6. IMPLEMENTATION OF PROPOSED ACTION PLANS

6.1 Basic Concept for Implementation of Proposed Action Plans

As mentioned in Chapter 5, the proposed integrated agricultural development to the study area under the Master Plan includes various scheme components and action plans as follows:

(1) Increase and Stabilization of Agricultural Productivity

- (i) Strengthening of agricultural support services
- (ii) Establishment and operation of the integrated agricultural station

(2) Development of Agricultural Production Infrastructures

- (i) Rehabilitation and upgrading of existing traditional irrigation system
- (ii) Improvement and establishment of water users association
- (iii) Strengthening and improvement of meteo-hydrological network
- (iv) Construction of new irrigation system

(3) Development of Social Infrastructure

- (i) Rehabilitation and upgrading of district road network
- (ii) Construction of additional rural water supply facilities
- (iii) Rehabilitation and construction of primary schools
- (iv) Development of rural electrification

(4) Measure to Environmental Problems

(5) Support Service for Women's Group

However, some of the action plans mentioned above are zatill technically not sound for implementation at present. Therefore, the implementation should be made under well-designed "stage-wise" schedule with time enough for applying the result of previous stage for the next stage implementation, also taking into account the technical and managerial capability of the staff concerned and their accumulated experience in this type of development.

On the basis of the final target year of 2010 for the proposed development, the implementation is planned to be carried out in three stages, namely "short term (1995 to 2000)", "medium term (2001 to 2005)" and "long term (2006 to 2010)". In line with the above stages, the programs under the action plans are tabulated, on the basis of the development objective and strategy at each stage, for stage-wise implementation of the Master Plan by the following categories as shown in Table M-5 and Fig. M-4.

(1) Study and preparation of concrete action plans and programs
(2) Development of most appropriate technologies in various fields of the agricultural development
(3) Execution of various pilot model schemes
(4) Execution of development schemes

6.2 Short Term Development

6.2.1 Objective and Strategy for Short Term Development

The objectives of the short term development are to establish the technical and implementing base as a "model area" which will have to be the core to demonstrate the effects of the integrated agricultural development and will also be the base for further expansion and settlement of the improved and profitable agriculture that will be carried out under the medium and long term stage. In this connection, selection of model areas to be proposed for the implementation is made on the basis of data and information on physical, social and economic conditions of several potential sites in the study area, and also taking into account the following essential factors:

(1) Potential accessibility via roads to the administrative and marketing centres.
(2) Potential for agricultural improvement.
(3) Potential for irrigation development especially in terms of topography suitable for irrigated farming and availability of water resources.
(4) Potential population density especially to expect higher demonstration effect.
(5) Potential for having direct positive effect on control of slash-and-burn cultivation.
(6) Motivation of people to expect progressive involvement of the people in planning, implementation and subsequent operation and maintenance of the Scheme.
(7) Balance of ethnic composition.
(8) Province's priority ranking.
(9) Absence of negative effects on other projects and areas.

Then, three model areas, one in each district, are selected through analysis of the data and information as well as discussions with the government institutes concerned (details are given in ANNEX-MI "MODEL AREA SELECTION"). The model areas are located at Tham Nhuang site (Xai model area), on the left bank of the Nam Beng river (Beng model area) and at Nam Kham site (Hun model area) as shown in Fig. M-5.

It is planned that all the action plans and programs under the short term stage be concentrated on these model areas, and various scheme components will be tested, demonstrated and evaluated through the implementation of the model areas. In addition, some research works, improvement and strengthening of the provincial and district offices and training of the project staff as well as farmers will be carried out in order to obtain data and information that can be applied for the next development stage as well as to accumulate the experience of the staff and farmers in the improved farming and its management.

6.2.2 Action Plan and Program at Short Term Stage

The following action plans and programs for possible early implementation of the model areas are proposed at short term development stage as the first step for the implementation of the Master Plan in the study area. These action plans and programs are further studied in detailin "Feasibility Study as Model Areas, Volume III".

(1) Strengthening of Agricultural Support Services: this action plan at the short term stage will include two programs such as (i) strengthening of extension services, and (ii) improvement of efficient marketing system.

(i) Strengthening of Extension Services: for successful implementation of the action plans and programs to be carried out in the model areas, theactivities of existing extension section in each district office will be supported by the following works under this program. Activities of these extension offices are shown in Sub-section 5.1.1.

(a) Construction of office buildings including storage and garage
(b) Construction of staff quarter
(c) Supply of necessary equipment for each office
(d) Appointment of additional extension staff
(e) Training of extension staff at the "integrated agricultural station"

(ii) Establishment of Efficient Marketing System: in order to improve the present marketing system, establishment of a "rice bank" to be operated by the existing women's union is proposed for each model area. The activities of the rice bank will be processing and selling of rice, and collection, selection and selling of sesame as well as to provide more local credit services. To support this, the following works will be implemented by the program:

(a) Construction of office building, storage and drying yard
(b) Supply of small-scale rice mill, sesame cleaner, and other necessary equipment
(c) Training of the rice bank staff at the "integrated agricultural station"

(2) Establishment and Operation of Integrated Agricultural Station: the programs for this purpose (refer to Sub-section 5.1.2) will be carried out under this action plan.

(3) Rehabilitation and Upgrading of Existing Traditional Irrigation System: the programs to be implemented under this action plan include (i) development of irrigation system for about 302 ha (net) in Xai model area, (ii) development of irrigation system for about 270 ha (net) in Beng model area, and (iii) development of about 258 ha (net) irrigation system in Hun model area.

(4) Improvement and Establishment of Water Users Association: it is essential to establish the efficient water users associations by organizing the existing farmers groups in connection with the proposed irrigation development in the model areas (for activity programs, refer to Sub-section 5.2.2).

(5) Strengthening and Improvement of Meteo-Hydrological Network: the programs for this purpose shown in Sub-section 5.2.3 will be implemented under this action plan.

(6) Rehabilitation and Upgrading of District road Network: one district road connecting Nasao and Nale villages to the National Road No.2 with a total length of about 1.9 km in Xai model area, and the other district road running from Hun town to Somphon village with a total length of 7.5 km in Hun model area, will be rehabilitated.

(7) Construction of Additional Rural Water Supply Facilities: construction of three (3) rural water supply systems, one in each district, will be proposed. These systems will supply clean water to 12 villages in and around the model areas, three in Xai model area, four around Beng model area and five in Hun model area.

(8) Rehabilitation and Construction of Primary Schools: four (4) Thaohom schools and eight (8) village primary schools will be rehabilitated with the required number of desks, chairs and blackboards in each school. They are five in Xai model area, three in Beng model area and four in Hun model area.

(9) Measure to Environmental Problems: the measures for alleviation of environmental problems proposed in Section 5.4 will be carried out as one of the components of the Scheme mainly by the integrated agricultural station in collaboration with the offices concerned.

(10) Support Service for Women's Group: the programs for this purpose shown in Section 5.5 will be implemented under this action plan mainly by the extension offices.

6.3 Medium Term Development

6.3.1 Objective and Strategy for Medium Term Development

The implementation and operations of the model areas would provide various data and information useful for preparation and execution of concrete action plans for extension and settlement of the intensive farming with the improved techniques in other potential areas of each district. In addition, the government staff as well as farmers will obtain more experience in such an intensive farming, especially in lowland rice field, through its practices, training and extension services to be provided under the model areas scheme.

However, these data and information, especially on upland farming in hill areas will still be the preliminary ones which should be confirmed and supplemented by the continuous field trials, and the experience of the staff and farmers will also be at the initial stage. Although some research works and demonstration of intensive farming in upland on hill slope adjacent to the model areas will also be carried out, in addition, these will still be limited to very small area at the trial stage.

Therefore, the agricultural development under the medium term program will have two main objectives: one is the expansion of improved farming techniques with irrigation for increase in yield of lowland rice with the related supporting services to the selected potential lowland ; and the other is the accumulation of more technical data and information on and experience in the improved upland farming through the continuous trial and demonstration activities and pilot schemes.

With the completion of medium term development, more efficient organizations and systems in both the government institutes and farmers groups supported by the improved technologies and accumulated experience in both the lowland and upland farming could be built up for successful execution of the next long term development program.

6.3.2 Action Plan and Program at Medium Term Development Stage

Proposed action plans and programs at medium term stage under each component are listed as follows:

(1) Strengthening of Agricultural Support Services: extension of the same programs of short term stage such as (i) strengthening of extension services, and (ii) improvement of efficient marketing system.to the outside areas of the model areas. In addition, program for strengthening of veterinary services will be proposed to start from this stage.

(2) Operation of the Integrated Agricultural Station: the main programs to be carried out in this stage are (i) establishment of improved livestock system; (ii) establishment of steep slope farming system; and (iii) preparation of concrete action plan for establishment of farmers' organization, rehabilitation of existing irrigation system in the remote area and for development of new irrigation system including water resource development.

(3) Rehabilitation and Upgrading of Existing Traditional Irrigation System: rehabilitation of existing irrigation system for about 440 ha in the remote area. For this purpose, further study by the integrated agricultural station will be required to establish the concrete action plan during the short term stage.

(4) Improvement and Establishment of Water Users Association: extension of the same programs as in the short term stage to the irrigation systems to be rehabilitated and newly developed during this stage.

(5) Construction of New Irrigation System: construction of new irrigation system in the potential gentle sloping lands as a "model system" on the basis of the concrete action plan to be prepared by the integrated agricultural station during the short term stage.

(6) Rehabilitation and Upgrading of District road Network: about 138 km of earth road will be rehabilitated and/or upgraded to gravel road and about 73 km of footpath to gravel road.

(7) Construction of Additional Rural Water Supply Facilities: construction of rural water supply systems for the 40 villages.

(8) Rehabilitation and Construction of Primary Schools: rehabilitation of primary schools in the 30 villages.

(9) Development of Rural Electrification: strengthening of Beng town electricity system.

(10) Measure to Environmental Problems: extension of the programs for measures to environmental problem to be established during the short term stage to the critical areas.

(11) Support Service for Women's Group: extension of the same programs as in the short term stage to the outside of the model areas.

6.4 Long Term Development

6.4.1 Objective and Strategy for Long Term Development

The long term development will be the last stage of this Master Plan, but not the final goal of the rural socio-economic development in the study area. It is planned that the strategy for the development at this stage is to continue various programs included in the Master Plan by the efforts of the government staff and farmers themselves, using fully their technologies and experience accumulated through the previous short and medium term development.

6.4.2 Action Plan and Program at Long Term Development Stage

Proposed action plans and programs at long term stage under each component are listed as follows:

(1) Strengthening of Agricultural Support Services: extension of the same programs as in the medium term stage to the whole study area.

(2) Operation of the Integrated Agricultural Station: the main programs to be carried out in this stage are (i) establishment of steep slope farming system, and (ii) preparation of concrete action plan for development of new irrigation system including water resource development.

(3) Rehabilitation and Upgrading of Existing Traditional Irrigation System: rehabilitation of existing irrigation system covering about 970 ha in the remote area. Further study by the integrated agricultural station will be required to establish the concrete action plan during the medium term stage.

(4) Improvement and Establishment of Water Users Association: extension of the same programs as in the short term and medium term stages to the irrigation systems to be rehabilitated and newly developed during this stage.

(5) Construction of New Irrigation System: construction of new irrigation systems in the potential gentle sloping lands on the basis of the concrete action plan to be prepared by the integrated agricultural station during the medium term stage.

(6) Rehabilitation and Upgrading of District road Network: about 79 km of earth road will be rehabilitated and/or upgraded to gravel road and about 200 km of footpath to gravel road.

(7) Construction of Additional Rural Water Supply Facilities: construction of rural water supply systems for the 114 villages.

(8) Rehabilitation and Construction of Primary Schools: rehabilitation of primary schools in the 140 villages.

(9) Development of Rural Electrification: study on the development possibility in the study area.

(10) Measure to Environmental Problems: extension of the same programs of medium term stage to the whole study area.

(11) Support Service for Women's Group: extension of the same programs of short term stage to the whole study area.

7. EVALUATION

The implementation of the Master Plan proposed for integrated rural agricultural development is planned to be carried out over the period of 16 years on the assumption that the short term development program with start from 1995. During such a period, some changes in socio-economic situations might be foreseen in the study area and the Province as well as in the country. In addition, reliable data and information useful for quantitative analysis for evaluation of the Project's effects are very limited at present. Therefore, the evaluation of the Project shown in this chapter is a trial mainly in terms of the qualitative analysis rather than quantitative one. Various effects and impacts on the agricultural and socio-economic situations in the study area and the Province would be expected from the implementation of the Project as discussed below:

7.1 Agricultural Impacts

(1) Increase in Rice Production

The main agricultural impact to be expected from the Project implementation will be increase in rice production. The major increase will be expected in both lowland and upland rice field through improved irrigation, inputs and extension services under the Project implementation. For evaluation of the increase in rice production at each development stage, two assumptions are set as follows:

(i) Harvested area: it is assumed that all the potential areas suitable for irrigated rice farming will be developed at the maximum level through implementation of the Project. As a result, lowland and upland rice fields with technical irrigation system will reach 3,700 ha (4,000 ha of harvested area) and 3,500 ha, respectively. The change in harvested areas of rice at each stage would be expected as follows:

(Unit: ha)

	Without Project*	With Project		
		Short term	Medium term	Long term
Lowland				
Irrigated				
Technical (wet)	0	830	2,280	3,700
Technical (dry)**	0	125	250	300
Traditional	2,660	1,930	1,000	0
Rainfed	440	440	220	0
sub-total	3,100	3,325	3,750	4,000
Upland				
Irrigated	0	0	1,500	3,500
Rainfed***	12,750	12,750	12,750	12,750
sub-total	12,750	12,750	14,250	16,250
Total	15,850	16,075	18,000	20,250

Note: *; estimated as the same as at present.
**; estimated from the potential water resources for irrigation as shown in Table M-3.
***; slash-and-burn cultivation.

(ii) Yield: with implementation of the Project, yield of irrigated rice will significantly increase by stable supply of irrigation water and improved farming practices through proper agricultural support services. In addition, the yield of rainfed rice will also increase due to improvement of farming sytem to be introduced by the extension services. Anticipated yield of rice at each development stage is thus estimated as follows:

(Unit: ton/ha)

	Without Project	With Project		
		Short term	Medium term	Long term
Lowland				
Irrigated				
Technical	-	4.0	4.5	5.0
Traditional	2.6	2.9*	3.2*	3.5*
Rainfed	2.0	2.3*	2.5*	2.8*
Upland				
Irrigated	-	-	3.0	3.5
Rainfed	1.4	1.4	1.6*	1.8*

Note: *; estimated by increase rate of 2% for rainfed and traditional irrigated rice.

Based on the above assumptions, the rice production at each development stage is calculated in the following table. According to this, incremental rice production in each stage is estimated at about 2,600 tons (10% increase over the production at present), 16,400 tons (56%) and 29,600 tons (115%), respectively. Increase in rice production as a result of the Project will play an important role in food security of the study area as well as Oudomxay province.

(Unit: ton)

	Without Project	With Project		
		Short term	Medium term	Long term
Lowland				
Irrigated				
Technical	0	3,820	11,390	20,000
Traditional	6,920	5,600	3,200	0
Rainfed	880	1,010	550	0
sub-total	7,800	10,530	15,140	20,000
Upland				
Irrigated	0	0	4,500	12,250
Rainfed	17,850	17,850	20,400	22,950
sub-total	17,850	17,850	24,900	35,200
Total	25,650	28,280	40,040	55,200
Incremental Production	-	2,630	14,390	29,550

Note: detail calculation is given in Table M-6.

(2) Increase in Other Crops Production

The production of other crops such as sesame, cotton, vegetable, wheat soybean, rapeseed, etc. would also increase through introduction of dry season farming and establishment of efficient marketing system. The increased production of these crops will be used not only for local consumption but for export to Thailand, China, etc. and will also contribute to generate the farmers cash income.

(3) Increase in Livestock Production

The livestock production would also increase through more extension of veterinary services and establishment of marketing system. In addition, crop residuals after harvest and by-products from processing of crops will improve the fertility of livestock. The increased livestock production will contribute to increase the farmers' cash income through local marketing as well as from the export to Thailand, China, etc.

(4) Demonstration Effects

With implementation of the Project, farmers not only in the study area but also those in other agricultural areas, especially the Northern Region of Laos, will become familiar with modern irrigation farming practices both lowland rice field and gentle sloping upland field, and the incentive for adopting improved irrigation farming practices will be greatly enhanced. Enthusiasm generated from this success may even shorten the development period of other projects.

7.2 Socio-economic Impacts

(1) Foreign Exchange Saving

Rice production in Laos is insufficient to meet domestic demand. In 1990, 40,000 ton of milled rice were imported at a cost of US$ 9.6 million as shown in Table M-4. With implementation of the Project, local rice production will increase as mentioned in Section 7.1. As a result, the annual foreign exchange saving will be expected as follows:

	Incremental paddy production (ton)	Convert into rice (ton)	Expectative foreign exchange saving (million US$)
Short Term	2,630	1,710	0.4
Medium Term	14,390	9,350	2.2
Long Term	29,550	19,210	4.6

(2) Increase of Farmer's Income

The farmer's income will be expected to improve considerably due to the increase in crop production. The increase of net farm income will function to provide motive power in improvement of living standards of the farmers as well as of regional economic development.

(3) Expansion of Women's Activity

The Project would improve/expand women's activities in the study area through establishment of rice bank and women's school to be carried out by the extension workers. Increase of the farmers' income will also contribute to improve women's activity in not only farm families of the study area but also other families through the economic chain since housewifes are said to manage family budgets in many cases in the study area.

(4) Improvement of Local Transportation

Local transportation will be much improved by the rehabilitation and upgrading of district roads. The expanded road system will not only enhance economic activities such as transportation of the agricultural products, inputs, livestock and other commodities but will also contribute to inter-regional accessibility and communication.

(5) Expansion of Business Chance

With an increase of the farmers' income, the farmer's purchasing power would rise in the rural markets. Particularly markets of farm inputs and equipment would be more active and this impacts in rural economy would make other markets more active subsequent, which would expand business chances to local non-farmers indirectly. Increased crop production and improvement of the road system will also increase the business of millers millers, merchants and transporters with respect to processing, marketing and transportation costs.

(6) Increase in Employment Opportunities

The Project will generate employment opportunities for unskilled laborers during the construction period. Most of the manpower will be supplied from the farmers in and around the study area. Furthermore, employees will be able to gain more experience and skilfulness in the various working fields. The accumulation of experience and skills will be very useful for O&M work of the farmers and will provide the motivation for future development in the study area, the Oudomxay province and the Northern Region of Laos as well.

(7) Strengthening Rural Economy

All the Project benefits will serve to improve the standard of living and the quality of life of the local people in and around the study area and will contribute substantially to strengthening the economy of the study area, Oudomxay province and Laos as a whole.

7.3 Environmental Impacts

(1) Sustainability

The need is increasing nationwide to adjust land use system, to improve efficiency of land use, and to prevent environmental degradation, so that natural resources may be managed in perpetuity for the benefit of successive generations. From this point of view, the proposed integrated agricultural development by this Master Plan will enable to suitable, economical and

sustainable land use which may be expected to produce sustainable benefit definitely.

(2) Conservation on Destruction of Forest

To evaluate the magnitude of forest degradation, the comparative study is made between without project and with project conditions as shown below. The results show that the estimated slash-and-burn cultivation area without project condition is remarkably large in contrast to with project condition. Therefore, it is considered that increased rice production by the Project will alleviate the pressure on the degradation of forest by slash-and-burn cultivation activities.

	Short Term		Medium Term		Long Term	
	Without	With	Without	With	Without	With
Rice Production (ton)	25,650	28,280	25,650	40,040	25,650	55,200
Rice Demand (ton)*	40,110	40,110	46,870	46,870	64,300	64,300
Deficit in Rice (ton)	-14,460	-11,830	-21,220	-6,830	-38,650	-9,100
Converted into Upland Rice Area (ha)**	10,330	8,450	15,160	4,880	27,610	6,500

Note: *; estimated from the population projection and per capita consumption (details are given in ANNEX-MA AGRO-ECONOMY AND MARKETING of this Volume).
**; deficit in rice divides unit yield of rainfed upland rice (1.4 ton/ha).

In addition, the direct measures proposed by this Master Plan will also alleviate the pressure on the degradation of forest by slash-and-burn cultivation activities.

(3) Improvement of Living Environment

The serious living environment issues in the study area are poor road condition, poor rural water supply system, poor electric supply system both in quality and in quantity, and poor sanitary condition mainly due to the life style of rural people. These issues cause the inconvenience and disadvantage to the people in the study area such as transportation of agricultural products and fuel wood by hand, carrying water from the river, water born diseases, high infant mortality rate, etc. The Project will contribute to mitigate the living environmental issues through the improvement of social infrastructures (road and water supply) and several extension services for improvement of living standard.

Table

Table M-1 Retail Prices of Agricultural Products (1992)

(Unit: Kip)

	Agriculutral products		Xai market		Hun market	
		Unit	May	November	May	November
I. Meat	Beef	kg	1,200	1,200	900	1,100
	Buffalo	"	1,200	1,200	900	1,100
	Pork	"	1,200	1,200	900	900
	Chicken	"	1,500	1,000	1,500	-
	Fish	"	1,500	1,500	1,500	1,500
	Egg	piece	80	50		50
	Egg(duck)	piece		70		80
II. Cereals&grains	Paddy	kg	100	60	80	50
	Rice(milled)	"	150	150	100	120
	Maize(dried w/comb)	"	50			
	Sesame	"	300	350	350	350
	Soybean	"	-	600		500
	Mungbean	"	-	600		500
	Groudnuts	"	500	400	500	500
III. Vegetables	Sweet potato	kg	150	80	200	80
	Cassava(tuber)	"	100	120	100	120
	Garlic	"	500	600	600	600
	Onion(dried)	"	1,000			600
	Red onion(dried)	"	600	1,000	500	1,000
	Garlic leaves	"	1,000	800		300
	Onion leaves	"	1,000	800		400
	Coriander leaves	"	1,000	800		700
	Spinach	"	1,500	1,000		1,200
	Lettuce	"	200	700		500
	Pak bon(Ipomea sp.)	"	200	200	320	200
	Celery	"	500	600		600
	Cabbage	"	200	150	200	150
	Tomato	"	150	400	500	300
	Bean sprout(mung)	"	300	300		
	Cucumber	"	350	150		100
	Eggplant	"	600	120	350	120
	Green pepper	"	1,000	600	1,000	400
	Red pepper(dried)	"	1,000	800	1,500	600
	Pumpkin	"	100	100		50
	Black pepper	"	1,200	1,500		1,500
IV. Collected from forest	Barking deer	kg	800	1,500		
	Barking deer(dried)	"	1,500	2,000		
	Samber deer	"	1,000	1,500		
	Samber deer(dried)	"	1,600	2,000		
	Wild pork	"	700	1,500		
	Wild pork(dried)	"	1,500	2,000		
	Wild chicken	"	1,000	1,700	1,800	
	Wild chicken(dried)	"	1,500	2,500	2,000	1,000
	Squirrel	"	1,800	1,200	2,000	80
	Bsamboo shoot	"	700	100	400	100
	Ginger	"	500	200	300	100
	Galanga	"	500	200	300	50
	Rattan shoot	"	100	150	100	1,500
	Mushroom	"	500	2,000		
V. Fruits						
	Banana	kg	350	100	200	100
	Papaya	"		50	100	80
	Mango	"	700		300	
	Water melon	"	200			
	Tamarind	"	150	300		300

Table M-2 Inventory of Existing Irrigation System

Command Area Category	No. of Scheme	Total Irrigation Area (ha)	Average Irri. Area (ha)	Remarks
Xai District :				
Less than 5 ha	39	99.6	2.6	All brushwood weir
6 - 10 ha	7	57.8	8.3	All brushwood weir
11 - 20 ha	11	150.9	13.7	All brushwood weir
21 - 30 ha	4	102.8	25.7	All brushwood weir
31 - 50 ha	5	180.0	36.0	All brushwood weir
More than 51 ha	3	406.5	135.5	Con. weir 1 scheme
Sub-total	69	997.6		
Beng District :				
Less than 5 ha	17	63.4	3.7	Con. weir 1 scheme
6 - 10 ha	10	58.6	5.9	All brushwood weir
11 - 20 ha	3	42.0	14.0	All brushwood weir
21 - 30 ha	1	25.0		All brushwood weir
31 - 50 ha	3	117.3	39.1	Con. weir 1 scheme
More than 51 ha	6	532.9	88.8	Con. weir 2 schemes
Sub-total	40	839.2		
Hun District :				
Less than 5 ha	4	15.0	3.8	Con. weir 1 scheme
6 - 10 ha	3	21.7	7.2	All brushwood weir
11 - 20 ha	6	103.7	17.3	Con. weir 1 scheme
21 - 30 ha	4	110.5	27.6	Con. weir 1 scheme
31 - 50 ha	5	211.4	42.3	Con. weir 3 schemes
More than 51 ha	4	362.7	90.7	Con. weir 3 schemes
Sub-total	26	825.0		
Total, Study Area :				
Less than 5 ha	60	178.0	3.0	Con. weir 2 schemes
6 - 10 ha	20	138.1	6.9	All brushwood weir
11 - 20 ha	20	296.6	14.8	Con. weir 1 scheme
21 - 30 ha	9	238.3	26.5	Con. weir 1 scheme
31 - 50 ha	13	508.7	39.1	Con. weir 4 schemes
More than 51 ha	13	1,302.1	100.2	Con. weir 6 schemes
Total	135	2,661.8	19.7	

Source : Data obtained from both provincial and district offices.

