INTERIM REPORT

FOR THE RECONNAISSANCE SURVEY OF THE MULTI-PURPOSE DEVELOPMENT OF THE AREA S-W OF THE GREAT LAKE IN CAMBODIA

June 1968

Investigation Team
organized by the
Overseas Technical Cooperation Agency, Japan

CONTENTS

I. Introduction

A reconnaissance survey of the northern area of the Great Lake was carried out from December 1966 to January 1967 by the staff members of the Secretariat of the Mekong Committee and the OTCA, Japan.
As a result, the team recommended to perform the following in the future.

(1) Feasibility study of the St. Chinit as one of the major tributaries in the northern area of the Lake.
(2) Feasibility study of one or two polder projects in the northern area between the highway and the Lake.
(3) Reconnaissance study in the southern area of the Great Lake.
(4) Detailed soil classification study in the whole area around the Great Lake.
(5) Providing the experimental farms.
(6) Further mapping and collection of hydrological data.

With regard to the above (3), the reconnaissance report pointed out that some projects in the southern area would be more favourable than the northern area.

The Government of Japan, in August 1967, offered to the Mekong Committee to undertake the multi-purpose reconnaissance survey of the area S-W of the Great Lake. The plan of operation involved in the offer on the reconnaissance survey was prepared by the Committee and agreed by the countries relative concerned and the Committee in March 1968. From March to May of 1968, the investigation team was organized by OTCA, Japan* for the reconnaissance survey and was sent to Cambodia.

The reconnaissance study will be completed by the end of 1969 in the close cooperation with the Government of Cambodia and the Mekong Committee. Present interim report involves the result of phase I, the preliminary study of the area, and phase II, the field investigation and paper study, which is supposed to be carried out by the team until May 1968.

In accordance with the plan of operation, next stage including a result of analysis of soil samples and the survey will be carried out by the end of coming rainy season of 1968, and the report will be presented to the Mekong Committee by the end of 1969.

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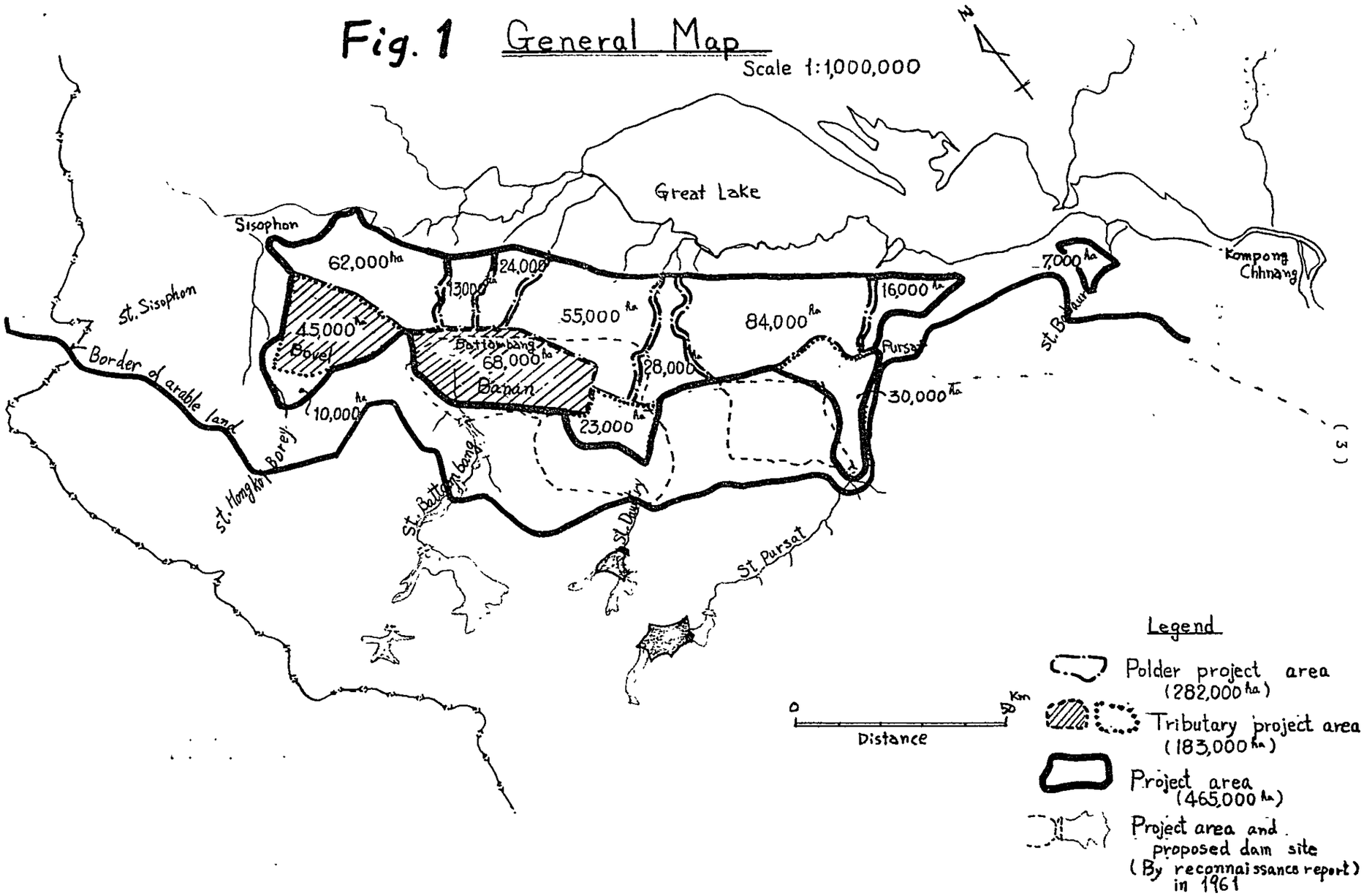
* Overseas Technical Cooperation Agency, which is an executing agency of the Government of Japan.

Fig. 1 General Map

Scale 1:1,000,000



II. Purpose of the project

The Great Lake is rich in fish production and land surrounding the Great Lake (the area about three million ha) is fertile and produce a good yield of rice, especially in the south and the South-West parts of the Lake. There is also fairly big potential on the power generation in the upper reaches of some of the major tributaries flowing down to the Great Lake. The future prospects of comsumption of the agricultural production and power generation are quite promising.

The purpose of the present program of reconnaissance is vested in studying the possibilities of the multi-purpose development of the area to apply the modern techniques and management. It envisages to promote an agricultural development in an area of approximately 1.0 million ha by deviding the project area into several parts using necessary water to be supplied either part from the Great Lake or the tributaries. It may also give favourable effect on power generation, flood control and navigation in the tributaries.

III. Short history of the survey and study on the development of the area

The development of the area has started since old times. The Bovel project was built more than 30 years ago to divert water from the Stung Mongkol Borei for irrigation. It was reviewed a few years ago and is now supplying irrigation water 30,000 ha in the total irrigable area of 45,000 ha.

The survey of the Bannan project had been undertaken since 1935, and the final report was presented by the SOGREAH in 1964. The project plan includes two reservoirs in the Stung Battambang to supply water to 68,000 ha of total irrigable area of 80,000 ha along the river and also generate some hydraulic power.

"Comprehensive Reconnaissance Report on the Major Tributaries of the Lower Mekong Basin" was presented in 1961 by the Government of Japan. Regarding the area S-W of the Great Lake, the report suggested a possibility to irrigate some areas by constructing reservoirs on major tributaries such as the Stung Mongkol Borei, the Stung Battambang, the Stung Daun Try and the Stung Pursat. The last one was especially recommended by the Reconnaissance Team since it was the most promising. The Stung Pursat development plan

includes 35,000 ha of the irrigable area and 21,000 kw of hydraulic power generation by means of constructing a dam and a diversion weir, the former having a gross capacity of 800 million cubic meters, of which 420 million is effective.

In January 1964, the report on "Designs and cost estimates of the Tonle Sap Barrage" was presented by the Government of India. The Tonle Sap Barrage project is multi-purpose project to have aimed flood control and irrigation as the major objectives.

