LAO PEOPLE'S DEMOCRATIC REPUBLIC

FEASIBILITY STUDY
ON
XE KATAM SMALL-SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT

FINAL REPORT

SUMMARY

MARCH, 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of Lao People's Democratic Republic, the Government of Japan decided to conduct a feasibility study on Xe Katam Small-scale Hydroelectric Power Development Project and entrusted the study to the Japan International Cooperation Agency (JICA).

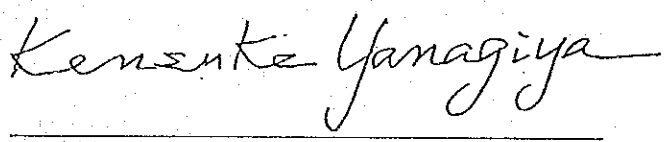
JICA sent to Laos a study team headed by Dr. Hiroshi Hori of Electric Power Development Company, Ltd., 9 times between December 1990 and March 1992.

The team held discussions with the officials concerned of the Government of Laos, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Lao People's Democratic Republic for their close cooperation extended to the team.

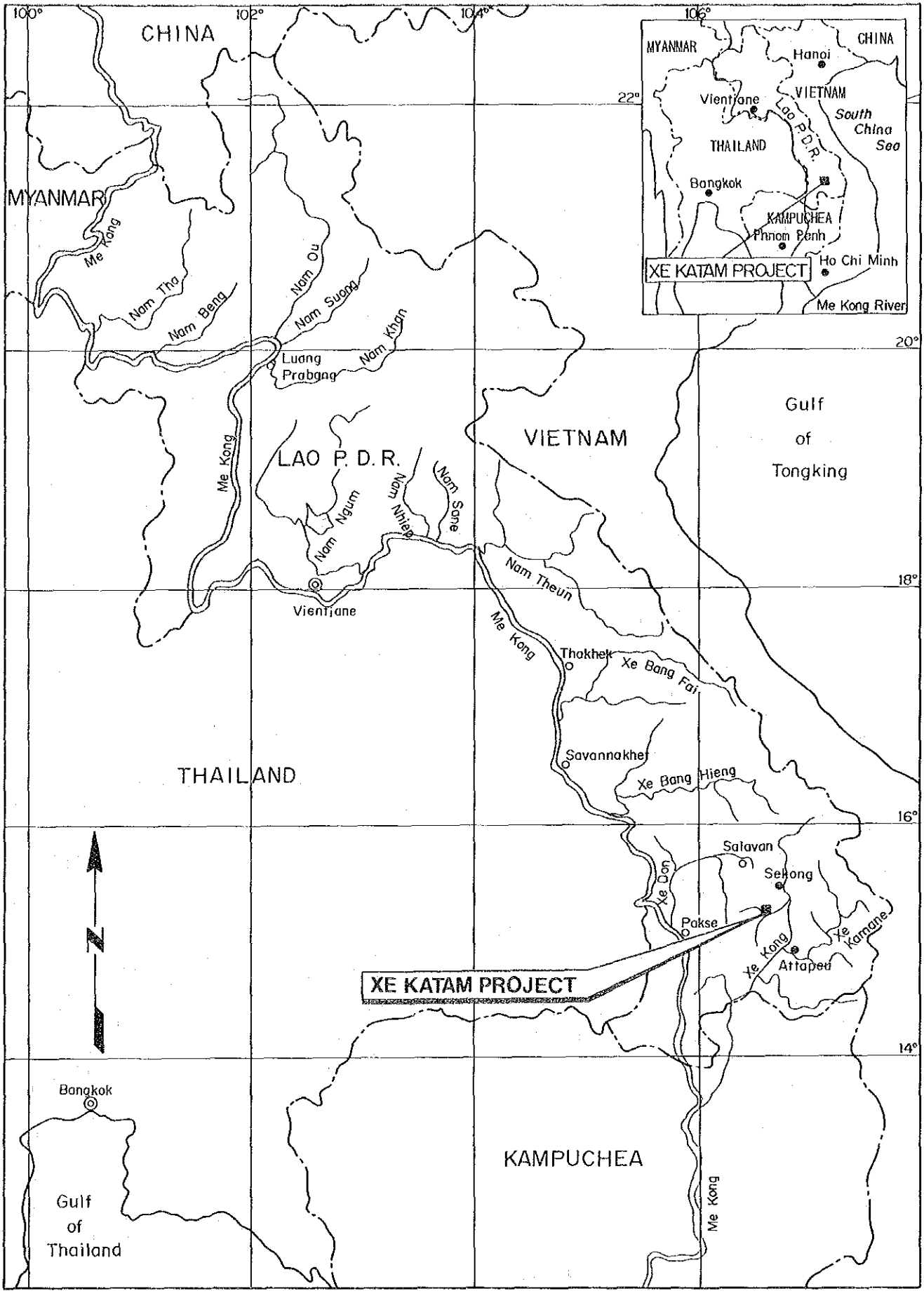
March 1992



Kensuke Yanagiya
President
Japan International Cooperation Agency

XE KATAM PROJECT

LOCATION OF PROJECT



XESET PROJECT

SELABAM Hydropower Station

SALAVAN

PAKXE

SEKONG

XE KATAM PROJECT

ATTAPEU

CHONG MEK (THAILAND)