Table M-3 Potential Water Resources for Irrigation

River	District	Catchment Area (km2)	Category	Unit Irrigable Area by Catchment: RS Rice (ha/km2)	DS Rice (ha/km2)	DS Upland Crop (ha/km2)	Potential Water Resources for Irrigation: RS Rice (ha)	Alternative-1 DS Rice (ha)	Alternative-2 DS Upland Crop (ha)	Irrigable Area by Land in Net (ha)
1. Nam Ko										
Nam Mao	Xai	200	1	17.5	0.6	1.2	3,500	120	240	452
Nam Hin	Xai	133	2	4.4	0	0	585	0	0	208
Houay Lai	Xai	13	1	17.5	0.6	1.2	228	8	16	162
Nam Fen	Xai	17	1	17.5	0.6	1.2	298	10	20	175
Nam Kat	Xai	66	1	17.5	0.6	1.2	1,155	40	79	89
Sub-total		429					5,765	178	355	1,086
Others		551	2	4.4	0	0	2,424	0	0	305
Total of Nam Ko		980					8,190	178	355	1,391
2. Nam Beng										
Nam Met	Beng	74	1	17.5	0.6	1.2	1,295	44	89	43
Nam Lo	Beng	40	1	17.5	0.6	1.2	700	24	48	98
Nam Hao	Beng	72	3	10.4	0	0	749	0	0	168
Nam Phao	Beng, Xai	286	2	4.4	0	0	1,258	0	0	27
Nam Heng(1)	Beng	61	2	4.4	0	0	268	0	0	160
Houay Kao	Hun	29	2	4.4	0	0	128	0	0	44
Nam Kham	Hun	55	2	4.4	0	0	242	0	0	297
Nam Ngat	Hun	52	2	4.4	0	0	229	0	0	434
Nam Oun	Hun	89	2	4.4	0	0	392	0	0	115
Houay Sat	Hun	14	2	4.4	0	0	62	0	0	35
Houay leng	Hun	45	2	4.4	0	0	198	0	0	0
Houay Kho	Hun	51	3	10.4	0	0	530	0	0	0
Nam Heng(2)	Hun	84	1	17.5	0.6	1.2	1,470	50	101	177
Sub-total		952					7,521	119	238	1,599
Others		1,188	2	4.4	0	0	5,227	0	0	740
Total of Nam Beng		2,140					12,748	119	238	2,339
Grand Total		3,120					20,937	296	593	3,730

Note:

Category 1 : The river basin has reserved forest.
Category 2 : The river basin has mostly cultivated.
Category 3 : Complex of Category 1 and 2

RS : Rain season
DS : Dry season

Alternative-1 : RS rice + DS rice
Alternative-2 : RD rice + DS upland crop

Tabel M-4 Imported Agricultural Products in both Thailand and Laos

	Unit	1985	1986	1987	1988	1989	1990
Import of Thailnd							
Bovine Cattle	Head	3,498	2,200	9,476	10,434	23,978	24,340
	1,000 $	227	331	9,062	12,922	12,512	14,610
Wheat & Flour (wheat equivalent)	1,000 ton	170	186	246	292	336	374
	10000$	2,943	2,993	3,559	5,028	6,804	6,791
Silk	ton	227	284	504	854	818	1,149
	1,000 $	4,290	5,666	9,790	17,909	24,685	25,803
Cotton Lint	1,000 ton	133	193	250	213	259	284
	1,000 $	174			319,313	375,920	486,564
Import of Laos							
Wheat Flour	ton	13,900	13,900	13,900	10,000	1,000	10,000
	1,000 $	3,200	3,000	3,000	3,000	3,000	3,000
Milk	1,000 $		50	100	562	10,300	12,080
Rice	ton	23,000	24,000	61,600	35,400	42,000	40,000
	1,000 $	4,600	4,500	12,500	8,100	10,500	9,600

Source: FAO, Trade Yearbook

Table M-5 (1/2) Action Plans and Programs for Irrigated Agricultural Development

Scheme Component, Action Plan and Program	Short Term Development Stage (1995 to 2000)	Short Term Development Stage (2001 to 2005)	Long Term Development Stage (2006 to 2010)
A. Increase and Stabilization of Agricultural Productivity			
A.1 Improvement and Strengthening of Agricultural Support Services			
A.1.1 Strengthening of Agricultural Extension Services	○ Construction of office buildings with storage and garage in each model area ○ Construction of staffquater, if necessary ○ Supply of necessary equipment for each office ○ Assignment of extension workers ○ Training of extention workers ○ Demonstration of improved lowland rice farming system for model areas ○ Distribution of improved seeds and seedlings to model areas ○ Periodical opening of women's school for model areas ○ Extension of improved sericulture to model areas	● Increase in staffing of extension workers ● Training of extention workers ● Demonstration of improved lowland rice farming system for the study area ● Demonstration of improved gentle sloping upland field farming system for the study area ● Distribution of improved seeds and seedlings to the study are ● Periodical opening of women's school to the study area ● Extension of improved sericulture to the study area	● Increase in staffing of extension workers ● Training of extention workers ● Demonstration of improved lowland rice farming system for the study area ● Demonstration of improved gentle sloping upland field farming system for the study area ● Demonstration of improved steep sloping areas' farming system for the study area ● Distribution of improved seeds and seedlings to the study area ● Periodical opening of women's school to the study area ● Extension of improved sericulture to the study area
A.1.2 Strengthening of Veterinary Services		● Promotion of vaccine injection effects to farmers ● Support services for vaccine injection	● Promotion of vaccine injection effects to farmers ● Support services for vaccine injection
A.1.3 Establishment of Efficient Marketing System			
(a) Establishment of Farmers' Organization	○ Establishment of rice bank in each model area ○ Construction of office buildings with storage and drying yard for rice bank in each model area ○ Supply of rice mill, sesame cleaner and office equipment for each office ○ Training of rice bank staff	● Establishment of additional rice bank ● Supply of equipment and instruments	● Re-organization of rice bank to the farmers' organization ● Construction of offices for farmer's organization ● Construction of storage ● Supply of equipment and instruments
(b) Strengthening of Government Institution		● Training of staff concerned of province and districts ● Improvement of facilities and equipment related to this component	
A.2 Establishment of Integrated Agricultural Station	○ Construction of integrated agricultural station ○ Construction of training facilities ○ Development of trial farm plots ○ Supply of necessary equipment for station ○ Supply of O&M machinery for model areas ○ Multiplication of seeds and seedlings ○ Training of extension workers and rice bank staff ○ O&M of irrigation system and roads in model areas ★ Development of technologies for irrigated lowland rice field farming ★ Development of technologies for gentle sloping upland field farming ★ Introduction of improved sericulture ☆ Preparation of concrete program for strengthening of veterinary services ☆ Preparation of concrete program for establishment of farmers' organization, and strengthening of government institution ☆ Preparation of stage-wise implementation programs for rehabilitation and upgrading of existing irrigation system ☆ Preparation of concete programs for new irrigation development ☆ Preparation of stage-wise implementation programs for rehabilitation and upgrading of district road, development of rural water supply system, and rehabilitation and construction of primary schools and village communities ☆ Basic study and analysis on environmental issues	● Multiplication of seeds and seedlings ● Training of extension workers and rice bank staff ★ Development of farming technologies in steep sloping areas ★ Improvement of livestock raising techniques ☆ Preparation of stage-wise implementation programs for rehabilitation and upgrading of existing irrigation system ☆ Preparation of stage-wise implementation programs for new irrigation development ☆ Preparation of concrete program for small-scale storages development for irrigation purpose	● Multiplication of seeds and seedlings ● Training of extension workers and rice bank staff ★ Development of farming technologies in steep sloping areas ★ Improvement of livestock raising techniques ☆ Preparation of stage-wise implementation programs for rehabilitation and upgrading of existing irrigation system ☆ Preparation of stage-wise implementation programs for new irrigation development ☆ Preparation of stage-wise implementation programs for small-scale storages development

☆ Preparation of Concrete Action Plans & Programs
★ Development of Appropriate Technologies
○ Execution of Pilot Model Areas Scheme
● Execution of Development Scheme

Table M-5 (2/2) Action Plans and Programs for Irrigated Agricultural Development

Scheme Component, Action Plan and Program	Short Term Development Stage (1995 to 2000)	Short Term Development Stage (2001 to 2005)	Long Term Development Stage (2006 to 2010)
B. Development of Agricultural Production Infrastructure			
B.1 Rehabilitation and Grade-up of Existing Irrigation System	○ Rehabilitation and upgrading of existing irrigation system in model areas ○ Training of staff concerned of province and district	● Rehabilitation and grade-up of existing irrigation systems in the study area	● Rehabilitation and grade-up of existing irrigation systems in the study area
B.2 Establishment of Water Users Association	○ Development of laws and regulations related to water users association ○ Improvement of existing water users association in model areas ○ Training of farmers in on-farm water management and O&M of irrigation facilities for model areas	● Strengthening of existing associations ● Training of farmers staff in proper management of association ● Training of farmers in on-farm water management and O&M of irrigation facilities	● Strengthening of existing associations ● Training of farmers staff in proper management of association ● Training of farmers in on-farm water management and O&M of irrigation facilities
B.3 Improvement of Meteo-Hydrological Network	○ Strengthening of existing meteorological station in Xai ○ Construction of additional meteorological yards in Beng ○ Installation of rainfall recorders at 9 sites ○ Installation of water level gauge staff in main rivers		
B.4 Construction of New Irrigation System		● Construction of new irrigation system in lowland area ○ Construction of new irrigation system in gentle sloping area for upland crops	● Construction of new irrigation system in lowland area ● Construction of new irrigation system in gentle sloping area for upland crops ○ Construction of small-scale storage for irrigation
C. Development of Social Infrastructures			
C.1 Rehabilitation and Upgrading of District Road Network	○ Rehabilitation and gravel pavement of existing roads in model areas ○ Construction of bridge related to model areas ○ Training of staff concerned of province and district	● Rehabilitation and gravel pavement of other existing road network ● Supply of construction and O&M equipment	● Rehabilitation and gravel pavement of other existing road network ● Supply of construction and O&M equipment
C.2 Construction of Rural Water Supply Facility	○ Construction of rural water supply system in villages related to model areas ○ Training of staff concerned of province and district	● Construction of additional water supply system in other areas ● Supply of construction and O&M equipment	● Construction of additional water supply system in other areas ● Supply of construction and O&M equipment
C.3 Rehabilitation and Construction of Primary School and Community Facility	○ Rehabilitation of primary schools in model areas	● Rehabilitation and construction of primary schools and village communities in other areas ● Supply of necessary equipment	● Rehabilitation and construction of primary schools and village communities in other areas ● Supply of necessary equipment
D. Measures to Environmental Problems			
D.1 Integrated Agricultural Development (Indirect Mesures to Environment Problems)	○ Increase and stabilization of agricultural productivity (item A mentioned above) ○ Development of agricultural production infrastructure (item B) ○ Development of social infrastructure (item C)	● Increase and stabilization of agricultural productivity (item A mentioned above) ● Development of agricultural production infrastructure (item B) ● Development of social infrastructure (item C)	● Increase and stabilization of agricultural productivity (item A mentioned above) ● Development of agricultural production infrastructure (item B) ● Development of social infrastructure (item C)
D.2 Control and Management Program for Slash-and-burn Cultivation (Direct Measures to Environment Problems)	○ Program for evaluation of slash-and-burn cultivation ○ Reserved forest establishment program ○ Management program for uncontrolled fire ○ Program for minimization of rotation cycle	● Reserved forest establishment program ● Management program for uncontrolled fire ● Program for minimization of rotation cycle	● Reserved forest establishment program ● Management program for uncontrolled fire ● Program for minimization of rotation cycle
E. Support Services for Women's Group	○ Training of key staff of existing Women Union at district and village level in model areas ○ Support for improvement of people's living standard in model areas ○ Support for promotion of health education in model areas ○ Support for promotion of women's education in model areas ○ Demonstration of sericulture in model areas Extension of garden farming in model areas ○ Promotion of participation in rice bank for model areas	● Training of key staff of existing Women Union at district and village level ● Support for improvement of people's living standard ● Support for promotion of health education ● Support for promotion of women's education ● Extension of sericulture ● Extension of garden farming ● Promotion of participation in rice bank	● Training of key staff of existing Women Union at district and village level ● Support for improvement of people's living standard ● Support for promotion of health education ● Support for promotion of women's education ● Extension of sericulture ● Extension of garden farming ● Promotion of participation in rice bank

☆ Preparation of Concrete Action Plans & Programs
★ Development of Appropriate Technologies
○ Execution of Pilot Model Areas Scheme
● Execution of Development Scheme

Table M-6 Incremental Rice Production

	Short Term Stage			Medium Term Stage			Long Term Stage		
	Without Project	With Project	Increment	Without Project	With Project	Increment	Without Project	With Project	Increment
1. Harvested Area (ha)									
Lowland Rice Field									
Irrigated									
Traditional	2,660	1,930	-730	2,660	1,000	-1,660	2,660	0	-2,660
Technical (wet)	0	830	830	0	2,280	2,280	0	3,700	3,700
Technical (dry)	0	125	125	0	250	250	0	300	300
Rainfed	440	440	0	440	220	-220	440	0	-440
Total	3,100	3,325	225	3,100	3,750	650	3,100	4,000	900
Upland Rice Field									
Rainfed	12,750	12,750	0	12,750	12,750	0	12,750	12,750	0
Irrigated	0	0	0	0	1,500	1,500	0	3,500	3,500
Total	12,750	12,750	0	12,750	14,250	1,500	12,750	16,250	3,500
2. Yield (ton/ha)									
Lowland Rice Field									
Irrigated									
Traditional	2.6	2.9	0.3	2.6	3.2	0.6	2.6	3.5	0.9
Technical		4.0	4.0		4.5	4.5		5.0	5.0
Rainfed	2.0	2.3	0.3	2.0	2.5	0.5	2.0	2.8	0.8
Upland Rice Field									
Rainfed	1.4	1.4	0.0	1.4	1.6	0.2	1.4	1.8	0.4
Irrigated			0.0		3.0	3.0		3.5	3.5
3. Production (ton)									
Lowland Rice Field									
Irrigated									
Traditional	6,916	5,597	-1,319	6,916	3,200	-3,716	6,916	0	-6,916
Technical (wet)	0	3,320	3,320	0	10,260	10,260	0	18,500	18,500
Technical (dry)	0	500	500	0	1,125	1,125	0	1,500	1,500
Rainfed	880	1,012	132	880	550	-330	880	0	-880
Sub-total	7,796	10,429	2,633	7,796	15,135	7,339	7,796	20,000	12,204
Upland Rice Field									
Rainfed	17,850	17,850	0	17,850	20,400	2,550	17,850	22,950	5,100
Irrigated	0	0	0	0	4,500	4,500	0	12,250	12,250
Sub-total	17,850	17,850	0	17,850	24,900	7,050	17,850	35,200	17,350
Total	25,646	28,279	2,633	25,646	40,035	14,389	25,646	55,200	29,554

Figure

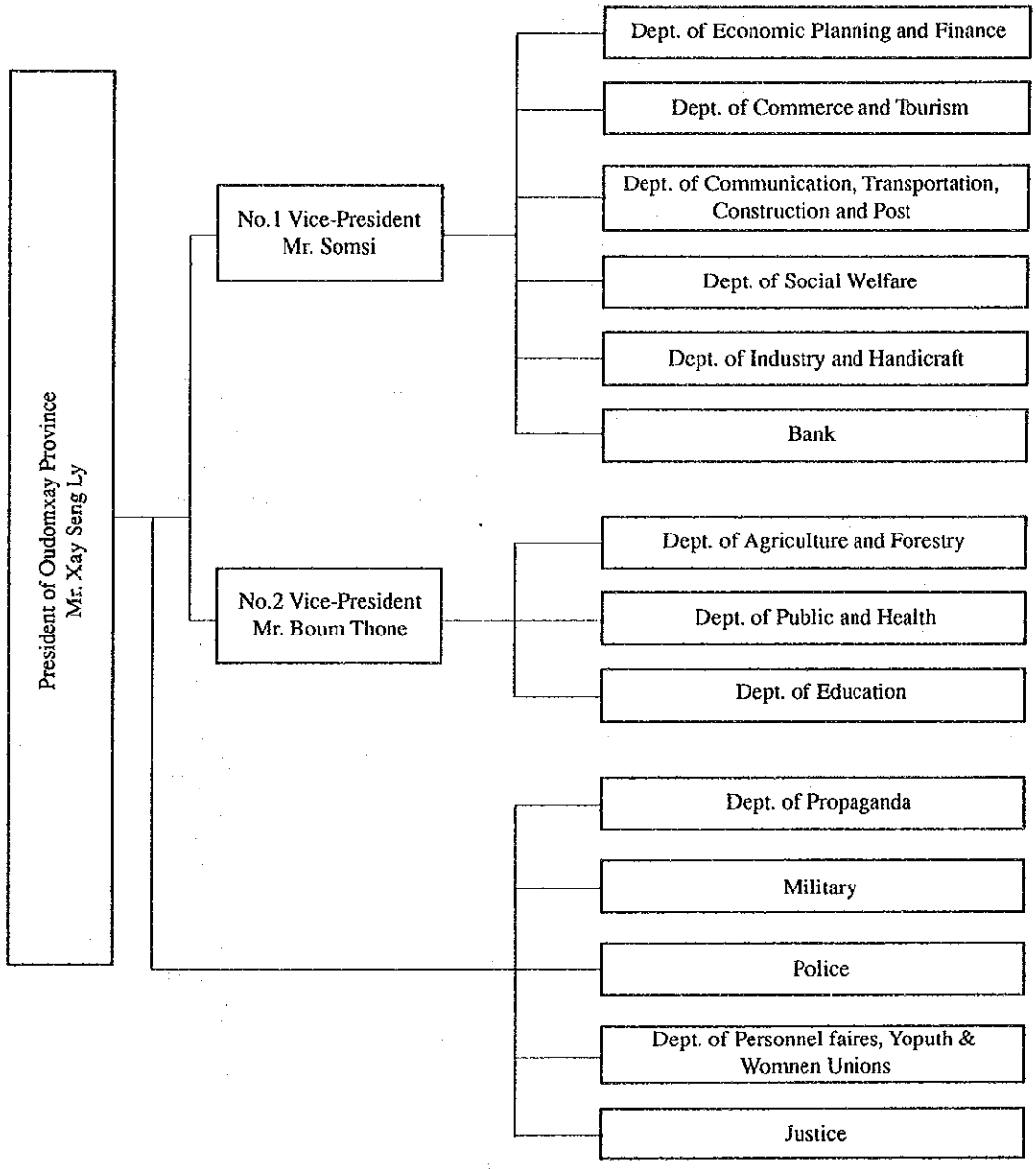

Fig. M-1 Present Organization of Oudomxay Province

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
MINISTRY OF AGRICULTURE AND FORESTRY

AGRICULTURAL DEVELOPMENT PROJECT
TO CONTROL SLASH AND BURN CULTIVATION
IN OUDOMXAY PROVINCE

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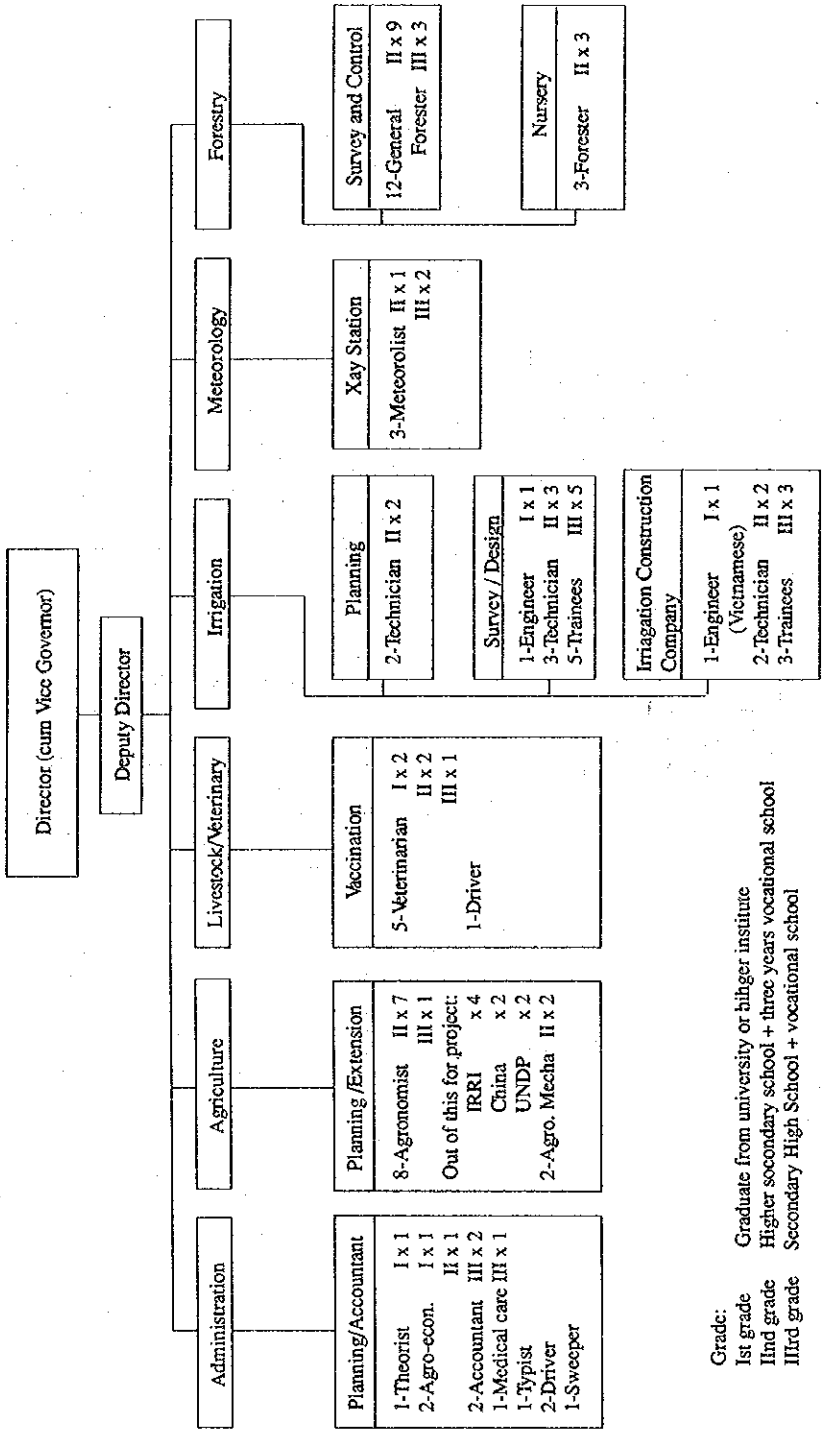

Fig. M-2 Organization and Staffing of Department of Agriculture and Forestry Services in Oudomxay Province

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC MINISTRY OF AGRICULTURE AND FORESTRY
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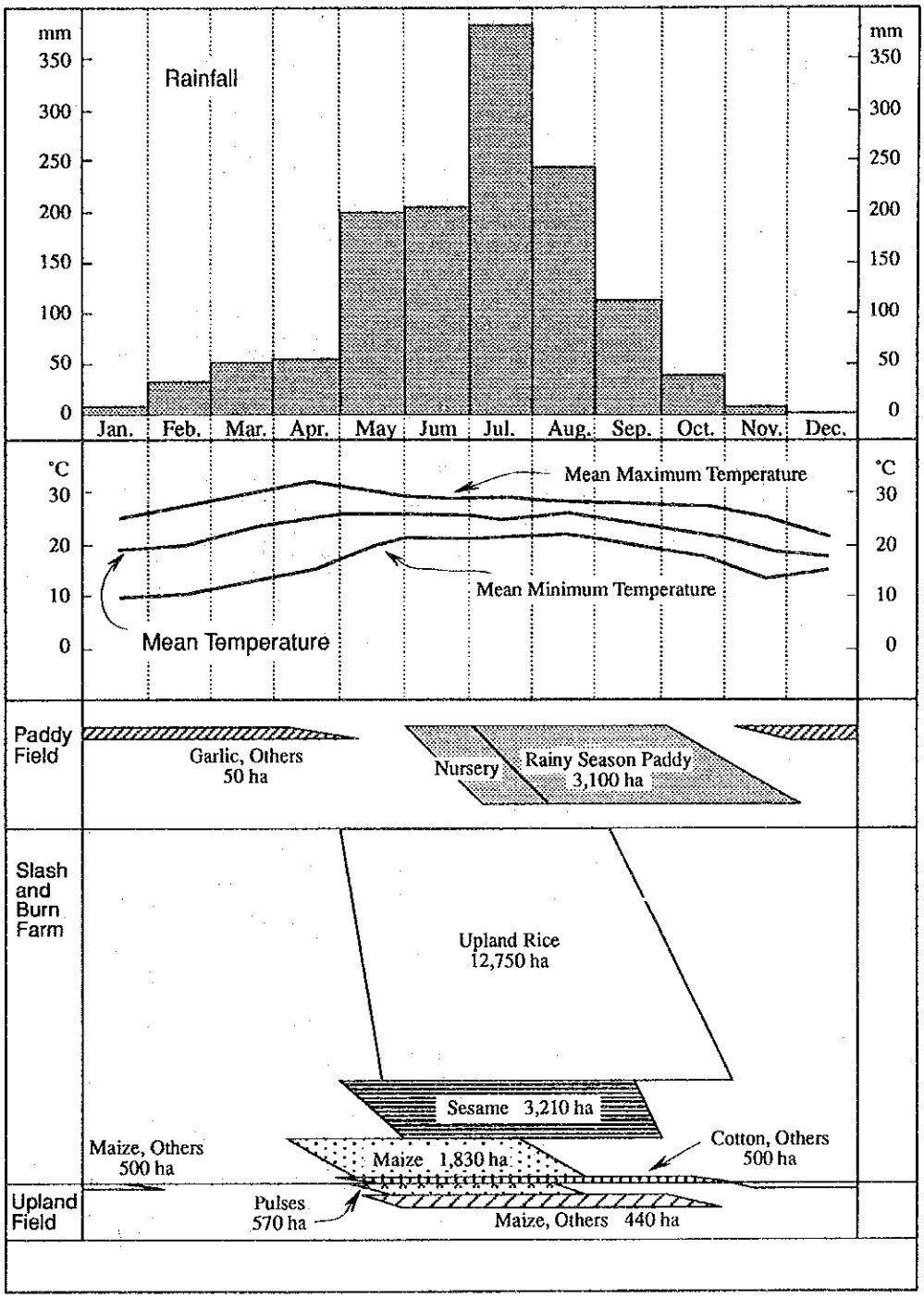