In the mid 1967 a report on Mathematical Model of Mekong River Delta was submitted to the Committee by SOGREAH, a French contracting firm. The study was contributed by the UN special fund. It was disclosed in the report that some areas of higher elevation at the fringe of the Great Lake which has been often submerged by the Lake in the wettest season. It will not be inundated and cultivated after constructing the proposed Tonle Sap Barrage.

The area S-W of the Great Lake is now being studied by the Japanese Team with an objective similar to the Reconnaissance Survey of the Northern area of the Great Lake, for which previous survey was already mentioned in the introduction. The final report will be submitted by the end of 1969.

IV. Features of the development of the area

The area S-W of the Great Lake from Sisophon to Kompong Chhnang covers a drainage basin of approximately 30,000 km^2 having an average annual rainfall of 2,000 mm. The Great Lake has an area of about 3,000 km^2 at 3 m water level in the dry season and about 10,000 km^2 at 10 m water level in the rainy season. Its detaining capacity between 3 m and 10 m W.L. is about 45 billion m^3.

Of some 50 billions m^3 of the ordinary flow through the Tonle Sap some 20 billions m^3 is known to be reversed flow from the Mekong in the usual year, then the other 30 billion m^3 of flow is considered as the annual runoff through the drainage basin around the Great Lake.

Since the amount of annual rainfall in the northern area is smaller than the amount of annual rainfall in the S-W area, and both regions have almost the same catchment area, it could be expected more than 15 billion m^3 of the annual runoff in the area S-W of the Great Lake.

The area S-W of the Great Lake may have some 1.0 million ha of arable land including 0.6 million ha of existing cultivated area. To irrigate these 1.0 million ha some of which are upland fields, some 10 billion m^3 of water and about 100 days irrigation period may be required.

Theoretically it is possible to introduce the above irrigation water by the runoff from the Great Lake. To achieve the actual development of this area but it is necessary to find the potential reservoir sites and the diversion dam sites along the tributaries, especially at St. Sisophon, St. Mongkol Borei, St. Dauntri and St. Pursat, and also possible polder projects around the Great Lake using the lift irrigation. At the same time, of course the development of hydraulic power, fishery, improvement in navigation and their influence on the downstream basin should be also considered.

V. Outline of the tentative scheme in the South-West of the Great Lake

The potential arable area for development in the South-Western portion of the Great Lake is located between EL 50 m and 5 m in the coastal zone of the Great Lake (excluding the reserved area for fishing purpose etc.) and is regarded as about 1.0 million ha including some 0.6 million ha of the existing cultivation land.

This 1.0 million ha would be classified into the following three categories, according to the topographic condition fertility of the soil, possibility of the irrigation (existence of a source of water supply, possibility of providing reservoir site and diversion weir site) and so on.

1) Reclamation of the inundated area by the polder dike, and the area to be irrigated using the Great Lake as water resource (about 282,000 ha).
2) The area to be irrigated by the water in the tributaries (about 183,000 ha).
3) Other areas (the remaining area).

(Refer to Fig. 1)

Polder project:

The area between EL 5 m and EL 12 m on the coast of the Great Lake happens to be fertile due to the inundation. Accordingly the project aims at protecting the area from inundation in the rainy season and making the

cultivation possible. As for irrigation, the productive water in the Great Lake will be irrigated by pumping up.
Making 7 blocks of the polder areas providing the dikes along the near shore of the Great Lake at the elevation about 5 m and both banks of the tributaries, total 282,000 ha of the polder projects area will be planned.

Tributary project:

Of 183,000 ha in this area it included the Banan Project area (68,000 ha) depending on the water resources of the Stung Battambang and the Bovel Project (45,000 ha) which is using St. Mongkol Borey as water resource. What is going to be developed by this scheme is 7,000 ha located in the upstream of the St. Mongkol Borey, 30,000 ha located in the basin of the St. Pursat, 23,000 ha in the St. Dauntry and 7,000 ha in the St. Babour. Speaking of the tributary projects, they will be selected at a place where gravity irrigation becomes possible by the construction of dams and head-works and also at the place where soil is fertile. Dams make possible the power generation simultaneously with securing irrigation water and besides will serve as an electric power source for the pumping irrigation, contributing greatly also for the factory and general domestic utilization. The reservoir operation study concerning the St. Pursat, the most important river is indicated in VI-2. Table 1 indicates the hydrological data for the main tributaries in the area.

The remaining area:

This is generally in bad soil condition and securance of the irrigation water is difficult. However, regarding the St. Sisophon basin and other small basins, detailed study could not be done owing to difficulty for reaching all the sites. Further investigations are necessary to find the potential areas of development.

Comprehensive effect:

The above developing schemes contribute greatly not only to the development of the agriculture but to the development of other industries. The assurance of the power by the hydro-power generation enables the advancement of the factory. The polder dikes in the polder project can be used for road traffics, thus making much benefits for fishery and sight seeing.

VI. Progress of the investigation

VI-1. Meteorological and hydrologic observation

The meteological and hydrologic records in the south-western area of the Great Lake were collected as shown below Table 1 and Fig. 2.

Hydrography:

Table 1. Gauge height station

	River	Station	Drainage Area (km^2)	Observation Yrs.	Calender Year
1.	Stung Sisophon	* Sisophon	4,310	4	1962-63, 1965-66
2.	Stung Mongkor-Borey	* Mongkor Borey	4,170	3	1962-63, 1966
3.	Stung Sangker (Stung Battambang)	Battambang	3,230	1	1966
	"	Prek Tal	...	1	1966
	"	Bac Prea	...	1	1966
	"	Treng	...	1	1966
	"	Sre Penlu	...	1	1966
4.	Stung Dauntry	* Maung	835	5	1962-66
	"	Tamea	...	5	1962-66
	"	Kbal Ter	...	2	1965-66
5.	Stung Pursat	* Pursat	4,480	5	1962-66
	"	* Taing Luoch	2,080	2	1965-66
	"	Kancher	...	1	1966
6.	Stung Kg. Lar	* Thnot Chum	420	5	1962-66
7.	Stung Krakor	Krakor	...	1	1966
8.	Stung Babaur	* Babaur	869	3	1962-63, 1966
9.	Grand Lac	Kg. Luong	...	1	1966
	"	Penlich Sdey	...	1	1966
10.	Tonle Sap	Snoc Trou	...	1	1966

Note: An asterisk (*) shows the discharge data available.

Presipitation:

Table 2. Precipitation

Station	Observation Year	Calender Year
Pursat	37	1967-58, 1956-55, 1953-52, 1938-36, 1933-25, 1923-13.
Kg. Chhnang	21	1967-61, 1953-52, 1940-29.
Battambang	29	1967-56, 1954-51, 1940-28.
Krakor	28	1967-58, 1952-46, 1943-41, 1939-32.

Evaporation:

The evaporation data from 1963 are available at the following stations:

Phnom-Penh, Kampot, Slakou, Treng, Sre Khlong, Kauk Patry, Chamcar Krauch, Kauk Trap, Pailin, Petit Takeo, Snuol, Pochentong, Battambang, Svay Rieng, Stung Treng, Sihanouk Ville, Stung Chral, Siem Reap, Sisophon, Kompong Cham, O Raing, Angkor Wath.

Wind:

Monthly diagram of frequency of the wind direction and wind velocity at surface, described by the Service Meteorology, Ministry of T.P., were available at the following stations:

Table 3. Wind

Station	Observation Yrs.	Calender year
Kompong Cham	10	1951-1960
Phnom-Penh	"	"
Svay Rieng	"	"
Kampot	"	"
Sihanouk Ville	4	1957-1960
Battambang	8	1952-54, 1956-60
Siem Reap	10	1951-1960
Krakor	6	1951-53, 1958-60
Stung Treng	10	1951-60

Other data:

The following data on the meteorology of Cambodia, calculated by the Service Meteorology of the Ministry of T.P., were offered for the study.

