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PAPER VI

WATER USE
IN THE LOWER MEKONG BASIN

FINAL REPORT

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WUP-JICA TEAM

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SUMMARY

INTRODUCTION

1. The water of the Mekong River is mostly used for irrigation, hydropower generation, domestic and industrial sectors. Both peak and low flows in the river are of major concern for sustainable development of the Lower Mekong Basin (LMB). However, the low flow regime on the mainstream has been affected and altered due to enhanced water use in various sectors and development activities in the LMB. Hence, the low flow regimes, at several key hydrological stations along the mainstream, were investigated to draw attention on some pertinent issues related to a future hydrological monitoring on the Mekong mainstream in accordance with the Rules for the Maintenance of Flows on the Mainstream. The Rules are now being drafted for approval by the MRC Council scheduled around the end 2004.

2. To investigate on changes in low flow regime in the LMB, studies were carried out focusing on: (i) identification of low flow increase in the Nam Ngum River due to the Nam Ngum hydropower project development in Lao PDR, (ii) identification of low flow regime changes in the Nam Mun-Chi River due to extensive development of water resources projects in the north-eastern Thailand, and (iii) assessment of low flow increase in the Mekong mainstream due to lateral inflow from tributaries.

WATER RESOURCES DEVELOPMENTS IN THE MEKONG BASIN

3. There are many seasonal storage facilities (reservoirs) in the LMB. At present the total storage capacity of the existing large reservoirs amounts to approx. 12.1 billion m^3. The seasonal regulation rate of all of the existing reservoirs in the whole Mekong River Basin (MRB) is roughly estimated to be around 2.5%.

Total Effective Storage Volume by Riparian Country

Country (Coverage of MRB)	No. of Reservoirs	Storage Volume (million m^3)
China (22%)	2	498
Myanmar (3%)	0	0
Lao PDR (25%)	3	5,408
Thailand (23%)	9	5,462
Cambodia (19%)	0	0
Vietnam (8%)	1	779
Total	**15**	**12,147**

4. Over the Lancang River in China (22% area of the entire MRB falls in China) two hydropower development projects have already been completed, at Manwan and Dachaosan, as cascade hydropower developments on the Mekong mainstream. The effective storage capacity of both reservoirs is 498 million m^3. Although these projects are provided with large reservoirs for hydropower generation, they are operated under the mode of run-of-river basically for maintaining the maximum water level in reservoir for maximizing energy output (in principle so called “inflow = outflow” operation without seasonal regulation). It might be said that these two hydropower dams have no significant impacts on the low flow regime of the Mekong mainstream.

5. However, the third on-going dam construction at Xiaowan (4200 MW) over the Lancang River, with storage capacity of 11,500 million m^3 for seasonal flow regulation, is expected to increase dry season flow by around 555 m^3/s. Further, after completion of all cascade projects, the low flow is expected to increase by around 1,230 m^3/s. Hence, it is reported that the mean monthly flow in the Mekong downstream is expected to increase by about 28%, 27%, 27% and 17% at Chiang Saen, Luang Prabang, Vientiane and Mukdahan, respectively, in May.

6. The Mekong River forms part of the eastern border of Myanmar. In Myanmar, the Mekong River drains 28,000 km^2 (3% area of MRB) watershed. Water resources development activities in this watershed are quite few. Only a few mini-hydropower plants have been constructed along the tributaries of the Mekong, which do not have much impact in the flow regime at the downstream part of the mainstream.

7. Lao PDR, which covers 25% area of MRB, has a large potential for hydropower development. Currently there are 5 hydropower projects (above 10 MW) with an installed capacity of totally 615 MW. Among these projects, 3 are of reservoir type hydropower projects. Those 3 projects are: Nam Ngum and Nam Leuk hydropower projects in Nam Ngum River; and Houay Ho project in Se Kong River. The total effective storage capacity of these projects is about 5,200 million m^3. The flow increase in terms of monthly mean discharges in the dry season (February to April) was estimated to be around 190 m^3/s from the historic operation records of the Nam Ngum dam. The water used for power generation at the Nam Leuk Power Station is diverted into the Nam Ngum reservoir, enhancing the power generation of Nam Ngum Power Station. The Houay Ho Hydropower Project harnesses the high water head of 765 m using the maximum plant discharge of around 24 m^3/s. The Houay Ho Hydropower Project therefore cannot expect any significant change in the low flow regime.

8. In Thailand, the Mekong River has about 170,000 km^2 of watershed lying on north-eastern part of the country, which is 22% of the area of MRB,. The Nam Mun-Chi River is the largest tributary with a catchment area of about 120,000 km^2. In this basin, intensive water resources development has been made from the mid-1960s to mid-1970s. At present, there are 9 seasonal regulating large-scale reservoirs, which are supplying water for irrigation during the dry season. Among the 9 reservoirs, the 4 reservoirs are also used for hydropower generation. In total the reservoirs have the storage capacity of about 5,460 million m^3 and the command area for irrigation is about 240,000 ha. The seasonal regulation rate of all the reservoirs to the mean annual flow volume in the Nam Mun-Chi basin is estimated to be around 6.9%.

9. In Cambodia, about 155,000 km^2 watershed, which occupies 19% of the area of MRB and 90% of the area of the country, is drained by the Mekong River. The Tonle Sap River, which compose with largest freshwater Great Lake, is the major tributary of the Mekong River. The Great Lake, with storage capacity of about 150 billion m^3, is not only the major source of inland fishery but also vital for mitigating flood at the downstream in the Mekong Delta. There are no other reservoirs existing in Cambodia at present.

10. In Vietnam, the Mekong Basin falls on two parts of the country, namely, the Mekong Delta (39,000 km^2) and Central Highland Region (48,500 km^2). Altogether, 8% of the area of MRB falls in Vietnam. The Se San (14,800 km^2) and Sre Pok (18,200 km^2) are the major tributaries of the Mekong River in the Central Highland Region, with great potential for hydropower and irrigation development. However, the Yali (720 MW), a reservoir type of hydropower project and the first seasonal regulation reservoir in MRB with 779 million m^3 of effective storage capacity, was completed on the Se San River in 2000. Further, the Mekong Delta is the major agricultural zone, where irrigation and drainage networks have

extensively developed, covering about 2.4 million hectares of land for paddy and mixed crops.

11. In the Mekong River Basin, as of 2000, there were 13 hydropower plants with installed capacity greater than 10 MW. Among those hydropower plants, 7 are seasonal storage (reservoir) type and 6 are run-of-river type. Moreover, seasonal storage type hydropower projects have significant roles in regulating the flow in the tributaries in the dry season, because the seasonal storages (reservoirs) retain wet season river flow to generate power in the dry season, whereas, in run-of-river type hydropower projects water release and inflow rates are maintained equal so as not to have any impact on the flow regime of the river.

WATER ABSTRACTIONS IN THE MEKONG BASIN

12. For domestic water use about 48.3 million m^3/year was estimated for Lao PDR in 1999, however, 74% of this was estimated for Vientiane. Further, according to ESCAP (1991), in north-eastern Thailand the total domestic water use was estimated as 92.3 million m^3/year, in which urban and rural water uses were estimated as 77.3 and 15.0 million m^3/year, respectively. Similarly, in Cambodia 68 million m^3/year was estimated as urban water use for Phnom Penh in 2002. Moreover, for the Mekong Delta in Vietnam, the domestic water use was estimated as 400 million m^3/year in 2000. This indicates that domestic water use in the Mekong Delta is far higher than in other parts of the Mekong Basin.

13. About 75% of the population of LMB is dependent on agricultural activities, which includes fisheries as well. In 1999, the contributions of agriculture on the GDP in each riparian country were 47.2%, 18.3%, 36.5% and 22.7% in Lao PDR, Thailand, Cambodia and Vietnam, respectively. According to the LRIAD, MRC project report (2002), the total irrigated areas under LRIAD in each riparian country in the Mekong Basin were 224,232 ha, 941,425 ha, 392,117 ha, and 1,719,102 ha in Lao PDR, Thailand, Cambodia and Vietnam, respectively. However, the statistics of DOI, MOAF (2001) of Lao PDR shows that total irrigated area in Lao PDR was 152,000 ha in 1990/91. Further, the Lower Mekong Basin Water Balance Study Report (1984) shows that the total irrigated area in the Mekong Basin of north-eastern Thailand was 924,398 ha at that time. Similarly, the Cambodian Agricultural Development Option Review Report (1994) shows that total irrigated area was 306,000 ha in Cambodia in 1990. Based on the study reports, it could be concluded that the irrigated area has considerably increased in Lao PDR and Cambodia during the last decade, however, expansion of the irrigated area in the Mekong Basin in Thailand was negligible during that period.

14. The pumped irrigation system has been practiced to irrigate the agricultural land in the basin as usual. In total, there are 494 pumped irrigation systems in Lao PDR, which are irrigating 81,225 ha of land. Pumped irrigation is a significant portion of the current irrigation systems in Lao PDR, accounting for the irrigation of around 80% of the total irrigation area. In Thailand, pumped irrigation is very active along the Nam Mun-Chi River (283 systems by DEDP in 1994) as well as the Mekong mainstream (247 systems by DEDP in 1994). Although no recent data were available, according to the Lower Mekong Basin Water Balance Study Phase II Report (1984), there were 1,426 pumped irrigation systems (in total for DEDP, RID and MOI) in the Mekong Basin in Thailand, which had been irrigating 924,400 ha of agricultural land. This indicates that command areas of pumped irrigation systems are quite remarkable in the basin.

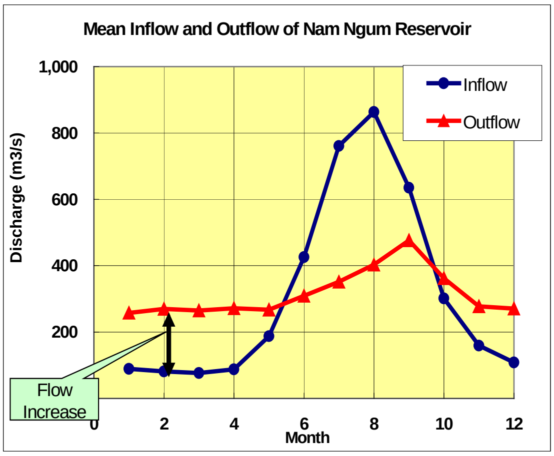
15. The irrigation diversion requirements have been estimated for irrigating agricultural land in the riparian countries of the LMB. The diversion requirements to irrigate paddy and other field crops during wet and dry seasons have been estimated in various study reports. In the

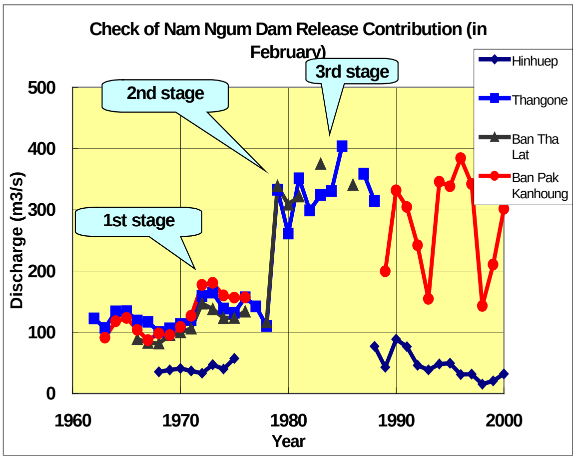
case of Vietnam, however, the diversion requirements were estimated for double paddy, triple paddy, field crops and perennial crops. The total dry season (January to April) irrigation diversion requirements are in the range of 1,423-2,495 mm (Lao PDR), 2,005-2,400 mm (Nam Chi basin in Thailand), 1,448-2,400 mm (Nam Mun basin in Thailand), 1224-2400 mm (Mekong tributaries in Thailand), and 1,505-2,100 mm (Cambodia). Similarly, the total dry season irrigation diversion requirements for the Mekong Delta in Vietnam are in the range of 410-1,089 mm (double paddy), 887-1,247 mm (triple paddy), 401-599 mm (field crops) and 381-535 mm (perennial crops). Currently there are no trans-basin irrigation diversion projects in the Lower Mekong Basin; however, a number of trans-basin projects are under consideration.

16. Based on the available information related to the current dry season irrigation areas and diversion requirements, preliminary estimation of current irrigation water use in the dry season is made for each riparian country. The total dry season irrigation demand is estimated to be around 18.1 billion m^3; i.e., 3.5 billion m^3 in Thailand, 1.2 billion m^3 in Lao PDR, 1.8 billion m^3 in Cambodia, and 11.6 billion m^3 in Vietnam.

LOW FLOW INCREASES

17. In Lao PDR, the Nam Ngum hydropower project was completed in three phases: Phase I (30 MW, 1972-78); Phase II (110 MW, 1979-84); and Phase III (150 MW, 1985-to date). Further, the Nam Song water diversion project was completed in 1995 to divert water to the Nam Ngum hydropower plant. Similarly, the Nam Leuk hydropower project (60 MW) was completed in 2000, and the water used for power generation is diverted to the Nam Ngum reservoir to enhance energy generation. Hence, the impact of Nam Ngum hydropower project on the low flow increase in the Nam Ngum River was analyzed. For this, a comparative study was performed in two approaches: (i) estimation of flow increases in the dry season from the reservoir operation data, and (ii) comparison of the observed mean monthly dry season (February to April) flows before and after the project at the hydrologic stations in the Nam Ngum River. Average flow increases due to release of the water from the reservoir are 188, 189 and 184 m^3/s in February, March and April, respectively. On the other hand, the results show that the mean monthly dry season flow has increased annually in the period 1989-2000 by 169, 189 and 238 m^3/s in February, March and April, respectively, after the completion of the project in the river.

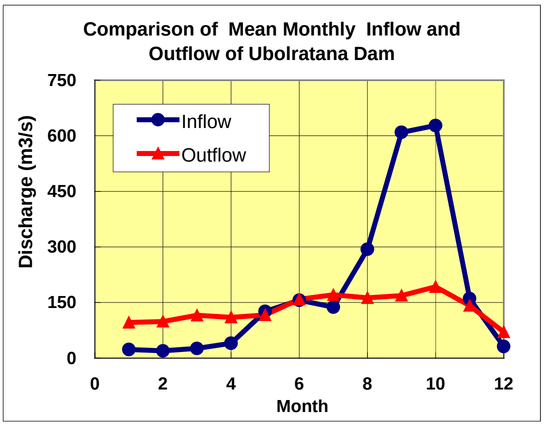


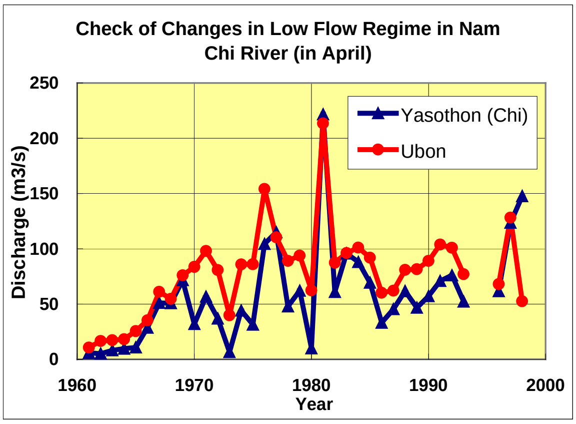


18. In Thailand, large storage reservoirs with total effective storage capacities of 1,626, 3,100 and 736 million m^3 have been constructed on the Nam Mun River, Nam Chi River and other Mekong tributaries, respectively. These storage reservoirs play a significant role in

dry season flow regulation in those rivers systems. From the historical reservoir operation records, average dry season flow increases due to release of water from these reservoirs is estimated at around 2,561 million m^3 in seasonal volume, and in the range of 220 to 290 m^3/s in January to April. To estimate low flow increase into the Mekong mainstream due to the construction of these dams, it is assumed that water released from the dams are fully used for dry season irrigation, although 30% of the water is assumed to have returned to the rivers as return flow. Based on these assumptions, the estimated average low flow increase into the Mekong due to seasonal regulation of the reservoirs is around 74 m^3/s in the dry season (January to April).

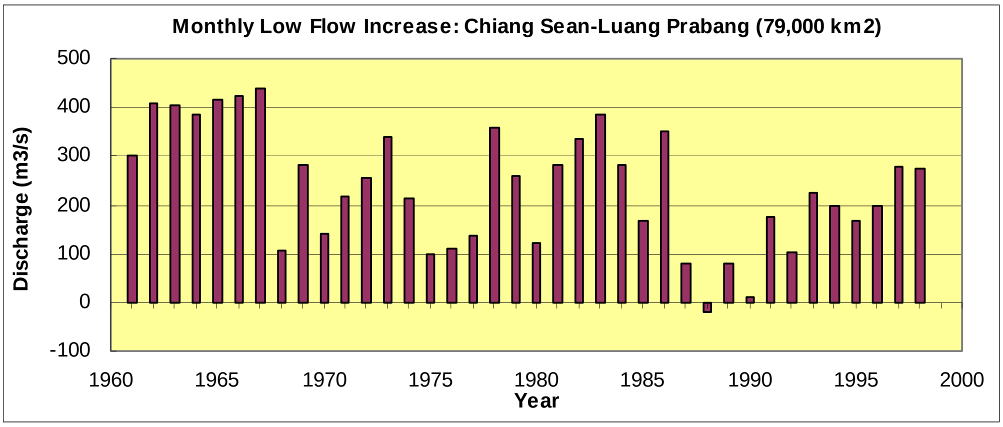
19. For instance, average low flow increase in the Chi River system is presented here. The average low flow increase in the Chi River during the dry season was estimated based on the operation records of three reservoirs, namely, Lam Pao (completed in 1971), Chulabhorn (1971) and Ubolratana (1966). The estimated average monthly low flow increases in the Chi River are 46, 50, 59 and 46 m^3/s in January, February, March and April, respectively.

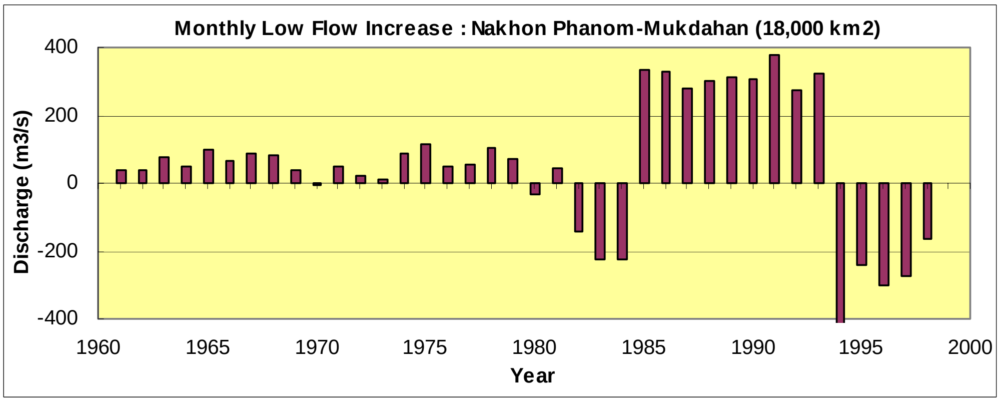


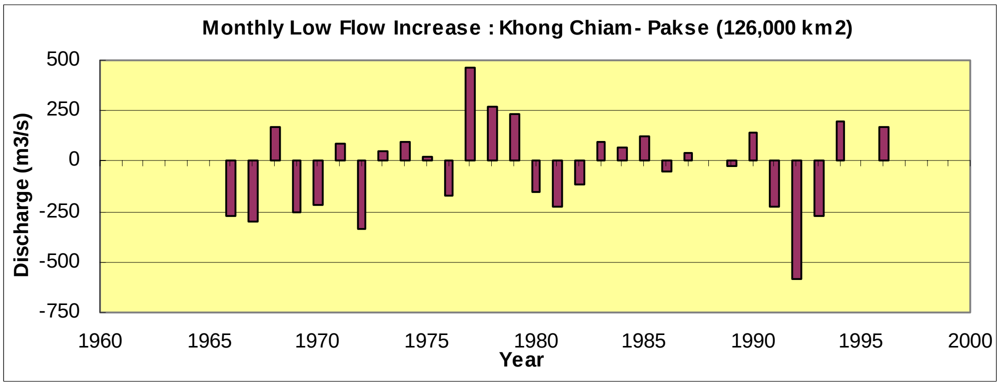


20. Finally, the low flow increase in the Mekong mainstream due to the lateral inflows from tributaries has been analyzed. For this, flow balance study was done in 12 river reaches along the Mekong mainstream in-between Chaing Saen (Thailand) to Chrui Changvar (Cambodia). The principle undertaken for flow balance study in a particular river reach along the Mekong mainstream is: the lateral inflow into the reach equalize to summation of the outflow at downstream of the reach and the water abstraction from the reach less the inflow at upstream of the reach. The flow balance was made by use of the monthly mean discharges during January to May, when the river flows are substantially reflecting the base flows almost without any contribution of local flood inflows from the contributing catchment.

21. Upstream and downstream flow balance inconsistencies (mean monthly discharge at the upstream station is larger than that at the downstream station) are observed in several years and at several stations. For instance, results of the flow balance study in March at the river reaches of Chiang Sean-Luang Prabang (79,000 km^2 in the remnant area), Nakhon Phanom-Mukdahan (18,000 km^2) and Khon Chiam-Pakse (126,000 km^2) are presented here. In many years the observed discharges at Chiang Khan are larger than at the upstream Luang Prabang station. The discharges at Khon Chiam are larger in many years compared with those at the downstream Pakse station.