CHINA

MYANMAR

VIETNAM

LUANG PRABANG

LAOS

VIENTIANE

THAILAND

SALAVAN

PAKSE

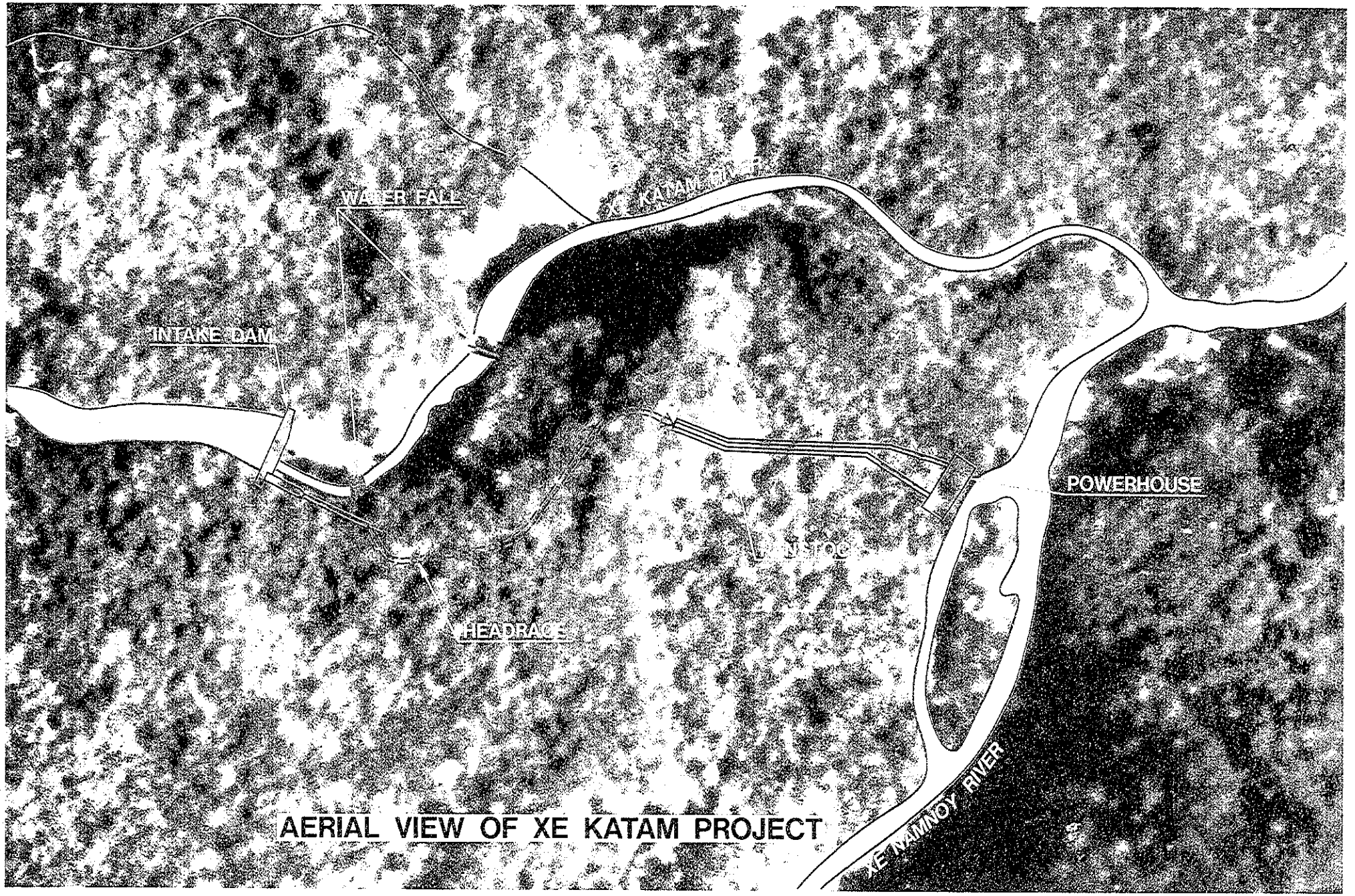
SEKONG

ATTAPEU

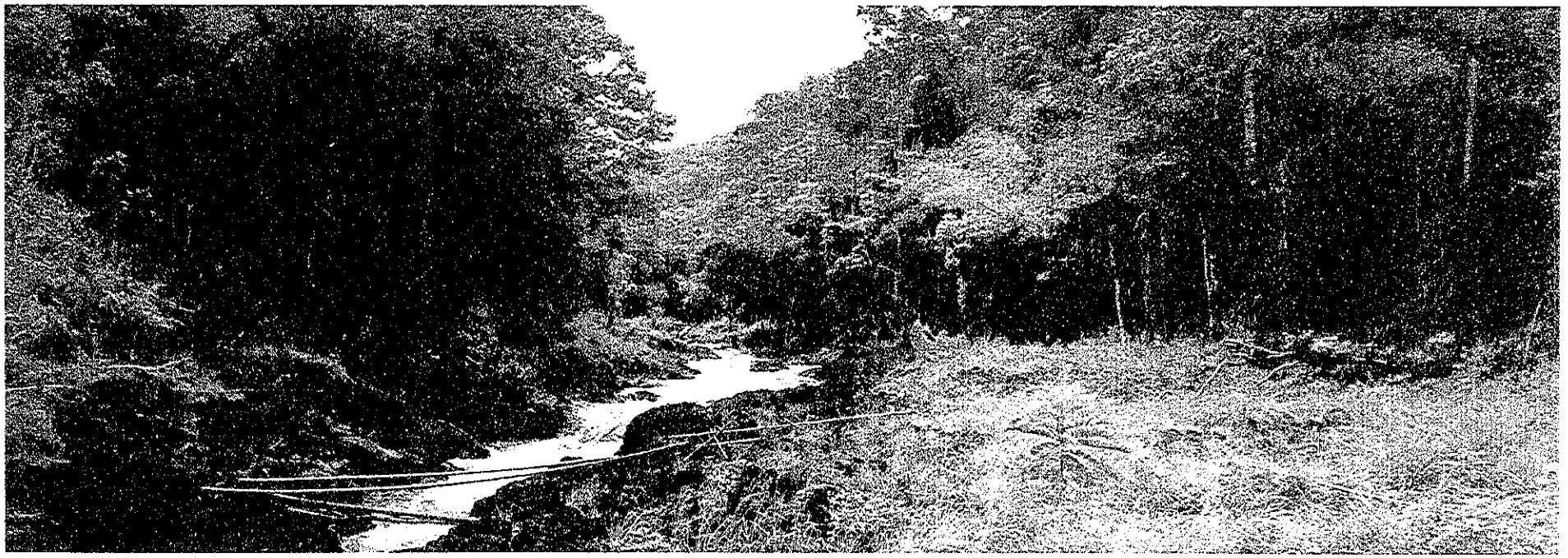
KAMPUCHEA

XE KATAM SMALL-SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT

