SAMBOR PROJECT REPORT

Lower Mekong River Basin

Volume VI

Fishery

OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

JUNE 1969

SAMBOR PROJECT REPORT

The Sambor Project Report consists of the following eight volumes:

Volume I	General Report (1)
Volume II	General Report (2) — Sambor with Nam Ngum and Pa Mong
Volume III	Dam and Hydroelectric Power — Supplementary Material to Volume I
Volume IV	Irrigation and Agriculture — Supplementary Material to Volume I
Volume V	Navigation — Supplementary Material to Volume I
Volume VI	Fishery — Supplementary Material to Volume I
Volume VII	Basic Data — Appendix (1) to Volume III
Volume VIII	Drill Hole Logs — Appendix (2) to Volumes III and V

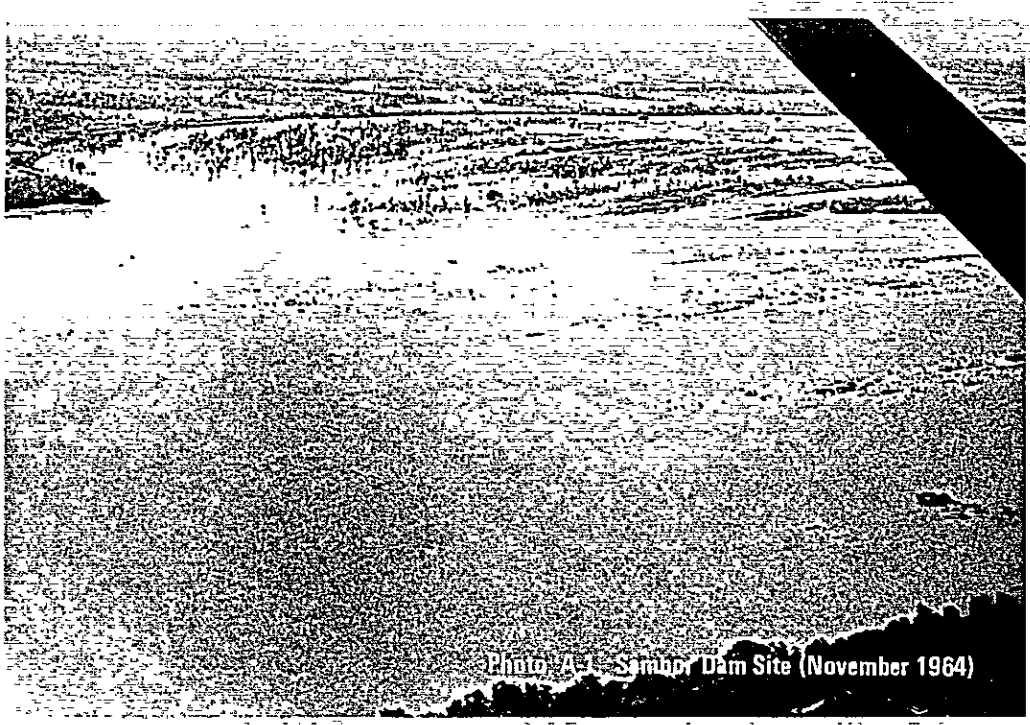
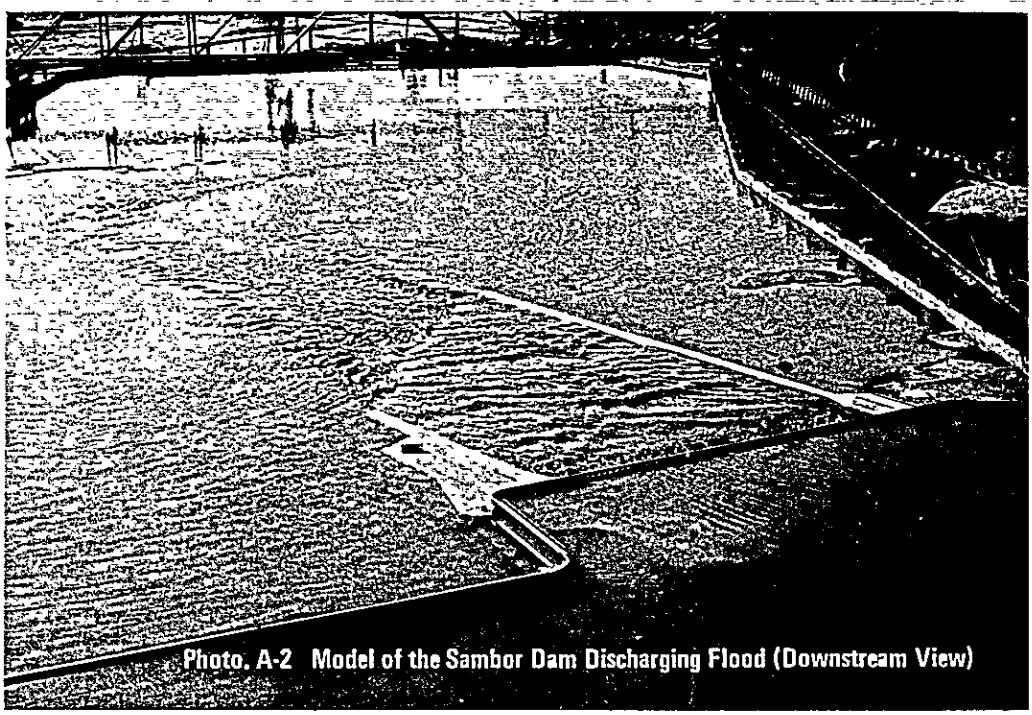


Photo. A-1 Sambor Dam Site (November 1964)



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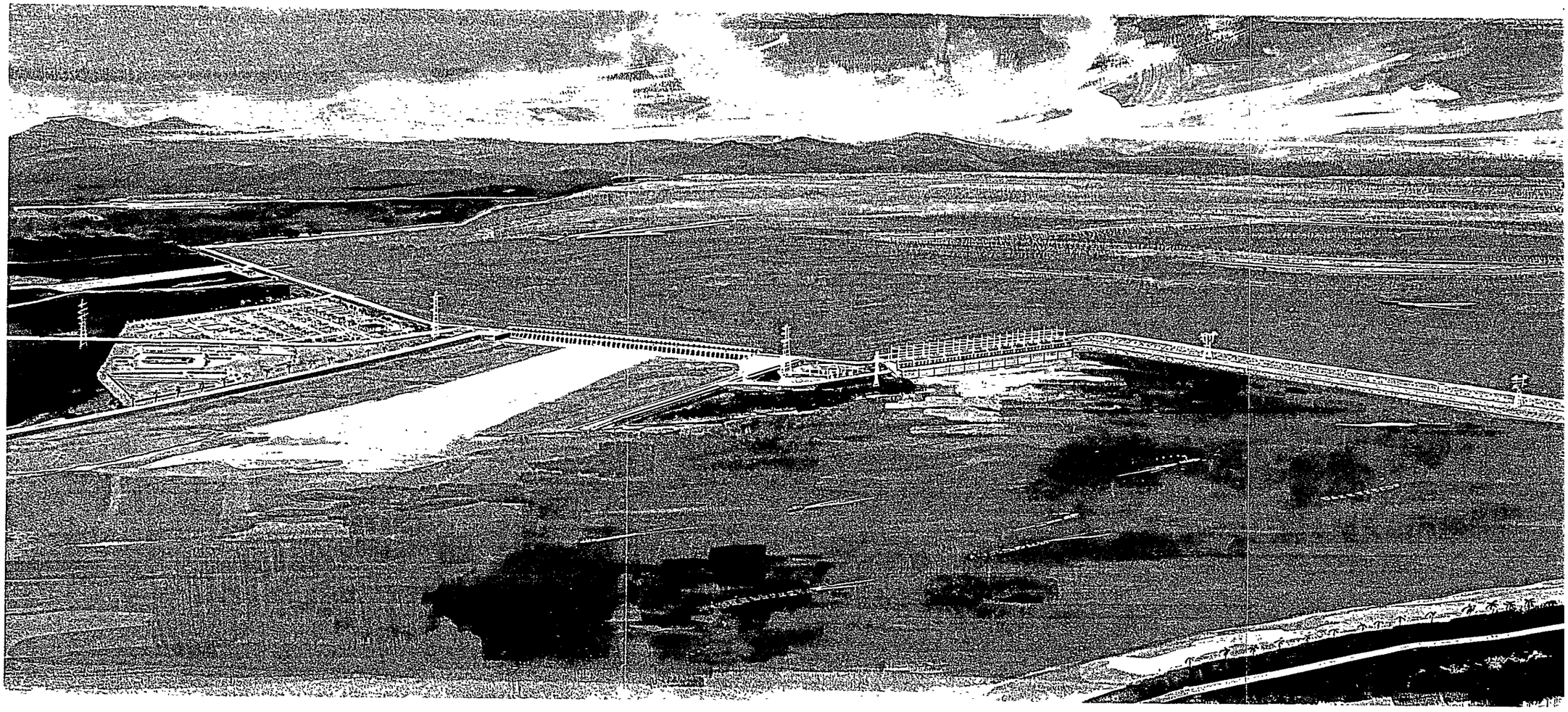
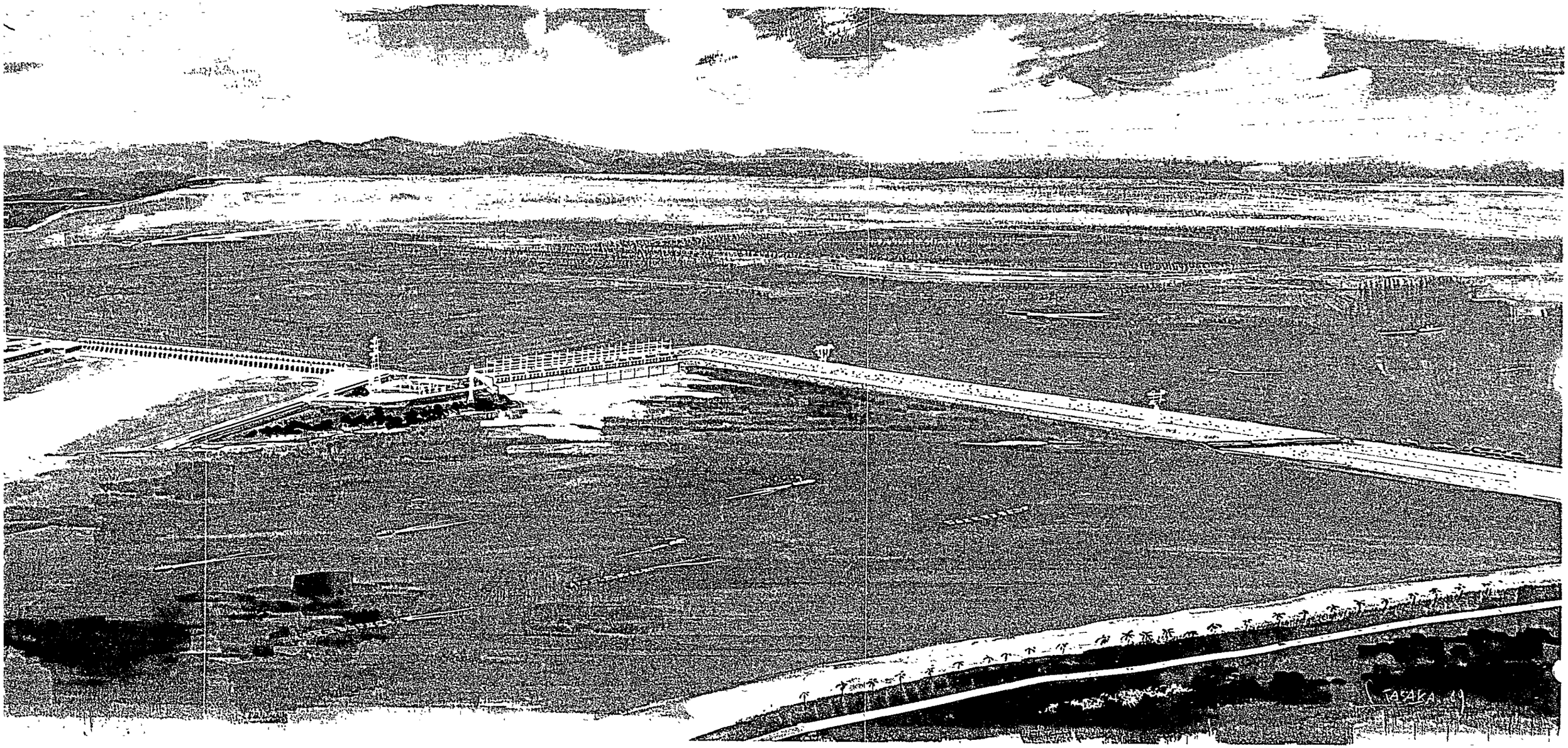


Aerial View of the Projected Sambor Dam



Aerial View of the Projected Sambor Dam

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Supplementary Material to Volume I

OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

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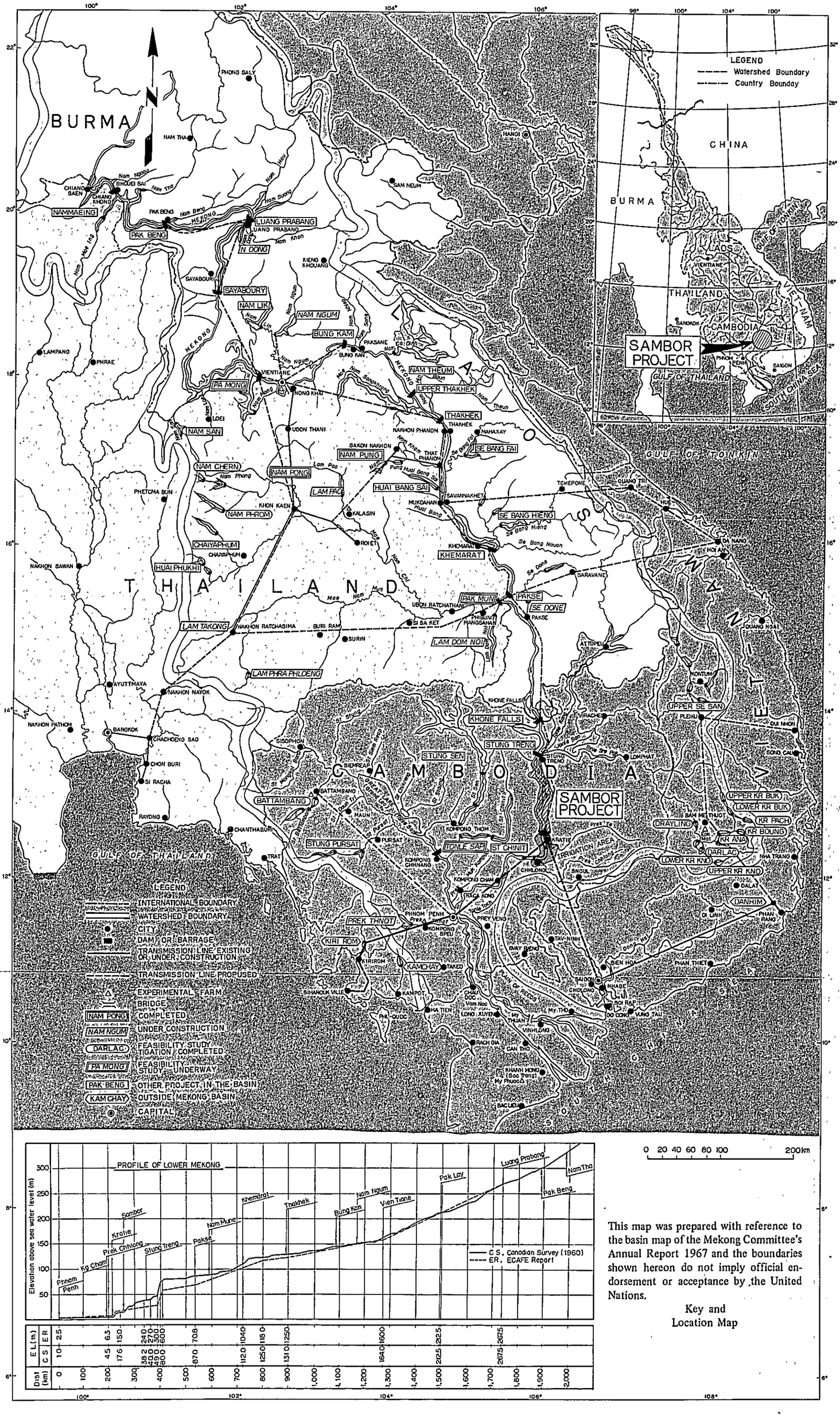
BURMA
THAILAND
LAOS
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CHINA
VIET-NAM
GULF OF THAILAND
GULF OF TONKIN
SOUTH CHINA SEA
SAMBOR PROJECT
LEGEND
Watershed Boundary
Country Boundary
INTERNATIONAL BOUNDARY
WATERSHED BOUNDARY
CITY
DAM OR BARRAGE
TRANSMISSION LINE EXISTING OR UNDER CONSTRUCTION
TRANSMISSION LINE PROPUSED
EXPERIMENTAL FARM
BRIDGE
NAM PONG COMPLETED
NAM NGUM UNDER CONSTRUCTION
DARLAC FEASIBILITY STUDY TIGATION COMPLETED
PA MONG FEASIBILITY STUDY UNDERWAY
PAK BENG OTHER PROJECT IN THE BASIN
KAM CHAY OUTSIDE MEKONG BASIN
CAPITAL
PROFILE OF LOWER MEKONG
Elevation above sea water level (m)
C S, Canadian Survey (1960)
ER, ECAFE Report
0 20 40 60 80 100 200km
This map was prepared with reference to the basin map of the Mekong Committee's Annual Report 1967 and the boundaries shown hereon do not imply official endorsement or acceptance by the United Nations.
Key and Location Map

STUNG TRENG DAM

STUNG-TRENG

MEKONG

To PLEIKU

SAMBOR

SAMBOR RESERVOIR

INCLINED PASAGE FACILITY

POWER PLANT

SAMBOR DAM

SAOP

KRATIE

RIGHT BANK OF PREK TE

PREK PRASAP

Irrigation Canal

IRRIGATION AREA

KANHCHOR

CHHLONG

MEKONG

To Phnom Penh Substation

Transmission line

Access road

To Kg CHAM

Highway

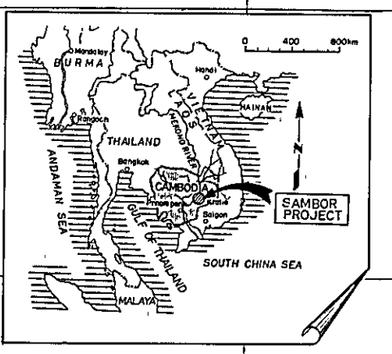
To Saigon Substation

To Kg CHAM

0 5 10km

SAMBOR PROJECT

GENERAL PLAN



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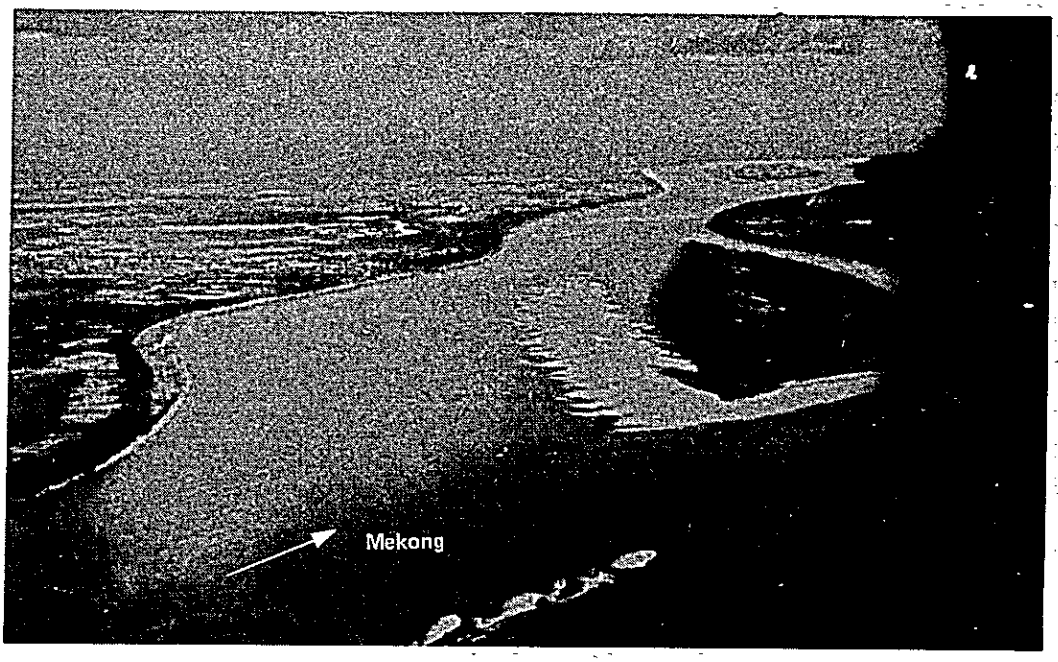

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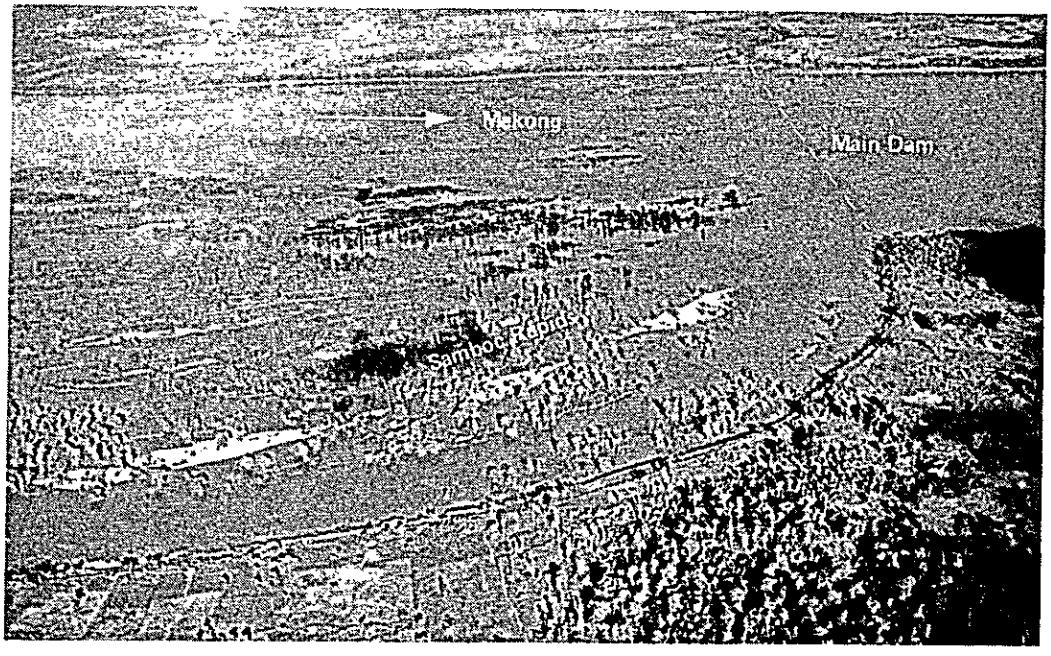

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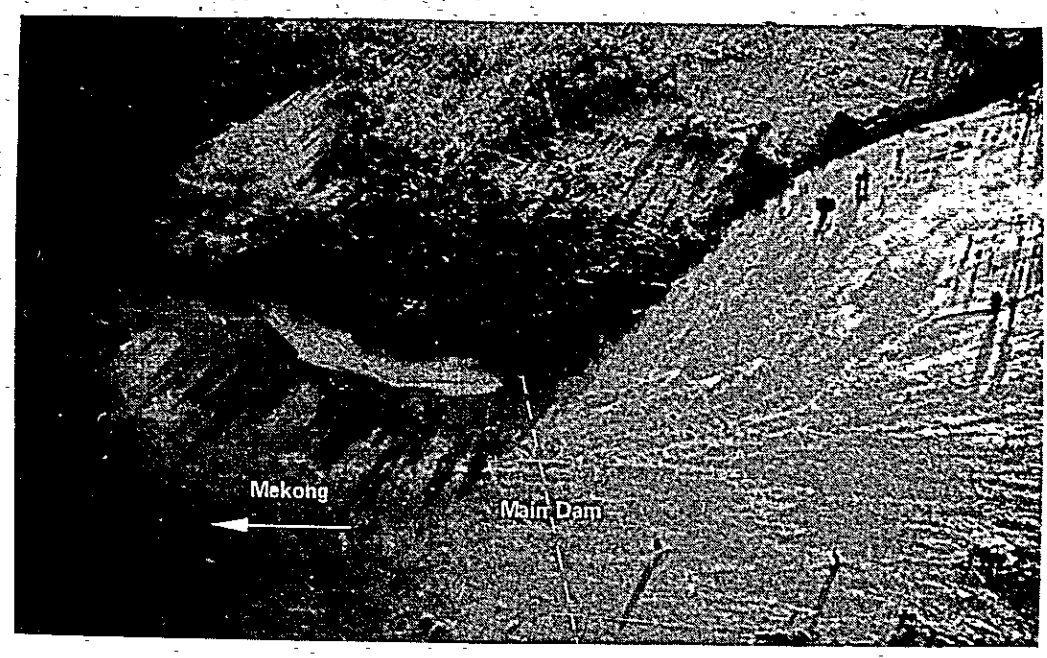