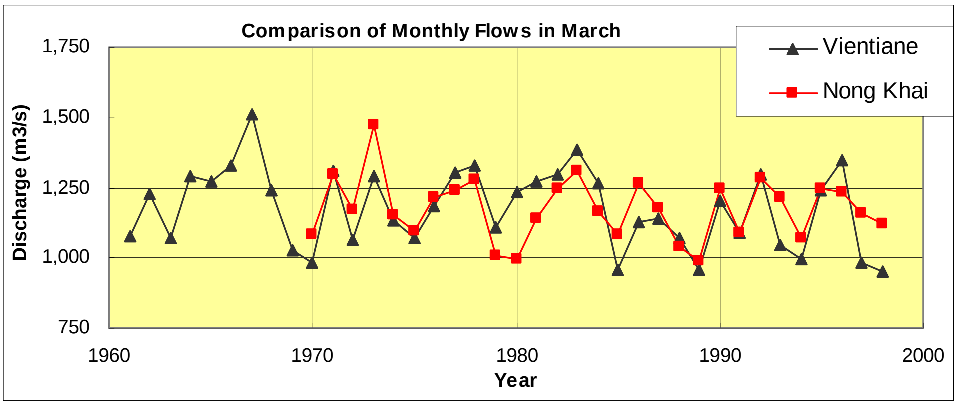




21. For tributaries entering mainly from Lao PDR, the estimated specific discharges of lateral inflow in the dry season are 0.30 to 0.36 m^3/s per 100 km^2, and for the Mun-Chi River in north-eastern Thailand, they are around 0.11 $m^3/s/100km^2$. Likelihood of occurrence of flow balance inconsistencies between stations is closely related with the size of flow contributing area and the error range of water level-discharge rating curves at stations. Considering such relatively small specific discharges of lateral inflows in the dry season, flow balance inconsistency is highly likely to occur in such river reaches as the Luang Prabang-Chiang Khan (contributing area of 24,000 km^2), Chieng Khan-Vientiane (7,000 km^2), Vientiane-Nonk Khai (3,000 km^2) and Nakon Phanom-Mukdahan (18,000 km^2). At this moment the allowable error range of rating curve is unknown. Hence the practicalities of rating curve might be worthy of detailed examination.

22. From the hydrological viewpoints, both the Vientiane and Nong Khai stations are closely located to each other. The lateral inflow contributing area between stations is only 3,000 km^2. The lateral inflow in the dry season is expected to be as small as 9 m^3/s applying 0.30

$m^3/s/100km^2$ in the Chiang Sean-Luang Prabang reaches. The estimated mean monthly discharges in the dry season are almost the same at both stations. However the results of flow balance on the monthly mean basis show wide-ranging lateral inflows varying from -200 to 200 m^3/s. This might be due to the errors of rating curve at both stations although it is unknown that there are spaces for avoiding or minimizing errors.



1. INTRODUCTION

There are many water resource development projects in the Mekong River Basin. The Mekong River water has been utilized for various sectors such as irrigation and hydropower generation, as well as domestic and industrial purposes. Such water uses influence more or less the low flow (dry season) regimes on the Mekong mainstream. It is evident that large-scale consumptive water extraction from rivers in the dry season would make impacts on the low flow regimes in the downstream as the dry season flows decrease. On the other hand, low flows are likely to increase due to water release by operation of seasonal-regulating reservoirs. Thus river flow regimes have changed historically due to the enhanced water usage and development activities carried out in the Basin.

The purpose this Paper VI, Water Use in the Lower Mekong Basin, is to present the results of the study on current water uses and preliminary check of changes in the low flow regimes at several key hydrologic stations due to various water resources development projects in the Mekong River Basin, and to draw attention on some pertinent issues related to a future hydrological monitoring on the Mekong mainstream in accordance with the Rules for the Maintenance of Flows on the Mainstream. The Rules are now being drafted for approval by the MRC Council scheduled around the end 2004.

Changes in low flow regimes are crucial technical factors for establishing the Rules as well as the future hydrological monitoring. This paper also aimed at providing material for the Regional Training Workshop on Water Allocation and Monitoring; namely, the International Experiences that were successfully carried out on 23-25 January 2002 at Ho Chi Minh City in Vietnam.

The preliminary check of changes in the low flow regimes was undertaken with the main focus on the:

(1) Identification of low flow increase of the Nam Ngum River due to the Nam Ngum hydropower development project;

(2) Identification of low flow regime change of the Nam Mun-Chi River due to intensive developments of water resources projects in north-eastern Thailand; and

(3) Assessment of low flow increase due to lateral inflows at the selected hydrological stations along the Mekong mainstream

Low flows in the dry season usually reflect the “base flow” almost without any contribution of local flood flows. Predominant flow components of lateral inflows into the Mekong River in the dry season are subsurface flow and groundwater outflow from the contributing watersheds.

The analysis undertaken is based on the historic discharge records available in the HYMOS database and various but limited documents on water usages available at MRC. It is therefore noted that this document is still of a preliminary nature and requires further verification with inputs of accurate data on the historic water usages in the Basin.

2. EXISTING WATER RESOURCE FACILITIES IN THE MEKONG RIVER BASIN

2.1 Existing Large Reservoirs

The table below presents the salient features of the existing large-scale seasonal reservoirs in the entire Mekong River basin. It is highly likely from the hydrological viewpoints that historic operations of large-scale reservoirs have influenced the flow regimes in the downstream, reducing the high flows in the wet season and increasing the low flows in the dry season.

Table 2.1 Salient Features of Existing Large Reservoirs

Country	Name of Dam	River/ Major Tributary	Purpose	Catchment Area (km^2)	Comp -letion Year	Dam Height (m)	Gross Storage (mil. m^3)	Effective Storage (mil. m^3)
China	Manwan	Mekong	HY (Run-of-river)	114,500	1993	132	920	258
	Dachaoshan	Mekong	HY (Run-of-river)	121,000	2000	118	890	240
Lao PDR	Nam Ngum	Nam Ngum	HY	8,460	1971-85	75	7,030	4,700
	Houay Ho	Se Kong	HY	193	1999	93	620	523
	Nam Leuk	Nam Leuk	HY (water diversion to the Nam Ngum dam)	274	2000	45	185	-
Thailand	Lam Dong Noi (Sirindhorn)	Nam Mun	HY (36MW), IR (24,000 ha)	2,097	1968	42	1,966	1,191
	Lam Takong	Nam Mun	IR (22,000 ha)	1,430	1970	-	-	290
	Lam Phra Ploeng	Nam Mun	IR (10,097 ha)	807	1967	-	-	145
	Chulabhorn (Nam Phrom)	Nam Chi	HY (40MW), IR (9,600 ha)	545	1971	-	-	145
	Ubolratana (Nam Pong)	Nam Chi	HY (25MW), IR (40,700 ha)	14,000	1966	32	2,010	1,695
	Lam Pao	Nam Chi	IR (50,416 ha)	5,960	1971	-	-	1,260
	Huai Luang	Nam Luang	IR (12,800 ha)	666	1984	-	-	113
	Nam Oon	Nam Oon	IR (29,728 ha)	1,100	1973	-	-	475
	Huai Mong	Nam Mong	IR (8,640 ha)	1,307	1988	-	-	26
	Nam Pung	Nam Pung	HY (6.3MW), IR (32,000 ha)	297	1965	40	150	122
Vietnam	Ialy (Yali)	Se San	HY	7,455	2000-01	65	1,037	779

Note: HY: Hydropower; IR: Irrigation
Source: MRCS and other related reports

From the table above the total effective storage of major reservoirs in each riparian country is summarized below.

Table 2.2 Comparison of Total Storage Volume by Riparian Country

Country	No. of Reservoirs	Storage Volume (million m^3)
China (22%)	2	498
Myanmar (3%)	0	0
Lao PDR (25%)	3	5,408
Thailand (23%)	9	5,462
Cambodia (19%)	0	0
Vietnam (8%)	1	779
Total	**15**	**12,147**

Note: Figures in parenthesis are areas in % of the total Mekong River Basin.
Source: JICA Study Team

2.2 Overview of Water Resources Developments in the Mekong Countries

China

In China, the Mekong River is known as the Lancang River and flows mostly through Yunnan Province. The Lancang River drains a watershed area of 165,000 km^2, or 22% of the total area of the Mekong River Basin. Topographically, the Lancang watershed is quite steep. The north of the Lancang River Valley is parallel to the Gaoligonshan and Rushan mountains and the Yunling mountains and is characterized by such high mountains from 3,500 to 5,000 m and valleys above 2,000 m. The southern part of the Lancang is characterized with medium and low mountains and valleys below 1,000 m, with small population centers scattered along the mainstream and limited arable land.

Fig. 2.1 Hydropower Development Projects on the Mekong Mainstream in China

An average elevation drop of 6.5 m per kilometer (average river gradient of 1/154) demonstrates the hydropower potential of the Lancang River. Two dams have already been completed on the Lancang mainstream provided with run-of-river type hydropower generation station as a series of cascade hydropower development. In total 14 hydropower schemes were planned on the Lancang mainstream including two large reservoir type projects. A series of cascade hydropower projects on the Lancang mainstream is illustrated below.

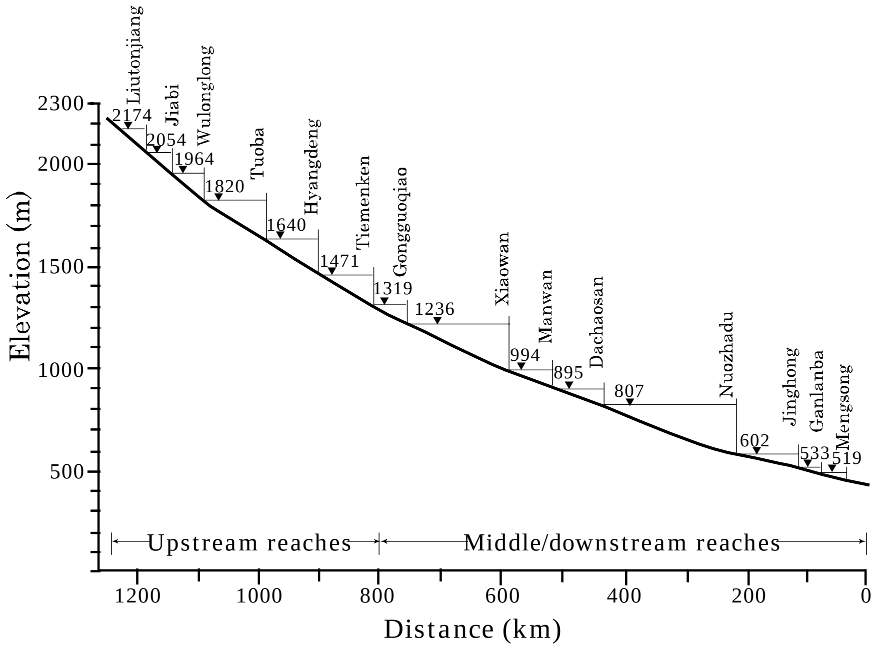


Fig. 2.2 Longitudinal Profile of Cascade Hydropower Development on the Mekong Mainstream in China

Photo: Lancang River in China (Source: MRCS)

It is reported that the construction of Xiaowan hydropower project has started as one of two large-scale reservoir-type projects (Xiaowan and Nuozhadu projects). Salient features of the cascade development are summarized below.

Table 2.3 Hydropower Development in Lancang River in China

No.	Name of Plant	Catchment Area (km2)	Dam Height (m)	Gross Storage (mil. m3)	Installed Capacity (MW)	Annual Output (GWh)	Average Inflow (m3/s)	Low Flow Increase (m3/s)	Status of Project
1	Liutonjiang	83,000	-	500	550	3,360	698	11	Desk Study
2	Jiabi	84,000	-	320	430	2,650	720	6	Desk Study
3	Wulonglong	85,500	-	980	800	4,890	754	22	Desk Study
4	Tuoba	88,000	-	5,150	1,640	7,630	809	219	Pre-F/S (?)
5	Hyangdeng	92,000	-	2,290	1,860	8,500	898	71	Pre-F/S (?)
6	Tiemenkan	93,400	-	2,150	1,780	8,270	929	62	Pre-F/S (?)
7	Gongguoqiao	97,300	130	510	900	4,670	985	8	F/S (?)
8	Xiaowan	113,300	290	15,130	4,200	18,540	1,220	555	Ongoing
9	Manwan	114,500	132	920	1,500	7,870	1,230	26	Completed in 1993
10	Dachaosan	121,000	118	880	1,350	7,090	1,340	15	Completed in 2000
11	Nuozhadu	144,700	260	24,670	5,000	22,670	1,750	212	Pre-F/S (?)
12	Jinghong	149,100	107	1,040	1,500	8,470	1,840	14	Pre-F/S (?)
13	Ganlanba	151,800	10	-	150	1,010	1,880	-	F/S (?)
14	Mengsong	160,000	28	-	600	3,740	2,020	-	F/S (?)
Total			-	**32,340**	**22,260**	**109,360**	-	**1,230**	

Source: Yunnan Provincial Science and Technology Commission and Yunnan Institute of Geography (1993), Investigation and Study of the Current Status of the Lancang River-Mekong River Basin in Yunnan, P.R.C. Other related reports and international symposium papers.

Large-scale reservoir projects will have significant impacts on the downstream flow regime. It is highly expected that the ongoing Xiaowan Dam with active storage capacity of 11,500 million m^3 for seasonal flow regulation will increase the dry season flow by around 555 m^3/sec. The expected low flow increase due to full development of cascade projects is reportedly around 1,230 m^3/s in total. Sustainable development of irrigation in the Lancang River Basin is unlikely because of a shortage of suitable land and the low fertility of soils. Over 86% of Yunan Province has a ground slope greater than 15%. Irrigation and dry-land agriculture areas are 3.5% and 17.4% of the entire Lancang basin. The table below indicates the predicted impacts of the cascade development on the Lancang River in Yunnan Province in China in terms of the contribution to dry season flows at selected stations on the Mekong downstream.

Table 2.4 Percent Increase to Mean Monthly Flow on the Mekong Mainstream due to Cascade Power Development in China

Location	Dec	Jan	Feb	Mar	Apr	May
Chiang Saen	32	48	73	89	80	28
Luang Prabang	22	38	52	80	66	27
Vientiane	22	38	52	72	60	27
Mukdahan	17	27	37	43	40	17

Source: David Plinston and He Daming, Australian Mekong Research Network, Water Resources and Hydropower in the Lancang River Basin (quoted from the paper entitled China’s Mekong Dam Plans, David Blake, February 2001)

The implications from above are:

(1) The ongoing large-scale reservoir development will have drastic impacts on the hydrological low flow regime of the Lower Mekong.

(2) Large quantity of the dry season base flow will be generated by large scale regulation by reservoirs in China; at Chiang Saen the dry season flow increases are more than 80% in March and April.

(3) From the viewpoint of water resources availability in the Lower Mekong, this significant contribution in the low flow regime would be crucially important.

Myanmar

The Mekong River forms part of the eastern border of Myanmar. A 350 km long reach of the Mekong River separates Myanmar from the northwest region of Lao PDR. The Mekong watershed drains an area of 28,000 km^2, or 3% of the total Mekong Basin. The major river in Myanmar is the Ayeyarwady River draining a catchment area of 193,000 km^2. Thus, the water resources of the Mekong catchment are quite few. Only a number of mini hydropower plants were constructed on the tributaries of the Mekong. Major projects are listed below.

Table 2.5 Existing Hydropower Projects in Myanmar

Project	Installed Capacity (kW)	Completed Year
Kyaington No.2	480	1991
Mainglor No.1	60	1992
Selu	20	1992
Kyaington No.1	3,000	1994

Source: MRC (1997), Mekong River Basin Diagnostic Study, Final Report

Lao PDR

Lao PDR is water rich and topographically favourable for hydropower generation. Thus Lao PDR has large potential for hydropower development. A number of potential hydropower projects on the Mekong tributaries have been identified. However only a few of its many possible projects have been developed. Currently there are five hydropower schemes generating a total of 615 MW although the total capacity is 640.6 MW including small-scale hydropower plants with less than 10 MW of installed capacity as well as diesel plants. Of these, three projects are reservoir type development. They are the Nam Ngum and Nam Leuk hydropower development projects in the Nam Ngum River, and the Houay Ho project in the Se Kong River. The total capacity of effective storage amounts to 5,200 million m^3. These projects on the tributaries involve seasonal storage that will influence the flow regime in the downstream reaches of the Mekong mainstream as improved regulations of dry season flows. It is readily apparent that hydropower potential of Lao PDR exceeds its own electric demands. Prospects for future hydropower development depends on external demands from riparian countries such as Thailand and possibly Vietnam. Hydropower developments in Lao PDR are likely to become one of the mainstays of its future economic growth. The Nam Theun-2 Project of 1,080 MW will commence soon. This project is a large reservoir type development (effective storage of 2,607 million m^3) involving the water diversion from the Nam Theun River to a power station in the upper reaches of the Se Bang Fai River. Table below shows the annual power generation and supply balance from 1990:

Table 2.6 Power Generation and Supply Balance in Lao PDR

Year	Capacity (MW)	Annual Output (GWh)	Power Supply (GWh)			
			Domestic	Export	Import	Net Export
1990	163.56	833	165	595	28	567
1991	209.21	834	221	563	35	528
1992	209.90	752	253	460	41	419
1993	211.75	920	265	596	48	548
1994	217.39	1,199	279	829	57	772
1995	218.25	1,085	338	676	77	599
1996	218.60	1,248	380	792	88	704
1997	221.80	1,219	434	710	102	608
1998	415.00	948	513	405	142	263
1999	580.60	1,169	566	598	173	425
2000	640.60	1,579	640	863	163	700

Source: Electricite du Laos (EDL)

At present there are 23 IPP projects on tributaries of the Mekong. The table below shows the present status of IPP schemes:

Table 2.7 Present Status of IPP Schemes in Lao PDR as of End 2001

No.	Project	Capacity (MW)	Sponsor	Agreement Type	Signing
1	Theun-Hinboun	210	THPC	PPA	Jun. 1996
2	Houay Ho	150	Daewoo	PPA	Jun. 1997
3	Hongsa Lignite	720	Thai-Lao Lignite	CA	Jun. 1994
4	Nam Theun 2	980	NTEC	PPA (provisional)	Feb. 2002
5	Nam Ngum 2	615	Shlapak	CA	Mar. 1998
6	Nam Ngum 3	440	GMS Power	PDA	Nov. 1997
7	Xe Pian-Xe Namnoy	390	Dong Ah	CA	Aug. 1994
8	Xe Kaman 1	468	ALP Mgt	CA	Nov. 1997
9	Southern Laol Trans.	-	ALP Mgt	CA	Nov. 1997
10	Nam Theun 3	237	Heard Energy	PDA	Aug. 1994
11	Nam Mo	105	Mahawongse	PDA	Nov. 1999
12	Nam Tha 1	263	SPS	MOU	Oct. 1995
13	Nam Theun 1	540	SUSCO	MOU	Mar. 1994
14	Nam Lik	100	Hainana STT	MOU	Feb. 1994
15	Nam Ngum 5	90	Melkyma	MOU	Sep. 1996
16	Nam Ou	600	Pacific Rim	MOU	Nov. 1994
17	Xe Katam	100	Hydro Power	MOU	Oct. 1994
18	Nam Khan 2	126	Hydro Quebec	MOU	Jun. 1994
19	Nam Suang 2	190	VKS	MOU	Mar. 1995
20	Nam Niep 2+3	565	VKS	MOU	Mar. 1995
21	Xe Kong 5	250	Sondel	MOU	Apr. 2000
22	Phapheng (Thakho)	30	True Assess Ltd	MOU	
23	Nam Bak (Cha) 2B	120	Nisho Iwai	MOU	

Note: MOU: Memorandum of Understanding, PDA: Project Development Agreement, CA: Concession Agreement, PPA: Power Purchase Agreement

Source: Power Sector Strategy Study, Draft Final Report, February 2001

Thailand

In North-eastern Thailand, the Mekong River drains an area of 170,000 km^2, which amounts to about 22% of the Mekong River basin and one-third of the total area of the country. The easterly flowing Nam Mun River and its major tributary, Nam Chi River (together known as the Nam Mun-Chi River) drains the southern two-thirds of the Mekong River basin (120,000 km^2). A series of northerly and easterly flowing tributaries drain the remaining one-third of the Mekong River catchment (50,000 km^2). The Nam Mun-Chi River basin consists of a shallow saucer-shaped plateau (part of the Korat Plateau of North-eastern Thailand), which has an average height of 100-200 m above sea level. Farmland covers about 43% of the total area, of which paddy fields account for about two-thirds (27%). Forests cover only 21% of the total area. Most surface water development projects in this area are based on the three rivers. The figure below is the mean monthly discharge at Ubon (1961-1966 before intensive water resources development in the Nam Mun-Chi Basin), the growth center in the Basin located in the downstream from the confluence of the Nam Mun and Chi Rivers.