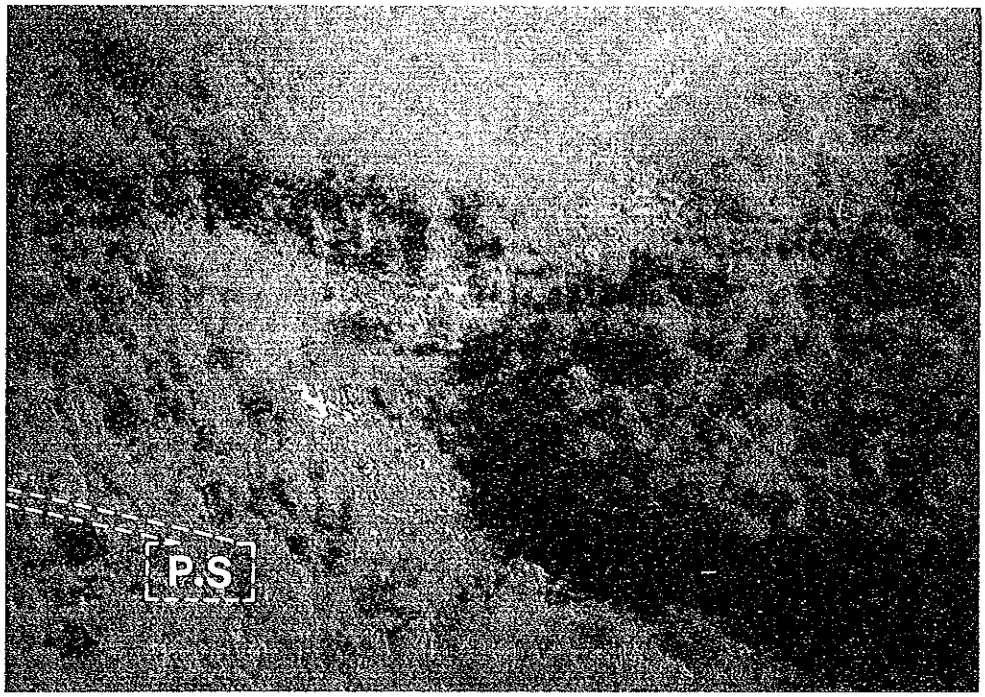
PROJECT AREA



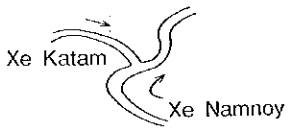
AERIAL VIEW OF XE KATAM PROJECT

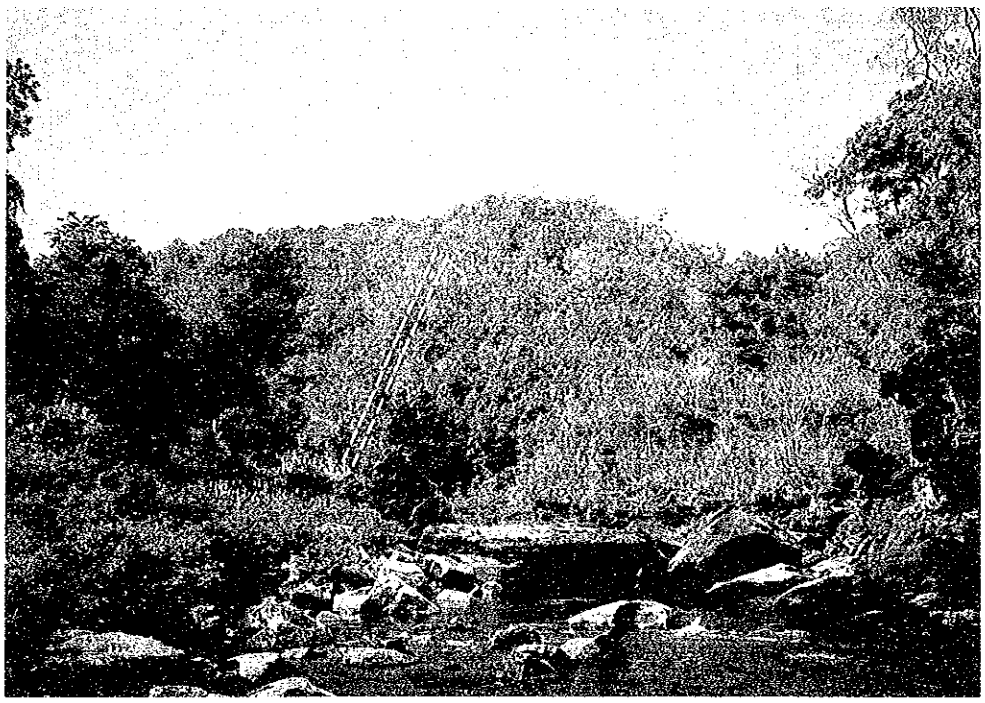


Intake Dam Site (upstream View)