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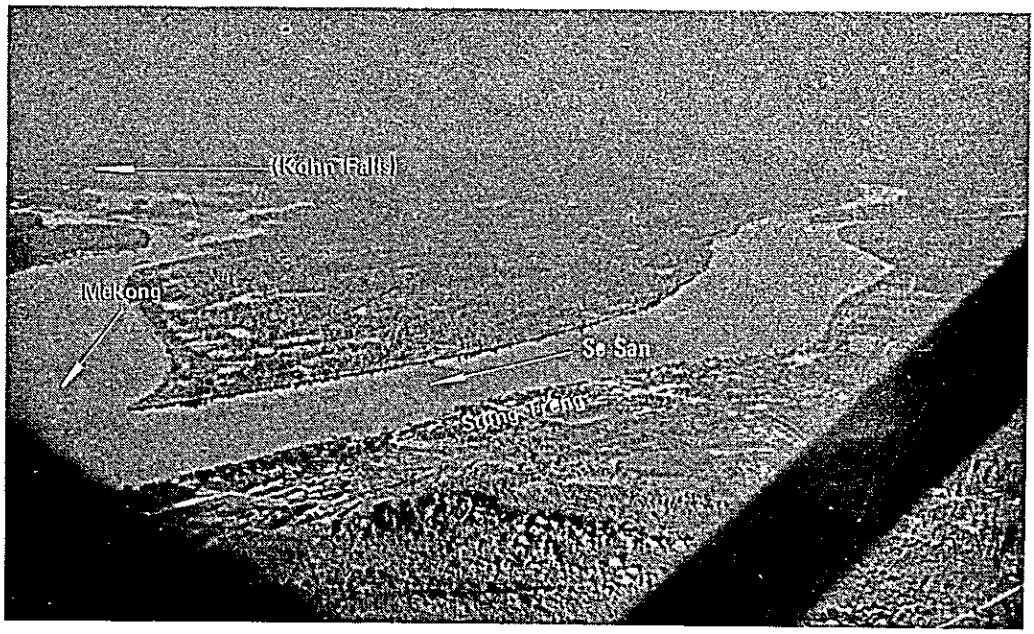

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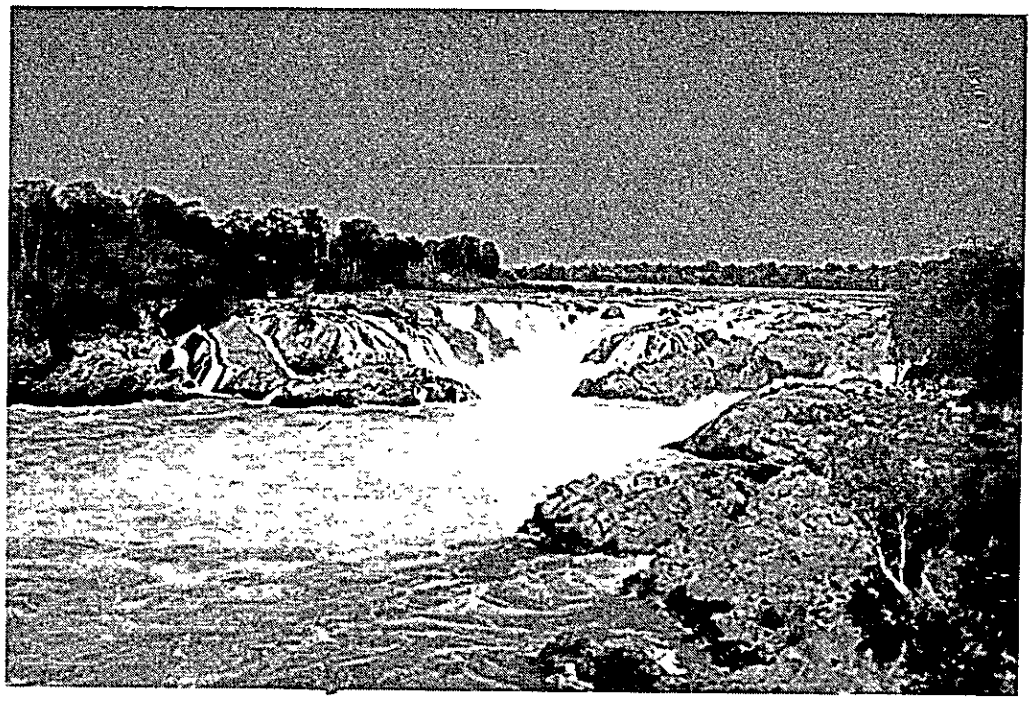

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PART ONE FISHERIES in CAMBODIA with SPECIAL REFERENCE to the SAMBOR PROJECT

Chapter A. CONCLUSION AND RECOMMENDATION

PART ONE FISHERIES in CAMBODIA with SPECIAL REFERENCE to the SAMBOR PROJECT

CHAPTER A. CONCLUSION AND RECOMMENDATION

A-1 Conclusion

As a result of studies and investigations conducted in 1966 and 1967, with respect to the effects of the projected Sambor Dam construction on the migrating behavior of fishes and on the fish resources, the following conclusion has been reached.

(1) Fishes that gather in Quatre Bras Area in the dry season migrate upstream into the Great Lake through the Tonle Sap or up the Mekong mainstream and tributaries and further into swamps. This spawning migration is considered to take place with the advent of the wet season when the waterlevel rises and the flow velocity declines.

(2) If fishes are prevented from migrating up the Mekong by the Sambor Dam, it will cause a decrease of spawning activities in upstream areas of the Dam, which will be inevitably accompanied by production drop of young fishes And this in turn will invite a decrease in the number of fishes that migrate downstream at the beginning of the dry season. The only plausible result, then, would be a decrease in catches in the Mekong, and possibly in the fish resources of the Great Lake Area.

(3) On the other hand, spawners and sea fishes that migrate upstream in the wet season will gather immediately below the Dam where they are liable to be subjected to reckless fishing.

(4) Construction of the Sambor Dam could create a second Great Lake. It is highly probable that the new artificial lake will provide excellent breeding environments for fishes that migrate from upstream areas, and become the center of fish production in northeastern Cambodia.

A-2 Recommendation

Based on the above conclusion, the following recommendation is given.

(A) Since sea fishes and spawners that migrate upstream are considered to assemble in downstream waters of the Dam, it is recommended that the following measures are taken.

1) To investigate the ecology of important species including their anadromous capacity and spawning migration, thereby to obtain data required for the proper construction and rational management of fishways.

2) To prohibit fishing operation in tributaries and downstream waters of the Dam

3) To construct, where possible, fishways provided with lock gates. If this is not feasible, they may be substituted by fish ladders.

4) To construct fishways on either side of the spillway.

5) To provide the fishways with a structure allowing flow control in at least three stages depending upon the reservoir water level. Detailed design of the fishways should, however, be determined upon clarification of anadromous capacity of each important species.

6) To assign one fishery expert who would participate in the control and management of the reservoir and fishways, especially the control of water level.

(B) It is desirable that the new reservoir be fully utilized as the supply center of protein food in northeastern Cambodia. For this purpose, the following measures are recommended to be taken.

1) To stock the reservoir with the fry of the most appropriate species selected after the examples set by India and Thailand, and to separate, in advance, the breeding ground from the growing ground or fishing ground to assure rational management of the reservoir.

2) To conserve fish resources and prevent overcatching through enforcement of a special fishery control law under which to designate fishing period, fishing area, fishing method and the size of catchable fishes; and to place strict control, through the exercise of police power if required, on the overcatching of fry and young fishes which are the source of fish production in the coming seasons.

3) To clear and readjust that part of the prospective reservoir area which should become a good fishing ground so that dragnet, trap and other types of fishing may be efficiently operated when the reservoir is created.

4) To make necessary arrangements in advance for the inducement of fishermen, formation of fishing villages, construction of access roads, as well as provision of crafts.

5) To establish facilities for fish preserve and pisciculture to adjust the seasonal fluctuation of catches and their selling price as well as to enhance the progress of piscicultural techniques.

6) To establish a state training center intended specifically for the provision and dissemination of advanced knowledges and techniques relating to fishing method, fish preserve and pisciculture, freshness retention, processing of catches, etc.

7) To establish commercial circulation routes through which to carry out transactions involving catches as well as equipment and materials required for fishing operation.

Chapter B. OUTLINE AND CHARACTERISTICS OF THE CAMBODIAN FISHERY

CHAPTER B. OUTLINE AND CHARACTERISTICS OF THE CAMBODIAN FISHERY

B-1 Water System with Reference to Fishery

The water system of Cambodia can be roughly divided into the following four water areas.

1) Great Lake Area with adjacent waters
2) Mekong Mainstream Area with tributaries
3) Deltaic Area, south of Phnom Penh
4) Coastal Area facing the Gulf of Thailand

(1) The Great Lake Area with adjacent waters comprises the Great Lake which is the center of fish production, the *forêts inondées* encircling the Lake, and a number of large tributaries emptying into the Lake. In the dry season, the Lake has a maximum depth of as small as 3.6 m and an average depth of about 2 m despite its extensive surface area. With the advent of the wet season, however, its water depth increases to nearly 10 m and its surface area also expands outwardly inundating the surrounding shrubbery zone. Thus, the Lake in the wet season covers an area of 10,000 km^2, trebling its dry season area.

The Great Lake and its vicinities including the *forêts inondées* provide excellent breeding environments, and are generally considered to be blessed with abundant fish production that is enjoyed only in few places of the world. The area therefore serves as the supply center of protein food for the Cambodian people.

(2) In the Mekong Mainstream Area within the Cambodian territory, a number of tributaries flow into the Mekong River on its eastern bank. These tributaries are the Se Kong, the Se San, the Sre Pok and others. This area also has many *Preks* that run downstream in the dry season but flow back in the wet season. These tributaries and *Preks* have a close bearing upon the migration of fishes

Fishes bred and grown in the *forêts inondées* in the wet season migrate downstream at the beginning of the dry season when the water level starts falling, and become the catches in this area.

In the upstream sections of this Area, the fishing period is generally shorter and ends earlier with smaller catches when compared with the downstream areas

(3) The Quatre Bras Area, south of Phnom Penh, or the lower region of the Mekong River may be called the storage area of fishes grown in the Great Lake and the Mekong Mainstream Area.

Accordingly, the fish production in this area is most active from the end of the dry season towards the wet season.

(4) Waters in the Coastal Area facing the Gulf of Thailand are a group of riverines flowing down the southwestern slopes of the Cardamomes and the Elephant. Although heavy rainfall is observed in this area, the fish production is poor due to its steep topography.

B-2 Characteristics of the Cambodian Fishery

Characteristics of the Cambodian fishery can be summarized as follows:

(1) The fish fauna in Cambodia boasts of nearly 200 species which can be broadly classified into "white fishes" such as cyprinoids and "Black fishes" composed chiefly of snake-headed fishes and catfishes Another

outstanding feature of the Cambodian fishery is the abundance of sea fishes in its inland waters that may not be expected in other parts of the world.

(2) The inland waters of Cambodia can be divided into four areas as mentioned in Section B-1. The first three of these areas belong to a single river system, and fishes in Cambodia are considered to migrate throughout these three water areas.

(3) The Great Lake and Mekong Mainstream Areas provide breeding grounds in high water period, and serve as fishing grounds in low water period. On the other hand, Deltaic Area, south of Phnom Penh, serves exclusively as a fishing ground. Thus, each of the three water areas has its own characteristics with respect to breeding, growing as well as production of fishes.

(4) Generally speaking, Cambodia is rather behind with fishery researches particularly in the aspect of ecological studies including spawning and migration habits as well as in the collection and compilation of data on catches. It deserves attention that there still remain many problems demanding immediate solution for the desired promotion of the Cambodian fishery.

Chapter C. EFFECT OF SAMBOR DAM CONSTRUCTION ON FISHERY AND PROPOSED COUNTERMEASURES

CHAPTER C. EFFECT OF SAMBOR DAM CONSTRUCTION ON FISHERY, AND PROPOSED COUNTERMEASURES

If it can be generally concluded that spawners migrate upstream from Quatre Bras Area, the spawning season should coincide with the wet season when the water level rises everywhere in the country. Particularly in the lower basin, the rise in water level results in the decline of flow velocity. It is conceivable that many fishes migrate up the Tonle Sap or the Mekong Mainstream during this period of the year. In other words, it is possible that the migration of fishes, whether for spawning or feeding becomes easier in the wet season when rapids disappear with the rising water level.

In an attempt to substantiate the above assumption, the author studied the ecology of fishes and the directions in which fishing gear are set and further collected information by personal contacts during his three surveys in Cambodia. This, however, produced no data that may be considered acceptably objective.

A large-scale migration as mentioned above does not appear quite plausible when the ecology and activity of fishes are inferred from their feeding habit and the shape of their body. In evaluating the effect of the Dam construction, however, it would of course be safe and advisable to accept and take into account the possibility of the large-scale migration which has been reported by the French Fisheries Survey Team.

C-1 Effects on Downstream Areas and Proposed Countermeasures

Fishes found in the Mekong Basin count 20 species of sea fishes and 100 species of fresh-water fishes The proposed construction of the Sambor Dam would make it impossible, at least for sea fishes, to migrate beyond the Dam, and would subsequently oblige them to remain in downstream waters of the Dam.

In its report issued in 1964, the French Fisheries Survey Commission cites the following six species as important fishes that migrate up upper reaches.

Cirrhinus auratus
Cirrhinus jullieni
Pangasius sutchi
Thynnichthys thynnoides
Pangasianodon gigas
Pangasius sanitowongsei

The Commission states, in the same report, that Nov. – Mar. period is the migrating season of these fishes If the Sambor Dam should hamper the migrating behavior of these fishes, it would possibly invite, on the one hand, a decrease in their catches in upstream waters particularly at the beginning of the dry season due to the limited spawning migration, but would give rise, on the other hand, to an increased catches of both sea fishes and freshwater fishes that migrate from lower reaches and gather in waters immediately downstream of the Dam. It follows that the effect of the dam construction on the fish resources and catches in downstream waters would differ considerably by season. To be more precise, fishes that migrate from lower reaches at the beginning of the wet season would tend to stay in downstream waters of Sambor, i.e., around Kratie. Further, spawning and breeding activitiies would be largely impeded as fewer fishes would be allowed to migrate beyond Sambor This in turn would invite decrease of fry and sea-run fishes that migrate from upper reaches in the dry season.

To cope with this prospective change, the following measures are recommended for dry and wet seasons.

1) Fish preserve and pisciculture should be promoted to provide protein food in the dry season to Kratie, Kompong Cham and other cities.

2) Since fishes that migrate upstream from lower reaches in the wet season are spawners, measures should be taken to lead them safely to their spawning grounds. For this purpose, arrangements would have to be made to allow these spawners to migrate up the tributaries that join the Mekong Mainstream in areas downstream of the Dam, and the Sambor reservoir itself should be provided with adequate facilities that help fishes in their spawning migration. It is desirable that fishing operation be prohibited in the wet season on Prek Te, Prek Chhlong, Prek Sandeh and other tributaries that flow into the Mekong downstream of the Dam.

C-2 Effects on Upstream Area and Countermeasures

The major effect on upstream areas resulting from the Dam construction would be the decrease of spawners that migrate to upstream waters in the wet season, and this in turn would invite a drastic decrease of young fishes that migrate downstream in the dry season.

It is to be noted, however, that there actually are few fishes that migrate as far upstream as Kratie, and that the new reservoir, which will be 1,157 km^2 in surface area and 30 m in depth, would provide excellent breeding grounds of fishes. Fishes bred in the new reservoir would migrate to upstream waters in the wet season, and young fishes bred and grown in the upstream waters would migrate downstream in the dry season to the reservoir.

The construction of the Sambor Dam is not therefore considered to create any appreciable decrease; the fresh-water fish resources in upstream areas, though it would certainly hamper the migration of sea fishes. It follows that there is no necessity to take any particular measures for the preservation of fish resources in the upstream areas of the dam.

C-3 Characteristics of Sambor Reservoir, and Measures for Fishery Promotion Therein

C-3-1 Characteristics of Sambor Reservoir

The high productivity of the Great Lake may be attributed to the constant circulation of its surface water caused by its small depth as well as to the fact that it is protected by the encircling *forêts inodées*. The prospective fish production in the reservoir to be created at Sambor depends largely on the characteristics of the reservoir which are given below.

Area: The surface area of the new reservoir will be 1,150 km^2, and almost equals half the dry season area of the Great Lake.

Shore development: When observed in terms of contour at El. 40 m, the coast line presents quite an intricate pattern and extends over a length of 884 km. The shore development is 7.00, from which high production of fish is expected.

Water depth: The 40 m maximum depth of turbid water is too large and far from favorable condition for fish production. Further, since the dam site is in the windless area, the bottom water of the reservoir may become deficient oxygen. Generally speaking, however, the average depth of 8.7 m, which is almost equivalent to that of the Great Lake, is considered to promise plentiful fish production comparable to the Great Lake.

Vegetation: Due to the small variation expected in water level, the vegetation in Sambor District, which would otherwise provide excellent spawning grounds like those of the Great Lake, is not considered effective enough as a spawning ground. Further, growth of water lilies in the dry season is expected to give adverse effects on the desired fish production.

Fish fauna: Many migrating fishes that live in running water have been found in this section of the Mekong due to its high flow velocity. With the creation of the reservoir, it is evident that bottom dwellers and migratory fishes would breed in this area. It is also probable that this area would provide excellent environments for those fishes that gather here in the dry season and migrate upstream for breeding in the wet season.

C-3-2 Measures for Fishery Promotion in the Reservoir

Considering the high probability that the Sambor Reservoir would become a second Great Lake in its fish production, it is desirable that the following measures be taken for the effective and efficient utilization of its fish resources.

(1) Enforcement of Fishery Control Law: Protection of fish resources in the Reservoir and its downstream waters should be effected through enforcement of Fishery Control Law under which to designate closed areas, and fishing period as well as to place restrictions on the kind and quantity of catches.

(2) Preparation of fishing ground: *Forêts inondées* in the area where fishes are likely to gather should be cleared to create a fishing ground suitable to dragnet and trap fishing, with due consideration given to the convenience of landing and circulating catches. Access roads leading to the fishing ground should also be constructed in advance.

(3) Facilities for fish preserve and pisciculture: It will be required to store fishes alive when catches are good, and this will be particularly important in this area. This transitory fish preserve, whose techniques have substantially progressed in Cambodia, should be further promoted in combination with the development of piscicultural facilities, whereby fishes caught may not only be preserved alive but also fed and grown for off-season supply and for transportation to mountainous districts where fishes are hard to obtain.

(4) Fishery education: It is expected that many of fishing gear and methods hitherto employed in the Mekong would prove impracticable in the newly formed reservoir. Establishment of a new training center would therefore become an imperative to give instructions and training on the new fishing techniques compatible with the conditions of the Reservoir. In addition to providing trainees with rational fishing techniques, the training center is desired to positively play the role of disseminating the techniques of protecting fish resources and utilizing catches most effectively.

(5) Efficient utilization of catches: It is desirable to establish facilities intended for storing fishes without losing freshness and processing them most rationally. For the efficient utilization of catches, establishment of transportation system should also be prompted.

C-4 Fish Ladder

When the migrating behavior of fishes mentioned above is taken into due account, it appears imperative that the Sambor Dam should be provided with fishways through which fishes may be allowed to migrate upstream.

The following description deals with two different kinds of fishway, i.e., fishway with a lock gate and that with fish ladder.

C-4-1 Fishway with Lock Gate

The fishway with a lock gate, though considered suitable for cyprinoids, catfishes, snake-headed fishes and other fishes having limited anadromous capacity, is disadvantageous in that its construction demands a high cost. For the Sambor Dam, therefore, it is proposed that a canal with a lock gate be considered for utilization as fishway passage if its construction might be adopted in place of the presently planned inclined system which is intended for navigation purposes.

C-4-2 Fish Ladder

The fish ladder is the most common type of fishway and its construction at the Sambor Dam may safely be considered adequate. At the present stage, however, no precise and explicit description can be given regarding its structure due to the lack of data on the ecology of fishes that migrate up and down the Mekong. The following description therefore deals only with the position, principal structure and water control of the fish ladder.

It is known that fishes generally migrate up a river along its banks where the flow velocity is small. At the Sambor Dam, however, fishes are expected to migrate along either side of the flow of massive water which will be discharged from generators and spillway in the wet season. This clearly indicates that the fish ladder should be constructed along either side of the spillway.

With respect to the structure, lack of information on the anadromous ability of various migrating fishes renders it impossible to prepare any rational design. It is tentatively proposed that the fish ladder be designed, to have at least three passages so that the water level and velocity may be maintained at an appropriate value depending on the reservoir water level. This will enable fishes to migrate up along one of the three passages.

The estimated reservoir water level in the anticipated migrating season (June through August) is El. 40 m. In some years, this could drop to less than EL39.2 m in early June, but rises again to exceed EL 39.2 m in early to late June. Since the low and high water levels are thus EL 39.2 m and EL 40 m respectively, the height of the fish ladder intake has been determined in three stages, i.e., 39.2 m, 39.6 m and 40 m above sea level.

It is to be noted that values given above are rough values based on estimation and should be revised with the progress of investigation.

The Sambor Reservoir is primarily intended for power, irrigation and navigation purposes, however the good production of fish is also expected. It is therefore recommended that at least one fishery expert be permanently stationed at the Reservoir Management Office so that he may participate in the control and management of the new artificial lake and also perform the following work.

1) Maintaining a proper flow in the fish ladder, particularly during the migrating season (May through October).
2) Prevention of uncontrolled fishing operation to protect fishes that gather immediately below the Dam.
3) Prevention of sudden and drastic drop of reservoir water level in the spawning season (August through October).
4) Collection of data that will be required for the control and management of fishways and reservoirs to be constructed in the future.

Heartfelt gratitude is hereby expressed to the officials of the Royal Government of Cambodia whose unlimitting cooperation and invaluable assistance made the surveys successful as scheduled.

Mr. Sao Lean, former Chief of Cambodian Fisheries Services, Chiefs of Fisheries Offices at Stung Treng, Siem reap and Kompong Cham, etc.

PART TWO REFERENCE
(General Observation on Cambodian Fisheries)

Chapter A. ITINERARY AND SURVEY SITES

To ichthyologists, the southeastern areas embodying Cambodia are quite well-known as one of three important regions of the world whose fish fauna has not yet been clarified. With the diversity of fishes already clarified in the southeastern waters, these areas are considered one of the original areas of fishes, where lots of data can be collected that incite keen academic interest.

The author, Dr. Yoshikazu Shiraishi, had the opportunity to visit Cambodia twice in 1965. The objective of his visit was to study on problems involved in the proposed fishway construction for the Sambor Dam. During the 80-day survey period, he carried out the sampling of fishes from all Cambodian waters, and conducted surveys on water temperature, water quality, microorganisms and other environmental conditions. He also collected data on fishing gear, fishing method, catches, disposition and circulation of catches and other data related to fisheries.

The author is fully cognizant of that data collected and compiled in this report can hardly stand comparison with the multitide of data that have been gathered in the past over many years and on a much larger scale by France and the United States. This report merely reflects the author's humble hope that the information he has collected may serve to provide the basis for future surveys that Japan may undertake in Cambodian waters.

The author avails himself of this opportunity to express his gratitude to Mr. Sao Leang, former Chief of Fisheries Services, Mr. Ek Van, former Chief of Kompong Chnnang Fisheries Division and Chiefs of other Fisheries Divisions for their kind cooperation as well as the officers of the Development Survey Division, Overseas Technical Cooperation Agency as well as of the Fisheries Agency whose kind arrangement have made the survey possible.

CHAPTER A. ITINERARY AND SURVEY SITES

Maximum efforts were made to visit and survey as many places as possible within the 40-day period allowed for each survey. (See Table VI-1).

