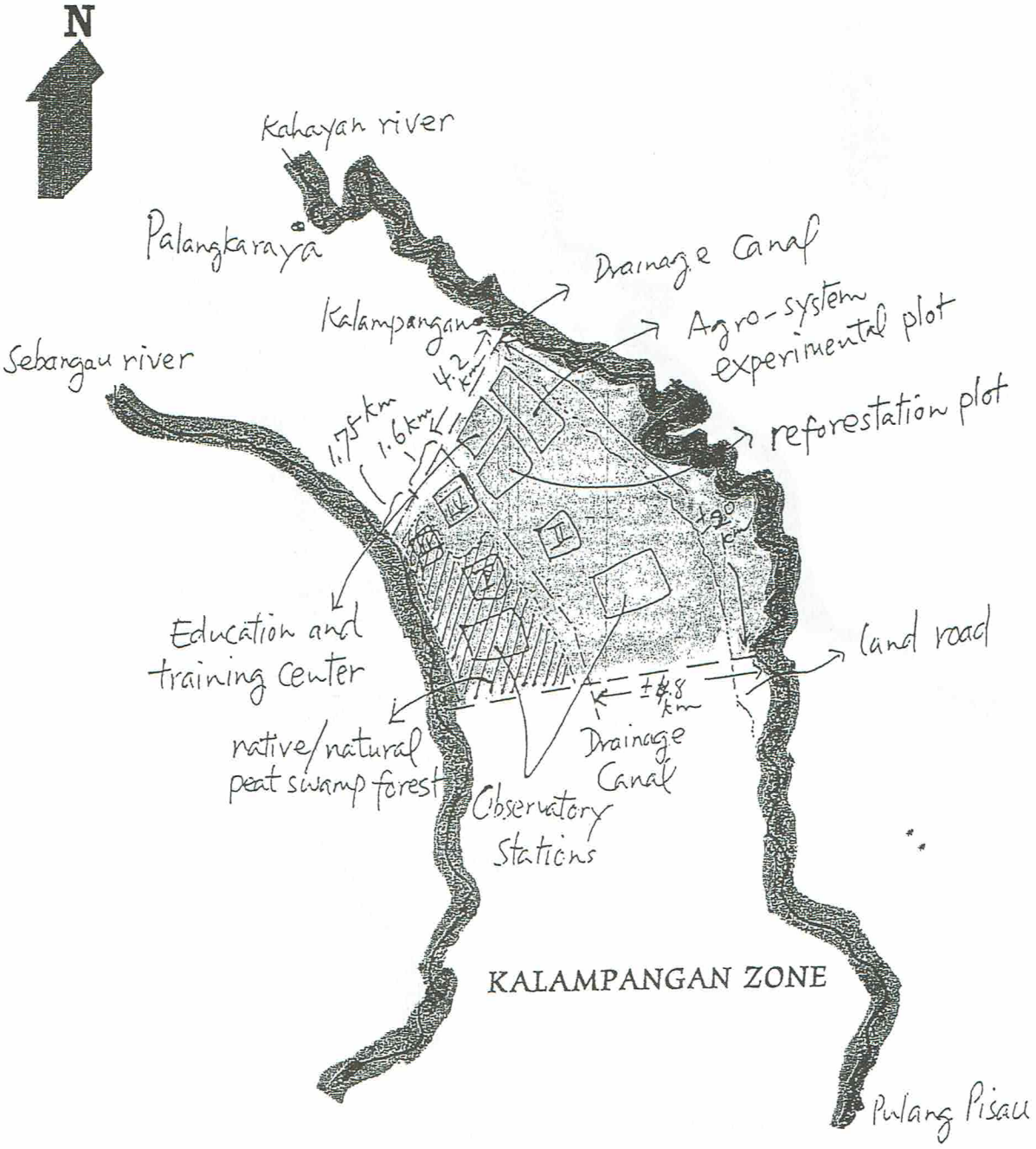


Figure 2. Proposed research sites upon a transitional peat area at Kalampangan Zone

Remarks:
Plot I - native deep peat
Plot II - burn deep peat
Plot III - native shallow peat
Plot IV - burn shallow peat

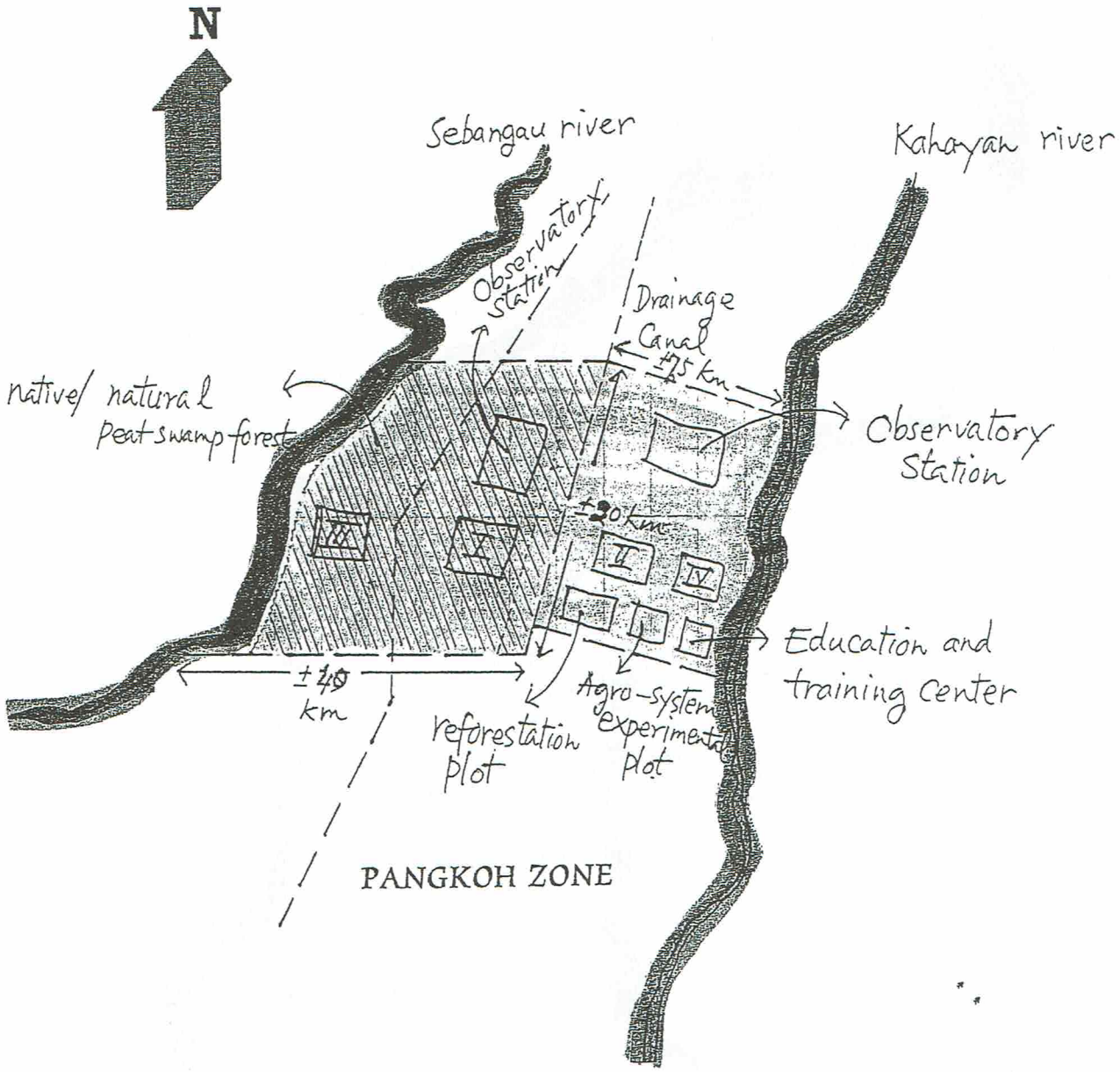


Figure 3. Proposed research sites upon an inland peat area at Pangkoh Zone

Remarks:
Plot I - native deep peat
Plot II - burn deep peat
Plot III - native shallow peat
Plot IV - secondary forest (association of *Melaleuca sp.*)

Collaborative study

(3)

River and peatland technology in the Sebangau River Basin, Central Kalimantan

River and Peatland Technology in the Sebangau River Basin

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1. River hydraulics

Observations of the water stage and the discharge were made at Kya of the Sebangau River.

Date	Stage H(m)	Discharge Q(m^3/sec)	Remarks
Aug. 12, 1998	0.20	18.9	
Sep. 20, 〃	-0.05	14.3	
Oct. 17, 〃	1.34	36.4	
Dec. 18, 〃	—	30.9	
Jan. 17, 1999	—	52.2	
Feb. 26, 〃	—	5.0	
Mar. 23, 〃	—	22.9	
May 31, 〃	—	17.8	
Nov. 29, 〃	0.98	32.6	
(Dec. 29, 〃	0.54	19.4)	cross section not sure

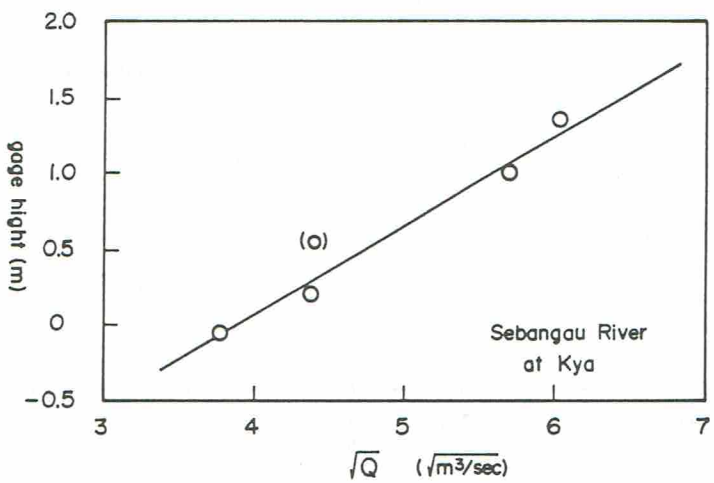


Fig. 1 Relationship between water stage and discharge

Fig.1 shows a relationship between the water stage and the discharge at Kya. A tentative stage-discharge relationship (H~Q) can be described by Eq.(1).

$$Q=(1.7H+3.9)^2 \qquad (1)$$

The discharge at Kya and the amount of daily rainfall at UNPAR are depicted in Fig.2.

The total amount of runoff, $\Sigma Q'$, for 63 days (Aug.25～Oct.26, 1998) was;

$$\Sigma Q' = 139.4\times10^6\ m^3$$

if the base flow was assumed to be $10m^3$/sec, the direct runoff, ΣQ, was;

$$\Sigma Q = 85.0\times10^6\ m^3$$

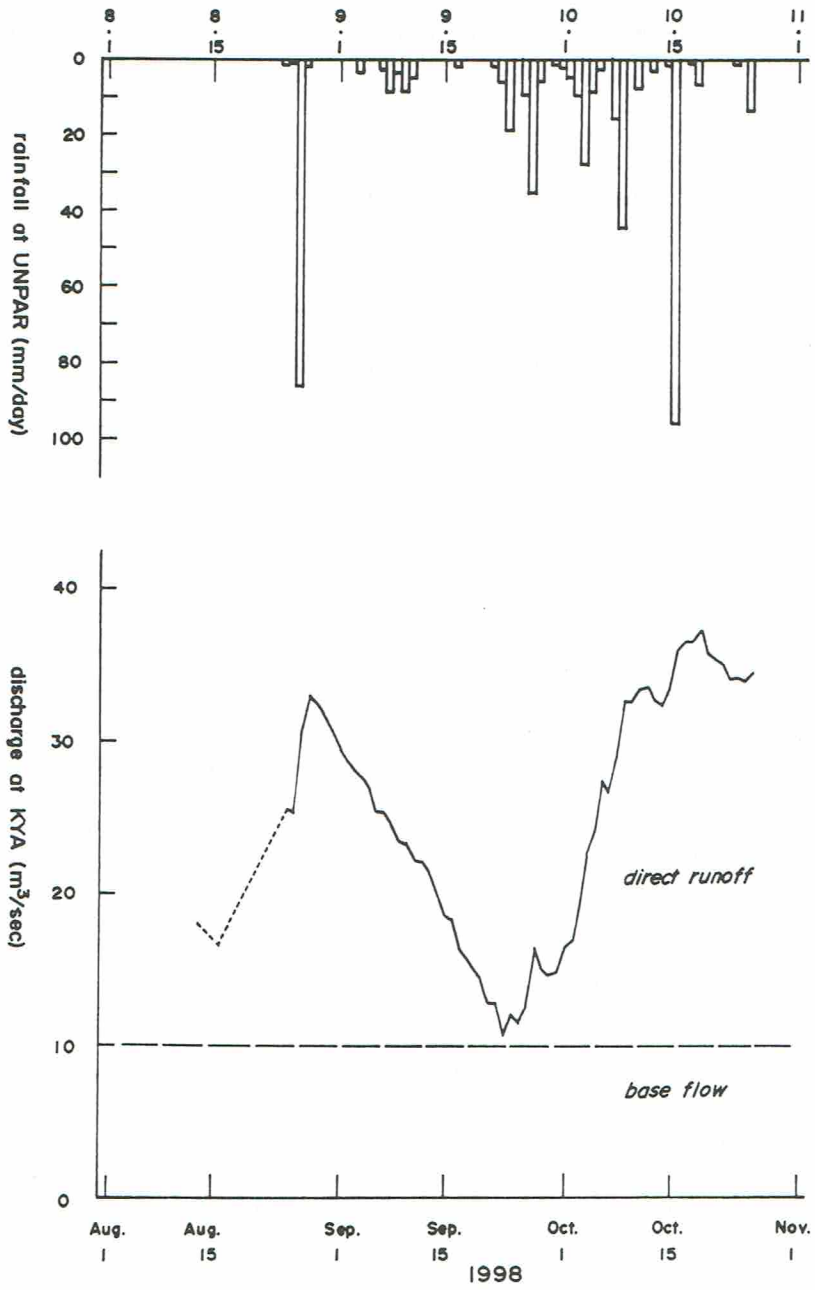


Fig. 2. Discharge and rainfall

The total amount of rainfall, ΣR, for the same 63 days at UNPAR was;

$$\Sigma R = 460.5 \text{ mm}$$

If the drainage area at Kya of the Sebangau River, A, is assumed to be A=600 km², an overall runoff coefficient, f, is evaluated as;

$$f = \frac{\Sigma Q}{A \cdot \Sigma R} = 0.31$$

The runoff coefficient will be more in the rainy season. It is 0.4～0.9 in the Sarobetsu Mire in Hokkaido, Japan. The lag of the discharge behind the rainfall is 1～2 days.