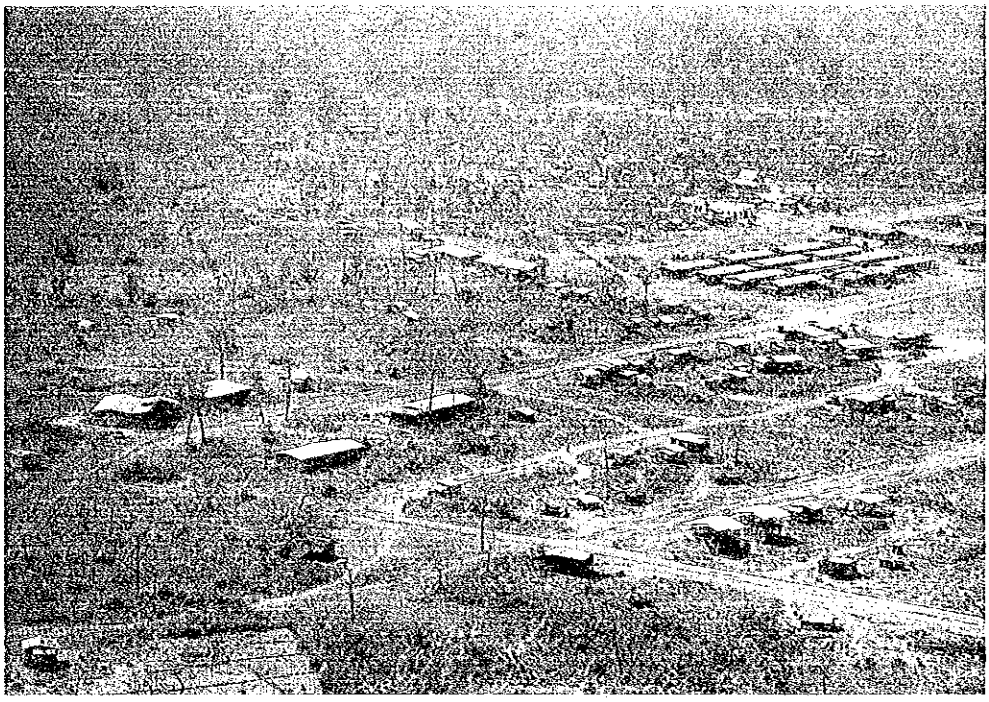


Confluence of Xe Katam and Xe Namnoy River

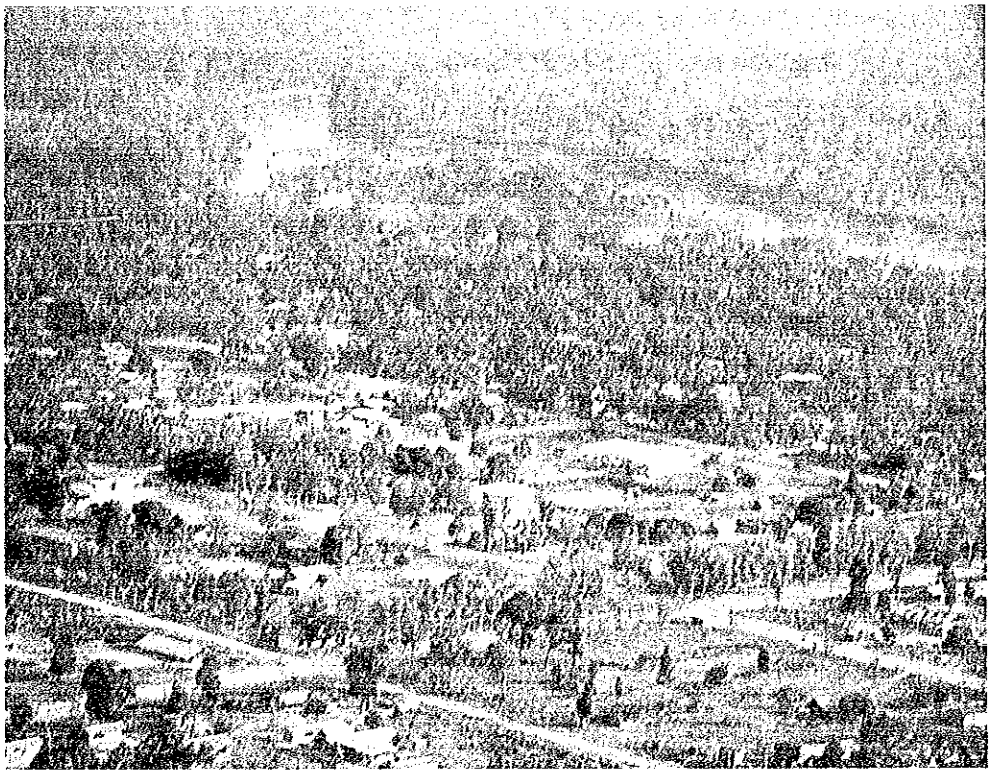




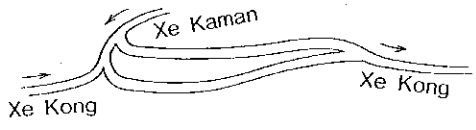
Penstock and Power House Site
(View from Confluence)

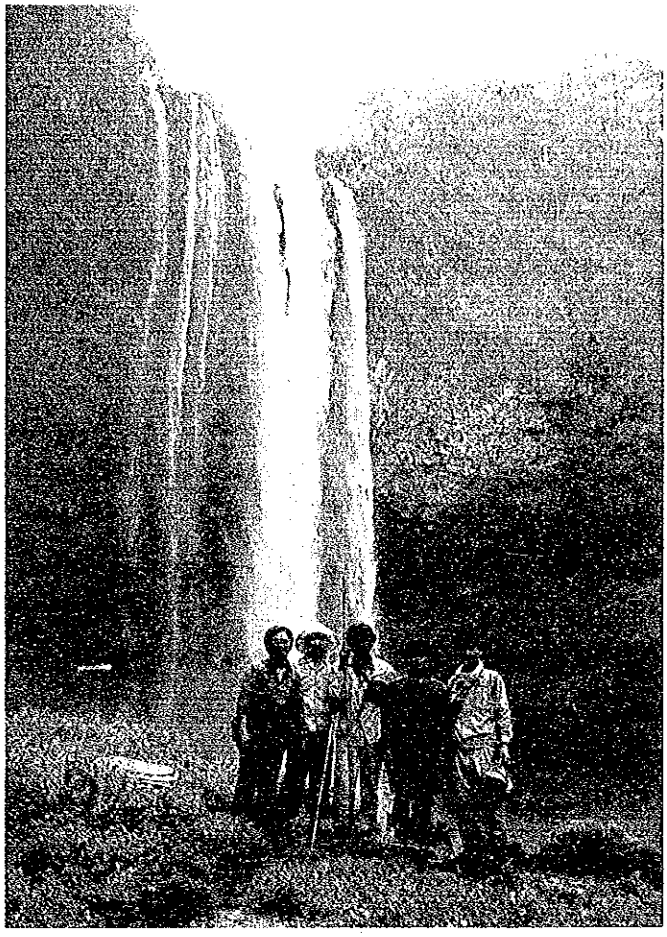


Sekong Town (Aerial Photo)

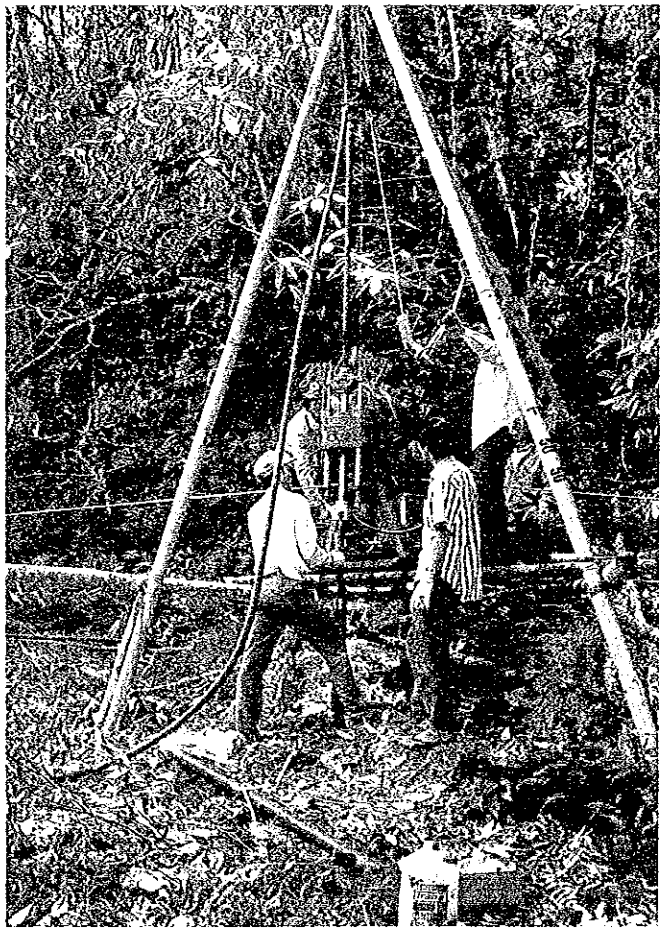


Attapeu Town (Aerial Photo)