The total distance covered during the two survey trips in Cambodia was about 4,000 km, four times the distance from the northern tip to the southern end of Japan.

The survey revealed that the solution of various problems involved in the fishway construction at Sambor calls for a full-scale and detailed survey on practically every aspect of fisheries, including inland water characteristies, identification and classification of fishes, fishing, disposition and circulation of products, and so forth. Necessity for such a wide scope of survey is primarily due to the extreme deficiency of relevant data and the marked difference existing between Cambodia and Japan with respect to the fisheries in general and fish fauna

Efforts were therefore directed towards collecting as much data as possible within the limited time allowed for the survey. However, the 80-day survey period was far from sufficient to collect enough data, particularly on ecological conditions, fisheries management, disposition and circulation of catches, etc. It is therefore hoped that further surveys be made in the future on these items.

Table-VI Itinerary

1st Survey			2nd Survey		
(Date)		(Place)	(Date)		(Place)
From	To		From	To	
Jan. 10, '65		Tokyo - Phnom Penh	Oct. 31, '65		Tokyo - Phnom Penh
Jan. 11 -	Jan. 17	Phnom Penh	Nov. 1 -	Nov. 4	Phnom Penh
Jan. 18 -	Jan. 21	Kratie	Nov. 5 -	Nov. 7	Kratie
Jan. 22 -	Jan. 25	Stung Treng	Nov. 8 -	Nov. 9	Kompong Cham
Jan. 26–	Jan 28	Kompong Cham	Nov. 10 -	Nov. 11	Kampot
Jan. 28 -	Jan. 30	Kep	Nov. 12 -	Nov. 13	Phnom Penh
Jan. 30 -	Feb. 5	Siemreap	Nov. 14 -	Nov. 16	Siemreap
Feb. 6 -	Feb. 8	Battambang	Nov. 17 -	Nov. 18	Battambang
Feb. 9 -	Feb. 13	Phnom Penh	Nov. 19 -	Nov. 22	Phnom Penh
Feb. 13 -	Feb. 20	Phnom Penh - Tokyo	Nov. 22 -	Nov. 24	Kratie
			Nov. 24 -	Nov. 26	Stung Treng
			Nov. 27		Kompong Cham
			Nov. 28 -	Dec. 1	Phnom Penh
			Dec. 2 -	Dec. 4	Kompong Cham
			Dec. 5 -	Dec. 10	Phnom Penh
			Dec 11 -	Dec 18	Return to Tokyo via Formosa

Chapter B. CHARACTERISTICS OF INLAND WATERS

CHAPTER B. CHARACTERISTICS OF INLAND WATERS

B-1 Natural Conditions

Geographically, Cambodia extends east to west within 10 – 15 N. Lat and 102 – 108 E. Long. It borders on Vietnam, Thailand and Laos, faces the Gulf of Thailand, and is situated within the area subjected to the tropical monsoon. The country covers an area of approximately 180,000 km^2.

When viewed topographically, it consists of the Elephant and the Cardamomes extending in the southwest, the Cambodian Plateau stretching in the northeast, and the alluvial plain surrounded by these ranges and the plateau. This alluvial plain can be broadly divided into two areas, i.e., the Mekong Basin Area in the east through which the Mekong Mainstream runs north to south, and the area extending around the Great Lake.

Since the country is located in the tropical zone, the temperature is high throughout the year, In Phnom Penh, the capital city of the country, the temperatures averages 27.4° C, with the highest value observed in April (29.4° C) and the lowest in December (25.4 °C). Although there are slight fluctuations in August and July, i e., rises in August and drops in July, the annual temperature change is negligibly small.

The cold monsoon blowing from northeast during the period from November to April brings no rain. In the remaining half of the year, i.e., from May to October, the rain-laden southwesterly wind blows from the Indian Ocean, producing lots of rain all over the country. The annual rainfall of more than 1,100 mm, observed at many places in the country, is due in effect to the wet season rainfall.

The dry season and the wet season are quite distinctly divided throughout the country. In Phnom Penh, for example, the maximum rainfall (252 mm) is observed in October, while the minimum value (7 mm) is recorded in January. Generally, there are not more than 15 rainy days during the Dec. - Apr. period when the monthly rainfall registers no more than 100 mm in Phnom Renh or even in Kas Moul located south of the Elephant ranges.

In the wet season which last from June to November, however, the monsoon brings lots of rain. In Phnom Penh, one observes as many as 105 rainy days, annual rainfall of 1,217 mm, and monthly rainfall of about 180 mm. Districts extending in the south of the Cardamomes ranges are known for intensive rainfall which rangaes from 450 mm to 850 mm per month. The highest annual rainfall recorded there is 7,971 mm (1927). In Kas Moul, located in one of the above-mentioned districts, a monthly rainfall of as much as 255 mm was observed in August 1925.

Thus, the country can be meteorologically divided into three areas, i.e., (1) the central plain with somewhat continental climatic conditions, where the annual rainfull marks about 1,500 mm. In this area, the temperature rises considerably in the dry season, while in the wet season, flood waters innundate all its area, (2) the northern plateau with highly continental climatic features such as extreme temperature difference between days and nights, (3) the southeastern coastal area delineated by the Cardamomes where flourishing jungles are found blessed by the high temperature and lots of rain.

Inland waters of Cambodia are subjected to these different climatic conditions and reflect the sharp distinction between the dry and the wet seasons.

B-2 Water System

As illustrated in Fig. VI-1, Cambodia can be divided into four areas with respect to its inland waters These are: (1) the Mekong Mainstream Basin, (2) the Great Lake Area with tributaries flowing into it, (3) the southeastern

Deltaic Area where many canals are found. In this area, the Mekong is joined by the Tonle Sap and then branches into the mainstream and the Bassac; and (4) the coastal area with riverines empty into the Gulf of Thailand.

The fact that former three areas are embodied in a single river basin which occupies the greater portion of the country will convince anyone of the vastness of its water system.

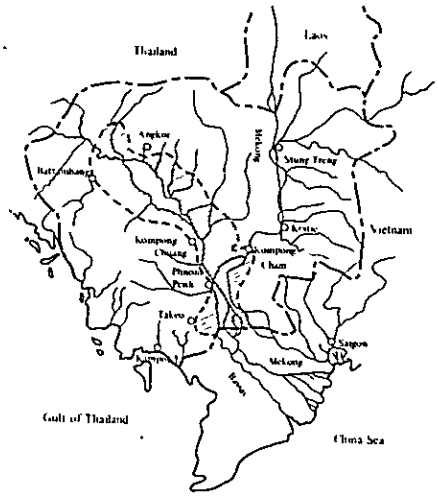


Fig. VI-1 Water System of Cambodia

Note: 1) Area delineated by the dotted line shows the inundated are in the wet season.
2) Broken line indicates the border line.

O: Ditches that can be stepped over.
Ong: Rapids that flow with rushing current in the wet season, but dry up in the dry season.
Prek: Rivers that flow back in the high water season.
Sung: Long tributaries.
Khong: Rivers.
Tonle: Rivers or large rivers

Lakes and marshes are also classified into two groups, i.e., *Trapeang* (swamp or marsh) and *Beng* (lake).

All these waters are subject to seasonal transfiguration from time to time which may be one of the outstanding features of tropical waters.

In addition to natural lakes and swamps, there have been built a total of 47 man-made lake in the country. These are intended primarily for flood control and irrigation, but are used for storage of drinking water as well.

(1) Mekong Mainstream Basin: The Mekong, the 9th largest river in the world, rises in the Tibetan Plateaus of El. 5,000 m, flows through mainland China, Thailand, Laos, Cambodia and Vietnam, and into the China Sea in the south of Saigon. The total length of the river is 4,200 km. In the Cambodian territory, the river covers a distance of about 500 km.

In the upper reaches of the river, i.e., from its source to as far down as Vientiane, rocky stretches and falls are found at many places where the navigation is quite difficult even for small crafts.

This section of the Mekong has not many tributaries.

Between Vientiane and Kratie (Cambodia), the river is navigable in certain limited sections, however at Khemerat, Khone and Sambor, rapids and falls are hindering navigation in the dry season. There are a number of tributaries that flow into this section of the Mekong.

Tributaries that join the Mekong Mainstream on the left bank within the Cambodian territory rise in the mountainous area stretching along the border line of Cambodia and the adjoining two countries, Laos and Vietnam. Largest of these tributaries are as follows:

The Se Kong, the Se San, and the Sre Pok (these join the Mekong near Stung Treng);

The Preah and the Krieng (these dry up in the dry season)

The Prek Te (this has the countercurrent in the wet season).

All of these tributaries present markedly different appearances by season. In the wet season, all of them have voluminous discharge and large width. With the advent of the dry season, however, most of them get dried up into small brooks that flow along the bottom of the river bed, rending the navigation utterly impossible, while some get covered with water lilies (See Photo 1 - b), or dry up completely until the last drop of water. An interesting feature peculiar to Cambodian rivers is that some of them, called *Preks*, flow downstream in the dry season but flow back in the wet season.

(2) The Great Lake Area: The Great Lake, which gathers water from many tributaries, flows out through *Veel Pok* (low-lying district) into the Tonle Sap which joins the Mekong at Phnom Penh. A little downstream of Phnom Penh, the Mekong again branches into two streams, the Mekong Mainstream and the Bassac, forming a vast fertile area called the "Four-Arm Area" where abundant fish populations are found.

The lake is encircled by "Cambodia's granary area" and is known for the drastic seasonal change in its surface area. As the water level rises in the wet season, its water surface expands outwardly to cover an area three times as wide as it is in the dry season. It is for note that this change in surface area has a close bearing on the Cambodian people.

The Great Lake Area can be divided into three districts, i.e., *Beng Tauch* which is usually called the "Petit Tauch," *Beng Thom* or the Great Lake, and the low-lying district called *Veel Pok* where sandy islets are found scattered. In the dry season, these three districts combined which is 150 km in length and 32 km in width cover approximately 3,000 km^2 of area. This vast water surface of the lake expands outwardly as the water level rises in the wet season until it extends over an area of 10,000 km^2. This is about three times its dry season area. (See Figs. VI-1 & 14)

Tributaries flowing into the Great Lake are quite productive in that they provide water required for the cultivation of the Cambodian Plain, the country's "granary area," and also serves to create the *forêts inondées*, which encircling the lake, offer one of the most valuable area in fish production in Cambodia.

On the left bank of the lake are found large tributaries which, rising in the northeast of the Lake, flow from the Dangrek and run through the northern plateau into the Great Lake Area.

These are: the Sreng, the Siem Reap, the Roluos, the Chikreng, the Staung and the Chinit.

On the right bank of the lake are a number of tributaries that flow from the jungles near the Cardamomes and run northwards. These are: the Monkor Borei, the Sanker, the Dountri, the Pursat, and the Babaur.

All the above-mentioned tributaries, combined with the Great Lake and the surrounding *forêts inondées*, form the center of fish production in Cambodia.

(3) Quatre Bras Area: The Tonle Sap which connects the Great Lake and the Mekong Mainstream is known for one outstanding feature: in the wet season, the water of the Mekong flows back through the Tonle Sap into the Great Lake, and in the dry season, the Great Lake overflows into the Tonle Sap, resulting in a rise of as much as 10 m in the water level of the Tonle Sap.

The Tonle Sap joins the Mekong Mainstream near Phnom Penh, and a little downstream of Phnom Penh, the Mekong branches into the mainstream and the Bassac. The area extending from the junction of the Tonle Sap and the Mekong Mainstream as far southward as the river mouth in Vietnam is so-called the Deltaic Area which is covered by a well-developed network of canals. In the dry season, fishes migrate from upstream waters into this area. And as the water level rises in the wet season, these fishes migrate upstream into the Great Lake and the Mekong Mainstream for spawning Thus, the Quatre Bras Area provides important exploitable fish populations.

(4) Coastal Area Facing Gulf of Thailand: As already mentioned, abundant rainfall is observed in the south-western slopes of the Cardamomes. Rivers in the Coastal Area are unexceptionally short, with many rapids and falls found in their upper reaches. As they reach the level land, they follow a zigzag course through mangrove woods until they empty into the Gulf of Thailand. A point to be noted about these short rivers is that sections near the river mouths are susceptible to the effects of tides. These rivers are: the St. Rusei Chrum, the St. Kep, the St. Chai Areng, the Pr. Kg. Sam, the St. Cah Sla, etc.

Upstream sections of these rivers are rapids; navigation is possible only in the lower reaches where canoes are used for fishing and transportation.

B-3 Surface Area and Water Volume

All inland water of Cambodia are subjected to large seasonal changes in surface area, of which the Great Lake is a typical example.

In the dry season, the Great Lake has a maximum depth of 3.6 m and an average of 2.0 m, covering an area of 3,000 km^2. Thus, the lake is so wide even in the dry season that its extension as viewed from one side of it ends in a haze. And at the offshore of this vast water surface are found floating houses and dragnets hung, which is rather queer at a first glance. The entire lake, shallow and presenting shore-side conditions of lakes of Japan, offers many valuable fishing grounds.

But in the wet season, the lake's water surface which is quite so wide in the dry season, expands drastically as large tributaries carry voluminous water into it and an immense amount of water (21 billion tons) flows back into it from the Mekong through the Tonle Sap. This results in an approximately 10 m rise in the lake's water level, whereby the shrubbery zone encircling the lake is completely submerged. The submerged forests are known as the *forêts inondées* (see Fig. VI-1). The change in water surface resulting from the seasonal inflow or outflow of water is almost astounding, and it is difficult for us to realize the fact.

This extreme seasonal change in water level is also seen in the Mekong Mainstream and tributaries. Many of the tributaries, which are either dried up or transformed into small brooks flowing along the bottom of deep valleys in the dry season, regain voluminous water as the wet season commences, and resume their large and turbid flows This marked fluctuation in water level is often manifested by river banks in the dry season which stand as high as 10 m above the river bed.

The Cambodian Plain, noted for its plentiful paddy production and called "one of the word's richest granaries," is no exception. In the dry season, the entire plain presents an appearance of dry field area, with not a single brook nor a drop of water detectable, allowing cattlecarts to go freely in any direction. Once the wet season visits, however, the plain is immediately and totally transformed into paddy fields.

Although the seasonal difference in water surface is thus very large, it is not accompanied by the correspondingly large change in the water depth or water volume. For instance, the Great Lake in the wet season gains 45 billion tons. This, however, is not small amount at all. Anyone would be convinced of the hugeness of 45 billion tons of water. It is believed that during the few months that cover the end of the wet season and the beginning of the dry season, the water that flow out of Great Lake into the Mekong through the Tonle Sap amounts to 48.66 billion tons, or approximately the total water volume of the Lake. A little less than half this volume, or 21 billion tons of water, flows back into the Lake from the end of the dry season until the beginning of the wet season.

The vastness of these figures will be better understood if comparison is made with those in Japan: The 40-m high Sambor Dam on the Mekong Mainstream is designed to make use of 2,000 tons - 3,000 tons of water per second as against 40 tons of water utilized at the 112-m high Ikari Dam in Japan. Yet, the maximum available depth of the Sambor Dam is no more than 1 m. Further, the annual discharge of the Tone River (Japan) amounts only to 11 billion tons; the water consumption of the whole Tokyo Metropolis is about 500 million tons per year or 17 tons per sec.

B-4 Water Level

The water level variation is one of the outstanding features of Cambodian inland waters. Fig. VI-2 shows the changes in water level observed throughout a year on the Andal (a tributary of the Mekong), the Mekong Mainstream, and the Tonle Sap. As is clear in the figure, the water level drops to the lowest around the end of the dry season (April to the end of May), when no water is found in many places of the country, inclusive of paddy fields, dry fields, rivers, lakes, etc. During this period, one would often find such districts that are so devastatingly dried up that one would wonder how people get necessary water there.

But in June, rain starts falling, and in three months from August to October, muddy waters cover every part of the country as if the whole country were submerged.

In the Mekong, the difference between the maximum and the minimum water levels ranges from 10 m to 17 m (see Table VI-2). Even at Stung Treng, which is located far upstream about 680 km from the sea, the seasonal change in water level is as much as 9 m - 10 m. At Kratie, located a little downstream of Stung Treng, the discrepancy becomes larger, marking a 15 m - 17 m level, and river banks stand steep 17 m above the water in the dry season, making it extremely difficult for passengers to embark or disembark the boats.

The Samboc Rapids, located 4 km north of Kratie, runs through the area where a large reservoir is proposed to be constructed. In the dry season, this section of the Mekong is not navigable because of the rushing current, but it turns in the wet season into a vast and voluminous flow of water.

Fig. VI-2 Seasonal Change in Water Level and Flow Velocity of the Andal, the Mekong and the Tonle Sap

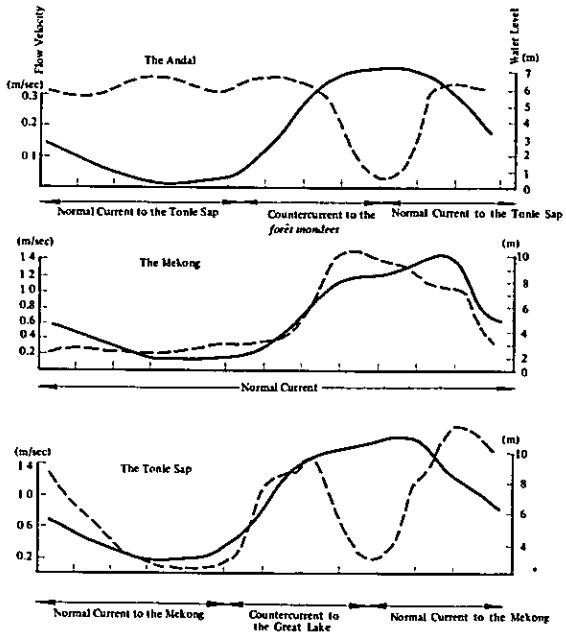


Table VI - 2 Changes in Water Level of the Mekong (EL at Hai Tiem)

(Unit: m)

Selected observation points	Distance from river mouth (km)	1961			1962		
		Max. level	Min. level	Difference	Max. level	Min. level	Difference
Stung Treng	680	48.30	38.20	10.10	47.27	38.36	8.91
Kratie	547	21.32	4.02	17.30	19.84	4.22	15.62
Kompong Cham	437	14.45	1.32	13.13	13.70	1.07	12.63
Phenom Penh	332	9 95	0.68	9.27	9.20	0.73	3.47

Table VI-2 indicates that the highest water level does not always coincides with the maximum flow velocity except in the mainstream whose flow velocity increases proportionally to the rise in the water level created by the flood water and snow-thawing in the upper reaches. It is known that the flow velocity suddenly drops after the highest water level is attained. This phenomenon occurs on the Andal, the Tonle Sap and many other tributaries that flow into the Mekong, and is attributed to the countercurrent which is observed after the maximum water level is attained. This backflow of water is seen every year is *Preks* that lead to the *forêts inondées* spreading on either side of the Mekong as well as in those tributaries that flow into the Great Lake.

Each year, a grand water festival is held at Phnom Penh when the high water level of the Mekong is about to subside. Tradition says that as the ruler of the country calls loudly to the Tonle Sap, it stops the countercurrent flow and starts to run downstream.

B-5 Water Temperature

Very little data are available on the temperature of Cambodian inland waters. The only information which the author knows now available is found in the *French Fisheries Report* (1963) and the *Harza Report* (Harza Engineering Co., 1967 & 1968). According to these two reports, the water temperatures are higher in the dry season than in the wet season. Temperature readings recorded in the wet season (around the end of August) are: 30°C in paddy fields and stagnant waters, 28°C - 29°C (surface water) and 26°C - 28°C (bottom water) in the Great Lake, 29°C or more in the shaded water in the *forêts inondées* and at the bottom of the Great Lake. A noteworthy fact about the dry season temperature is that values observed around the beginning of the season (November - December) are higher than those in the latter part of the season (January - February).

Table VI-3 shows the temperature distribution of inland waters in the dry season as obtained from more than 100 observations which the author carried out during his stay in Cambodia. Temperatures observed during the first two months of the dry season (November - December) in rivers, lakes and stagnant waters ranged from 28°C to 32°C, 31°C being the value observed most frequently. Relatively low temperatures were observed in northern Cambodia, e.g., 22.5°C in springs and 24°C in rivers. Further, some difference in temperature was generally observed between the surface water and bottom water; in waters not exceeding 1 m in depth, the surface water recorded an average of 33°C, while the bottom water registered 31°C at many places. Temperatures observed in the last two months of the dry season (January - February) were lower than these values. While the surface water temperature ranged from 28°C to 29°C, the bottom water temperature was as low as 25°C - 26°C. In deep wells in Angkor-Wat and in shaded waters, the temperature was not more than 24°C - 25°C.

These findings of the author show some discrepancy when compared with temperature data collected by the French Survey Team. It may as well be pointed out here that the observation made by Mr. Takakura, the Water Works Bureau of Phnom Penh produced the same results as the author's with respect to the surface water temperatures of the Mekong (See Fig. VI - 3). Mr. Takakura's observation revealed that the surface water of

the Mokong shows the lowest temperature of about 27°C in January, rises slightly in the wet season to about 28°C, then ranges from 28°C to 29°C in the beginning of the dry season.

Table VI-3 Frequency Distribution of Temperature in Dry Season Cambodian Inland Waters

C°	Surface water	Bottom water
20		1
21		
22		
23		1
24		2
25		
26		3
27	2	
28	7	2
29	9	6
30	8	11
31	15	11
32	4	11
33	3	14
34	1	3
35		3
36		1
37		1
No. of observations	49	70
Average temp.	30.1°C	30.9°C

Fig. VI-3 Changes in Water Properties of the Mekong throughout One-year Period (Observation made by Mr. Takakura)

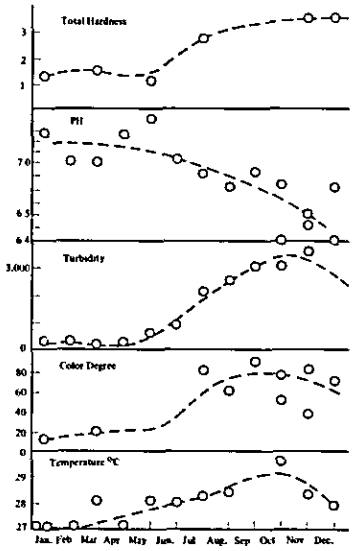


Fig. VI-4 24-Hour Transition of Water and Atmospheric Temperatures Observed on the Tonle Sap from Feb. 10 to 11, 1965

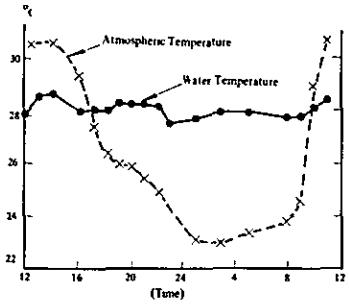


Fig. VI-4 shows the changes in atmospheric and water temperatures within 24-hour period observed on the Tonle Sap from February 10 to 11, 1965. The figure shows a daily fluctuation of 7°C in atmospheric temperature but indicates no appreciable change in water temperature which maintains 28°C level throughout the one-day period. The stability of water temperature is ascribed to the huge water volume of the river which is just too voluminous to reflect any sizable change in atmospheric temperature.

In the vicinity of Bokor (EL 1,075 m), there were observed a number of rivers whose temperature stood at 20°C level. In the Koh Sla, one of larger rivers found near Bokor, the thermometer pointed to 24°C. These values are quite low in comparison with those observed in other parts of the country. It is to be noted that waters in high lands have temperatures as low as 20°C.

The highest mountain in Cambodia is Mt. Au Ral (1,813 m) which is 50 km northwest of Phnom Penh. A chain of mountains are found along the Cardamomes stretching in this district, but none has an elevation exceeding 1,100 m. Mountains in the northwest of the country are similarly low, ranging from 800 m to 900 m in height. Waters in these mountain systems are accordingly considered to have the lowest temperature of about 20°C.

Throughout the year, the Cambodian waters retain temperatures close to values observed in the summer in Japan at the surface waters of low-lying lands. The high water temperatures thus maintained all the year round provides excellent hydrobiological conditions for planktons and other aquatic lives on which fishes feed, bringing about lots of catches in many kinds of fishes.

B-6 Turbidity

One of the prominent characteristic of the Mekong is its high turbidity. It is no exaggeration at all to say that all Cambodian waters are muddy, with a few such exceptions as well waters, ponds in Buddhist temples, rapids flowing out of jungles and mountainous districts (see Photo 1 - a). The turbidity of the Cambodian waters, which becomes particularly high in the dry season, is attributable to a number of different causes as described below.