(1) Annual and monthly isohyetal maps in 1960

(2) Probable monthly rainfall and record of continuous rainy days at the following stations:

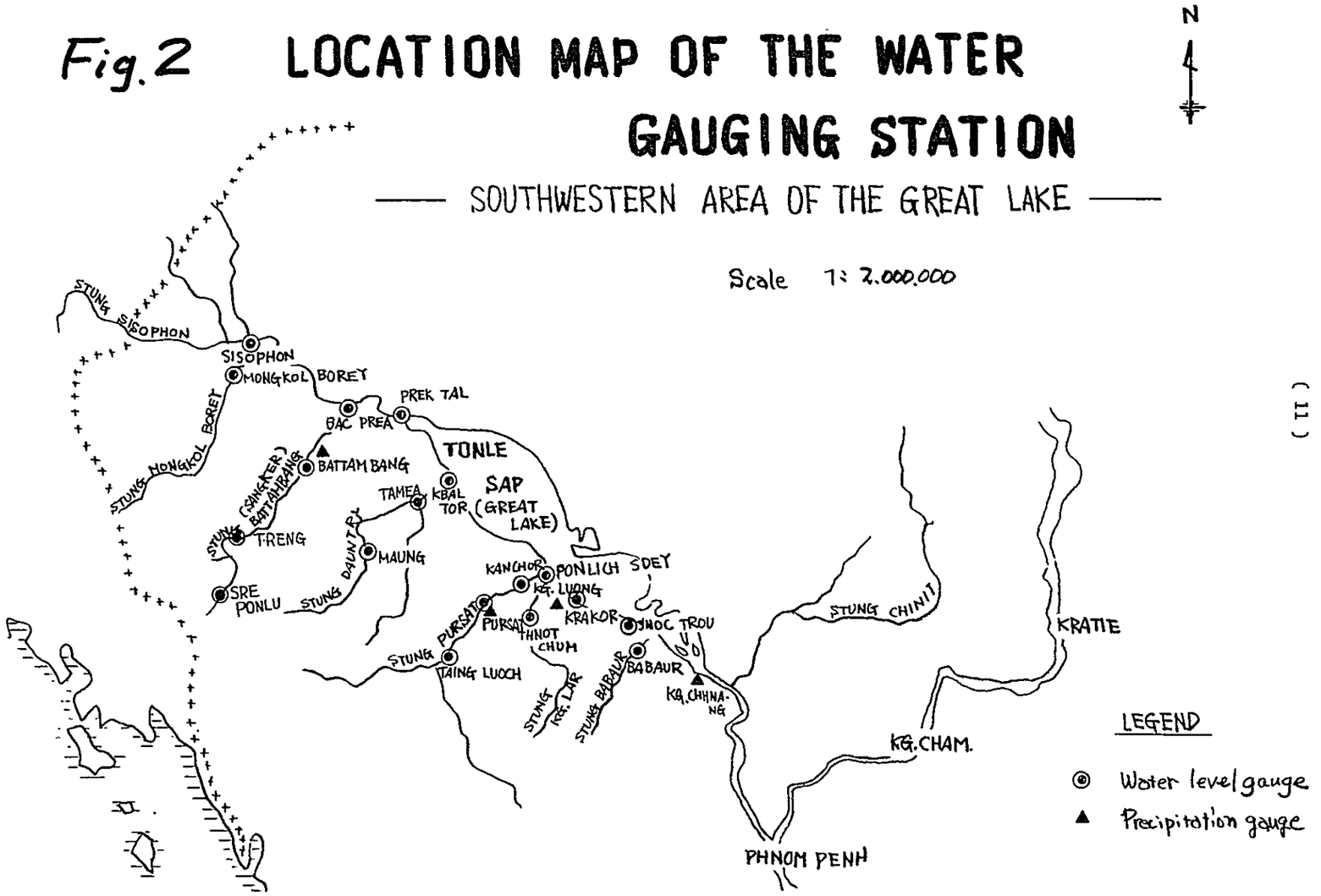
Krakor, Pursat, Battambang, Stung Treng, Svay Rieng, Kampot, Bokor Ferme, Pochentong, Bokor ville, Barai, Siem Reap, Sihanouk ville, Kompong Speu.

Collection of these meteorological and hydrologic data should be done further continuously. Appraisal and analysis of the data are being studied.

Fig.2 LOCATION MAP OF THE WATER GAUGING STATION

—— SOUTHWESTERN AREA OF THE GREAT LAKE ——

Scale 1: 2,000,000



VI-2. Study on the topography and water resources

The south-western basin of the Great Lake covers approximately 29,500 km^2 from the Stung Sisophon basin to the Stung Sre Pak basin, bounded on the Cardamomes mountain range in the south. (Refer to Fig.3) A high mountain area which has the elevation about 1,500 m, is located along the south-western border of the basin from the Stung Mongkor Borey to the Stung Pursat. The other areas of the basin rather belong to Gentle slope of plateau and broad alluvial plain which is located at the elevation almost below 50 m. The arable land in the basin should mainly be situated on this plain including some 6,000 km^2 of present paddy fields and some 4,000 km^2 of inundated brush land at the fringe of the great Lake. Thus the whole basin may be classified based on its topography as the following table 4.

Table 4. Topographic classification

Kind of land	Area	Note
Mountain and plateau	17,830 km^2	Almost higher than EL 50 m. Some of upland farm and orchard exist along the bottom valley of the tributaries.
Arable plain	11,670	Almost lower than EL 50 m.
Reserved fishery area	1,670	Inundated brushwood, lower than EL 5 m, alluvium formed by the Lake.
Polder project area	2,820	Almost inundated alluvium formed by the Lake, lower than the national highway. Floating rice field exists partially.
Others	7,180	South of the highway, higher than EL 12 m, existing paddy field in more than half of the area, partially clear forest
Total	29,500	

Table 5. Outline of the main tributaries

River name	Station[1]	Year	Discharge (m^3/s)				Drainage[2] area (km^2)	Specific discharge ($l/s/km^2$)	
			Max.	Min.	Annual mean	Droughty dis.		Annual mean	Droughty dis.
1. St. Sisophon	Sisophon	1962-Apr. - 1963-Mar.	515.0	0.10	48.5*	0.14	4,310	11.25	0.003
2. St. Mongkor Borey	Mongkor Borey	"	150.0	0.40	24.90	0.82	4,170	5.97	0.20
3. St. Battambang	Battambang	"	600.0	1.46	61.5	2.77	3,230	19.0	0.83
4. St. Duntry	Maung	"	40.5	0.00	2.76	0.01	835	3.30	0.01
5. St. Pursat	Taing Louch	1965	510.0	0.82	35.2	1.19	2,080	16.9	0.57
"	"	1966	319.0	0.70	22.7	1.39	"	10.9	0.67
"	Pursat	1962-Apr.- 1963-Mar.	394.0	0.10	57.3	0.50	4,480	12.79	0.11
6. St. Kompong Lar	Thnot Chum	"	65.0	0.00	5.60	0.09	420	13.32	0.21
7. St. Krakor	Krakor	"	10.9	0.00	1.05	0.00	138	7.64	0.00
8. St. Babaur	Babaur	"	123.0	0.04	15.98	0.51	870	18.36	0.58

Note * *Withought date for 3 months, May, Jun. and Jul.*

1) Water height gauges of these eight rivers excluding Taing Louch, are located at crossing point of the national highway and the rivers.

2) 18,453 km^2 for total drainage area of the eight rivers and 16,190 km^2 for the big four river (1 + 2 + 3 + 5)

Outline of the drainage area and discharge of the main tributaries are shown in Table 5. In this Table 5 the drainage area was estimated at the gauge stations located along the national highway. Among the whole drainage area of the eight rivers, the four big rivers namely the St. Sisophon, St. Mongkor Borey, St. Battambang and St. Pursat occupy the most drainage area of 16,190 km^2, about 88 % of the whole drainage area. Consequently their runoff also possess almost all the amount of runoff.