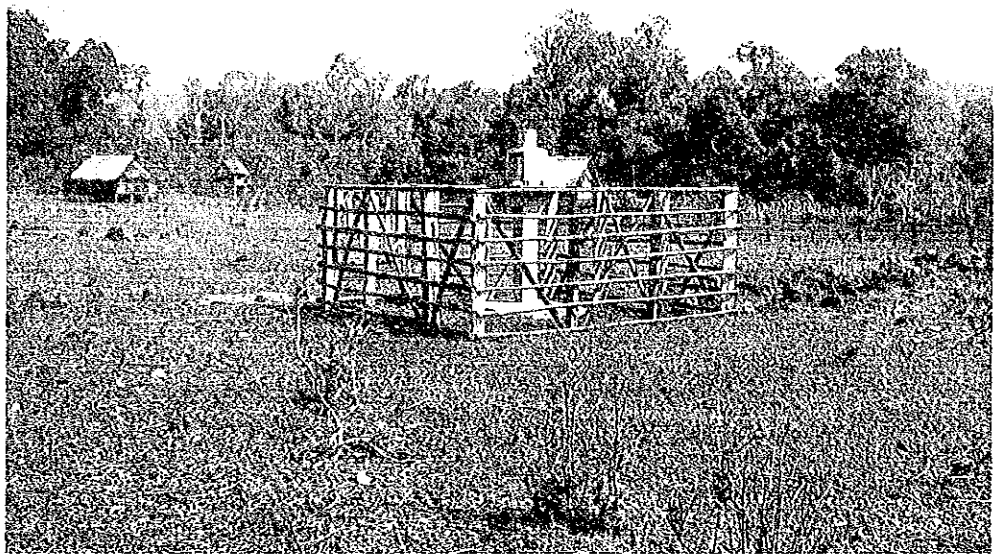




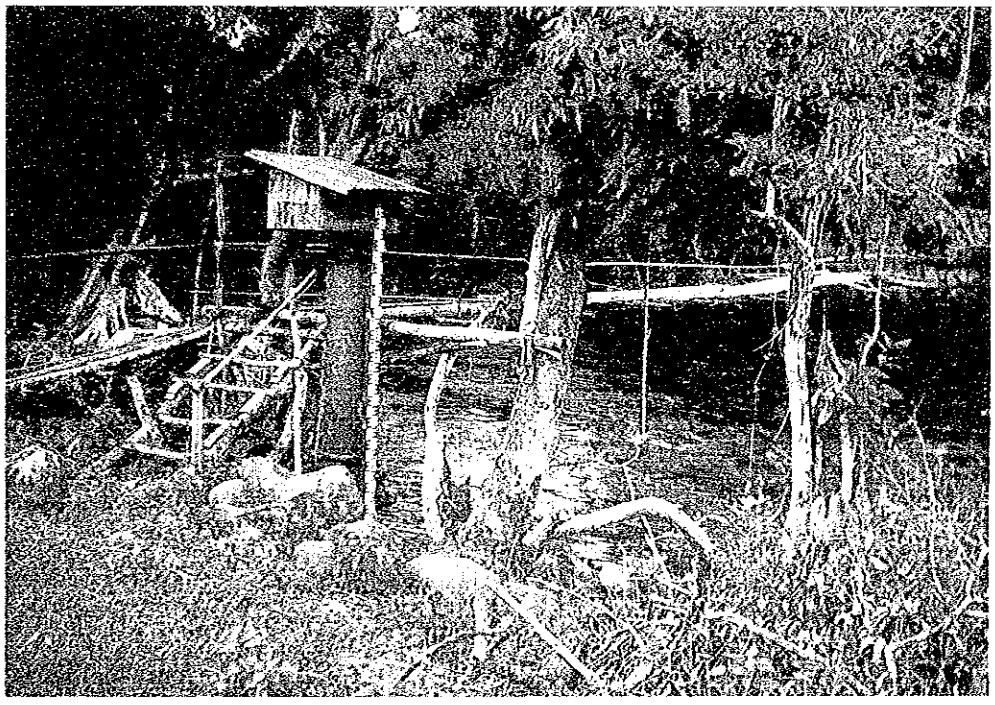
Water Fall located at the downstream of Intake Dam Site