(1) The turbidity of the Mekong Mainstream and its tributaries is caused because they carry soil particles washed away from the banks along their long course of voyage.

(2) The Great Lake becomes as shallow as 2 m - 3 m in the dry season. Hence, a slight undulation of the water surface agitates the soft, muddy bottom to make the lake as turbid as it always is.

(3) Virtually every part of Cambodia gets inundated in the wet season (see Photo 1-b). As the waters recede with advent of the dry season, stagnant waters, brooks, ditches, etc. become very muddy as people rummage and drain them to catch small fishes (see Photo 2-a).

The turbidity of the Cambodian waters is so extreme that it is often impossible to see through 10 cm deep waters. Only exception to this are the ponds carefully preserved within the premises of Buddhist temples, where fishing is prohibited for religious reasons. These ponds are inhabited by belonoids, snake-head fishes and catfishes, with such emerging plants as lotus flourishing on them (see Photo 1-g).

An old saying, "A clear stream is avoided by fish," is quite true with the Cambodian inland waters which, blessed with lots of diversified and exploitable fishes, present features common to all inland waters is south-western Asia. It is considered that the vigorous vertility of fishes in these muddy waters will present questions of immense interest to ichthyologists and limnologists.

The data given in Fig. VI-3, prepared by Mr. Takakura based on his own observations, are the only objective information now available on the seasonal change of the turbidity in the Mekong over the one-year period. As the figures clearly indicate, the turbidity of both the Mekong and the Tonle Sap increases during the transitory period from the wet to dry season. It reaches a maximum value in Sep. - Nov. period when the water starts falling. This is due to the fact that as the water level declines, the corrasion of river banks and river beds becomes more intensive and soil particles are increasingly washed away into the river. The turbidity declines substantially towards the end of the dry season.

Muddy soils accumulated on the Mekong banks are the deposits of fine soil grains that have been carried from the far upstream glaciers in Tibetan Plateaus. Once such deposits are washed away by the turbulent flow of rivers, they do not easily precipitate but keep suspending in the water, often carried over the border line into the China Sea. These fine suspension grains, washed away in the stream off the river banks on which they have been repeatedly deposited, are, as it were, "bleached soil grains" having not much nutrient salts despite the intensive turbidity they create (see Table VI-4).

Table VI-4 Water Properties of the Mekong and the Tonle Sap
(Based on Observations by Mr. Takakura)

	The Tonle Sap			The Mekong		The Bassac
	July 1965	October 1965	Nov. 1965	Oct. 1965	Nov. 1965	Nov. 1965
Color degree	—	30	18	70–80	35	22
Turbidity	—	—	2500	3000	3000-3500	2500
pH	7.0–7.6	6.8	6.7	6.4	6.5	6.2
RpH	—	—	7.6	—	—	—
Total hardness	2.0–2.8	—	3.0	—	2.9	2.9
TAC	7.0	5.6	5.6	4.4	5.2	5.2
Fe mg/*l*	0	0.6	0.6	1.2	—	—
Carbonic acid	27.5	—	—	—	—	—
Specific resistance (Ω)	—	8000	—	9500	—	—

B-7 Water Properties

Records of observations made by Mr. Takakura are the only data available at present on the chemical properties of the Cambodian inland waters. These records, as shown in Table VI-4, reveal that the water of the Mekong and the Tonle Sap indicates a weak acidity (pH 6.0 - pH 7.0) during the first two months of the dry season (October and November), though slight alkalinity is observed occasionally. This may be considered due to the geological conditions of the country where basalt layers and effusive rock layers are found in many places, with the Quaternary formation developed estensively in the mountainous and hilly areas. Most rivers rising from these mountainous areas have a weak acidity which, for instance, proved to be as low as pH 4.6 in one spring. It is to be noted, however, that stagnant waters and lakes are often slightly alkaline. Table VI-5 shows frequency distribution of pH obtained in 110 points in Cambodia during the dry season. In contrast to the dominantly alkaline waters in Japan, the Cambodian inland waters showed weak acidity at 72 points, weak alkalinity at 27 points, and neutrality at 12 points. Fig. VI-5, showing pH values at different places of Cambodia, indicates that most rivers and spring waters are weakly acidic (with one conspicuous pH value 4.6 observed in a spring water in the north-western district of the country), and that stagnant waters and lakes occasionally show an alkalinity exceeding pH 8.0.

Table VI-5 pH Distribution in Cambodian Inland Waters

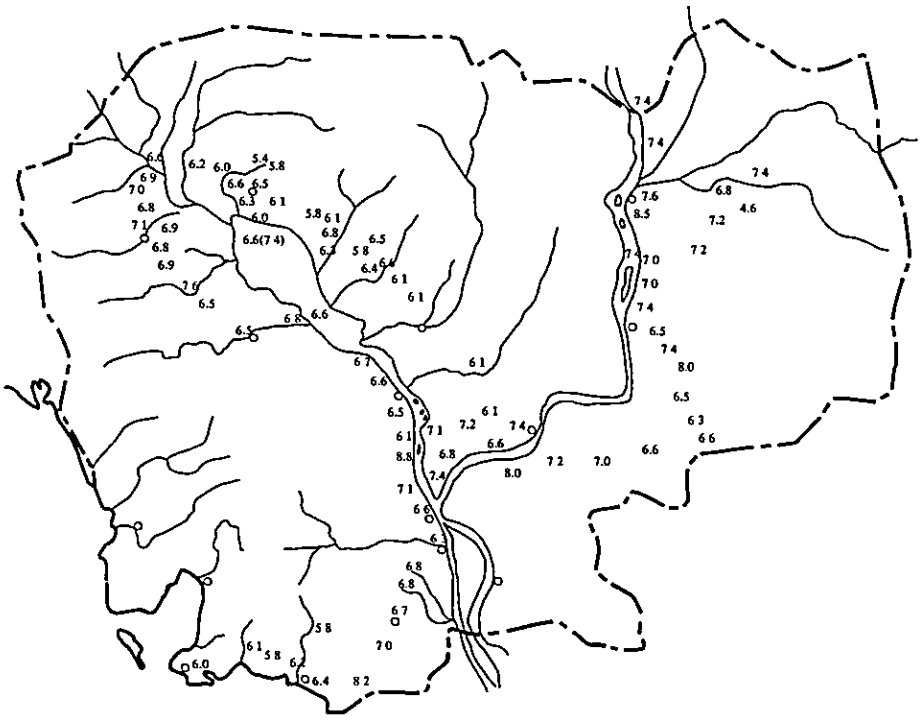
Range of pH value	Cambodia	Japan
-5.8	6	1
5.9-6.2	15	8
6.3-6.6	18	28
6.7-7.0	24	50
7.1-7.4	11	58
7.5-7.8	4	25
7.9-8.2	3	13
8.3-8.6	2	3

As indicated by the pH curve shown in Fig. VI-3, the water of the Mekong generally presents a weak alkalinity at the end of the dry season when the water level is low; but in the transitory period from the wet to the dry season, when the water level starts falling, it takes on the acidity. This phenomenon may be explained, by the active assimilation of phytoplanktons which is accelerated by the falling water level around the end of the dry season, and by the inactivated assimilation attributable to the rising water level and turbidity in the wet season, by which the aforementioned geological conditions becomes a more influential factor than at the end of the dry season.

Fig. VI-3 also indicates that the hardness curve is approximately in parallel with the turbidity curve, i.e., low at the end of the dry season, and increasing in the wet season when organic matters from the land flow into rivers, reaches a maximum value at the beginning of the dry season.

The high specific resistance of 8,000Ω - 9,000Ω (dry season value), shown in Table VI - 4, indicates that an extremely small quantity of conductive chemical materials is contained in the water of the Mekong, suggesting a poor productivity of the river water. In actuality, however, it is inhabited by lots of fishes, introducing problems for which future studies are awaited.

Fig. VI-5 pH Distribution in Cambodia



B-8 Summary

8) Summary: Characteristics of Cambodian inland waters may be summarized as follows:

(1) Water system in Cambodia can be considered to comprise the following four areas:

(a) Great Lake Area with tributaries flowing into it, (b) the Mekong Mainstream Basin, (c) the Tonle Sap and Deltaic Area south of Phnom Penh and (d) small rivers emptying into the Gulf of Thailand.

(2) A prominent seasonal change is observed in the surface area of the Great Lake. The surface area, 3,000 km^2 in the dry season, expands outwardly in the wet season to cover an area of 10,000 km^2 embodying the *forêts inondées.*

(3) Change in water level is also prominent, ranging from 2 m to 10 m in the Great Lake, and reaching more than 17 m at some points of the Mekong Mainstream.

(4) The lowest water temperature is observed in Jan. - Feb. period, and the highest during the transitory period from the wet season to the dry season.

(5) All inland waters, excepting temple ponds and rapids in upper reaches, are muddy all the year round registering as high turbidity as 3,000 degrees during the transitory period from the end of the wet season to the beginning of the dry season.

(6) The pH values indicate weak alkalinity when the assimilation of phytoplanktons is active, but weak acidity is observed at many places.

(7) Despite their high turbidity, inland waters of Cambodia contain very poor chemical materials.

(8) Inland waters can be classified as tabulated below (Table VI-6).

Table VI - 6 - Classification of Inland Waters of Cambodia

	Flowing water	Stagnant water
Clear waters	Stream water in mountainous water pH value– acid Temperature < 25°C	Lake and pond water pH value– alkaline Temperature: 28°C– 30°C
Turbid waters	Lower River water pH value–neutral Temperature: 25°C–30°C	Stangnant waters other than lakes and ponds pH value– alkaline Temperature > 30°C

As tabulated above, Cambodian inland waters can be classified into clear waters and turbid waters, each subdivided into flowing water and stagnant water having different pH values and temperatures.

(9) The most outstanding characteristic of the Cambodian inland waters is the substantial seasonal difference observed in their level, volume, turbidity, temperature and other properties.

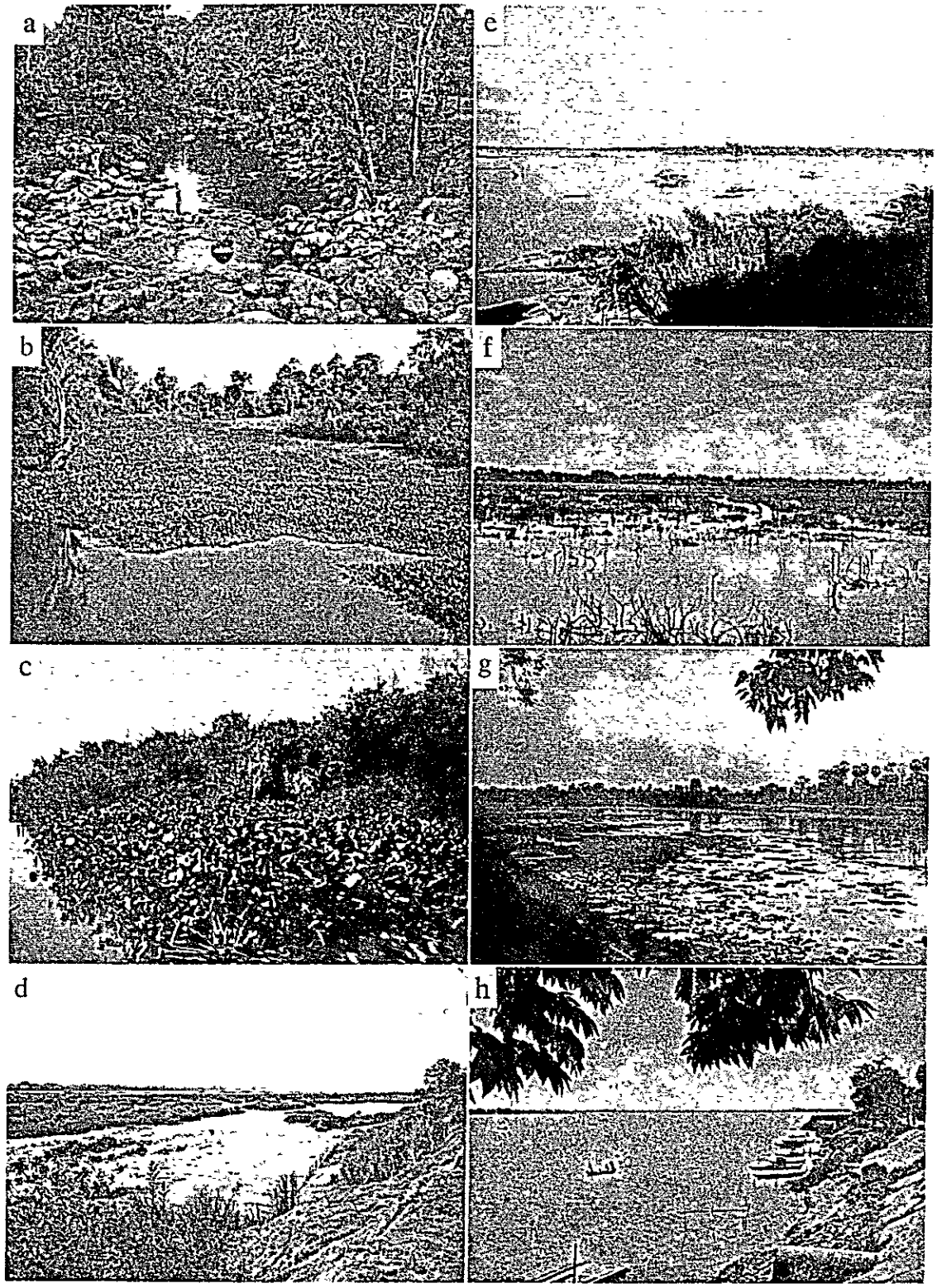


Photo 1. General Views of Cambodian Fresh Waters

a The Stung Chral, one of the few rapids found in the mountainous districts. About 10 species of fish were collected in this rapid, among them were found cyprinoid fishes which inhabit only in flowing water

b A typical example of dry season rivers. Water lilies cover the stagnant water surface, and fishes die of the lack of oxygen

c The *forêts mondées* at the beginning of the dry season, where water lilies flourish.

d Samboc Rapids in the dry season. Trees grow on numerous rocky islets found in the rapids, and snowy herons live in flocks. The rapids turn into a section of the vast Mekong stream in the wet season.

e: The Mekong Mainstream near Kratie at the beginning of the dry season. A floating house is seen about the middle of the river

f: An inundated paddy field at the beginning of the dry season that provides excellent environments for fishes

g: A pond surrounding a Buddhist temple, where floating weeds and water lilies flourish and fishing is prohibited.

h. The Mekong Mainstream. Its seasonal water level change reaches 10 m

Chapter C. FISH FAUNA AND ITS ECOLOGICAL CONDITIONS

CHAPTER C. FISH FAUNA AND ITS ECOLOGICAL CONDITIONS

C-1 Fish Fauna

In Japan, one often hears elders say, "There used to be a lot more fishes when I was young." It appears that the decrease in fish populations is as considerable in Cambodia as in Japan. The following traditions of Cambodia tell of the abundance of fish the country was once blessed with.

(1) If you fish at night with a lamp in one hand and a harpoon in another, you never miss a catch wherever you may cast the harpoon.

(2) The Cambodian housewife never worries about the dish for supper because she always finds fish in her water-pail.

(3) Barbels of catfish sometimes fill the water surface on a rainy day.

(4) You can see dead fish lying everywhere in Cambodia.

At present, the fish populations in Cambodia cannot be considered to be so voluminous as these traditions suggest.

Even so, Cambodia and the surrounding areas are considered one of the original sites of fishes, and kinds of fishes identified in Cambodia are quite diversified

While there are only about 70 kinds of fresh-water fishes (including brackish-water fishes) in Japan, 200 kinds of fishes have already been identified in Cambodia despite the fact that the fishery research activities of the country are more or less behindhand. Fishes seen on the market alone count as many as 50 kinds. In Thailand, more than 700 different fishes are said to have been identified.

The French Fisheries Survey Team, which carried out a large-scale survey work from 1961 to 1963, reported that there are 144 kinds of larger fishes and 44 kinds of smaller fishes in Cambodia. And the number of identified fishes is, as shown in Table VI-7, on a steady increase.

Table VI - 7 - Classification of Fishes in Cambodia

Classified by	Family	Genera	Species
Bardach (1959)	30	91	176
Rene Lioze (1964)	34	101	198
Ek Van (1964)	38	102	202

In Table VI-8, which lists up all fishes that have hitherto been found and identified in Cambodia, there different mark, ⊙, ○ and △, are placed before the species to indicate the economically most important species, the species having the second-degree importance, and the sea-water fishes, respectively. Further, ● and ○ marks are put at the end of species to indicate whitefishes and blackfishes, for which explanation will be given under a separate item.

Table VI - 8 - List of Fishes Identified in Cambodian Waters

	Carcharinidae			*Osteochilus brachynotopterus*	
△	*Scoliodon sorrakowah*		⊙	*Osteochilus melanopleura*	○
	Socoliodon Walbeehmii			*Osteochilus Schlegeli*	○
	Pristidae			*Osteochilus vittatus*	○
△	*Pristis microdon*		○	*Osteochilus hasselti*	○
	Dasybatidae			*Osteochilus triporus*	
△	*Dasybatus imbricatus*			*Osteochilus spilopleura*	
△	*Dasybatus krempfi*	○	⊙	*Cirrhinus auratus*	○
	Notopteridae		⊙	*Cirrhinus jullieni*	○
○	*Notopterus notopterus*	○		*Cultrops siamensis*	○
○	*Notopterus chitala*	○		*Cosmochilus harmandi*	○
	Clupeidae			*Cosmochilus pellegrini*	○
○	*Setipinna melanochir*	○	⊙	*Hampala macrolepidota*	○
△	*Lycothrissa crocodilus*	○	○	*Cyclocheilichthys enoplos*	○
△	*Coilia macrognathos*	○		*Cyclocheilichthys apogon*	○
△	*Corica geniognathus*	○		*Cyclocheilichthys repasson*	
△	*Clupeiodes borneensis*	○		*Cyclocheilichthys siaja*	
△	*Clupea thibaudeani*	○		*Cyclocheilichthys armatus*	○
△	*Clupea kanagurta*			*Cyclocheilichthys mekogensis*	
	Cobitidae			*Puntioplites proctozysron*	○
	Botia hymenophysa	○		*Puntius binotatus*	
	Botia modesta	○		*Puntius brevis*	○
	Botia morleti	○		*Puntius bulu*	○
	Acanthopsis choirorhynchus	○		*Puntius orphoides*	○
	Cyprinidae			*Puntius bramoides*	○
	Chela mouthoti	○	○	*Puntius javanicus*	○
	Chela oxygastroides			*Puntius elongatus*	
	Chela coeruleo			*Puntius chola*	
	Paralaubuca typus	○		*Puntius altus*	○
	Paralaubuca harmandi	○		*Probarbus jullieni*	○
	Paralaubuca siamensis			*Balantiocheilus melanopterus*	○
	Paralaubuca stigmabrachium	○		*Barbichthys leavis*	○
	Macrochirichthys macrochirus	○		*Barilius guttatus*	○
	Rasbora argyrotaenia	○		*Labeo erythrura*	○
	Rasbora aurotaenia		⊙	*Labeo chrysophékadion*	
	Luciosoma bleekeri	○		*Labeo erythropterus*	○
	Luciosoma setigerum	○		*Labeo pleurotaenia*	
	Esomus danrica			*Labeo prûol*	
	Oxygaster oxygastroides	○		*Labeo stygmapleura*	○
⊙	*Leptobarbus hoeveni*	○		*Varicorhinus dyocheilus*	
○	*Catlacarpio siamensis*	○		*Tylognathus bo*	
	Catla catra			*Tylognathus lehat*	
	Amblyrhynchichthys truncatus	○		*Tylognathus falcifer*	
	Amblyrhynchichthys altus			*Gyrinocheilus aymonieri*	○
	Xenocheilichthys loppei	○		*Gyrinocheilus pustulosus*	○
○	*Albulichthys krempfi*	○		*Gyrinocheilops pennocki*	
⊙	*Dangila siemensis*			*Crossochilus latius*	
	Dangila cuvieri	○		*Crossochilus cobitis*	
	Dangila spilopleura	○		*Crossochilus gnathopogon*	
	Psilorhynchus aymonieri			*Crossochilus cambodgiensis*	
⊙	*Thynichthys thynnoides*	○		Clariidae	
	Thynichthys bo	○	⊙	*Clarias batrachus*	

Clarias nieuhofi ●
Clarias fuscus

Siluridae

⊙ *Wallago attu* ○
Wallago leerii
Wallago miostoma ○
○ *Belodontichthys dinema* ○
Penesilurus bokorensis
Silurodes hypophthalmus
○ *Callichrous bimaculatus* ○
Cryptopterus schilbeides ○
Cryptopterus cryptopterus
Soccobranchus fossilis
Cryptopterus cheveyi
⊙ *Cryptopterus apogon* ○
Cryptopterus micronema
Cryptopterus bicirrhis

Plotosidae

Plotosus canis

Pangasidae

Helicophagus waandersi
Helicophagus hypothalmus
○ *Pangasius nasutus* ○
○ *Pangasius pangasius*
Pangasius polyuranodon
⊙ *Pangasius macronemus* ○
○ *Pangasius sutchi* ○
Pangasius burgini
⊙ *Pangasius larnaudi* ○
Pangasius sanitowongsei
Pangasius beani
⊙ *Pangasius micronemus*
Pangasius altifrons
Pteropangasius culturatus
⊙ *Pangasianodon gigas* ○
Ambliceps mangois

Bagaridae

Bagarius bagarius ●
Glyptosternum sp

Ariidae

Arius microcéphalus
Hemipimelodus daugueti
Hemipimelodus cochlearis
Hemipimelodus siamensis
Hemipimelodus bornensis ●
Hemipimelodus macrocephalus
Osteogeneiosus militaris
Batracocephalus mino

Bagridae

Macrones nigriceps ●
Macrones micracanthus
Macrones vittatus ●
Macrones wolffi
Macrones wychkii
○ *Macrones nemurus* ●
Macrones planiceps
Macrones rubicauda ●
Begrichthys hypselopterus
Bagroides macropterus ●
Bagroides macracanthus ●
Heterobagrus bocourti ●
Leiocassis albicollaris
Leiocassis siamensis ●

Synbranchidae

Monopterus albus
○ *Synbranchus bengalensis* ●

Ophichthyidae

Ophichthys rhytidoderma

Syngnathidae

△ *Microphis boaja* ○
Syngnathus spicifer ○

Scombresocidae

△ *Tylosurus strongylurus* ○
△ *Xenentodon canciloides*
△ *Hemiramphus mocquardianus* ○
△ *Zenarchopterus ectuntio*
△ *Zenarchopterus buffoni*

Polynemidae

△ *Polynemus longipectralis* ○
△ *Polynemus borneensis*

Ophicephalidae

Ophicephalus gachua
⊙ *Ophicephalus striatus* ●
⊙ *Ophicephalus micropeltis* ●
Ophicephalus melanopterus
Ophicephalus siamensis
Ophicephalus lucius ●

Anabantidae

⊙ *Anabas testudineus* ●
Macropodus opercularis
Osphronemus siamensis
Osphronemus goramy
Trichogaster microlepis ●
Trichogaster siamensis
○ *Trichogaster trichopterus* ●
Trichogaster pectoralis ●
Ctenope vittatus
Betta splendens
Betta taeniata

Centropomidae

△ *Lates calcarifer* ○
Ambassis wolffi ○
Ambassis ranga ○

	Sciaenidae				
⊙	*Pseudosciaena soldado*	○	⊙	*Oxyeleotris marmorata*	●
	Nandidae			*Glossogobius giuris*	○
	Nandus nebulosus	●		Rhynchobdellidae	
○	*Pristolepis fasciatus*	●		*Mastacembelus armatus*	●
	Lobotidae			*Mastacembelus favus*	●
	Datnioides microlepis			*Mastacembelus circumcinctus*	●
	Toxotidae			*Mastacembelus argus*	
	Toxotes chatareus	○		*Mastacembelus maculatus*	●
	Toxotes microlepis	○		*Rhynchobdella aculeata*	
	Scombridae			Tetrodontidae	
△	*Cybium cambodgiense*	○	△	*Tetradon cambodgiensis*	○
	Soleidae		△	*Chonerhinus modestus*	○
△	*Synaptura orientalis*	○		Anguilidae	
△	*Synaptura krempfi*			*Anguilla japonica*	
△	*Cynoglossus microlepis*	○		*Anguilla mauritiana*	
	Gobiidae				

C-2 Migration of Sea Fishes into Rivers

An interesting fact about the fish fauna in Cambodia is that so many salt-water fishes are found in the Great Lake, the Tonle Sap, and even in fresh waters 400 km - 500 km upstream of the mouth of the Mekong Mainstream. According to Mori et al (1959), 27 kinds of salt-water fishes, or 15% of all fishes identified, were caught in the *"forêts inondées"* as well as in purely fresh waters like lakes and ponds. These include scombroids, rays, flat-fishes, needlefish, swellfish, clupeoids, etc., and their catches are not small.