According to Table 5, the annual runoff of the eight rivers may be estimated at some 7 billion m^3 for the drainage area of 18,453 km^2 in the common year. More than 10 billion m^3 of the total runoff for the entire basin of 29,500 km^2 would be expected.

Several adequate diversion weir sites could be found out in each tributary in order to supply the suplemental irrigation water to the down-stream basin in the rainy season. But it is difficult to find out some suitable reservoir sites in the area except at the Stung Pursat and Stung Daun Try basin due to the topography.

A result of present preliminary study concerning the dam and weir sites is shown in Table 6. This of course is subject to revision and excluding some of irrigable areas by diversion facilities in the other tributaries.

Regarding the Pursat reservoir, the river flow at the damsite will completely be regulated by the main dam since it has some 180 million m^3 of the capacity with 6 m draw down. Discharge water of some ~~50~~ 11.5 cumec or a little more will be used for irrigation and hydroelectric power generation throughout the year. (Based on an operation study in 1965 - 66).
Some 100 x 10^6 kwh of the power annually will be created with firm power of 11,000 kw.

Table 6. Reservoir and irrigable area

Name of River	Effective storage capacity ($10^6 m^3$)	Drainage area (at damsite) (km^2)	Annual discharge at damsite ($10^6 m^3$)	Irrigable area * (ha)	Dam height
1) St. Mongkol-Borey	20	2,400	455 (1962)	10,000	10 m (HWL 30 m)
2) St. Dauntry	69	680	69 (1962)	23,000	30 m (HWL 90 m)
3) St. Pursat	180	1,000	346 (1965-66)	30,000	20 m (HWL 180 m)
"	Diversion weir	2,080	720		(HWL 35 m)
4) St. Babaur	20	600	350 (1962)	7,000	10 m (HWL 50 m)
5) Bavel Project at St. Mongkol Borey				45,000	
6) Battambang Project at St. B. Baug				68,000	
Total				183,000 ha	

Note. *Location of the dam sites:*

1) at 15 km upstream of Bovel.

2) at 35 km upstream of Moung

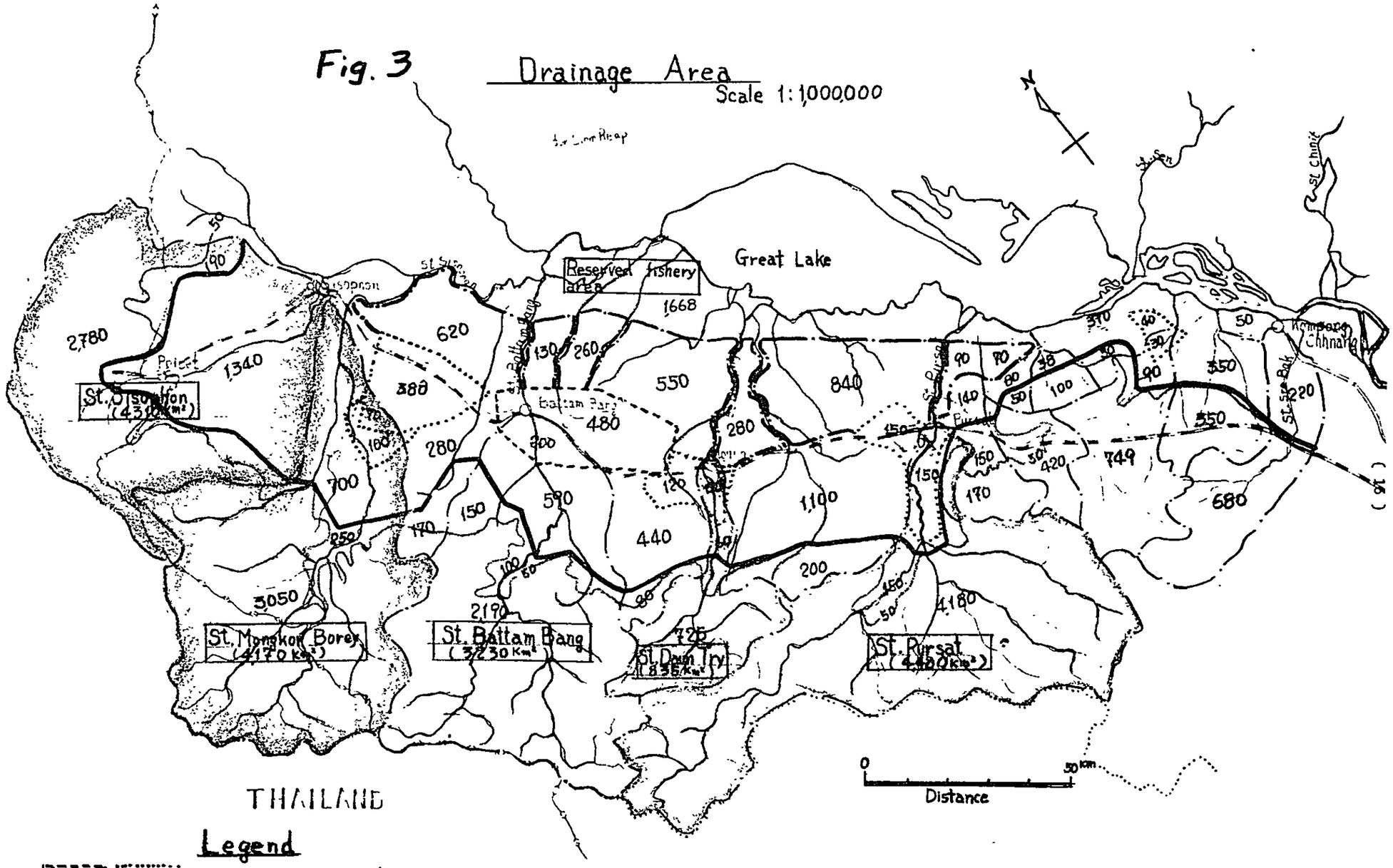
3) at 45 km upstream of Taing Loveh for maindam and at Taing Louch for diversion weir.

4) at 20 km upstream of the national highway.

* *Mainly in the rainy season paddy. The irrigable area in the dry season will be reduced to about half.*

Fig. 3 Drainage Area

Scale 1:1,000,000



Legend

- Tributary project area
- Polder project area
- Border of arable land
- Border of drainage area
- —50— Contour line of EL. 50m

Note

Figure of drainalge area is shown in km².

VI-3. Soil survey

The following shows a summary on the results of the soil survey conducted in the south-west area of the Great Lake. In the survey area, the soil mainly consists of the Grayish Brown Soils, and this soil is equivalent to the Brown Hydromorphics which was classified by C.D. Croker. Moreover, there are other two types of soils, that is Plinthic Red-Yellow Podzolic Soils and Red Yellow Podzolic Soils, but these areas are very small.

The area located in the south-east bank along the Great Lake is classified into the following 4 Soil Groups. (Refer to Fig. 4)

A Soil Group:

(I) Information on the site

(a) Location: The west area located between the Stung Mongkol Borey and Stung Daun Try.

(b) Elevation: Approximately 10 - 25 m

(c) Land use: Land is used for the cultivation of rice widely

(II) Result of Investigation

(a) Development of soil profile: Very good

(b) Soil colour: Grayish brown

(c) Soil texture: Light clay

(d) Depth of soil layer: Approximately 1 m

(e) Effect of irrigation: To be expected

B Soil Group:

(I) Information on the site

(a) Location: The area located between the Stung Daun Try and near Kompong Chhnang.

(b) Elevation: Approximately 10 m or more.

(c) Land use: Land is used for the cultivation of rice partly and the other places covered by the clear forest. Sandy layer can be found partly by the influence of the mountain located towards the south of these areas.

(II) Result of Investigation

(a) Development of Soil profile: Good

(b) Soil Colour: Grayish brown

(c) Soil Texture: Clayey loam to fine sandy loam

(d) Depth of soil layer: Deep condiderably

(e) Effect of irrigation: To be expected following A Soil Group

C Soil Group:

(I) Information on the site

(a) Location: The area surrounded Kompong Chhnang

(b) Elevation: Approximately 10 m or more

(c) Land use: Land is used paddy field and clear forest. The soil condition of this soil group is most poor by the strongly influence of the mountain located towards the south of these areas.