A flood routing was performed for a runoff from Sep. 23, 1998 using a simple storage function method.

$$\frac{ds}{dt} = f \cdot r - q \tag{3}$$

$$S = kq^P \tag{4}$$

Eq.(3) and Eq.(4) are the equation of continuity and the storage function, respectively. In which s : storage hight of the basin, t : time, r : rainfall, q : discharge, f : runoff coefficient and k, p : coefficients.

Fig.3 shows the calculated discharges with several sets of coefficients compared to the observations. Although the observation of the decreasing stage of this particular runoff was not clear, a filtering effect seems to be predominat in this river basin and the runoff is highly non-linear.

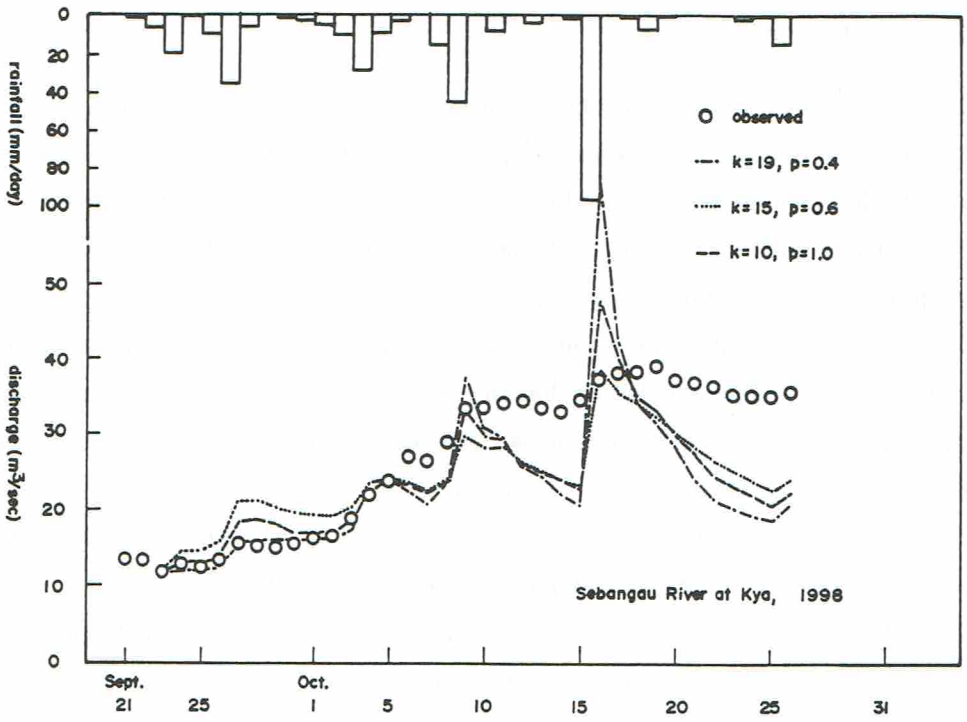


Fig. 3 Flood routing using storage function method

The change of the bed of the river channel was observed at the cross section at Kya of the Sebangau River. The change was 0.5～2.0m during 2 months. But it is not sure that the change was caused by the sediment transport or not. The change of the cross section is depicted in Fig.4.

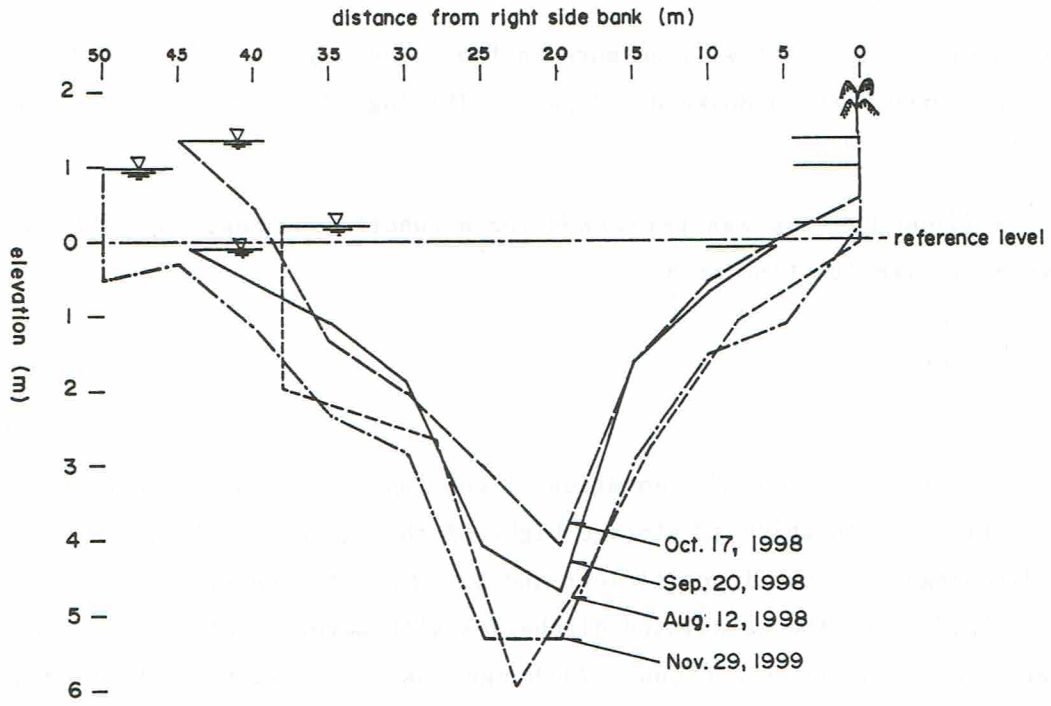


Fig. 4 Cross section at Kya

2. Quality of water

Obsevations of the quality of ground water and river water, and the characteristics of the peat were performed in the Sebangau River basin.

pH of the ground water in the peat land was low and the organic carbon existed at high concentration. These characteristics are similar to that of the Sarobetsu Mire in Hokkaido, Japan.

On the other hand, the concentration of phosphorus of the ground water was higher in the Sebangau River basin and this is a distinctive feature of the woody peat land. The ground water of the peat land affects more the Sebangau River than the Kahayan River.

The water in the study area was less affected by the sea water for the concentration of the general inorganic components was low.

C/N of the peat soil existed in the ratio of 50 to 60, that is almost the same as the Sarobetsu Mire in Hokkaido, Japan.

3. Coliform group in ground water and river water

The coliform group test which is one of the microbiological examination was carried out using simplified test paper. The results of the test were as follows:

1) The coliform group was hardly detected in the well water which was the ground water pumped up from a depth of 12m.

2) The numbers of the coliform group in the water of the Kahayan River and the Sebangau River were within the range from 1,400 to 1,700 (average number of colonies/100ml).

3) The numbers at the Kerengbangkirai Port and Rambang Port were within the range from 2,600 to 23,000.

4. Physical properties of peat

The field tests of peat were carried out at Setia Alam (not reclaimed land) and at Kalampangan (reclaimed land).

The ignition loss of Kalampangan, in which the content of mineral matter has increased due to the development of land use for farming, was lower than that obtained from Setia Alam. Due to the water drainage conducted at Kalampangan to prepare the land use for farming, the water content was also much lower at Kalampangan (about 20%) than at Setia Alam (more than 200%).

The coefficient of permeability at Setia Alam decreased with depth. It was 8×10^{-4}cm/sec at the depth of 0.9m and 6.1×10^{-4}cm/sec at 1.6m. These coefficients of permeability were relatively large for the peat mire.

5. General remarks of the cooperative studies

Discussions and exercises were performed at the University of Palangka Raya for the following subjects;

1) details of the collaborative research,
2) hydrologic data and geographical data,
3) observations of discharge in river,
4) chemical characteristics of river water and ground water, and
5) sewage and sewerage system.

Field observations and exercises were performed in Sebangau River basin for the following subjects;

1) survey of the geography and the maps of the river basin,
2) survey of the observation stations and the data of meteorology,
3) observations of the discharge at Kya,

4) observation of the bed material,
5) improve the water stage recorder at Kya and perform the measurements,
6) measurements of the quality of the river water (temperature, pH, DO, COD, electric con ductivity, N and P and coliform group),
7) measurements of the quality of ground water, river water, rain-fall and drinking water,
8) survey of the sewage and sewerage system in the city of Palangka Raya,
9) measurement of bearing capacity of peat land,
10) analysis of the specimen of the peat soil, and
11) analysis of permeability of peat land.

All the field observations have just started in 1998 and succesive measurements are necessary and important.

A trouble was found on the electro-magnetic current meter and is going to be sent back to UNPAR after a repair. The water depth sounder, the simplified water quality measuring devices, the cone penetro-meter and the piezo-meter have been kept at UNPAR. The field observations of the discharge at Kya and quality of water have been carried out by the members in UNPAR of the research group of the technology once a month or so at various water stages. Some reagents to analyze the water quality were not able to pass an airport and some parts of the analyses were not made.

In general, the proposed projects of the River and Peatland Technology are going well, although there have been some unexpected troubles.

The itinerary of the collaborative research of the River and Peatland Technology in 1999 was: From November 21 to December 1, six members from Japan visited Indonesia to attend the International Symposium on Tropical Peatland Management and to make the field observations.

6. Field data

The field data have been obtained for the following subjects in the Sebangau River basin in 1999. They are summerized and depicted in tables and figures on the succesive pages.