Fig. M-3 Present Cropping Pattern

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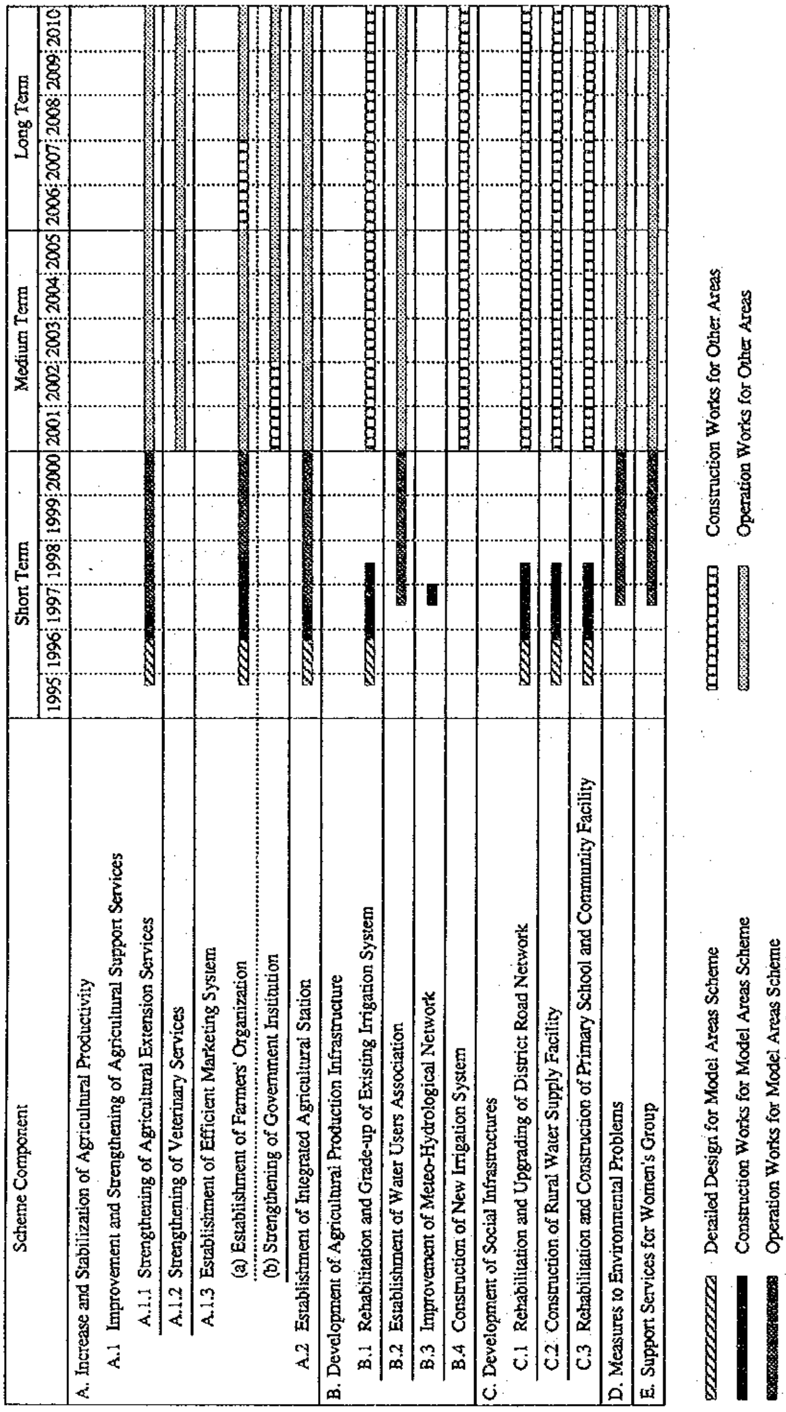

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Fig. M-4 Implementation Schedule of the Integrated Agricultural Development

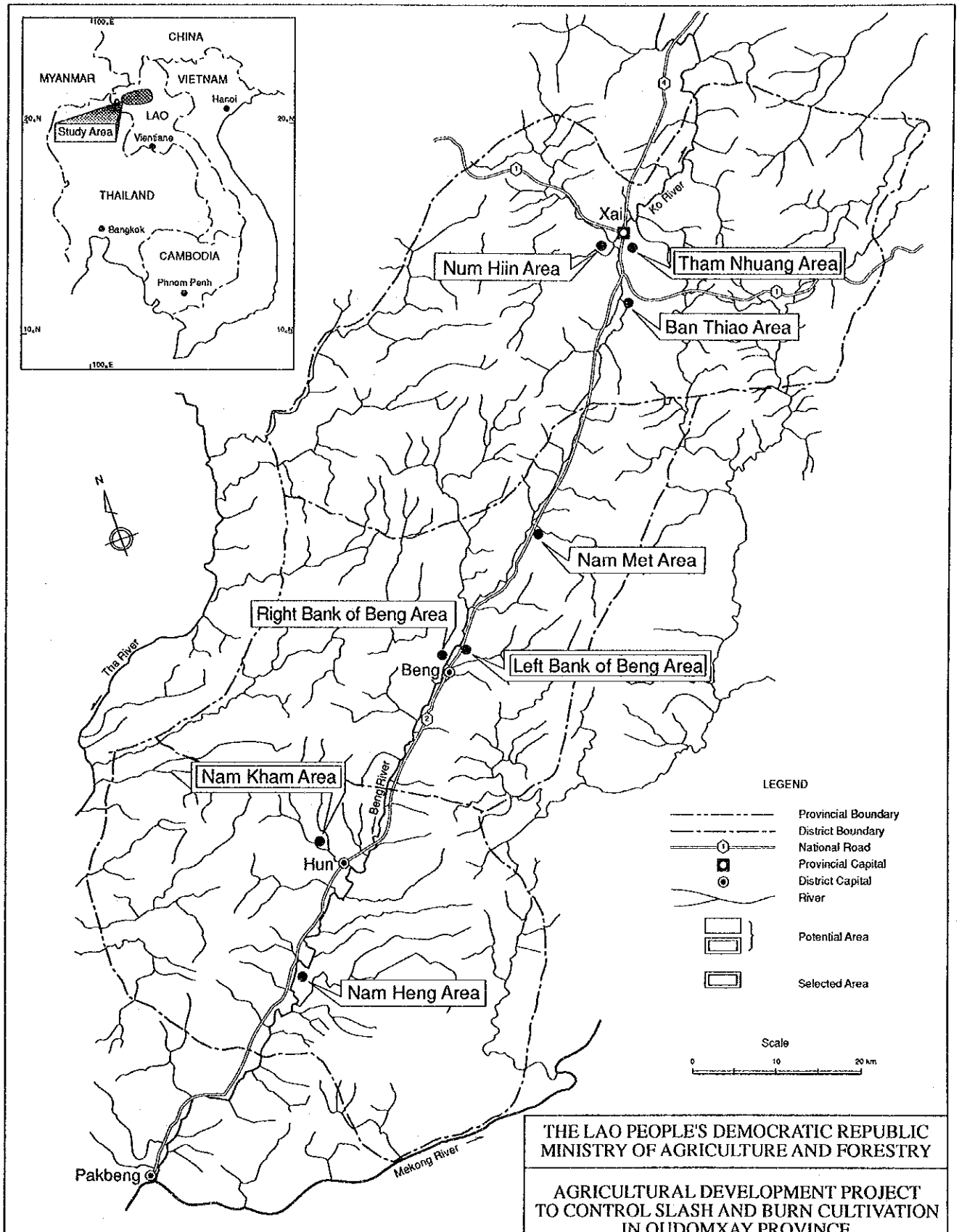

Fig. M-5 Potential and Selected Model Areas

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
MINISTRY OF AGRICULTURE AND FORESTRY

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ANNEX-MA
METEOROLOGY AND HYDROLOGY

ANNEX-MA METEOROLOGY AND HYDROLOGY

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APPENDIX

1. INTRODUCTION

Oudomxay Province is located in northern Lao PDR and is characterized by mountainous topography. The climate and runoff iregime n this province is also characterized by the mountainous one. The Beng river (Nam Beng), a tributary of the Mekong river, flows southwest direction through Oudomxay Province. This Nam Beng and its tributaries are the main water resource for socio-economic activities of the people in this province. This ANNEX presents the results of meteorological and hydrological study for Xai, Beng and Hun districts of Oudomxay Province.

2. AVAILABLE DATA

2.1 Meteorological Data

In Oudomxay Province, there are one meteorological station at Xai town and one rainfall station which is operated by MCTPC at Pakbeng. In addition, JICA study team installed a rain-recorder at the center of Hun district in April 1992.

The Oudomxay meteorological station is established by MAF in April 1984 and is located in Muang Xai (2041'N, 102°00'E). According to a list which is prepared by the Department of Meteorology and Hydrology, MAF, the elevation of the station is 550 m above sea level. This station belongs to the Department of Agriculture and Forestry of the Oudomxay provincial office and is managed by 3 staff. However, all of original records are sent to the Department of Meteorology and Hydrology, MAF in Vientiane. Available records are atmospheric pressure, precipitations, temperature, maximum temperature, minimum temperature, relative humidity, cloudiness, sunshine hours and evaporation (pitch) from 1987.

Since duration of available rainfall record of the Oudomxay meteorological station is short, only 5 years from 1988 to 1992 on monthly data and 2 years from 1991 to 1992 on daily data, and the rainfall records around the Oudomxay Province has to be referred for further analysis. The List of available rainfall records is shown in Table MA-1 and the location of the stations is presented in Fig. MA-1.

2.2 Runoff Data

There are no hydrological data and sediment data for the tributaries of the Mekong river in this study area. Therefore, JICA study team installed a water-level recorder on the Nam Beng in Beng district and staff-gages on the Nam Mao, Nam Ko and Nam Kham. Also, JICA study team measured the discharges of perennial rivers by current meter.

Some data are available in the Luang Prabang province, which are compiled in the "Lower Mekong Hydrologic Yearbook", Mekong Committee. Also, the data in the areas of northern Thailand are available in the same publication. For the hydrological analysis, these data can be referred. The available data are tabulated in Table MA-2.

3. METEOROLOGY

3.1 Climate

The climate in Oudomxay Province is subtropical and dominated by the southwest monsoon which brings rainfall, high humidity and high temperature during the period from May to September. The period from October to March is a dry season and lower temperature that is caused by northeast monsoon. Since over 80% of the rain falls in the wet season, the climate is characterized by a high variability with the occurrence of both flooding and drought. Monthly climate data of Oudomxay and Luang Prabang meteorological stations are respectively tabulated in Table MA-3 and Table MA-4 and presented in Fig. MA-2.

3.2 Rainfall

Annual rainfall in Oudomxay ranges from 1,100 to 1,300 mm and 81% of it on an average falls in monsoon season from May to September. Annual rainfalls of northern Laos and northern Thailand from 1980 to 1991 are presented in Table MA-5. Monthly rainfalls of northern Laos are tabulated in Table MA-6 and Fig. MA-3. As seen in Fig. MA-3, annual rainfall pattern in Oudomxay is similar to that of other stations in northern Laos. Annual rain days in Oudomxay and Luang Prabang are 106 and 119 days in on average, respectively. Monthly rain days are presented in Table MA-7. Daily maximum rainfall is tabulated in Table MA-8. Mean monthly rainfalls in Oudomxay, Pakbeng and Luang Prabang are as follows:

(Unit: mm)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Oudomxay	5.4	39.5	39.7	78.6	159.2	190.5	277.8	238.0	122.8	48.5	17.7	3.1	1,220.6
Pakbeng	4.0	11.2	31.1	79.8	241.6	234.1	260.6	195.4	174.9	60.2	16.4	15.0	1,324.0
L. Prabang	11.7	18.4	34.2	137.1	163.9	182.4	234.0	258.7	127.3	135.5	67.3	5.2	1,375.6

3.2.1 Correlation

In the northern Laos, Luang Prabang station has the longest period of rainfall record. Therefore, correlation and regression analysis between Luang Prabang station and Oudomxay station has been examined. The regression equation applied in this analysis is as follows:

$$Rx = a \times Ry + b$$

where, Rx : monthly rainfall at "x" station

Ry : monthly rainfall at "y" station

a and b : regression coefficient

It is estimated that there is good correlation between Luang Prabang and Oudomxay with a correlation coefficient of 0.83. The result is presented in Fig. MA-4 and the equation of regression line is as below:

$$Rx = 0.914 \times Ry - 4.331$$

where, Rx : monthly rainfall at Oudomxay station
Ry : monthly rainfall at Luang Prabang station

3.2.2 Rainfall Probability

For irrigation planning, the probability of non-exceedance of the rainfall is analyzed by using the data of Oudomxay and the data which is converted from the data of Luang Prabang to Oudomxay by the above-mentioned regression equation. Probable monthly rainfall corresponding to 5, 10 and 20-year return period of drought is estimated by means of Gumbel method and the result is shown below:

(Unit: mm)

Return Period	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1/5	6.8	19.0	24.0	86.1	129.3	149.8	189.0	202.1	92.2	77.7	32.0	3.9	1,011.8
1/10	6.3	17.7	22.4	80.4	120.8	139.9	176.5	188.8	86.2	72.6	29.9	3.7	945.2
1/20	6.0	16.9	21.4	76.7	115.3	133.6	168.5	180.2	82.2	69.3	28.5	3.5	902.1

Probable maximum daily rainfall is estimated for drainage planning by means of Gumbel method. The result is as follows:

Return period	1/5	1/10	1/20	1/30	1/40	1/50
Daily maximum rainfall (mm)	127.6	154.4	180.1	194.9	205.3	213.3

3.3 Other Meteorological Conditions

3.3.1 Air Temperature

Mean annual temperature is 23.4°C which is cooler than those in Vientiane and Luang Prabang. The highest temperature of 36-38°C occurs in April or May. The period from December to February is cool, and the lowest of 4-6°C occurs during this period. No frosts have been reported in the study area. Monthly mean temperatures at Oudomxay and Luang Prabang are shown below.

(Unit: °C)

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Oudomxay (1987-1992)													
Mean	19.0	20.5	23.4	26.1	26.7	26.5	25.8	25.9	25.6	23.7	20.8	17.5	23.4
Max.	26.5	28.7	30.9	32.9	32.2	30.2	29.5	30.0	30.0	28.4	26.3	24.4	32.9
Min.	10.4	10.2	13.7	17.0	20.3	22.1	22.0	21.7	21.0	18.6	14.6	9.6	9.6
Luang Prabang (1980-1990)													
Mean	19.3	22.3	24.6	27.0	27.6	27.4	27.0	26.7	26.3	24.8	22.0	18.2	24.4
Max.	27.9	31.3	33.7	34.8	33.9	32.1	31.5	31.5	32.1	31.1	28.9	26.1	34.8
Min.	14.2	15.8	17.9	21.2	23.3	24.2	23.9	23.9	22.6	21.2	18.1	13.6	13.6

3.3.2 Relative Humidity

The annual mean relative humidity at Oudomxay is 80% and is higher than that in Vientiane. Driest season is March and April with the monthly mean of 68%. Monthly mean relative humidity at Oudomxay is as shown below:

(Unit: %)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
81	74	68	68	75	85	87	83	86	84	85	84	80

3.3.3 Sunshine Hours

Mean annual sunshine hours at Oudomxay is 1,700 hours. Monthly mean sunshine hours is as shown below:

(Unit: hours/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
5.0	5.8	5.6	5.7	6.0	2.6	2.8	4.4	4.5	4.3	4.5	5.1	4.7

3.3.4 Cloudiness

The annual mean cloudiness at Oudomxay is 6 in oktas. Monthly mean cloudiness is as shown below:

(Unit: oktas)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
6	4	4	5	6	7	8	7	7	6	6	6	6

3.3.5 Evaporation

The evaporation is measured by the Piche evaporimeter. The annual mean evaporation at Oudomxay is 2.2 mm/day. Monthly mean evaporation is as shown below:

(Unit: mm/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
2.0	3.4	3.3	3.8	2.6	1.5	1.3	1.7	1.5	1.9	1.5	1.5	2.2

3.3.6 Wind Speed

No data on wind speed are available at Oudomxay. Monthly mean wind speed shown below is at Luang Prabang. This wind speed is measured at the height of 10 m above the ground. Annual mean wind speed is 2.0 knots (1.0 m/s), with a maximum mean monthly in April of 2.6 knots (1.3 m/s).

(Unit: knots)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1.8	1.8	2.3	2.6	2.3	2.1	1.9	1.7	1.7	1.9	1.8	1.7	2.0

4. RUNOFF STUDY

4.1 River System

Main water resources in the study area are the Nam Beng which is a tributary of the Mekong river, and the Nam Ko, a tributary of the Nam Ou. The Nam Ou is the longest tributary of the Mekong river in Lao PDR.

The Nam Beng is the biggest river in the study area with a length of 154 km and flows southwest direction through Oudomxay Province. It has a catchment area of 2,140 km^2 at Pakbeng and 600 km^2 at Ban Gno, near the confluence with the Nam Phao, in Beng district. This river is perennial watercourse with a discharge of about 1 m^3/sec at Hun town in the dry season. However, the river is currently not used for irrigation, because the river is deeply incised, and it is difficult to obtain irrigation water by farmers themselves. On the other hand, the tributaries of the Nam Beng such as Nam Met, Nam Lo, Nam Phao, Nam Hao in Beng district and Nam Kham, Nam Oun, Nam Heng in Hun district are used for irrigation by farmers themselves. They have discharges of 50 to 380 lit./sec in the dry season (measured in March 1992), depending on their catchment areas.

The Nam Ko runs northeast direction through Xai town and flows into the Nam Phak which is a tributary of the Nam Ou. The total length of the Nam Ko is 84 km. The Nam Ko is perennial watercourse with a catchment area of 980 km^2 at Pakko and 600 km^2 at the bridge of Road No.1 in Xai town. The Nam Mao and Nam Hin are the main tributaries of Nam Ko and are perennial watercourses, having discharges of 340 lit./sec and 150 lit./sec in the dry season (measured in March 1992).

The river system and the profile of main rivers in the study area is presented in Fig. MA-5 and Fig. MA-6, respectively. The catchment area of each river is shown in Table MA-9.

4.2 Discharge Measurement

Since no hydrological data are available for the study area, JICA study team measured the discharges of main perennial rivers by current meter during the 1st. and 2nd. field works in 1992. The discharge measured and its location are presented in Table MA-10 and Fig. MA-7 respectively. The specific runoff at the end of the dry season in 1992 is tabulated for main perennial rivers as follows:

District	Name of River	Specific Runoff (l/sec/km^2)	Watershed Condition
Xai	Nam Ko	1.4	complex
	Nam Mao	1.7	partly reserved forest
	Nam Hin	1.0	spreading shifting cultivation
Beng	Nam Met	5.2	reserved forest
	Nam Lo	2.4	reserved forest
	Nam Phao	0.6	spreading shifting cultivation
	Nam Hao	1.9	reserved forest
Hun	Nam Kham	1.0	spreading shifting cultivation
	Nam Ngat	0.7	spreading shifting cultivation
	Nam Oun	0.8	spreading shifting cultivation
	Nam Heng	3.1	reserved forest

The above table shows that the specific runoff is closely related to the watershed condition and the rivers in the study area have to be categorized according to the watershed condition. Then, the rivers are categorized as follows:

(1) Category 1: Watershed is mostly covered by the reserved forest;
(2) Category 2: Watershed is mostly the area of the shifting cultivation; and
(3) Category 3: Complex of Category 1 and 2

JICA study team installed the staff-gages on the Nam Mao, Nam Ko and Nam Kham and observed the gage height from April to October 1992. Based on the spot discharge records measured by JICA study team, rating curve shown below is prepared to convert the gage height into the discharge. This rating curve should be updated when additional discharge measurement is made. The records of the staff-gages reading and the discharge converted are presented in Tables MA-11 to MA-13.

Name of River	Location No.	Nos. of Data	Rating Curve
Nam Mao	X3	4	$Q = (2.05 \times H + 0.52)^2$
Nam Ko	X4	3	$Q = (1.96 \times H + 1.07)^2$
Nam Kham	H8	3	$Q = (1.33 \times H + 0.00)^2$

Note: Q; discharge (m^3/s)
H; gage height (m)

4.3 Runoff Analysis

4.3.1 General

For irrigation planning, runoff analysis is carried out in order to estimate the available river runoff. However, there are no available runoff records in the study area and only the data measured by JICA study team is available for the analysis. Since the observation period of water level and discharge records is insufficient in the study area, the long-term runoff is estimated by regression analysis between runoff and rainfall using the data from

Luang Prabang and northern Thailand. Then, the runoff model made by the data in Luang Prabang and northern Thailand is checked and modified with measured spot discharges for the study area. The runoff models are prepared according to the watershed categories mentioned above in Section A.4.2.

4.3.2 Multiple Regressional Analysis

As for the long-term runoff analysis, the relation between runoff and rainfall is expressed as the following multiple regressional equation:

$$Q0 = A0 \times R0 + A1 \times R1 + ...+ At \times Rt$$

where, Q0: runoff at current month (mm)
A0, A1 & At: weighting coefficients
Rt: monthly rainfall before "t" months (mm)

The catchment area of the tributaries of the Nam Beng and Nam Ko is small, less than 300 km^2. Considering the number of available data, the size of catchment area and watershed condition (refer to Tables MA-1 and MA-2), the following data are used for the analysis:

Model No.	Runoff Data	Rainfall Data
1	Nam Pa at Ban Kok Van	Luang Prabang
2	Nam Mae Chan at Ban Huai Yano Mai	Mae Chan

Correlation and regression between the runoff and the rainfall for the above two cases are computed by means of the above-mentioned multiple regressional equation. The results are as follows:

	Correlation Coefficient	Weighting Coefficient			
		A0	A1	A2	A3
Model 1	0.55	0.1052			
(Nam Pa)	0.76	0.0345	0.1209		
	0.78	0.0347	0.0996	0.0391	
	0.79	0.0378	0.0958	0.0264	0.0240
Model 2	0.78	0.2850			
(Nam Mae Chan)	0.85	0.1778	0.1611		
	0.87	0.1998	0.0745	0.1042	
	0.88	0.2197	0.0667	0.0631	0.0596

Taking into account correlation coefficient, the best fitted model can be made by considering the rainfall of three months before. The runoff models are expressed as follows:

(1) Model 1: $Q = 0.0378\ R0 + 0.0958\ R1 + 0.0264\ R2 + 0.0240\ R3$
(2) Model 2: $Q = 0.2197\ R0 + 0.0667\ R1 + 0.0631\ R2 + 0.0596\ R3$

4.3.3 Runoff of the Rivers in the Study Area

To check and modify the runoff model mentioned in Section A.4.3.2, the monthly rainfalls in Oudomxay and Hun in 1992 are applied to the above models to estimate the monthly runoff. These estimated runoff values are compared with measured runoff records, and the models are modified. The estimated runoff by rainfall in Oudomxay and Muang Hun is tabulated in Table MA-14 and Table MA-15, respectively. As a result, model 2 is applicable for the Nam Hao, and model 3 that is a mean of model 1 and model 2 is applicable for the Nam Heng, Nam Lo and Nam Met. Model 4 that is 1/2 of model 2 is applicable for the Nam Kham, Nam Oun and Nam Phao.

Considering the watershed condition of the above rivers, runoff model 2 can be applied for the rivers of watershed Category 3, and model 3 for Category 1. Model 4 can be applied to Category 2.

The estimated runoff for each Category under the condition of 5-year return period of probable minimum rainfall is presented in Table MA-16. The unit runoff per km^2 of the catchment area for each category of watershed condition is as follows: It is applicable for the small rivers only.