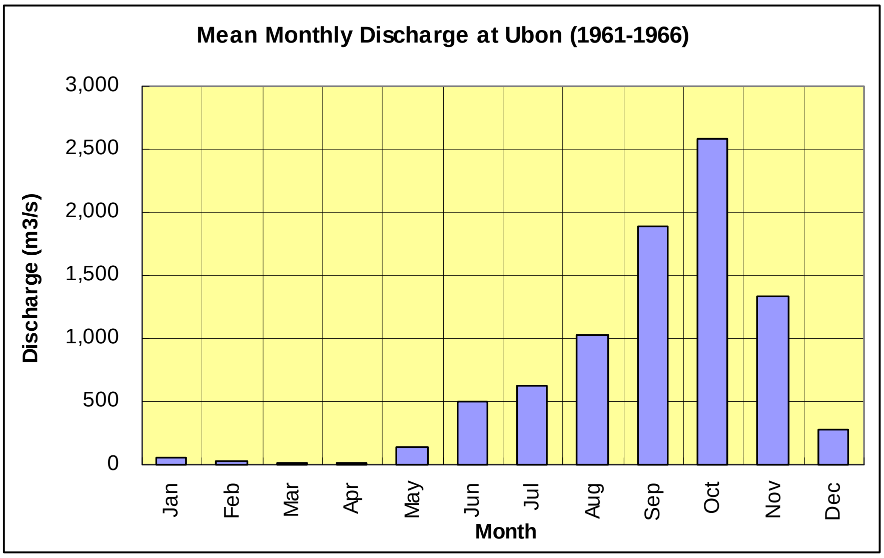


Fig. 2.3 Mean Monthly Discharge at Ubon Station

The Nam Mun-Chi River Basin is characterized hydrologically by relatively small annual rainfall (1,200-1,800 mm) and large difference of river flows in the wet and dry seasons. At Ubon, over 95% of the annual runoff occurs in the wet season. Only 3% occurs in the dry season (January to May). In this area, the agriculture sector has been the predominant one and thus irrigation is essential for cultivated crops. In the dry season irrigation virtually depends on the source of water.

Under the condition above, intensive water resources development mainly for irrigation development has been made from the mid-1960s to early 1970s. At present there are nine seasonal-regulating large reservoirs supplying the supplementary water for dry-season irrigation. Of nine reservoirs, four projects are provided with hydropower generating facilities. The total capacity of effective storage is approximately 5,460 million m^3. The location map of major reservoirs is shown below.

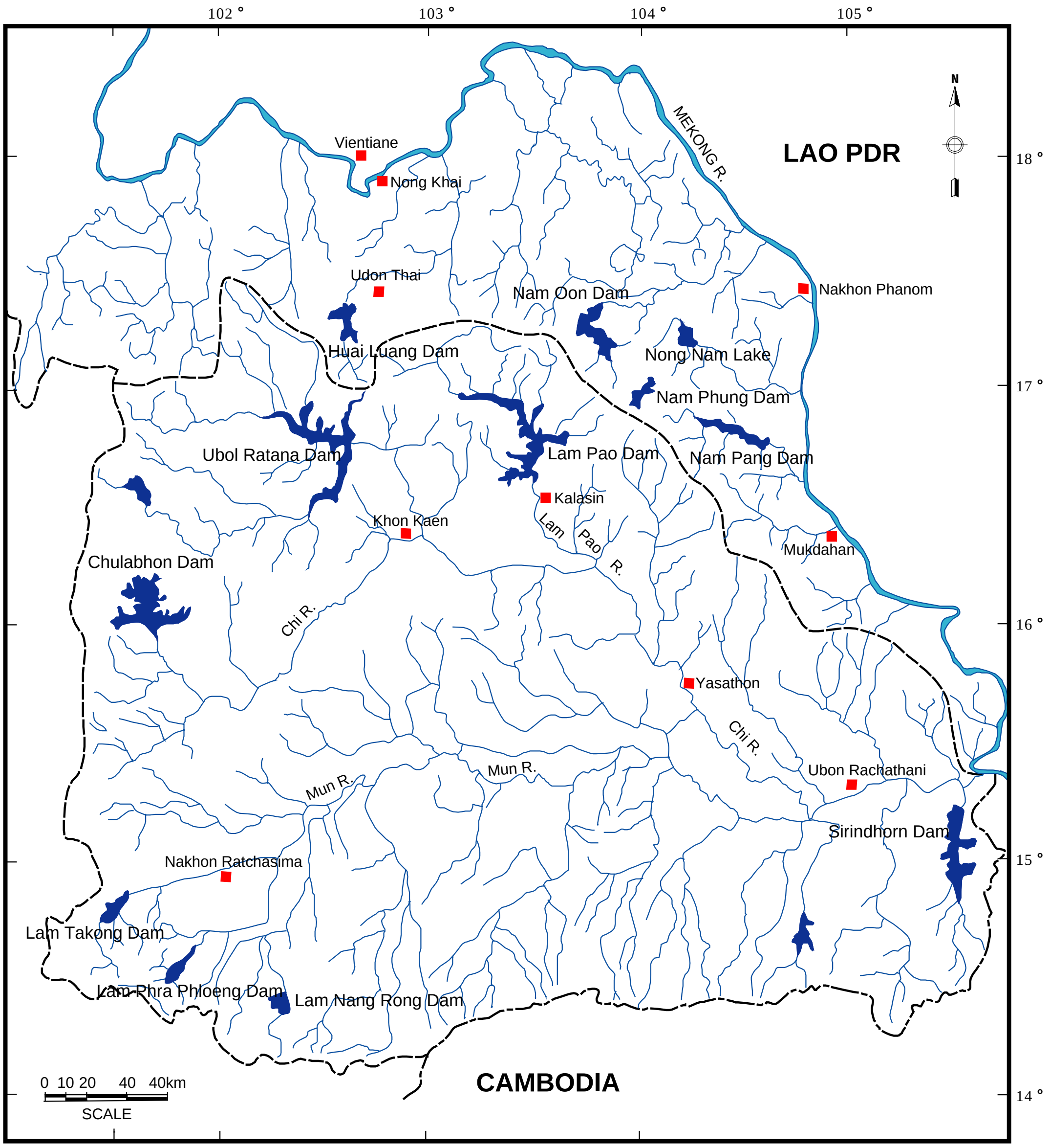


Fig. 2.4 Location Map of Major Reservoirs in Thailand

Historic water resources development in terms of the accumulation of developed effective storage in reservoirs is shown in Fig. 2.5 below. The total irrigation service area covered by the reservoirs is around 240,000 ha. Besides the large reservoirs, there are numerous small and medium scale irrigation reservoirs (ponds) in the area.

In Thailand, oppositions against new hydropower development projects are increasing concern. The Pak Mun run-of-river type hydropower project constructed at almost the outlet of the Nam Mun-Chi River into the Mekong River has been suspended (full gate opening at the intake weir) due to triggered local protests. It appears that Thailand has almost utilised the obvious hydropower potential of the major Mekong tributaries. Further medium to large-scale developments on the tributaries are unlikely.

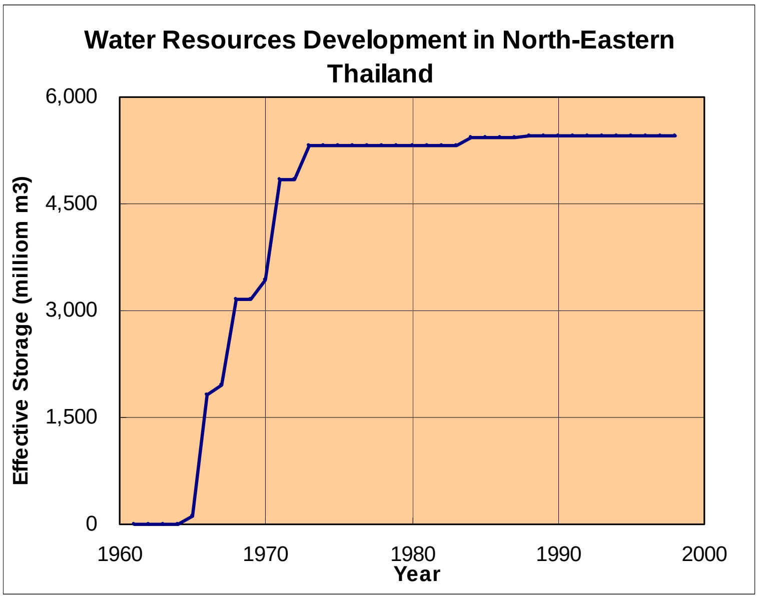


Fig. 2.5 Historic Water Resources Development in North-eastern Thailand

Cambodia

Cambodia is predominantly a low-lying country that occupies the central plains of the Mekong Basin. The Mekong River drains a catchment area of 155,000 km^2 in Cambodia, which amounts to about 19% of the whole Mekong Basin and about 90% of the total area of the country. The Tonle Sap River is a major tributary of the Mekong in Cambodia. At Prek Kdam located on the Tonle Sap River some 30 km upstream from its confluence with the Mekong, the Tonle Sap River has a drainage area of 84,000 km^2, or nearly 54% of the total Mekong catchment in Cambodia. The principal feature of Tonle Sap catchment is the Great (Tonle Sap) Lake, which covers an area of 13,750 km^2 and is the largest freshwater lake in the South-East Asia. The lake provides vital inland migrating fisheries to Cambodia and mitigates significantly downstream floods into the Mekong delta in Vietnam. The total natural storage capacity of the Great Lake is estimated to be some 150 billion m^3. During the flood season, the water surface of the lake expands from 250,000 to 300,000 ha in the dry season to 1.0 to 1.4 million ha.

In Cambodia there are no existing reservoirs at present. The construction of Prek Thnot multipurpose dam has been interrupted since 1973 due to the political unrest in the country as well as the financial situation. There is a development plan for a series of run-of-river type hydropower schemes on the Mekong mainstream at Don Sahong, Stung Treng and Sambor. Cambodia is highly dependent on a migrating fishery for its annual protein. Construction of barrages on the mainstream has significant adverse effects on the existing fishery. In this respect, the possibility of implementing hydropower development on the mainstream might be very low.

Vietnam

There are two distinct regions in the Vietnam part of the Mekong River Basin; the Mekong Delta (39,000 km^2) and the Highland of Central Region of Vietnam (48,500 km^2). The Highland of Central Region is a part of the upstream watersheds of the Se San (14,800 km^2 in the territory of Vietnam) and Sre Pok (18,200 km^2) rivers. The Mekong Delta includes the Mekong and Bassac rivers.

According to the 1987 Indicative Plan, the upper part of the Highland has the highest potential for hydropower generation with its relief. On the other hand the lower part has areas suitable for irrigation development. The Ialy (Yali) reservoir-type hydropower development project was completed in the Se San River in 2000. The Yali reservoir is the first seasonal regulation reservoir in the Mekong watershed in Vietnam. The effective storage capacity is reportedly around 779 million m^3. Although the operation procedure of Yali reservoir is unknown at the moment, it is highly expected that the low flow regime of the Se San River would be influenced due to the hydropower generating operation. The Mekong delta is the richest agricultural zone in Vietnam where irrigation and drainage infrastructure has been intensely developed covering around 2.4 million hectares of rice and mixed crops.

Notification of the construction of the Se San 3A Hydropower Project (run-of-river scheme) on the Se San River was submitted to the Joint Committee meeting in June 2003. This is based on the procedure as stipulated in Article 5: Reasonable and Equitable Utilization of the 1995 Mekong Agreement.

The description of the Notification is as follows: "Notification of the Se San 3A Project:, located on some 14km downstream of the Se San 3 Hydropower Project in Sa Thay district of Kon Tum province (right bank) and Chu Pah district of Gia Lai province (left bank).The total catchment area at project site of 8,084 km^2, the river has an average natural flow of 283 m^3/sec while the peak flood flow is ranging from 14,900 – 15,700 m^3/sec. The sole purpose of the project is electricity generation with total installed capacity of 108MW. The project is constituted by a concrete gravity dam; a spillway; a power station consisting of two pressured tunnels, a power house and transmission system in the left bank".

2.3 Existing Hydropower Plants

(1) Salient Features

As of the year 2000, there were 13 hydropower plants with an installed capacity above 10 MW in the whole Mekong River Basin. The salient features of the existing hydropower plants are presented in the next page.

Table 2.8 Salient Feature of Existing Hydropower Plants

Country	Name of Plant	River	Type	Capacity (MW)	Comple-tion Year	Annual Output (GWh)	Rated Head (m)	Plant Discharge (m^3/s)
China	Manwan	Mekong	RoR	1,500	1993	7,870	99	-
	Dachaoshan	Mekong	RoR	1,350	2000	5,931	80	-
Lao PDR	Nam Ngum	Nam Ngum	SS	150	1971-85	900	32	220
	Xeset	Xe Don	RoR	45	1991	180	157	-
	Theun Hinboun	Nam Theun, Nam Hinboun	RoR	210	1998	1,645	230	100
	Houay Ho	Se Kong	SS	150	1999	600	765	10.4
	Nam Leuk	Nam Leuk	SS	60	2000	184	-	-
Thailand	Sirindhorn	Nam Mun	SS	36	1968	115	30.3	-
	Chulabhorn	Nam Chi	SS	15	1971	62	85	-
	Ubolratana	Nam Chi	SS	25	1966	75	16.75	75
	Pak Mun	Nam Mun	RoR	136	1997	462	-	-
Vietnam	Dray Ling	Se Srepok	RoR	13	1995	70	-	-
	Ialy (Yali)	Se San	SS	720	2000-01	3,642	189	105

Note: SS: Seasonal storage; RoR: Run-of-River
Source: MRCS and other related reports

These projects above are indicated on the map below.

Fig. 2.6 Location Map of Existing Hydropower Project in Mekong River Basin
(Source: MRC, MRC Hydropower Development Strategy, 2001)

(2) Type of Hydropower Development

Hydropower development is broadly divided into two types: a run-of-river type power plant scheme and a reservoir type (storage type) power plant scheme. An extensive hydroelectric cascade development on the mainstream of the upper Mekong (Lancang) River in China consists of a combination of both scheme types to utilize the full potential water head of the river. Both hydropower schemes impose new flow regimes in the rivers below the generating plants to a greater or less extent. Impacts on the downstream flow regime due to both schemes are defined below.

Reservoir (storage) scheme

Schemes which have storage reservoirs retain wet season river flows and to use them to generate energy during the dry season. Hence the downstream river flows are reduced in the wet season and increased in the dry season. An extensive impoundment of water in a reservoir allows for regulation of the river flow downstream. Reservoir scheme allows a relatively constant supply of energy over the year. Significant storage is often used for large base load plants. Due to the operation of reservoir type power plant, seasonal regulation of river water is expected although highly depending on the magnitude of storage capacity of a reservoir and installed capacity of power plants (plant discharge). As introduced earlier, the ongoing Xiaowan project in China on the Mekong mainstream, having a active storage capacity of 11,500 million m^3, is expected to augment the dry season flow by around 555 m^3/s in the downstream of Mekong River.

Run-of-river scheme

Run-of-river scheme is a type of hydropower plant that releases water at the same rate as the natural river flow, i.e. outflow equals inflow. Typically a weir or barrage is built across a river and the water head created is used to generate power energy. The completed large-scaled run-of-river type hydropower plants of Manwan (1,500 MW) and Dachaoshan (1,350 MW) in China are both provided with over-100 m high dams to obtain such huge plant capacity (higher water head for power generation). Basic operation process of run-of-river power plant is as illustrated below.

Usually a run-of-river hydropower plant has limited storage capacity without flow regulation compared to a storage type, and only use river water when available. Its firm

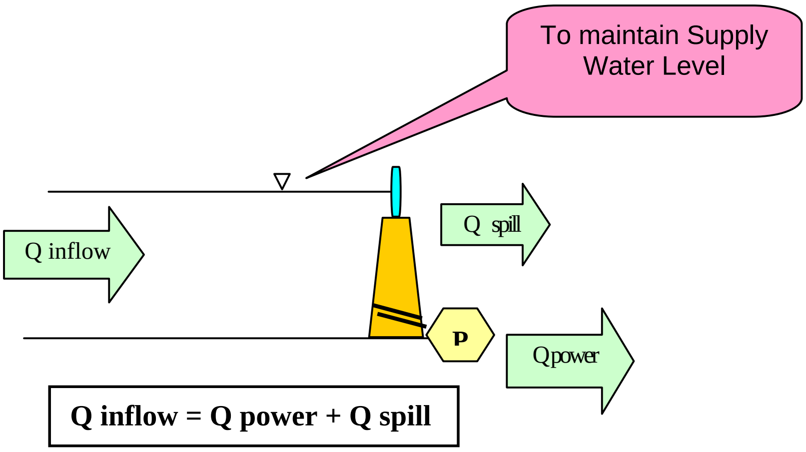


Fig. 2.7 Illustration of Run-of-river Type

capacity of power plant is low because the water available is not uniform throughout the year; however, it can serve as a base load plant. Some plants may have enough upstream pondage to provide partial flow regulation to meet daily power demand variations (peak load plant). Typical example of base load and peak load operations is shown below.

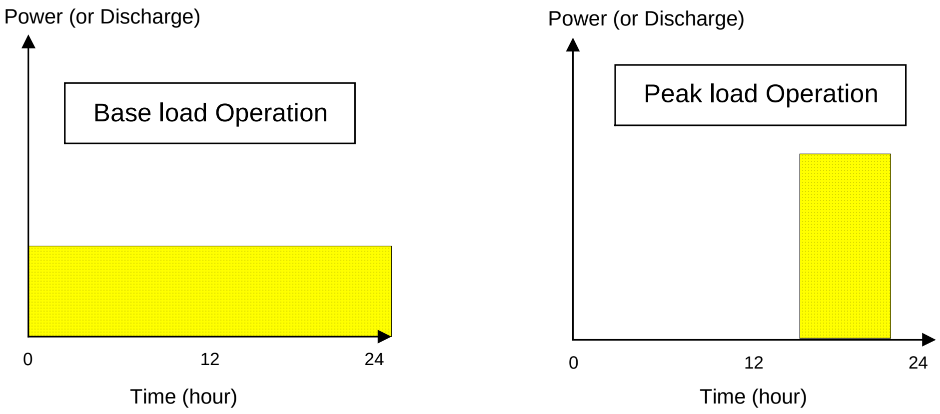


Fig. 2.8 Illustration of Base and Peak Load Operations

A peaking plant usually releases a large quantity of water during the day and little or no water during the night (off-peak) period. Constructing a downstream re-regulating pond can mitigate this situation. The pond collects the water from the power plant and releases them evenly over the 24-hour a day, or over the week where the cycle is weekly.

(3) Downstream flows of Run-of-river Type Power Plants

From the hydrological viewpoints on the likely influences to the downstream river flows due to the hydropower generation, run-of-river type hydropower plants would not cause significant impacts on the downstream flow regime, because no seasonal regulation capacity is provided.

As illustrated in Fig. 2.7, run-of-river plant operation is usually made to maintain the intake water supply level at reservoir or pondage for maximizing energy output. As a result, the outflow discharge comprising the spilling-out discharge and plant discharge for power generation is basically kept almost equal to the inflow discharge as the reservoir water level is maintained to the water supply level.

There are two huge run-of-river type hydropower plants in China. Both power plants have water storage on the Mekong mainstream with total effective capacity of 498 million m^3 as detailed below.

Table 2.9 Detailed Features of Existing Run-of-river Plants in China

Name of Power Plant	Storage Volume (million m^3)	Average Rated Head (m)	Firm Power (MW)	Installed Capacity (MW)	Plant Factor (%)	Utilisation Hours (hour)
Manwan	258	99	796 (314)	1,500	68.1	5,260
Dachaoshan	240	80	680 (276)	1,350	60.3	5,200

Note: See Tables 2.1 and 2.8 for other information on features. Firm power in bracket is based on the individual development instead of the cascade development.

Source: Yunnan Provincial Science and Technology Commission and Yunnan Institute of Geography (1993), Investigation and Study of the Current Status of the Lancang River-Mekong River Basin in Yunnan, P.R.C. Other related reports and international symposium papers.

The maximum plant discharges (Qmax) is defined as the discharge when full operation by means of the installed capacity is made. On the other hand, the firm discharge (Qf) is as the discharge for operation of firm power. These discharges at both stations are roughly estimated as follows:

Qmax of Manwan = 1,500,000 / (9.8 x 0.84 x 99) = approx. 1,840 m^3/sec

Qf of Manwan = 796,000 / (9.8 x 0.84 x 99) = approx. 980 m^3/sec

Qf of Manwan = 314,000 / (9.8 x 0.84 x 99) = approx. 390 m^3/sec

Qmax of Dachaoshan = 1,350,000 / (9.8 x 0.84 x 80) = approx. 2,050 m^3/sec

Qf of Dachaoshan = 680,000 / (9.8 x 0.84 x 80) = approx. 1,030 m^3/sec

Qf of Dachaoshan = 276,000 / (9.8 x 0.84 x 80) = approx. 420 m^3/sec

where, 1,500,000 and 1,350,000 : Installed capacity of power plant (kW)
9.8 : Acceleration of gravity (m/s^2)
0.84 : Combined efficiency of power plant (assumed)
99 and 80 : Rated head (m)

Table 2.10 Comparison of Estimated Maximum Plant Discharges and Firm Discharges of Existing Run-of-river Plants in China

Name of Power Plant	Average Annual Inflow (m^3/s)	Storage Volume (million m^3)	Maximum Plant Discharge (m^3/s)	Firm Discharge (m^3/s)
Manwan	1,230	258	1,840	980 (390)
Dachaoshan	1,230	240	2,050	1,030 (420)

Note: Firm discharge in bracket is based on the individual development instead of the cascade development.
Source: WUP-JICA Study Team

Usually the firm discharge (Qf) of run-of-river hydropower plant is determined as the discharge as the 95-97% discharge of inflow duration curve at a plant site. In other wards, the firm discharge is the ensured (guaranteed) discharge that river flow exceeding the firm discharge is expected with a probability of 95-97% over a long period. The firm power is also defined as the capacity that is guaranteed for 95-97% over a long period. The installed capacity is determined as the optimal development scale through optimization. The relationship between the maximum plant discharge and firm discharge is illustrated below.