1) Discharge, Cross Section and Quality of Water at Kya
2) Water Stage, Discharge and Precipitation (Aug.25～Oct.26, 1998)
3) Cross Sectional Distribution of DO at Kya
4) Drainage Basin of the Sebangau River at Kya

1) Discharge, Cross Section and Quality of Water

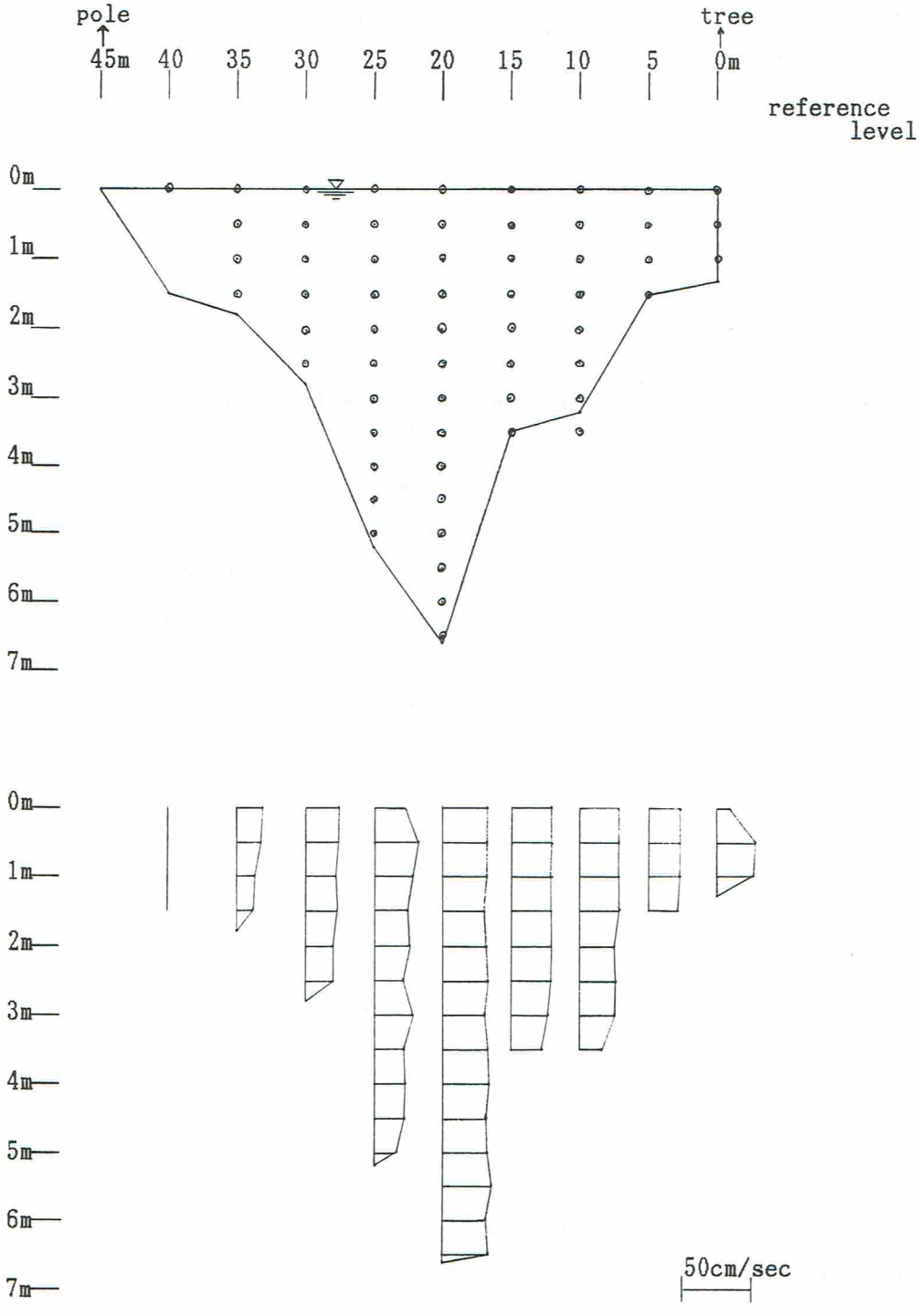
Name of River	Sebangau River
Station	Kya, upstream of Kerengbangkirai
Date and Time	December 18, 1998
Water stage	H=
Width of flow	B=45.00m
Cross sectional area	A=125.08m^2
Wetted perimeter	W=48.54m
Hydraulic radius	R=2.58m
Discharge	Q=30.87m^3/sec

below w.	distance from tree on right side bank (m)										
surf.(m)	45	40	35	30	25	20	15	10	5	tree	
0.00	-	0.0	0.181	0.241	0.233	0.329	0.295	0.280	0.233	0.091	
0.50	-	-	0.171	0.242	0.322	0.322	0.294	0.292	0.235	0.282	
1.00	-	-	0.124	0.217	0.281	0.322	0.291	0.292	0.228	0.262	
1.50	-	-	0.117	0.231	0.252	0.304	0.294	0.295	0.226	-	
2.00	-	-	-	0.204	0.256	0.321	0.292	0.253	-	-	
2.50	-	-	-	0.201	0.206	0.332	0.293	0.274	-	-	
3.00	-	-	-	-	0.276	0.311	0.273	0.251	-	-	
3.50	-	-	-	-	0.214	0.326	0.236	0.161	-	-	
4.00	-	-	-	-	0.221	0.332	-	-	-	-	
4.50	-	-	-	-	0.210	0.314	-	-	-	-	
5.00	-	-	-	-	0.159	0.323	-	-	-	-	
5.50	-	-	-	-	-	0.352	-	-	-	-	
6.00	-	-	-	-	-	0.321	-	-	-	-	
6.50	-	-	-	-	-	0.331	-	-	-	-	
depth(m)	0.0	1.5	1.8	2.8	5.2	6.6	3.5	3.2	1.5	1.3	

Elect. Conductivity	6.49 6.62 μS/cm
Water Temperature	27.3 28.2 ℃
DO	2.82 3.40 mg/ℓ
COD	
pH	4.14 4.17

Sebangau River

December 18, 1998



Discharge, Cross Section and Quality of Water

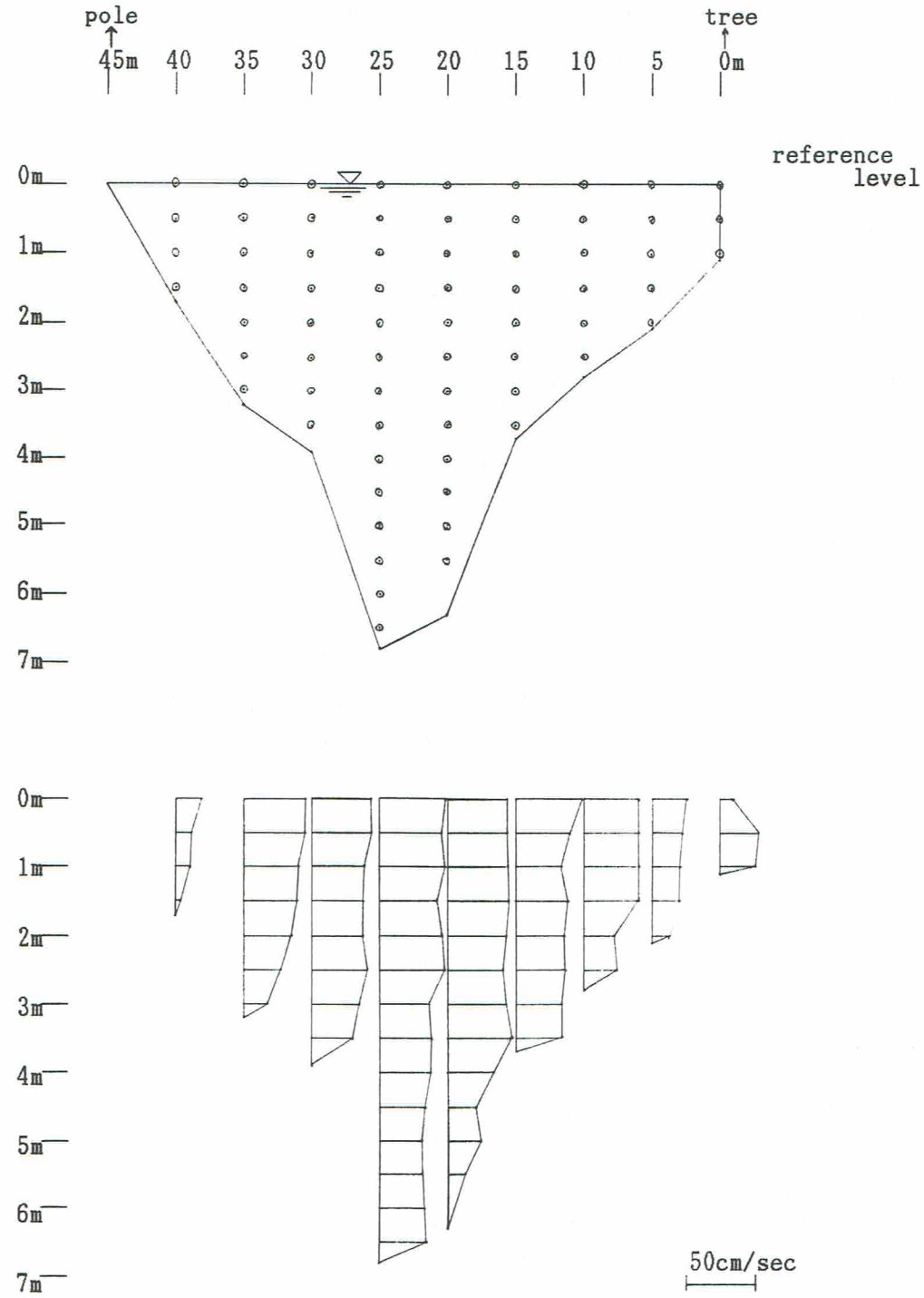
Name of River	Sebangau River
Station	Kya, upstream of Kerengbangkirai
Date and Time	January 17, 1999
Water stage	H=
Width of flow	B=45.00m
Cross sectional area	A=151.39m^2
Wetted perimeter	W=48.32m
Hydraulic radius	R=3.13m
Discharge	Q=52.24m^3/sec

below w.	distance from tree on right side bank (m)										
surf.(m)	45	40	35	30	25	20	15	10	5	tree	
0.00	-	0.195	0.456	0.433	0.497	0.433	0.486	0.355	0.263	0.091	
0.50	-	0.117	0.462	0.427	0.452	0.441	0.392	0.357	0.221	0.282	
1.00	-	0.105	0.401	0.390	0.487	0.442	0.343	0.366	0.211	0.262	
1.50	-	0.026	0.394	0.381	0.421	0.452	0.383	0.350	0.201	-	
2.00	-	-	0.356	0.383	0.465	0.439	0.365	0.221	0.122	-	
2.50	-	-	0.269	0.411	0.486	0.414	0.363	0.233	-	-	
3.00	-	-	0.217	0.363	0.368	0.427	0.337	-	-	-	
3.50	-	-	-	0.302	0.390	0.483	0.335	-	-	-	
4.00	-	-	-	-	0.385	0.330	-	-	-	-	
4.50	-	-	-	-	0.327	0.215	-	-	-	-	
5.00	-	-	-	-	0.312	0.250	-	-	-	-	
5.50	-	-	-	-	0.311	0.135	-	-	-	-	
6.00	-	-	-	-	0.329	-	-	-	-	-	
6.50	-	-	-	-	0.339	-	-	-	-	-	
depth(m)	0.0	1.7	3.2	3.9	6.8	6.3	3.7	2.8	2.1	1.1	

Elect. Conductivity	5.82 6.03 μS/cm
Water Temperature	28.2 28.4 ℃
DO	3.25 3.35 mg/ℓ
COD	
pH	4.18 4.21

Sebangau River

January 17, 1999



Discharge, Cross Section and Quality of Water

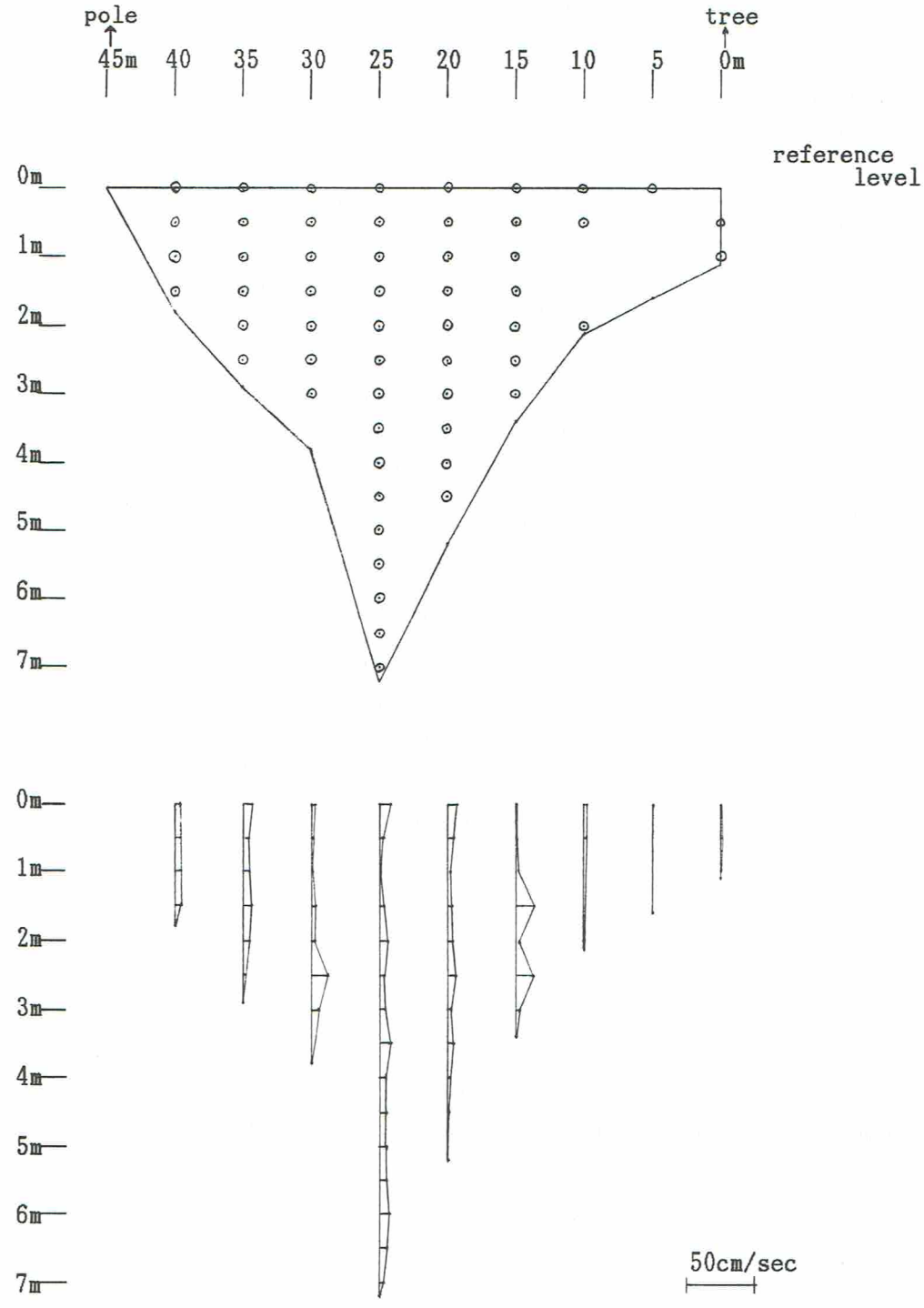
Name of River	Sebangau River
Station	Kya, upstream of Kerengbangkirai
Date and Time	February 26, 1999 13:00
Water stage	H=
Width of flow	B=45.00m
Cross sectional area	A=140.37m²
Wetted perimeter	W=48.59m
Hydraulic radius	R=2.89m
Discharge	Q=5.00m³/sec