(Unit: lit/sec/km^2)

Category	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Category 1	2.2	1.9	1.9	5.5	9.5	13.4	17.1	20.0	16.6	12.9	8.9	3.9
Category 2	0.6	0.5	0.6	1.2	2.7	4.0	5.0	6.1	6.1	4.0	3.1	1.4
Category 3	1.2	0.9	1.1	2.4	5.3	8.1	10.1	12.2	12.1	8.1	6.1	2.8

5. FLOOD STUDY

5.1 General

The flood in the study area is characterized by the mountainous topography. The flood occurs locally by the local storm. Since catchment area of the rivers in the study area is small, mostly less than 200 km^2, time of concentration is short. Therefore, the flood contains rocks and tumbled woods, and these deposits are found at the top of a fan. No serious damage for crops is reported because of short duration, only a few hours, of ponding.

In order to design river crossing structures such as diversion weir and bridge, a peak flood discharge of the river has to be estimated. However, no discharge record is available for the study. Therefore, it is estimated by using result of hearing survey on previous floods and floodmark survey.

5.2 Flood Discharge of Small Streams in the Study Area

In August 1985, a big flood occurred in Oudomxay. According to the hearing from officers and villagers, this flood is assumed to be the flood of 40-year return period. Flood discharge at that time is roughly estimated by the water level which is obtained by hearing, cross section and longitudinal slope of the river, as shown below.

River	Point	Catchment area (km^2)	Discharge (m^3/sec)	Specific runoff (m^3/sec/km^2)
Nam Mao	Ban Houaykhoum	200	540	2.7
Nam Ko	Xai town at the bridge of Route No.1	600	1,660	2.8
Nam Kham	Ban Nakham-tai	55	132	2.4

The design peek flood discharge is decided, making reference to the above table on the specific runoff of 2.7 $m^3/s/km^2$ for Xai and Beng areas and 2.4 $m^3/s/km^2$ for Hun area.

6. CONSTRAINTS AND POTENTIALS ON WATER RESOURCE

6.1 Physical Constraints and Potentials

As mentioned in Section 4.2, there are many rivers in the study area. Among them, the main rivers which have relatively large potential for development of irrigated agriculture are the Nam Beng, the Nam Ko and the Nam Mao. The Nam Beng and the Nam Ko, which are perennial water source, are currently not used for irrigation purpose because of a incised river that would require medium to large-scale weir and long headrace or pump equipment. Although the Nam Mao is also perennial river, it could not irrigate the whole command area in the dry season because of the limited amount of river water.

Many of their tributaries are used by the farmers for supplemental irrigation to wet season rice. Since most of them have small catchment area, however, they mostly dry up in the dry season. Even if the existing irrigation schemes were rehabilitated by permanent facilities, therefore, most of these schemes could not irrigate the whole command area in the dry season.

An analysis of potential water resources in the study area is made for the year-round irrigation with the probable rainfall corresponding to 5-year return period of drought. According to the proposed cropping pattern which is mentioned in ANNEX-FC, unit irrigable area (irrigable area per 1 km^2 of catchment area) in each river is estimated in consideration of the river maintenance flow of 1 lit/s/km^2. The results are shown below, and the details are presented in Tables MA-17 and MA-18.

(Unit: ha/km^2)

Category of watershed	Wet season rice	Dry season rice	Dry season upland crop
Category 1	17.5	0.6	1.2
Category 2	4.4	0	0
Category 3	10.4	0	0

Note: Each category is defined in Section 4.2.

As seen in the above table, a potential of the water resource depends on the watershed condition. In the case that the watershed is covered by the well-maintained forest, the potential of water resource is high. However, the potential is low in the watersheds where slash--and-burn cultivation is widely practice.

Applying the above unit irrigable area to all the rivers in the study area, the total potential of water resource for irrigation development is estimated at 3,730 ha of irrigable land including existing rice field that could fully be irrigated for cultivation of wet season rice. In the dry season, however, the potential water resource could irrigate only 8% (296 ha) of the total irrigable land for cultivation of dry season rice. In the case of upland crops, the land that could

be irrigated in the dry season will increase to 16% (593 ha). This means that the availability of water for irrigation purpose especially in the dry season is very low, without construction of storage dams to store ample river water in the wet season. Details are shown in Table MA-19.

6.2 Institutional and Technical Constraints

Since no hydrological investigation and study even on the main water resources are carried out so far by the provincial office, appropriate services for water users such as proper planning and design of the irrigation schemes could not be provided by the office. It is caused mainly by lack of equipment for the investigation such as current meter, staff-gages and rainfall-recorder, by poor network of meteorological and rainfall observation, and by low abilities of the staff for hydrological investigation.

7. WATER RESOURCE DEVELOPMENT PLAN

7.1 Basic Development Concept

As mentioned in Section 6.1, the potential water resource for irrigation development could irrigate fully wet season rice. In the dry season, however, the potential is low. Even if there is a site to construct small dam, the land for irrigation development is small. The potentiality of water resource is low in the watershed where slash-and-burn cultivation is widely practiced. Therefore, the first priority for the development is given to the stable supply of irrigation water to the wet season rice, together with rehabilitation of existing irrigation system and watershed management, especially for the watershed area in Category 2. However, a basic data, the meteorological and hydrological data, is not sufficient for the planning and design of such a development. At the initial stage of the development, therefore, improvement of climatic and hydrometric network should be carried out. This program is essential not only for the irrigation development and watershed management, but also for the agricultural extension services and monitoring of the development.

7.2 Improvement of Climatic and Hydrometric Network

The present meteorological observation network in Oudomxay province includes one meteorological station established by MAF and one rainfall station that belongs to MCTPC. In addition, the study team installed one rainfall-recorder in Hun district center. There exist no hydrological observation stations, except only one water-level recorder installed in the middle reach of the Beng river by the study team. In order to strengthen the existing observation networks for supporting the implementation of the proposed agricultural development as well as further acceleration of socio-economic development in the future, the following programs will be conducted at the short-term development stage under the Master Plan. The instruments required are shown in Table MA-20.

(a) Supply of additional equipment and instruments to Xai meteorological observation station.
(b) Construction of additional meteorological yard at Beng district center. (Meteorological yard at Hun district center is under construction by UNDP)
(c) Installation of additional rainfall recorders, one in 250 km^2 of catchment area, nine sites in total.
(d) Installation of additional staff gages in the five main rivers.

The new observation network will be maintained and managed by the Department of Agriculture and Forestry of Oudomxay Provincial Office with advice of the proposed Integrated Agriculture Station.

8. REFERENCES

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9. Rehabilitation and Extension Project of Nam Fen Perimeter (Oudomsay Province, Xay District), Detailled Project : UNDP, 1991
10. Lao PDR, Agricultural Development and Watershed Management Project, Preparation Mission : FAO, 1991

Table

Table MA-1 Available Rainfall Record

No.*	Station	Province	Location	Altitude	Year												Organization
			Latitude, Longitude	(m)	- 79	80	81	82	83	84	85	86	87	88	89	90	91	
Lao PDR																		
-	Oudomxay	Oudomxay	20 41'N, 102 00'E	550										═	═	═	═	MAF
201	Pakbeng	Oudomxay	19 55'N, 100 35'E	299	63-66, 68	═									═	═	═	MCTPC
252	Luang Namtha	Luang Namtha	21 03'N, 101 28'E	644	78	═								═				Mekong C.
-	Muang Khoa	Phongsali	21 05'N, 102 30'E	360										═	═	═	═	MAF
251	Muang Ngoy	Luang Prabang	20 42'N, 102 42'E	500	77-79	═												MAF
206	Luang Prabang	Luang Prabang	19 53'N, 102 08'E	306	40-79	═	═	═	═	═	═	═	═	═	═	═		MAF
264	Xieng Khouang	Xieng Khouang	19 28'N, 103 08'E	1050				═	═	═	═	═	═	═	═			MAF
204	Sayaboury	Sayaboury	19 14'N, 101 44'E	326	63-75, 78	═	═	═	═	═	═	═	═	═	═			MAF
Northern Thailand in the Mekong River Basin																		
301	Mae Chan		20 09'N, 99 52'E	413				═	═	═	═	═	═	═	═			Mekong C.
302	Chiang Saen		20 16'N, 100 06'E	369		═	═	═	═	═	═	═	═	═	═			Mekong C.
303	Chiang Khong		20 16'N, 100 25'E	361		═	═	═	═	═	═	═	═	═	═			Mekong C.
307	Chiang Kham		19 31'N, 100 18'E	394									═	═	═			Mekong C.
308	Thoeng		19 41'N, 100 11'E	396		═	═				═	═	═					Mekong C.
309	Phayao		19 12'N, 99 59'E	395			═	═	═	═	═	═	═	═	═			Mekong C.
310	Chiang Rai		19 55'N, 99 50'E	416		═	═	═	═	═	═	═	═	═	═			Mekong C.
317	Fang		19 58'N, 99 14'E	470		═	═	═	═	═	═	═	═	═	═			Mekong C.
581	Mae Kok Dam Site		19 57'N, 99 54'E	391		═	═	═	═	═	═	═	═	═	═			Mekong C.
586	Ban Mae Ai		20 02'N, 99 18'E	460		═	═	═	═	═	═	═	═	═	═			Mekong C.
597	Khao Ing Rod		19 26'N, 100 04'E	368		═	═	═	═	═	═	═	═	═	═			Mekong C.
599	Ban Huai Tham		19 04'N, 100 04'E	430		═	═	═	═	═	═	═	═	═	═			Mekong C.
604	Mae Suai Dam Site		19 42'N, 99 31'E	480		═	═	═	═	═	═	═	═	═	═			Mekong C.
608	Mae Sai		20 22'N, 99 54'E	-					═	═	═	═	═	═	═			Mekong C.

Note: * This is the station number which is given in the Lower Mekong Hydrologic Yearbook, Mekong Committee.

Table MA-2 Available Discharge Record

No.	River	Location	Catchment area (km2)	Year									
				80	81	82	83	84	85	86	87	88	89
Lao PDR													
1	Nam Ou	Muong Ngoy	19,700	+++	+++				+++	+++	═══	═══	═══
2	Nam Suong	Ban Sibounhom (B. Sieou)	5,800	+++	+++	+++	+++	+++	+++	+++	═══	═══	═══
3	Nam Pa	Ban Kok Van	700		+++	+++	+++	+++	+++		+++	═══	═══
4	Nam Khan	Ban Pak Bak	5,800		+++				═══	═══	═══	═══	═══
5	Nam Khan	Ban Mixay (B. Mout)	6,100	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══
Northern Thailand in the Mekong River Basin													
6	Nam Mae Kham	Ban Pa Yang	518	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══
7	Nam Mae Chan	Ban Huai Yano Mai	203	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══
8	Nam Mae Fang	Ban Tha Mai Liam	1,800	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══
9	Nam Mae Kok	Ban Tha Ton	2,980	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══
10	Nam Mae Kok	Chiang Rai	6,060	═══	═══				═══	═══	═══	═══	═══
11	Nam Mae Pun Luang	Dam Site	258	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══
12	Nam Mae Suai	Dam Site	426	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══
13	Nam Mae Lao	Ban Tha Sai	3,050	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══
14	Nam Mae Ing	Thoeng	5,700	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══

Note: +++; gage height record is available.
═══; gage height and discharge records are available.

Source: Lower Mekong Hydrologic Yearbook, Mekong Committee

Table MA-3 (1/2) Climate in Oudomxay

MONTHLY MEAN TEMPERATURE

(Unit: 'C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1987					27.9	27.1	25.9	25.9	25.7	25.1	22.7	16.3	-
1988	19.7	22.1	23.9	25.5	26.7	26.7	26.0	25.1	25.3	23.8	19.7	17.7	23.5
1989	19.0	21.3	22.5	26.4	26.6	26.5	26.0	26.3	25.7	24.1	21.1	17.1	23.6
1990	19.9	20.8	22.7	26.3	25.4	26.3	25.3	26.5	25.5	23.7	21.4	18.6	23.5
1991	19.6	18.9	23.5	25.0	26.7	25.4	25.5	25.6	25.6	23.9	20.3	17.7	23.1
1992	16.9	19.5	24.3	27.4	26.7	26.7	25.8	26.2	25.5	21.6	19.4		-
Average	19.0	20.5	23.4	26.1	26.7	26.5	25.8	25.9	25.6	23.7	20.8	17.5	23.4

MONTHLY MEAN MAXIMUM TEMPERATURE

(Unit: 'C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Maximum
1987					34.5	31.2	30.0	30.3	29.9	30.4	27.7	23.2	-
1988	27.4	30.5	31.9	32.1	31.9	31.0	30.7	28.1	30.5	29.2	25.8	25.2	32.1
1989	26.1	29.5	28.6	33.2	31.4	30.1	29.3	30.5	30.0	28.1	26.7	25.0	33.2
1990	27.4	28.0	29.1	32.8	30.0	29.1	28.6	31.2	30.0	28.6	27.0	25.0	32.8
1991	28.2	29.0	32.4	32.0	31.9	28.5	29.2	29.2	29.9	28.5	25.6	23.8	32.4
1992	23.2	26.7	32.3	34.2	33.2	31.1	29.4	30.7	29.7	25.6	25.1		-
Average	26.5	28.7	30.9	32.9	32.2	30.2	29.5	30.0	30.0	28.4	26.3	24.4	32.9

MONTHLY MEAN MINIMUM TEMPERATURE

(Unit: 'C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Minimum
1987					19.8	22.3	22.3	21.6	21.0	19.4	17.5	7.3	-
1988	9.3	10.9	13.3	17.6	21.5	21.8	21.8	21.8	20.6	18.4	12.8	8.8	8.8
1989	10.8	9.7	14.3	15.9	20.6	21.8	21.9	21.6	21.1	19.1	14.3	8.2	8.2
1990	11.2	11.9	14.6	16.8	20.2	22.3	22.1	21.7	20.9	18.7	15.7	12.3	11.2
1991	11.0	8.8	14.6	17.9	20.4	22.4	22.2	21.9	21.5	18.9	14.3	11.2	8.8
1992	9.5	9.9	11.9	16.9	19.5	21.8	21.8	21.4	21.1	16.8	13.0		-
Average	10.4	10.2	13.7	17.0	20.3	22.1	22.0	21.7	21.0	18.6	14.6	9.6	9.6

MONTHLY MEAN RELATIVE HUMIDITY

(Unit: %)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1990	77	77	73	66	80	88	91	81	87	82	82	82	81
1991	82	74	69	72	74	85	84	84	86	84	88	85	81
1992	84	70	62	65	72	81	85	85	84	85	84		-
Average	81	74	68	68	75	85	87	83	86	84	85	84	80

Source: Oudomxay Meteorological Station and Department of Meteorology and Hydrology, MAF

Table MA-3 (2/2) Climate in Oudomxay

MONTHLY MEAN CLOUDINESS

(Unit: oktas)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1990	6	6	6	5	7	7	8	7	7	7	6	5	6
1991	5	3	4	5	6	8	8	7	7	6	6	6	6
1992	6	4	3	5	5	7	7	6	6	6	5		-
Average	6	4	4	5	6	7	8	7	7	6	6	6	6

MONTHLY SUNSHINE HOURS

(Unit: hours)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1989					176.3	101.8	130.5	162.2	130.8	152.2		182.8	-
1990	139.6	138.5	162.6	168.3	105.4	29.0	39.6	142.0	102.6	94.6	126.7	168.3	1417.2
1991	184.9	169.4	148.7	157.8	227.2	60.9	65.7	84.1	137.2	163.3	124.9	122.9	1647.0
1992	140.7	158.8	213.9	188.7	218.8	124.2	108.7	162.2	168.6	112.2	152.4		-
Average	155.1	155.6	175.1	171.6	181.9	79.0	86.1	137.6	134.8	130.6	134.7	158.0	1700.0

MONTHLY MEAN SUNSHINE HOURS

(Unit: hours)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1989					5.9	3.4	4.2	5.2	4.4	4.9		5.9	-
1990	4.5	5.3	5.2	5.6	3.4	1.0	1.3	4.6	3.4	3.1	4.2	5.4	3.9
1991	5.9	6.1	4.8	5.3	7.3	2.0	2.1	2.7	4.6	5.3	4.2	4.0	4.5
1992	4.5	6.1	6.9	6.3	7.3	4.1	3.5	5.2	5.6	3.7	5.1		-
Average	5.0	5.8	5.6	5.7	6.0	2.6	2.8	4.4	4.5	4.3	4.5	5.1	4.7

MONTHLY EVAPORATION (Piche)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1989	55.6	83.0				58.9	33.9	49.0	41.1	44.7	52.6	49.9	-
1990	62.9	67.9	83.8	142.4	77.1	44.3	40.6	36.7	39.8	49.0	49.3	49.6	743.4
1991	67.0	170.4	106.7	74.0	51.6	25.2	32.0	21.1	18.3	34.7	41.4	38.3	680.7
1992	47.7	61.0	113.7	127.6	104.4	46.0	53.0	96.0	82.6	98.4	31.9		-
Average	58.3	95.6	101.4	114.7	77.7	43.6	39.9	50.7	45.5	56.7	43.8	45.9	773.7

MONTHLY MEAN EVAPORATION (Piche)

(Unit: mm/day)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1989	2.1	3.0				2.0	1.1	1.7	1.4	1.4	1.8	1.6	-
1990	2.0	2.4	2.7	4.7	2.5	1.5	1.3	1.3	1.3	1.6	1.6	1.6	2.0
1991	2.2	6.1	3.4	2.5	1.7	0.8	1.1	0.7	0.6	1.1	1.4	1.2	1.9
1992	1.5	2.2	3.7	4.3	3.5	1.5	1.7	3.1	2.8	3.3	1.1		-
Average	2.0	3.4	3.3	3.8	2.6	1.5	1.3	1.7	1.5	1.9	1.5	1.5	2.2

Source: Oudomxay Meteorological Station and Department of Meteorology and Hydrology, MAF

Table MA-4 (1/2) Climate in Luang Prabang

MONTHLY MEAN TEMPERATURE

(Unit: 'C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1980	19.7	22.2	24.9	27.5	28.7	27.2	27.2	27.1	26.5	25.3	22.4	20.1	24.9
1981	19.2	22.4	25.7	26.8	26.6	27.1	26.5	26.9	26.8	24.7	22.8	17.7	24.4
1982	18.4	22.1	25.6	25.1	27.8	27.5	27.0	26.3	26.3	25.2	23.2	19.2	24.5
1983	17.7	22.0	23.1	28.3	28.1	28.7	28.3	26.9	26.7	25.4	20.7	16.3	24.4
1984	18.6	23.5	24.9	28.1	27.2	27.6	26.5	26.5	25.8	23.7	21.4	19.4	24.4
1985	20.3	22.2	25.8	26.3	27.3	27.2	26.3	26.1	26.6	24.6	22.4	18.3	24.5
1986	18.2	21.9	22.3	26.3	26.5	26.5	26.5	27.2	25.0	24.3	21.3	18.5	23.7
1987	18.7	21.1	24.4	27.6	29.2	27.8	27.4	26.7	26.5	25.6	23.6	16.1	24.6
1988	19.8	23.8	25.5	27.2	27.8	27.3	27.2	26.2	26.3	24.7	20.2	18.4	24.5
1989	20.2	22.8	24.3	27.4	27.3	27.3	27.0	26.6	26.3	24.6	21.7	17.7	24.4
1990	21.1	21.2	23.7	26.2	26.7	27.2	26.6	27.5	26.1	24.4	22.3	18.7	24.3
Average	19.3	22.3	24.6	27.0	27.6	27.4	27.0	26.7	26.3	24.8	22.0	18.2	24.4

MONTHLY MEAN MAXIMUM TEMPERATURE

(Unit: 'C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Maximum
1980	29.3	31.5	34.5	34.5	35.6	32.4	32.1	32.0	32.3	31.7	29.8	27.5	35.6
1981	27.6	33.0	35.4	34.0	31.6	31.7	30.8	31.5	32.7	30.0	28.4	23.4	35.4
1982	26.1	31.7	34.8	31.6	34.2	31.2	31.5	30.6	31.3	31.6	30.1	25.4	34.8
1983	24.9	31.7		37.5	34.1	33.7	33.0	31.1	31.5	30.3	26.5	24.7	37.5
1984	27.8	31.2	34.5	36.7	34.0	32.6	31.5	31.7	32.0	30.0	29.1	27.6	36.7
1985	29.0	32.0	33.0	33.7	33.9	31.5	31.3	30.4	32.0	31.2	28.4	26.2	33.9
1986	27.0	30.5	32.9	34.7	32.5	30.8	30.4	32.2	32.0	32.1	30.1	25.6	34.7
1987	27.4	28.4	33.3	35.4	36.3	32.0	31.9	31.3	32.3	32.8	29.3	25.3	36.3
1988	29.7	32.7	34.7	34.4	33.1	32.6	32.0	30.7	32.4	30.7	27.4	27.7	34.7
1989	28.7	32.4	32.3	36.0	33.7	32.6	31.6	32.2	32.0	30.8	28.7	27.1	36.0
1990	28.9	29.6	31.9	34.7	33.6	31.7	30.7	33.2	32.1	30.7	29.7	27.0	34.7
Average	27.9	31.3	33.7	34.8	33.9	32.1	31.5	31.5	32.1	31.1	28.9	26.1	34.8

MONTHLY MEAN MINIMUM TEMPERATURE

(Unit: 'C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Minimum
1980	13.5	15.0	18.2	22.2	23.9	24.5	24.5	24.2	23.2	21.7	18.1	16.4	13.5
1981	14.1	14.9	18.7	20.7	23.1	24.2	24.2	24.4	23.0	21.8	19.6	14.4	14.1
1982	14.6	15.9	19.1	20.9	23.6	24.7	24.3	23.8	23.5	21.9	19.3	12.9	12.9
1983	13.9	15.7		21.3	23.9	25.0	25.0	24.2	23.1	22.3	16.9	11.9	11.9
1984	13.5	17.4	17.7	22.6	22.6	24.4	23.7	23.6	22.1	20.2	17.3	15.2	13.5
1985	15.6	15.6	18.6	21.4	22.6	24.2	21.3	23.5	22.7	20.5	18.9	14.6	14.6
1986	12.6	15.0	14.1	20.2	23.3	23.6	23.5	23.6	21.1	20.9	17.2	14.6	12.6
1987	13.4	15.7	17.6	21.9	23.8	24.5	24.5	24.3	23.0	21.8	20.4	10.9	10.9
1988	14.0	17.1	18.7	21.3	23.9	23.6	24.1	23.5	21.7	21.1	15.4	12.8	12.8
1989	14.7	15.2	18.2	20.5	22.8	23.6	23.6	23.2	23.0	21.1	17.8	12.5	12.5
1990	16.5	15.8	18.1	20.0	22.5	24.2	24.4	24.1	22.5	20.4	18.3	13.9	13.9
Average	14.2	15.8	17.9	21.2	23.3	24.2	23.9	23.9	22.6	21.2	18.1	13.6	13.6

Source: 1980-82, 84-89 Lower Mekong Hydrologic Yearbook, Mekong Committee
1983 & 90 Department of Meteorology and Hydrology, MAF

Table MA-4 (2/2) Climate in Luang Prabang

MONTHLY MEAN RELATIVE HUMIDITY

(Unit: %)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1980	78	67	67	72	69	81	84	84	81	80	82	84	77
1981	78	68	66	70	81	82	86	86	84	86	83	82	79
1982	84	76	71	78	77	84	86	87	86	86	83	75	81
1983													
1984	82	75	63	68	72	85	86	87	86	87	84	84	80
1985	83	76	70	74	77	81	83	87	84	81	84	83	80
1986	79	72	65	73	81	84	85	81	83	83	82	84	79
1987	81	81	72	70	70	79	80	84	83	82	85	79	79
1988	78	73	65	70	80	80	83	86	87	84	77	78	78
1989	78	68	68	67	76	82	84	84	85	88	86	85	79
Average	80	73	67	71	76	82	84	85	84	84	83	82	79

MONTHLY MEAN WIND SPEED

(Unit: knots)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1980	1.0	2.0	2.0	2.0	3.0	2.0	2.0	1.0	1.0	2.0	1.0	1.0	1.7
1981	2.0	2.0	4.0	4.0	3.0	3.0	2.0	3.0	1.0	2.0	2.0	1.0	2.4
1982	1.0	1.0	1.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.3
1983													
1984	2.9	1.8	2.0	2.8	2.6	2.2	1.4	1.1	1.8	1.3	1.1	1.7	1.9
1985	2.5	2.3	2.9	1.6	1.8	2.3	1.8	2.2	2.0	1.6	1.5	1.5	2.0
1986	1.6	1.9	1.9	2.3	2.0	1.0	2.0	2.0	1.8	2.0	2.0	2.0	1.9
1987	1.7	1.7	2.0	1.7	2.0	1.7	2.0	1.5	1.6	2.0	2.0	3.0	1.9
1988	2.8	2.6	4.2	6.0	3.6	4.0	3.4	2.8	4.2	3.8	4.8	3.8	3.8
1989	0.6	0.7	1.0	0.8	0.7	0.7	0.7	0.6	0.6	1.5	0.4	0.5	0.7
Average	1.8	1.8	2.3	2.6	2.3	2.1	1.9	1.7	1.7	1.9	1.8	1.7	2.0