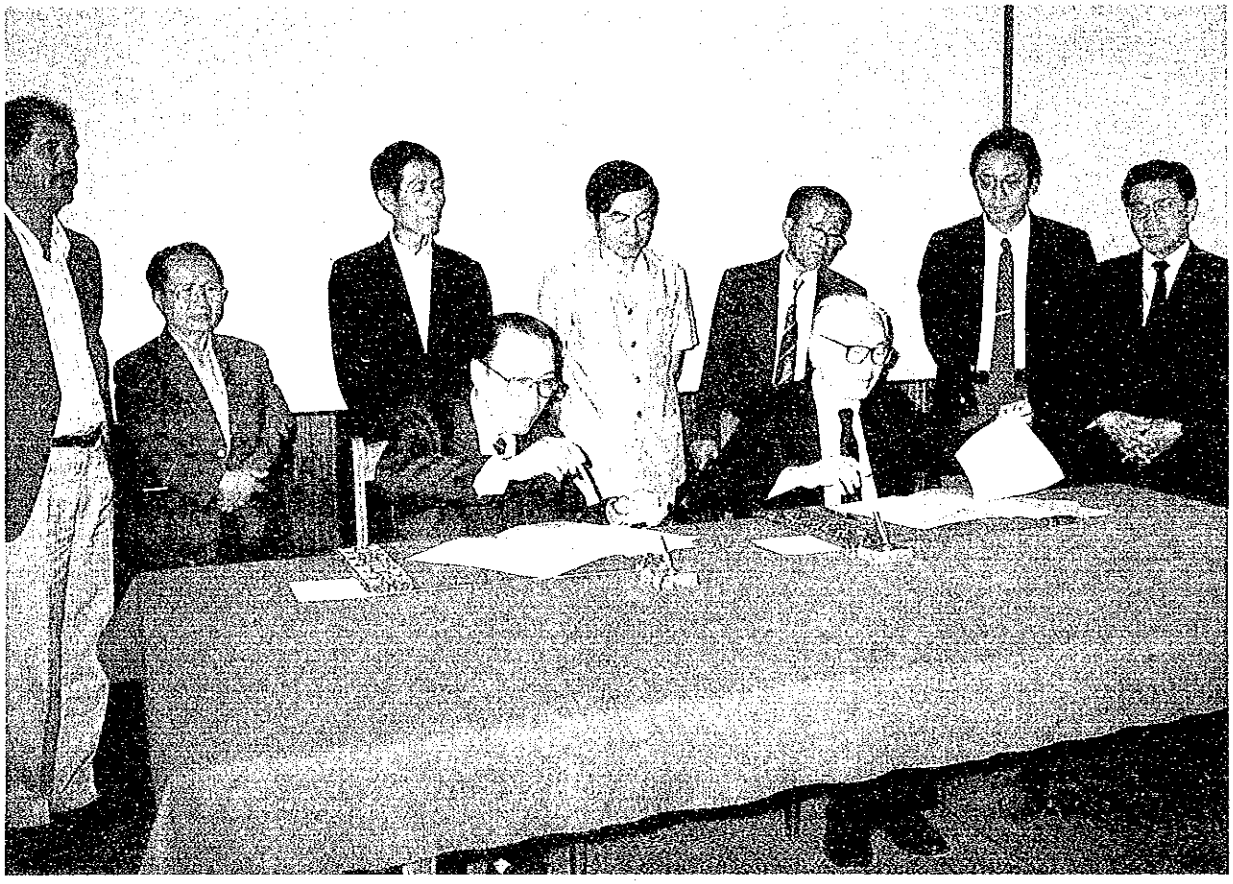
Drilling Work of Geological Investigation (KI-2)



Newly Installed Rainfall Gauge (B. Xe Katam)



Newly Installed Water Level Gauge (B. Nonghin)



Signing of Minutes of Meeting

Left : Mr. Damdouane PHOMDOVANGSY
Director of Cabinet, MIH
Right : Dr. Hiroshi HORI
JICA Team Leader

FEASIBILITY STUDY
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CONCLUSION AND RECOMMENDATION

The feasibility study on the Xe Katam Small-scale Hydroelectric Power Development Project was carried out by JICA Team with a purpose to electrify towns of Sekong and Attapeu, both of which have not so far been satisfactorily electrified, by supplying reliable power which will be generated at the proposed power station.

To examine a possibility of hydropower development potentials from a comprehensive viewpoint, the Xe Katam river basin was surveyed in the closest context of the overall Xe Namnoy river basin. In order to do so, the study team formulated plans of various development projects within the Xe Namnoy river basin, and a composite evaluation was made for all possible development projects in regard to the economic and technical aspects. As a result, it was concluded that the proposed Xe Katam project would be quite an appropriate project as a means to satisfy urgent, latent demand of power of the two towns, taking into account of its timing and scale of development as well as its amount of investment.

In general, a small-hydro power project requires relatively high unit cost for power generation, that is, kWh cost. Keeping this in mind, sequence studies were made with full care; first, field reconnaissance was made to cover target areas and, next, fundamental information and data on topography, geology, hydrology, etc., on the whole area, as well as environment was collected. Third, based on the above-mentioned collected data and information, several comparison studies on various development plans were made in the Xe Namnoy and the Xe Katam river basin. As a result, the final plan of development was adopted, taking into consideration of its easiness of construction and also of its benefits to be derived from investment. The development plan thus finally adopted was further examined again in detail on the topography, geology and hydro meteorology. On the plan, the most appropriate design was applied.

Regarding the optimization of scale of development, analysis was made on the future demand of power forecasted in the two towns, and, in order to meet the forecasted demand, it was concluded to set up a power station with the

installed capacity of 2,000 kW at the initial development stage and of 6,000 kW as the final scale of development, in view of social and economic aspects.

For the economic evaluation, a diesel power plant was selected as an alternative power supply scheme to replace this project with a view to meeting future power demand to arise in the towns of Sekong and Attapeu. As a result of the comparison study, it has proved that the proposed hydropower plant would be superior to the said alternative scheme. It is also concluded that the development not to rely upon imported diesel oil would contribute to saving of foreign exchange outlays.

As far as the financial analysis is concerned, it has become apparent that the financial equalizing discount rate of the project would not reach 10% which is the social discount rate prevailingly used as a criterion for project evaluation in Lao P.D.R. unless some specially favoured financial arrangements are made in connection with the invested capitals for 2,000 kW at the first stage. It was thus concluded that some special financial measures should be needed for the sound implementation of the proposed project.

Regarding environmental effects of the proposed project, as the project is of a small-scale run-of-river type, there would not be any resettlement problems to be encountered and also the anticipated natural destruction during its construction as well as its operation would be minor.

In summary, the proposed project was judged as quite adequate as a power development project to be set up near the service area, even though some special financial measures may have to be made for the sound project implementation, because the study made by the Team clarified this project to be by all means viable from all view points including technical, economic, social as well as environmental and other considerations.

Nevertheless, this study had to be carried out within quite a limited period of time and on inadequate conditions, so that it had to be completed without success to collect a satisfactory amount of hydro-meteorological data, which collection require a long-term observation period as a matter of fact, although the utmost efforts were made by the Team throughout the study period

to try to collect such data from neighbouring observation stations as well as hydropower stations and also a limited number of data collected from new precipitation and run-off observation stations which were set up at the proposed area in this year. The river discharge simulation was carried out by means of all run off data collected.

In regard to the power demand survey, it was not necessarily easy to forecast demand due to paucity of historical data in service area. In fact, in the forecasting work, there were certain uncertainties on several factors, which are important for forecasting demands.