In mainland China, swellfish are often found in rivers and lakes; and in Burma, the author found swellfish and belonoids in lakes. The diversity and quantity of sea-water fishes found in fresh waters of Southeast Asia may be considered to give a clue in genetically tracing fishes to their origin.

One of mammals, which people call mermaid, is generally found in the sea, but this aquatic mammals is quite often found in the Mekong. Specially in the wet season, it is seen in rivers more than 500 km upstream of the mouth of the Mekong. When the nursing season comes, the adult female attract people's attention with her falling mamma.

C-3 Whitefishes and Blackfishes

Fishes living in Cambodian inland waters are usually classified into two groups, i.e., the migratory fishes including carps, silvercarps, etc. which are also called *"Poissons Blance* (Whitefishes)," and the bottom fishes like catfishes, snake-head fishes, etc. which are called *"Poissons Noirs* (Blackfishes)."

In Table VI-8 given above, whitefishes and blackfishes are respectively distinguished by ○ and ● marks placed after their names. Whitefishes have silvery scales, and feed upon planktons. Being intensively migratory, they move into the Great Lake or migrate back into the Mekong depending on the water level. In the transitory period from the wet to the dry season, therefore, losts of fishes migrate from the *forêts inondées* into the Great Lake and downstream sections of the Mekong.

In constrast to this, blackfishes live near the bottom water and feed on insects and small fishes, and do not migrate to other areas when the water level falls. Instead, they stay in stagnant waters in the *forêts inondées,* and are caught by housewives, or become the game of dragnet fishing and lots fishing in the lakes and rivers during the dry season.

C-4 Spawning Migration and Spawning Season

The spawning migration can be most clearly seen in the fishes of the Great Lake. Their migration into the surrounding forests commences with the rise in water level in wet season when the *forêts inondées* provide phytoplanktons. While whitefishes start migrating with the rise in water level, blackfishes are considered to move sometimes before the highest water level is reached.

Another clear instance of spawning migration is that of fishes in Quatre Bras Area, the Deltaic Area extending in the south of Phnom Penh. Fishes in this area also start migrating in April when the water level begins to rise, and move up the Mekong and the Tonle Sap into the *forêts inondées* through *Preks*.

As is clear in Fig. VI-6, which shows the relationship between the spawning season and the water level, the spawning activity takes place before the maximum water level is attained. The histogram in Fig. VI-6 indicates the monthly proportion of fish populations by the degree of growth, i.e., immature fishes, adult fishes and mature fishes. Solid lines given below the diagram indicate the duration of the wet season, the closed season in the north and south of Phnom Penh, respectively. The one-month discrepancy noted in the two closed seasons suggests that there is some difference in the spawning season between areas north and south of Phnom Penh.

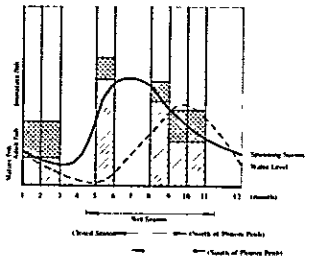


Fig. VI-6 Relationship between Spawning Season and Water Level

In 1964, the French Fisheries Survey Team listed, in reply to an enquiry made by the Government of Japan the following six species as main fishes that migrate up the Mekong,

Cirrhinus auratus	*Thynichthys thynnoides*
C. Jullieni	*Pangasianodon gigas*
Pangasius sutchi	*Pangasius sanitowongesi*

This information, however, is not supported by Mr. Sao-Leang, former Chief of Cambodian Fisheries Service, who claims that *C. auratus* is the only fish that moves up the Mekong for spawning. The question therefore must be solved by further investigation.

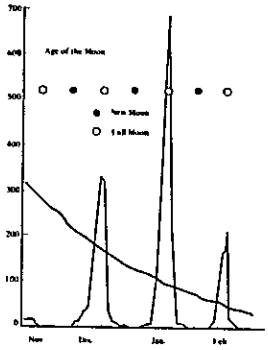


Fig. VI-7 Relationship between Down Migration and Water Level in the Dry Season

C-5 Down Migration

When the spawning season has passed and the water level starts falling, "whitefishes" first migrate downstream from their spawning ground in the *"forêts inondées"* into the Deltaic Area. It is interesting that the down migration takes place, as is clear in Fig. VI-7, only on full-moon nights, indicating that fishes are strongly affected by moonlight.

It is generally accepted that rainfall causes less down migration, which is probably because the rain impedes the decline of water level. The migration, therefore, is most active on fullmoon nights with no rain.

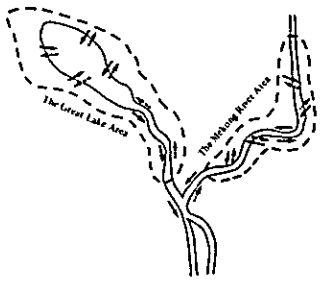


Fig. VI-8
Spawning (marked with ···►) and Down Migrations (marked with——►) in the Entire Water System

Fig. VI - 8 illustrates the spawning and down migrations in the entire water system. In the wet season when the water level rises and the flow velocity declines, spawners migrate into the *forêts inondées* and lay eggs. As the water level starts falling, fishes hatched and grown there to fries move downstream and gather in the lower basins. In this case, too, the whitefishes are the first to move.

Three fishes, i.e., *Pasei, Pava* and *Paken,* present an interesting question with respect to fish distribution in Cambodia. As their names imply, these fishes are found mostly in Laos; in Cambodia, they are found at a specific place and time, i.e., in the neighborhood of Stung Treng during the period from Mid-November to the end of January when the water level is low. But nothing is known about their spawning place. *Pasei* is known as the most tasty fish in Cambodia.

C-6 Fishes with Peculiar Features

While *Osphronemus goramy* and few other fishes can be rarely found in Cambodia, there are such fishes as *Esomus, Rusbora,* etc. which can be found practically everywhere in the country. These common fishes can be easily caught with a scoop basket.

Labeo nukta, or *Pava,* has a stepped snout as its name indicates, and lives in clear water as *Pasei. Trey chovet* has the peculiar habit of eating human feces. *T. Ksan (Ophicephalus sp.),* another rare species, is known for its interesting ecological features. It is a xerophilous fish that climbs trees, and is provided with the respiratory system capable of breathing in the air. Since it appears in the wet season, it is believed to pass the dry season in the dry soil.

While *Pasei* is, as mentioned above, very well known for its delicious taste, *Bagarius bagarius (Trey Krabei,* meaning the buffalo's horn) is equally well known since no one at all would attempt to eat it.

Fishes like *Trey kros menay (Osteochilus sp.), Trey sanday (Wallagonia attu)* and *Synaptura* are known in association with Cambodian legends in which they play leading roles. In addition to these three fishes, there is *T. Damrei (Oxyeleotris marmorata)* which is called "loving-mother fish" among people of Chinese descendant. It is believed that the mother of a devoted daughter has been transfigured into this fish, and old people dare not eat it.

Inland waters of Cambodia also produce fishes of many different sizes. While there are many large fishes including *Pangasianodon gigas* which often weighs about 300 kg, and *Pseudosciaena soldado* and *Cybium cambodgiense,* each measuring 1.5 m and 1 m, there are many small fishes that measure several centimeters only, such as *Ambassis* and the like which are also seen in Japan as ornamental tropical fishes.

C-7 Aquatic Resources Other Than Fishes

Turtles and shrimps are the most important non-piscine products of the Cambodian inland waters. Turtles measure about 20 cm, and are sold for 25 Riels per head for their delicious taste. Their eggs are also sold sometimes on the open market along the Mekong banks at about 2 Riels each.

Shrimps are available in different sizes and are also sold for a good price. (See Table VI-13)

Chapter D. FISHING GEAR AND ITS DEVELOPMENT

CHAPTER D. FISHING GEAR AND ITS DEVELOPMENT

D-1 Fishing Gear and Its Methods

D-1-1 Harpoons and Spears

Sang, or Xa-di (Bamboo spear): A forked-head spear made of elastic bamboo bar intended for catching fishes alive. (See Fig. VI-9-a & b)

Chbauk, or *Xa-bup* (trident). A 200 cm–300 cm long stick with a three-way fork on end and a string connected with the other end. The string is tied on the fisherman's hand. (See Fig. VI-9-d)

Sño, or *Xa-no* (spear): Same as *Chbauk*, but with a steel spear fitted on one end. (See Fig. VI-9-c)

Sâm. or *Chang-Kram* (forked spear): Same as *Chbauk*, but with a 2-way fork fitted on one end and the wooden grip connected to the other. The bamboo stick is 70 cm–100 cm long. Intended for catching spined eels in swamps and marshes. (See Fig. VI-9-a)

Eel rake: Used for catching spined eels in muddy bottom. (See Fig. VI-9-e)

D-1-2 Baskets and Traps

Chhneang-Dai: A basket made of bamboo or rattan with a grip on either side, about 60 cm in diameter.

Lêan: A tubular basket made of bamboo or rattan, with a funnel-shaped mouth and flat bottom.

Chuck: A cone-shaped flat-bottom rattan basket, 40 cm–60 cm in length. Used in the paddy field to catch snakehead fishes and spined eels.

Lan (eel trap): A hollow bamboo tube with one of its ends cut to induce eel to get in, 10 cm in diameter and 100 cm in length.

Bampong-Kanchronk (eel trap): A bundle of 2–3 bound bamboo tubes, each having a hole and 100 cm–200 cm long. Used for trapping spined eels.

Angrouth (funnel-shaped basket): A cone-shaped flat-bottom basket made of thin bars of bamboo or rattan. Fishes getting in it are grasped out by hand from above. Used for trapping snake-head fishes and catfishes in ponds and swamps. (See Fig. 11-a)

Chitt. A small tubular cage, about 150 cm long, laid flat in the *"forêts inondées"* and in water plants. Its diameter being less than 20 cm, fishes trapped in it are found in a row. (See Fig. VI-10-j)

Kanchreng-Anchiat (scoop basket): A round basket made of thin bamboo bars, less than 100 cm in diameter and about 80 cm in depth. Dipped horizontally in water to trap various fishes, using fish oil and guts as bait. (See Fig. VI-9-f & g)

Pong, or *Cai-lo*: A lacquer coated bamboo cage shaped like a water jar, 150 cm in height and 80 cm in diameter. The bottom is provided with a round or triangular cut to which a funnel is fitted from inside. Used to trap catfishes, with rotten meat used as bait. (See Fig. VI-10-a & b)

Tomm: An inversed cone-shaped cage of rattan, with a square mouth provided at the bottom. Dipped in inundated bushes to trap shrimps and small fishes, using fish heads as bait. Used mostly during Dec.–May period. (Fig. VI-10-c)

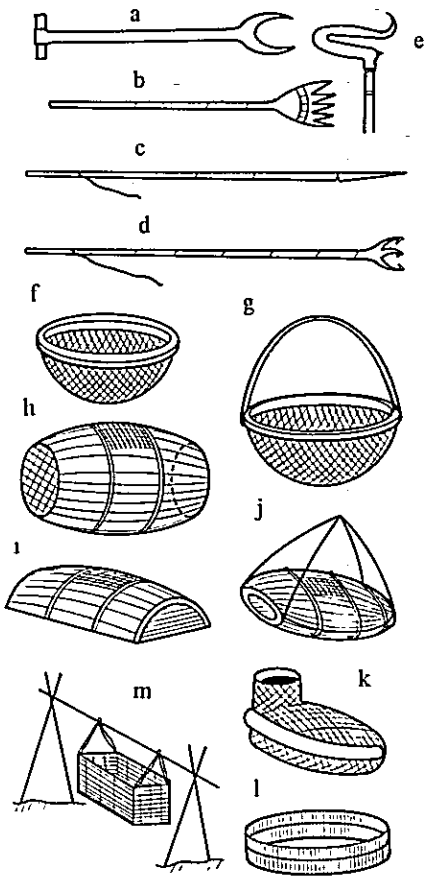


Fig. VI-9 Fishing Gear (1): Harpoons and Spears

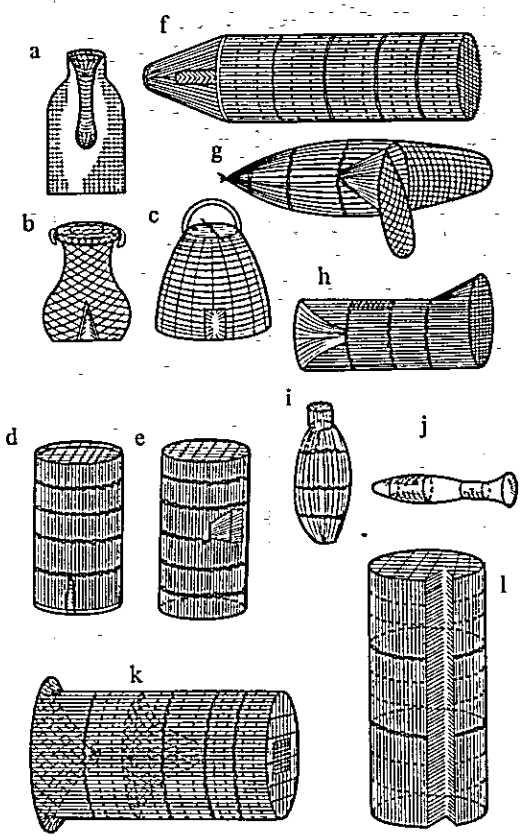


Fig. VI-10 Fishing Gear (2): Baskets

Chhneang-Kang: A wooden-shoe shaped bamboo cage with a long handle fitted to one end, 200 cm in length and 120 cm in width. Dipped in water with twigs filled in it at night and taken out of water in the morning. (See Fig. VI-11-d)

Praom: Similar to *Chhneang Kang,* but shaped more like a spoon. Dipped near the river bank to trap small fishes.

Sampan: A rough-knit bamboo basket measuring 200 cm in width and 100 cm in depth. Dipped on the river bed with twigs filled in it, using a bob to indicate its position. (See Fig. VI-11-b)

Chhneang-Tram, or *Cai-bo:* A rough-knit bamboo basket shaped like a wooden shoe, measuring 300 cm in length, 200 cm in width and 150 cm in depth. Two sticks, serving as sledges, are connected to one of its ends. Dipped close to the river bank with twigs filled in it. A pulley is sometimes used when pulling it out of water. In the Mekong Mainstream, it is often laid on steep outer banks in curved sections subjected to rushing current. (See Fig. VI-11-c)

Trou, or *Cai-ro:* A tubular cage used combined with the leading net, narrow at its end to which is provided a trap cut made of thin bamboo plates. Maximum dimensions: 300 cm in length and 80 cm in diameter. Laid horizontally in the weir.

Srayeun: A rough-knit tubular bamboo cage with a cut provided all along its length. The V-shaped trap cut is made of thin bamboo sticks. Available in various sizes and used as shown in Fig. VI-12-b. (See Fig. VI - 10-1)

Lops, or *Cai-Song:* A tubular cage measuring 80 cm– 300 cm in length and 30 cm – 180 cm in diameter, with

its one end closed and heart-shaped and the other end shaped circular having a funnel-type single or double stage trap cut fitted from inside. Usually laid horizontally around the end of the leading net. Used trap fishes throughout the year, but used intensely during Sep.– Feb. period. (See Fig. VI-10-h)

Lop Na: Shaped like *Lops*, 500 cm long and 200 cm in diameter. Used in combination with weirs extending over several kilometers 2 pcs.– 8 pcs. of *lops* are used for each 50 m of weir. (See Figs. VI-10-k and 12-c)

Song-Kanchos, or *Ca dong:* A large tubular cage with a cut provided about the middle of it. 250 cm in length and 150 cm in thickness. Laid vertically on the river bed and connected with the leading net. Fish draff is used to induce fishes.

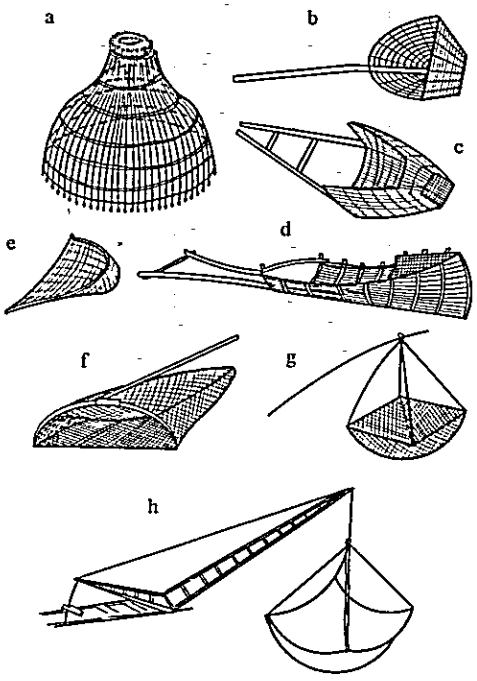


Fig. VI-11 Fishing Gear (3): Traps

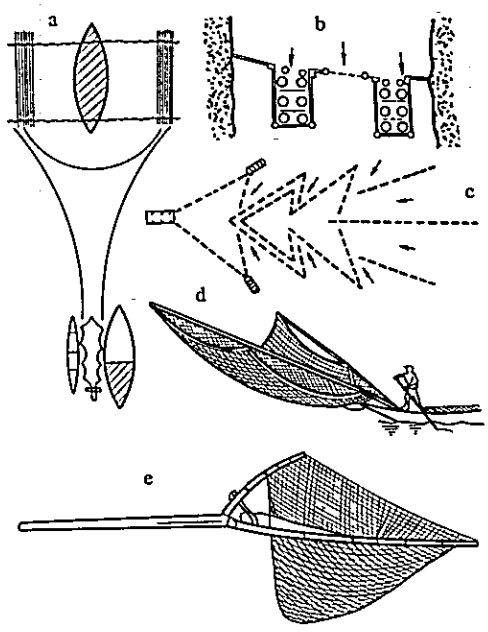


Fig. VI-12 Fishing Gear (4): Traps
a: *Days* fishing
b: Trap fishing
c: Trap fishing
d: Scoop net
e: Scoop net

D-1-3 Cast Nets

Samnanh-Team: One type of cast net of 6-cm mesh, 10 m^2 when fully spread.
Samnanh-Krala tauch: A small cast net of 2-cm mesh, with small steel chains used as sinkers.
Chayra, or *Samnanh-Kia:* A large drag net with a bag on its end. Cast by the circling boat and pulled up slowly when it is closed.

D-1-4 Scoop Nets

Thnang (scoop net): A small-meshed triangular net stretched between two support bars. Max. dimensions: 300 cm in length, 150 cm in width and 100 cm in depth. (See Fig. VI-12-d)

Troeung: A kind of *Thnang.*

Ter. A kind of *Thnang,* provided with a long handle and used for catching small shrimps. Capable of scooping 300 gr.– 500 gr. of shrimps at a time (See Fig. VI-12-e)

Chon: A larger type of *Thnang,* measuring 4 m in width, 3 m in length and 2 m in depth of bag. Placed at the head of small boats and manipulated by six people. Capable of scooping 5 kg – 20 kg of fishes at a time.

Chhnoc (large four-armed scoop net): A pulley-type four-armed scoop net set on the floating house or raft, used for fishing along the river banks. (See Fig. VI-11-h)

Chovo: A scoop net used in brooks to catch snake-head fishes and the like all the year round. (See Fig. VI-11-f)

D-1-5 *Neams*

Rectangular nets cast by the boat that moves sideways.

Neam Réach: A 20-cm mesh rectangular net measuring 8 m– 10 m in length and 3 m in height, used for catching large fishes. When cast, it is suspended a few meters below the water surface by means of hemp strings which are held by fishermen on the boat that moves sideways. Fishes are induced into the net.

Neam Pruol, and *Kaek:* A 6-cm mesh net measuring 10 m in length and 3 m in height, used for catching *pruols, kaeks* and other medium-sized fishes.

D-1-6 *Mongs*

Rectangular nets using bamboo floaters to keep them floating on the water. Fishes are induced into them. Nylon threads and cords which have been used as netting twines for three years already are imported mostly through Nichimen Co. of Japan, partly from Bangkok. Nets are webbed by fishermen themselves.

Mong Dèh: A small rectangular net of 1 cm – 2 cm mesh, measuring 10 m in length and 2 m in height and used for fishing in swamps and marshes.

Mong Way: A 6-cm mesh rectangular net with a bar used to fix its either end, 10 m – 20 m long. Dipped in swamps and marshes when the water level is low. Fishes are driven into it by beating the water surface.

Mong Changvar: A 6-cm mesh net with a height ranging from 2 m to 3 m and a length extending for several kilometers. Used to catch small cyprinoid fishes.

Mong Pra: A 10 cm – 15 cm mesh net measuring 10 m – 18 m in height and 1 km – 2 km in length, used for catching catfishes and the like.

Mong Pruol: A 6-cm mesh net extending for several hundred meters in length. Drifted at time of high and medium water level to catch *pruols* and other migratory fishes.

Mong Trasak, Mong Kolreang: A 20 cm – 50 cm mesh, 4 m high net used to catch larger fishes, particularly *Trasas*

Mong Réach. Drifting gill net employed for catching *Réaches* and other small fishes.

Mong Banidet: A drift net with no floaters, 5 cm –30 cm mesh, 2 m – 15 m in height and 200 m in length. Mostly used to catch "whitefishes."

Mong Boas: Used with sinkers in upper reaches of the Mekong. At Stung Treng, it is used to catch cyprinoid fishes such as *Pasei, Pava,* etc. that migrate from upstream sections.

Mong Prana: About 2.5 m in height, drifted about 1 m below the water surface by means of floaters connected at every 5 m to catch migratory fishes. Length of one net: 80 m.

Mong Riel Renh: 1.2 m in height, drifted on the river bed using floaters provided at an interval of 5 m and strings of about 10 cm diameter suspended from the bottom of the net. Used mostly to catch *Riels* and *Lenhs.*

Mong Sak: A 10-cm mesh net, about 500 m long, used to catch *Trey Pamas.*

Mong Hum: A 2 cm– 4 cm mesh net measuring 2 m– 2.5 m in height and 200 cm– 300 cm in length. Drifted by boats in large rivers and lakes using wooden floaters.

Mong Loeuk: Extend across a river or along its flow to partition a section of the river. Fishing by this method requires a special permission as in the case of the *Days* Fishing.

D-1-7 *Uons* (Dragnets)

The *Uon* is a dragnet with a hoop net. It is dragged ashore into a fenced area. In the mainstream, a catch of 200 tons– 300 tons is possible for each fishing group during one fishing season In the tributaries, however, the annual catch is much less than in the mainstream. At Kratie, 30 dragnet fishing groups are found, the length of the net being 40 m to 100 m and the number of each group being five at minimum. Each hauler is paid 900 Riels–1,000 Riels plus some cigarettes. To temporary laborers, fishes are given just as in the case of the Japanese fishing villages.

Each hauling operation, which lasts more than an hour, produces catches of 400 kg– 500 kg when successful and 10 kg– 15 kg is the haul in poor. Catches are said to be decreasing around Kratie because of the increase of fishermen. The hauling operation is performed three times in the day time and once at night.

A cotton dragnet, 150 m long costing 30,000 Riels, can be used only for a year even if treated with the antiseptic extracted from the bark of a tree called "*Cha.*" Nylon nets have therefore come to be used more widely than before though they cost as much as 100,000 Riels a net.

Dragnets are classified into two groups by the kind of the intended games.

Uon Changvar: The most frequently used dragnet, 1 cm–2 cm in mesh, 2.5 m – 3 m in height and several kilometers in length, with wooden floaters connected to its top and lead or chain sinkers fitted to the bottom. In the Great Lake, there are occasionally found nets as long as 8 km which are hauled by means of powerful winches.

Uon Pra: A net having a height of 12 m for use at high water level, with floaters and sinkers connected to its upper and bottom ends. Hauled from the shore. 2 cm. in mesh, and several kilometers length.

D-1-8 Manks

A 2-cm mesh net provided with a hoop net and used mainly in the Great Lake when the water level is high. It has a length of several kilometers and a height of about 3 m. Both the length and height vary depending on the water level.

The duct-like hoop net measures 6 m (W) x 3 m (H) x 100 m (L) in the end of net.

The net is not hauled from the shore but pulled up to the boat when fishes have been driven into the hoop net by beating the water surface.