Height of wind vane above ground : 10.00m
1.0 knot = 0.5148 m/sec

Source: Lower Mekong Hydrologic Yearbook, Mekong Committee

MONTHLY MEAN SUNSHINE HOURS

(Unit: hours)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1981	6.7	8.1	6.5	7.0	5.2		2.8	3.9	7.5	4.4	5.2		
1982	5.2	7.3	5.8	5.5	5.8	4.2	4.4	3.4	5.1	6.3	6.5	5.5	5.4
1983	5.0	7.5	5.0	8.9	7.9	7.6	6.8	5.6	6.4	5.6	5.8	5.8	6.5
1984	7.0	7.6			6.7							6.0	
1985	6.8	7.9	6.5	6.3	6.5		4.8	3.0	6.4	6.6	4.6	6.8	
1986													
1987	6.1	5.7	5.9	7.0	7.4		2.4	4.5	6.2	7.2	4.0	6.3	
1988	6.8	5.4			6.3	4.8	3.4	3.3	5.5	4.0	5.9	6.9	
1989	6.6	8.3	5.5	7.4	6.7	5.6	5.0	6.1	6.1	5.9	6.7	6.6	6.4
1990	5.8	5.9	7.1	6.7	4.3	3.0	2.5	6.2	6.2	5.7	6.6	6.1	5.5
Average	6.2	7.1	6.0	7.0	6.3	5.0	4.0	4.5	6.2	5.7	5.7	6.3	5.8

Source: Department of Meteorology and Hydrology, MAF

Table MA-5 Annual Rainfall

(Unit: mm)

No.	Station	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Lao PDR													
-	Oudomxay	-	-	-	-	-	-	-	-	1,167.7	1,279.0	1,229.2	1,275.6
201	Pakbeng	1,594.3	-	-	-	-	-	-	-	-	1,303.1	-	1,238.0
252	Luang Namtha	1,429.2	-	-	-	-	-	-	-	1,074.8	-	-	-
-	Muang Khoa	-	-	-	-	-	-	-	-	-	1,442.6	-	1,598.3
251	Muang Ngoy	-	-	-	-	-	-	-	-	-	-	-	-
206	Luang Prabang	1,559.2	1,831.6	1,226.3	1,383.8	1,086.0	1,158.7	1,839.7	1,035.8	1,156.1	1,415.2	1,623.1	-
264	Xieng Khouang	-	-	1,561.5	1,046.9	1,565.6	1,438.0	1,467.5	1,176.2	1,332.8	-	-	-
204	Sayaboury	1,826.5	1,196.2	1,190.6	1,219.5	1,475.5	1,255.8	1,604.4	1,223.2	1,174.2	1,334.4	-	-
Northern Thailand													
301	Mae Chan	2,128.6	2,277.3	1,722.8	1,878.8	1,476.3	1,626.3	1,426.5	1,601.7	1,761.6	1,654.5	-	-
302	Chiang Saen	1,923.3	2,340.5	2,008.8	1,526.7	1,444.0	1,858.2	1,675.8	1,510.6	2,059.9	1,708.0	-	-
303	Chiang Khong	1,977.4	2,348.2	1,487.7	1,569.0	1,386.1	1,580.0	1,560.9	1,146.8	2,327.1	1,761.6	-	-
307	Chiang Kham	-	-	-	-	-	1,582.2	-	1,146.0	1,457.9	1,165.4	-	-
308	Thoeng	1,414.9	1,327.1	-	-	-	1,693.8	1,131.1	1,152.3	-	1,546.7	-	-
309	Phayao	-	1,038.8	856.7	1,148.9	885.3	851.6	945.3	1,137.2	1,283.5	848.6	-	-
310	Chiang Rai	1,852.4	1,867.9	1,577.7	1,785.7	1,576.4	1,935.6	1,473.4	1,243.5	1,720.2	1,521.3	-	-
317	Fang	1,463.6	1,851.3	1,247.2	1,544.0	1,178.2	1,273.0	1,115.2	1,227.5	1,614.1	1,168.7	-	-
581	Mae Kok Dam Site	1,861.5	1,854.1	1,731.7	2,050.7	1,917.5	-	1,687.5	1,486.0	2,112.8	1,935.0	-	-
586	Ban Mae Ai	1,580.0	1,875.4	1,435.0	1,655.5	1,171.3	1,448.7	1,154.4	1,163.0	1,329.1	1,199.1	-	-
597	Khao Ing Rod	1,569.9	1,211.4	998.1	1,326.8	1,164.2	1,325.8	1,334.6	1,553.4	1,168.8	1,274.1	-	-
599	Ban Huai Tham	1,349.2	1,536.1	1,139.7	1,028.5	1,141.6	1,524.2	947.0	1,276.4	1,272.1	1,173.1	-	-
604	Mae Suai Dam Site	1,760.9	1,480.8	1,349.7	1,599.9	1,186.8	1,440.2	1,519.8	1,429.2	1,765.9	1,302.5	-	-
608	Mae Sai	-	-	-	1,632.2	1,685.6	1,526.8	1,648.9	1,414.8	1,792.6	1,434.2	-	-

Source: Data of Thailand; Lower Mekong Hydrologic Yearbook, Mekong Committee
Data of Lao PDR; MAF and Lower Mekong Hydrologic Yearbook

Table MA-6 (1/2) Monthly Rainfall

MONTHLY RAINFALL IN OUDOMXAY
(OUDOMXAY PROVINCE)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1981*	0.0	0.0	6.5	186.1	249.3	188.4	254.0	250.9	155.4	320.2	24.3	0.0	1635.1
1982*	6.8	0.0	17.1	112.1	201.7	172.4	148.9	208.2	158.9	22.1	28.4	0.0	1076.6
1983*	62.8	27.1	38.9	23.5	150.1	139.8	198.3	373.2	47.9	96.5	36.7	18.1	1212.8
1984*	0.0	0.8	27.5	35.8	109.8	152.7	121.3	257.7	90.0	157.1	0.0	0.0	952.6
1985*	0.1	24.6	11.8	116.6	111.0	101.8	125.3	263.1	90.5	16.1	150.4	0.0	1011.4
1986*	0.0	0.0	5.2	240.0	192.1	337.0	317.4	188.0	52.3	239.9	45.6	20.8	1638.2
1987*	0.0	22.2	39.2	128.7	48.1	107.6	160.4	172.5	115.3	21.4	86.1	0.0	901.4
1988	0.0	87.8	0.0	154.6	139.2	97.5	343.3	262.4	37.2	35.6	10.1	0.0	1167.7
1989	19.0	0.0	81.3	44.0	188.4	96.6	349.2	238.6	154.6	106.8	0.5	0.0	1279.0
1990	1.1	55.5	45.5	58.6	126.6	277.7	336.3	155.4	107.3	21.6	35.6	8.0	1229.2
1991	0.1	0.2	71.5	103.8	155.3	290.0	137.0	301.2	134.4	54.6	23.2	4.3	1275.6
1992	7.0	53.8	0.0	32.0	186.5	190.5	223.0	232.2	180.7	23.8	19.1		1148.6
Average (1981-92)	8.1	22.7	28.7	103.0	154.8	179.3	226.2	241.9	110.4	93.0	38.3	4.7	1211.1
%	0.7	1.9	2.4	8.5	12.8	14.8	18.7	20.0	9.1	7.7	3.2	0.4	100.0
Average (1988-92)	5.4	39.5	39.7	78.6	159.2	190.5	277.8	238.0	122.8	48.5	17.7	3.1	1220.6
%	0.4	3.2	3.2	6.4	13.0	15.6	22.8	19.5	10.1	4.0	1.5	0.3	100.0

Source: Oudomxay Meteo Station and Department of Meteorology and Hydrology, MAF
*: Estimated by the rainfall in Luang Prabang

MONTHLY RAINFALL IN MUANG HUN
(OUDOMXAY PROVINCE)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1992	-	-	-	45.5	106.5	64.0	197.0	205.5	197.0	41.0	0.0		-

Note: This station is established by JICA study team in April 1st., 1992

MONTHLY RAINFALL IN PAKBENG
(OUDOMXAY PROVINCE)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1980	0.0	0.0	47.5	85.8	246.8	411.1	253.6	276.5	167.5	62.6	4.6	38.3	1594.3
1989	7.2	0.0	49.1	86.1	122.0	179.0	263.6	228.1	235.3	132.7	0.0	0.0	1303.1
1990	3.0	44.8	0.0	47.4	-	118.6	323.9	97.5	196.3	37.8	34.8	-	-
1991	5.8	0.0	27.7	99.7	356.0	227.6	201.1	179.6	100.3	7.5	26.0	6.7	1238.0
Average	4.0	11.2	31.1	79.8	241.6	234.1	260.6	195.4	174.9	60.2	16.4	15.0	1324.0

Source: - 1980,89 ; Lower Mekong Hydrologic Yearbook, Mekong Committee
- 1990,91 ; MCTPC

MONTHLY RAINFALL IN LUANG NAMTHA
(LUANG NAMTHA PROVINCE)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1980	0.0	3.0	12.5	33.6	126.3	330.6	320.0	375.9	137.6	28.1	15.0	46.6	1429.2
1988	0.0	81.1	10.7	112.6	115.2	135.0	158.0	339.4	122.8	0.0	0.0	0.0	1074.8
Average	0.0	42.1	11.6	73.1	120.8	232.8	239.0	357.7	130.2	14.1	7.5	23.3	1252.0

Source: Lower Mekong Hydrologic Yearbook, Mekong Committee

Table MA-6 (2/2) Monthly Rainfall

MONTHLY RAINFALL IN MUANG KHOA
(PHONGSALI PROVINCE)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1988	0.0	38.8	1.8	118.9	-	-	432.8	396.4	137.0	17.8	5.4	0.0	-
1989	38.5	16.2	171.7	135.8	129.7	411.5	198.6	189.8	116.3	34.5	0.0	0.0	1442.6
1990	11.7	32.0	81.6	117.1	196.3	344.4	323.8	96.5	85.0	-	-	-	-
1991	1.0	1.4	82.5	127.3	170.7	435.7	177.2	253.4	238.6	51.3	31.0	28.2	1598.3
Average	12.8	22.1	84.4	124.8	165.6	397.2	283.1	234.0	144.2	34.5	12.1	9.4	1524.3

Source: Department of Meteorology and Hydrology, MAF

MONTHLY RAINFALL IN LUANG PRABANG
(LUANG PRABANG PROVINCE)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1980	0.2	37.2	74.0	63.8	130.5	330.9	255.2	254.1	258.8	115.9	22.0	16.6	1559.2
1981	0.0	0.0	11.8	208.4	277.5	210.9	282.6	279.2	174.8	355.1	31.3	0.0	1831.6
1982	12.2	1.0	23.5	127.4	225.4	193.4	167.6	232.5	178.6	28.9	35.8	0.0	1226.3
1983	73.4	34.4	47.3	30.5	169.0	157.7	221.7	413.0	57.1	110.3	44.9	24.5	1383.8
1984	0.0	5.6	34.8	43.9	124.9	171.8	137.4	286.7	103.2	176.6	1.1	0.0	1086.0
1985	4.9	31.7	17.7	132.3	126.2	116.1	141.8	292.6	103.7	22.4	169.3	0.0	1158.7
1986	0.0	0.0	10.4	267.3	214.9	373.4	352.0	210.4	62.0	267.2	54.6	27.5	1839.7
1987	2.2	29.0	47.6	145.5	57.4	122.5	180.2	193.5	130.9	28.1	98.9	0.0	1035.8
1988	0.8	31.7	1.5	155.8	174.2	141.1	240.4	181.4	39.2	174.7	15.3	0.0	1156.1
1989	13.7	0.0	69.1	132.4	156.3	154.2	287.4	288.9	160.8	130.5	21.9	0.0	1415.2
1990	9.7	50.6	77.8	127.9	113.4	183.2	329.3	208.3	262.4	61.1	199.4	0.0	1623.1
Average	10.6	20.1	37.8	130.5	160.9	195.9	236.0	258.2	139.2	133.7	63.1	6.2	1392.3

Source: Department of Meteorology and Hydrology, MAF

MONTHLY RAINFALL IN XIENG KHOUANG
(XIENG KHOUANG PROVINCE)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1982	5.6	1.1	162.4	158.3	145.9	193.0	107.3	347.8	380.0	38.2	21.9	0.0	1561.5
1983	37.9	17.5	34.6	78.9	157.5	70.3	219.6	300.4	40.1	72.0	8.6	9.5	1046.9
1984	0.0	96.6	81.5	136.2	121.8	145.3	202.1	460.3	199.3	85.7	36.8	0.0	1565.6
1985	9.8	6.7	1.9	107.6	166.3	187.4	330.9	316.3	194.8	77.3	39.0	0.0	1438.0
1986	0.0	2.5	7.8	144.4	426.6	234.2	328.3	170.4	123.3	15.2	0.3	14.5	1467.5
1987	0.0	34.5	17.5	180.2	144.4	211.9	191.0	222.8	119.3	48.1	6.5	0.0	1176.2
1988	0.0	12.8	2.0	181.0	291.4	167.1	135.9	313.1	125.7	102.7	1.1	0.0	1332.8
1989	4.1	0.0	165.0	151.3	112.2	224.4	308.5	160.2	146.9	111.0	-	-	-
Average	7.2	21.5	59.1	142.2	195.8	179.2	228.0	286.4	166.2	68.8	16.3	3.4	1374.0

Source: Department of Meteorology and Hydrology, MAF

Table MA-7 (1/2) Monthly Rain Days

MONTHLY RAIN DAYS IN OUDOMXAY
(OUDOMXAY PROVINCE) (Unit: days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1991	1	1	7	6	14	16	20	17	18	8	3	3	114
1992	1	2	0	4	14	19	15	14	15	6	4	-	-
Average	1	2	4	5	14	18	18	16	17	7	4	3	106

Source: Oudomxay Meteo Station and Department of Meteorology and Hydrology, MAF

MONTHLY RAIN DAYS IN MUANG HUN
(OUDOMXAY PROVINCE) (Unit: days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1992	-	-	-	5	12	11	21	17	16	12	0	-	-

Note: This station is established by JICA study team in April 1st., 1992

MONTHLY RAIN DAYS IN PAKBENG
(OUDOMXAY PROVINCE) (Unit: days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1980	0	0	3	7	14	25	12	14	13	5	1	3	97
1989	2	0	4	8	13	18	17	18	15	12	0	0	107
1990	2	8	0	5	-	16	20	12	11	8	3	-	-
1991	2	0	4	9	18	15	10	14	6	1	2	2	83
Average	2	2	3	7	15	19	15	15	11	7	2	2	97

Source: - 1980,89 ; Lower Mekong Hydrologic Yearbook, Mekong Committee
- 1990,91 ; MCTPC

MONTHLY RAIN DAYS IN LUANG NAMTHA
(LUANG NAMTHA PROVINCE) (Unit: days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1980	0	1	3	4	14	24	21	21	11	6	3	4	112
1988	0	3	1	6	11	9	13	16	7	0	0	0	66
Average	0	2	2	5	13	17	17	19	9	3	2	2	89

Source: Lower Mekong Hydrologic Yearbook, Mekong Committee

MONTHLY RAIN DAYS IN MUANG KHOA
(PHONGSALI PROVINCE) (Unit: days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1988	0	2	1	6	-	-	22	20	8	4	1	0	-
1989	6	2	10	6	11	19	15	11	10	5	0	0	95
1990	3	5	12	8	12	18	13	8	8	-	-	-	-
1991	1	2	6	10	15	18	19	13	7	6	3	3	103
Average	3	3	7	8	13	18	17	13	8	5	1	1	97

Source: Department of Meteorology and Hydrology, MAF

Table MA-7 (2/2) Monthly Rain Days

MONTHLY RAIN DAYS IN LUANG PRABANG
(LUANG PRABANG PROVINCE) (Unit: days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1980	1	3	4	10	17	27	24	16	13	9	2	4	130
1981	0	0	3	12	18	23	25	24	11	13	7	0	136
1982	2	1	2	17	14	11	20	22	21	7	6	0	123
1983	7	5	7	8	14	15	14	23	15	19	9	2	138
1984	0	4	1	7	17	16	18	23	13	11	1	0	111
1985	1	3	3	12	13	17	22	24	12	6	10	0	123
1986	0	0	2	17	16	18	16	18	9	8	5	5	114
1987	1	4	5	7	6	17	20	18	10	3	6	0	97
1988	1	2	1	9	13	16	19	20	9	8	4	0	102
1989	3	0	6	7	16	14	18	15	14	12	3	0	108
1990	2	4	6	10	19	17	21	15	21	7	5	0	127
Average	2	2	4	11	15	17	20	20	13	9	5	1	119

Source: Department of Meteorology and Hydrology, MAF

MONTHLY RAIN DAYS IN XIENG KHOUANG
(XIENG KHOUANG PROVINCE) (Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1982	2	1	7	18	17	24	22	24	22	7	8	0	152
1983	6	4	3	9	15	14	15	23	12	11	3	2	117
1984	0	3	3	15	16	21	20	22	16	10	3	0	129
1985	2	3	4	15	18	22	26	25	14	9	8	0	146
1986	0	1	1	18	26	23	20	17	13	6	1	5	131
1987	0	7	7	10	17	15	22	19	13	12	5	0	127
1988	0	2	1	13	18	17	20	19	12	12	2	0	116
1989	4	0	9	10	16	23	20	23	14	13	-	-	-
Average	2	3	4	14	18	20	21	22	15	10	4	1	132

Source: Department of Meteorology and Hydrology, MAF

Table MA-8 Daily Maximum Rainfall

(Unit: mm)

Year	Oudomxay	Luang Prabang	Pakbeng	Luang Namtha	Muang Khoa	Xieng Khuang
1980	(69.0)	80.2	70.0	64.5	-	-
1981	(160.8)	180.7	-	-	-	-
1982	(40.0)	48.5	-	-	-	82.9
1983	(93.6)	107.1	-	-	-	73.1
1984	(62.0)	72.6	-	-	-	70.5
1985	(57.6)	67.8	-	-	-	58.5
1986	(131.3)	148.4	-	-	-	97.1
1987	(54.7)	64.6	-	-	-	55.5
1988	(108.8)	123.8	-	70.3	101.5	89.2
1989	(83.4)	96.0	66.9	-	137.1	93.9
1990	(147.4)	166.0	-	-	64.5	-
1991	90.5	-	70.8	-	77.3	-
1992	99.0	-	-	-	-	-

Note: Data which is shown in ( ) are calculated by regression line using data of Luang Prabang.

Table MA-9 Catchment Area of the Rivers

No.	Name of river	District	Catchment area (km2)	Remarks
(1) Beng River System				
1.1	Nam Beng	Xai, Beng	2,140	total area
		Hun, Pakbeng	595	at the confluence with Nam Phao
1.2	Nam Met	Beng	74	total area
1.3	Nam Phao	Beng, Xai	286	total area
1.4	Nam Lo	Beng	40	total area
1.5	Nam Hao	Beng	72	total area
1.6	Nam Heng (1)	Beng	61	
1.7	Houay Kao	Hun	29	
1.8	Nam Kham	Hun	127	total area
			55	at Ban Nakham
1.9	Nam Ngat	Hun	52	total area
1.10	Nam Oun	Hun	89	total area
1.11	Houay Kao	Hun	29	total area
1.12	Houay Sat	Hun	14	total area
1.13	Houay Leng	Hun	45	total area
1.14	Houay Kho	Hun	51	total area
1.15	Nam Heng (2)	Hun	94	total area
(2) Ko River System				
2.1	Nam Ko	Xai, La	980	total area
			600	at bridge in Xai town
2.2	Nam Mao	Xai	218	total area
			200	at Ban Houaykhoum
2.3	Nam Hin	Xai	144	total area
			133	at existing weir site
2.4	Nam Kat	Xai	66	

Table MA-10 Discharge Measurement Record

Site No.	Name of river	Catchment area (km2)	Discharge (m3/sec)	Specific run-off (l/s/km2)	Measured date (d/m/y)	Location
Xai District						
X1	Nam Sao	25	0.037	1.5	27/03/92	Ban Thiao
X2	Nam Mao	164	0.347	2.1	27/03/92	Ban Thiao
X3 *	Nam Mao	200	0.345	1.7	27/03/92	Ban Houaykhoum
		200	0.966	4.8	27/05/92	
		200	1.677	8.4	28/08/92	
		200	0.854	4.3	18/11/92	
		200	0.570	2.9	14/12/92	
X4 *	Nam Ko	600	0.823	1.4	27/03/92	Center of Xai town
		600	2.053	3.4	27/05/92	
		600	1.999	3.3	18/11/92	
		600	1.574	2.6	14/12/92	
X5	Nam Hin	144	0.145	1.0	27/03/92	Confluence with Nam Ko
X6	Nam Mao	218	0.344	1.6	27/03/92	Confluence with Nam Ko
X7	Nam Hin	133	0.164	1.2	30/03/92	Existing weir site
X8	Houay Phuk		0.009		18/11/92	
Beng District						
B1	Nam Hao	72	0.139	1.9	01/04/92	
		72	0.367	5.1	16/11/92	
B2 **	Nam Beng	595	0.900	1.5	01/04/92	Ban Gno
		595	1.007	1.7	26/05/92	
		595	1.450	2.4	16/11/92	
B3	Nam Phao	286	0.160	0.6	01/04/92	
B4	Nam Lo	40	0.096	2.4	01/04/92	Ban Soplo
B5	Nam Met	74	0.385	5.2	01/04/92	Ban Namet
Hun District						
H1	Nam Beng	960	0.958	1.0	31/03/92	Ban Donkham
H2	Nam Ngat	52	0.037	0.7	31/03/92	Ban Mai
H9	Nam Ngat	47	0.080	1.7	17/11/92	Ban Somxai
H3	Canal	-	0.043	-	31/03/92	Intake from Nam Kham
H4	Nam Kham	55	0.055	1.0	31/03/92	Ban Nakham-nua
		55	0.154	2.8	17/11/92	
H5	Nam Heng	84	0.261	3.1	09/04/92	Ban Navan
H6	Nam Beng	1480	1.037	0.7	09/04/92	Ban Navan
H7	Nam Oun	89	0.069	0.8	09/04/92	Ban Fen
H8 *	Nam Kham	55	0.030	0.5	10/04/92	Ban Nakham-tai
		55	0.021	0.4	26/05/92	

Note: * Staff gage has been installed by JICA team.
** Water-level recorder has been installed by JICA team.