below w.	distance from tree on right side bank (m)										
surf.(m)	45	40	35	30	25	20	15	10	5	tree	
0.00	-	0.034	0.070	0.019	0.076	0.071	0.007	0.010	0.006	-	
0.50	-	0.042	0.040	0.004	0.012	0.041	0.006	0.007	-	0.003	
1.00	-	0.041	0.050	0.009	0.011	0.019	0.019	-	-	0.005	
1.50	-	0.039	0.052	0.038	0.041	0.032	0.138	-	-	-	
2.00	-	-	0.038	0.025	0.059	0.033	0.017	0.003	-	-	
2.50	-	-	0.009	0.117	0.026	0.056	0.142	-	-	-	
3.00	-	-	-	0.055	0.042	0.013	0.019	-	-	-	
3.50	-	-	-	-	0.076	0.046	-	-	-	-	
4.00	-	-	-	-	0.049	0.012	-	-	-	-	
4.50	-	-	-	-	0.048	0.014	-	-	-	-	
5.00	-	-	-	-	0.045	-	-	-	-	-	
5.50	-	-	-	-	0.049	-	-	-	-	-	
6.00	-	-	-	-	0.072	-	-	-	-	-	
6.50	-	-	-	-	0.054	-	-	-	-	-	
7.00					0.026		-	-	-	-	
depth(m)	0.0	1.8	2.9	3.8	7.2	5.2	3.4	2.13	1.6	1.1	

Elect. Conductivity	6.0 6.05 μS/cm
Water Temperature	29.2 30.1 ℃
DO	3.60 4.03 mg/ℓ
COD	
pH	4.17 4.2

Sebangau River

February 26, 1999



Discharge, Cross Section and Quality of Water

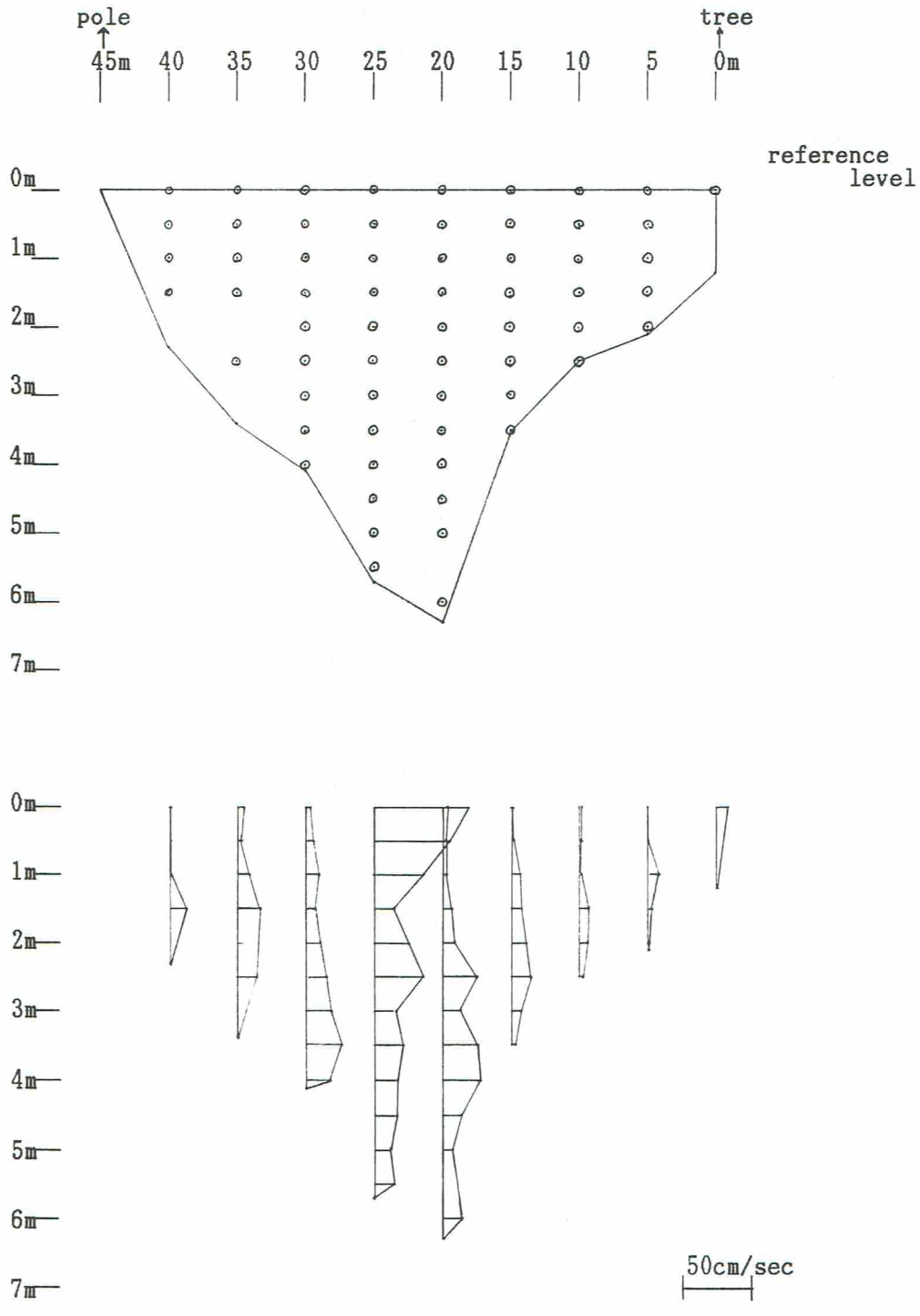
Name of River	Sebangau River
Station	Kya, upstream of Kerengbangkirai
Date and Time	March 23, 1999 10:00
Water stage	H=
Width of flow	B=45.00m
Cross sectional area	A=152.50m²
Wetted perimeter	W=48.93m
Hydraulic radius	R=3.17m
Discharge	Q=22.93m³/sec

below w.	distance from tree on right side bank (m)										
surf.(m)	45	40	35	30	25	20	15	10	5	tree	
0.00	-	0.011	0.054	0.027	0.690	0.042	0.007	0.016	0.005	0.090	
0.50	-	0.023	0.023	0.061	0.550	0.022	0.020	0.016	0.003	-	
1.00	-	0.016	0.089	0.089	0.360	0.023	0.058	0.011	0.077	-	
1.50	-	0.120	0.167	0.068	0.132	0.059	0.075	0.067	0.021	-	
2.00	-	-	-	0.100	0.247	0.091	0.106	0.059	0.005	-	
2.50	-	-	0.142	0.145	0.360	0.249	0.142	0.017	-	-	
3.00	-	-	-	0.192	0.156	0.123	0.067	-	-	-	
3.50	-	-	-	0.265	0.202	0.245	0.021	-	-	-	
4.00	-	-	-	0.175	0.171	0.267	-	-	-	-	
4.50	-	-	-	-	0.173	0.128	-	-	-	-	
5.00	-	-	-	-	0.115	0.074	-	-	-	-	
5.50	-	-	-	-	0.146	-	-	-	-	-	
6.00	-	-	-	-	-	0.134	-	-	-	-	
6.50											
depth(m)	0.0	2.3	3.4	4.1	5.7	6.3	3.5	2.5	2.1	1.2	

Elect. Conductivity	5.43 5.80 μS/cm
Water Temperature	27.3 ℃
DO	3.57 mg/ℓ
COD	
pH	4.32

Sebangau River

March 23, 1999



Discharge, Cross Section and Quality of Water

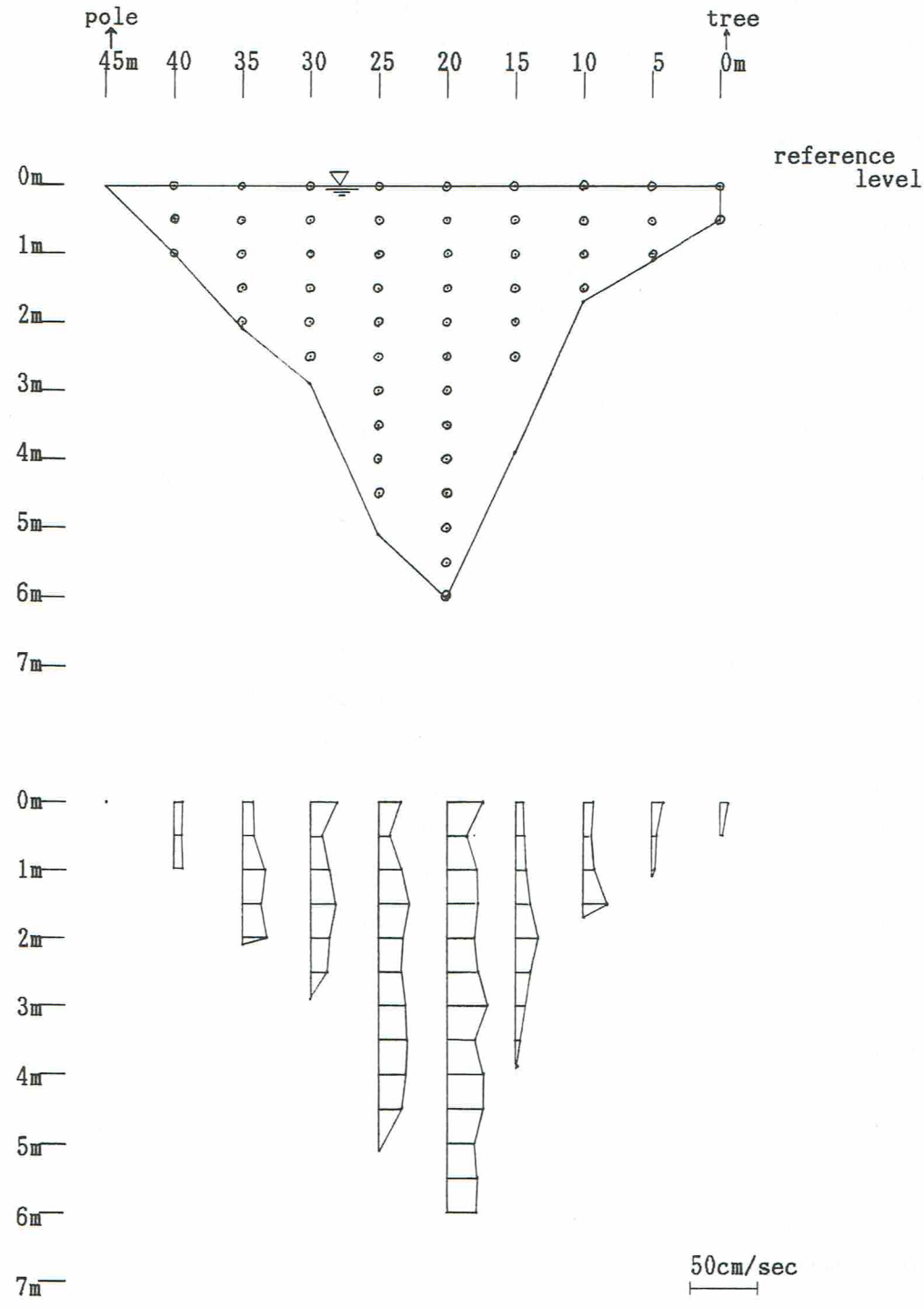
Name of River	Sebangau River
Station	Kya, upstream of Kerengbangkirai
Date and Time	May 31, 1999 10:00
Water stage	H=
Width of flow	B=45.00m
Cross sectional area	A=120.63m^2
Wetted perimeter	W=48.00m
Hydraulic radius	R=2.51m
Discharge	Q=17.77m^3/sec

below w. surf.(m)	distance from tree on right side bank (m)										
	45	40	35	30	25	20	15	10	5	tree	
0.00	-	0.056	0.069	0.195	0.167	0.227	0.062	0.068	0.079	0.068	
0.50	-	0.064	0.079	0.079	0.076	0.148	0.074	0.060	0.026	0.021	
1.00	-	0.067	0.163	0.136	0.175	0.216	0.083	0.077	0.021	-	
1.50	-	-	0.136	0.185	0.227	0.235	0.115	0.181	-	-	
2.00	-	-	0.182	0.138	0.179	0.205	0.165	-	-	-	
2.50	-	-	-	0.125	0.169	0.236	0.115	-	-	-	
3.00	-	-	-	-	0.189	0.294	-	-	-	-	
3.50	-	-	-	-	0.207	0.215	-	-	-	-	
4.00	-	-	-	-	0.205	0.257	-	-	-	-	
4.50	-	-	-	-	0.171	0.258	-	-	-	-	
5.00	-	-	-	-	-	0.205	-	-	-	-	
5.50	-	-	-	-	-	0.226	-	-	-	-	
6.00	-	-	-	-	-	0.218	-	-	-	-	
6.50											
depth(m)	0.0	1.0	2.1	2.9	5.1	6.0	3.9	1.7	1.1	0.5	