(II) Result of Investigation

(a) Development of soil profile:	Relatively good
(b) Soil Colour:	Grayish brown
(c) Soil texture:	Coarse sand
(d) Effect of irrigation	Can not be expected

D Soil Group:

(I) Information on the site

(a) Location: The area inundated by the flood of the Greate Lake

(b) Elevation: Approximately 5 - 10 m

(c) Land use: Uncultivated plain and clear forest

(II) Result of investigation

(a) Development of soil profile:	Relatively good
(b) Soil Colour:	Gray
(c) Soil texture:	Light clay - heavy clay
(d) Depth of soil layer:	More than 1 m
(e) Effect of irrigation:	To be expected greatly if irrigation practice is possible.

VI-4. Present situation of agriculture in the area

The arable area in the South-Western basin of the Great Lake lies in the Provinces of Battambang, Pursat and Kompong Chhnang. Various governmental agencies in Phnom-Penh, the local district offices, some existing irrigation projects and some experimental farms were visited for the purpose of getting a general information concerning the present situation and also to envisage the possible future prospects on agriculture in this area. Interviews were also made with farmers at many locations in the project area in order to supplement informations obtained from the official sources.

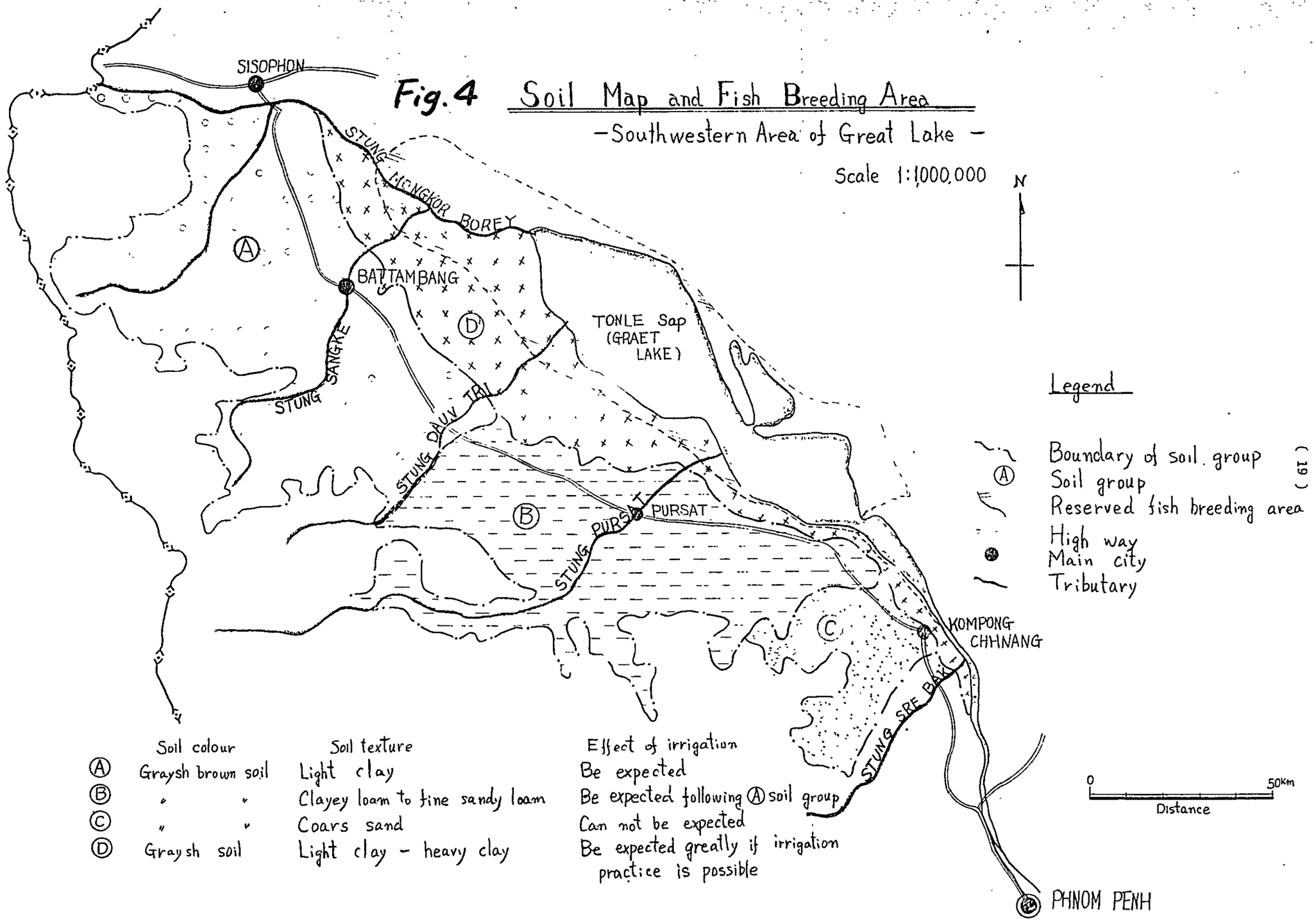


Fig. 4 Soil Map and Fish Breeding Area

– Southwestern Area of Great Lake –

Scale 1:1,000,000

	Soil colour	Soil texture	Effect of irrigation
Ⓐ	Graysh brown soil	Light clay	Be expected
Ⓑ	〃 〃	Clayey loam to fine sandy loam	Be expected following Ⓐ soil group
Ⓒ	〃 〃	Coars sand	Can not be expected
Ⓓ	Graysh soil	Light clay – heavy clay	Be expected greatly if irrigation practice is possible

The main points of the formal information are listed in Table 6. And the present situation of agriculture in the area is summarized as follows.

Chiefly, the rice cultivation during the rainy season has been conducted in the area, using the rain fall and inundation water in time by the Great Lake and many tributaries. The South-Western area of the Great Lake covers existing paddy field of approximately 600,000 ha possessing one-fourth of the whole cultivation paddy in Cambodia, and forms one of rice granary areas in Cambodia especially for the broad Battambang plain in question.

Regarding the hectare yield of paddy in the area comparing with some 1.1 ton of average yield in the whole Cambodia, it appears that almost similar condition exists in Kompong Chhnang Province, but a little higher in Battambang and Pursat Provinces according to their soil fertilities. However the fluctuation of the yields and also the planting areas and the productions are fairly remarkable due to suffering from the bad weather conditions such as lag of the beginning time of the rainy season, drought or serious flooding, and so on.

In order to stabilize the agricultural production as well as to increase in the hectare yield, it is necessary to have some irrigation and d drainage systems such as complete water controlled farms, thus it is possible to make input in the farm effectively. An unstable productivity may make the farmers enervate and bring a stagnation on the rural community.

In spite of the above matter, Battambang region has been maintaining an advancing region in the agricultural development such as in providing irrigation project, agricultural mechanization and so on. For example, the Bovel irrigation net work on the Stung Mongkor Borey was implemented more than 30 years ago and it covers 30,000 ha now and being extended to the canal system for total 45,000 ha in future. The proposed Battambang tributary project on the Stung Sangker envisages river regulation, irrigation of some 68,000 ha and also 31,500 kw installed hydroelectric power. The other small scaled irrigation systems are also seen in the neighbouring provinces.

As for the plowing by rental tractor, it could be seen that the mecanical plowing was begun even by March at some of the paddy fields in the region, Battambang Province, because a tractor should work for larger area till June being short of the numbers of machines. The diffusion of mecanizing agriculture would be advanced much more in the broad fertile plain

though still now a domestic animal power and man power are used for the main part of cultivation in the region.

Few chemical fertilizers have been used for the paddy field due to the high cost comparing with farmer's income at present and lack of the supply, but manure is being used positively nowadays. It is considered that fertilizing and also pest control, application of excellent seeds, mechanizing and so on are not so available without land improvement, for example unwell leveled or non-ridge paddy field as well as lack of terminal irrigation and drainage equipment. Even the Bovel project area has the disadvantage like mentioned above.