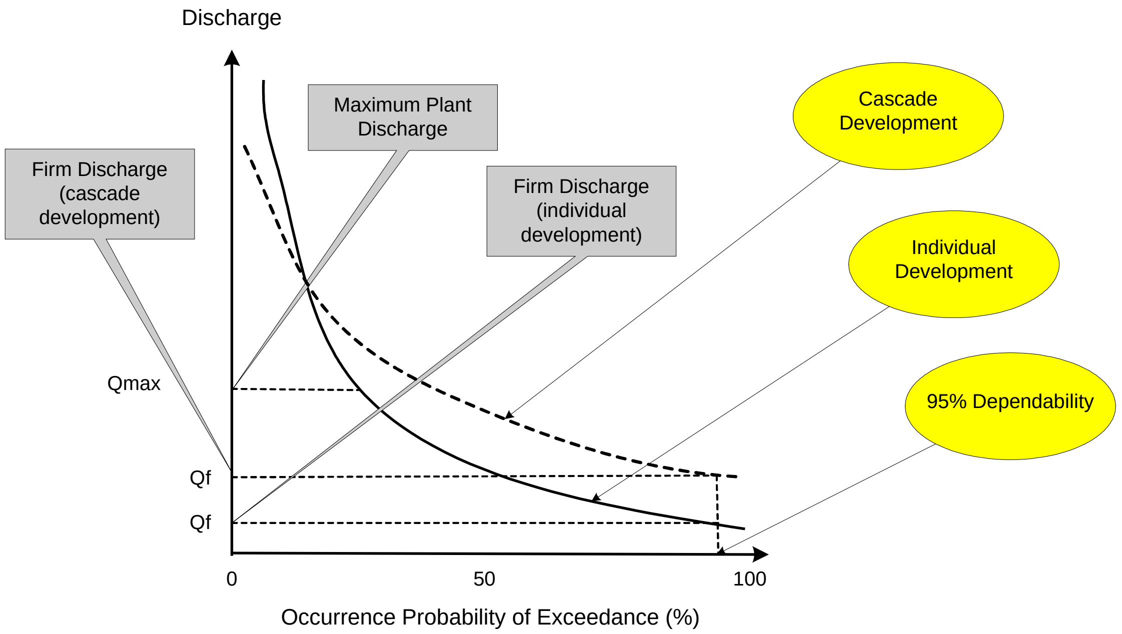


Fig. 2.9 Relationship between Maximum Plant Discharges and Firm Discharges

As shown above, the firm discharges at two run-of-river hydropower plants in China will be considerably increased after the completion of cascade development (the Xiaowan hydropower project in the upstream thereof). This is due to that the Mekong flow (or inflows into the reservoirs of run-of-river plant) is largely regulated by the large Xiaowan reservoir to be created (see the expected inflow duration curve change due to a cascade development as illustrated in Fig. 2.9). As a result, the annual energy out will be considerably increased.

Presently in the dry season, the Mekong flow decreases around 500-600 m^3/s on average at two these hydropower plants. Full operation that requires the plant discharge of more than 2,000 m^3/sec is thus difficult. Partial power generation is currently being made with a maximum use of the daily/weekly reservoir inflow volume, nevertheless whether it is operated in mode of “base load” or “peak load”. Fig. 2.10 in the next page presents typical operations of the run-of-river type power generation in view of comparison of inflow and outflow relationship both in the wet and dry seasons.

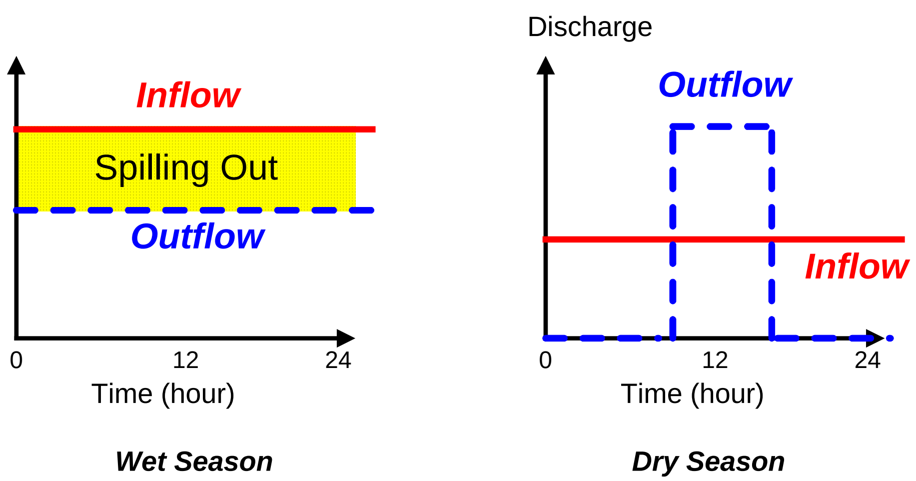


Fig. 2.10 Typical Run-of-River Type Operation in Wet and Dry Seasons

(4) Expected Low Flow Increase due to Reservoir Type Power Plants

It is likely that many reservoir type hydropower plants change the downstream flow regimes. Storage reservoirs retain wet season flows and use them to generate energy during the dry season.

The Nam Ngum hydropower plant having a large active storage of 4.7 billion m^3 is highly expected to increase the low flow regime on the Mekong mainstream as well as the Nam Ngum River (detailed discussion and analysis are made in Chapter 5).

On the other hand, the maximum plant discharge (Qmax) of the Houay Ho hydropower plant on the Se Kong River is roughly estimated as follows:

Qmax = 150,000 / (9.8 x 0.84 x 765) = approx. 24 m^3/sec

where, 150,000 : Installed capacity of generating equipment (kW)
9.8 : Acceleration of gravity (m/s^2)
0.84 : Combined efficiency of power plant
765 : Rated head (m)

The maximum plant discharge is expected at only around 24 m^3/s, although the installed capacity of 150,000 MW is the same as the Nam Ngum hydropower station. This is due to that the Houay Ho hydropower project harnesses the high water head for 765 m. The Houay Ho hydropower station would not significantly influence the low flow regime on the Se Kong River. Table 2.11 shows the monthly operation records of Houay Ho power station.

2.4 Surface Water Extraction for Domestic Water Supply

Actual domestic water usage by riparian countries is summarized below from the available information and reports. As discussed below, actual water usage is negligibly small compared to the flow in the Mekong River.

Lao PDR

The available surface water extraction amount at major pumping stations for domestic water supply as of 1999 in Lao PDR is summarized below.

Table 2.12 Major River Intakes for Domestic Water Supply in Lao PDR (1999)

Name	River	Water Extraction Amount
Luang Prabang	Nam Khan	8,000 m^3/day
Kaolieo (Vientiane)	Mekong	20,000 m^3/day
Chinaimo (Vientiane)	Mekong	77,800 m^3/day
Thangone (Vientiane)	Nam Ngum	480 m^3/day
Savannakhet	Mekong	7,200 m^3/day
Salavan	Xe Done	1,530 m^3/day
Pakse	Mekong	17,280 m^3/day
Total		**132,290 m^3/day (= 1.53 m^3/sec)**

Source: JICA Expert Report in Lao PDR, 2000

Based on the water extraction capacities above, the annual water supply in Lao PDR is roughly estimated at 48.3 million m^3/year in 1999, of which 74% was in Vientiane. In Luang Prabang, Sabanakhet and Pakse, the water productions are of the order of 3-6 million m^3 annually.

Thailand

No figures are available on the recent domestic water usage in the north-eastern part of Thailand. According to the ESCAP's report on Assessment of Water Resources and Water Demand by User Sectors in Thailand in 1991, the average annual volume of urban and rural water supply (1980-1989) in North-eastern Thailand was estimated at 92.3 million m^3, of 77.3 million m^3 which are for urban water supply and 15.0 million m^3 for rural water supply.

Cambodia

In Phnom Penh, there are three intakes on the Mekong and Tonle Sap Rivers for urban water supply as listed below.

Table 2.13 Major River Intakes for Domestic Water Supply in Cambodia (2002)

Name	River	Water Extraction Amount
Chrui Changvar	Mekong	65,000 m^3/day
Phnom Penh Port	Tonle Sap	100,000 m^3/day
Chang Kamong	Bassac	20,000 m^3/day
Total		**185,000 m^3/day (= 2.14 m^3/sec)**

Source: Phnom Penh Water Works

Urban water usage is estimated to be around 68 million m^3 annually based on the water extraction amount in the table above. The water extraction capacity of 2.14 m^3/sec represents about 0.09% of the mean monthly dry season flow of the Mekong at Phnom Penh (reportedly 2,500 m^3/sec in April when the flow becomes lowest in the dry season).

Photo: Chrui Changvar Intake on the Mekong in Cambodia

Vietnam

According to the Mekong Delta Master Plan in 1993, abstractions for urban and domestic water supply in the delta in 1990 were 52 million m^3, of which approximately 30% were supplied from groundwater. All of the 33 million m^3 of rural domestic water supply and the 12 million m^3 of industrial water supply were supplied from groundwater. The total domestic water supply is less than 1% of the estimated agricultural water supply. Groundwater abstractions for urban and rural domestic water supply were projected to double by 2000. Total projected domestic demand for the delta in 2000 was estimated as 400 million m^3, and total industrial demand for 2000 was estimated at 230 million m^3. These figures are over six times of the 1990 supply figures.

Table 2.14 Water Abstractions for Domestic Water Supply in 1990

(Unit: m3/day)

Purpose	Surface water	Groundwater
Urban	101,000 (1.2)	41,000 (0.5)
Rural	0	90,000 (1.0)
Industrial	0	34,000 (0.4)
Total	**101,000 (1.2)**	**165,000 (1.9)**

Note: Figures in a parenthesis are in m^3/s.
Source: Mekong Delta Master Plan, 1993

Table 2.15 Projected Domestic Water Demand in 2000 and 2015 for Entire Mekong Delta

(Unit: m3/day)

Year	Domestic	Other	Total
2000	1,087,000 (12.6)	630,400 (7.3)	1,717,400 (19.9)
2015	2,238,700 (25.9)	1,202,000 (13.9)	3,441,200 (39.8)

Note: Base year for projection is 1990. Figures in a parenthesis are m^3/s.
Source: Mekong Delta Master Plan, 1993

2.5 Operation Records of Existing Flow-Regulating Facilities

At the writing of this document no historical operational records of the existing water-regulating facilities are available at MRCS with an exception of the Nam Ngum reservoir in Lao PDR. Records of these facilities are very important and useful for evaluating the historical water usage in the whole Lower Mekong Basin. Furthermore they might be essentially required for calibration of the basin modelling when it appears that historical water usage has a significant effect on the hydrologic flow regime of the Lower Mekong mainstream.

The historic operational records to date (physical performance of the water resources development projects) might be available at respective responsible agencies in member countries. Limited operational records are available in several past planning studies.

2.6 Seasonal Regulation Rate of Mekong Flow by Major Reservoirs

At present the total capacity of existing large-scale reservoirs in the entire Mekong River basin amounts to approx. 12,147 million m^3.

As mentioned earlier two existing large reservoirs in China would have no seasonal regulating capacity on the Mekong River water, because they are basically operated for run-of-river type power generation. Thus it is suggested that the total capacity of seasonal regulation reservoirs is around 11,649 million m^3.

The seasonal regulation rate of all of the existing major reservoirs is roughly estimated to be around 2.5% as follows:

Average annual flow volume of the entire Mekong River = 475,000 million m^3

Seasonal regulation rate = 11,649 / 475,000 x 100 = 2.5%

Note: Average annual flow volume data was from the Mekong River Basin Diagnostic Study, MRC, 1997.

3. AVAILABLE INFORMATION ON IRRIGATION AREA IN LOWER MEKONG BASIN

3.1 Overview of Land Use in the Lower Mekong Basin

The approximately 75 million inhabitants (as of 1999) of the Mekong Basin, which has a total area of 795,000 km^2, depend on the natural resources to sustain livelihood. The Lower Mekong Basin (LMB) covers Cambodia, Lao PDR, Thailand and Vietnam with an area of 606,000 km^2, accounting for 76% of the entire Mekong Basin as tabulated below.

Table 3.1 Drainage Area of Mekong River Basin

Country	Area (km^2)	Area (%)	Area in LMB (km^2)	Area in LMB (%)
China	165,000	21		-
Myanmar	24,000	3	-	-
Lao PDR	202,000	25	202,000	33
Thailand	184,000	23	184,000	30
Cambodia	155,000	20	155,000	26
Vietnam	65,000	8	65,000	11
Total	**795,000**	**100**	**606,000**	**100**

Source: MRC

The table below gives an overview of estimated areas of land use by each riparian country within the Lower Mekong Basin as illustrated in Fig. 3.1 below.

Table 3.2 Land Use in the Lower Mekong Basin in 1997

(Unit:%)

Land Cover	Lao PDR	Cambodia	Thailand	Vietnam Delta	Vietnam Highlands	Viet Nam Total
Forest	40	54	16	0	43	21
Woodland/ grassland	42	15	3	0	25	13
Agriculture	14	23	79	84	29	57
Wetland/water	1	5	1	10	0	5
Other	2	0	0	4	0	2

Source: MRC Land Cover Dataset, 2001

The data is based on interpretations of remotely sensed Landsat TM imagery from 1997 and is a simplified version of a land cover map held by the MRC. Extensive areas of agriculture (mainly rice cultivation) are dominant on the Korat Plateau, the floodplains in Cambodia, the Mekong delta in Vietnam and around the Tonle Sap Lake. More than a third of the Lower Mekong Basin remained under forest cover in 1997. Much of this area is low-density deciduous forest in the north and east of the Cambodia plain. The main areas of tropical forest are in the more mountainous areas of Cambodia and southern and eastern Lao PDR. Northern Lao PDR is characterized by mixed forest with large areas of woodland, often associated with shifting cultivation.

In Vietnam there are significant differences of land use between the Mekong delta and Central Highland regions. The delta consists of almost entirely agricultural land with the majority of this being developed to paddy cultivation. Thus there is no significant forest area in the delta. On the other hand, the Central Highlands is 68% covered by forest, woodlands and grasslands. The Korat

Plateau, and the rest of the North-eastern region of Thailand, following rapid deforestation in the 1980s, are now almost 80% agricultural land. The soil is generally low in fertility and highly saline.

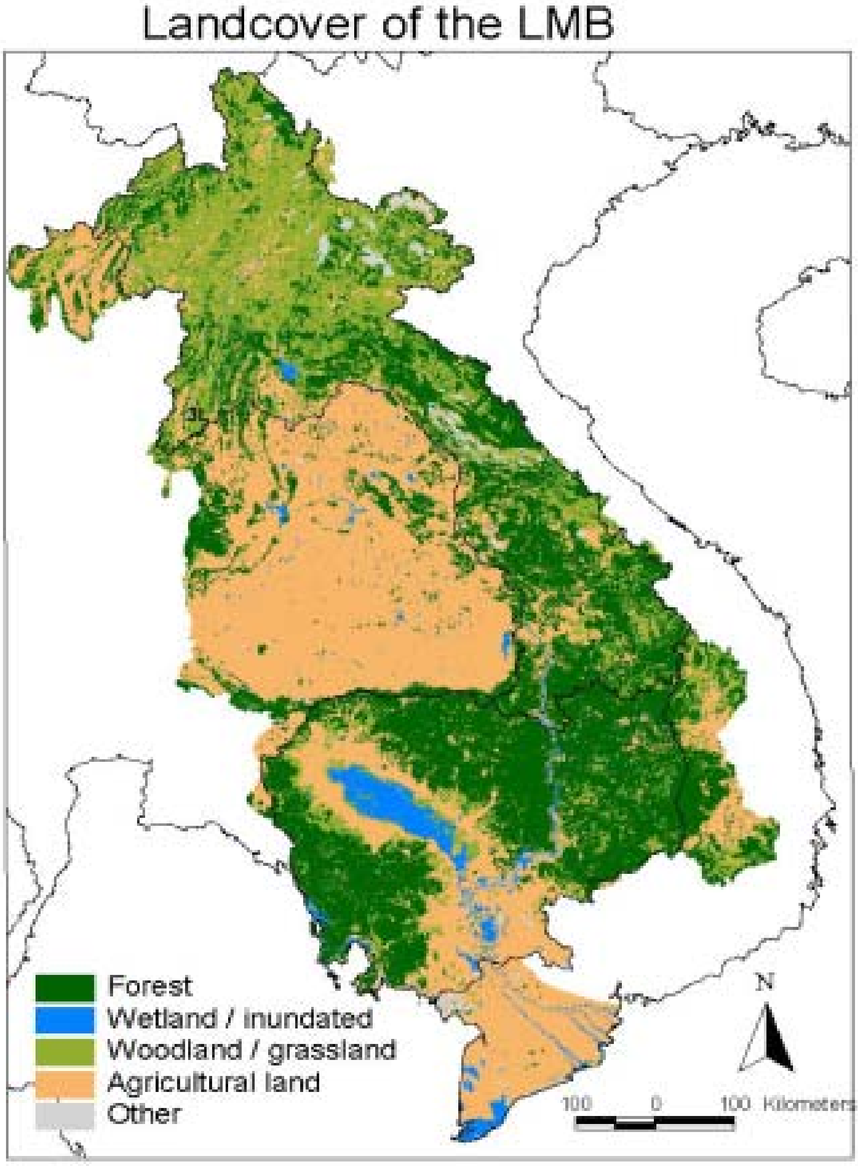


Fig. 3.1 Land Use in the Lower Mekong Basin (Source: MRC)

3.2 Historic Overview of Irrigation Areas

Agriculture is a predominant economic sector in the Lower Mekong Basin. About 75% of the region's population is dependent on agriculture and fisheries. Agriculture, with its vital issue of food security, has always been considered as one of the key sectors in development strategies of the riparian countries. It is also an important source of foreign-currency for Thailand and Vietnam, while agricultural activities are the mainstays of the Cambodian and Lao PDR economics and major providers of employment. The tables below show the contributions of the sector to GDP and national exports in the Lower Mekong basin area.

Table 3.3 Contributions of Agriculture and Forestry to GDP of Each Riparian Country

(Unit: %)

Sector	Cambodia		Lao PDR		Thailand		Vietnam	
	1995	1999	1990	1999	1993	1997	1990	1999
Crops	26.1	21.3	36.7	28.7	16.6	14.8	-	20.4
Livestock/Fisheries	13.4	15.2	20.7	18.5	4.3	3.5	-	2.3
Forestry	6.6	3.9	3.2	4.9	0	0	-	0.9
Total Share of GDP	**46.1**	**40.4**	**60.6**	**52.1**	**20.9**	**18**	**38.7**	**23.6**

Report Source: MRC, Basin Development Plan, Regional Sector Overview, Agriculture and Irrigation, November 2002

Source: Lao PDR Ministry of Agriculture and Forestry (2000), Thailand National Statistics Office (2000), Viet Nam General Statistical Office (1999), IMF (2002), IMF (2002), * includes entire country rather than only Mekong Basin Area.

Table 3.4 Contributions of Agriculture and Forestry to LMB Country Exports

(Unit: %)

Sector	Cambodia		Lao PDR		Thailand*		Vietnam	
	1995	1999	1995	1999	1993	2000	1995	1998
Share of Total Exports								
Agriculture	15	5	13	6	30	22	32	24
Forestry	69	16	39	29	0	0	3	2

Report Source: MRC, Basin Development Plan, Regional Sector Overview, Agriculture and Irrigation, November 2002

Source: Thailand National Statistics Office (1997, 2001), Viet Nam General Statistical Office (1999), IMF (2002), IMF (2002), * includes entire country rather than only Mekong Basin Area.

Historical review of irrigated areas was carried out for the riparian countries. The areas were collected from existing reports and others. The results of data collection are as summarised below.

3.2.1 Indicative Basin Plan in 1970

In 1970, the Committee for the Coordination of Investigations of the Lower Mekong Basin established the Indicative Basin Plan, which was proposed as a framework for the development of water and related resources of the Lower Mekong River Basin. The information included in the Indicative Basin Plan in 1970 pertaining to irrigation areas in the Lower Mekong Basin is as follows:

The total area commanded by irrigation projects amounted at to 213,000 ha within the Lower Mekong Basin of Lao PDR, Thailand and Cambodia in 1970. In Vietnam, some 60,000 ha of the Mekong delta was controlled artificially by either irrigation, drainage or salinity control. The total land under irrigation (272,750 ha) was less than 3% of the total cultivated area at that time (see Tables 3.5 and 3.6 in the next page).

Before 1970, the regularization of wet season water supply for rice cultivation was sufficient to meet the needs and there was little or no necessity to provide for multiple-cropping and dry season irrigation. As a consequence, the irrigated areas in Table 3.6 are of wet season paddy. Yield levels per hectare had varied little since the beginning of the century. Average yields of non-irrigated paddy in the better regions of the flood lands reached about 2,000 kg per crop ha. On the plateau, average yields did not go above 1,500 kg per ha, and in the hilly regions the average was lower, about 900-1,000 kg/ha.

Table 3.5 Cultivated Areas in Lower Mekong Basin (1965)

Zone	Gross Area (million ha)	Cultivated Area (million ha)	Remarks
Hills	16.0	0.6	
Plateau	41.6	6.3	Korat plateau, Vientiane plain, various tributary plains and Northern plains of Cambodia
Flood Plains	6.9	3.0	Below Kompong Cham extending to the sea
Total	**64.5**	**9.9**	

Source: Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1970), Report on Indicative Basin Plan

Table 3.6 Irrigated Areas in Lower Mekong Basin (1970)

Country	Irrigated Area (ha)	Remarks
Lao PDR	22,550	Command area of irrigation projects
Thailand	127,500	-ditto-
Cambodia	62,700	-ditto-
Vietnam	60,000	Artificially controlled water area
Total	**272,750**	

Source: Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1970), Report on Indicative Basin Plan

In addition, in Thailand and Cambodia, there were several irrigation projects under construction or likely to be completed before 1980, which would increase the irrigation area by at least 550,000 ha. In Vietnam, another water control development was contemplated to increase the area by an additional 250,000 ha. These developments would bring the total developed land close to 1.0 million ha.