Dragnets used at shallow places after the weir fishing are called *Manka Kea.*

D-1-9 *Days*

Day fishing is allowed only in the Tonle Sap during the specific period of the year. As shown in Fig. VI-13, more than 100 nets are drifted in the 20 km section of the river during the Oct.–Mar. fishing season when the fishes in the Great Lake migrate downstream as the water level starts to fall.

The net, funnel-shaped as shown in Fig. VI-12-a, is 80 m–100m long and has a mouth which is 25 m wide and 12 m deep. At the beginning of the fishing season, an ellipsoidal bamboo basket called "*Duc*" is fitted to the end of the net to catch large fishes. The net is connected to two boats and one raft which are anchored in the midst of flow.

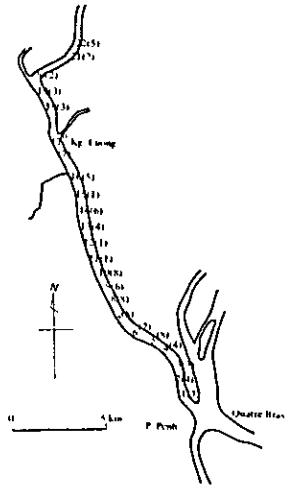


Fig. VI-13 Distribution of *Day* Fishing on the Tonle Sap (Figures in parentheses indicate the number of nets)

Fishes are driven by the current from the midway between the water surface and river bed into the *Duc* or the hoop net. Mesh size is 10 cm– 20 cm around the mouth, 5 cm between the mouth and the trapping section, and 2 cm in the trapping section. Because of these small mesh sizes, practically all fishes, including fries of 2 cm– 3 cm, are caught. The net in which fishes are trapped is pulled up on the boat by means of a winch. Catches are separated into large and small fishes; the former are kept alive in the hold while the latter are carried ashore and sold to farmers at a price equivalent to about 10 Riels per 18 lit. can. These small fishes are processed into *Prahoc.*

Generally speaking more than 50 different fishes are caught by *day* fishing in one season, and the catches during Oct.– Nov. period exceed 1,000 tons, averaging 50 tons per net. The maximum catch by a single net in 10-day period amounts about 15 tons.

Preparations for day fishing are completed about 10 days before the water level starts to drop. During the first half of the fishing season, i e., November and December, catches are mostly large fishes, while in the latter half of the season, i.e., January and February, small fishes are caught in more quantities. Best catches concentrate within about five days before and after the full moon.

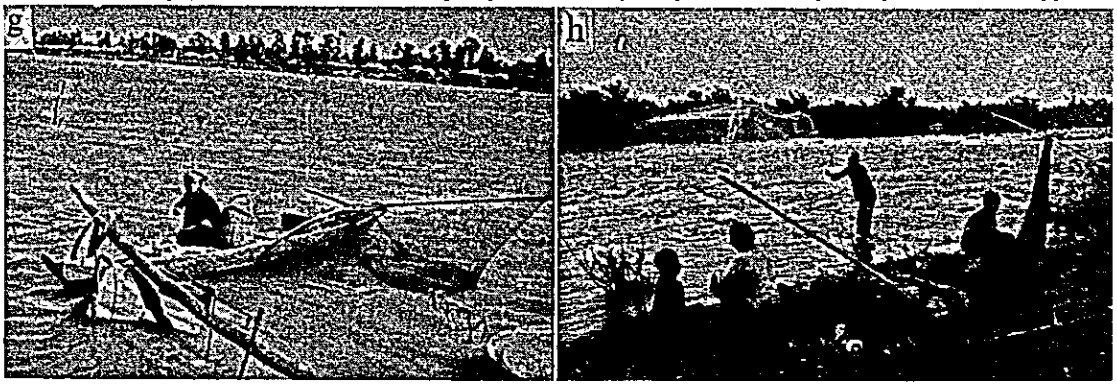
It is noteworthy that fishermen engaged in *day* fishing are dominantly Vietnamese or Malayans having Cambodian nationality and that the native Cambodians are rather reluctant to partake in it because of religious reasons. A 24-hour survey of catches conducted at a selected *day* fishing site revealed that fishes migrating downstream in the daytime are mostly whitefishes such as *Amblyrhynchichthys,* and in the night, *Ambassis, Hampala,* etc. increase in number, but hardly any blackfishes are caught. Larger fishes are caught more at night than in the daytime.

D-1-10 Long-Line

20 cm–30 cm long hemp ropes are connected, at an interval of 1 m, with the line having a serveral hundred meter length, and at the end of each hemp rope is connected a turned-up hook of about 2 cm which is baited with small fish. Depending on the kind of games, the line is cast near the water surface by means of piles or suspended midway between the water surface and the river bed, or laid to reach the river bed.

One of the long-lines, called "*Santouchs*" and usually employed for night fishing, is known by such different names as *Santouchs Ronong Râs, S.R. Chhdor, S.R. Kès* etc. depending on the size of hook and the length of the hemp rope used. But generally speaking the long-line is used to catch snake-head fishes.

Photo 2. Fishing Gear and Methods (1)



a: Drain fishing observed at many places at the beginning of the dry season.

b: Scoop basket dipped in water. Several fishes are caught by a single operation.

c: Photo shows villagers catching fishes with cover net and four-armed nets

d: Small traps dipped in ditches of paddy fields. Lots of small fishes are trapped in them.

e: A small-scale weir fishing. The weir is arranged to surround the brushwood. When the brushwood is taken out, fishes are driven out and caught in the cast net.

f: Eel-rake used to catch spined-eels from muddy water bottom.

g: A small scoop net. Photo shows a fisherman catching shrimps and small fishes by dipping the net repeatedly at the same place.

h: Cast net fishing at Samboc Rapids. Photo shows an old fisherman casting the net all day long; fishes caught are cut and dried by the attending wife on the spot.

Photo 2. Fishing Gear and Methods (1)

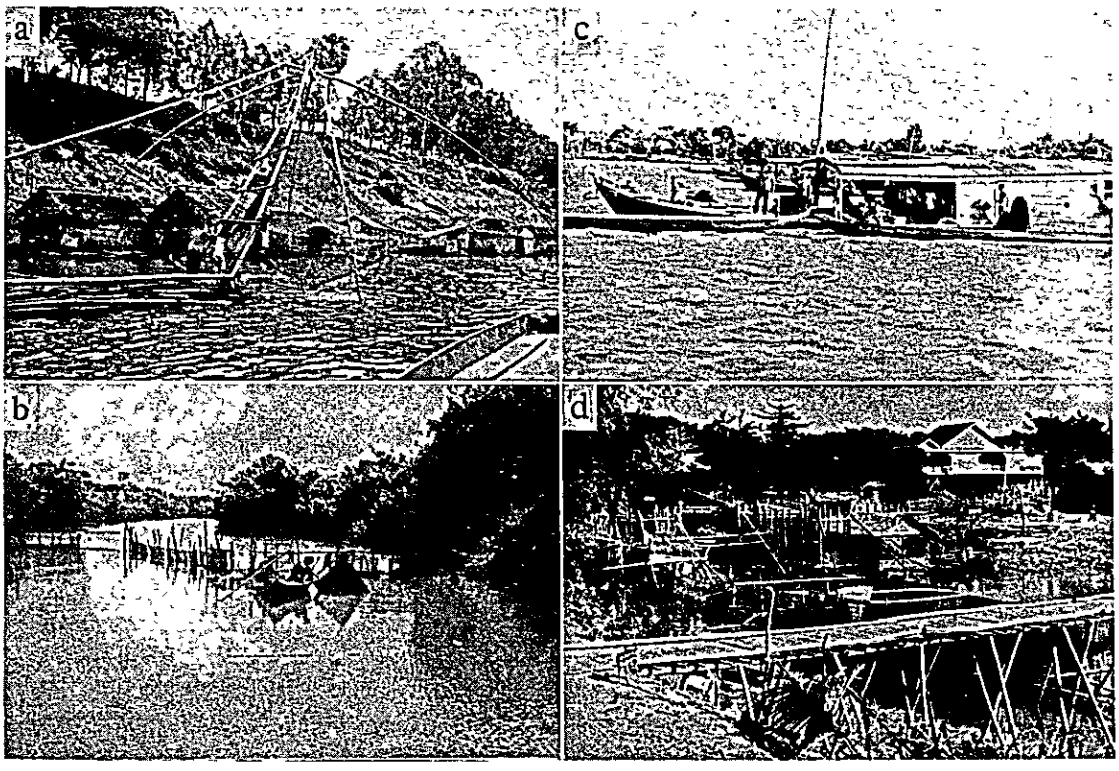
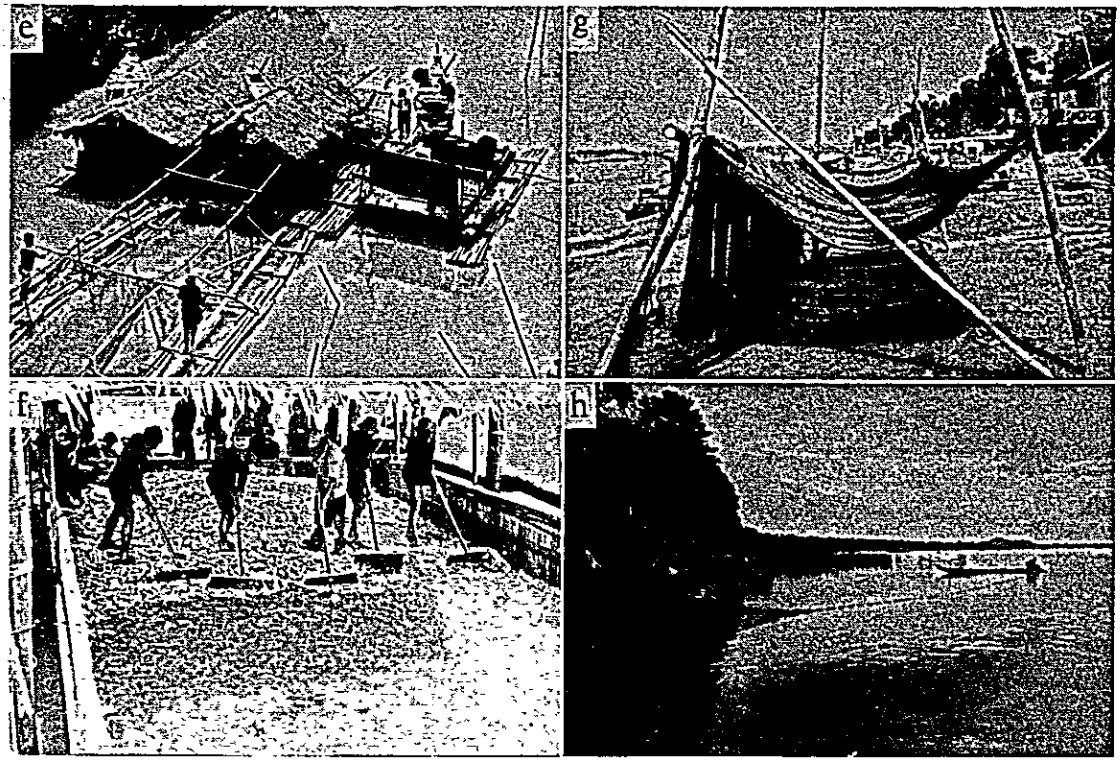


Photo 3. Fishing Gear and Methods (2)



a: A four-armed net fixed at an end of the floating house. The net is pulled out once in a while. Large fishes are used for food and small ones for feed of cultured fishes.

b: Trap fishing to catch fishes migrating downstream from the *forêts inondées* in the dry season.

c: *Day* fishing in the rushing current of the Tonle Sap. All fishes, irrespective of their size, are caught in a large hoop net. Photo shows the catcher boat.

d: Weir fishing. Lumbers are arranged to partition a section of the river to catch all fishes that migrate down the stream.

e: Cast net fishing at Samboc Rapids.

f: Scoop net fishing.

g: Drift net used in the Mekong and the Tonle Sap, not provided with sinkers, to catch "whitefish."

h: Dragnet fishing observed in Kratie District, to catch "blackfish," in the late season.

D-1-11 Weir Fishing

Another big fishing system in Cambodia is *Thos* weir fishery which generally begins around October and ends around December to January. The more upstream the fishing site goes the end of the fishing season comes sooner.

This method comprises row of a good number of piles measuring 20 cm in thickness and 10 m in length or larger, arranged in the mouth of tributaries flowing in the Mekong or of those flowing into the Great Lake; bamboo brushes supported to partition the river; and escapes through which fishes are impounded in a vertical trap called *Srayeun* or other suitable means.

The size of fishes captured is large in the first stage of operation and becomes smaller thereafter, just as in the case of *day* fishing. Anadromous season varies depending upon the kind of fishes: around October through November larger cyprinoid fishes are raised, and around December to January smaller cyprinoid fishes are captured, and February to April are favored with snake-head fishes and catfishes

In the latest part of the season, the river presents a comparatively low water level, and hauling and cast-net fishings are used in combination. Generally speaking, cyprinoid fishes go down the river in the daytime, whereas snake-head fishes and catfishes do in the nighttime. When it rains in the upper reaches, fishes do not go down the river, while when dry weather has continued and water temperature has been high, they begin to go down the river.

Some weirs cost as much as 100 thousand Riels or more. The labor cost is 1,000 Riels–3,000 Riels per month per man. For the production of weirs, 30 workers and more take part in. The installation site of the weirs is decided upon bidding every other year. 400 thousand Riels to 700 thousand Riels are liable for the weir fishery, but catches provide profits more than enough to cover the tax. There also is a modified weir fishing called *Kangyo* in Khmer. Its pound is mainly made of net, though a portion is made of wooden piles just as explained above. This weir costs some 170 thousand Riels, and is legally approved to be put in operation within 6 months against payment of 40 thousand Riels of tax. (See Photo 3-d, e & f)

D-1-12 Dike Fishing

In this fishing method, the "*preks*" is entirely blocked and earth or fascines are filled between the two palisades (each comprising piles arranged in an interval of 1.5 m and both arranged in parallel), and the end of the palisades has a fishing trap. Since this method not only hinders the migration of fishes but also blocks the river flow, its operation is strictly prohibited, though practised in such areas as Prey Veng and Takeo which are largely subjected to the influence of oceanic tides.

D-1-13 Lots Fishing

In this method, the artificial submerged woods are surrounded by fascines, and the fishes enter the woods thus arranged, and when the water level goes down fishes are in the wickerworks.

This fishing method is under the control of the competent authorities. The fishing grounds registered are seized by permanent piles. The Great Lake has more than one hundred of such grounds.

As can be seen in Fig. VI - 14, some 20 fishing villages lie within the Great Lake. In the vicinity of the villages, fishermen's grounds registered are dispersed.

Among various fishing methods, this can raise the largest catches. Fishing is carried out usually once a day.

Tuk-Tias. This is a small-sized *Samra*, the largest of which covers as large an area as several kilometers square. In the past, this was often seen in the rivers and marshes, but it is inhibited at present. (See Photo 2-e)

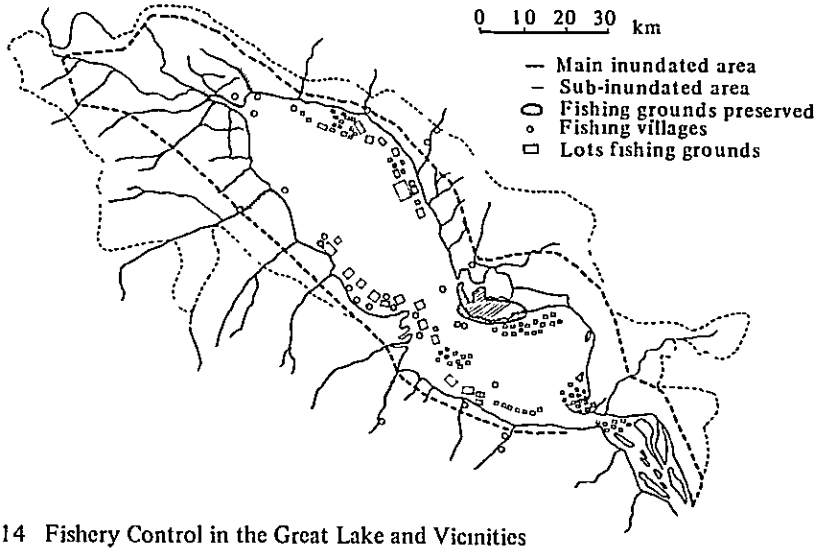


Fig VI-14 Fishery Control in the Great Lake and Vicinities

D-1-14 Fish Preserves

Various implements are available to preserve or transport fishes. (See Fig VI-9-g through *m*) These are all made of bamboo. For portable use, there are such means as *h*, *i* and *j* illustrated in Fig. VI-9. Submerged type fish preserves are *k* and *m* in Fig. VI-9. As its shape indicates, the model *k* is called *Tea* (meaning goose) which is reinforced around it with thick wooden pieces to float on water.

shown in Fig. VI-9-*m* is another fish preserve which is available in many kinds and is installed at a comparatively shallow river side. This kind of fish preserve may be regarded as an origin of the floating cage culture.

Other than these, a fish preserve of the round type called *Trong* is available.

Type *l* in Fig. VI-9 is called *Lok* and is used as a container in the fish market.

D-1-15 Crafts and Fishing Boats

The crafts and fishing boats in Cambodia number some 3,000 as registered as shown in Table VI-9, and the others not registered are innumerable.

Table VI-9 Registered Crafts and Fishing Boats

Kind	1960	1961	1962
Junks of 16 ton class and above	2268	2279	2281
Steel cargo ships	23	27	29
Steam ships	138	138	138
Motor boats	511	556	581
Others	7	7	9
Total	2947	3007	3038

These cover various types of including simple dugouts (1,000 Riels), floating house type canoes (as shown in Fig. VI-4-*b*, *g* & *h*) provided with a shed on the said simple dugout, tug-boat used for towing haul seine and large ships used for *day* fishing and equipped with fish preserves. (See Fig. VI-4-*d*).

These ships are driven by paddles, rows, accessory engines or diesel engines.

D-2 Classification of Fishing Gear and Fishing Methods

In the following paragraphs, shapes, structures and functions of various fishing gear are outlined.

D-2-1 Large-scale, medium-scale, and small-scale fisheries

Large-scale fishery: *Day*, weir, haul seine, pound, etc. coming under the category of commercial scale enterprises.

Medium-scale fishery: Drift net, dip net, four-armed scoop net, cast-net, etc. in which a part of catches is sold and the remaining are assigned for domestic use.

Small-scale fishery: Basket net, barricade, coverbasket, scoop basket, line-trawl, angling, special spear, etc. in which the catches are too little to be offerd for other purposes than domestic use.

D-2-2 Assessable and Tax-free Fishing Gear

Tax-Free fishing gear: Especially small-scale fishing gear and methods out of harpoons, weirs, cast-nets, dip-nets, drift nets, angling, etc.

Assessable fishing gear: Large-scale fishing gear and methods out of weirs, cast-nets, large dip-nets, drift nets, trawl nets, shrimp nets, trawls, pounds, etc.

Note: Table VI-18 shows the restrictions concerning the size of fishing gear.

D-2-3 Fisheries in Rivers, Lakes, and Marshes

River fishery: *Day*, weir, drift net, large dip-net, four-armed net, etc. of passive fishery

Marsh fishery. Pound, trawl-net, cast-net, coverbasket, etc. of active fishery.

D-2-4 Nektonic fish fishery and Bottom Fish Fishery

Nektonic fish fishery: Fishery using *day*, weir, drift net, dip-net, scooper, etc. intended to catch migrative fishes such as cyprinoid fishes,

Bottom fish fishery· Fishery using pound, trawl-net, coverbasket, long-line, etc. intended for catching bottom fishes, carnivorous fishes or nocturnal fishes such as catfishes, snake-head fishes, etc.

D-2-5 Fishing Village and Its Development

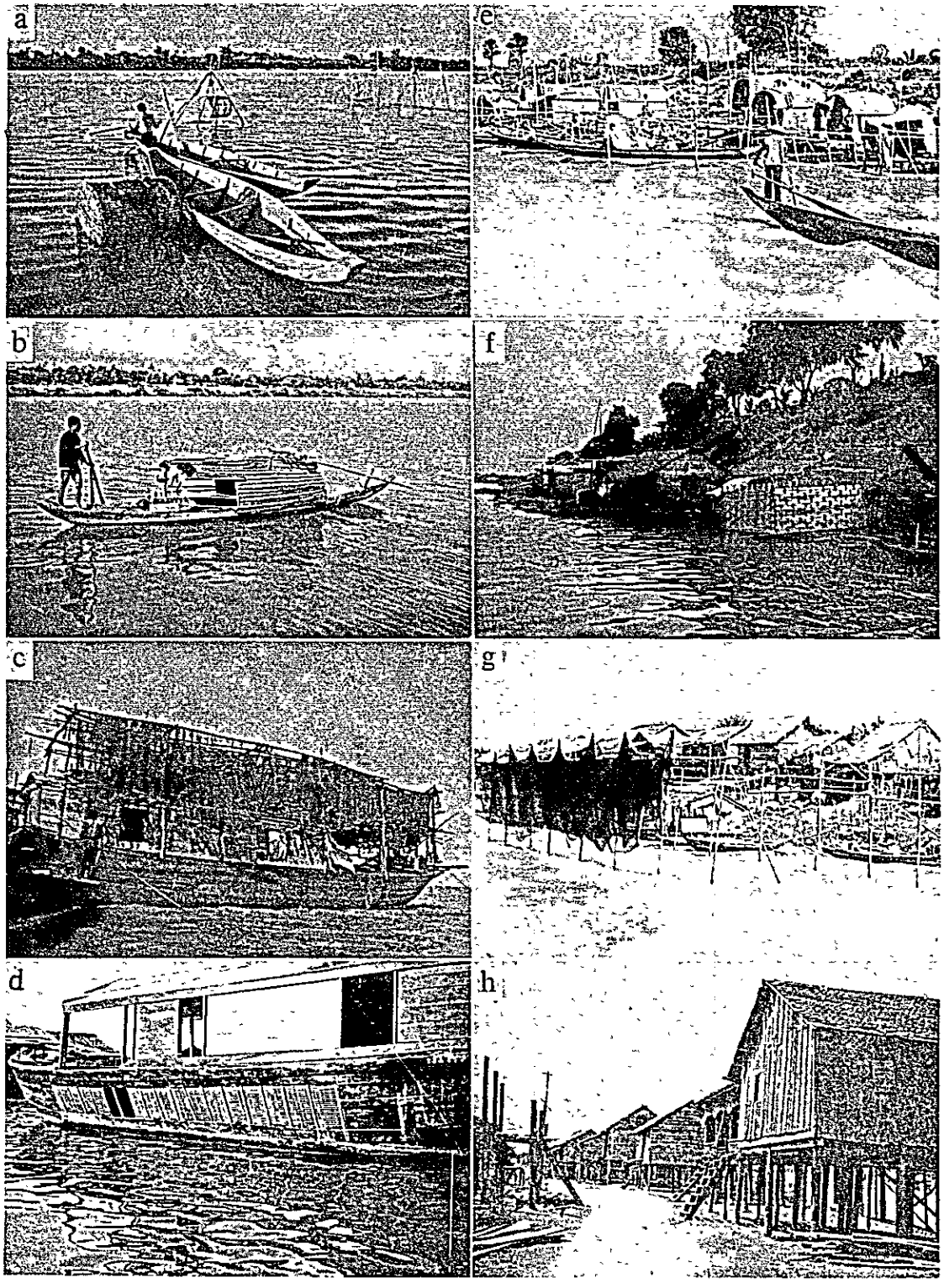
The author often encountered something of a clue upon which to envisage the process of the historical development of the Cambodian fishing villages For example, he occasionally met with what one may call the basic forms of fishing system; cast-net fisherman who make a village on the coast and travel to and fro along the Mekong, forming a group and each member carrying a cast-net; drift net fisherman operating only with drift nets; trawl-net fisherman who possess a common net and take a job collectively.

They set up temporary villages at placed along the Mekong, find markets in the neighboring towns and villages for large catches, and move on their annual journey along the Mekong.

These mono-fishing villages may have been specialized out of mixed community. Whether they have composed a specific community in a limited season or for a specified fishing, whether they have constituted a permanent community for everlasting journey, and what regulations have coordinated the fish-hungry villages, are quite exciting matters for tracing a chain or chain of the development of the Mekong fishery. It is said that in Cambodia one can own a farm for which he has worked for three years, from which it may justifiably be presumed that such fishermen go on traveling from one place to another while fishing, and hold no land in their own right

(1) From Fishery to Pisciculture: It has been described in the foregoing paragraph that there are innumerable floating houses on either side of the Mekong. These are more or less concerned with pisciculture. These floating houses may have been small in size and easy to move for the first time and may have operated drift net, cast-net and other small-scale fishing around the house. Then, partly they have formulated individual communities each having specialized fishing method Some floating houses may have developed into a large-scale fish preserve system and some may have specialized by pisciculture.