In the point of view of the population density, the area S-W of the Great Lake belongs to a rural region having no scarce population, rather the area has fairly enough man-power and its increasing tendency. There hardly is any doubt on abilities to contribute substantially towards improved standards of living in the area by facilitating agricultural development.

Table 7. Outline of agriculture

Item / Province		Battambang	Pursat	Kg.Chhnang	Cambodia	Note
Total area	(km^2)	19,184	12,692	5,521	181,035	
Population	(person)	628,300	261,473	265,600	≒ 6,800,000	1968
		(552,440)	(182,394)	(272,911)	(5,740,115)	(1962)
Population density	(p/km^2)	33	21	48	38	1968
Caltivated land (paddy field)	(km^2)	4,202	940	1,087	24,141 (1965-66)	1967 -68
Kind of paddy cultivated	(km^2)					1967-68
Hatif		17	28	58		
Mi-Saison		83	261	246		
Saison		1,809	359	323		
Tardif		1,353	128	204		
Flottant		941	164	150		
Saison Seche		-	-	75		
Average Production of paddy	(1,000t)	609	162	123* *(excluding dry season rice)		1967-68
Paddy yield	(t/ha)	1.45	1.73	1.21		"
Arable land in the basin	(km^2)	7,600	2,700	1,370	Total 11,670	
Farm size (ha/house hold)		6.3	2.9	2.4		
Number of livestock						
Cattle	(1,000 head)	309	83	106		
Bafalo	(-"-)	88	40	30		
Suine	(-"-)	95	39	27		

VI-5. Actual condition of the electric power supply in Cambodia

Electric utility: Each main city has a power station by installing the diesel engines to serve the power to the neighborhood. But there is still no power system to cover the entire Cambodia, since it will be more economical from the aspect of the construction cost remain in the present state of power supply by the isolated power station than having any other system of connecting to each power station, because the distance between each power station is too far and moreover the scale of the power station is small. The electric utility of Cambodia is conducted by Eléctricité de Cambodge (EDC) and Franco Khmeré de Eléctricité de Battambang. EDC supplies the whole country with power except at the procince of Battambang where Franco Khmer de Eléctricité de Battambang is controlling the power.

Service de Controle des Eau et de le Eléctricité, Ministere des Travaux Publics (TP) supervises the electric utility. TP makes plan of supply and demand programs, development schedule, and practises large scale construction works of the new or additional establishments.

TP also controls the electric power company for the electric tariff and its instrument capacities.

All power generating plant capacity in Cambodia in 1968 are as follows.

Table 8. Power generating plant capacity (Unit: kw)

Item	Diesel power	Steam power	Hydraulic power	Total
Elec. de Cambodge	32,890	21,000	10,000	63,890
Franco Khmer Elec. Co.	2,175	-	-	2,175
Total	35,065	21,000	10,000	66,065

Transition of the power generation: The following table shows the change of the power generation during the past 10 years in Cambodia. This table reveals the fact that annual rate of growth of the installed capacities is about 5-10 %, the capacities use factor is 15-20 % and annual load factor is 30-50 %. And a great quantity of loss-ratio is one of the distinctive features due to the insufficiency of the supplement works.

Sorts of the power consumption: The power consumption consists of private domestic use, lighting of public way, public building domestic use and electro-motive force for public and private use, in which private domestic use accounts about 60 % of all consumption.

Power generation for the demand of the industry has been supplied by its own power plant, for example hospitals, hotels and so forth on the ground that the Compagnie des le Eau et Eléctricité d'Indo-Chine, the predecessor EDC was aiming at and developed as a supplier for the public and domestic purpose.

A total power generating plant capacity of the private production is estimated at 25,000 - 30,000 kw. (The sambor feasibility report, OTCA, Japan. 1967). Power consumption has been decreasing from 1963, this might be due to the fact that the electro-motive force which had been supplied by the electric company was changed over to private production.

Power cost: As for Chak-Angré power station in Phnom-Penh in December of 1965, its total power generation was 4,920 kw, namely 3,000 kw (2 x 1,500 kw) by the steam power and 1,920 kw (3 x 640 kw) by the diesel power, and its total power cost was 1,764 Riel/kwh of which 0.936 Riel/kwh for the steam power and 1.254 Riel/kwh of the diesel power for the cost of fuel and other consumption goods. The unit project cost for the entire power station including maintenance, personnel, repayment, insurance and other expenses was 1.254 Riel/kwh. (EDC. Calcule de prix d'un kwh pour le mois de decembre 1965). The designed power cost of Kirirom No.1 power station which was constructed in 1968 as the first hydraulic power station in Cambodia (Installed capacity: 10,000 kw. Average annual production: 49,700,000 kwh, Construction cost: 8,981,781 $) was 0.38 Riel/kwh at the station and 0.5 Riel/kwh at Phnom-Penh after being transmitted for the distance of 110 km.

The electric tariff in the service area of EDC is as follows.

Table 9. Tarrif (unit: Riel/kwh)

Item	Phnom-Penh	Kandal province	Others
Private domestic use	3.604	3.171	6.337
Lighting of public way	2.873	2.953	5.470
Public building domestic use	3.046	3.136	6.153
Electro-motive force for private use			
Low voltage	1.778	1.778	4.370
High voltage	2.251	2.261	5.003
Electro-motive force for public use			
Low voltage	1.778	1.778	3.933
High voltage	2.301	2.311	4.786

Franco-Khmer de Eléctricité de Battambang also sells the power at the price indicated below.

Table 10. Tarrif (unit: Riel/kwh)

Item	Battambang
Electric-light	7.012
Electro-motive force	
Low voltage	5.176

VI-6. Fishery and navigation

Fishery: Fishery is one of essential industries for each Battambang, Pursat and Kg. Chhnang province. Each province has a distribution center of the fish production respectively, that is, Bac Prea located at confluence of the Stung Mongkol Borey and the Stung Sangker, Krakor situated near the shore of the Great Lake and Kg. Chhnang faced toward the Tonle Sap.

The fish production for each province is shown as Table 11.

Table 11. Fish production (in ton)

Year	Production		
	Battambang province	Pursat province	Kg. Chhnang province
1961	2,093	10,411	
1962	2,823	10,473	
1963	4,000	10,130	
1964	5,277	10,150	
1965	6,844	10,000	10,865
1966	7,635	11,000	17,175
1967	7,451	10,000	4,819

The production stated in Table 11 contains mostly raw fish, dried fish, smoked fish and "Prahoc" (salted small fish). Besides the above products, "Nac Mum" (fish source) is an important product in the region especially in Kg. Chhnang.

Regarding the monthly fishing product it is said that fishing is performed mainly in the duration from December to March and closed season from June to September as a spawning period, however the monthly product in statistics appears no correlation for the fact mentioned above. Further study may be required.

Fishing ground chiefly at the Great Lake and its inundation including the reserved brush wood area for fish propagation.

Fishing in the tributaries is mainly conducted in the flood period of September and October.

By providing project facilities such as regulating dams, polder dikes, and so forth, the fishery in the region would be more or affected less. Further investigation is necessary.

Navigation: Navigation practice is mainly seen at the Stung Pursat. As for the other river in the area S-W of the Great Lake, navigation is quite few.

The logs produced at the broad forest in the upstream basin of the Stung Pursat, are transported to the town of Leach, which is a big transportation transit for production of the timber which is located at the mid stream of the Stung Pursat, namely, 28 km upstream of Pursat town along the road. During November - June the transportation for timber production mostly depends on trucks. The navigation period is limited to September and October using logs with bamboo rafts in tow of ship through 80 km of the meandering river to the Great Lake.

The logs gathered to Kompong Chhnang from Pursat, are formed to big rafts and taken to Prek Kdam located near Phnom-Penh, the bigest timber market in Cambodia, via Tonle Sap. It requires about a week including the rafts preparation from Kg. Chhnang to Prek Kdam and the transportation cost of 45 Riels per one cubic meter of log.