Elect. Conductivity	2.87-7.78 μS/cm
Water Temperature	27.0-29.4 ℃
DO	3.53-4.0 mg/ℓ
COD	
pH	3.95-3.97

Sebangau River

May 31, 1999



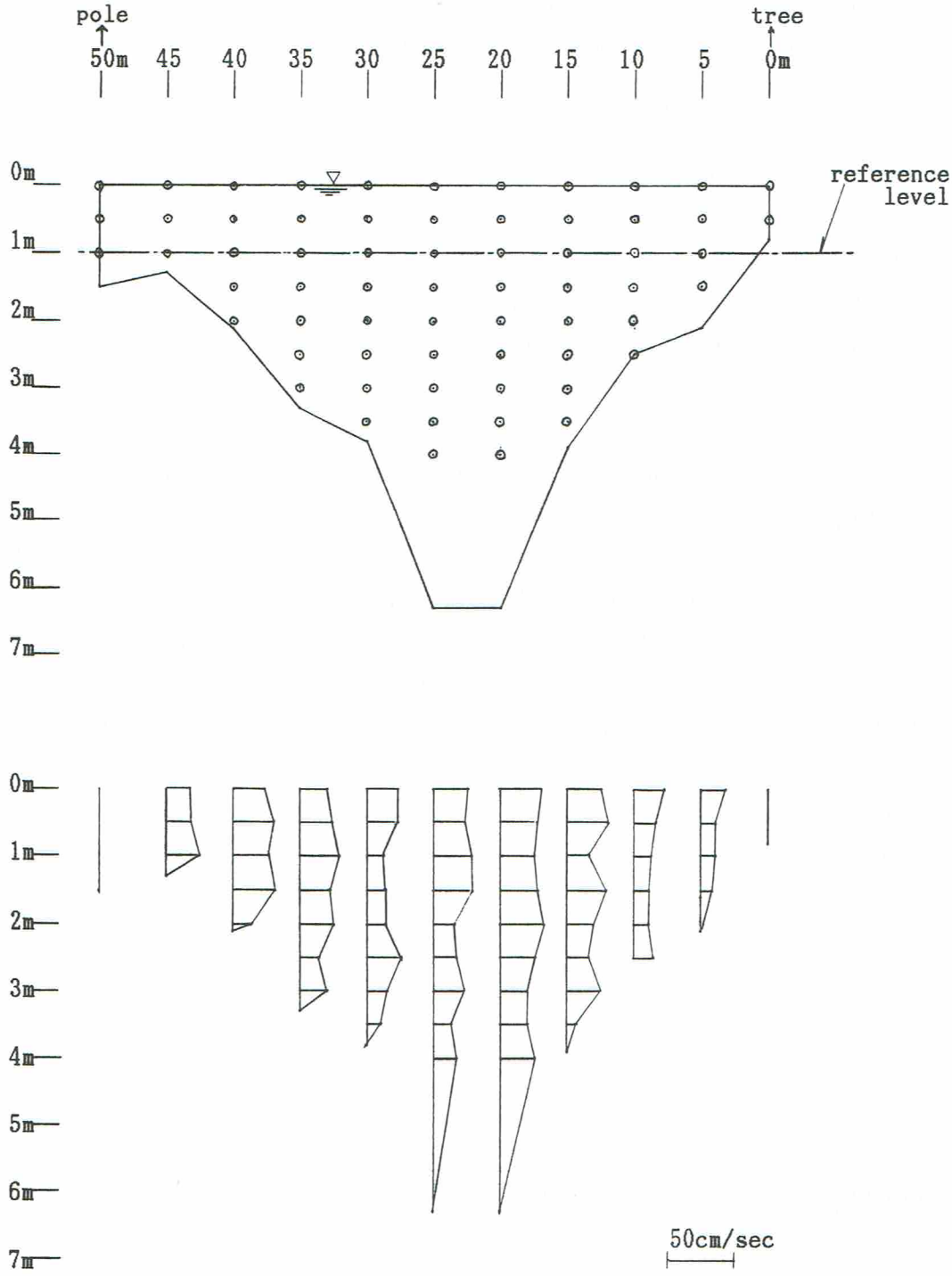
Discharge and Cross Section

Name of River	Sebangau River
Station	Kya, upstream of Kerengbangkirai
Date and Time	November 29, 1999 10:20
Water stage	H=0.98m
Width of flow	B=50.00m
Cross sectional area	A=157.31m^2
Wetted perimeter	W=54.03m
Hydraulic radius	R=2.91m
Discharge	Q=32.65m^3/sec
Water surface slope	I=1/39,000
Manning's n	n=0.050

below w.	distance from tree on right side bank (m)										
surf.(m)	50	45	40	35	30	25	20	15	10	5	tree
0.00	0.0	0.191	0.231	0.203	0.231	0.259	0.315	0.256	0.231	0.135	0.0
0.50	0.0	0.194	0.300	0.228	0.234	0.231	0.281	0.315	0.169	0.110	0.0
1.00	0.0	0.253	0.257	0.290	0.122	0.281	0.256	0.166	0.135	0.107	-
1.50	-	-	0.322	0.225	0.138	0.287	0.278	0.287	0.107	0.078	-
2.00	-	-	0.138	0.253	0.135	0.166	0.315	0.194	0.107	-	-
2.50	-	-	-	0.132	0.250	0.169	0.259	0.169	0.141	-	-
3.00	-	-	-	0.200	0.153	0.225	0.197	0.250	-	-	-
3.50	-	-	-	-	0.110	0.138	0.197	0.069	-	-	-
4.00	-	-	-	-	-	0.169	0.228	-	-	-	-
4.50	-	-	-	-	-	-	-	-	-	-	-
5.00	-	-	-	-	-	-	-	-	-	-	-
5.50	-	-	-	-	-	-	-	-	-	-	-
6.00	-	-	-	-	-	-	-	-	-	-	-
depth(m)	1.5	1.3	2.1	3.3	3.8	6.3	6.3	3.9	2.5	2.1	0.8

Sebangau River

November 29, 1999



Discharge, Cross Section and Quality of Water

Name of River	Sebangau River
Station	Kya, upstream of Kerengbangkirai
Date and Time	December 29, 1999 09:30
Water stage	H＝0.54m
Width of flow	B＝50.00m
Cross sectional area	(A＝129.06m²)
Wetted perimeter	(W＝50.33m)
Hydraulic radius	(R＝2.56m)
Discharge	(Q＝19.38m³/sec)

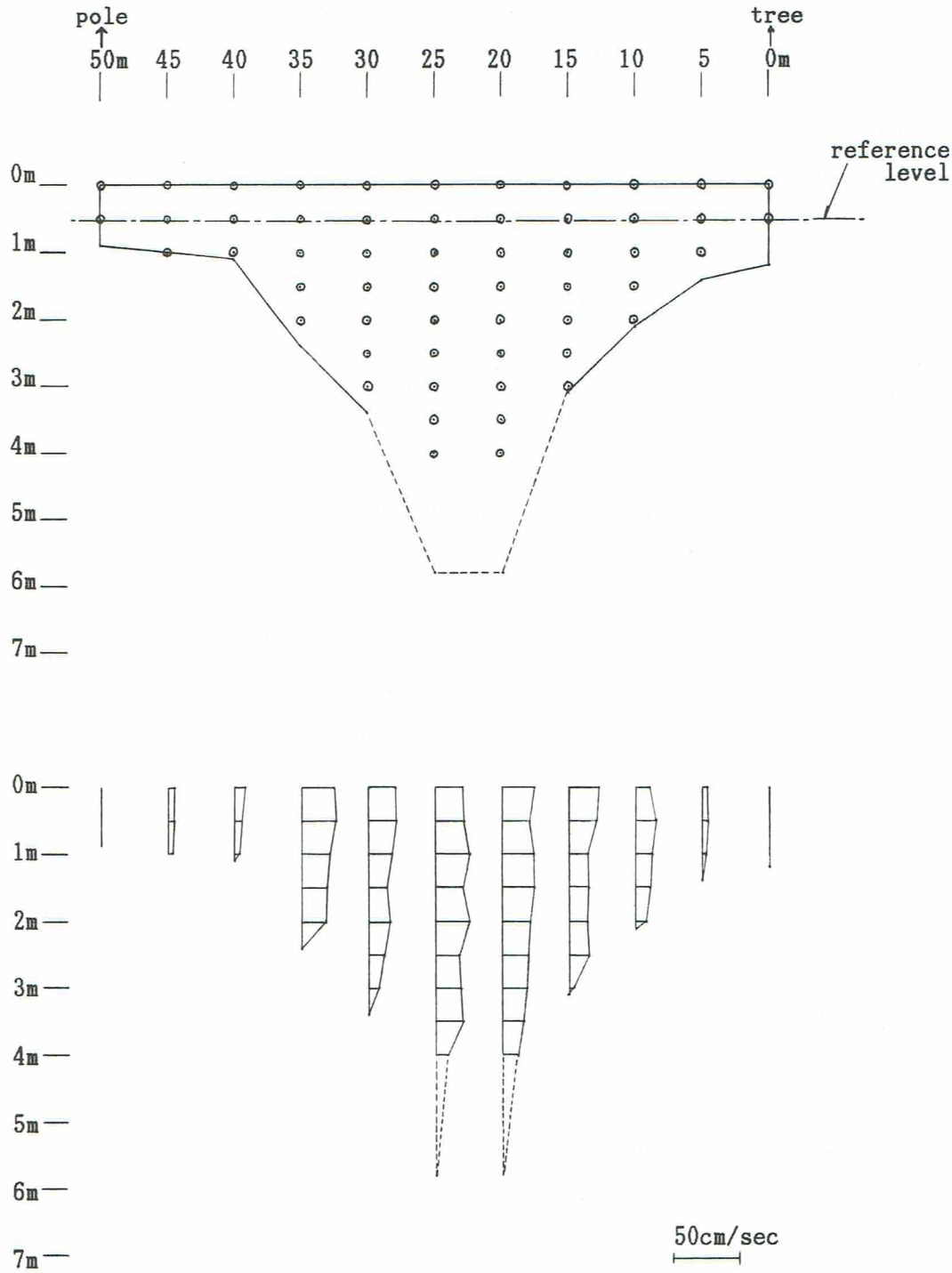
below w.	distance from tree on right side bank (m)										
surf.(m)	50	45	40	35	30	25	20	15	10	5	tree
0.00	0.0	0.038	0.072	0.244	0.200	0.209	0.244	0.231	0.107	0.029	0.0
0.50	0.0	0.044	0.047	0.247	0.209	0.216	0.209	0.209	0.147	0.038	0.0
1.00	-	0.026	0.029	0.209	0.169	0.250	0.234	0.141	0.122	0.022	-
1.50	-	-	-	0.181	0.141	0.147	0.238	0.153	0.107	-	-
2.00	-	-	-	0.184	0.156	0.175	0.206	0.141	0.075	-	-
2.50	-	-	-	-	0.122	0.119	0.191	0.150	-	-	-
3.00	-	-	-	-	0.075	0.138	0.181	0.041	-	-	-
3.50	-	-	-	-	-	0.147	0.160	-	-	-	-
4.00	-	-	-	-	-	0.078	0.107	-	-	-	-
4.50	-	-	-	-	-	-	-	-	-	-	-
5.00	-	-	-	-	-	-	-	-	-	-	-
depth(m)	0.9	1.0	1.1	2.4	3.4	(5.8)	(5.8)	3.1	2.1	1.4	1.2

＊Water depths at distances 20m and 25m are unknown.