As for Cambodia, Bovel project (command area: 45,000 ha), Western Baray project (13,000 ha), Prek Thnot multipurpose project (70,000 ha) and 35 smaller projects (29,675 ha) were included in the above projects. Although these command areas amount to 158,000 ha in total, these irrigation projects were not completed because of the political changes.

3.2.2 Revised Indicative Plan in 1987

Since the Indicative Basin Master Plan in 1970, there had been many changes in the political, economic, social and technical reality of the basin. The Plan in 1970 was revised reflecting changes above in 1987. The revised plan was called the Revised Indicative Plan. The information on irrigation at the time of the Revised Indicative Plan is as follows:

Some 13.5 million ha in total were cultivated. Across all four riparian countries, about 8.5 million ha were planted annually to paddy. The prevailing farming systems were predominantly based on rain-fed paddy cultivation. Farming practices were traditional and, use of modern inputs being limited, yields were low. The total irrigation area was less than 16% of the total cultivated area at that time is given in Table 3.7 below.

Lao PDR

An estimated 800,000 ha were cultivated annually, 700,000 ha of which are for rice. Supplementary irrigation of about 50,000 ha was available to the entire country, mostly from small weirs with little water control. About 20,000 ha received a relatively reliable water supply, and had improved primary and secondary irrigation infrastructure. Dry season irrigation, mostly pumped, was estimated at 8,000-13,000 ha, of which only 1,000 ha was cultivated intensively with full water control and adequate levels of inputs.

Thailand

Northeast Thailand had an arable land of some 8.5 million ha, but by far the lowest proportion of irrigated area. The irrigated area amounted to 0.5 million ha, which represented some 12% of the total farmland. Thailand had already developed a number of projects, which figured in the short-range plan under the Indicative Basin Plan in 1970.

Cambodia

Cambodia's irrigation infrastructure was in need of major repair, so that single rain-fed crop per year was possible at the time.

Vietnam

The cultivated area in the delta was 2.4 million ha, 2.0 million ha to paddy. Most of the delta could be irrigated to supplement wet season rainfall, with 25-30% of the cultivated area as double cropped, and a large part of the delta remained fallow.

Table 3.7 Irrigated Areas in Lower Mekong Basin (1987)

Country	Paddy Cultivated Area in LMB (million ha)	Irrigated Area (thousand ha)	Basin Yield (t/ha)
Lao PDR	0.7	60	1.9
Thailand	4.2	500	1.7
Cambodia	1.6	Negligible	1.1
Vietnam	2.0	1,600	3.7
Total	**8.5**	**2,150**	**2.1**

Note: Irrigated area in Lao PDR is for the entire country. Irrigated areas in Thailand and Vietnam are for the north-eastern Thailand and Mekong delta area, respectively.
Source: Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1988), Perspectives for Mekong Development

In Northeast Thailand, there was the area suffering from the lack of water, both in the dry season and during dry spells in the wet season, and from annual flooding which caused considerable loss of paddy production. In the other countries there was scope for expansion of the area under the plough. The national projects in the Revised Indicative Plan in 1987 consisted of 21 irrigation, 2 irrigation and power, and 3 power projects as given below.

Table 3.8 National Irrigation Projects in Lower Mekong Basin (1987)

Country	Total Command Area (ha)	Incremental Paddy Production (ton/year)
Laos	19,800	53,000
Thailand[1]	100,000	247,000
Vietnam	300,000	1,450,000
Total	**419,800**	**1,750,000**

Source: Committee for Coordination of Investigations of the Lower Mekong Basin (1988), Perspectives for Mekong Development

3.2.3 Other Existing Reports

In order to supplement the data aforementioned, other available reports were reviewed. The results are summarized below.

Lao PDR

Although Lao PDR still has significant amounts of unused land resources, most of the available arable land is located in the south, while demand is highest in the north. Arable land amounts to between 2 and 2.3 million ha (8-9% of the country's total area), but only about half of this is currently under cultivation. On the other hand, over 400,000 ha are cultivated on slopes of more than 20%.

The use of irrigation in Lao PDR has expanded rapidly over the 1990s, with the government reporting an eight-fold increase in irrigated area over the decade. However, the irrigation area is largely confined to the relatively affluent lands of the Mekong corridor, and remains a rarity in the upland areas.

Table 3.9 Historic Irrigated Area (1990-2000) in Lao PDR

Year	Wet-Season (ha)	Dry-Season (ha)	Total (ha)
1990/91	136,000	16,000	152,000
1991/92	138,000	18,000	156,000
1992/93	140,000	20,000	160,000
1993/94	145,000	22,000	167,000
1994/95	150,100	26,000	176,100
1995/96	156,000	28,000	184,000
1996/97	164,000	45,000	209,000
1997/98	216,892	75,000	291,892
1998/99	258,200	124,231	382,431
1999/00	295,535	197,131	492,666
2000/01	300,054	214,361	514,415

Source: Department of Irrigation, Ministry of Agriculture and Forestry (2001), Statistics of Irrigation in 2001

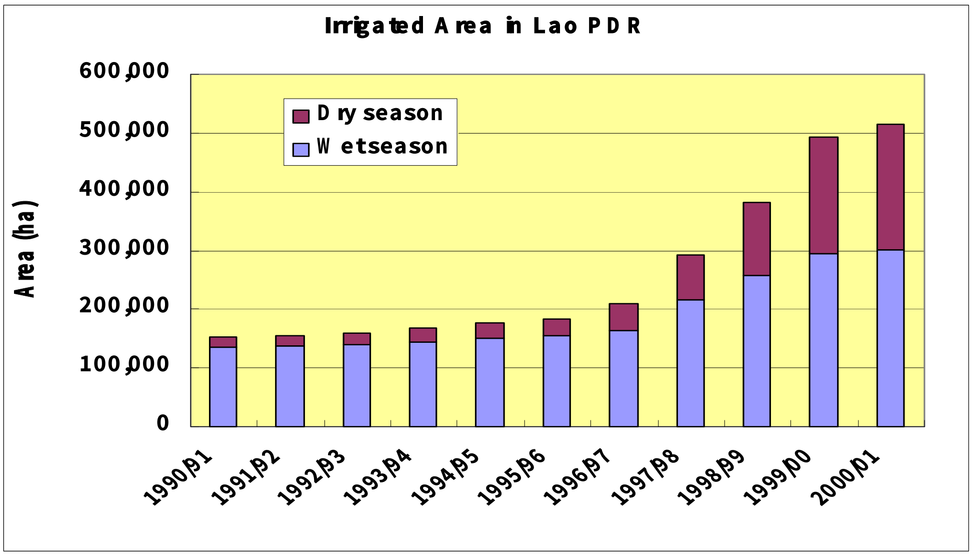


Fig. 3.2 Areas of Irrigated Land in Lao PDR (1990-2000)

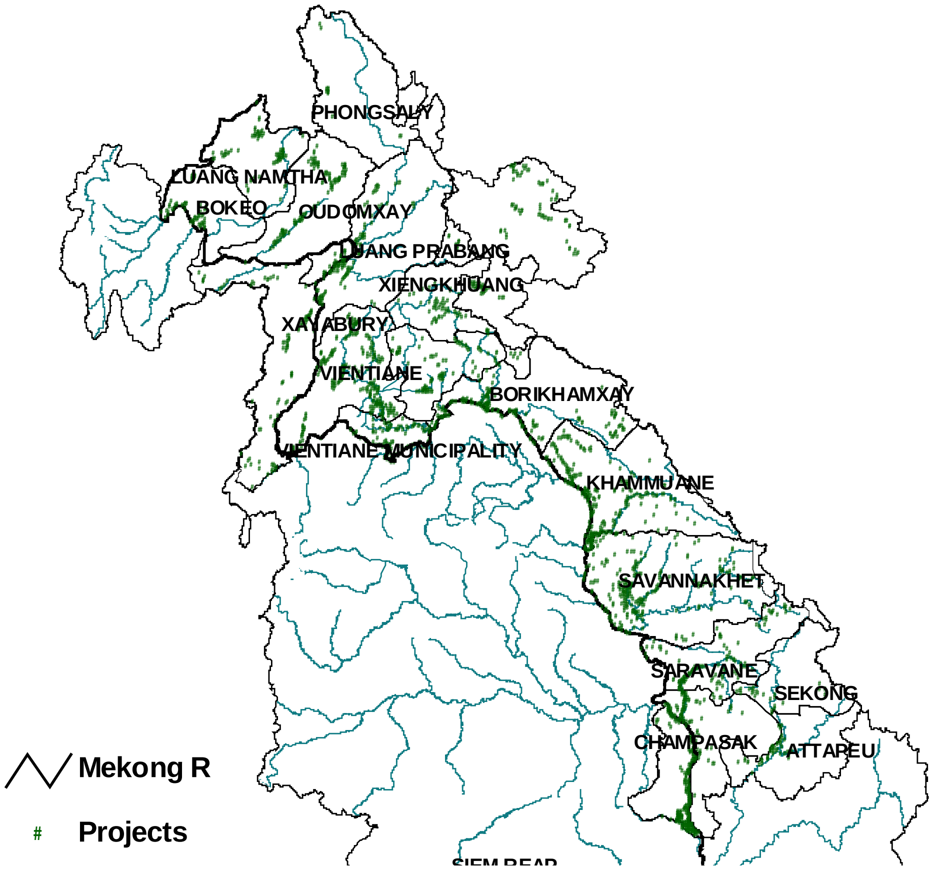


Fig. 3.3 Irrigation Projects in Lao PDR from MRC Irrigation Database

As seen in Fig. 3.2 above, the irrigated areas have expanded rapidly in 1996-2000, with a remarkable increase of dry season irrigation. The dry season crop is usually rice, but there is increasing diversification to other crops like maize, vegetable, tobacco and fruits. Figure 3.3 shows the irrigation areas from the MRC Irrigation Database. As seen in Table 3.12 below, the largest areas of both dry and wet season irrigation are in the Savannakhet province in the southern region and Vientiane Municipality.

Table 3.10 Existing Irrigation Schemes in Lao PDR

Types of Scheme	Number of Scheme	Irrigated Area (ha)		Area per Scheme (ha)	
		Wet Season	Dry Season	Wet Season	Dry Season
Weir	716	53,188	26,218	74	37
Reservoir	172	22,698	13,281	132	77
Pump	3,435	159,589	136,260	46	40
Sluice Gate	65	6,948	2,020	107	31
Traditional Weir	14,787	54,497	35,609	4	2
Gabion Weir	104	3,135	972	30	9
Total	**19,279**	**300,054**	**214,360**	**16**	**11**

Source: Department of Irrigation, Ministry of Agriculture and Forestry (2001), Statistic of Irrigation in 2001

Table 3.11 Existing Irrigated Area in Lao PDR (1995)

No.	Province	Irrigated Area (ha) Wet-Season	Irrigated Area (ha) Dry-Season	Total (ha)	Remarks
1	Vientiane Muni.	23,819	12,417	36,236	Central Region
2	Phonsaly	5,340	1,025	6,365	North Region
3	Louang Namtha	5,353	581	5,934	“
4	Oudomxay	8,576	932	9,508	“
5	Bokeo	3,576	578	4,154	“
6	Louang Prabang	4,332	1,606	5,938	“
7	Houa Phanh	8,177	1,005	9,182	Out of LMB
8	Xayaboury	13,340	1,373	14,713	North Region
9	Xieng Kouang	11,531	-	11,531	Central Region
10	Vientiane	17,647	2,311	19,958	“
11	Borikhamxay	4,290	210	4,500	“
12	Khammouane	7,180	4,390	11,570	“
13	Savannakhet	15,790	4,853	20,643	“
14	Saravane	2,110	710	2,820	South Region
15	Sekong	577	82	659	“
16	Champasack	11,113	1,550	12,663	“
17	Attaphou	2,119	75	2,194	“
18	Saysomboun	3,273	19	3,292	Central Region
	Total	**148,143**	**33,717**	**181,860**	

Source: Sustainable Irrigated Agriculture Project (SIRAP), Special Report, National Conference on Irrigation Management Transfer, Vientiane ,Lao PDR, 1996

Table 3.12 Existing Irrigated Area in Lao PDR (2000/2001)

No.	Province	Irrigated Area (ha) Wet-Season	Irrigated Area (ha) Dry-Season	Total (ha)	Remarks
1	Vientiane Muni.	42,352	36,722	79,074	Central Region
2	Phonsaly	4,065	1,326	5,391	North Region
3	Louang Namtha	7,343	3,509	10,852	“
4	Oudomxay	7,598	3,932	11,530	“
5	Bokeo	7,389	3,037	10,426	“
6	Louang Prabang	7,627	5,141	12,768	“
7	Houa Phanh	10,142	3,761	13,903	Out of LMB
8	Xayaboury	13,684	8,544	22,228	North Region
9	Xieng Kouang	12,221	2,623	14,844	Central Region
10	Vientiane	36,452	28,878	65,330	“
11	Borikhamxay	20,784	15,623	36,407	“
12	Khammouane	23,387	15,427	38,814	“
13	Savannakhet	42,194	35,615	77,809	“
14	Saravane	18,100	11,333	29,433	South Region
15	Sekong	2,655	1,485	4,140	“
16	Champasack	37,800	34,778	72,578	“
17	Attaphou	3,725	2,295	6,020	“
18	Saysomboun	2,536	332	2,868	Central Region
	Total	**300,054**	**214,361**	**514,415**	

Source: Department of Irrigation, Ministry of Agriculture and Forestry (2001), Statistic of Irrigation in 2001

Table 3.13 Existing Irrigation Area of Mekong Basin in Lao PDR (2000)

Item	Unit	Whole Country (1)	Central Mekong River of Loa PDR							
			Vientiane Mun.	Vientiane	Bori Khan Xay	Hamm-uan	Avann-akhe	Saravan	Total (2)	Rate (%) (2)/(1)
1. Gravity System										
(1) Reservoirs										
Number	No	149	7	8	9	5	37	10	76	51
Wet Season Area	ha	20,204	6,130	2,075	2,378	470	3,942	155	15,150	75
Dry Season Area	ha	11,750	4,983	1,045	1,255	223	2,254	55	9,815	84
(2) Weirs										
Number	No	643	3	56	10	11	40	27	147	23
Wet Season Area	ha	48,164	600	9,483	1,380	1,485	1,840	5,595	20,383	42
Dry Season Area	ha	23,226	171	4,514	560	424	696	4,637	11,002	47
(3) Other										
Number	No	15,072	2,502	261	238	10	23	6	3,040	20
Wet Season Area	ha	73,840	5,567	6,249	5,779	675	2,468	43	20,781	28
Dry Season Area	ha	36,887	5,437	1,811	3,732	595	1,758	10	13,343	36
(4) Total										
Number	No	15,864	2,512	325	257	26	100	43	3,263	21
Wet Season Area	ha	142,208	12,297	17,807	9,537	2,630	8,250	5,793	56,314	40
Dry Season Area	ha	71,863	10,591	7,370	5,547	1,242	4,708	4,702	34,160	48
2. Pumping System										
Number	No	3,306	89	78	158	176	158	237	896	27
Wet Season Area	ha	153,327	26,555	14,365	10,338	21,007	38,650	9,192	120,107	78
Dry Season Area	ha	125,269	20,520	10,634	10,363	17,250	28,657	7,703	95,127	76
3. Grand Total(1+2)										
Number	No	19,170	2,601	403	415	202	258	280	4,159	22
Wet Season Area (1)	ha	295,535	38,852	32,172	19,875	23,637	46,900	14,985	176,421	60
Dry Season Area (2)	ha	197,132	31,111	18,004	15,910	18,492	33,365	12,405	129,287	66
4. Irrigation Ratio										
Farm Area (3)	ha	1,045,000	83,300	73,100	45,200	54,900	150,000	84,500	491,000	47
Wet Season Area (1)/(3)	%	28	47	44	44	43	31	18	37	-
Dry Season Area (2)/(3)	%	19	37	25	35	34	22	15	26	-

Source: Department of Irrigation, Ministry of Agriculture and Forestry

Thailand

Irrigation ratios are much lower in the north-eastern Thailand, where farming methods remain comparatively traditional, than elsewhere in the country. There are huge variations in the scale and type of irrigation schemes in this north-eastern Thailand area. The largest individual scheme is the around 50,000 ha Lam Pao project in the country, while the smallest are simple manual lift operations irrigating less than a hectare. The most basic systems provide only supplementary water during the wet season, while more intensive schemes have the capacity to grow 2-3 crops per year. Major types of irrigation systems include: river, lake, or stream diversion by gravity for wet season supplementary irrigation without storage; pumping of water from rivers in the wet or dry season without storage; reservoir systems storing water from streams, rivers and runoff, and employing gravity or pump-based abstraction; and flood recession reservoir systems using floodwaters for land preparation and wet or dry season irrigation.

Various large-scale irrigation projects have been completed on the Chi and Mun Rivers, but very strong local opposition to dam projects has made it difficult for the government to undertake further large and medium scale developments. Furthermore, water scarcity is a major concern. Water shortages prevent full utilization of existing irrigation works in the dry season and there are even reports of water shortages in the wet season.

Table 3.14 Existing Irrigation Area of Mekong Basin in Thailand

River Basin & Province	Large Scale		Medium Scale		Small Scale		Pumping		Total Irrigation Area (ha)	Total Farm Area (10^3 ha)	Irrigation Rate (%)
	No of Project	Irrigation Area (ha)	No of Project	Irrigation Area (ha)	No of Project	Irrigation Area (ha)	No of Project	Irrigation Area (ha)			
1. Khong Basin											
(1) North Khong Basin											
Loei	-	-	13	20,740	168	15,490	30	10,050	46,280	370	12
North bua lumphu	-	-	1	320	72	15,070	23	5,660	21,050	236	9
Nong Khai	-	-	8	2,320	147	11,020	108	43,790	57,130	420	14
Udon Thani	1	13,920	14	5,090	214	14,480	23	6,420	39,910	606	7
Sakon Nakhon	1	29,730	22	22,160	167	28,230	34	10,980	91,100	474	19
Sub Total	**2**	**43,650**	**58**	**50,630**	**768**	**84,290**	**218**	**76,900**	**255,470**	**2,106**	**12**
(2) East Khong Basin											
Nakhon Phanom	-	-	14	7,330	142	10,590	-	-	17,920	251	7
Mukdahan	-	-	8	5,410	92	8,000	30	11,340	24,750	131	19
Yasotjon	-	-	2	2,940	165	11,650	40	16,390	30,980	290	11
Amnat Charoen	-	-	4	3,710	67	5,050	-	-	8,760	180	5
Ubon Ratchathani	1	25,490	8	7,580	171	9,150	90	37,180	78,950	780	10
Sub Total	**1**	**25,940**	**36**	**26,970**	**637**	**44,440**	**160**	**64,910**	**162,260**	**1,632**	**10**
Total	**3**	**69,590**	**94**	**77,600**	**1,405**	**128,730**	**378**	**141,810**	**417,730**	**3,738**	**11**
2. Chi and Mun Basin											
(1) Chi Basin											
Chaiyaphum	2	17,200	14	29,810	298	29,100	62	20,270	96,380	535	18
Khon kaen	1	42,240	15	5,990	400	24,690	-	-	72,920	673	11
Kalasin	1	50,410	18	11,170	187	11,700	47	17,140	90,420	394	23
Maha Sarakhan	-	-	19	20,260	281	18,600	73	27,990	66,850	423	16
Roiet	-	-	11	42,710	274	18,700	92	39,640	101,050	539	19
Sub Total	**4**	**109,850**	**77**	**109,940**	**1,440**	**102,790**	**274**	**105,040**	**427,620**	**2,564**	**17**
(2) Mun Basin											
Nakhon Ratchasima	6	81,070	35	19,990	492	54,420	41	15,440	170,920	1,252	14
Buri Ram	1	10,940	14	10,570	302	30,030	50	17,310	68,850	620	11
Surin	-	0	20	18,160	280	31,670	36	10,900	60,730	549	11
Sisaket	-	0	12	11,380	270	31,100	38	14,910	57,390	534	11
Sub Total	**7**	**92,010**	**81**	**60,100**	**1,344**	**147,220**	**165**	**58,560**	**357,890**	**2,955**	**12**
Total	**11**	**201,860**	**158**	**170,040**	**2,784**	**250,010**	**439**	**163,600**	**785,510**	**5,519**	**14**
Grand Total	**14**	**271,450**	**252**	**247,640**	**4,189**	**378,740**	**817**	**305,410**	**1,203,240**	**9,257**	**13**
Whole Country	**85**	**1,864,000**	**523**	**1,021,000**	**8,489**	**1,417,000**	**777**	**640,000**	**4,942,000**	**21,200**	**23**

Source: RID

Table 3.15 Summary of Existing Irrigation Schemes in North-eastern Thailand (1/2)

Scheme	Total Irrigation Area (ha)	Active Storage (Mm^3)	Irrigation Demand (million m^3)				
			Wet	Dr y (1)		Dry (2)	
			(Mm^3)	(Mm^3)	CI (%)	(Mm^3)	CI (%)
Chi Basin							
Large Scale	102,259	3,100	818	1,080	60	720	40
Medium Scale	49,491	346	396	79	20	40	10
Pumping	72,480	-	413	545	60	364	40
Sub-Total	**224,230**	**3,446**	**1,627**	**1,704**		**1,124**	
Mun Basin							
Large Scale	56,097	1,570	449	592	60	395	40
Medium Scale	48,912	342	391	78	20	39	10
Pumping	28,800	-	164	217	60	145	40
Sub-Total	**133,809**	**1,912**	**1,004**	**887**		**579**	
Mekong Tributary							
Large Scale	83,168	769	665	878	60	586	40
Medium Scale	44,328	310	354	71	20	35	10
Pumping	61,440	-	350	463	60	308	40
Sub-Total	**188,936**	**1,079**	**1,369**	**1,412**		**929**	
Small Scale	200,000	1,000	1,140	114	10	57	5
Total	**746,975**	**7,437**	**5,140**	**4,117**		**2,689**	