Regarding the information for the amount or frequency of the navigation utitization, it will be studied.

VII. Acknowledgements

The team wishes to express its gratitude for the suggestions made and the informations provided by the officials listed below.

Ministry of Public Works, Phnom-Penh

Mr. Khy Taing Lim	Deputy Representative of Mekong Committee for Cambodia, and Director, Direction of Hydraulics and Energy.
Mr. Mey Path	Chief of Service Hydraulics and Navigation
Mr. S.A. Satharainsy	Chief of Service Climate
Mr. Thay Thai	Chief of Service Agricultural Meteorology
Mr. Pa Pheng	Director of Kirirom I project
Mr. Songthara Om-Kar	Principal Engineer, Liaison officer for OTCA team
Mr. Hu Nil	Engineer, Division of Construction

Ministry of Agriculture, Phnom-Penh

Mr. Hing Un	Director, Direction of Agriculture
Mr. Te Sun Hoa	Chief of Division of Agricultural Statistics, Direction of Agriculture
Mr. Sor Thay Seng	Chief of Division of Agronomy, Division of Agriculture
Mr. Lemi Savandy	Chief of Cereals Service, Direction of Agriculture
Mr. M. Yamashita	Advisor, Division of Agricultural Statistics, Ministry of Agriculture

Service Geographique of FARK, Phnom-Penh

Mr. Teao Sunthan	Director, Service Geographique

Other offices

Mr. Roland Reifenrath	Deputy Resident Representative, UNDP
Mr. Minoru Nakagawa	1st Secretary, Embassy of Japan

Secretariat of Committee for Coordination of Investigations of the Lower Mekong Basin.

Mr. Kanwar Sain	Director, Engineering Services Division
Mr. I.S. Macaspac	Director, Economic and Social Studies Division
Mr. Hiroshi Hori	Planning Engineer
Mr. W.J. Van Liere	Agricultural Economist and Development Specialist
Mr. D. Benyehuda	Civil Engineer-Irrigation
Mr. Khammone Phonekeo	Liaison Engineer

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Governments of Battambang, Pursat and Kompong Chhnang

Sectional Agriculture Offices of Battambang, Pursat, Kompong Chhnang and Siem Reap

Direction of Provincial OROC of Battambang, Pursat and Kompong Chhnang

Division of Forestry of Battambang, Pursat and Kompong Chhnang

Veterinary Offices of Battambang, Pursat and Kompong Chhnang

Sectional Public Works Offices of Battambang, Pursat and Kompong Chhnang

Bureau of Fishery of Great Lake, Kompong Chhnang

Division of Fishery of Battambang, Pursat and Kompong Chhnang

EDC (Elēctricité de Cambodge), Bureau of Technique

Office of Bovel Irrigation Net-work

Office of Prey Chhor Irrigation Net-work

Cambodian Agricultural Experimental Station at Chamker Krock

Cambodian Agricultural Experimental Station at Koh Patry

Cambodian-Japanese Experimental Farm at Battambang

Cambodian-Japanese Livestock Experimental Farm at Kompong Cham

Prek Thnot Experimental and Demonstration Farm (Cambodia-Israel)

IRCC of Chup rubber plantation

VIII. Participants and short itinerary of the survey trip.

Member of the survey team

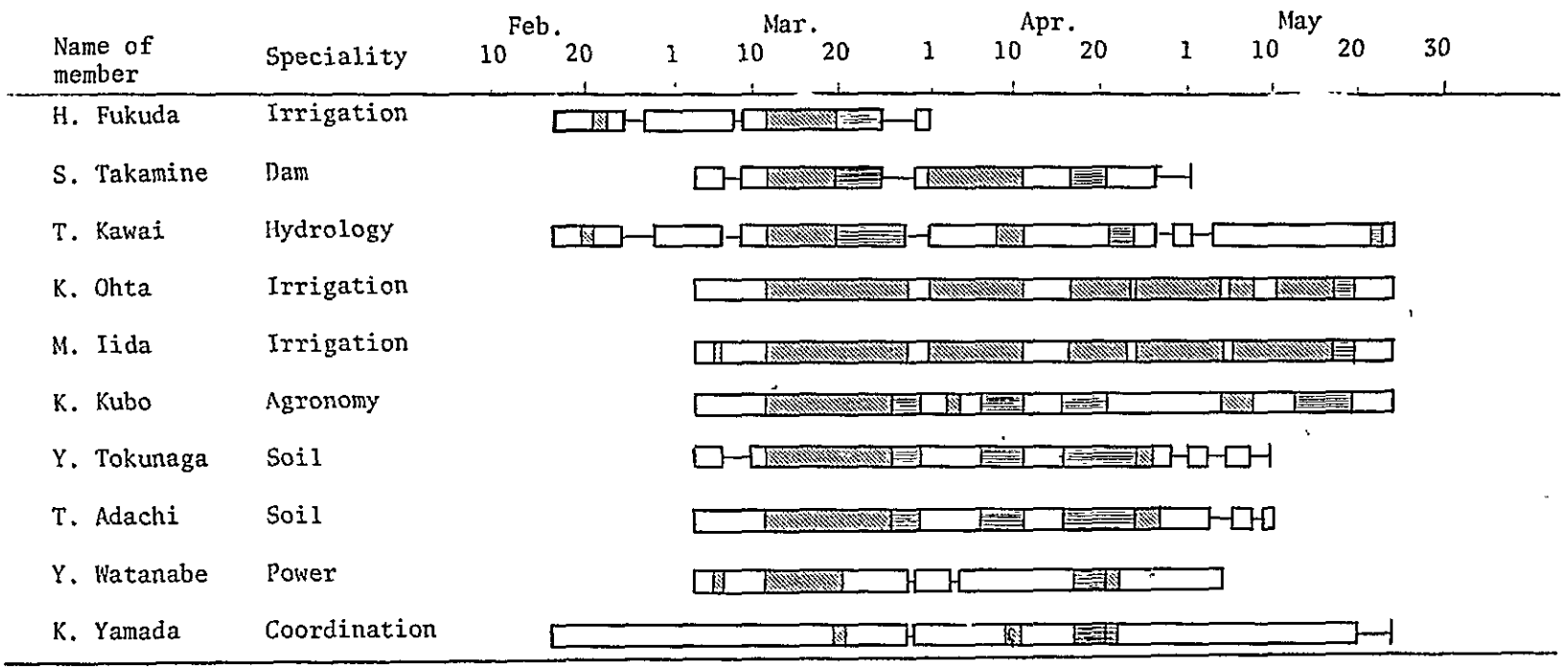
Dr. Hitoshi Fukuda	Leader of the team: Irrigation expert	Advisor to Sanyu Consultants International, Inc. and OTCA*
Mr. Susumu Takamine	Deputy leader: Dam engineer	Sanyu Consultants International, Inc.
Mr. Kiyoaki Kubo	Agronomist:	Sanyu Consultants International, Inc.
Mr. Takashi Kawai	Hydrologist and irrigation engineer:	Sanyu Consultants International, Inc.
Mr. Kunio Ohta	Irrigation engineer:	Sanyu Consultants International, Inc.
Mr. Masahiro Iida	Irrigation engineer:	Sanyu Consultants International, Inc.
Dr. Yoshiharu Tokunaga	Soil expert:	Ministry of Agriculture and Forestry
Mr. Tsuguo Adachi	Soil expert:	Ministry of Agriculture and Forestry
Mr. Yuhziro Watanabe	Power engineer:	New Japan Engineering Consultant
Mr. Kazuo Yamada	Coordinator:	OTCA*

Temporary participants in the team

Mr. Mitsuru Yoshikawa	Geologist:	Sanyu Consultants International, Inc.
Mr. Makoto Okakiuchi	Economist:	Sanyu Consultants International, Inc.

* Overseas Technical Cooperation Agency Japan

Itinerary



Note: *Field work for the survey of the St. Chinit project.*

Field work for the Area S-W of the Great Lake.