It is therefore recommended that the hydro-meteorological data observation be continued up to the next stage, that is, definite design stage, and that further more detailed survey be made for the power demand study which should include future investment plans for the development of mining, industry and agriculture in Sekong and Attapeu areas as well as the trend study on power demand in other neighbouring areas where electrification have already been materialized.

Furthermore, it is to be advised that monitoring of the environmental parameters should always be made even from the period prior to the project's implementation from the viewpoint of conservation of the river basin although there would not be any significant negative environmental effects caused by the Xe Katam project.

In addition, since this project is of a run-of-river type, there is some fear to be partly unable to supply stable power for a certain short period in the driest season after commissioning of this project. It is therefore expected that some transmission line expansion project to interconnect lines between the proposed ones and the adjacent existing ones would be realized in the future.

GENERAL PROJECT FEATURE (1/3)

Items	Description
Project Name	Xe Katam Small-scale Hydroelectric Power Development Project
River	Xe Katam River
Catchment Area	290 km^2
Installed Capacity	2,000 kW (First Stage) 6,000 kW (Final Stage)
Firm Capacity	1,400 kW (First Stage) 1,400 kW (Final Stage)
Available Annual Energy	16,613 MWh (First Stage) 40,299 MWh (Final Stage)
Intake Dam Intake Water Level Available Drawdown Gross Storage Capacity Effective Storage Capacity Type Dam Height Crest Length Sand Flush Gate Design Flood (100 year return period)	 EL. 469.0 m 1.0 m 30,000 m^3 10,000 m^3 Overflow type concrete gravity dam 8.6 m 77 m 5.0 m width x 4.0 m height 840 m^3/s
Intake	Side intake type with right-angled to the dam axis 6.0 m ~ 5.0 m width x 8.0 m height x 140 m length Gate 5.0 m width x 4.1 m height
Sand Stilling Basin	R.C open channel type 5.0 m width x 7.0 m height 33.0 m length
Culvert	Round reinforced concrete pressurized 2.0 m inside diameter 75.64 m length
Headrace Tunnel	Round lining reinforced concrete 2.0 m inside diameter 342.25 m length 25 cm lining thickness
Penstock	Exposed type & backfill type Steel pipes and FRP pipes First Stage: 336.788 m length Latter Stage: 290.104 m length
Powerhouse	Reinforced concrete, surface type First Stage: 15 m width x 11 m height 26 m length Latter Stage: 15 m width x 11 m height 25 m length Tail Water Level 306.7 m

GENERAL PROJECT FEATURE (2/3)

Items	Description
Turbine	Horizontal shaft Pelton turbine First Stage: 1,030 kW x 2 units Latter Stage I: 2,060 kW x 1 unit Latter Stage II: 2,060 kW x 1 unit
Generator	Horizontal shaft AC synchronous generator First Stage: 1,180 kVA x 2 units 3.3 kV Latter Stage I: 2,350 kVA x 1 unit 3.3 kV Latter Stage II: 2,350 kVA x 1 unit 3.3 kV
Transmission Line	to Sekong / to Attapeu Number of Circuit: 1 / 1 Line Length: 50 km / 73 km System Voltage: 22 kV / 22 kV Cable Type and Size: HAL 55 mm^2 / HAL 150 mm^2 Transmission Capacity: 2,000 kW / 3,000 kW
Construction Period	First Stage: 17 months (March 1994 - July 1995) Latter Stage I : 17 months Latter Stage II: 16 months
Total Construction Cost (including transmission line and interest during construction)	First Stage (2,000 kW): US$15,677,000 Latter Stage (4,000 kW): US$10,096,000 Total: US$25,772,000 (in 1991 price)

GENERAL PROJECT FEATURE (3/3)

Items	Description
Economic Evaluation (for final installed capacity of 6,000 kW) The net present value of the total cost to be incurred over the service life is assumed to be C, whereas that of the alternative diesel power plant during the same depreciation period is assumed to be B. The surplus benefit (B-C) and the benefit cost ratio (B/C) were calculated at a social discount rate of 10% in Laos. The economic equalizing discount rate (EEDR) at which the net present value of B and C are balanced was also calculated.	B - C = 1,365 x 10^3\$ B/C = 1.08 EEDR = 10.08% (which exceeds a social discount rate of 10%)
Financial Analysis (for final installed capacity of 6,000 kW) (1) Financial Analysis of the Project in terms of Invested Capitals The net present values of electricity sales revenue and total cost (Construction Cost + Operation and Maintenance Cost) are assumed to be B and C respectively. The surplus benefit (B-C) and the benefit cost ratio (B/C) were calculated at a discount rate of 10%. The financial equalizing discount rate (FEDR) at which the net present value of B and C are balanced was also calculated.	In case invested capitals are summed up for the first 2,000 kW: B - C = -1,178 x 10^3\$ B/C = 0.37 FEDR = 2.7% In case the amount of invested capitals is regarded as zero for the first 2,000 kW: B - C = +1,107 x 10^3\$ B/C = 1.2 FEDR = 14.3%
(2) Financial Analysis from the Standpoint of Power Utilities Debt Service Ratio (ratio of internal funds generated (operating profit + depreciation allowance) to debt (repayment of principal + payment of interest)) was calculated for the cases.	In case invested capitals are accounted up for the first 2,000 kW: Debt Service Ratio: 1.16 (Cumulative Average for 40 years) In case the amount of invested capitals is regarded as zero for the first 2,000 kW: Debt Service Ratio: 1.49 (Cumulative Average for 40 years)

1. Background of Project

1.1 Laos

The Lao People's Democratic Republic is an inland country whose area is 236,800 km^2, total population of 17 provinces is 4,170,000 and population density is 17.6 persons/km^2 (the governmental statistics of 1990). The population and area of the southern 6 provinces (Champasak, Savannakhet, Salavane, Khammouan, Sekong, Attapeu,) where the project is located and the energy supply area is located, account for 35 percent and 40 percent of total area and population, respectively.

Laos, being a mountainous country, is naturally endowed with mineral and forestry resources. Agricultural products such as rice and cash crops are cultivated around Vientiane and in other area. The total rice cultivate area of the southern 6 provinces is 272,000 ha which accounts for about 40 percent of the total rice cultivated area of Laos (1990) but almost all area is rainfed, not irrigated yet.