Note: (1) High cropping intensity, (2) Moderate cropping intensity

Report: Mekong Irrigation Programme, Volume5: Study of a Water Resources, Development Plan for Northeast Thailand, May 1991

Table 3.15 Summary of Existing Irrigation Schemes in North-eastern Thailand (2/2)

Scheme	Total Irrigation Area (ha)	Irrigated Area (ha)				
		Wet	Dry (1)		Dry (2)	
		Area	CI (%)	Area	CI (%)	Area
Chi Basin						
Large Scale	102,259	102,259	60	61,355	40	40,904
Medium Scale	49,491	49,491	20	9,898	10	4,949
Pumping	72,480	72,480	60	43,488	40	28,992
Sub-Total	224,230	224,230		114,741		74,845
Mun Basin						
Large Scale	56,097	56,097	60	33,658	40	22,439
Medium Scale	48,912	48,912	20	9,782	10	4,891
Pumping	28,800	28,800	60	17,280	40	11,520
Sub-Total	133,809	133,809		60,720		38,850
Mekong Tributary						
Large Scale	83,168	83,168	60	49,901	40	33,267
Medium Scale	44,328	44,328	20	8,866	10	4,433
Pumping	61,440	61,440	60	36,864	40	24,576
Sub-Total	188,936	188,936		95,631		62,276
Small Scale	200,000	200,000	10	20,000	5	10,000
Total	**746,975**	**746,975**		**291,092**		**185,971**

Note: (1) High cropping intensity, (2) Moderate cropping intensity

Report: Mekong Irrigation Programme, Volume5: Study of a Water Resources, Development Plan for Northeast Thailand, May 1991

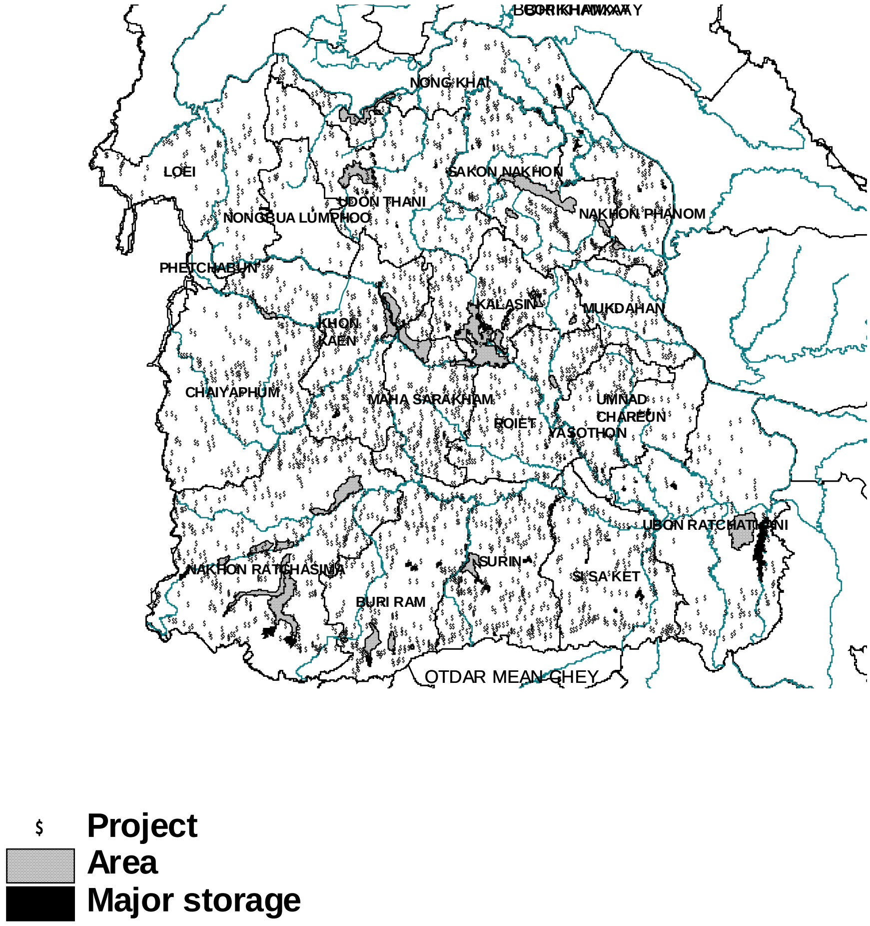


Fig. 3.4 Irrigation Projects in North-eastern Thailand from MRC Irrigation Database

Cambodia

Irrigation in Cambodia by the annual floods is dominant with large parts of the irrigation area using the receding floodwaters as the source of irrigation water. Irrigated recession rice is gradually replacing the lower yielding traditional floating rice. Pumping is also a major feature of Cambodian irrigation, traditionally this was done manually but petrol propelled pumps are gradually becoming more common.

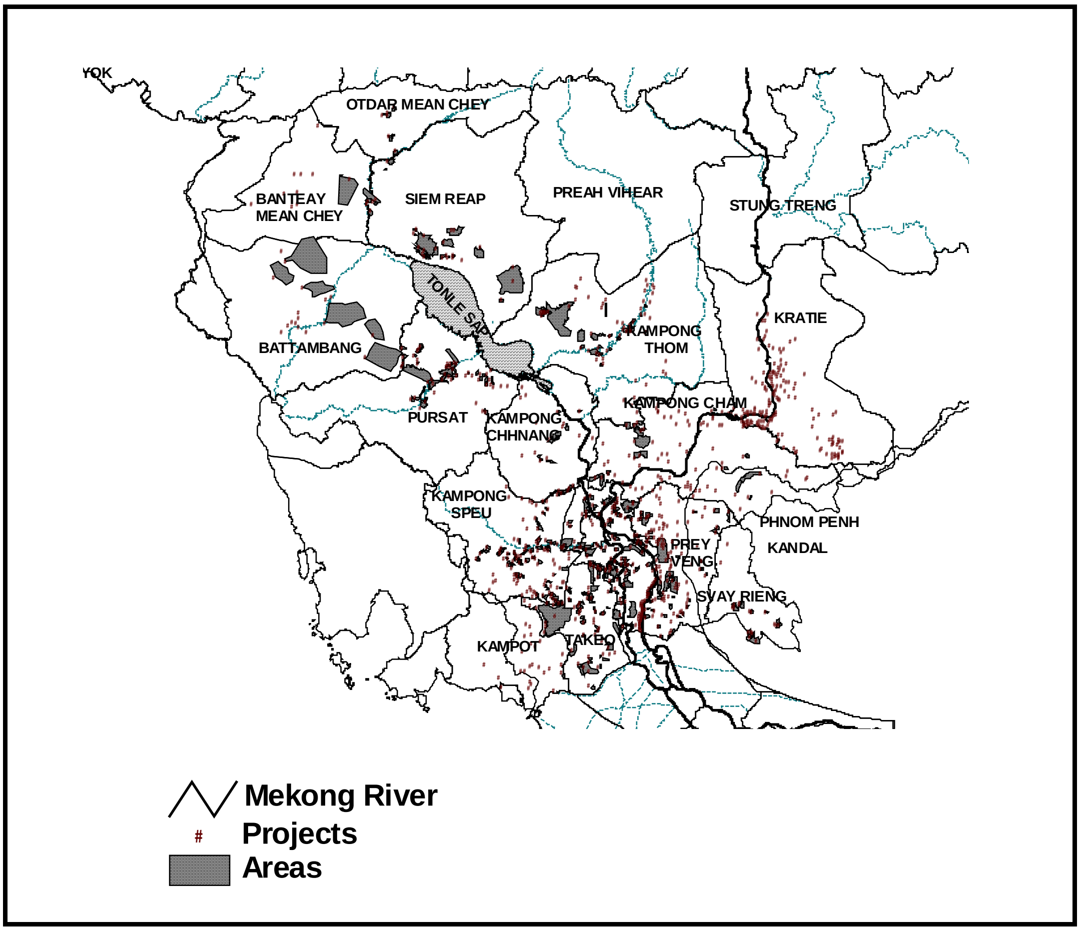


Fig. 3.5 Irrigation Projects in Cambodia from MRC Irrigation Database

Table 3.16 Area of Rice Production by Year in Cambodia

Year	Cultivated Areas (thousand ha)			Harvested Area (thousand ha)	Yield (ton/ha)	Production (thousand ton)
	Total	Dry-Season	Wet-Season			
1979-80	774	88	686	700	0.77	538
1980-81	1,441	95	1,346	1,440	1.19	1,717
1981-82	1,493	150	1,343	1,317	1.13	1,490
1982-83	1,674	128	1,546	1,615	1.20	1,949
1983-84	1,740	116	1,624	1,612	1.26	2,039
1984-85	1,418	119	1,299	978	1.29	1,260
1985-86	1,462	117	1,345	1,450	1.25	1,812
1986-87	1,535	122	1,413	1,520	1.37	2,093
1987-88	1,378	129	1,249	1,370	1.32	1,815
1988-89	1,879	144	1,735	1,825	1.36	2,500
1989-90	1,932	145	1,787	1,861	1.43	2,672
1990-91	1,890	150	1,740	1,855	1.34	2,500
1991-92	1,910	149	1,761	1,719	1.39	2,400
1992-93	1,844	143	1,701	1,685	1.31	2,221

Source: Bulletin of Statistics and Agricultural Studies No 1, Department of Planning and Statistics, Ministry of Agriculture, 1993

Table 3.17 Inventory of Existing Irrigation Systems in Cambodia (1992/93)

Province	Number of Systems Reported[2]	Total Area of Systems Reported (ha)[1]	
		Wet-Season	Dry-Season
Banteay Meanchey	12	9,120	93
Battambang	16	23,990	507
Pursat	47	4,317	0
Kompong Chhnang	18	5,615	709
Kompong Speu	96	18,558	743
Kampot	23	4,980	1,370
Takeo	49	12,445	41,640
Kandal[2]	114	11,582	21,200
Prey Veng	104	8,080	17,322
Svay Rieng	18	243	315
Kompong Cham	78	24,270	3,325
Kratie	165	2,547	3,317
Kompong Thom	64	32,720	1,370
Siem Reap	37	14,260	11,745
Total	**841**	**172,727**	**103,656**

Note: [1]Excludes systems less than 10 ha in area. [2]Includes 2 systems in Phnom Penh Municipality.

Source: Irrigation Rehabilitation Study in Cambodia, Inventory & Analysis of Existing Systems, April 1994

Table 3.18 Cropping Patterns and Yields in Cambodia

Province	Number of Operational Systems				Average Yield (ton/ha)	
	Wet Season	Double	Recession	Total	Wet Season	Dry Season
Banteay Meanchey	1	7	0	8	0.8	0.9
Battambang	4	2	0	6	2.3	3.0
Pursat	15	0	0	15	1.3	-
Kompong Chhnang	12	1	5	18	1.3	2.2
Kompong Speu	73	21	0	94	1.3	2.0
Kampot	9	10	0	19	1.7	2.2
Takeo	7	15	27	49	1.2	2.0
Kandal	11	8	94	113	1.9	3.3
Prey Veng	25	27	47	99	1.2	2.0
Svay Rieng	1	4	0	5	1.2	1.7
Kompong Cham	31	10	21	62	1.5	1.3
Kratie	53	0	88	141	2.1	2.2
Kompong Thom	43	17	0	60	1.2	1.8
Siem Reap	19	4	14	37	1.6	2.2
Total	**304**	**126**	**296**	**726**	**1.4**	**2.2**

Source: Irrigation Rehabilitation Study in Cambodia, Inventory & Analysis of Existing Systems, April 1994

Table 3.19 Existing Irrigated Areas in Cambodia (1990)

Province	Harvested Area (thousand ha)			Irrigated Area (thousand ha)
	Wet-Season	Dry-Season	Total	
Banteay Meanchey	79.0	0.06	79.1	31.0
Siem Reap	131.7	4.1	135.8	13.5
Preah Vihear	11.7	-	11.7	0.3
Stung Treng	9.5	-	9.5	0.8
Ratanakiri	10.9	-	10.9	0.2
Mondulkiri	4.9	-	4.9	0.2
Kratie	23.7	5.3	29.0	7.0
Kompong Thom	110.7	0.6	111.3	37.0
Battambang	89.8	0.8	90.6	46.0
Pursat	51.4	0.007	51.4	22.0
Kompong Chhnang	52.6	4.8	57.4	16.0
Kompong Cham	151.1	18.4	169.5	18.0
Svay Rieng	146.6	0.7	147.3	13.0
Prey Veng	212.1	22.4	234.5	14.0
Kandal	35.4	32.5	67.9	15.0
Takeo	155.5	38.0	193.5	30.0
Kompong Speu	35.4	1.0	36.4	22.0
Koh Kong	3.9	-	3.9	0.6
Kampot	67.4	0.9	68.3	18.2
Kompong Som	8.9	-	8.9	-
Phnom Penh	10.0	0.6	10.6	1.1
Total	**1,402.2**	**130.2**	**1,532.4**	**305.9**

Source: Cambodia Agricultural Development Options Review (Phase I), Sector Review Vol. 2, 1994

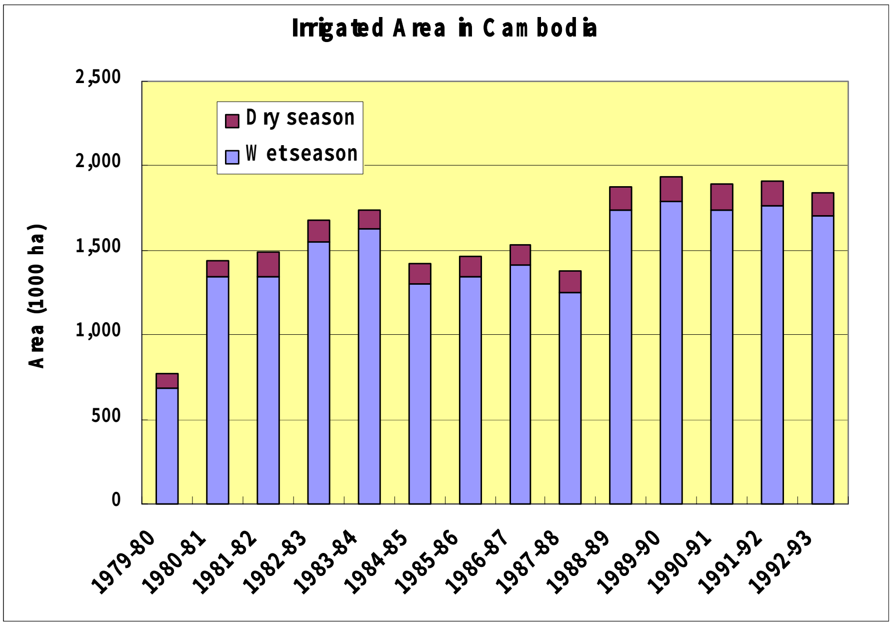


Fig. 3.6 Areas of Irrigated Land in Cambodia (1979-1993)

Vietnam

Irrigation is extremely important in the Mekong delta region, and forms the basis of the very high productivity of this area. More than half of the total area of the delta is flooded during the wet season, which means that irrigation schemes have a critical role to play in allowing farmers to plan and examine the intensive rice cropping into the flood free period. The rapid rise in irrigation development has been as a result of intensive investment in irrigation and related flood and salinity control works with the Doi Moi economic reforms. Government planning and management of irrigation has been decentralized, with the provincial authorities now autonomous and self-financing many of the irrigation activities. Irrigation in the Highland area is less developed than in the delta, the main crops irrigated are upland rice and coffee.

Table 3.20 Existing Irrigated Rice Areas in Mekong Delta in Vietnam

Year	Summer Crop[1] (thousand ha)	Autumn Crop[1] (thousand ha)	Spring Crop[1] (thousand ha)	Annual Total (million ha)
1980	300	260	330	0.9
1981	380	400	320	1.1
1982	320	440	310	1.1
1983	500	400	330	1.2
1984	610	470	370	1.4
1985	550	530	430	1.5
1986	610	560	460	1.6
1987	580	560	500	1.6
1988	580	620	530	1.7
1989	590	750	640	2.0
1990	510	820	740	2.1
1991	770	880	810	2.5
1992	550	920	860	2.3
1993	660	940	860	2.5
1994	1,010	1,070	1,000	3.1

Note: [1]These areas were obtained by graph readings because only graphs are indicated in the report.

Source: Agricultural Water Control Institutions in Vietnam, Functions, Financing and Sustainability

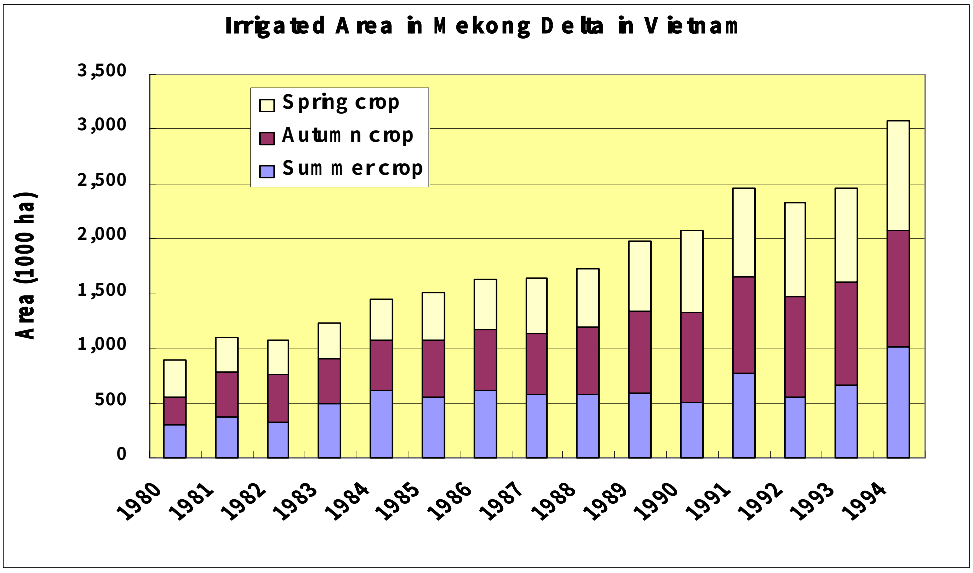


Fig. 3.7 Areas of Irrigated Land in Mekong Delta in Vietnam (1980-1994)

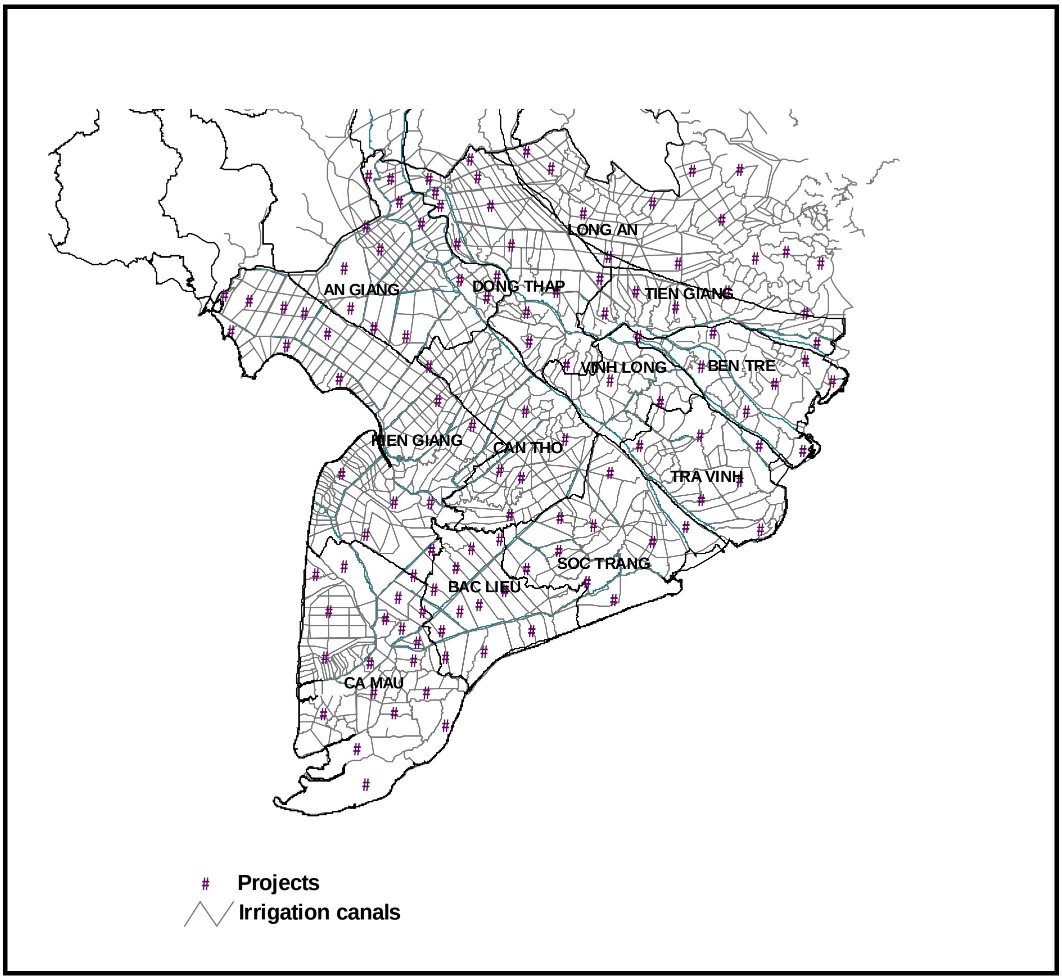


Fig. 3.8 Irrigation Projects in Mekong Delta in Vietnam from MRC Irrigation Database

Table 3.21 Cropping Patterns of Mekong Delta in Vietnam

Area	**Cropping Areas (ha)**				
	Triple Rice	**Double Rice**	**Upland**	**Perennials**	**Total**
In projects	49,823	614,406	72,518	220,000	956,747
In non-project	0	91,000	0	22,000	113,000
Total	**49,823**	**705,406**	**72,518**	**242,000**	**1,069,747**

Source: Mekong Delta Master Plan, Working Paper No. 3, Irrigation, Drainage and Flood Control, September 1991

Figure 3.9 shows the current cropping pattern in the Mekong delta.