Elect. Conductivity	54.0-59.0 μS/cm
Water Temperature	27.5-28.3 ℃
Air Temperature	31.3-33.3 ℃
DO	2.55-5.20 mg/ℓ
pH	3.80-3.85

Sebangau River

December 29, 1999



2) Water Stage, Discharge and Precipitation

Water stage H(cm), Discharge Q(m^3/sec)	Kya, Sebangau River
Precipitation R(mm/day)	University of Palangka Raya

August, 1998				September, 1998				October, 1998			
day	H	Q	R	day	H	Q	R	day	H	Q	R
0801				0901	91.4	29.7	0	1001	8.4	16.3	2.5
02				02	86.6	28.9	0	02	11.2	16.7	5.0
03				03	81.8	28.0	0	03	26.1	18.9	10.0
04				04	78.5	27.4	3.5	04	47.3	22.1	28.5
05				05	73.2	26.5	0	05	56.4	23.6	9.0
06				06	63.6	24.8	0	06	77.0	27.1	3.0
07				07	64.5	25.0	3.0	07	73.2	26.5	0
08				08	59.7	24.2	9.0	08	87.6	29.0	15.5
09				09	52.5	23.0	4.0	09	110.6	33.4	45.0
10				10	51.1	22.7	9.0	10	110.6	33.4	0
11				11	44.9	21.7	5.0	11	114.5	34.2	8.0
12	20.0	18.0		12	44.4	21.7	0	12	115.5	34.4	0
13				13	40.5	21.0	0	13	110.6	33.4	4.0
14				14	31.4	19.6	0	14	108.2	32.9	0
15				15	24.7	18.7	0	15	115.9	34.5	1.5
16	10.0	16.6		16	20.4	18.0	0.5	16	130.3	37.4	96.5
17				17	8.8	16.4	2.5	17	134.2	38.2	0
18				18	4.5	15.8	-	18	134.7	38.3	1.0
19				19	-0.3	15.2	-	19	139.0	39.2	7.0
20				20	-4.6	14.6	-	20	129.4	37.2	0.5
21				21	-14.2	13.4	-	21	127.5	36.8	0
22				22	-13.7	13.4	1.5	22	125.5	36.4	0
23				23	-27.2	11.8	6.5	23	119.3	35.1	0
24				24	-19.0	12.8	19.5	24	119.8	35.2	1.5
25	65.5	25.1	1.5	25	-21.9	12.4	0.5	25	118.8	35.0	0.5
26	63.6	24.8	1.0	26	-14.7	13.3	9.5	26	121.7	35.6	14.5
27	99.1	31.2	86.0	27	9.3	15.3	35.5	27			
28	112.6	33.8	1.5	28	-0.8	15.1	6.0	28			
29	110.2	33.3	0	29	-3.2	14.8	0	29			
30	105.4	32.4	0	30	1.2	15.4	1.5	30			
31	99.1	31.2	0					31			
total		211.8	90.0	total		580.6	117.0	total		820.8	253.5

3) Cross Sectional Distribution of DO at Kya

Name of River	Sebangau River
Station	Kya, upstream of Kerengbangkirai
Date and Time	December 29, 1999 09:30
Water stage	H=0.54m
Width of flow	B=50.00m
Cross sectional area	(A=129.06m²)
Wetted perimeter	(W=50.33m)
Hydraulic radius	(R=2.56m)
Discharge	(Q=19.38m³/sec)

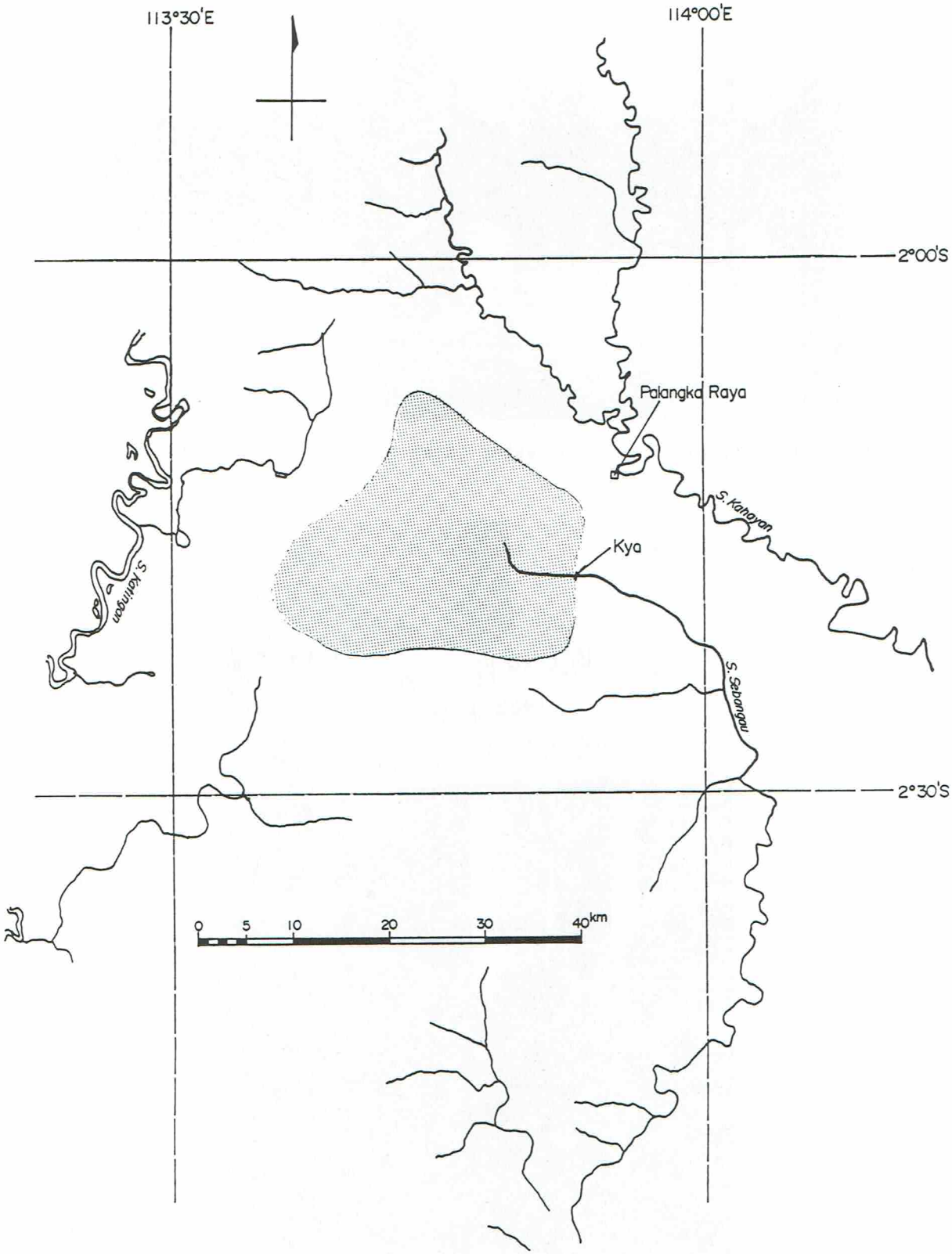
below w.	distance from tree on right side bank (m)										
surf.(m)	50	45	40	35	30	25	20	15	10	5	tree
0.00	5.20	4.62	4.23	4.61	4.75	4.73	4.95	4.91	4.76	4.31	5.15
0.50	4.40	3.69	4.18	4.47	4.58	4.62	4.68	4.82	4.56	4.35	4.47
1.00	-	2.55	4.30	4.43	4.48	4.50	4.62	4.47	4.40	3.83	-
1.50	-	-	-	4.32	4.43	4.51	4.60	4.61	4.51	-	-
2.00	-	-	-	3.45	4.33	4.52	4.53	4.61	4.07	-	-
2.50	-	-	-	-	4.22	4.42	4.51	4.52	-	-	-
3.00	-	-	-	-	4.23	4.44	4.44	4.42	-	-	-
3.50	-	-	-	-	-	4.35	4.46	-	-	-	-
4.00	-	-	-	-	-	4.42	4.45	-	-	-	-
4.50	-	-	-	-	-	-	-	-	-	-	-
water(℃)	27.5	27.5	27.5	27.5	27.7	27.7	27.8	28.1	28.3	28.3	28.3
air(℃)	31.3	31.3	31.3	31.6	31.6	32.3	32.6	32.8	32.8	32.8	33.3
depth(m)	0.9	1.0	1.1	2.4	3.4	(5.8)	(5.8)	3.1	2.1	1.4	1.2

*Water depths at distances 20m and 25m are unknown.

Elect. Conductivity	54.0-59.0 μS/cm
Water Temperature	27.5-28.3 ℃
Air Temperature	31.3-33.3 ℃
DO	2.55-5.20 mg/ℓ
pH	3.80-3.85

4) Drainage Basin of the Sebangau River at Kya

Drainage Area = 600 ㎢



Observation station of water stage and discharge at Kya

Water stage recorder and tree at the right side bank

Appendix 3-1

Meteorological Data at the weather station in University of Palangka Raya

Location

S 02° 12' 55.3"
E 113° 54' 00.0"

Climatic elements and dimension

Air temperature (°C): Daily mean, max.and min.
Air relative humidity (%): Daily min.
Precipitation (mm day^{-1}): Daily total
Solar radiation (MJ m^{-2} day^{-1}): Daily total

Remarks

Following data are supplied from other stations.
Solar radiation, 16 Dec. '98 - 2 Feb. '99 : Open site in a forest
Precipitation, 12 Dec.,'98 – 30 June,'99: Open site in a forest
Precipitation, 1 Sept.,'99 – 31 Oct.,'99: Air port of Palangka Raya

Climatic Table Draied Area (UNPAR) Nov. 1998

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
981101	27.7	33.2	23.6	54.1	0.0	-
981102	27.1	32.1	24.4	65.3	0.0	-
981103	26.4	32.8	24.0	59.7	8.0	-
981104	27.0	34.3	24.1	52.0	7.5	-
981105	27.6	32.6	24.3	59.3	0.0	-
981106	25.9	33.2	23.6	59.6	20.5	-
981107	26.0	33.0	23.4	59.5	37.0	-
981108	25.8	32.5	23.7	60.1	5.5	-
981109	26.4	32.5	23.5	60.7	2.5	-
981110	26.3	32.3	23.8	60.1	3.0	-
981111	27.0	33.0	23.0	59.4	17.0	-
981112	25.2	29.9	23.0	72.4	55.0	-
981113	26.5	31.0	23.1	66.2	0.0	-
981114	28.0	34.4	23.8	51.0	23.0	-
981115	27.9	33.7	23.1	55.9	0.5	-
981116	27.0	34.1	22.9	52.7	24.5	-
981117	26.2	32.1	23.6	63.3	3.5	-
981118	27.2	34.8	22.7	49.1	13.5	-
981119	26.9	34.0	22.7	50.0	9.5	-
981120	26.7	34.3	22.7	52.4	15.0	-
981121	27.3	35.0	23.1	47.9	13.5	-
981122	26.9	34.0	23.3	55.1	0.0	-
981123	27.8	34.2	23.3	50.3	28.0	-
981124	27.5	35.0	23.7	50.0	1.5	-
981125	26.9	34.2	23.9	54.4	2.0	-
981126	27.5	34.0	24.0	50.3	2.0	-
981127	28.3	34.1	23.8	53.3	0.0	-
981128	27.8	35.1	22.5	48.1	7.0	-
981129	26.8	31.9	22.8	58.1	0.0	-
981130	28.6	35.3	24.0	46.0	0.0	-
1st decade	26.6	32.9	23.8	59.0	84.0	
2st decade	26.9	33.1	23.1	57.2	161.5	
3st decade	27.5	34.3	23.4	51.4	54.0	
mean/total	27.0	33.4	23.4	55.9	299.5	
max	28.6	35.3	24.4	72.4	55.0	
min	25.2	29.9	22.5	46.0	0.0	