Table MA-11 Water Level and Discharge of the Nam Mao

WATER LEVEL

Station: Nam Mao (X3)
Year: 1992 (Unit: m)

Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1					0.005	0.035	0.500	0.220	0.620	0.485		
2					0.000	0.030	0.350	0.445	0.575	0.480		
3						0.000	0.300	0.250	0.525	0.445		
4					0.002	0.000	0.300	0.300	0.515	0.445		
5					0.010	0.000	0.250	0.300	0.520	0.435		
6					0.015	0.000	0.200	0.650	0.475	0.430		
7					0.005	0.000	0.205	0.645	0.475	0.430		
8					0.000	0.000	0.250	0.580	0.465	0.425		
9					0.000	0.000	0.300	0.575	0.640	0.405		
10						0.000	0.450	0.550	0.515	0.390		
11						0.000	0.500	0.545	0.480	0.385		
12					0.022	0.035	0.505	0.540	0.465	0.375		
13					0.002	0.045	0.600	0.500	0.540	0.355		
14						0.055	0.500	0.400	0.470	0.365		
15					0.105	0.050	0.490	3.005	0.685	0.380		
16					0.000	0.050	0.400	0.885	0.485	0.405		
17				0.035		0.050	0.370	0.715	0.760	0.435		
18				0.050	0.025	0.045	0.350	0.675	0.950	0.460		
19				0.060	0.000	0.035	0.320	0.640	0.725	0.340		
20				0.022	0.000	0.030	0.300	0.585	0.535	0.340		
21				0.000	0.000	0.047	0.350	0.605	0.660	0.335		
22				0.000	0.000	0.045	0.200	0.680	0.540	0.330		
23				0.000	0.000	0.040	0.400	0.620	0.490	0.315		
24				0.000		0.030	0.250	0.590	0.470	0.315		
25				0.000	0.242	0.025	0.240	0.655	0.480			
26						0.024	0.270	0.600	0.445			
27				0.000	0.170	0.020	0.415	0.435	0.425	0.310		
28				0.000	0.335	0.025	0.310	0.370	0.395	0.305		
29				0.000	0.250	0.020	0.245	0.355	0.385			
30				0.180	0.180	0.390	0.405	0.350	0.395			
31					0.110		0.245	0.335		0.305		
Avg	ERR	ERR	ERR	0.027	0.062	0.038	0.347	0.600	0.537	0.386	ERR	ERR
Max	ERR	ERR	ERR	0.180	0.335	0.390	0.600	3.005	0.950	0.485	ERR	ERR

River Discharge

Station: Nam Mao (X3)
Year: 1992 (Unit: m3/s)

Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1					0.281	0.350	2.387	0.943	3.208	2.293		
2					0.270	0.338	1.531	2.051	2.886	2.262		
3						0.270	1.288	1.066	2.548	2.051		
4					0.275	0.270	1.288	1.288	2.483	2.051		
5					0.292	0.270	1.066	1.288	2.515	1.993		
6					0.303	0.270	0.865	3.432	2.231	1.964		
7					0.281	0.270	0.884	3.394	2.231	1.964		
8					0.270	0.270	1.066	2.921	2.170	1.936		
9					0.270	0.270	1.288	2.886	3.356	1.823		
10						0.270	2.081	2.714	2.483	1.741		
11						0.270	2.387	2.681	2.262	1.714		
12					0.319	0.350	2.419	2.647	2.170	1.661		
13					0.275	0.375	3.063	2.387	2.647	1.557		
14						0.400	2.387	1.796	2.201	1.608		
15					0.541	0.388	2.324	44.626	3.703	1.687		
16					0.270	0.388	1.796	5.449	2.293	1.823		
17				0.350		0.388	1.635	3.943	4.318	1.993		
18				0.388	0.326	0.375	1.531	3.624	6.089	2.140		
19				0.413	0.270	0.350	1.383	3.356	4.025	1.481		
20				0.319	0.270	0.338	1.288	2.956	2.614	1.481		
21				0.270	0.270	0.380	1.531	3.098	3.508	1.456		
22				0.270	0.270	0.375	0.865	3.663	2.647	1.432		
23				0.270	0.270	0.362	1.796	3.208	2.324	1.359		
24				0.270		0.338	1.066	2.991	2.201	1.359		
25				0.270	1.032	0.326	1.024	3.470	2.262			
26						0.324	1.152	3.063	2.051			
27				0.270	0.754	0.315	1.879	1.993	1.936	1.335		
28				0.270	1.456	0.326	1.335	1.635	1.768	1.312		
29				0.270	1.066	0.315	1.045	1.557	1.714			
30				0.790	0.790	1.741	1.823	1.531	1.768			
31					0.556		1.045	1.456		1.312		
Avg	ERR	ERR	ERR	0.340	0.458	0.376	1.565	3.971	2.687	1.733	ERR	ERR
Max	ERR	ERR	ERR	0.790	1.456	1.741	3.063	44.626	6.089	2.293	ERR	ERR

Q = (A * H + B)^2 Data: H Q
A= 2.05 0.245 0.966
B= 0.52 0.370 1.677
0.155 0.854
0.140 0.570

Table MA-12 Water Level and Discharge of the Nam Ko

WATER LEVEL

Station: Nam Ko (X4)
Year: 1992 (Unit: m)

Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1					0.000	0.050	1.100	0.250	1.300	0.565		
2					0.000	0.040	0.755	0.535	0.740	0.400		
3						0.015	0.275	0.405	0.550	0.395		
4					0.000	0.002	0.215	0.830	0.525	0.390		
5					0.015	0.000	0.200	0.550	0.500	0.370		
6					0.040	0.000	0.165	0.780	0.500	0.365		
7					0.035	0.010	0.110	0.875	0.470	0.360		
8					0.000	0.004	0.150	0.600	0.550	0.360		
9					0.000	0.000	0.280	0.500	0.440	0.355		
10						0.000	0.300	0.445	0.860	0.355		
11					0.000	0.000	0.250	0.475	0.570	0.340		
12					0.001	0.085	0.350	0.400	0.570	0.300		
13					0.900	0.055	0.370	0.380	0.560	0.250		
14						0.100	0.475	0.265	0.570	0.270		
15					0.130	0.080	1.000	4.085	0.590	0.290		
16					0.100	0.060	0.640	1.270	0.615	0.300		
17				0.060		0.040	0.370	0.855	0.620	0.350		
18				0.100	0.050	0.040	0.340	0.540	1.330	0.410		
19				0.130	0.020	0.080	0.305	0.410	1.260	0.370		
20				0.085	0.015	0.105	0.250	0.395	0.920	0.325		
21				0.040	0.010	0.100	0.210	0.385	0.835	0.300		
22				0.025	0.000	0.070	0.185	0.640	0.710	0.285		
23				0.012	0.000	0.050	0.800	0.520	0.665	0.280		
24				0.005		0.040	0.790	0.500	0.620	0.280		
25				0.010	0.500	0.040	0.755	0.750	0.580			
26						0.035	0.760	0.550	0.565			
27				0.008	0.100	0.030	1.400	0.500	0.520	0.210		
28				0.005	0.415	0.080	0.700	0.485	0.440	0.205		
29				0.010	0.395	0.255	0.535	0.480	0.420			
30				0.003	0.220	0.850	0.760	0.475	0.445			
31					0.120		0.400	0.450		0.200		
Avg	ERR	ERR	ERR	0.038	0.087	0.077	0.490	0.664	0.661	0.329	ERR	ERR
Max	ERR	ERR	ERR	0.130	0.500	0.850	1.400	4.085	1.330	0.565	ERR	ERR

RIVER DISCHARGE

Station: Nam Ko (X4)
Year: 1992 (Unit: m3/s)

Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1					1.145	1.364	10.407	2.434	13.090	4.741		
2					1.145	1.319	6.501	4.488	6.352	3.437		
3						1.209	2.589	3.474	4.614	3.401		
4					1.145	1.153	2.224	7.273	4.406	3.365		
5					1.209	1.145	2.137	4.614	4.203	3.223		
6					1.319	1.145	1.942	6.754	4.203	3.188		
7					1.296	1.187	1.653	7.756	3.965	3.153		
8					1.145	1.162	1.860	5.045	4.614	3.153		
9					1.145	1.145	2.621	4.203	3.734	3.118		
10						1.145	2.749	3.772	7.593	3.118		
11					1.145	1.145	2.434	4.004	4.784	3.015		
12					1.149	1.529	3.084	3.437	4.784	2.749		
13					1.145	1.387	3.223	3.293	4.698	2.434		
14						1.603	4.004	2.526	4.784	2.557		
15					1.755	1.505	9.181	82.385	4.957	2.684		
16					1.603	1.410	5.403	12.668	5.177	2.749		
17				1.410		1.319	3.223	7.539	5.222	3.084		
18				1.603	1.364	1.319	3.015	4.530	13.519	3.510		
19				1.755	1.230	1.505	2.782	3.510	12.529	3.223		
20				1.529	1.209	1.628	2.434	3.401	8.255	2.914		
21				1.319	1.187	1.603	2.195	3.329	7.326	2.749		
22				1.252	1.145	1.457	2.052	5.403	6.059	2.652		
23				1.196	1.145	1.364	6.959	4.365	5.633	2.621		
24				1.166		1.319	6.856	4.203	5.222	2.621		
25				1.187	4.203	1.319	6.501	6.452	4.870			
26						1.296	6.552	4.614	4.741			
27				1.179	1.603	1.274	14.547	4.203	4.365	2.195		
28				1.166	3.547	1.505	5.963	4.083	3.734	2.166		
29				1.187	3.401	2.464	4.488	4.043	3.584			
30				1.158	2.254	7.486	6.552	4.004	3.772			
31					1.704		3.437	3.810		2.137		
Avg	ERR	ERR	ERR	1.316	1.613	1.580	4.502	7.278	5.826	2.961	ERR	ERR
Max	ERR	ERR	ERR	1.755	4.203	7.486	14.547	82.385	13.519	4.741	ERR	ERR

Q = (A * H + B)^2 Data: H Q
A= 1.96 0.195 2.053
B= 1.07 0.160 1.999
0.100 1.574

Table MA-13 Water Level and Discharge of the Nam Kham

WATER LEVEL

Station: Nam Kham (H8)
Year: 1992 (Unit: m)

Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1					0.140	0.020	0.020	0.120	0.160	0.460		
2					0.130	0.020	0.000	0.120	0.170	0.460		
3					0.120	0.020	0.000	0.130	0.160	0.470		
4					0.120	0.020	0.000	0.140	0.150	0.460		
5					0.120	0.030	0.000	0.140	0.150	0.480		
6					0.120	0.030	0.000	0.130	0.150	0.430		
7					0.120	0.030	0.040	0.120	0.140	0.420		
8					0.125	0.020	0.060	0.120	0.140	0.420		
9					0.130	0.020	0.130	0.120	0.550	0.410		
10				0.120	0.130	0.020	0.120	0.140	0.900	0.420		
11					0.125	0.030	0.080	0.140	0.720	0.430		
12					0.120	0.030	0.040	0.130	0.600	0.430		
13					0.110	0.030	0.070	0.130	0.530	0.400		
14					0.110	0.030	0.550	0.125	0.600	0.410		
15					0.120	0.025	0.140	0.120	0.550	0.410		
16					0.120	0.025	0.140	0.110	0.500	0.400		
17					0.130	0.030	0.120	0.100	0.580	0.400		
18					0.120	0.030	0.120	0.130	0.570	0.390		
19					0.120	0.030	0.120	0.150	0.610	0.390		
20					0.140	0.020	0.120	0.170	0.570	0.385		
21					0.130	0.000	0.110	0.180	0.600	0.380		
22					0.130	0.000	0.110	0.200	0.610	0.380		
23					0.125	0.000	0.120	0.190	0.560	0.380		
24					0.125	0.000	0.130	0.300	0.530	0.370		
25					0.130	0.000	0.130	0.250	0.510	0.360		
26					0.130	0.000	0.140	0.250	0.500	0.360		
27					0.130	0.000	0.140	0.200	0.500	0.360		
28					0.130	0.000	0.140	0.180	0.490	0.355		
29					0.200	0.000	0.130	0.180	0.480	0.350		
30					0.100	0.060	0.120	0.160	0.480	0.350		
31					0.020		0.120	0.160				
Avg	ERR	ERR	ERR	0.120	0.123	0.019	0.105	0.156	0.459	0.404	ERR	ERR
Max	ERR	ERR	ERR	0.120	0.200	0.060	0.550	0.300	0.900	0.480	ERR	ERR

Note:Irrigation has started on 31/May

RIVER DISCHARGE

Station: Nam Kham (H8)
Year: 1992 (Unit: m3/s)

Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1					0.035	0.001	0.001	0.025	0.045	0.374		
2					0.030	0.001	0.000	0.025	0.051	0.374		
3					0.025	0.001	0.000	0.030	0.045	0.391		
4					0.025	0.001	0.000	0.035	0.040	0.374		
5					0.025	0.002	0.000	0.035	0.040	0.408		
6					0.025	0.002	0.000	0.030	0.040	0.327		
7					0.025	0.002	0.003	0.025	0.035	0.312		
8					0.028	0.001	0.006	0.025	0.035	0.312		
9					0.030	0.001	0.030	0.025	0.535	0.297		
10				0.025	0.030	0.001	0.025	0.035	1.433	0.312		
11					0.028	0.002	0.011	0.035	0.917	0.327		
12					0.025	0.002	0.003	0.030	0.637	0.327		
13					0.021	0.002	0.009	0.030	0.497	0.283		
14					0.021	0.002	0.535	0.028	0.637	0.297		
15					0.025	0.001	0.035	0.025	0.535	0.297		
16					0.025	0.001	0.035	0.021	0.442	0.283		
17					0.030	0.002	0.025	0.018	0.595	0.283		
18					0.025	0.002	0.025	0.030	0.575	0.269		
19					0.025	0.002	0.025	0.040	0.658	0.269		
20					0.035	0.001	0.025	0.051	0.575	0.262		
21					0.030	0.000	0.021	0.057	0.637	0.255		
22					0.030	0.000	0.021	0.071	0.658	0.255		
23					0.028	0.000	0.025	0.064	0.555	0.255		
24					0.028	0.000	0.030	0.159	0.497	0.242		
25					0.030	0.000	0.030	0.111	0.460	0.229		
26					0.030	0.000	0.035	0.111	0.442	0.229		
27					0.030	0.000	0.035	0.071	0.442	0.229		
28					0.030	0.000	0.035	0.057	0.425	0.223		
29					0.071	0.000	0.030	0.057	0.408	0.217		
30					0.018	0.006	0.025	0.045	0.408	0.217		
31					0.001		0.025	0.045				
Avg	ERR	ERR	ERR	0.025	0.028	0.001	0.036	0.047	0.443	0.291	ERR	ERR
Max	ERR	ERR	ERR	0.025	0.071	0.006	0.535	0.159	1.433	0.408	ERR	ERR

Q = (A * H + B)^2
A= 1.33
B= 0.00

Data:

H	Q
0.120	0.030
0.120	0.021
0.295	0.154

Table MA-14 (1/2) Runoff Estimated by the Rainfall at Xai in 1992

Model 1

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days					31	28	31	30	31	30	31	31	30	31	30	31	
Rainfall at Xai (1992) (mm)		54.6	23.2	4.3	7.0	53.8	0.0	32.0	186.5	190.5	223.0	232.2	180.7	23.8	19.1	0.0	1,148.6
Discharge				(mm)	6.5	13.9	4.3	10.8	46.3	56.3	75.4	89.0	80.6	45.2	31.0	13.5	473.0
Catchment=	1 km2			(m3/s)	0.0024	0.0058	0.0016	0.0042	0.0173	0.0217	0.0281	0.0332	0.0311	0.0169	0.0120	0.0051	
	20 km2			(m3/s)	0.05	0.12	0.03	0.08	0.35	0.43	0.56	0.66	0.62	0.34	0.24	0.10	
	30 km2			(m3/s)	0.07	0.17	0.05	0.13	0.52	0.65	0.84	1.00	0.93	0.51	0.36	0.15	
	40 km2			(m3/s)	0.10	0.23	0.06	0.17	0.69	0.87	1.13	1.33	1.24	0.68	0.48	0.20	
	50 km2			(m3/s)	0.12	0.29	0.08	0.21	0.86	1.09	1.41	1.66	1.56	0.84	0.60	0.25	
	60 km2			(m3/s)	0.15	0.35	0.10	0.25	1.04	1.30	1.69	1.99	1.87	1.01	0.72	0.30	
	70 km2			(m3/s)	0.17	0.40	0.11	0.29	1.21	1.52	1.97	2.33	2.18	1.18	0.84	0.35	
	80 km2			(m3/s)	0.20	0.46	0.13	0.33	1.38	1.74	2.25	2.66	2.49	1.35	0.96	0.40	
	90 km2			(m3/s)	0.22	0.52	0.14	0.38	1.56	1.96	2.53	2.99	2.80	1.52	1.08	0.46	
	100 km2			(m3/s)	0.24	0.58	0.16	0.42	1.73	2.17	2.81	3.32	3.11	1.69	1.20	0.51	
	120 km2			(m3/s)	0.29	0.69	0.19	0.50	2.08	2.61	3.38	3.99	3.73	2.03	1.44	0.61	
	140 km2			(m3/s)	0.34	0.81	0.22	0.59	2.42	3.04	3.94	4.65	4.35	2.36	1.68	0.71	
	160 km2			(m3/s)	0.39	0.92	0.26	0.67	2.77	3.48	4.50	5.32	4.98	2.70	1.92	0.81	
	180 km2			(m3/s)	0.44	1.04	0.29	0.75	3.11	3.91	5.07	5.98	5.60	3.04	2.15	0.91	
	200 km2			(m3/s)	0.49	1.15	0.32	0.84	3.46	4.35	5.63	6.65	6.22	3.38	2.39	1.01	
	250 km2			(m3/s)	0.61	1.44	0.40	1.05	4.32	5.43	7.04	8.31	7.78	4.22	2.99	1.26	
	300 km2			(m3/s)	0.73	1.73	0.48	1.25	5.19	6.52	8.44	9.97	9.33	5.07	3.59	1.52	

Note: $Q = A0*R0 + A1*R(0-1) + A2*R(0-2) + A3*R(0-3)$

where,

A0	A1	A2	A3
0.2197	0.0667	0.0631	0.0596

This eqation is given by the rainfall data of Mae Chan and the runoff data of Nam Mae Chan at Ban Huai Yano Mai in North Thailand.

Model 2

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days					31	28	31	30	31	30	31	31	30	31	30	31	
Rainfall at Xai (1992) (mm)		54.6	23.2	4.3	7.0	53.8	0.0	32.0	186.5	190.5	223.0	232.2	180.7	23.8	19.1	0.0	1,148.6
Discharge				(mm)	2.6	3.4	5.4	2.8	11.4	25.9	32.4	39.6	39.5	29.7	13.3	6.8	212.9
Catchment=	1 km2			(m3/s)	0.0010	0.0014	0.0020	0.0011	0.0043	0.0100	0.0121	0.0148	0.0153	0.0111	0.0051	0.0025	
	20 km2			(m3/s)	0.02	0.03	0.04	0.02	0.09	0.20	0.24	0.30	0.31	0.22	0.10	0.05	
	30 km2			(m3/s)	0.03	0.04	0.06	0.03	0.13	0.30	0.36	0.44	0.46	0.33	0.15	0.08	
	40 km2			(m3/s)	0.04	0.06	0.08	0.04	0.17	0.40	0.48	0.59	0.61	0.44	0.21	0.10	
	50 km2			(m3/s)	0.05	0.07	0.10	0.05	0.21	0.50	0.60	0.74	0.76	0.55	0.26	0.13	
	60 km2			(m3/s)	0.06	0.08	0.12	0.06	0.26	0.60	0.73	0.89	0.92	0.67	0.31	0.15	
	70 km2			(m3/s)	0.07	0.10	0.14	0.08	0.30	0.70	0.85	1.04	1.07	0.78	0.36	0.18	
	80 km2			(m3/s)	0.08	0.11	0.16	0.09	0.34	0.80	0.97	1.18	1.22	0.89	0.41	0.20	
	90 km2			(m3/s)	0.09	0.13	0.18	0.10	0.38	0.90	1.09	1.33	1.37	1.00	0.46	0.23	
	100 km2			(m3/s)	0.10	0.14	0.20	0.11	0.43	1.00	1.21	1.48	1.53	1.11	0.51	0.25	
	120 km2			(m3/s)	0.12	0.17	0.24	0.13	0.51	1.20	1.45	1.78	1.83	1.33	0.62	0.30	
	140 km2			(m3/s)	0.14	0.20	0.28	0.15	0.60	1.40	1.69	2.07	2.14	1.55	0.72	0.36	
	160 km2			(m3/s)	0.16	0.22	0.33	0.17	0.68	1.60	1.93	2.37	2.44	1.77	0.82	0.41	
	180 km2			(m3/s)	0.17	0.25	0.37	0.19	0.77	1.80	2.18	2.66	2.75	2.00	0.93	0.46	
	200 km2			(m3/s)	0.19	0.28	0.41	0.22	0.85	2.00	2.42	2.96	3.05	2.22	1.03	0.51	
	250 km2			(m3/s)	0.24	0.35	0.51	0.27	1.06	2.50	3.02	3.70	3.81	2.77	1.29	0.63	
	300 km2			(m3/s)	0.29	0.42	0.61	0.32	1.28	3.00	3.63	4.44	4.58	3.33	1.54	0.76	

Note: $Q = A0*R0 + A1*R(0-1) + A2*R(0-2) + A3*R(0-3)$

where,

A0	A1	A2	A3
0.0378	0.0958	0.0264	0.024

This eqation is given by the rainfall data of Luang Prabang and the runoff data of Nam Pa at Ban Kok Van in Lao PDR.

Table MA-14 (2/2) Runoff Estimated by the Rainfall at Xai in 1992

Model 3 (Mean of Model1 and Model 2)

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days					31	28	31	30	31	30	31	31	30	31	30	31	
Rainfall at Xai (1992) (mm)		54.6	23.2	4.3	7.0	53.8	0.0	32.0	186.5	190.5	223.0	232.2	180.7	23.8	19.1	0.0	1,148.6
Discharge				(mm)	4.6	8.7	4.9	6.8	28.9	41.1	53.9	64.3	60.1	37.5	22.2	10.2	343.0
Catchment=	1 km2			(m3/s)	0.0017	0.0036	0.0018	0.0026	0.0108	0.0159	0.0201	0.0240	0.0232	0.0140	0.0086	0.0038	
	20 km2			(m3/s)	0.03	0.07	0.04	0.05	0.22	0.32	0.40	0.48	0.46	0.28	0.17	0.08	
	30 km2			(m3/s)	0.05	0.11	0.05	0.08	0.32	0.48	0.60	0.72	0.70	0.42	0.26	0.11	
	40 km2			(m3/s)	0.07	0.14	0.07	0.11	0.43	0.63	0.80	0.96	0.93	0.56	0.34	0.15	
	50 km2			(m3/s)	0.09	0.18	0.09	0.13	0.54	0.79	1.01	1.20	1.16	0.70	0.43	0.19	
	60 km2			(m3/s)	0.10	0.21	0.11	0.16	0.65	0.95	1.21	1.44	1.39	0.84	0.51	0.23	
	70 km2			(m3/s)	0.12	0.25	0.13	0.18	0.75	1.11	1.41	1.68	1.62	0.98	0.60	0.27	
	80 km2			(m3/s)	0.14	0.29	0.15	0.21	0.86	1.27	1.61	1.92	1.85	1.12	0.68	0.30	
	90 km2			(m3/s)	0.15	0.32	0.16	0.24	0.97	1.43	1.81	2.16	2.09	1.26	0.77	0.34	
	100 km2			(m3/s)	0.17	0.36	0.18	0.26	1.08	1.59	2.01	2.40	2.32	1.40	0.86	0.38	
	120 km2			(m3/s)	0.20	0.43	0.22	0.32	1.29	1.90	2.41	2.88	2.78	1.68	1.03	0.46	
	140 km2			(m3/s)	0.24	0.50	0.25	0.37	1.51	2.22	2.82	3.36	3.24	1.96	1.20	0.53	
	160 km2			(m3/s)	0.27	0.57	0.29	0.42	1.72	2.54	3.22	3.84	3.71	2.24	1.37	0.61	
	180 km2			(m3/s)	0.31	0.64	0.33	0.47	1.94	2.86	3.62	4.32	4.17	2.52	1.54	0.68	
	200 km2			(m3/s)	0.34	0.72	0.36	0.53	2.16	3.17	4.02	4.80	4.64	2.80	1.71	0.76	
	250 km2			(m3/s)	0.43	0.89	0.45	0.66	2.69	3.97	5.03	6.00	5.79	3.50	2.14	0.95	
	300 km2			(m3/s)	0.51	1.07	0.54	0.79	3.23	4.76	6.03	7.21	6.95	4.20	2.57	1.14	

Model 4 (Model 2 x 1/2)

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days					31	28	31	30	31	30	31	31	30	31	30	31	
Rainfall at Xai (1992) (mm)		54.6	23.2	4.3	7.0	53.8	0.0	32.0	186.5	190.5	223.0	232.2	180.7	23.8	19.1	0.0	1,148.6
Discharge				(mm)	1.3	1.7	2.7	1.4	5.7	13.0	16.2	19.8	19.8	14.8	6.7	3.4	106.5
Catchment=	1 km2			(m3/s)	0.0005	0.0007	0.0010	0.0005	0.0021	0.0050	0.0060	0.0074	0.0076	0.0055	0.0026	0.0013	
	20 km2			(m3/s)	0.01	0.01	0.02	0.01	0.04	0.10	0.12	0.15	0.15	0.11	0.05	0.03	
	30 km2			(m3/s)	0.01	0.02	0.03	0.02	0.06	0.15	0.18	0.22	0.23	0.17	0.08	0.04	
	40 km2			(m3/s)	0.02	0.03	0.04	0.02	0.09	0.20	0.24	0.30	0.31	0.22	0.10	0.05	
	50 km2			(m3/s)	0.02	0.03	0.05	0.03	0.11	0.25	0.30	0.37	0.38	0.28	0.13	0.06	
	60 km2			(m3/s)	0.03	0.04	0.06	0.03	0.13	0.30	0.36	0.44	0.46	0.33	0.15	0.08	
	70 km2			(m3/s)	0.03	0.05	0.07	0.04	0.15	0.35	0.42	0.52	0.53	0.39	0.18	0.09	
	80 km2			(m3/s)	0.04	0.06	0.08	0.04	0.17	0.40	0.48	0.59	0.61	0.44	0.21	0.10	
	90 km2			(m3/s)	0.04	0.06	0.09	0.05	0.19	0.45	0.54	0.67	0.69	0.50	0.23	0.11	
	100 km2			(m3/s)	0.05	0.07	0.10	0.05	0.21	0.50	0.60	0.74	0.76	0.55	0.26	0.13	
	120 km2			(m3/s)	0.06	0.08	0.12	0.06	0.26	0.60	0.73	0.89	0.92	0.67	0.31	0.15	
	140 km2			(m3/s)	0.07	0.10	0.14	0.08	0.30	0.70	0.85	1.04	1.07	0.78	0.36	0.18	
	160 km2			(m3/s)	0.08	0.11	0.16	0.09	0.34	0.80	0.97	1.18	1.22	0.89	0.41	0.20	
	180 km2			(m3/s)	0.09	0.13	0.18	0.10	0.38	0.90	1.09	1.33	1.37	1.00	0.46	0.23	
	200 km2			(m3/s)	0.10	0.14	0.20	0.11	0.43	1.00	1.21	1.48	1.53	1.11	0.51	0.25	
	250 km2			(m3/s)	0.12	0.17	0.25	0.13	0.53	1.25	1.51	1.85	1.91	1.39	0.64	0.32	
	300 km2			(m3/s)	0.15	0.21	0.30	0.16	0.64	1.50	1.81	2.22	2.29	1.66	0.77	0.38	

Table MA-15 (1/2) Runoff Estimated by the Rainfall at Hun in 1992

Model 1

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days					31	28	31	30	31	30	31	31	30	31	30	31	
Rainfall at Hun (1992) (mm)		54.6	23.2	4.3	7.0	53.8	0.0	45.5	106.5	64.0	197.0	205.5	197.0	41.0	0.0	0.0	917.3
Discharge				(mm)	6.5	13.9	4.3	13.8	29.6	24.0	57.0	68.7	73.2	46.9	27.4	14.3	379.7
Catchment=	1 km2			(m3/s)	0.0024	0.0058	0.0016	0.0053	0.0111	0.0093	0.0213	0.0256	0.0283	0.0175	0.0106	0.0053	
	20 km2			(m3/s)	0.05	0.12	0.03	0.11	0.22	0.19	0.43	0.51	0.57	0.35	0.21	0.11	
	30 km2			(m3/s)	0.07	0.17	0.05	0.16	0.33	0.28	0.64	0.77	0.85	0.52	0.32	0.16	
	40 km2			(m3/s)	0.10	0.23	0.06	0.21	0.44	0.37	0.85	1.03	1.13	0.70	0.42	0.21	
	50 km2			(m3/s)	0.12	0.29	0.08	0.27	0.55	0.46	1.06	1.28	1.41	0.87	0.53	0.27	
	60 km2			(m3/s)	0.15	0.35	0.10	0.32	0.66	0.56	1.28	1.54	1.70	1.05	0.63	0.32	
	70 km2			(m3/s)	0.17	0.40	0.11	0.37	0.77	0.65	1.49	1.79	1.98	1.22	0.74	0.37	
	80 km2			(m3/s)	0.20	0.46	0.13	0.43	0.89	0.74	1.70	2.05	2.26	1.40	0.85	0.43	
	90 km2			(m3/s)	0.22	0.52	0.14	0.48	1.00	0.83	1.91	2.31	2.54	1.57	0.95	0.48	
	100 km2			(m3/s)	0.24	0.58	0.16	0.53	1.11	0.93	2.13	2.56	2.83	1.75	1.06	0.53	
	120 km2			(m3/s)	0.29	0.69	0.19	0.64	1.33	1.11	2.55	3.08	3.39	2.10	1.27	0.64	
	140 km2			(m3/s)	0.34	0.81	0.22	0.75	1.55	1.30	2.98	3.59	3.96	2.45	1.48	0.75	
	160 km2			(m3/s)	0.39	0.92	0.26	0.85	1.77	1.48	3.40	4.10	4.52	2.80	1.69	0.86	
	180 km2			(m3/s)	0.44	1.04	0.29	0.96	1.99	1.67	3.83	4.62	5.09	3.15	1.90	0.96	
	200 km2			(m3/s)	0.49	1.15	0.32	1.07	2.21	1.85	4.25	5.13	5.65	3.50	2.12	1.07	
	250 km2			(m3/s)	0.61	1.44	0.40	1.33	2.77	2.32	5.32	6.41	7.06	4.37	2.64	1.34	
	300 km2			(m3/s)	0.73	1.73	0.48	1.60	3.32	2.78	6.38	7.69	8.48	5.25	3.17	1.60	

Note: $Q = A0*R0 + A1*R(0-1) + A2*R(0-2) + A3*R(0-3)$

where,	A0	A1	A2	A3
	0.2197	0.0667	0.0631	0.0596

This eqation is given by the rainfall data of Mae Chan and the runoff data of Nam Mae Chan at Ban Huai Yano Mai in North Thailand.