Field work at other places for the survey of the St. Chinit and the Area S-W of the Great Lake concerned.

Desk study and visit the offices at Phnom-Penh for the survey of the St. Chinit project and the Area S-W of the Great Lake.

Annex Table 1. Actual Condition of Power Supply in Cambodia

Year	Installed capacities kw	Rate of growth(%)	Max. required capacities kw	Rate of growth(%)	Production Mwh	Rate of growth(%)	Consumption Mwh	Rate of growth(%)	Annual load factor(%)	Annual capacities use factor(%)
1956	11,026		9,036		34,402		31,117		43	36
1957	11,267	2	9,350	3	39,729	15	36,798	18	48	40
1958	17,419	54	10,916	17	45,378	14	35,724	3	47	30
1959	18,052	4	12,457	14	50,959	12	40,981	15	46	32
1960	20,400	13	14,611	17	59,816	17	45,245	10	47	33
1961	23,852	17	17,820	22	71,527	19	52,280	15	46	34
1962	23,223	-2	16,649	-7	78,445	10	59,045	13	54	39
1963	31,504	36	20,949	27	86,782	10	65,750	11	47	31
1964	33,299	6	16,776	-20	84,248	-3	63,686	-3	57	29
1965	56,065	69	18,690	12	80,753	-4	62,894	-1	49	16
1966	56,065	0	-	-	89,304	11	65,848	4	-	18
1967										
Average		19.9		9.3		10.1		8.5		

Annex Table .2. Actual Condition of Power Supply in Phnom-Penh

	Installed capacities		Max. required capacities		Production		Consumption		Annual load factor(%)	Annual capacities use factor(%)
Year	kw	Rate of growth(%)	kw	Rate of growth(%)	Mwh	Rate of growth(%)	Mwh	Rate of growth(%)		
1956	7,320		6,860		28,251		25,571		47	44
1957	7,320	0	7,050	3	33,024	17	30,959	21	54	51
1958	12,420	70	8,180	16	37,547	14	29,858	-4	53	34
1959	12,420	0	9,500	16	42,615	13	34,166	14	51	39
1960	14,780	18	11,250	19	50,144	18	37,814	10	51	39
1961	17,288	17	14,100	25	61,352	22	44,800	18	49	40
1962	17,288	0	14,500	3	67,436	10	50,511	13	53	44
1963	24,000	39	17,000	17	75,822	12	57,232	13	51	36
1964	25,336	5	13,000	-24	72,461	-4	54,306	-5	64	33
1965	46,136	82	15,000	15	70,487	-3	54,723	1	54	17
1966	46,136	0	-	-	78,075	11	56,513	3	-	19
1967										
Average		23.1		10.0		11.0				

Annex Table 3. Actual Condition of Power Supply in Battambang

Year	Installed capacities kw	Rate of growth(%)	Max. required capacities kw	Rate of growth(%)	Production Mwh	Rate of growth(%)	Consumption Mwh	Rate of growth(%)	Annual load factor(%)	Annual capacities use factor(%)
1956	600		470		1,368		1,059		33	26
1957	600	0	500	6	1,395	2	1,227	16	32	26
1958	600	0	500	0	1,568	12	1,258	2	36	30
1959	1,100	83	500	0	1,642	5	1,308	4	37	17
1960	1,100	0	580	16	1,799	9	1,572	20	35	19
1961	1,100	0	580	0	1,850	3	1,495	-5	36	19
1962	1,100	0	580	0	2,181	18	1,752	17	43	23
1963	1,100	0	580	0	2,243	3	1,825	4	44	23
1964	1,100	0	583	0	2,217	-1	1,781	-2	43	23
1965	2,175	98	580	0	2,033	-8	1,704	-4	40	11
1966	2,175	0	-	-	2,167	6	1,818	6	-	11
1967										
Average		18.1		2.4		4.6		5.8		

Annex Table 4. Actual Condition of Power Supply in Kg. Cham

Year	Installed capacities kw	Rate of growth(%)	Max. required capacities kw	Rate of growth(%)	Production Mwh	Rate of growth(%)	Consumption Mwh	Rate of growth(%)	Annual load factor(%)	Annual capacities use factor(%)
1956	670		360		1,080		983		33	18
1957	670	0	370	2	1,074	4	1,033	5	33	18
1958	670	0	390	5	1,166	9	888	-14	34	20
1959	670	0	395	1	1,280	10	973	10	37	22
1960	670	0	400	1	1,485	16	1,102	13	42	25
1961	915	37	480	20	1,610	9	1,182	7	38	20
1962	915	0	580	21	1,690	5	1,337	13	33	21
1963	970	6	590	23	1,940	15	1,459	9	37	23
1964	1,026	6	559	-5	1,832	-6	1,379	-5	37	20
1965	1,026	0	500	-10	1,596	-13	1,171	-15	37	18
1966	1,026	0	-	-	1,703	7	1,236	6	-	19
1967										
Average		4.9		6.4		5.6		2.9		

Annex Table 5. Actual Condition of Power Supply in Kg. Thom

Year	Installed capacities kw	Rate of growth(%)	Max. required capacities kw	Rate of growth(%)	Production Mwh	Rate of growth(%)	Consumption Mwh	Rate of growth(%)	Annual load factor(%)	Annual capacities use factor(%)
1956	152		70		185		173		30	14
1957	152	0	78	11	205	11	195	13	30	15
1958	152	0	108	39	234	14	194	0	25	17
1959	152	0	88	-19	239	2	191	2	31	18
1960	152	0	120	37	288	21	234	23	27	22
1961	200	31	120	0	325	13	251	7	31	18
1962	200	0	146	22	468	44	293	17	36	27
1963	152	-24	144	-1	406	-13	307	4	32	31
1964	288	90	154	7	444	9	334	9	32	18
1965	288	0	125	-19	372	-16	292	-13	34	15
1966	288	0	-	-	377	1	300	3	-	15
1967										
Average		9.7		8.6		8.4		6.5		

Annex Table 6. Actual Condition of Power Supply in Pursat

Year	Installed capacities		Max. required capacities		Production		Consumption		Annual load factor(%)	Annual capacities use factor(%)
	kw	Rate of growth(%)	kw	Rate of growth(%)	Mwh	Rate of growth(%)	Mwh	Rate of growth(%)		
1956	100		80		294		172		42	34
1957	150	50	120	50	292	-1	168	-2	28	22
1958	443	195	200	67	315	8	202	20	18	8
1959	443	0	200	0	407	29	232	14	23	10
1960	443	0	210	5	489	20	260	12	27	12
1961	443	0	200	-5	513	5	262	1	29	13
1962	420	-5	260	30	507	-1	263	0	22	14
1963	420	0	260	0	345	-32	234	0	15	9
1964	330	-21	115	-56	226	-34	226	-4	23	8
1965	330	0	200	74	189	-16	189	-16	11	7
1966	330	0	-	-	230	21	230	22	-	8
1967										
Average		21.9		18.1		0		4.7		

Annex Table 7. Actual Condition of Power Supply in Kg. Chhnang

Year	Installed capacities kw	Rate of growth(%)	Max. required capacities kw	Rate of growth(%)	Production Mwh	Rate of growth(%)	Consumption Mwh	Rate of growth(%)	Annual load factor(%)	Annual capacities use factor(%)
1956	330		109		293		281		31	10
1957	330	0	118	8	295	1	295	5	29	10
1958	582	76	250	112	480	62	384	30	22	9
1959	582	0	250	0	482	0	384	0	22	9
1960	582	0	312	25	486	1	397	4	18	9
1961	582	0	250	-20	497	2	403	1	23	10
1962	479	-17	250	0	497	0	486	20	23	12
1963	479	0	250	0	269	-46	263	-44	12	6
1964	310	-35	125	-50	223	-17	223	-15	20	8
1965	630	103	230	84	247	11	247	11	12	4
1966	630	0	-	-	342	38	342	38	-	6
1967										
Average		12.7		17.7		5.2		5.0		