Climatic Table Draied Area (UNPAR) Dec. 1998

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
981201	25.4	31.4	22.1	61.4	56.0	-
981202	26.4	32.0	22.6	60.0	5.5	-
981203	27.0	34.0	22.6	51.2	6.5	-
981204	27.6	35.1	22.9	48.4	19.0	-
981205	26.6	32.7	23.6	62.1	25.0	-
981206	26.8	34.5	23.2	52.6	10.0	-
981207	26.6	32.2	23.0	61.6	6.0	-
981208	25.8	32.8	23.6	59.8	22.5	-
981209	25.9	30.9	23.2	70.2	0.0	-
981210	26.4	32.6	22.9	57.1	6.0	-
981211	27.4	33.6	22.4	52.6	0.0	-
981212	28.5	33.9	23.5	49.8	0.5	-
981213	28.9	35.1	23.7	48.1	7.0	-
981214	26.5	30.2	24.5	71.5	10.0	-
981215	27.4	33.4	24.0	57.7	9.0	-
981216	27.3	32.3	24.1	57.4	3.5	13.60
981217	27.2	33.3	22.5	56.4	7.0	15.71
981218	27.9	33.4	23.9	50.9	0.0	15.92
981219	26.5	33.2	23.7	57.5	29.0	12.50
981220	26.6	32.6	23.9	61.1	3.0	11.30
981221	26.7	32.9	22.7	58.1	0.0	14.74
981222	27.6	32.8	23.9	59.1	0.0	13.51
981223	27.2	32.8	22.1	58.7	40.0	15.59
981224	26.6	32.8	23.9	62.3	6.0	8.72
981225	27.1	32.5	23.3	60.6	2.0	14.62
981226	26.9	32.7	22.7	58.0	32.5	13.02
981227	25.8	30.5	22.9	66.6	5.0	12.18
981228	27.2	33.1	23.2	54.8	38.5	16.64
981229	26.5	33.5	22.9	58.7	24.0	14.50
981230	25.4	31.5	22.9	60.5	16.0	11.65
981231	25.9	33.2	23.3	56.2	7.0	13.81
1st decade	26.5	32.8	23.0	58.4	156.50	-
2st decade	27.4	33.1	23.6	56.3	69.00	-
3st decade	26.6	32.6	23.1	59.4	171.00	148.98
mean/total	26.8	32.8	23.2	58.1	396.50	-
max	28.9	35.1	24.5	71.5	56.00	-
min	25.4	30.2	22.1	48.1	0.00	-

Climatic Table Draied Area (UNPAR) Jan. 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
990101	24.8	29.7	23.0	72.8	10.0	7.31
990102	24.9	29.7	23.0	67.9	4.0	8.50
990103	25.6	30.6	23.0	68.9	3.5	10.12
990104	26.0	30.2	23.4	61.0	0.0	12.66
990105	27.6	33.2	22.7	53.3	0.0	19.36
990106	27.1	33.2	22.7	54.0	3.5	17.25
990107	26.5	34.2	22.6	56.8	21.0	14.03
990108	25.2	32.2	21.8	67.7	59.0	9.20
990109	26.0	32.3	21.9	64.6	22.0	13.16
990110	25.8	31.8	22.7	64.0	5.0	14.53
990111	26.5	31.0	22.8	63.9	0.0	11.16
990112	27.9	33.8	24.1	53.0	11.0	19.28
990113	26.2	30.2	24.6	65.7	6.0	12.04
990114	29.0	35.8	23.7	47.7	0.0	21.67
990115	25.9	28.3	23.5	78.9	0.0	9.28
990116	26.1	31.3	22.3	57.4	0.0	16.18
990117	27.5	33.8	22.8	54.7	0.0	15.13
990118	26.9	31.8	23.6	60.5	-	14.11
990119	27.1	33.1	22.4	57.5	-	16.27
990120	27.5	32.6	23.7	58.4	-	16.65
990121	28.5	34.8	24.1	51.0	-	18.07
990122	27.0	33.3	23.8	56.7	-	13.34
990123	27.7	34.8	23.8	52.4	0.0	15.48
990124	26.3	31.3	23.6	67.7	21.5	13.31
990125	27.0	33.6	23.6	56.5	8.0	14.80
990126	26.3	32.8	23.1	55.4	7.5	14.68
990127	24.7	28.0	22.8	82.4	7.5	6.15
990128	26.6	33.1	22.6	56.2	3.0	13.86
990129	26.7	32.1	24.1	65.7	16.5	12.01
990130	26.4	33.4	22.9	55.4	5.5	15.29
990131	27.1	33.0	23.5	55.6	1.5	17.49
1st decade	26.0	31.7	22.7	63.1	128.0	126.12
2st decade	27.1	32.2	23.4	59.8	17.0	151.77
3st decade	26.8	32.7	23.4	59.5	71.0	154.48
mean/total	26.6	32.2	23.2	60.8	216.0	432.37
max	29.0	35.8	24.6	82.4	59.0	21.67
min	24.7	28.0	21.8	47.7	0.0	6.15

Climatic Table Draied Area (UNPAR) Feb. 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
990201	28.5	34.1	23.1	47.6	0.0	20.57
990202	28.5	33.8	23.2	48.7	0.0	18.13
990203	27.8	32.5	24.3	59.1	0.0	12.53
990204	27.8	33.8	22.9	49.7	0.0	18.27
990205	26.6	34.2	23.8	54.0	11.5	15.97
990206	27.1	33.9	21.8	51.7	37.5	19.07
990207	27.6	34.6	22.4	51.8	0.0	16.40
990208	28.8	34.8	23.9	47.1		18.06
990209	27.6	32.9	23.8	55.4	13.0	15.11
990210	26.8	31.1	23.1	67.6	4.5	9.93
990211	25.7	32.9	22.7	58.7	6.0	17.08
990212	27.8	34.9	22.1	51.7	71.0	19.96
990213	26.1	33.2	21.8	56.6	39.0	14.58
990214	25.7	33.3	21.6	53.5	1.0	17.42
990215	26.8	33.1	22.6	57.6	0.0	14.34
990216	26.6	31.4	22.1	69.3	8.0	11.92
990217	25.5	32.4	22.2	65.5	2.5	12.93
990218	26.5	31.1	23.7	66.7	6.0	9.38
990219	26.8	32.0	23.9	62.5	12.0	13.07
990220	27.3	33.3	23.4	60.6	0.0	14.41
990221	26.0	32.5	23.7	59.0	42.5	8.53
990222	25.7	32.3	23.3	60.5	7.5	12.16
990223	26.8	32.0	23.1	60.9	55.5	16.82
990224	26.5	34.3	22.0	54.9	22.5	18.12
990225	27.2	32.2	22.8	59.0	0.0	16.69
990226	28.9	35.5	23.8	47.1	0.0	20.35
990227	25.1	27.6	23.0	78.3	117.5	7.62
990228	26.3	33.2	23.4	53.8	4.5	13.64
1st decade	27.7	33.6	23.2	53.3	66.5	164.0
2st decade	26.5	32.8	22.6	60.3	145.5	145.1
3st decade	26.6	32.5	23.1	59.2	250.0	113.9
mean/total	26.9	33.0	23.0	57.5	462.0	423.1
max	28.9	35.5	24.3	78.3	117.5	20.6
min	25.1	27.6	21.6	47.1	0.0	7.6

Climatic Table Draied Area (UNPAR) Mar. 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
990301	26.6	31.6	22.5	62.3	1.0	17.14
990302	26.5	33.2	23.8	54.1	1.0	17.47
990303	25.7	31.0	23.3	65.6	0.5	12.73
990304	26.0	32.3	22.9	61.6	2.5	13.66
990305	26.1	30.5	23.7	70.0	14.0	13.73
990306	27.3	35.8	23.0	45.9	8.0	21.54
990307	25.2	28.9	23.0	75.5	20.5	8.17
990308	27.6	34.1	24.2	57.2	0.0	14.08
990309	28.4	33.4	23.9	58.2	0.0	19.83
990310	27.4	32.5	24.4	65.5	3.0	12.09
990311	28.7	35.2	23.7	48.8	0.0	19.31
990312	28.3	34.7	24.8	51.6	2.5	21.34
990313	27.2	33.7	23.1	55.4	7.5	17.82
990314	26.1	33.0	23.5	58.4	6.0	14.64
990315	28.0	34.9	23.4	51.9	55.0	20.72
990316	26.6	30.5	23.9	69.6	5.0	9.82
990317	29.3	35.7	23.1	48.4	0.0	20.76
990318	26.3	32.5	22.8	60.8	25.0	11.71
990319	28.0	35.0	23.7	51.3	0.0	19.70
990320	25.0	30.4	23.3	70.7	24.0	6.56
990321	25.8	29.5	23.2	69.9	0.0	12.16
990322	28.2	33.6	24.0	59.9	5.0	18.09
990323	25.7	30.7	22.3	66.6	0.5	8.99
990324	28.1	34.8	22.9	46.1	0.0	18.84
990325	27.7	33.1	23.7	52.7	0.0	18.00
990326	26.8	33.6	23.0	56.6	3.5	17.83
990327	27.5	34.5	22.8	52.5	14.5	17.88
990328	27.2	32.3	23.0	62.0	15.5	14.82
990329	28.5	35.0	23.1	51.0	1.5	19.29
990330	26.9	31.4	24.6	72.0	0.0	9.36
990331	25.1	31.0	23.2	70.9	2.0	10.17
1st decade	26.7	32.3	23.5	61.6	50.5	150.44
2st decade	27.4	33.6	23.5	56.7	125.0	162.38
3st decade	27.0	32.7	23.3	60.0	42.5	165.43
mean/total	27.0	32.9	23.4	59.5	218.00	478.25
max	29.3	35.8	24.8	75.5	55.00	21.54
min	25.0	28.9	22.3	45.9	0.00	6.56

Climatic Table Draied Area (UNPAR) Apr. 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
990401	26.8	33.9	22.5	57.8	1.5	18.12
990402	28.5	34.4	23.2	50.7	0.0	19.14
990403	27.2	30.5	24.6	73.8	24.0	8.50
990404	27.9	32.7	23.6	62.1	0.0	14.05
990405	27.9	34.4	23.6	50.1	0.0	15.84
990406	28.6	34.3	24.4	50.7	0.0	16.98
990407	28.9	35.5	23.4	53.6	0.0	20.80
990408	27.7	34.6	25.1	54.0	0.0	15.75
990409	28.1	33.8	24.9	63.0	0.0	15.71
990410	26.2	30.5	24.1	65.5	0.0	11.27
990411	28.5	34.4	24.3	53.3	0.0	17.92
990412	27.9	34.3	23.3	51.6	36.5	16.10
990413	28.1	34.7	23.6	53.4	30.0	19.64
990414	25.6	29.1	23.4	75.3	19.0	7.49
990415	26.9	32.7	23.1	59.2	1.0	15.48
990416	27.5	34.1	23.0	48.2	1.0	19.42
990417	25.5	32.2	22.9	64.3	13.0	6.61
990418	26.5	31.9	22.2	61.4	2.0	12.67
990419	26.6	33.9	23.1	56.2	25.5	15.84
990420	27.4	32.4	23.1	58.9	0.0	13.23
990421	28.3	34.3	23.9	51.5	0.0	17.31
990422	28.2	34.5	23.2	48.6	0.0	17.35
990423	27.2	34.4	23.4	50.5	3.0	14.74
990424	28.0	34.0	23.3	47.8	0.0	18.40
990425	27.9	35.1	22.6	54.0	0.0	18.28
990426	26.9	33.2	22.6	58.9	19.5	14.60
990427	29.3	35.7	24.0	50.7	0.0	21.35
990428	28.2	35.4	24.5	54.9	1.0	8.42
990429	28.2	35.9	23.8	52.2	4.5	15.59
990430	28.6	35.2	23.9	49.2	44.5	17.56
1st decade	27.8	33.5	23.9	58.1	25.50	156.16
2st decade	27.1	33.0	23.2	58.2	128.00	144.40
3st decade	28.1	34.8	23.5	51.8	72.50	163.60
mean/total	27.6	33.7	23.6	56.0	226.00	464.16
max	29.3	35.9	25.1	75.3	44.50	21.35
min	25.5	29.1	22.2	47.8	0.00	6.61

Climatic Table Draied Area (UNPAR) May 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ m^{-2})
990501	26.7	31.8	22.6	61.2	45.5	11.88
990502	28.0	35.1	23.3	50.3	0.0	17.44
990503	27.2	33.8	24.0	55.7	0.0	13.11
990504	27.9	34.9	23.1	56.0	0.0	19.75
990505	26.1	31.0	23.7	71.6	2.5	9.83
990506	27.4	32.9	22.8	55.0	0.0	16.65
990507	25.4	29.5	23.2	70.4	34.0	8.44
990508	27.0	33.5	22.4	55.0	0.0	17.43
990509	26.9	32.2	24.0	62.1	2.0	11.47
990510	27.7	34.8	23.5	52.4	0.0	19.55
990511	27.6	33.6	22.2	54.8	29.5	16.28
990512	26.6	30.7	24.5	70.0	1.0	8.77
990513	27.4	32.9	23.2	57.0	22.0	15.96
990514	27.7	34.4	23.3	53.7	1.0	17.74
990515	25.8	31.5	24.1	73.9	9.0	4.31
990516	26.9	31.7	23.2	68.0	0.5	14.75
990517	27.6	32.8	23.6	56.3	0.5	18.06
990518	26.0	32.7	23.4	62.6	2.0	11.72
990519	27.0	33.9	23.6	56.0	2.0	17.02
990520	26.4	30.6	24.1	69.8	3.0	10.54
990521	26.9	33.8	23.9	54.1	0.0	13.41
990522	27.3	34.0	24.3	56.2	0.0	16.11
990523	27.1	32.8	23.7	61.9	0.0	13.00
990524	27.1	32.8	23.0	57.7	0.0	14.42
990525	27.5	33.3	23.8	57.2	39.0	18.37
990526	26.3	30.4	23.8	74.4	13.0	10.64
990527	25.4	28.1	23.4	78.8	0.5	5.53
990528	25.9	31.1	23.5	65.1	1.5	11.31
990529	27.7	34.1	23.3	51.4	0.0	18.08
990530	28.2	34.4	23.5	50.4	0.0	16.22
990531	27.3	34.4	22.7	49.5	0.0	17.65
1st decade	27.0	33.0	23.3	59.0	84.0	145.55
2st decade	26.9	32.5	23.5	62.2	70.5	135.15
3st decade	27.0	32.7	23.5	59.7	54.0	154.74
mean/total	27.0	32.7	23.4	60.3	208.5	435.44
max	28.2	35.1	24.5	78.8	45.5	19.75
min	25.4	28.1	22.2	49.5	0.0	4.31