Model 2

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days					31	28	31	30	31	30	31	31	30	31	30	31	
Rainfall at Hun (1992) (mm)		54.6	23.2	4.3	7.0	53.8	0.0	45.5	106.5	64.0	197.0	205.5	197.0	41.0	0.0	0.0	917.3
Discharge				(mm)	2.6	3.4	5.4	3.3	9.7	13.8	17.5	30.9	33.9	30.6	14.1	5.8	170.9
Catchment=	1 km2			(m3/s)	0.0010	0.0014	0.0020	0.0013	0.0036	0.0053	0.0065	0.0115	0.0131	0.0114	0.0054	0.0022	
	20 km2			(m3/s)	0.02	0.03	0.04	0.03	0.07	0.11	0.13	0.23	0.26	0.23	0.11	0.04	
	30 km2			(m3/s)	0.03	0.04	0.06	0.04	0.11	0.16	0.20	0.35	0.39	0.34	0.16	0.07	
	40 km2			(m3/s)	0.04	0.06	0.08	0.05	0.14	0.21	0.26	0.46	0.52	0.46	0.22	0.09	
	50 km2			(m3/s)	0.05	0.07	0.10	0.06	0.18	0.27	0.33	0.58	0.65	0.57	0.27	0.11	
	60 km2			(m3/s)	0.06	0.08	0.12	0.08	0.22	0.32	0.39	0.69	0.78	0.68	0.33	0.13	
	70 km2			(m3/s)	0.07	0.10	0.14	0.09	0.25	0.37	0.46	0.81	0.91	0.80	0.38	0.15	
	80 km2			(m3/s)	0.08	0.11	0.16	0.10	0.29	0.43	0.52	0.92	1.05	0.91	0.43	0.17	
	90 km2			(m3/s)	0.09	0.13	0.18	0.11	0.33	0.48	0.59	1.04	1.18	1.03	0.49	0.20	
	100 km2			(m3/s)	0.10	0.14	0.20	0.13	0.36	0.53	0.65	1.15	1.31	1.14	0.54	0.22	
	120 km2			(m3/s)	0.12	0.17	0.24	0.15	0.43	0.64	0.78	1.38	1.57	1.37	0.65	0.26	
	140 km2			(m3/s)	0.14	0.20	0.28	0.18	0.51	0.75	0.91	1.61	1.83	1.60	0.76	0.30	
	160 km2			(m3/s)	0.16	0.22	0.33	0.20	0.58	0.85	1.04	1.85	2.09	1.83	0.87	0.35	
	180 km2			(m3/s)	0.17	0.25	0.37	0.23	0.65	0.96	1.17	2.08	2.35	2.05	0.98	0.39	
	200 km2			(m3/s)	0.19	0.28	0.41	0.26	0.72	1.07	1.31	2.31	2.61	2.28	1.08	0.43	
	250 km2			(m3/s)	0.24	0.35	0.51	0.32	0.90	1.33	1.63	2.88	3.27	2.85	1.36	0.54	
	300 km2			(m3/s)	0.29	0.42	0.61	0.38	1.08	1.60	1.96	3.46	3.92	3.42	1.63	0.65	

Note: $Q = A0*R0 + A1*R(0-1) + A2*R(0-2) + A3*R(0-3)$

where,	A0	A1	A2	A3
	0.0378	0.0958	0.0264	0.024

This eqation is given by the rainfall data of Luang Prabang and the runoff data of Nam Pa at Ban Kok Van in Lao PDR.

Table MA-15 (2/2) Runoff Estimated by the Rainfall at Hun in 1992

Model 3 (Mean of Model1 and Model 2)

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days					31	28	31	30	31	30	31	31	30	31	30	31	
Rainfall at Hun (1992) (mm)		54.6	23.2	4.3	7.0	53.8	0.0	45.5	106.5	64.0	197.0	205.5	197.0	41.0	0.0	0.0	917.3
Discharge				(mm)	4.6	8.7	4.9	8.6	19.7	18.9	37.2	49.8	53.6	38.7	20.7	10.1	275.3
Catchment=	1 km2			(m3/s)	0.0017	0.0036	0.0018	0.0033	0.0073	0.0073	0.0139	0.0186	0.0207	0.0145	0.0080	0.0038	
	20 km2			(m3/s)	0.03	0.07	0.04	0.07	0.15	0.15	0.28	0.37	0.41	0.29	0.16	0.08	
	30 km2			(m3/s)	0.05	0.11	0.05	0.10	0.22	0.22	0.42	0.56	0.62	0.43	0.24	0.11	
	40 km2			(m3/s)	0.07	0.14	0.07	0.13	0.29	0.29	0.56	0.74	0.83	0.58	0.32	0.15	
	50 km2			(m3/s)	0.09	0.18	0.09	0.17	0.37	0.37	0.70	0.93	1.03	0.72	0.40	0.19	
	60 km2			(m3/s)	0.10	0.21	0.11	0.20	0.44	0.44	0.83	1.12	1.24	0.87	0.48	0.23	
	70 km2			(m3/s)	0.12	0.25	0.13	0.23	0.51	0.51	0.97	1.30	1.45	1.01	0.56	0.26	
	80 km2			(m3/s)	0.14	0.29	0.15	0.26	0.59	0.58	1.11	1.49	1.65	1.16	0.64	0.30	
	90 km2			(m3/s)	0.15	0.32	0.16	0.30	0.66	0.66	1.25	1.67	1.86	1.30	0.72	0.34	
	100 km2			(m3/s)	0.17	0.36	0.18	0.33	0.73	0.73	1.39	1.86	2.07	1.45	0.80	0.38	
	120 km2			(m3/s)	0.20	0.43	0.22	0.40	0.88	0.88	1.67	2.23	2.48	1.73	0.96	0.45	
	140 km2			(m3/s)	0.24	0.50	0.25	0.46	1.03	1.02	1.95	2.60	2.89	2.02	1.12	0.53	
	160 km2			(m3/s)	0.27	0.57	0.29	0.53	1.17	1.17	2.22	2.97	3.31	2.31	1.28	0.60	
	180 km2			(m3/s)	0.31	0.64	0.33	0.59	1.32	1.31	2.50	3.35	3.72	2.60	1.44	0.68	
	200 km2			(m3/s)	0.34	0.72	0.36	0.66	1.47	1.46	2.78	3.72	4.13	2.89	1.60	0.75	
	250 km2			(m3/s)	0.43	0.89	0.45	0.83	1.83	1.83	3.48	4.65	5.17	3.61	2.00	0.94	
	300 km2			(m3/s)	0.51	1.07	0.54	0.99	2.20	2.19	4.17	5.58	6.20	4.34	2.40	1.13	

Model 4 (Model 2 x 1/2)

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days					31	28	31	30	31	30	31	31	30	31	30	31	
Rainfall at Hun (1992) (mm)		54.6	23.2	4.3	7.0	53.8	0.0	45.5	106.5	64.0	197.0	205.5	197.0	41.0	0.0	0.0	917.3
Discharge				(mm)	1.3	1.7	2.7	1.7	4.8	6.9	8.7	15.4	16.9	15.3	7.0	2.9	85.5
Catchment=	1 km2			(m3/s)	0.0005	0.0007	0.0010	0.0006	0.0018	0.0027	0.0033	0.0058	0.0065	0.0057	0.0027	0.0011	
	20 km2			(m3/s)	0.01	0.01	0.02	0.01	0.04	0.05	0.07	0.12	0.13	0.11	0.05	0.02	
	30 km2			(m3/s)	0.01	0.02	0.03	0.02	0.05	0.08	0.10	0.17	0.20	0.17	0.08	0.03	
	40 km2			(m3/s)	0.02	0.03	0.04	0.03	0.07	0.11	0.13	0.23	0.26	0.23	0.11	0.04	
	50 km2			(m3/s)	0.02	0.03	0.05	0.03	0.09	0.13	0.16	0.29	0.33	0.29	0.14	0.05	
	60 km2			(m3/s)	0.03	0.04	0.06	0.04	0.11	0.16	0.20	0.35	0.39	0.34	0.16	0.07	
	70 km2			(m3/s)	0.03	0.05	0.07	0.04	0.13	0.19	0.23	0.40	0.46	0.40	0.19	0.08	
	80 km2			(m3/s)	0.04	0.06	0.08	0.05	0.14	0.21	0.26	0.46	0.52	0.46	0.22	0.09	
	90 km2			(m3/s)	0.04	0.06	0.09	0.06	0.16	0.24	0.29	0.52	0.59	0.51	0.24	0.10	
	100 km2			(m3/s)	0.05	0.07	0.10	0.06	0.18	0.27	0.33	0.58	0.65	0.57	0.27	0.11	
	120 km2			(m3/s)	0.06	0.08	0.12	0.08	0.22	0.32	0.39	0.69	0.78	0.68	0.33	0.13	
	140 km2			(m3/s)	0.07	0.10	0.14	0.09	0.25	0.37	0.46	0.81	0.91	0.80	0.38	0.15	
	160 km2			(m3/s)	0.08	0.11	0.16	0.10	0.29	0.43	0.52	0.92	1.05	0.91	0.43	0.17	
	180 km2			(m3/s)	0.09	0.13	0.18	0.11	0.33	0.48	0.59	1.04	1.18	1.03	0.49	0.20	
	200 km2			(m3/s)	0.10	0.14	0.20	0.13	0.36	0.53	0.65	1.15	1.31	1.14	0.54	0.22	
	250 km2			(m3/s)	0.12	0.17	0.25	0.16	0.45	0.67	0.82	1.44	1.63	1.43	0.68	0.27	
	300 km2			(m3/s)	0.15	0.21	0.30	0.19	0.54	0.80	0.98	1.73	1.96	1.71	0.81	0.33	

Table MA-16 (1/2) Estimated Runoff

Category 1

Model 3 (Mean of Model1 and Model 2)

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days				31	28	31	30	31	30	31	31	30	31	30	31	
Probable rainfall (mm)	77.7	32.0	3.9	6.8	19.0	24.0	86.1	129.3	149.8	189.0	202.1	92.2	77.7	32.0	3.9	1,011.9
Discharge			(mm)	5.9	4.5	5.1	14.2	25.5	34.6	45.9	53.5	43.0	34.4	23.0	10.4	300.1
Catchment= 1 km2			(m3/s)	0.0022	0.0019	0.0019	0.0055	0.0095	0.0134	0.0171	0.0200	0.0166	0.0129	0.0089	0.0039	
20 km2			(m3/s)	0.04	0.04	0.04	0.11	0.19	0.27	0.34	0.40	0.33	0.26	0.18	0.08	
30 km2			(m3/s)	0.07	0.06	0.06	0.16	0.29	0.40	0.51	0.60	0.50	0.39	0.27	0.12	
40 km2			(m3/s)	0.09	0.07	0.08	0.22	0.38	0.53	0.69	0.80	0.66	0.51	0.36	0.16	
50 km2			(m3/s)	0.11	0.09	0.10	0.27	0.48	0.67	0.86	1.00	0.83	0.64	0.44	0.19	
60 km2			(m3/s)	0.13	0.11	0.11	0.33	0.57	0.80	1.03	1.20	1.00	0.77	0.53	0.23	
70 km2			(m3/s)	0.15	0.13	0.13	0.38	0.67	0.94	1.20	1.40	1.16	0.90	0.62	0.27	
80 km2			(m3/s)	0.18	0.15	0.15	0.44	0.76	1.07	1.37	1.60	1.33	1.03	0.71	0.31	
90 km2			(m3/s)	0.20	0.17	0.17	0.49	0.86	1.20	1.54	1.80	1.49	1.16	0.80	0.35	
100 km2			(m3/s)	0.22	0.19	0.19	0.55	0.95	1.34	1.71	2.00	1.66	1.29	0.89	0.39	
120 km2			(m3/s)	0.26	0.22	0.23	0.66	1.14	1.60	2.06	2.40	1.99	1.54	1.07	0.47	
140 km2			(m3/s)	0.31	0.26	0.27	0.77	1.33	1.87	2.40	2.80	2.32	1.80	1.24	0.55	
160 km2			(m3/s)	0.35	0.30	0.30	0.87	1.52	2.14	2.74	3.20	2.65	2.06	1.42	0.62	
180 km2			(m3/s)	0.39	0.34	0.34	0.98	1.71	2.41	3.08	3.59	2.99	2.31	1.60	0.70	
200 km2			(m3/s)	0.44	0.37	0.38	1.09	1.90	2.67	3.43	3.99	3.32	2.57	1.78	0.78	
250 km2			(m3/s)	0.55	0.47	0.48	1.37	2.38	3.34	4.28	4.99	4.15	3.21	2.22	0.97	
300 km2			(m3/s)	0.66	0.56	0.57	1.64	2.86	4.01	5.14	5.99	4.98	3.86	2.66	1.17	

Category 2

Model 4 (Model 2 x 1/2)

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days				31	28	31	30	31	30	31	31	30	31	30	31	
Probable rainfall (mm)	77.7	32.0	3.9	6.8	19.0	24.0	86.1	129.3	149.8	189.0	202.1	92.2	77.7	32.0	3.9	1,011.9
Discharge			(mm)	1.7	1.1	1.5	3.1	7.1	10.4	13.5	16.4	15.7	10.8	8.0	3.7	93.1
Catchment= 1 km2			(m3/s)	0.0006	0.0005	0.0006	0.0012	0.0027	0.0040	0.0050	0.0061	0.0061	0.0040	0.0031	0.0014	
20 km2			(m3/s)	0.01	0.01	0.01	0.02	0.05	0.08	0.10	0.12	0.12	0.08	0.06	0.03	
30 km2			(m3/s)	0.02	0.01	0.02	0.04	0.08	0.12	0.15	0.18	0.18	0.12	0.09	0.04	
40 km2			(m3/s)	0.02	0.02	0.02	0.05	0.11	0.16	0.20	0.24	0.24	0.16	0.12	0.06	
50 km2			(m3/s)	0.03	0.02	0.03	0.06	0.13	0.20	0.25	0.31	0.30	0.20	0.15	0.07	
60 km2			(m3/s)	0.04	0.03	0.03	0.07	0.16	0.24	0.30	0.37	0.36	0.24	0.18	0.08	
70 km2			(m3/s)	0.04	0.03	0.04	0.08	0.19	0.28	0.35	0.43	0.42	0.28	0.22	0.10	
80 km2			(m3/s)	0.05	0.04	0.04	0.10	0.21	0.32	0.40	0.49	0.49	0.32	0.25	0.11	
90 km2			(m3/s)	0.06	0.04	0.05	0.11	0.24	0.36	0.45	0.55	0.55	0.36	0.28	0.13	
100 km2			(m3/s)	0.06	0.05	0.06	0.12	0.27	0.40	0.50	0.61	0.61	0.40	0.31	0.14	
120 km2			(m3/s)	0.07	0.06	0.07	0.14	0.32	0.48	0.60	0.73	0.73	0.48	0.37	0.17	
140 km2			(m3/s)	0.09	0.06	0.08	0.17	0.37	0.56	0.70	0.86	0.85	0.57	0.43	0.20	
160 km2			(m3/s)	0.10	0.07	0.09	0.19	0.42	0.65	0.81	0.98	0.97	0.65	0.49	0.22	
180 km2			(m3/s)	0.11	0.08	0.10	0.22	0.48	0.73	0.91	1.10	1.09	0.73	0.55	0.25	
200 km2			(m3/s)	0.12	0.09	0.11	0.24	0.53	0.81	1.01	1.22	1.21	0.81	0.61	0.28	
250 km2			(m3/s)	0.16	0.12	0.14	0.30	0.66	1.01	1.26	1.53	1.52	1.01	0.77	0.35	
300 km2			(m3/s)	0.19	0.14	0.17	0.36	0.80	1.21	1.51	1.84	1.82	1.21	0.92	0.42	

Table MA-16 (2/2) Estimated Runoff

Category 3

Model 2

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Days				31	28	31	30	31	30	31	31	30	31	30	31	
Probable rainfall (mm)	77.7	32.0	3.9	6.8	19.0	24.0	86.1	129.3	149.8	189.0	202.1	92.2	77.7	32.0	3.9	1,011.9
Discharge			(mm)	3.3	2.2	3.0	6.2	14.2	20.9	27.0	32.8	31.4	21.6	15.9	7.5	186.2
Catchment= 1 km2			(m3/s)	0.0012	0.0009	0.0011	0.0024	0.0053	0.0081	0.0101	0.0122	0.0121	0.0081	0.0061	0.0028	
20 km2			(m3/s)	0.02	0.02	0.02	0.05	0.11	0.16	0.20	0.24	0.24	0.16	0.12	0.06	
30 km2			(m3/s)	0.04	0.03	0.03	0.07	0.16	0.24	0.30	0.37	0.36	0.24	0.18	0.08	
40 km2			(m3/s)	0.05	0.04	0.04	0.10	0.21	0.32	0.40	0.49	0.49	0.32	0.25	0.11	
50 km2			(m3/s)	0.06	0.05	0.06	0.12	0.27	0.40	0.50	0.61	0.61	0.40	0.31	0.14	
60 km2			(m3/s)	0.07	0.06	0.07	0.14	0.32	0.48	0.60	0.73	0.73	0.48	0.37	0.17	
70 km2			(m3/s)	0.09	0.06	0.08	0.17	0.37	0.56	0.70	0.86	0.85	0.57	0.43	0.20	
80 km2			(m3/s)	0.10	0.07	0.09	0.19	0.42	0.65	0.81	0.98	0.97	0.65	0.49	0.22	
90 km2			(m3/s)	0.11	0.08	0.10	0.22	0.48	0.73	0.91	1.10	1.09	0.73	0.55	0.25	
100 km2			(m3/s)	0.12	0.09	0.11	0.24	0.53	0.81	1.01	1.22	1.21	0.81	0.61	0.28	
120 km2			(m3/s)	0.15	0.11	0.13	0.29	0.64	0.97	1.21	1.47	1.46	0.97	0.74	0.33	
140 km2			(m3/s)	0.17	0.13	0.16	0.34	0.74	1.13	1.41	1.71	1.70	1.13	0.86	0.39	
160 km2			(m3/s)	0.20	0.15	0.18	0.38	0.85	1.29	1.61	1.96	1.94	1.29	0.98	0.45	
180 km2			(m3/s)	0.22	0.17	0.20	0.43	0.96	1.45	1.81	2.20	2.18	1.45	1.11	0.50	
200 km2			(m3/s)	0.25	0.19	0.22	0.48	1.06	1.61	2.01	2.45	2.43	1.62	1.23	0.56	
250 km2			(m3/s)	0.31	0.23	0.28	0.60	1.33	2.02	2.52	3.06	3.03	2.02	1.54	0.70	
300 km2			(m3/s)	0.37	0.28	0.34	0.72	1.59	2.42	3.02	3.67	3.64	2.42	1.84	0.84	

Note: $Q = A0*R0 + A1*R(0-1) + A2*R(0-2) + A3*R(0-3)$

where,

A0	A1	A2	A3
0.0378	0.0958	0.0264	0.024

This eqation is given by the rainfall data of Luang Prabang and the runoff data of Nam Pa at Ban Kok Van in Lao PDR.