The industrial products has varieties, consisting of such as textile, clothing, metal processing, pharmaceutical,pottery, paper making and printing, but it's productivity is minor. There are small industries such as sawmills, rice mills and coffee mills in Sekong, and sawmills, rice mills, ice plants and car repair shops in Attapeu. The shortage of energy is one of the reasons why such industry has not been developed much.

The transportation and telecommunication system is poor especially in southern provinces. Transportation condition in the project area during rainy season from May to November is so miserable that fuel can't be supplied to diesel power plants in local towns.

1.2 Hydroelectric Potential

Laos has abundant hydroelectric potential with annual average precipitation of 1,500-2,000 mm.

The amount of theoretical hydroelectric power potential in Laos, excluding those on the main stream of the Mekong River, is estimated to be 37,000 MW and the potential which can be technically and economically developed is estimated to be more than 10,000 MW.

The potential in the southern 6 provinces only is estimated to be more or less 2,000 MW. The practical potential in the Xe Namnoy River basin (1,500 km^2) was estimated to be 360 MW in our study.

1.3 Power Facilities in Laos

1.3.1 In Laos

The total installed capacity in Laos is 212,000 KW (in 1991). The powerstations consist of Nam Ngum Powerstation of 150,000 MW, Selabam Powerstation of 2,040 KW, Xe Set Powerstation of 45,000 MW which operation has recently been commissioned and of Luang Prabang Powerstation and of some local diesel power stations (13,700 MW in total). Present annual energy production is estimated to be 800-1,000 GWh which is above the forecasted total energy demand in Laos 657.2 GWh in the year of 2,000. The surplus energy is being exported to Thailand.

1.3.2 In Southern Provinces

Since 1975, the Government of Laos has been concentrating her efforts on the improvement of the capital its suburbs. The Nam Ngum Powerstation has been greatly contributing to it. Since the latter half of 1980, the Government of Laos has began to provide electric facilities for the southern area development. Now, the promotion of electric power development has been being carried out both in the southern area and in Vientiane area in parallel. (The project which the Government of Laos is intending to develop around the capital is the hydropower of Nam Mang and the transmission line between Vientiane and Luang Prabang.)

In the southern provinces, Savannakhet and Khammouane Provinces are importing energy from Thailand through cable lines (22 kV) running under the Mekong River.

An expansion work of the Selabam Powerstation which was constructed in the Xe Don River in the Champassak Province is now being carried out and its installed capacity will become to 3,000 kW in June 1993. The generated energy will be supplied to Pakse through 22 kV transmission line.

In 1991, the Xe Set Powerstation in the Salavane Province begun its operation. The energy is supplied to both Salavane and Pakse cities and the surplus energy is exported to Thailand through 115 kV transmission line crossing the Mekong River.

1.4 Electrification Projects in the Southern Provinces

The Southern Province Electrification Project is under way and will be promoted under the SPE-I (1988-1993) and SPE-II (1992-1996) programmes.

1.4.1 SPE-I Plan (1988-1993)

The EDL (Electricite du Laos) started the project in 1988 with the objective of supplying energy to the Champassak and Salavane provinces by the construction of the Xe Set and the Selabam powerstations by securing the IDA credit. The project is on the way and is expected to be completed in midyear of 1993.

1.4.2 SPE-II Plan (1992-1996)

The EDL ordered TATA, an Indian consultant, to formulate the SPE-II Plan, as a continued programme of SPE-I, with IDA credit. The energy demand in the Southern Provinces from 1992 to 2001 is forecasted in the report submitted in May 1991.

The plan is intending to expand electrification in some of the southern areas where electrification was not covered by the SPE-I. It must be noted, however, that the plan is so far a desk plan without any financial background.

2. Xe Katam Small-Scale Hydroelectric Power Development Project

2.1 Past Activities Leading to This Study

The Government of Laos has studied about 16 small hydroelectric development projects which are scattered all over Laos in the Second 5-Year Economic and Social Development Plan period. Based on this study, the Government of Laos has requested grant aid by the Government of Japan in May, 1989 for the feasibility study of the Xe Katam Project with the expectation that this project would contribute to the development of Attapeu and Sekong area both of which are promising agricultural and forestry areas in the southern region of Laos.

2.2 The Study Schedule

The study was started in December, 1990, and was completed in March, 1992. The study is divided into three stages, the Identification Stage, Field Investigation Stage and Preliminary Design Stage.

2.3 Hydroelectric Potential of the Xe Namnoy River Basin and Xe Katam Project

The Xe Namnoy is a river which has an drainage area of 1,500 km^2 located in the central part of the Bolaven Plateau (EL. 500 to 1,600 m), a conical shaped lave plateau situated in the southern part of Laos. The Xe Namnoy River discharges to the Xe Kong River, which is a large tributary of the Mekong River.

This study has indicated that, if the main stream of the Xe Namnoy River and its tributary, Houay Katak-Tok River are developed, approximately 360,000 kW of electric power could be generated by building three or four dams. However, at present, there is few road in this basin and, in addition, survey data are not sufficiently available to start any development project so that further surveys and studies are required.

There is no major city in the basin, and there are only two towns, Sekong and Attapeu, in the vicinity of the basin. There is Pakse City along the main stream of the Mekong River in a location not very far way, but the electric power demand of this city has been currently met by the power transmitted from the two hydroelectric power plants of Xe Set and Selabam. The future power demand of Pakse City will be met in this manner for a relatively long time. Therefore, the development of the Xe Namnoy River, which could produce as much as 360,000 kW of power from several hydroelectric sites, would become realistic only after an arrangement is made to export electric power from Pakse to Thailand across the Mekong River. The timing of development of the Xe Namnoy basin must be determined within a framework of a comprehensive development plans in which the development of the whole basin of the Mekong River after year 2000 and the economic development of Laos as well as the requirement of energy in Thailand is duly taken into account.

In the Xe Namnoy river basin, there are several sites where small-scale hydropower development are seemed to be possible. After carrying out simple comparison studies, it was concluded that the Xe Katam Project could be developed most easily and economically.

In view of the above considerations, it was concluded that the development of a small-scale hydroelectric power plant on the Xe Katam River, with the objective to satisfy urgent (but small) power demands in the two towns of Sekong and Attapeu, would be most appropriate as a step in the overall development concept of the Xe Namnoy Basin. both in terms of the scale of the project and the ease of the construction works involved.

However, since this projectd is of a run-of-river type, it is desirable that several medium and small reservoir type power facilities would be installed and be interconnected with this project. After the development of the Xe Katam Project, such prospects would be discussed.