Climatic Table Draied Area (UNPAR) June 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
990601	26.6	33.6	20.7	47.4	0.0	18.49
990602	27.8	34.6	22.1	46.2	0.0	17.33
990603	27.8	34.0	23.0	50.8	0.0	16.92
990604	26.1	34.0	22.5	57.6	2.0	14.28
990605	26.9	34.7	22.2	50.7	0.0	15.88
990606	26.5	33.0	23.8	64.3	0.0	10.48
990607	26.9	33.8	22.6	54.5	1.0	14.59
990608	28.2	34.7	23.3	51.8	0.0	16.88
990609	27.4	33.5	23.7	57.2	0.0	14.55
990610	26.4	32.8	23.5	58.3	13.0	12.66
990611	26.7	32.8	23.4	58.7	0.0	13.67
990612	27.7	33.5	22.3	47.8	0.0	17.32
990613	27.9	34.5	22.3	43.2	0.0	16.39
990614	28.0	34.8	22.4	44.2	0.0	17.03
990615	28.5	35.0	23.4	46.7	0.0	17.03
990616	27.6	32.9	23.4	58.1	1.0	14.15
990617	27.3	33.2	23.8	57.3	0.0	15.70
990618	27.7	32.9	23.5	55.2	0.0	14.85
990619	28.3	34.6	22.6	49.4	0.0	16.44
990620	26.7	33.5	21.5	57.8	114.5	13.83
990621	26.9	32.9	22.1	53.8	0.0	15.80
990622	27.6	34.0	23.8	51.5	8.5	14.64
990623	26.3	31.8	23.8	58.4	0.0	9.68
990624	26.5	32.8	23.1	56.8	1.0	14.64
990625	27.2	33.6	22.1	52.2	0.0	16.91
990626	24.4	28.5	22.9	77.1	6.5	8.26
990627	27.0	33.4	21.2	50.9	0.0	15.48
990628	27.3	33.0	22.3	52.3	0.0	15.81
990629	26.8	33.7	23.2	50.0	0.0	16.25
990630	27.1	33.4	23.0	49.7	0.0	14.93
1st decade	27.1	33.9	22.7	53.9	16.0	152.06
2st decade	27.6	33.8	22.9	51.8	115.5	156.41
3st decade	26.7	32.7	22.8	55.3	16.0	142.40
mean/total	27.1	33.5	22.8	53.7	147.5	450.87
max	28.5	35.0	23.8	77.1	114.5	18.49
min	24.4	28.5	20.7	43.2	0.0	8.26

Climatic Table Draied Area (UNPAR) July 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
990701	26.4	32.8	22.6	57.1	-	14.39
990702	27.8	34.0	22.8	51.5	-	14.25
990703	27.8	34.2	23.7	49.9	-	18.06
990704	27.8	34.8	22.8	49.8	-	15.95
990705	25.4	31.6	23.0	67.1	-	8.68
990706	26.7	32.8	22.6	56.1	-	12.88
990707	25.2	31.5	22.5	59.9	-	13.11
990708	26.2	31.7	22.3	64.0	-	13.41
990709	27.0	33.4	22.2	49.5	-	16.61
990710	26.5	32.8	22.8	57.5	-	12.49
990711	27.0	33.2	23.2	54.5	-	13.92
990712	25.3	32.2	21.6	57.6	-	14.00
990713	26.6	33.4	21.1	52.1	-	15.84
990714	27.3	33.1	22.4	50.9	-	17.52
990715	28.0	34.5	23.0	51.1	-	16.69
990716	25.9	31.2	22.4	63.5	-	13.18
990717	24.0	26.4	21.8	76.7	-	6.78
990718	25.9	31.6	22.2	56.6	-	13.06
990719	27.0	32.7	22.3	53.3	-	13.91
990720	26.7	32.7	22.4	47.1	-	17.32
990721	26.9	33.5	21.0	44.6	-	17.80
990722	27.1	34.6	21.8	41.4	-	17.17
990723	27.4	34.1	22.9	49.3	-	17.35
990724	27.1	33.8	21.4	46.8	-	18.08
990725	27.5	33.9	21.7	47.7	-	18.05
990726	27.6	33.5	22.3	52.2	-	17.45
990727	27.9	33.5	22.7	54.4	-	16.79
990728	27.7	34.1	23.4	50.2	-	16.87
990729	27.7	34.6	23.0	47.5	-	16.51
990730	27.2	33.5	22.3	48.6	-	17.25
990731	27.4	34.3	22.1	46.4	-	17.54
1st decade	26.7	33.0	22.7	56.2	-	139.83
2st decade	26.4	32.1	22.2	56.3	-	142.22
3st decade	27.4	33.9	22.2	48.1	-	190.86
mean/total	26.8	33.0	22.4	53.4	-	472.91
max	28.0	34.8	23.7	76.7	-	18.08
min	24.0	26.4	21.0	41.4	-	6.78

Climatic Table Draied Area (UNPAR) Aug. 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
990801	27.8	35.7	22.0	41.9	-	17.34
990802	27.9	34.8	24.4	48.6	-	17.12
990803	28.1	34.8	23.1	46.3	-	17.27
990804	28.0	34.4	22.5	44.7	-	18.66
990805	27.6	32.1	22.7	57.9	-	15.69
990806	27.3	32.4	23.7	60.2	-	11.63
990807	27.8	34.0	22.9	54.0	-	16.63
990808	26.0	32.6	22.4	55.9	-	12.83
990809	26.0	32.6	22.0	55.8	-	14.67
990810	28.0	34.8	22.6	49.6	-	17.86
990811	25.7	32.2	21.8	57.3	-	13.85
990812	25.8	31.9	21.7	52.6	-	17.95
990813	27.2	34.8	21.6	40.1	-	18.45
990814	27.4	34.7	21.8	45.5	-	17.84
990815	27.4	34.3	22.1	45.8	-	19.05
990816	25.4	31.4	21.8	60.0	-	13.42
990817	27.1	32.9	22.2	48.7	-	17.81
990818	26.6	32.3	22.9	52.8	-	13.59
990819	26.2	31.6	22.2	56.5	-	12.28
990820	27.1	34.6	21.1	42.4	-	20.00
990821	27.3	33.4	22.8	54.4	-	14.52
990822	26.7	33.5	22.9	55.0	-	13.12
990823	27.4	34.5	23.1	52.7	-	16.66
990824	26.8	34.3	23.2	50.8	-	13.33
990825	27.7	34.3	22.9	46.4	-	18.87
990826	27.1	33.1	21.2	47.4	-	17.48
990827	27.3	32.0	23.5	52.6	-	12.70
990828	25.5	30.9	22.9	64.4	-	9.55
990829	26.1	31.3	22.7	60.7	-	17.94
990830	26.8	33.2	21.3	49.1	-	16.83
990831	26.9	34.1	19.7	34.2	-	-
1st decade	27.5	33.8	22.8	51.5	-	159.70
2st decade	26.6	33.1	21.9	50.2	-	164.24
3st decade	26.9	33.1	22.4	51.6	-	-
mean/total	27.0	33.3	22.4	51.1	-	-
max	28.1	35.7	24.4	64.4	-	-
min	25.4	30.9	19.7	34.2	-	-

Climatic Table Draied Area (UNPAR) Sept. 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
990901	26.7	34.0	20.6	38.6	0.0	21.26
990902	26.7	33.5	20.2	38.5	0.0	20.52
990903	26.8	34.4	20.6	33.5	0.0	21.40
990904	26.8	34.3	19.2	40.8	0.0	19.85
990905	27.3	34.4	21.0	43.8	0.0	19.32
990906	28.3	34.8	23.1	44.1	0.0	19.31
990907	28.3	35.3	22.1	46.8	40.5	17.52
990908	26.5	32.1	22.0	62.4	0.0	15.75
990909	28.5	34.7	23.6	46.0	0.0	18.82
990910	27.7	34.4	22.5	33.0	0.0	20.01
990911	27.4	34.6	21.3	40.3	0.0	19.80
990912	27.3	34.9	21.7	45.2	0.0	15.56
990913	27.6	35.3	22.7	48.0	0.0	16.44
990914	26.9	34.0	23.1	51.6	0.0	13.61
990915	28.0	34.2	22.4	51.9	0.0	16.43
990916	25.9	32.5	22.7	61.8	12.5	10.36
990917	26.5	31.9	21.7	60.7	0.0	13.69
990918	27.8	34.5	21.8	45.0	0.0	18.29
990919	27.2	34.2	22.6	51.5	37.2	11.69
990920	25.9	31.7	22.3	63.6	0.0	12.79
990921	27.6	34.7	21.8	48.8	0.5	18.35
990922	28.6	34.7	23.3	53.8	3.7	18.13
990923	27.6	34.6	23.4	52.1	13.0	15.73
990924	27.7	34.3	22.8	54.8	0.0	18.17
990925	27.1	34.0	22.2	55.7	15.5	12.64
990926	27.7	35.3	22.5	48.3	3.6	18.70
990927	26.3	33.2	23.1	61.9	84.6	12.21
990928	26.4	31.8	23.6	64.2	1.2	11.15
990929	26.8	33.7	23.3	53.6	0.0	13.97
990930	27.1	32.9	23.7	56.5	7.4	12.92
1st decade	27.4	34.2	21.5	42.8	40.5	193.76
2st decade	27.1	33.8	22.2	52.0	49.7	148.66
3st decade	27.3	33.9	23.0	55.0	129.5	151.97
mean/total	27.2	34.0	22.2	49.9	219.7	494.39
max	28.6	35.3	23.7	64.2	84.6	21.40
min	25.9	31.7	19.2	33.0	0.0	10.36

Climatic Table Draied Area (UNPAR) Oct. 1999

Draied (UNPAR) yymmdd	Air Temp mean (°C)	Air Temp max (°C)	Air Temp min (°C)	Humid. min (%)	Precip. total (mm)	Solar R. total (MJ/m/m)
991001	26.1	31.3	24.1	71.5	5.3	11.53
991002	27.0	34.7	23.5	48.4	23.5	18.11
991003	27.9	34.2	23.5	49.3	7.4	18.76
991004	27.8	33.5	23.0	55.0	0.7	17.19
991005	27.5	35.1	22.2	53.6	55.1	15.52
991006	26.9	33.7	23.3	57.6	26.4	16.04
991007	25.5	31.8	23.4	66.9	0.0	9.41
991008	27.1	32.4	23.2	61.9	0.0	14.96
991009	25.9	32.7	23.3	61.9	17.9	8.02
991010	26.2	32.2	23.1	60.9	0.2	14.76
991011	26.3	32.3	23.9	60.0	8.7	13.09
991012	27.4	33.9	23.8	51.8	20.5	19.51
991013	24.8	28.3	22.4	82.4	76.0	5.40
991014	26.9	32.7	22.6	59.5	0.0	16.72
991015	26.5	34.7	22.7	55.5	7.3	12.64
991016	28.1	35.4	22.8	49.5	14.9	17.69
991017	27.3	34.3	23.8	55.1	3.0	14.11
991018	27.9	34.5	23.6	53.5	0.0	15.55
991019	27.7	32.4	23.7	65.3	13.6	14.97
991020	25.8	32.6	23.5	60.6	23.4	11.92
991021	27.7	34.5	22.4	50.6	2.4	21.35
991022	26.4	32.1	24.1	62.8	1.7	12.63
991023	27.9	34.6	23.3	52.0	0.0	18.67
991024	28.1	34.0	24.5	52.1	0.0	20.41
991025	25.5	29.7	23.8	71.5	17.0	6.71
991026	26.3	33.2	23.1	56.4	0.5	12.63
991027	28.0	36.0	23.3	48.3	1.4	16.66
991028	26.7	34.2	23.4	57.4	13.7	12.75
991029	26.7	32.4	23.4	65.4	55.7	14.91
991030	25.5	28.8	23.2	75.8	0.0	7.84
991031	27.1	32.9	23.8	58.3	1.4	15.10
1st decade	26.8	33.2	23.3	58.7	136.5	144.30
2st decade	26.9	33.1	23.3	59.3	167.4	141.60
3st decade	26.9	32.9	23.5	59.1	93.8	159.66
mean/total	26.9	33.1	23.3	59.1	397.7	445.56
max	28.1	36.0	24.5	82.4	76.0	21.35
min	24.8	28.3	22.2	48.3	0.0	5.40