Table MA-17 Unit Irrigable Area (Rice - Rice)

Watershed Category		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Diversion water requirement		I---------- Dry season rice					----------II---------- Wet season rice					----------I	
Dry season rice	(l/s/ha)	0.77	1.37	1.42	1.21	0.48	0.00						
Wet season rice	(l/s/ha)						0.00	0.33	0.36	0.89	0.68	0.28	
Unit irrigable area considering river maintenamce flow													
(1) Model of northern Thailand													
Runoff	(m3/s/km2)	0.0031	0.0028	0.0027	0.0085	0.0137	0.0187	0.0242	0.0277	0.0211	0.0176	0.0116	0.0050
Maintenamce flow	(m3/s/km2)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Balance	(m3/s/km2)	0.0021	0.0018	0.0017	0.0075	0.0127	0.0177	0.0232	0.0267	0.0201	0.0166	0.0106	0.0040
Unit irrigable area	(ha/km2)	2.7	1.3	1.2	6.2	26.5		70.3	74.2	22.6	24.4	37.9	
(2) Category 3													
Runoff	(m3/s/km2)	0.0012	0.0009	0.0011	0.0024	0.0053	0.0081	0.0101	0.0122	0.0121	0.0081	0.0061	0.0028
Maintenamce flow	(m3/s/km2)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Balance	(m3/s/km2)	0.0002	-0.0001	0.0001	0.0014	0.0043	0.0071	0.0091	0.0112	0.0111	0.0071	0.0051	0.0018
Unit irrigable area	(ha/km2)	0.3	-0.1	0.1	1.2	9.0		27.6	31.1	12.5	10.4	18.2	
(3) Category 2, (2)/2													
Runoff	(m3/s/km2)	0.0006	0.0005	0.0006	0.0012	0.0027	0.0040	0.0050	0.0061	0.0061	0.0040	0.0031	0.0014
Maintenamce flow	(m3/s/km2)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Balance	(m3/s/km2)	-0.0004	-0.0005	-0.0004	0.0002	0.0017	0.0030	0.0040	0.0051	0.0051	0.0030	0.0021	0.0004
Unit irrigable area	(ha/km2)	-0.5	-0.4	-0.3	0.2	3.5		12.1	14.2	5.7	4.4	7.5	
(4) Category 1, ((1)+(2))/2													
Runoff	(m3/s/km2)	0.0022	0.0019	0.0019	0.0055	0.0095	0.0134	0.0171	0.0200	0.0166	0.0129	0.0089	0.0039
Maintenamce flow	(m3/s/km2)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Balance	(m3/s/km2)	0.0012	0.0009	0.0009	0.0045	0.0085	0.0124	0.0161	0.0190	0.0156	0.0119	0.0079	0.0029
Unit irrigable area	(ha/km2)	1.6	0.7	0.6	3.7	17.7		48.8	52.8	17.5	17.5	28.2	

Table MA-18 Unit Irrigable Area (Rice - Onion)

Watershed Category		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Diversion water requirement		---- Dry season onion -----I					I---------- Wet season rice				----------I I---------		
Dry season onion	(l/s/ha)	0.48	0.76	0.36									0.31
Wet season rice	(l/s/ha)						0.00	0.33	0.36	0.89	0.68	0.28	
Irrigable area considering river maintenamce flow													
(1) Model of northern Thailand													
Runoff	(m3/s/km2)	0.0031	0.0028	0.0027	0.0085	0.0137	0.0187	0.0242	0.0277	0.0211	0.0176	0.0116	0.0050
Maintenamce flow	(m3/s/km2)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Balance	(m3/s/km2)	0.0021	0.0018	0.0017	0.0075	0.0127	0.0177	0.0232	0.0267	0.0201	0.0166	0.0106	0.0040
Unit irrigable area	(ha/km2)	4.4	2.4	4.7				70.3	74.2	22.6	24.4	37.9	12.9
(2) Category 3													
Runoff	(m3/s/km2)	0.0012	0.0009	0.0011	0.0024	0.0053	0.0081	0.0101	0.0122	0.0121	0.0081	0.0061	0.0028
Maintenamce flow	(m3/s/km2)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Balance	(m3/s/km2)	0.0002	-0.0001	0.0001	0.0014	0.0043	0.0071	0.0091	0.0112	0.0111	0.0071	0.0051	0.0018
Unit irrigable area	(ha/km2)	0.4	-0.1	0.3				27.6	31.1	12.5	10.4	18.2	5.8
(3) Category 2, (2)/2													
Runoff	(m3/s/km2)	0.0006	0.0005	0.0006	0.0012	0.0027	0.0040	0.0050	0.0061	0.0061	0.0040	0.0031	0.0014
Maintenamce flow	(m3/s/km2)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Balance	(m3/s/km2)	-0.0004	-0.0005	-0.0004	0.0002	0.0017	0.0030	0.0040	0.0051	0.0051	0.0030	0.0021	0.0004
Unit irrigable area	(ha/km2)	-0.8	-0.7	-1.1				12.1	14.2	5.7	4.4	7.5	1.3
(4) Category 1, ((1)+(2))/2													
Runoff	(m3/s/km2)	0.0022	0.0019	0.0019	0.0055	0.0095	0.0134	0.0171	0.0200	0.0166	0.0129	0.0089	0.0039
Maintenamce flow	(m3/s/km2)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Balance	(m3/s/km2)	0.0012	0.0009	0.0009	0.0045	0.0085	0.0124	0.0161	0.0190	0.0156	0.0119	0.0079	0.0029
Unit irrigable area	(ha/km2)	2.5	1.2	2.5				48.8	52.8	17.5	17.5	28.2	9.4

Table MA-19 Potential Water Resources for Irrigation

River	District	Catchment Area (km2)	Category	Unit Irrigable Area by Catchment: RS Rice (ha/km2)	DS Rice (ha/km2)	DS Upland Crop (ha/km2)	Potential Water Resources for Irrigation: RS Rice (ha)	Alternative-1 DS Rice (ha)	Alternative-2 DS Upland Crop (ha)	Irrigable Area by Land in Net (ha)
1. Nam Ko										
Nam Mao	Xai	200	1	17.5	0.6	1.2	3,500	120	240	452
Nam Hin	Xai	133	2	4.4	0	0	585	0	0	208
Houay Lai	Xai	13	1	17.5	0.6	1.2	228	8	16	162
Nam Fen	Xai	17	1	17.5	0.6	1.2	298	10	20	175
Nam Kat	Xai	66	1	17.5	0.6	1.2	1,155	40	79	89
Sub-total		429					5,765	178	355	1,086
Others		551	2	4.4	0	0	2,424	0	0	305
Total of Nam Ko		980					8,190	178	355	1,391
2. Nam Beng										
Nam Met	Beng	74	1	17.5	0.6	1.2	1,295	44	89	43
Nam Lo	Beng	40	1	17.5	0.6	1.2	700	24	48	98
Nam Hao	Beng	72	3	10.4	0	0	749	0	0	168
Nam Phao	Beng, Xai	286	2	4.4	0	0	1,258	0	0	27
Nam Heng(1)	Beng	61	2	4.4	0	0	268	0	0	160
Houay Kao	Hun	29	2	4.4	0	0	128	0	0	44
Nam Kham	Hun	55	2	4.4	0	0	242	0	0	297
Nam Ngat	Hun	52	2	4.4	0	0	229	0	0	434
Nam Oun	Hun	89	2	4.4	0	0	392	0	0	115
Houay Sat	Hun	14	2	4.4	0	0	62	0	0	35
Houay leng	Hun	45	2	4.4	0	0	198	0	0	0
Houay Kho	Hun	51	3	10.4	0	0	530	0	0	0
Nam Heng(2)	Hun	84	1	17.5	0.6	1.2	1,470	50	101	177
Sub-total		952					7,521	119	238	1,599
Others		1,188	2	4.4	0	0	5,227	0	0	740
Total of Nam Beng		2,140					12,748	119	238	2,339
Grand Total		3,120					20,937	296	593	3,730

Note:

Category 1 : The river basin has reserved forest.
Category 2 : The river basin has mostly cultivated.
Category 3 : Complex of Category 1 and 2

RS : Rain season
DS : Dry season

Alternative-1 : RS rice + DS rice
Alternative-2 : RD rice + DS upland crop

Table MA-20 List of Meteorological Instrument Required

Item	Quantity	Remarks
(1) Xai Meteorological Station		Supply of additional instruments
Rainfall Recorder	1	
Evaporation pan (Class A-pan)	1	
Wind Vane & Anemometer	1	
(2) Beng Meteorological Yard		New establishment
Instument shelter	1	
Thermometer	1	
Max. & Min. thermometer	1	
Psychrometer	1	
Sunshine Recorder	1	
Rainfall Recorder	1	
Evaporation pan (Class A-pan)	1	
Wind Vane & Anemometer	1	
(3) Rainfall Station		
Rainfall Recorder	9	1 no./ 250 km2
(4) Staff-gage	5	Nam Hin & Nam Kat in Xai District Nam Met & Nam Heng in Beng District Nam Heng in Hun District

Figure

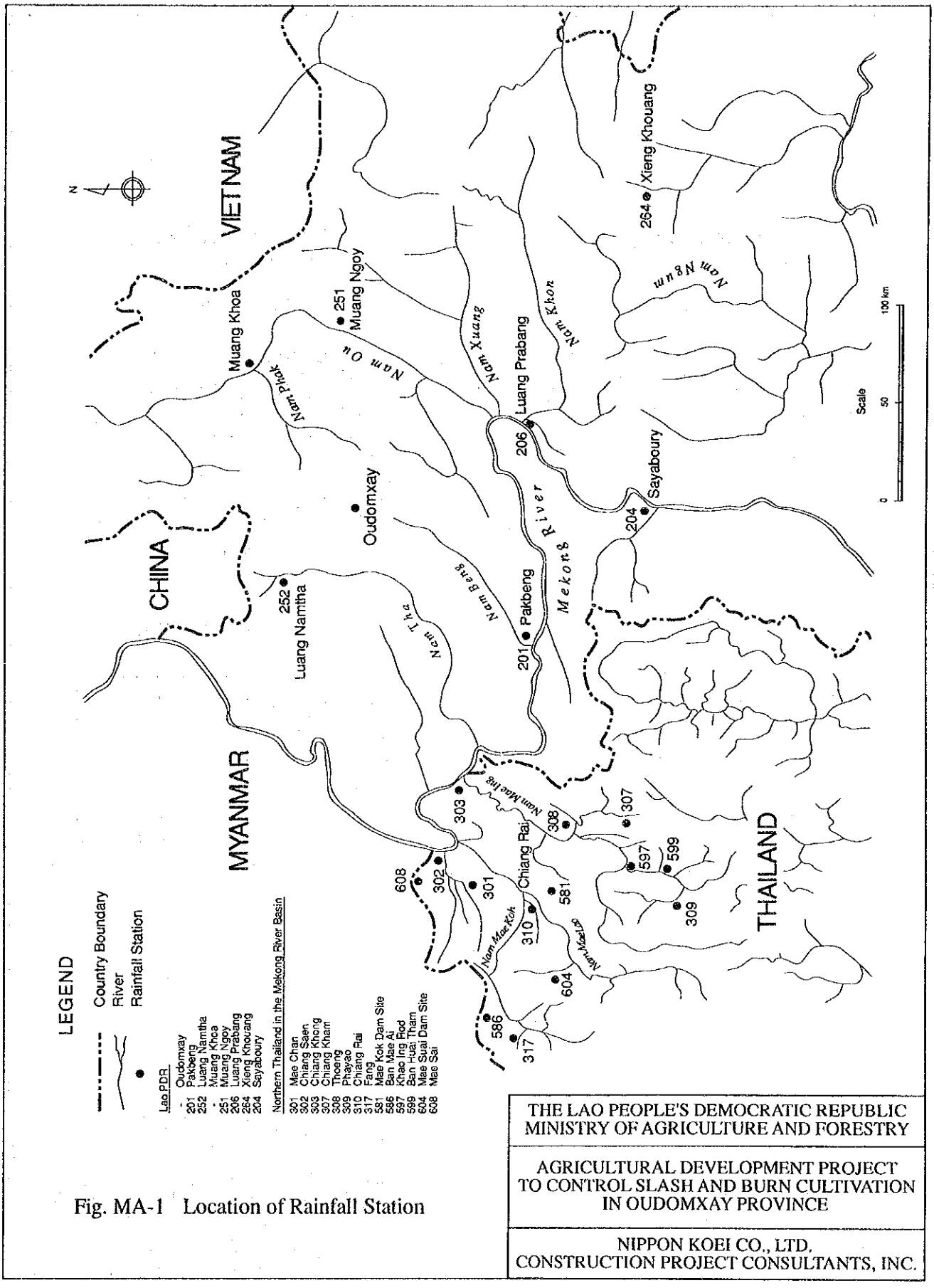

Fig. MA-1 Location of Rainfall Station

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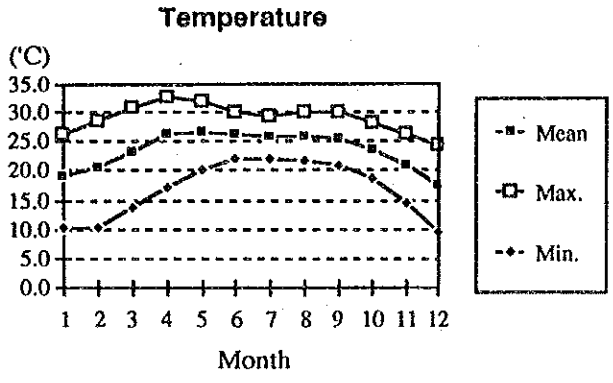
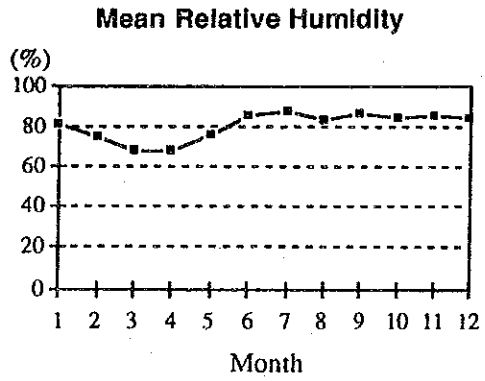
NIPPON KOEI CO., LTD. CONSTRUCTION PROJECT CONSULTANTS, INC.

Oudomxay

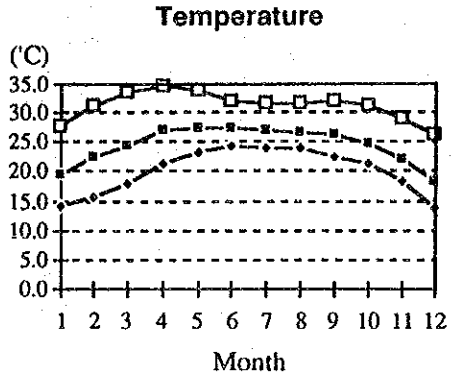
Average of 6 years (1987-92)





Luang Prabang

Average of 11 years (1980-90)



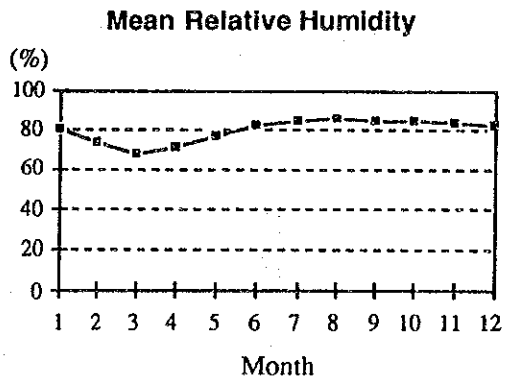


Fig. MA-2 Climatic in Oudomxay and Luang Prabang

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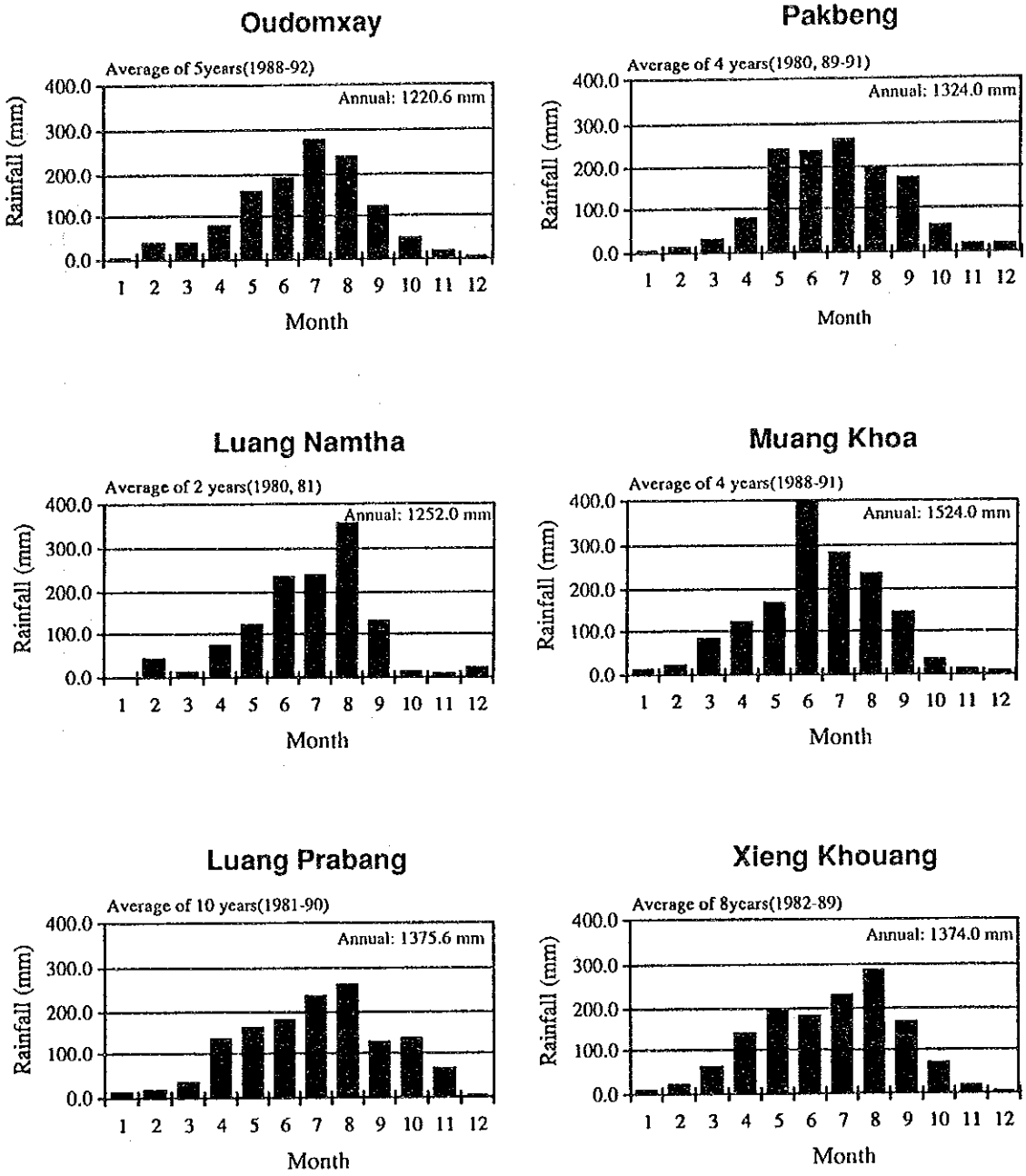

Fig. MA-3 Rainfall Pattern in Northern Laos

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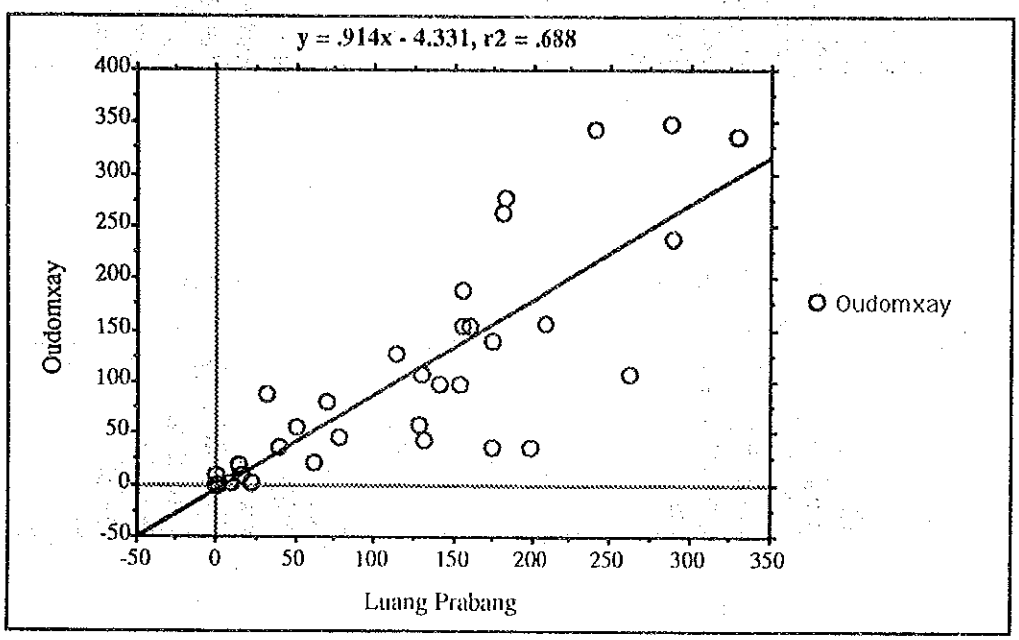

Corr. Coeff. X [1] : Luang Prabang Y [1] : Oudomxay

Count:	Covariance:	Correlation:	R-squared:
36	8499.19	.83	.688

Fig. MA-4 Correlation of Oudomxay and Luang Prabang

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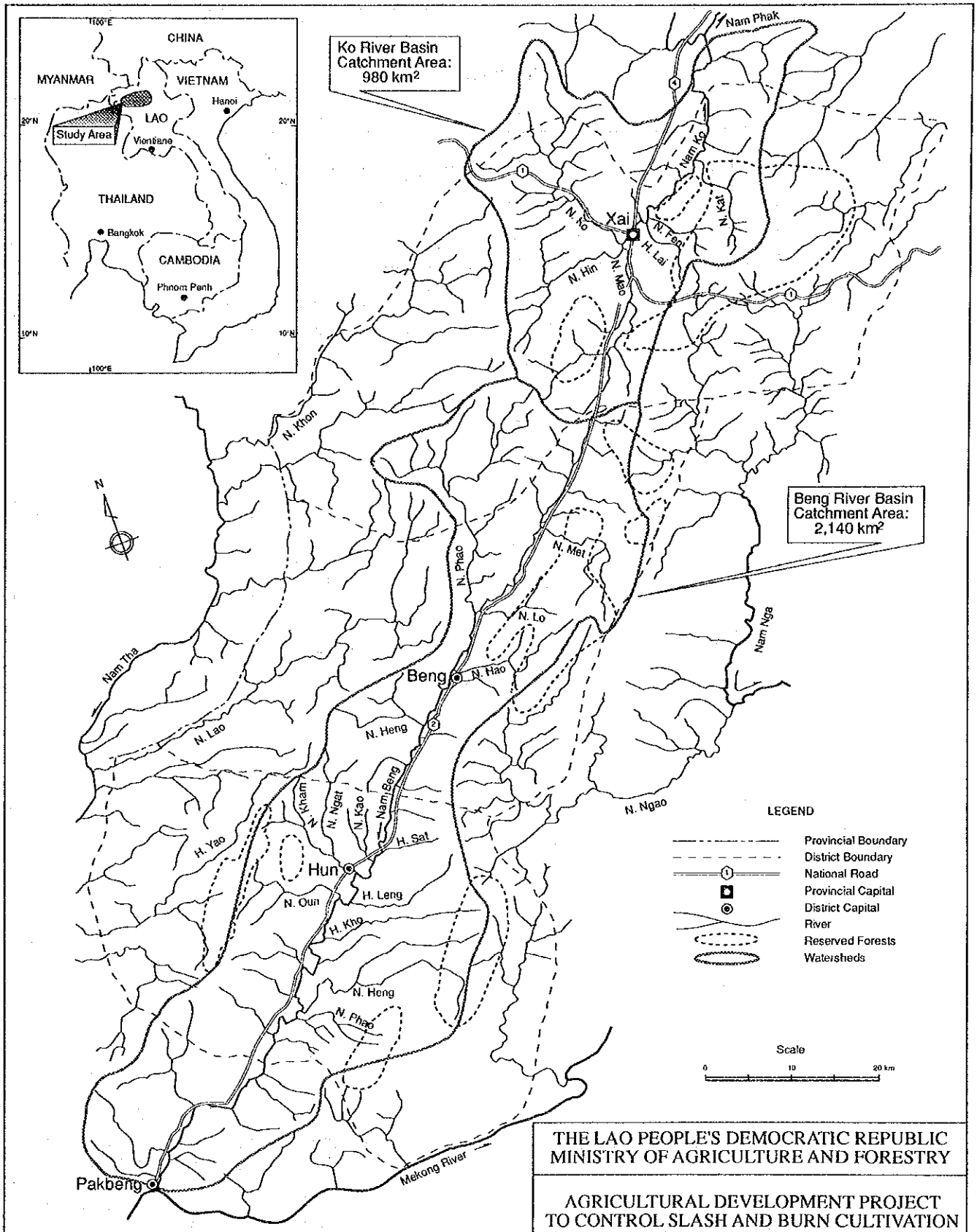

Fig. MA-5 River System in the Study Area

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
MINISTRY OF AGRICULTURE AND FORESTRY

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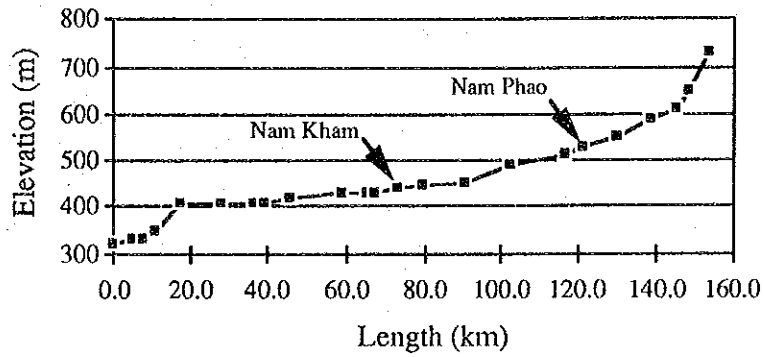
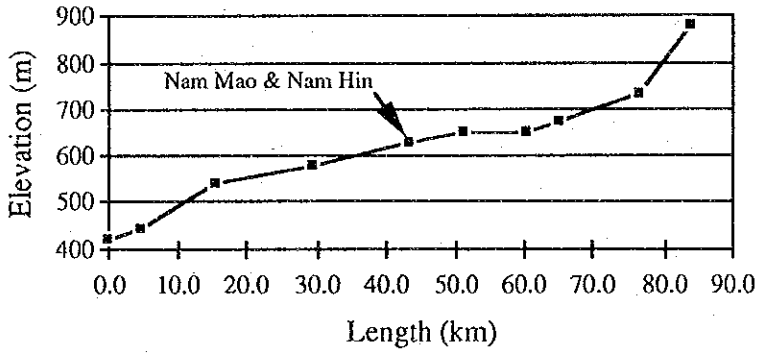
Nam Beng



Nam Ko



Profile of the Rivers

River	Length (km)	Elevation difference (m)	Longitudinal slope
Nam Beng	153.6	410	1/ 375
BP - B.Xiengle	32.0	200	1/ 160
B.Xiengle - Pakbeng	121.6	210	1/ 579
Nam Phao (Nam Ching)	39.4	220	1/ 179
Nam Met	19.9	750	1/ 27
Nam Lo	13.8	920	1/ 15
Nam Hao	22.5	1,170	1/ 19
Nam Kham	15.8	660	1/ 24
Nam Oun	18.4	780	1/ 24
Nam Heng	25.0	490	1/ 51
Nam Ko	83.8	460	1/ 182
BP - Xai	40.6	250	1/ 162
Xai - Pakko	43.2	210	1/ 206

Fig. MA-6 Profile of the River

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