Photo 4. Development from Boat to High-Floored House



a: Dugout

b: Roofed canoe in which primitive life is performed.

c: Large dragnet boat in which men live, and on which nets are dried

d: Fish preserve boat in which fisherman live.

e: Boat berth formed by boat-men.

f: Floating houses built on the bamboo floats or pisciculture ponds near the river shore.

g: High-floored houses overhanging from somewhat high wall to overcome changes in water level.

h: High-floored houses built on solid foundation piers.

Floating houses of the Mekong which make a long history are built rationally to a certain extent, but they are not stable, as a matter of fact, as compared with those houses which are built on land. Accordingly, some of pisciculture men have migrated to the land to live, leaving pisciculture facilities.

As is clear from the above description, the Mekong covers various aspects of development stages; aggressive fishery using movable floating house, pisciculture by fixed floating house, and other fishing system in which pisciculture facilities and living place are separated.

(2) Fishing Ground: There are many good fishing grounds crowded with fishes where drift net operation is prevalent.

The fishermen's boss monopolizes the fishing grounds by bid and rent them to individual tenants. The drift net fishing grounds are well cultured in the vicinity of the ports frequented by large ships. It is a general pattern that there are floating houses selling fishes on either side of the pier, and that there are other floating houses, adjacent to the said fish sellers, which are equipped with four-armed nets.

This pattern is the origin of the fisherman village as one may call it, representing a place of great interest for persons concernd.

(3) Migratory Village near the Great Lake: While the Mekong riparian fishermen enjoy a constant year-round fishing operation irrespective of the drastic water level change of the Mekong, those in the neighborhood of the Great Lake are compelled to migrate and run after the fishing grounds that emerge from and submerge into the Great Lake because its coastal zone shifts over a wide range of 5 km– 10 km.

Although the fishing village possesses specialized working groups including fishermen, processers, sellers, etc., all of these must move with the change in water level two to three times every fishing season. To be more precise, in the wet season, fishery operation is closed whereas the farming begins to be busy, and the fishermen return to the farm; around December, the Great Lake begins to show lesser and lesser water level, and all the men enter into the fishing operation forming a temporary village on the shore– a village in which the above-mentioned specialized groupes are of necessity set up and bamboo pounds are fabricated by full force of the workers. As the time goes by, the water level goes down and the temporary village follows the descending shores.

Namely, the temporary village moves two to three times in the dry season. This is the actual status of the migratory fishermen village that is experienced around the Great Lake, It should be noted that good fishing grounds such as those on the throats of the *Beng* (marsh) are occupied by fixed villages on the water because the Great Lake is less affected by water level change or water flow as compared with the mainstream of the Mekong These villages are enjoying year-round fishing and large-scale pisciculture, and are featured by a number of floating houses that are well built for semi-permanent use.

There are many large-scale preserves measuring 4 m– 5 m in width and 40 m– 50 m in length and baits are afforded by the migratory fishermen villages thriving near them.

As mentioned above, there are two types of villages migratory and fixed villages. The latter are mainly engaged in the pound fishery and are composed of sub-classified villages each specialized by its fishing gear.

Chapter E. CATCHES

CHAPTER E. CATCHES

E-1 Important Fishes

As already explained in the foregoing paragraphes, there are known about 200 species of fishes in Cambodia. Of these, about 19 species are cited by Rene Lioze (1964) as the most important fishes (see Table VI-8).

The importance should, of course, be defined either by the catches or by the price of the fish.

If the fishes of majority in number are important, they would be the 19 fishes cited by Rene Lioze. Namely, the important species are merely one-tenth of 200 fishes. The important species are marked with ⦿ indicating the most important and ○ indicating the next.

E-2 Annual Change of Catch Amount

Reportedly, the catches of fishes in Cambodia are decreasing year after year. Proceedings of the 5th Annual Meeting of Colombo Plan (1965) noticed as follows:

Production from freshwater fisheries appears to have declined in 1955. Accurate statistics are lacking, but dried fish collected by the Freshwater Fisheries Co-operations in the 1954-55 season amounted to only 1762 tons, or 45% of the 1953-54 collections. Lower production may be attributed in part to the irregular movement of waters, due to drought, through the Great Lake, the principal enter to the fishing industry.

In fact, it is unknown as yet, for want of data, that the production decrease is attributable to the decline of the natural resources, to the superficial decline due to the transient change in the fishing efforts, or to the sand bank standing in the way to the Great Lake as noted above.

To rationalize the fishing management in Cambodia, there are many problems to solve.

The yearly total catches reported by each regional Fisheries Bureau are as given in Fig VI - 15, though these may be inaccurate because only a few years have passed since the Fisheries Bureau became independent of the Forestry Bureau in 1960.

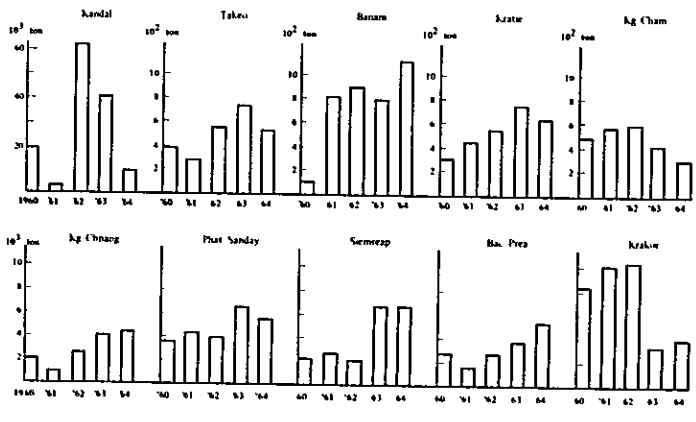


Fig. VI-15 Annual Change of Catch Amount in Each Fishing Division of Cambodia.

As can be seen from the above figure, the catches in Kratie and Kompong Cham have tended to decrease since 1962-63. Cathes in Kompong Cham District have been stagnant during the past three years. On the contrary, however, the regional Fisheries Bureau of Phat Sanday, Siemreap and Bac Prea have enjoyed ever increasing production, with only Krakor resistering a sharp decrease in 1963-64. On the other hand, the southern Phnom Penh Districts including Kandal, Takeo and Banam did not show a definite tendency; especially Kandal gave extremely unstable catches by year.

Comparing the catches by the district– Mekong Mainstream Area, the Great Lake Area and the southern Phnom Penh–the southern Phnom Penh raises a large catches while the mainstream of the Mekong does not, as shown in Table VI - 10. This is ascribable to the active fishery in the southern Phnom Penh, and partly to a large amount of collection in this district.

In any way, it would be still premature to judge that the fish resources begin to decrease, since the whole aspect of the fishing industry is not unfolded to us yet. With reference to Table VI-10, it is worth attention that the production of marine fishes one-tenth to one-thirtieth that of inland fish production, and that the fishes for domestic use are not involved. This evidently shows the significance of the freshwater fishery, which is not expected in Japan.

The Cambodian farmers are 90% of the whole population, or 5,140,000, and they resort to freshwater products as their protein source.

Therefore, the true amount of the freshwater fishery products will be far beyond the statistical figures.

Table VI-10 Annual Transition of Catches in Each Regional Fishing Division of Cambodia
– Comparison of Marine Products and Freshwater Products

(Unit: ton)

		1960	1961	1962	1963	1964
Southern Phnom Penh Area	Kandal	19.004	3,349	61,216	41,210	10,000
	Takeo	390	280	548	730	545
	Banam	100	803	875	775	1,113
	Subtotal	19,459	4,433	62,641	42,716	11,659
Mekong Mainstream Area	Kg. Cham	4,952	5,173	5,985	4,290	3,164
	Kratie	308	435	545	748	625
	Kg. Chnang	1,988	1,083	2,638	4,115	4,469
	Subtotal	7,250	7,231	9,168	9,153	8,258
Great Lake Area	Phat. Sanday	3,654	4,383	4,105	6,682	5,727
	Siemreap	2,131	2,613	2,120	6,687	6,724
	Bac. Prea	2,745	1,593	2,823	3,900	5,277
	Krakor	8,350	10,411	10,473	3,602	4,220
	Subtotal	16,881	19,001	19,522	20,872	21,948
Total (Freshwater products)		43,626	30,665	91,331	72,741	41,865
Coastal Area	Kampot	680	221	560	320	315
	Kg. Som		180	578	409	343
	Ream		498	679	705	577
	Koh. Kapik	800	400	1,000	1,200	1,800
	Chamlang-Ko			850	1,150	1,340
Total (Marine products)		1,480	1,300	3,667	3,785	4,375

E-3 Monthly Fluctuation of Catch Amount

The monthly fluctuation of catch amount seems to be affected diversely not only by the fisherman's characteristics including their composition, activity and nature, the natural and meteorological factors, but also by the ecological factors of fishes.

With reference to Fig. VI-16, there is illustrated the monthly transition of the catches of fresh fishes; Kandal, the southern district of Phnom Penh, enjoys the maximum vintage during May-Aug. period of the rainy season, and experiences the worst fishery business during Oct.-Nov. period of the dry season. On the other hand,

Kratie in the Mekong Mainstream has little or no catches during Jun.-Sep. period but enjoys the best time during Jan.-Mar. period. Also, Krankor in the Great Lake Area enjoys the maximum catches during Jan.-Mar. Namely, there are two typical districts, one where the best time is the wet season, and the other where the best time is the dry season.

In the southern Deltaic Area, the adult fishes are gathered in the dry season, and disperesed for laying toward the Great Lake or upper tributaries in the wet season.

It happens therefore that the fishes migrating for spawning in the initial stage of the wet season are mostly caught. This must be borne in mind for the sake of securing and protecting fish resources.

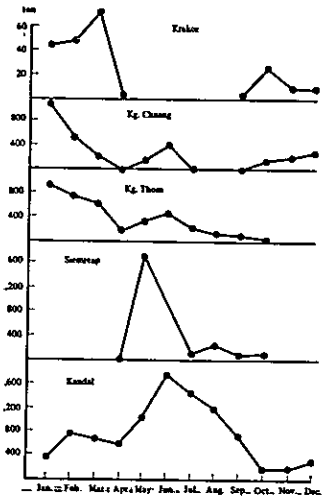


Fig. VI-16 Monthly Product of Fishes in Each Fishery Division

Note : There are two typical fishing grounds; one which maximum catch is seen in the dry season, and the other which has the maximum catch in the wet season.

How is the condition in Kratie, an upper district of the Mekong? Kratie has little or no catches in the season from June to September, but it turns well in the dry season from January to March. This is very hard to understand from the viewpoint of the ecology of fish.

Why do statistics show the peak catches in the dry season which, the author heard there, is the season during which all fishes have gone downstream? Since there are many such instances that the ecological data of fish are like to disagree with the statistics, strict and further studies are awaited.

It was also reported that a catches of 15 kg– 50 kg is usually raised by a single fisherman using a drift net of 30 m – 100 m on the Great Lake, though there are not available sure data as yet. The fisherman's economic problems bear greatly upon the management policy of the Cambodian fishery. It is obvious from the ecological viewpoint that in some season the fish is well to catch, and another season it is not.

With reference to the most important fishes, there is illustrated in Fig. VI-17 a seasonal change of catches.

As is clear from this figure, the fishes that are well to catch in the wet season are *Esomus, Heterobagrus, Wallagonia, Pangasius,* and *Marcones,* where as those which are well in the dry season are *Thynichthys, Cirrhinus, Cyclocheilichthys* and *Ophicephalus* (adult).

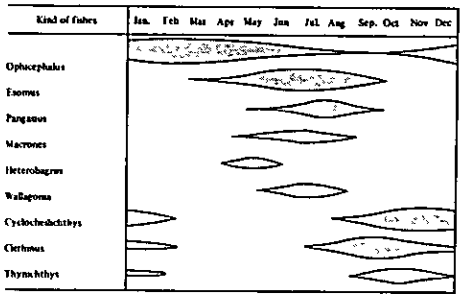


Fig. VI-17 Fishing Season

Since two surveys conducted by the author all encountered ry season, the actual status of the wet season fishery is not However, if the wet season fishery goes well actively in many :ts including the southern Phnom Penh Area as mentioned foregoing paragraph, it should also be examined further. to October period comes within the closed season (given in I - 6), which may be referred to pisciculture, and must be cleared as well.

Chapter F. PISCICULTURE AND ITS DEVELOPMENT

CHAPTER F. PISCICULTURE AND ITS DEVELOPMENT

It is very strange that Cambodia is exuberant in water pisciculture but has no more than two places operating the pond culture.

To be more precise, most of floating houses on either side of the Mekong as well as on the periphery of the Great Lake operate pisciculture facilities provided under them.

In Japan, this scheme of operation begins to be a great interest to the fishing industry, but has not yet been put to a practice at all.

In Cambodia where bamboo is abundant, the natural flow water pisciculture has been well progressed.

The following deals briefly with the pond culture and water pisciculture.

F-1 Pond Culture

The pond culture using artificial ponds is limited to only two places in Cambodia.

One of these two farms is found 10 km north from Phnom Penh where two kinds of fish ponds, one measuring 60 m x 60 m and the other 100 m x 100 m, are used (13 in total). The depth is more than 2 m; and the water is pumped up from the Mekong, and is muddy.

The seedlings are *Labeo, Cirrhunus, Cyclocheilichthys, Osteochilus* and *Puntius* that are available from *day* fishery in that district at the end of the dry season, and the fry of *Cyprinus*, and Chinese carp are imported from Hong Kong and cultured.

Around Jul. - Aug., these fishes, especially grass fishes, are exported far aboard, for instance,to Hong Kong. The pisciculture ground is planted first with rice watered a little, and then it is fully supplied with water to decay the rice that has grown up to about 50 cm in height, and the fry are fostered there. Shells of peanuts, green peas and beans, and green peas pods, corns, rice and grass are cooked as bait. Also, leavings of pigeon baits are reused.

A manager of the farm said that he should like to solve, by artificial hatching, the problem of importing fry all the way from Hong Kong. Much the same remark was made by Mr. Lim who owns pisciculture grounds in what once was the quarrying site of brick clay in southern Phnom Penh District. He is importing fry of Chinese carp from Hong Kong at 5 Riels per fish. Since the big head carp, one of Chinese carp is strong against any diseases and delicious, it is regarded as one of the most important fishes.

Only the above two were discovered during the survey, This will be ascribable not only to the difficulty of the water management which must cope with the drastic seasonal change, but also to the fact that the water pisciculture is favored by nature in its own right, whereas the pond culture must solve the difficulty of bait procurement.

F-2 Development of Water Pisciculture

In the foregoing paragraphs, various Cambodian fishery methods using fishing gear have been explained. Of these, the ones for pisciculture have clearly been tracing such an empirical development as from simple to

complicated and from small scale to large scale. This tells of the development from the primitive fish preserving scheme to the baiting pisciculture (see Fig. VI-18). Namely, the fishermen may have started with a small-sized portable fish preserve such as *Trong*. (See Fig. VI-9-*n* through *k*), then with large-sized preserves such as *Be* (see Fig. VI-9-*m* and Photo 5-*a*), and then with the baiting system for them.

For baiting, they came to provide the fish preserves with a small landing on them. The landing was developed into a living house (a floating house with fish preserve). The baits were caught by a simple method using dip basket first, while as the time went by, they were scooped by large four-armed net. Large fishes caught thereby may have been used as food, and small fishes as baits for fishes preserved beneath the landing (see Photo 5-*d*). Such floating houses with fish preserves extend even some hundred kilometers along the mainstream of the Mekong (see Photo 4 - *e* & *f*).

These floating house type preserves are easy to move and manage, and have the advantage in that their temperature are free from ambient atmospheric temperature.

Aiso observable along the Mekong are large-sized fish preserves that are reinforced with bamboo frames each measuring 4 m x 4 m, and 15 to 20 fish preserves being arranged as a block measuring more than 80 m in length (see Fig. VI-9).

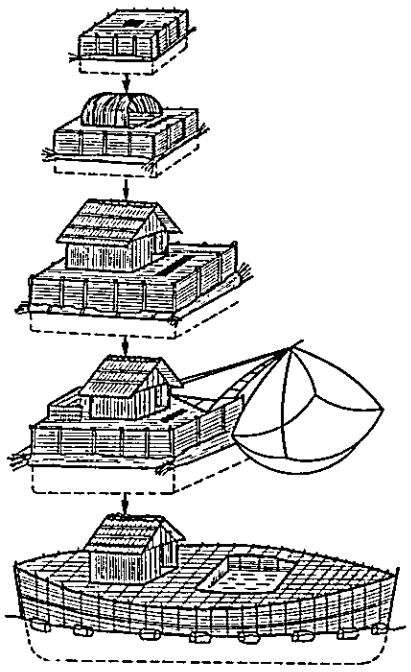


Fig. VI-18 Process of Development from Primitive Preserves to Water Pisciculture

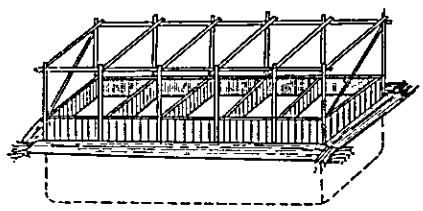


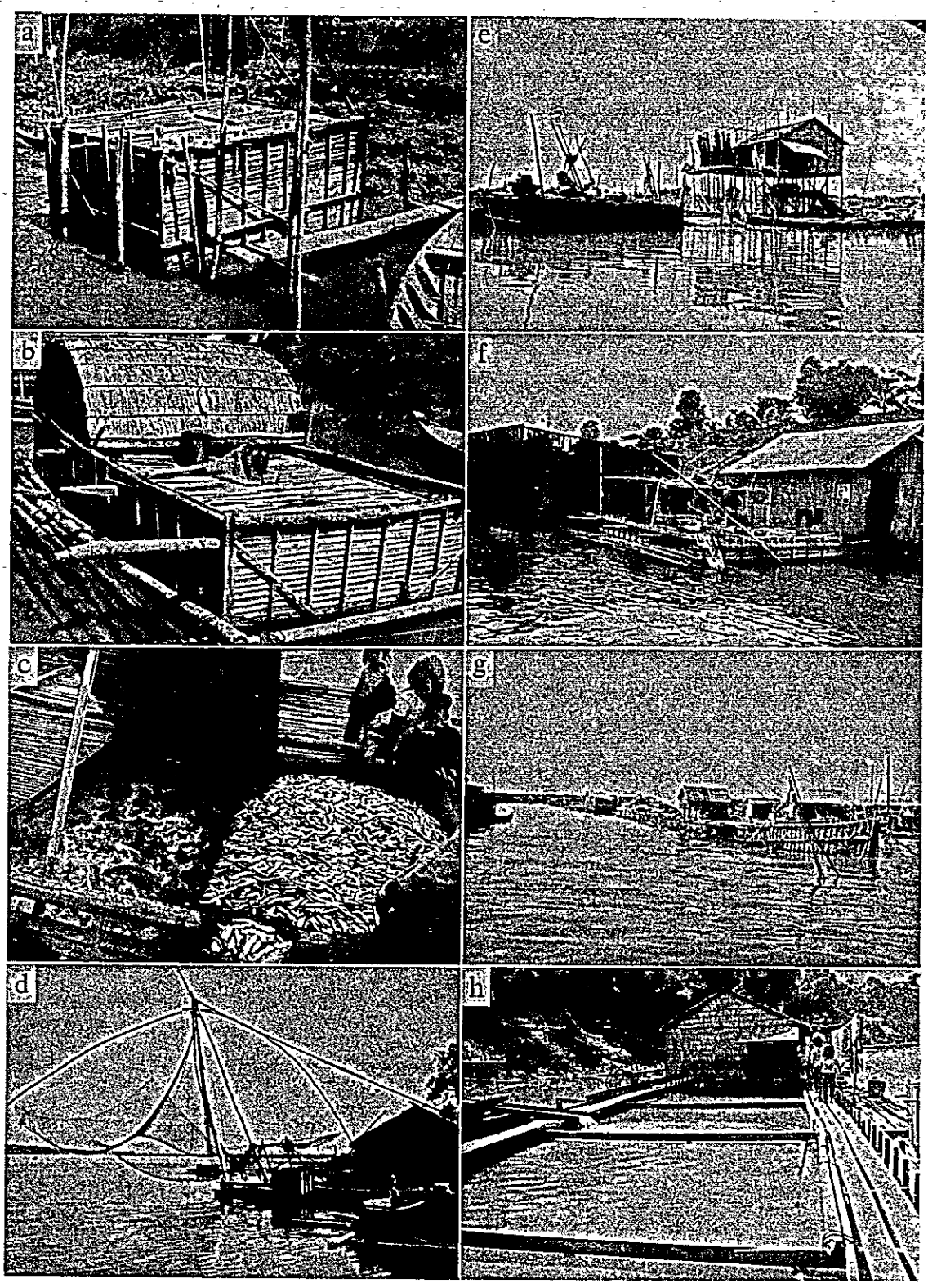
Fig. VI-19 Most Developed Water Pisciculture System

One of the most largest preserves is a boat type one as illustrated in Fig. VI-18. This is formed in a stream line to reduce drag resistance, and measures 5 m in width and 50 m in length, and is provided with about 24 drums around it. This boat type fish preserve is mostly located where the water flow or wind is very moderate, especially at such places as are near the bays around the Great Lake. (See Photo 5-*g*)

Such large-scale pisciculture systems as above cannot afford baits for fishes – baits can no longer be procured by the large four-armed nets that are often used in the floating house type pisciculture system, and therefore, they must be procured from those specialized fishing communities where the required baits are caught by means of trawl-nets or cast-nets. (See Photo 5-*e* & *f*)

As described above, the Cambodian fishery shows itself in its whole aspect of development stages covering primitive and simple fishing modes to the commercial scale of the water pisciculture, unfolding the grandeur of the Mekong in its all majestry.

Photo 5. Developing Process of Fish Preserving System



a, A typical preserve basket which may be call "proto type fish preserve."

b: For catering, a watch house is arranged on the preserve; the float material is bamboo.

c: Small fishes are used as bait for snake-head fishes, etc. Large fishes are for food.

d: Bait fishes to be caught by large four-armed nets usually equipped to the floating houses.

e: Photo shows a typical floating house and a fish preserve. Water level variation is several meters

f: Floating house and fish preserve along the river. For larger scale of fish preserve, bait fishes are caught by trawl-nets. Drum cans are used as floats of the fish preserve.

g: A boat-type fish preserve measuring as large as 4 m in width and 50 m in length, on which man lives and caters for fishes

h: A most developed floating fish preserves on the river side.

F-3 Water Pisciculture

The water pisciculture whose history has been studied in the foregoing paragraphs is applied limitedly to the following fishes: Catfishes including *Pangasius, Clarias,* and carnivorous fishes such as *Ophicephalus* or snake-head fishes, etc., and rarely cyprinoid fishes including *Cyclocheilichthys, Puntius,* etc. which eat putrid fishes.

Around July, fry of about 3 cm are obtained from marshes, and around September fry are again caught by trawl-nets. The young of *Ophicephalus melanopterus* are caught at the brooks in the mountains.

The fry are provided with cooked matter including pumpkin, banana or glued crumbled rice first, and then with small fishes as they grow up; especially carnivorous fishes are mostly provided with small raw fishes that are caught by trawl-net and the like.

In many cases, monoculture system is employed, but in some cases, multiculture of snake-head fishes and cyprinoid fishes including *Puntius* is observable.

One breeding uses about 6,000 fry– 10,000 fry, that grow up to 1.5 kg– 2.5 kg per fish in February and are furnished for sale at site or delivered to Phnom Penh. Fish preserves stand for about 4 years. Old fish preserves are let to flow down to Phnom Penh together with fishes for sale. And, they are disposed there. Alternative new fish preserves are then reconstructed. It is reported that these fishes sent to Phnom Penh are further exported to Hong Kong District.

The small fishes for bait are purchased at a rate of 20 Riels per kg. On the other hand, the adult fishes of snake-head fishes and catfishes grown up to more than 1 kg can be merchandised at a rate of 13.5 Riels per kg at site, and they get a good price of about 17 Riels per kg at Phnom Penh.

Water pisciculture fishes sometimes suffer gill diseases, fungus disease, etc. In order to cure these diseases, dungs of cow, barks of a certain tree, and a mixture of salt, mud, and leaves of some plant, are dosed into water in addition to the use of chemicals such as sulphuric acid, benzene, salt, etc. Their efficacy, however, is not clearly known.