3.3 Land Resources Inventory for Agricultural Development Project by MRC

MRC Secretariat completed a Land Resources Inventory for Agricultural Development Project (LRIAD), funded by the Ministry of Agriculture, Forestry and Fisheries of Japan, in June 2002. The main objective of LRIAD is to provide decision-makers and planners of the riparian governments with up-to-date data on land resources for sustainable agricultural development in the Lower Mekong Basin in coordination with MRC. Main outcomes of LRIAD are the irrigation, inundation and soil databases in the Lower Mekong Basin. The developed databases are of spatial GIS database with a good grounding.

The irrigation database consists of the following data sets for information:

(1) **Irrigation projects**: Each irrigation project has been digitized as a point, which represents the location.

(2) **Irrigation headworks:** Where the location of the project headwork has been clearly defined, these have been digitized as a point.

(3) **Irrigation area:** Command area of irrigation scheme has been digitized as a polygon.

(4) **Irrigation canals:** For the larger schemes, irrigation canals have been defined and digitized.

(5) **Reservoirs:** Reservoirs for irrigation purpose have been digitized as a polygon.

(6) **Irrigation data:** Attribute tables giving information on the irrigation projects are included in dbf (data base files) format possibly to link with the spatial information files. These tables provide key information on the project, including general description, project status, irrigated cropping data, investment information, government administration, hydrology and others.

The number of irrigation projects totally collected is 12,469 as summarized below.

Table 3.22 Summary of Irrigation Projects under LRIAD in Lower Mekong Basin

Country	Number of Scheme	Area of Wet Season Irrigation (ha)	Area of Dry Season Irrigation (ha)	Area of 3rd Season Irrigation (ha)	Irrigated Area (ha)
Lao PDR	2,532	224,232	151,940	0	224,232
Thailand	8,764	-	-	-	941,425
RID (medium/large)	441	330,056	72,140	0	330,056
RID (other)	291	-	-	-	-
RID (small)	5,497	-	-	-	-
DEDP	1,072	-	-	-	517,205
MOI	1,463	-	-	-	94,164
Cambodia	1,012	248,842	181,506	0	392,117
Vietnam	161	1,719,102	1,424,839	351,506	1,719,102
Mekong Delta	85	1,683,094	1,417,549	351,506	1,683,094
Highlands	76	36,008	7,290	-	36,008
Total	**12,469**	-	-	-	**3,276,876**

Note: Irrigation in Thailand is managed by three separate agencies. RID: Royal Irrigation Department, Ministry of Agriculture and Cooperatives. DEDP: Department of Energy Development and Promotion, Ministry of Science, Technology and Environment. MOI: Ministry of Interior

Source: MRC (2002), Land Resources Inventory for Agriculture Development Project, Technical Report, Part II

In the table above, in Thailand, there is no comprehensive wet or dry season cropping data; therefore, the irrigable area has been taken as the common measure of the irrigated area. Where wet and dry season irrigated areas are the measures of area irrigated, the irrigable area has been taken as the largest of the wet or dry season area. Further, irrigation area data on other 291 schemes is considered unreliable and has not been included. As for 5,491 small schemes in Thailand, there is no data on the actual irrigation area.

The table below presents the summary of status of the irrigation database under LRIAD.

Table 3.23 Summary of Status of Irrigation Database under LRIAD

Category	Lower Mekong Basin	Cambodia	Lao PDR	Thailand	Vietnam
Irrigation Project	12,469	803	2,532	8,764	161
Irrigation Area	4,449	361	701	2,218	196
Irrigation Headworks	12,460	324	2,532	8,764	258
Irrigation Canals	3,420	208	115	1,968	1,129
Irrigation Reservoirs	992	No data	414	578	No data

Source: MRC (2002), Land Resources Inventory for Agriculture Development Project, Technical Report, Part II

Assuming that irrigation projects with a service area of less than 100 ha are as minor water use, the total number of projects and irrigation areas are summarized as follows:

Table 3.24 Summary of Projects and Irrigation Areas under LRIAD

Item	Lao PDR	Thailand	Cambodia	Vietnam	Total
Intake from Mainstream					
Nos. of Project	101	143 [1)]	62	85 [3)]	
Whole Area (ha)	28,785	37,459 [1)]	32,190	1,683,094	1,781,528
Dry Season Area (ha)	23,085	No data	27,847	1,417,549	
Intake from Tributaries					
Nos. of Project	602	1,283 [2)]	324	None	
Whole Area (ha)	136,543	886,939 [2)]	237,452	None	1,260,934
Dry Season Area (ha)	89,995	No data	110,619	None	
Total Intake					
Nos. of Project	703	1,426	386	85 [3)]	
Whole Area (ha)	165,328	924,398	269,642	1,683,094	3,042,462
Dry Season Area (ha)	113,080	No data	138,466	1,417,549	

Note: 1): Data from the Study of Potential Development of Water Resources in Mae Khong River Basin, May 1994, Asian Institute of Technology.
2): JICA Study Team estimate (Total Intake – Intake from Mainstream).
3): Number of irrigation blocks that are further divided into many small projects.

Source: JICA, Hydro-Meteorological Monitoring for Water Quantity Rules in Mekong River Basin, Interim Report (Vol. 2), Water Use Management and Monitoring, February 2003

Figures 3.10 and 3.11 below are examples of the irrigation database maps. In Fig. 3.10, totally 12,469 irrigation projects are plotted as a point.

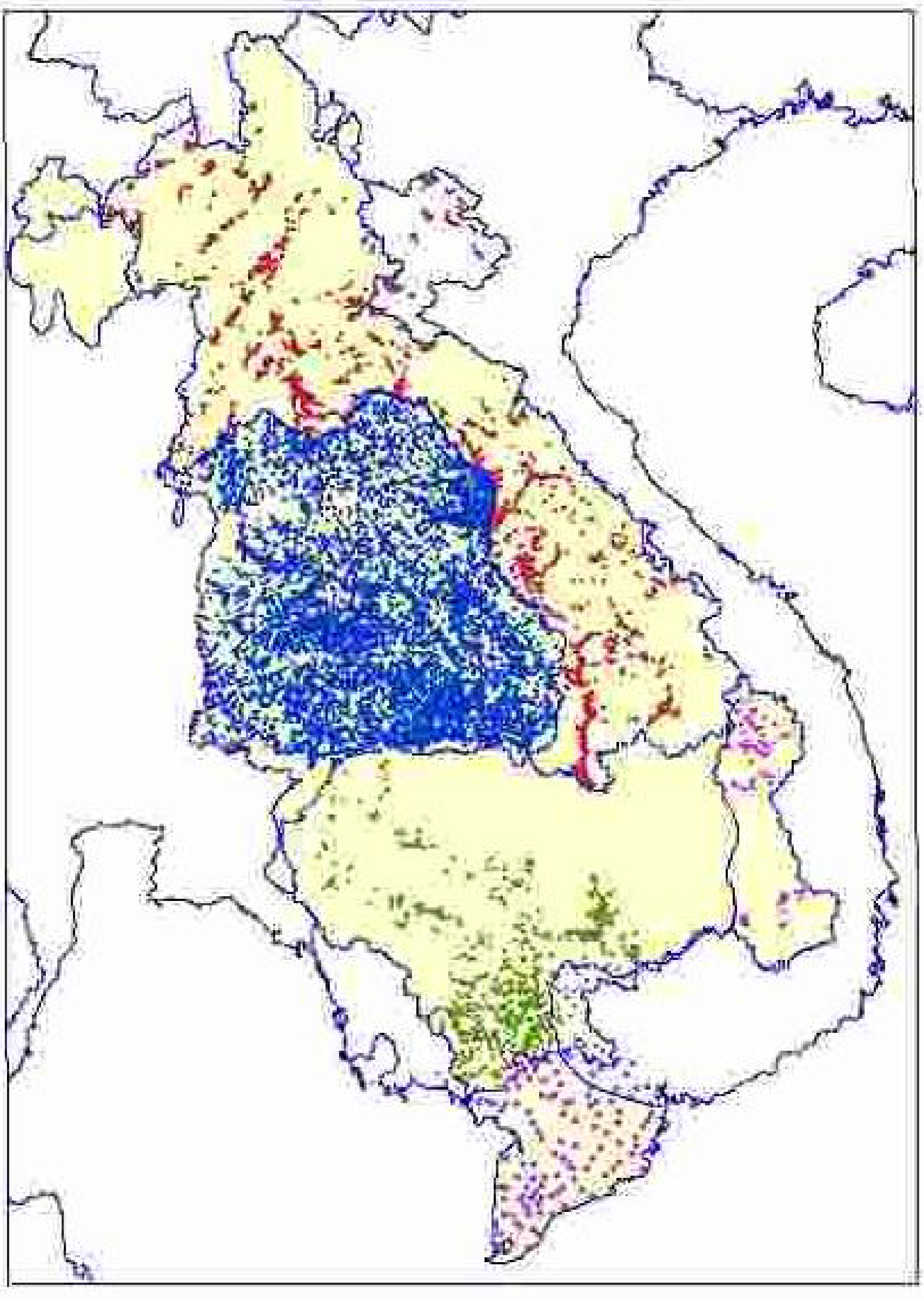


Fig. 3.10 Distribution of Irrigation Projects in Lower Mekong Basin
(Note: Each project is shown as a point)
(Source: LRIAD Project Technical Report Part I, MRC, 2002)

Fig. 3.11 Irrigation Canals and Salinity Control Structures in Mekong Delta
(Note: Salinity control structure is shown as a point)

In the figure above, 334 primary and 795 secondary irrigation canals in the Mekong delta are digitized.

3.4 Surface Water Extraction by Pumping-up Irrigation

In the Lower Mekong Basin, surface water extraction for pumping-up irrigation is active mainly in Lao PDR and Thailand.

Lao PDR:

The irrigation projects larger than 100 ha during dry season are selected from the MRC irrigation database. Number of the projects, and their project size and irrigation area by irrigation type are summarized below.

Table 3.25 Major Irrigation Projects at LMB in Lao PDR

Item	G	Pump Type				Total
		EP	DP	P	Total	
Nos. of Project	63	324	80	27	431	494
Project Size (ha)	100-2,300	100-2,300	100-450	100-1,500	-	-
Irrigation Area (ha)	22,239	65,276	10,693	5,256	81,225	103,464

Note: G: gravity, EP: electric fixed pump, D: diesel fixed pump, P: fixed pump (type: unknown)
Source: MRC (2002), Land Resources Inventory for Agriculture Development Project

As seen above, pumping irrigation is significant portion of current irrigation systems in Lao PDR. Pumping irrigation area accounts for around 80% of the total irrigation area in the Lower Mekong Basin. Out of them, electric fixed pump is around 80%. In Lao PDR, there is a firm policy directed at the development and expansion of small to medium scale irrigation in the tributary systems and as the electricity transmission line network expands there will be no doubt be an associated and significant growth in electric pumped river abstractions. This reflects the affordability and availability of electricity in the country.

Thailand:

Pumping-up irrigation is very active in the north-eastern part of Thailand, where many pump stations have been erected along the Nam Mun-Chi River as well as the Mekong mainstream. However limited information is available in past planning studies on the pumping-up irrigation in the north-eastern Thailand. The majority of pumped irrigation schemes on the Mekong mainstream as of 1982 is summarized as follows:

Table 3.26 Major Pumped Irrigation Schemes on Mekong River in North-eastern Thailand (1982)

Province	No. of Schemes	Total Pump Capacity (m^3/s)
Nong Khai	55	15.5 (4)
Nakhong Phanom	29	1.8 (23)
Mukdahan	15	0.3 (14)
Ubon	1	N.A.
Total	**100**	**17.6**

Note: N.A. means not available
Source: Lower Mekong Basin Water Balance Study, Phase 2 Report, May 1984

In the above table, the numbers in bracket give the number of schemes for which no data were available to compute the total pump capacity. Thus the total pump capacity on the Mekong mainstream in 1982 was incomplete showing the smaller figure than the actual one. Table 3.27 shows summary of pump irrigation by province in the North-eastern Thailand.

Pump irrigation projects in Thailand have been constructed by the Royal Irrigation Department (RID), Department of Energy Development and Promotion (DEDP) and Ministry of Interior (MOI). The pump irrigation areas are normally within a 1 km distance from rivers. Historic increase of the number of irrigation pump stations implemented by DEDP in the period of 1974-1989 is shown in Fig.3.12 (ESCAP, Assessment of Water Resources and Water Demand by User Sectors in Thailand, 1991). Further the location map of pump station is given in Fig. 3.13.

According to the Study of Potential Development of Water Resources in the Mekong River Basin by AIT in 1994, DEDP pumping irrigation stations amount to 283 projects in the Nam Mun-Chi River Basin and 247 projects in the other Mekong tributaries as well as the Mekong mainstream, respectively.

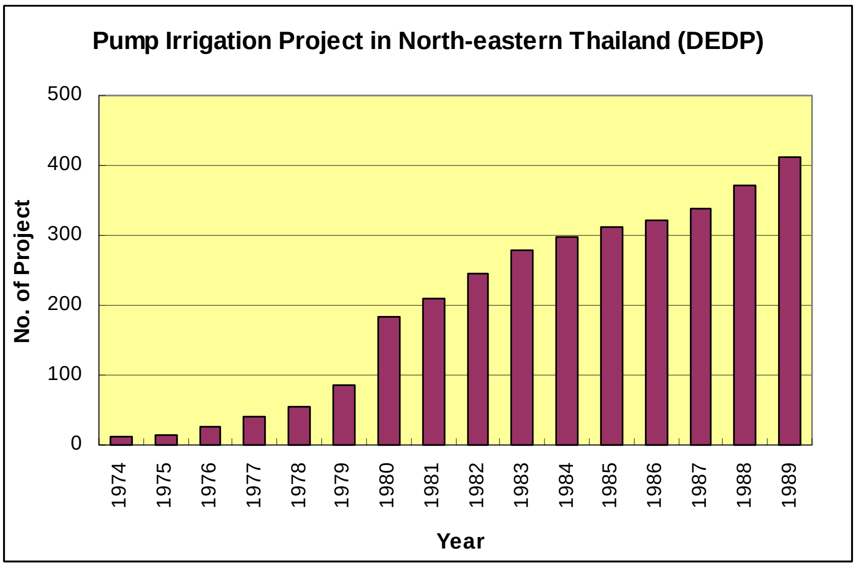


Fig. 3.12 Number of Irrigation Pump Stations in North-Eastern Thailand

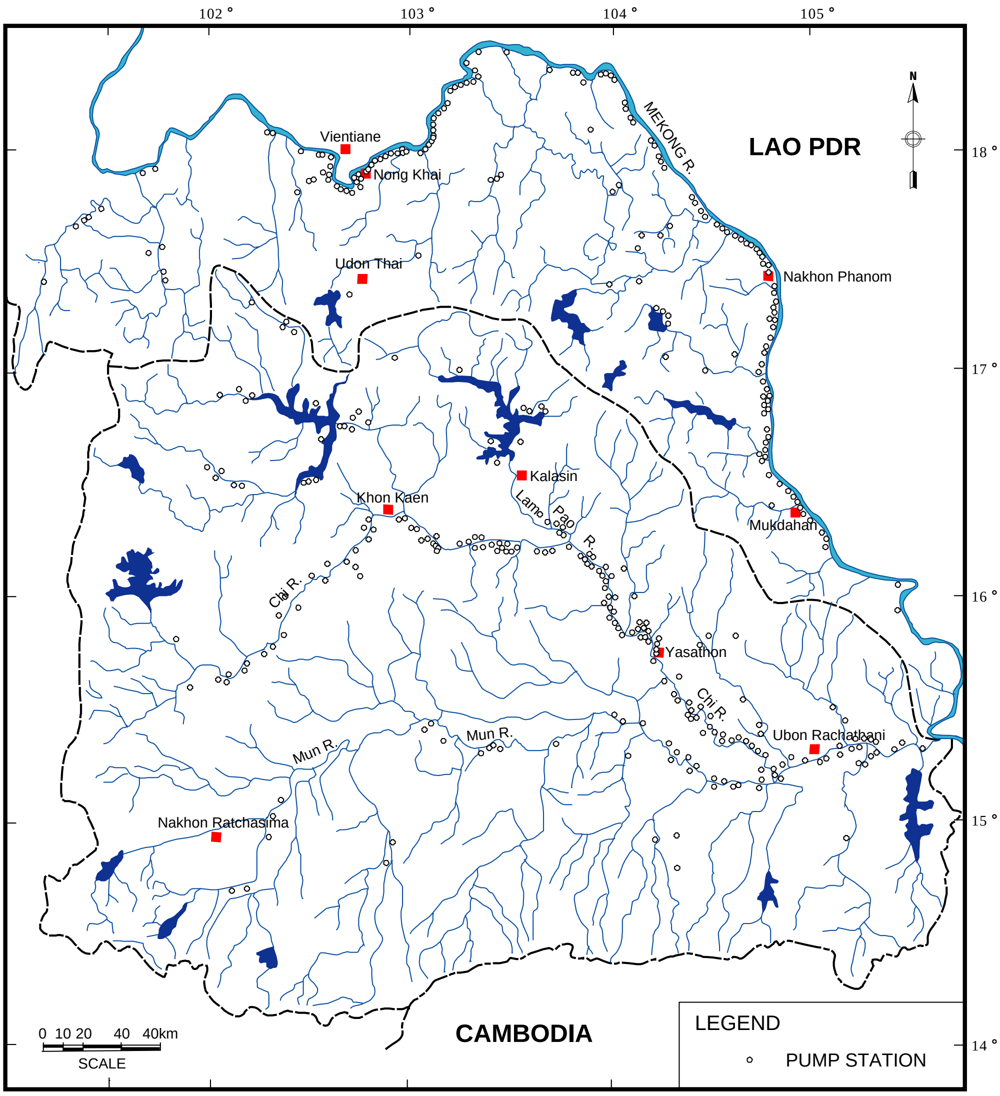


Fig. 3.13 Location Map of Pump Irrigation Project by DEDP as of 1989

As shown above, pumping irrigation is active mainly along the Mekong River, in the middle and downstream reaches of the Chi River and in the downstream reaches of the Mun River.

Table 3.28 below shows the irrigation projects consisting of RID large/medium size projects, all DEDP projects and all MOI projects from the MRC irrigation database. These projects are all larger than 100 ha in the service area. RID small projects are excluded since their data are not available. The RID projects are irrigated by gravity, DEDP by mostly electric fixed pump, and MOI by gravity, fixed pump, mobile pump, traditional lift and their mixtures. Total project numbers and irrigation areas of the respective agencies are shown below. The irrigation projects of MOI are mostly small and their irrigation type is complicated.

Table 3.28 Major Pumped Irrigation Schemes in North-eastern Thailand

Item	RID	DEDP	MOI	Total
Nos. of Project	157	950	319	1,426
Project Size (ha)	112 – 50,416	101 – 90,411	100 – 1,200	
Total Irrigation Area (ha)	327,783	513,178	83,437	924,398
Irrigation Type	G	Mostly Elec. P.	G, P, M, T, Mixed	

Note: G: gravity, P: fixed pump, M: mobile pump, T: traditional lift
Source: Lower Mekong Basin Water Balance Study, Phase 2 Report, May 1984

4. CURRENT WATER USE IN THE LOWER MEKONG BASIN

4.1 General

The Basin Modeling and Knowledge Base Development Project (WUP-A) is being undertaken by the consultants under the Component-A of Water Utilization Program (WUP) of MRC. Important and expected outcomes of this project are a Decision Support System (DSF), which contains a knowledge base, a Basin Modeling Package and Impact Assessment Tools. The Model shall not only accurately and reliably simulate the hydrology and hydraulics of the basin, but also water use, the important linkages and effects that changes or variations in water use flow and water level have on the environment including important water related functions. The current and future water use data including the irrigation water usage will be collected and stored in the database (Knowledge Base) for support the formulation of modeling as well as future use within the proposed DSF. According to the Working Paper No.14 of WUP-A, irrigation demands are simulated for all sub-catchment in the Lower Mekong Basin because of significant limitations of available data on irrigation water use and abstractions. Irrigation is already practiced in the Mekong Basin. Irrigated crop is almost exclusively rice. Herein review of historical irrigation water use was carried out from available reports and information.

4.2 Estimated Irrigation Diversion Requirements from Past Studies

Irrigation modules indicate specific irrigation factors in accordance with the agronomical characteristics of the proposed crops and study areas. These factors comprise potential evapo-transpiration, crop coefficient, effective rainfall, irrigation losses and other relevant water consumptions. Obtainable irrigation modules for LMB were collected from existing study reports. The number of the collected reports is ten (10): two (2) for Lao PDR, five (5) for Thailand, two (2) for Cambodia and one (1) for Vietnam. Irrigation Water Use.