Table VI-11 Number of Fishing Gears along the Mekong

	Kratie - Phnom Penh Kg.	Chhnang - Phnom Penh
Floating houses	1,943	379
Cage culture	723	223
Fishing boats	2,268	2,862
Four-armed nets	173	64
Trawl-nets	309	28
Traps	∞	28
Weirs		12

Although the amount of water pisciculture products is unknown, it will be quite large because in Kratie, for example, all of the floating houses are engaged in water pisciculture and the mainstream of the Mekong holds on its either side some hundred kilometers long line of floating houses.

The status of the Mekong fishery will be well understood from Table VI-11 in which the number of fishing gear and fish preserves is listed.

Not only the Mekong Mainstream but also innumerable tributaries and marshes are full of floating houses with pisciculture facilities, which fact implies the significance of water pisciculture in the future.

Chapter G. FISHING PRODUCTS AND COMMERCIAL ASPECTS

CHAPTER G. FISHING PRODUCTS AND COMMERCIAL ASPECTS

G-1 Kings of Fishing Products

The Cambodian fishing is featured by: (1) the fishing catches are mostly raised at the beginning of the dry season, and are very small in the wet season; (2) the production of fishes is not evenly distributed over the entire country, but is limited to the neighborhood of the Great Lake and the area south of Phnom Penh. Namely, in order to enjoy the year-round fishing products, the Cambodian people must process and preserve the catches.

In fact, processed fishing products are very large both in kind and volume.

Let us see the kind of the processed fishing products.

(1) Fresh Fishes: These are raw fishes and can be classified into live fishes, dead fishes, landing fishes, and chopped raw fishes. In Japan, freshwater fishes do not sell unless they are live, while in Cambodia, they are dead because almost all of them are landed in the night before selling. (See Fig. 6-*e*) Of course, aerobic fishes such as snake-head fishes, catfishes, etc. can sell alive. (See Photo 6-*f*)

Some of cyprinoid fishes, scombroid are in almost all cases more than 50 cm in length. It is also reported that catfishes of as large as 300 kg are not rarely caught. These large fishes are usually cut into suitable sizes of pieces for sale.

A good variety of fishes are raised from rivers, lakes and marshes, and most of them are edible except for *Bagarius* that is called "buffalo's horn." Therefore, 40 to 50 different kinds of fishes are always available on the market.

Freshwater animals such as shrimps, soft-shelled turtles, and frogs, are also put on sale.

Especially, large shrimp raised from freshwater is one of the most important fishing products, and the establishment of its culture system is awaited.

(2) Dried Fish and Salted Dry Fish: To preserve fishes that can be caught in excess of consumption at a time, drying or salting is the nearest approach practicable. The drying is conducted after removal of entrails or after cutting the back of fish, and the salting is done in such a way that the fish is dried after it is once salted. (See Photo 7)

Dried fishes are mainly cyprinoid fishes including *Cirrhinus, Probarbus, Cyclocheilichthys, Thynichthys,* catfishes including *Ophicephalus,* rays including *Dasybatus, Belonoid* including *Xenentodon.*

Salted dried fishes are made from *Pseudoscianena,* etc.

A curious processed matter is a dried cheek meat of cyprinoid fish. (See Photo 7-*g*). Seasoning is dependent one the kind of fish. Namely, about 1 kg of salt is given to 3.5 kg of catfishes, and to 2 kg – 2.5 kg of cyprinoid fishes.

(3) Smoked Fishes: As shown in Photo 6-*g*, *Cirrhinus, Xenentodon, Belonoid* and *Cryptopterus* (catfish) are mostly smoked.

These smoked fishes are processed by a simple facility set along the mouth of the lake or along the river side.

To be precise, as shown in Photo 6-*b*, fishes are laid on a hurdle that is mounted on a simple rack, the

fishes being sometimes covered with a straw mat; and the fishes are smoked from the bottom for about five hours. These smoked, dried or salted dry fishes are more or less oil-stained so their processing or preserving method should be improved.

(4) *Prahoc*: *Prahoc* is a flavoring indispensable for Thailanders, Vietnamese and Cambodians, just as the *Nuc Mum* (soy sauce made of fish). Cyprinoid fishes such as *Cirrhinus, Dangila* of about 5 cm are mostly used to make *Prahoc*, but *Ambassis* and *Trichopodus* are the best materials. The processing is as explained below.

Fish head and tail are cut away, and the remainder is charged into a basket and trample out the viscera at the river side. Then the fish are dried halfway, and mixed with salt (at a ratio of 2 kg of salt to 40 kg of the half dried fish). The salted fish is called *"Pra lak."* The *Pra lak* is then brought back home in bags and then mixed with 5 kg of salt and preserved in a bottle in a shaded and well-ventilated place. It is used after elapse of about 10 days.

Prahoc which is produced in Siemreap is white and free from fine bones, and is spoken of as the best quality in Cambodia. (See Photo 6-*a*)

The *Prahoc* making is an annual function of Cambodian farmers. When the cropping of rice is completed, groups of ox-carts comprising 50 men – 100 men gather in the neighborhood of the Great Lake or Coastal Districts where *day* fishing is prevalent, carry out fishing for 4–5 days before and after the full moon to obtain a necessary volume of flavoring for a year.

Prahoc is an indispensable flavoring for Cambodian people, and is made by family, though it is put on the market in the best season (see Photo 6-*d*). It is reported that 5-man family has 80 kg *Prahoc* made of 140 kg fish. Namely, about 16,000 tons– 220,000 tons of *Prahoc* is consumed annually in Cambodia.

Since small fishes measuring less than several centimeters used to make this large quantity of *Prahoc*, it throws an important problem on the preservation of fish resources just as in the case of *Nuc Mum* explained in the next item.

Although marine products have been utilized for this purpose in recent years, the problem must be solved as soon as possible because freshwater fishes are still the main materials of *Prahoc*.

(5) *Nuc Mum* or *Tuk Trey* (Soy-sauce made of fishes): For Cambodian people, *Nuc Mum* is an important flavoring which is rather like, or even more important than *Prahoc*. In addition 22,000 tons consumed by the Cambodian people at home a year, 20,000 tons of *Nuc Mum* is produced for export to Southeast Asian countries. *Nuc Mum* manufacturing companies number 40 in Phnom Penh, 3 in Battambang and 10 in Kampot. In order to cope with the recent demand increase, ten companies in Kampot have attempted to use marine fishes to produce quality *Nuc Mum*.

Materials of *Nuc Mum* are fishes left over after the process for *Prahoc* making or a little degraded fishes. 2.5 tons of fishes are to be charged into a large bottle together with 1 ton salt, and the mixture is left for half a year to 1 year after sealed. Then, it is filtered by means of palmy net, the supernatant portion of the filtered liquid being used after the filtered liquid is colored, flavored and left for a certain period of time.

Nuc Mum is graded in a wide variety, and it is said that *Nuc Mum* contains 20 gr of nitrogen per litre and rich in many nutritious ingredients and tasteful too. (See Photo 6-*h*)

As mentioned in the previous paragraph, *Nuc Mum* also raises a problem in the preservation of freshwater fish resources.

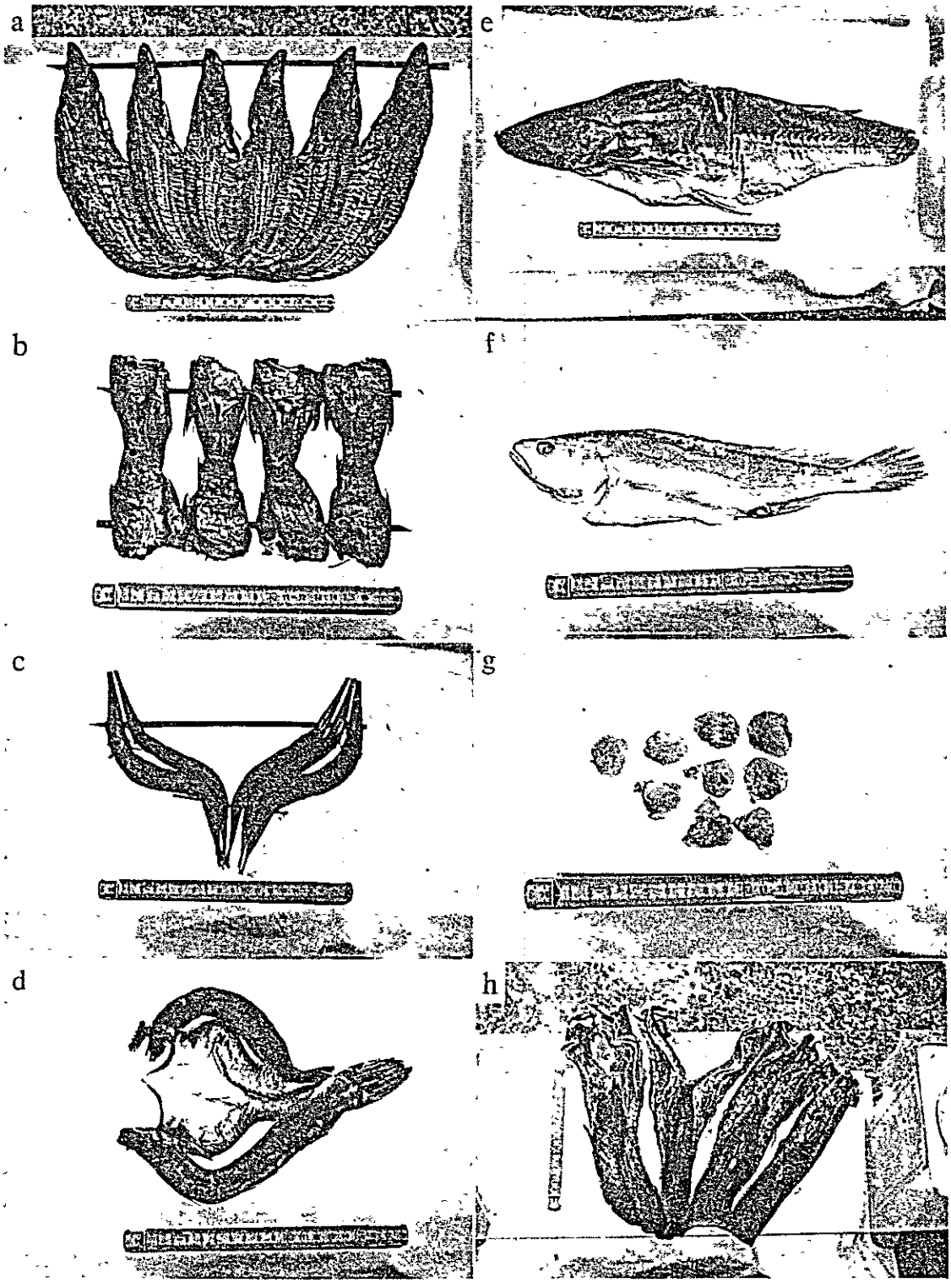
Photo 6 - Various Fishing Products

a: Prahoc making. After removal of fine bones and head, fishes are dried for a while in the sun and then salted.

b: Smoked fish making - Fishes are arrangaed on a simple table under which smoking is carried out. In some cases, they are covered with a straw mat in the smoking process.

c: Fish Drying Process - Small fishes are dried in the sun.
d: Prahoc - Processed prahoc is canned for markets.
e: Market in the - Fishes in a large basket are almost dead.
f: Snake-head fishes and catfishes are sold alive.
g: Various smoked and dried fishes put on sale.
h: Various fish-soys put on sale.

Photo 7 - Various Smoked and Dried Fishes



a: Smoked catfish
b. Smoked cyprinid fish
c: Smoked belonid
d: Dried snake-head fish
e: Dried catfish
f: Dried bass
g: Dried cheek meat of a cyprinid fish
h: Dried gray

(6) Others: Various foods using fishes other than above-mentioned are cited below.

Fish oil: Produced by boiling small fishes. During World War II, it was exported to Japan as a substitute for petroleum, but it is now produced in a limited quantity for lighting.

Mum: Salted matter made of a mixture of bone-free chopped fishes and chips of pepper and ginger. Used as a flavoring for vegetables and meat.

Paoh: Salted matter made of large fishes whose head, entrails and scales are removed and whose body is notched (salt 10 kg: material 40 kg).

Makok: A mixture of catfish chips, cooked glutinous rice and a red coloring matter called *"Beng tanep."*

G-2 Output

The output of these products is as listed in Table VI-12 , from which it is found that the total amount of fresh fish production exceeds 25–30 thousand tons, dried fishes 5 – 6 thousand tons, and smoked fishes 1 – 2.5 million bundles, all of which serve to provide protein source during the closed season.

Table 12 Output and Yearly Transition of Fishery Products in Cambodia

Name	60	61	62	63	64
Fresh fishes (tons)	25,858	20,034	24,006	31,391	31,406
Dried fishes (tons)	1,752	1,952	6,267	6.809	5,829
Smoked fishes (bundles)	580,159	1,484,530	1,000,000	1,932,685	2,640,033
Fish soy-sauce (lit.)	3,799,250	3,126,700	3,116,894	4,527,571	2,192,878
Prahoc (tons)	85	70	105	2,170	1,525
Small shrimp (tons)	45	83	164	109	111
Fresh crabs (tons)	28	23	86	189	195
Dried crabs (tons)	11	9	55	54	55

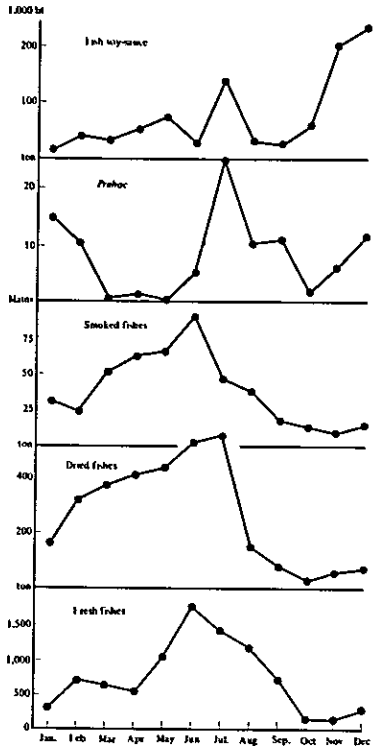


Fig. VI-20 Average Output of Various Fishing Products in Kandal, 1960 – 65

As can be seen in Fig. VI-20, these products are mostly produced in the wet season.

On the other hand, *Nuc Mum*, an important flavoring for Cambodian people, is manufactured both in the dry and the wet seasons and its output ranges from 2 to 4.5 million lit,, while *Prahoc*, also equally important, is considered to be manufactured in an unexpectedly large quantity because each farmer prepares his own use in the dry season, though the statistics show an amount of 70 tons–2,000 tons only.

Also not ignorable are shrimps and crabs which are very dear but small in output. Their production, however, is increasing year by year.

One must learn that the above-mentioned fishery products hold an important place of giving animal protein source to the Cambodian people.

To be precise, fishery products come to the top place with 42.6 % of the whole protein products, followed by birds with 22.9 %, reptiles with 16 %, livestocks with 12.0%, and *amphibia* with 6.6%. It must be noted the fact that the fishes are served at every meal of Cambodian people indicates that actual production is by far the greater than the figure given above and it will be well understood that the Cambodian fishery is very important.

G-3 Price

The Cambodian fishery products are very cheap, which will be clearly known from the fact that small fishes are transacted at a price of about 10 Riels per 18 lit.-can (about 20 kg).

Table VI-13 Prices of Various Fishing Products (Unit: Riel)

Name	Cost per kg
Fresh fish	
Snake-head fish	15–25
Cyprinoid fish	10
Small fish	6
Medium-sized fish	6–8
Large-sized fish	10–13
Large shrimp	60
Small shrimp	40
soft-shelled turtle	25
Processed fish	
Dried fish	20
Dried and salted fish	25
Smoked fish	20–25
Prahoc	8–
Nuc Mum	19–27/l
Mum	50
Mum made of fish egg	20–50
Paoh	30–50

Briefly stated, the prices of various fishery products are as listed in Table VI-13. Of fresh fishes, shrimps and soft-shelled turtles are comparatively dear, while the other fresh ones are inexpensive. Processed matters are dear just as in the case of Japan.

G-4 Marketing

As explained in the foregoing, the principal production areas are found in the vicinity of the Great Lake in which fishes are processed into dried fishes, *Prahoc* and other products, and from which most of products including fresh fishes are shipped to Phnom Penh.

The route of the transportation of fresh fishes to Phnom Penh connects the neighborhood of the Great Lake with the mouth of the Tonle Sap, and with a waterway on which to transport fresh fishes by boat to Snoc-Trou, and then with the highway on which trucks run to Phnom Penh in the night.

In transporting, some cyprinoid fishes are packaged in baskets as they are dead, while a few kinds of cyprinoid fishes, catfishes and snake-head fishes are contained in halved drums.

Fisherman, carrier and consignee are independent of each other. The consignee acts as a broker and wholesales to retailers. The retailers sell at small markets at places like Kompong Speu which is in the suburbs of Phnom Penh.

The market of Phnom Penh is the largest among other Cambodian markets, and deals with almost all articles used in the city. It is composed of about 1,000 marketing corners, of which 68 corners handle various fishery products including fresh fishes. Most of the fishery products are, as mentioned already, freshwater fishes and they occupy 6.8% of the whole marketing corners From this, one may easily learn the importance of fishery products for Cambodian people.

For the privilege of using marketing corners, the merchant is liable to the Royal Government of Cambodia for 1950 Riels a year in addition to daily payment of 20 Riels.

These fees are less in other districts. For instance, in Siemreap, 460 Riels per annum and 8 Riels per diem.

The fisherman's problem is the haggling; the majority of buyers in the Great Lake Area are Chinese merchants who take advantage of the fishermen who are forced to borrow money for fishing gear or salt in advance and give fishes in return for the loan. This status of marketing route heavily oppresses the Cambodian fishermen, and should be imporoved in the near future.

Exports of fishery products have tended to decrease since 1961 as shown in Table VI-14 in which average exports to Vietnam and Hong Kong registered 1,000 tons–5,000 tons or 6–30 million Riels.

This value is only about 1% of the whole export value of the country, and it is expected to decrease in the future with the anticipated upward trend in the intranational demand.

Table VI-14 Exports of Fishery Products from Cambodia

FY	Quantity (10^3 tons)	Amount (1 million Riels)
1960	3.2	13
1961	5.4	26
1962	5.3	31
1963	3.1	19
1964	0.9	6

Chapter H. FISHERY ADMINISTRATION AND EDUCATION

CHAPTER H. FISHERY ADMINISTRATION AND EDUCATION

H-1 Organization of Cambodian Fishery Administration

Only a few years have passed since Fishery Bureau was separated from the Forestry Bureau in 1960. Accordingly, its organization is still premature to display the desired administrative function.

Table VI-15 shows the institutional diagram of the Fishery Bureau, whose major duties are personnel management, programing of development and guidance of fishing industry, arrangement of bidding the fishing grounds and fishing gear and collection of taxes.

Table VI-15 Construction of Fishery Bureau
(Figures parenthesized denote the number of personnel)

Directeur	Adjoint	B. d. Personnel	1(6)
		B. d. Ordre	1(4)
		B. d. Exploitaition	1(4)
	Inspecteur	B. d. Contentieur	1(2)
		B. d. Statistique	1(1)
		B. d. Comtabilite	1(9)

Table VI-16 Organization of Regional Fishery Administration System

Service de Pêche	Contonement de Golfe	Division de Koh Kapik
		" Sihanouk Ville
		" Ream
		" Kampot
		" Chawlang Kour
	Cont. de Lacs	" Krakor
		" Kg. Chnang
		" Siemreap
		" Kg. Thom
		" Battambang
	Cont. de Mekong	" Kandal
		" Kg. Cham
		" Kratie
		" Danam
		" Takeo
	Division de Kg. Cham	Triage Shuou
		" Kg. Cham
		" Tonle Beth
		" Prek Sangke
		" Stung Trâng
		" Ream Chileng
		" Peam Khnong

With reference to Table VI-16, there is shown the organization of the regional fishery administration system which is composed of three bureaus (contonement), one concerning marine fishery, one concerning Great Lake fishery and one concerning Mekong fishery, each being divided into a number of divisions whose offices are located at the center of each fishing town or village. Each such office is operated by 3 – 10 persons. Further, each office controls acting offices called "Triages" that are engaged in direct jobs such as data collection and taxation.

For instance, the division of K.g. Cham comprises 5 personnels and controls 7 triages, each operated by two persons.

II-2 Taxation

There are the privilege due for fishing ground and teh fishing gear levy that support a part of the Cambodian finances.

The fishing grounds are made a bid for once a year (or two years in some districts) according to the official notice issued by the Bidding Committee.

The lowest privilege dues for fishing grounds are as given in Table VI-17 which is prepared based on the reference notes given in the official notice issued in May, 1966.

According to this table, the lowest price is nearly 30 million Riels, and the bid fishing grounds are 135 in total, registering about half the whole fishing grounds.

Levies for fishing gears are regulated in detail according to their scale. (See Table VI-18)

Table VI-17 Bed Fishing Grounds and Lowest Prices

Province	Owner	Date of bidding	No. of Fishing Grounds	Lowest Price, Total (10^3 Riels)
Kompong Chhnang	Government	7.14	9	1,542.3
Pursat	"	7.16	4	660.2
Battambang	"	7.18	7	3,885.0
Siemreap	"	7.20	3	398.1
Kompong Cham	Government	7.26	9	3,081.4
	Province	7.26	12	473.2
	Town	7.26	5	36.4
	Others	7.26	2	34 3
Kratie	Government	7.28	5	98.7
Kandal	Government		13	6,843.2
	Province		3	95.4
	Days	8.6	34	298.8
Prey Veng	Government	8.3	11	9,918.1
	Others	8.3	3	105.0
Takeo	Government	8.5	15	2,426.0
Total			135	29,896.1

Fig. VI-21 Locations of Fishery Management Offices

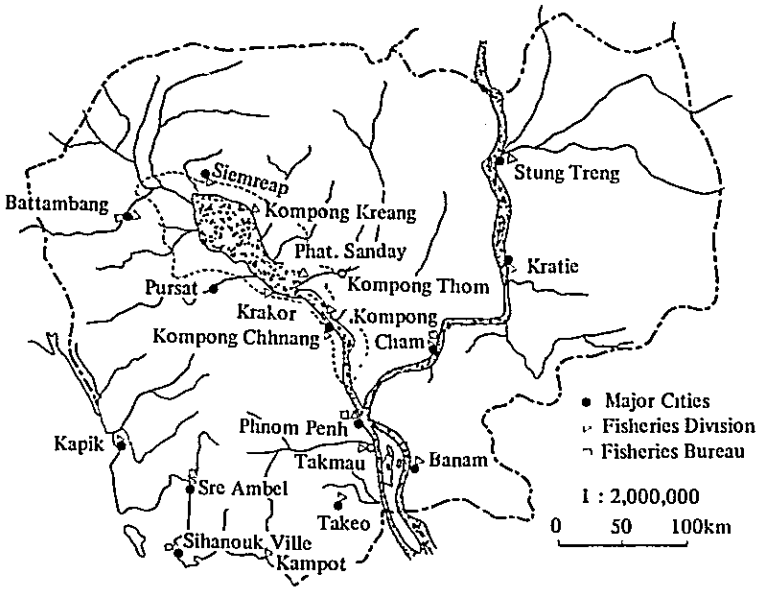


Table VI-18 Comprehensive List of Taxes Concerning Fishery Industry

Fishing privileges or fishing gear	Fees (in Riels)	Conditions for Granting
Drift net	1.5/m	Not levied for less than 20 m, mesh 3 cm – 7 cm
Drag net	2.1/m	Not levied for less than 20 m, mesh 3 cm–4 cm, less than 300 m
Trap	10/unit	Not levied for less than 0.8 m in length, limited to 3 units per fisherman
Weir	1.0/m	50 m – 100 m, 15 mm mesh in case of net
Market franchise	1950/year, 20/day	Phnom Penh
	750/year, 5/day	Battambang
	460/year, 8/day	Siemreap

H-3 Fishery Education

It is no exaggeration to say that the fishery education in Cambodia has just entered the dawning of its history.

In fact, only one fishery high school is operated. Alumni of middle schools enter it, and learn in the co-educational system together with forestry students until 2nd grade, and receive professional education in the 3rd grade.

The establishment of a fishery college has been planned, while the above-mentioned school deals not with the Cambodian fishery (because of lack of educational materials) but with French books.

Chapter I. CONCLUSION