One of the most interesting factors is irrigation requirement at diversion point. Based on the collected modules, the ranges of the diversion requirements are summarized as follows:

Table 4.1 Collected Ranges of Diversion Requirements

(Unit: mm/season)

Crop		Rice		Field Crop	
Season		Wet	Dry	Wet	Dry
Lao PDR		246-1,149	1,423-2,495	-	-
Thailand	: Chi Basin	570-1,398	2,005-2,400	152-707	570-1,347
	: Mun Basin	570-1,196	1,448-2,400	144-242	570-993
	: Mekong Tributaries	570-1,350	1,224-2,400	130-340	544-818
Cambodia		440-1,315	1,505-2,100	-	-

Crop		Triple Rice	Double Rice	Field Crop	Perennial
Vietnam	: Delta	887-1,247	410-1,089	401-599	381-535
	: Highlands	-	-	-	-

The outline of collected modules and diversion requirements by country are as follows:

Table 4.2 Collected Irrigation Modules in Thailand

Module	Study Name	Study Area
T1	Feasibility Study of Nam Suai Basin, December 1981	Provinces of Nong Khai and Udon Thani
T2	Upper Chi Development Feasibility Study, September 1991	Chaiyaphum Province
T3	Development of the Lower Mun Basin, June 1982	Provinces of Buriram, Surin, Maha Sarakham, Roi Et and Ubon Ratchathani
T4	Investigation and Preparation of a Water Resource Development Programme for North East Thailand, November 1987	Northeast Thailand
T5	Mekong Irrigation Programme, Volume 5, Study of a Water Resources Development Plan for Northeast Thailand, May 1991	Northeast Thailand

Table 4.3 Collected Irrigation Modules in Lao PDR

Module	Study Name	Study Area
L1	Mekong Irrigation Programme, Development of Pump Irrigation on the Mekong Phase II, Lao PDR, June 1990	Hat Sai Fong District, Vientiane Municipality
L2	Feasibility Study Report, Hydraulic Construction: Reservoir Huoi Saa, October 2001	Vilabuly District, Savannakhet Province

Table 4.4 Collected Irrigation Modules in Cambodia

Module	Study Name	Study Area
C1	Prek Thnot Pioneer Agricultural Project, Project Preparation, January 1975	Provinces of Kompong Speu and Kirirom
C2	Prek Thnot Multipurpose Project, Reappraisal Report, December 1991	Provinces of Kompong Speu, Kandal and Takeo

Table 4.5 Collected Irrigation Modules in Vietnam

Module	Study Name	Study Area
V1	Mekong Delta Master Plan, Working Paper No. 3, Irrigation, Drainage and Flood Control, September 1991	Mekong Delta

Collected diversion requirements are shown in Tables 4.6 to 4.9.

4.3 Estimated Return Flows from Past Studies

There is no report showing quantitative measurements of return flow from irrigated paddy fields, but there are some studies including conceptual approach of return flow, as follows:

Table 4.10 Collected Information on Return Flows

No.	Study Name and Area	Description
1	■ Feasibility Study of Nam Suai Basin, December 1981 □ Provinces of Nong Khai and Udon Thani, Thailand	➢ The return flows are considered to be **30%** of the irrigation application amounts. ➢ Taking into consideration the time distribution, the monthly return flow is assumed to be a combination of **9%** of the irrigation water of the preceding month and **21%** of the irrigation water of the month under consideration.
2	■ Upper Chi Development Feasibility Study, September 1991 □ Chaiyaphum Province, Thailand	➢ The return flows in the river channels are assumed to come from excess rainfall and the conveyance and field losses. They amount to **47%** of the diverted flow in the wet season and **23%** in the dry season.
3	■ Development of the Lower Mun Basin, June 1982 □ Provinces of Buriram, Surin, Maha Sarakham, Roi Et and Ubon Ratchathani, Thailand	➢ It was assumed that one-third of these losses will evaporate in and along drains and depressions. The balance, **DR (1-e) x 0.667**(*), is assumed to flow back into the reservoir, or the Nam Mun downstream of the reservoir, as return flow. (*) DR=Diversion Requirement, e=Irrigation Efficiency. ➢ It is assumed that most of the return flow (**70%**) will reach the reservoir or river in the month of irrigation. The remaining 30% is assumed to emerge via the groundwater as follows: **20%** after one month; **10%** after two months.
4	■ Effects of Proposed Irrigation on Water Quality and Return Flows, United Nations, February 1973 □ Khorat Plateau Thailand and Lao PDR	➢ For portions of new projects that are irrigating both wet and dry season crops on presently uncultivated land, the return flows are expected to be at least **30%** of the water diverted. ➢ For areas presently cultivated in a single-rain-fed crop each year, the return flows would be more than **50%** **(*)** if the same diversion rate was used when changing over to double cropping. Since most planned projects have at least one-half of the service area already cultivated in a single rain-fed crop, the typical return flows expected would be at about **50%** of the project diversions. **(*)** **52%** is assumed.

4.4 Current Water Use in Thailand

(1) Classification of Surface Water Resources Project

The surface water resources development project in Thailand is classified and defined in the following categories:

i) Large scale/Multipurpose project

ii) Medium scale project

iii) Small scale project

iv) Pump irrigation project

v) Trans-basin project

The following project features are from the main report of Study of Potential Development of Water Resources in The Mae Khong River Basin, prepared by Asian Institute of Technology, Office of the National Economic and social Development Board (NESDB), 1994.

Large scale/Multipurpose project:

Agencies with primary responsibility for the implementation of large scale water resources projects are the Royal Irrigation Department (RID), Electricity Generating Authority of Thailand (EGAT) and Department of Energy Development and Promotion (DEDP).

Among them, EGAT is responsible for large scale power generation schemes including multipurpose projects that generate hydropower as well as provide for irrigation, fisheries and flood control. RID constructs, operates and maintains all large scale irrigation projects, but where the projects include hydropower, EGAT shares responsibility. Whilst RID has responsibility for gravity schemes, those utilizing pumped abstractions from rivers are generally executed by DEDP. In addition, DEDP has responsibility for certain power generation projects which have an installed capacity of less than 6 MW. Large scale projects usually are defined as follows:

a. construction cost: more than 200 million Baht

b. storage volume: more than 100 million m^3

c. water surface area: more than 15 km2

d. irrigation area: more than 80,000 Rai (= 12,800 ha)

e. construction period: more than 5 years

Medium scale project:

A medium scale project is classified as that of costing more than 4 million Baht and less than 200 million Baht. Its construction period is longer than one year but shorter than 5 years. The storage capacity is from 10 to 100 million m^3. Most of the medium scale projects are used for supplementary wet season irrigation and extended dry season cropping. Some of the project are used for domestic supply and flood protection. Most of the medium scale projects are constructed, operated and managed by RID. In practice, most of the projects are initiated based more on social considerations, while the economic returns are considered a second priority. A survey of existing development indicates that various government agencies participate in this type of water resources development. They are namely RID, DEDP, EGAT, etc.

Small scale project:

Significant distinction between small and medium scale projects are that in the former one, no compensation is paid for land occupied by the scheme. The project budget provides only for the water storage/diversion facility. No provision is made for distribution works. The operation and maintenance are the responsibility of the beneficiaries. The construction cost of small scale project is less than 4 million Baht and the construction period is less than one year. Small scale projects can be further divided into four categories depending on their use as follows:

Table 4.11 Category of Small Scale Projects in Thailand

Category	Description
Type 1	An excavated pond or a small earth dam to create storage for domestic use, livestock and fish culture. These structure are filled by runoff and may form part of a watershed management project.
Typ2 2	An earth dam or concrete weir on a small river providing storage for domestic use, livestock, fish culture and irrigation. The reservoir does not command any land. So, dry season irrigation is normally by bucket or pump for rice nursery bed or for dry season upland crops. In the wet season, supplementary irrigation may be provided by flooding caused by the river banks overtopping.
Type 3	Similar to the Type 2, except the reservoir has command area and gravity irrigation can be carried out.
Type 4	A weir or regulator on a river with negligible storage. It provides water for wet season supplementary irrigation.

Source: Office of the National Economic and social Development Board (1994), Study of Potential Development of Water Resources in The Mae Khong River Basin, prepared by Asian Institute of Technology

Pump irrigation project:

Agencies with primary concern in pumping schemes are DEDP and RID. The DEDEP schemes are permanent with electricity driven pumps and generally serving a formal irrigation lay out. The RID schemes are diesel driven mobile pumps providing supplementary and compensation water supplies to informal irrigation schemes. In addition, there are some privately owned pump stations along the main river systems. The irrigation area by pump is approximately 80-480 ha.

Trans-basin project:

Currently there are no trans-basin (inter-basin) or intra-basin diversion projects within the Mekong River Basin of Thailand. However, a number of trans-basin schemes have been so far considered. Table below provides the main feature of the identified schemes. Location map of projects is shown in Fig. 4.1.

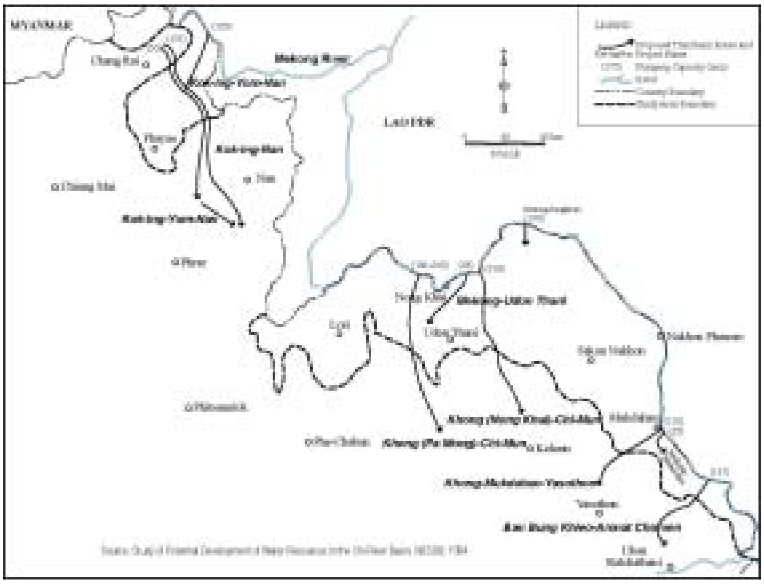


Fig. 4.1 Proposed Trans-basin Projects in Thailand

Table 4.12 Features of Trans-basin Projects in Thailand

No.	Project	Agency	Status	Pumping Capacity (m3/s)	Irrigation Area (ha)	Diversion Length (km)	Lift (m)
1	Kok-Ing-Nan	RID	F/S (199?)	175	270,000	107	-
2	Kok-Ing-Yom-Nam	EGAT/ RID	Pre-F/S (1982)	-	130,000	105	
3	Mekong (at Pamong)-Chi-Mun	DEDP	Pre-F/S (1978)	100	70,000		
4	Mekong (at Nong Khai)-Chi-Mun		Desk Study	400	320,000	125	25
5	Mekong-Songkharam		Pre-F/S (1983)	100	70,000	6	50
6	Mekong-Udon Thani		Pre-F/S (1989)	83	68,000		
7	Mekong (at Mukdahan)-Yasothon		Pre-F/S (1978)	110	88,000	28	49
8	Mekong (Ban Bung Khieo)-Amnat Charoen	NESDB	Pre-F/S (1978)	270	143,000	23	91
9	Khong-Chi-Mun	DEDP	F/S (1993)	310	800,000		
Total					**1,959,000**		

Source: Office of the National Economic and social Development Board (1994), Study of Potential Development of Water Resources in The Mae Khong River Basin, prepared by Asian Institute of Technology

(2) Current Water Use

For the large-scale irrigation projects, the average annual volume of water use for irrigation and the annual irrigated areas (wet season + dry season) are available from RID as given below.

Table 4.13 Average Seasonal Water Use of Large Irrigation Projects in North-eastern Thailand

Irrigation Project	Dry Season		Wet Season		Years in which data are available
	Water Amount (mil m3)	Area (ha)	Water Amount (mil m3)	Area (ha)	
Nong Wai	206.84	8,740.03	335.81	31,300.39	1980-1989
Huai Luang	15.10	131.76	42.80	13,051.39	1980-1989
Lam Pao	144.28	1,270.50	267.42	33,420.36	1980-1989
Nam Oon	98.22	27.81	173.83	28,981.79	1980-1989
Lam Prapleong	29.29	3,586.18	74.77	11,602.67	1980-1989
Siringdhorn	53.33	2,549.70	142.50	21,858.29	1980-1989
Lam Takhong	86.11	4.62	143.64	20,643.96	1980-1989
Total	**633.17**	**16,312.4**	**1,180.77**	**160,859.38**	

Note: Dry season is from January to June. Wet season is from July to December.
Source: Data from Water Operation Center, RID (1990) from Assessment of Water Resources and Water Demand by User sectors in Thailand, ESCAP, United Nations, 1991

According to the agricultural statistics of Thailand (Ministry of Agriculture and Cooperatives, 1989), the annual volume of water use and the annual irrigated areas of overall irrigation projects in the country is around 1.3 times those of the RID large-scale projects. The factor of 1.3 is calculated from the available data of the annual irrigated areas of the whole country and of RID. This ratio is assumed to be applicable also to the annual volume of water use for irrigation. An average ratio between dry season and wet season irrigated areas from 1984 to 1989 is 0.236 (Assessment of Water Resources and Water Demand by User sectors in Thailand, ESCAP, United Nations, 1991).

Table 4.14 in the next page shows details of estimated irrigation demand in three major river basins in the North-eastern Thailand. As shown, the storage associated with small scale irrigation schemes provides around 1,000 million m^3. The total active storage of reservoir schemes is around 7,440 million m^3, of which 5,440 million m^3 (73%) is provided by large scale reservoir and 2,000 million m^3 (27%) is by both medium and small scale reservoirs. The estimated irrigation demands are 5,140 million m^3 in the wet season and 2,689 million m^3 (moderate cropping intensity) in the dry season, totally around 7,830 million m^3

Table 4.15 in the next page shows the water extraction volume of pumping irrigation schemes in the North-eastern Thailand in the period of 1983-1989.

Table 4.14 Estimated Irrigation Demand in North-eastern Thailand

Scheme	Total Irrigation (ha)	Active[3)] Storage (Mm^3)	Irrigation Demand (Mm^3)				
			Wet Season	Dry Season [1)]		Dry Season [2)]	
			(Mm^3)	(Mm^3)	CI (%)	(Mm^3)	CI (%)
Chi Basin							
Large scale	102,259	3,100	818	1,080	60	720	40
Medium scale	49,491	346	396	79	20	40	10
Pumping	72,480	-	413	545	60	364	40
Chi Total	**224,230**	**3,446**	**1,627**	**1,704**		**1,124**	
Mun Basin							
Large scale	56,097	1,570	449	592	60	395	40
Medium scale	48,912	342	391	78	20	39	10
Pumping	28,800	-	164	217	60	145	40
Mun Total	**133,809**	**1,912**	**1,004**	**887**		**579**	
Mekong tributaries							
Large scale	83,168	769	665	878	60	586	40
Medium scale	44,328	310	354	71	20	35	10
Pumping	61,440	-	350	463	60	308	40
Mekong Total	**188,936**	**1,079**	**1,369**	**1,412**		**929**	
Northeast Sub Total	**546,975**	**6,437**	**4,000**	**4,003**			
Northeast small scale	200,000	1,000	1,140	114	10	57	5
North-east Total	**746,975**	**7,437**	**5,140**	**4,117**		**2,689**	

Note: 1) High cropping intensity; 60 percent values are well above presently realized; 20 and 10 percent are high values limited by reservoir water available.
2) Moderate cropping intensity
3) CI; cropping intensity
4) Medium scale reservoir storage estimated at 7,000 m^3/ha and small scale storage at 5000 m^3/ha

Source: International Development Research Center of Canada, State-of-the-Art Study of the Mekong River and the River Basin Area in Thailand, Working Paper, 1995

Table 4.15 Water Extraction Volume of Pump Irrigation in North-eastern Thailand (1983-1989)

(Unit: million m3)

Season	1983	1984	1985	1986	1987	1988	1989
Dry (Jan-Jun)	98.53	109.30	101.58	71.56	85.79	129.60	142.36
Wet (Jul-Dec)	22.18	23.18	28.63	47.00	83.12	71.51	67.27

Note: Irrigation pump stations only by DEDP
Source: ESCAP (1991), Assessment of Water Resources and Water Demand by User Sectors in Thailand

Table 4.16 in the next page shows details of estimated irrigation demand of future proposed schemes (16 schemes in the Chi basin and 20 schemes in the Mun basin) around in 1995 for reference. If all schemes were implemented, the total irrigation area in the North-eastern Thailand could increase by 835,878 ha. At this moment, the progress of implementation is rather hard for confirmation although all of the Mekong transfer schemes are still of preliminary study level and large-scale irrigation projects associated dam construction might be at the same level in 1995 almost without progress.

Table 4.16 Estimated Irrigation Demand of Proposed Projects in North-eastern Thailand

Description	Total Irrigation Area (ha)	Irrigation Demand		
		Wet Season (Mm^3)	Dry Season (Mm^3)	Dry Season CI (%)
Chi Basin				
Large scale	62,170	497	656	60
Medium scale	26,337	210	42	20
Chi total	**88,507**	**707**	**698**	
Mun Basin				
Large scale	81,988	657	865	60
Medium scale	56,869	455	91	20
Barrage	44,230	353	467	60
Mun total	**183,087**	**1,465**	**1,423**	
Mekong tributaries				
Large scale	82,198	658	868	60
Medium scale	24,926	199	40	20
Barrage	7,160	57	76	60
Mekong total	**114,284**	**914**	**984**	
Northeast small scale[1)]	50,000	285	29	10
Northeast pumping schemes[1)]	50,000	285	377	60
North-east Sub Total	**485,878**	**3,656**	**3,482**	
Mekong transfers				
Pa Mong-Chi-Mun	140,000	1,551	543	
Kong-Chi-Mun	320,000	3,546	1,240	
Mekong-Udon Thani	67,960	753	263	
Mekong Transfer total[2)]	350,000	3,880	1,355	
North-east Total	**835,878**	**7,538**	**4,837**	

Note:1) Provisional figure
2) Diversion schemes partially overlap is a provisional estimate avoiding overlap
3) CI; cropping intensity
Source: International Development Research Center of Canada, State-of-the-Art Study of the Mekong River and the River Basin Area in Thailand, Working Paper, 1995

4.5 Current Water Use in Lao PDR

The main use of irrigation in Lao PDR is the supplementary irrigation of wet season rice. There are a number of small scale pumping irrigation projects that use water from the Mekong River to irrigate dry season crops. There is little definitive data and reports on current water use.

Table 4.17 Current Water Demand, Lao PDR

Sector	1995
Agriculture	
□ Supplementary Irrigated Area (ha)	155,000
□ Dry Season Irrigated Area (ha)	31,000
Irrigation Water Use (Mm^3)	2,000

Source: LAOS – Environmental Values and Resource Sectors in Lao PDR, 1995

Herein preliminary rough estimate of the current water use is made by use of available data and information. From Table 3.13, the current irrigation areas within the Mekong watershed are estimated to be 129,000 ha in the dry season and 176,000 ha in the wet season. From Table 4.7

diversion requirements are assumed to be 1,900 mm/ha in the dry season and 700 mm/ha in the wet season, respectively. Applying to these, current water use are estimated 2,530 million m^3 in the wet season and 1,232 million m^3 in the dry season.

4.6 Current Water Use in Cambodia

Rice production in Cambodia has increased slowly in efficiency since the early 1990s due to ongoing pos-war rehabilitation and infrastructure reconstruction. Total wet season cultivated area has increased during the period from 1.7 million ha in 1993 to 2.1 million ha in 2000 as given below.

Table 4.18 Rice Production in Cambodia, 1993-2000

	1993	2000
Wet Season Rice		
Area harvested ('000 ha)	-	1,846
Production ('000 ton)	-	3,333
Yield (ton/ha)	-	1.81
Dry Season Rice		
Area harvested ('000 ha)	-	233
Production ('000 ton)	-	708
Yield (ton/ha)	-	3.04
Total Rice		
Area harvested ('000 ha)	**1,685**	**2,079**
Production ('000 ton)	**2,221**	**4,041**
Yield (ton/ha)	**1.31**	**1.94**

Source: Cambodia National Institute of Statistics (1994, 2000)

In Cambodia, paddy is cultivated under the management measures; i) rainfed lowland cultivation, ii) rainfed upland cultivation, iii) deep water cultivation (floating rice), and iv) dry season cultivation. Table below shows the area and production of the said cultivation systems in 1992-1993.

Table 4.19 Rice Production in Cambodia, 1992-1993

Cultivation System	No Irrigation		Irrigation		Flood Recession		Total	
	(1,000 ha)	(1,000 tons)	(1,000 ha)	(1,000 tons)	(1,000 ha)	(1,000 tons)	(1,000 ha)	(1,000 tons)
Rainfed Lowland	1,422	1,485	173	311	-	-	1,595	1,796
Dry Season	-	-	25	60	79	190	104	250
Rainfed Upland	24	29	-	-	-	-	24	29
Deep Water	121	146	-	-	-	-	121	146
Total	**1,567**	**1,660**	**198**	**371**	**79**	**190**	**1,844**	**2,221**

Note: Area indicates the cultivated area.
Source: Cambodia Statistics, Interim Mekong Committee, 1992

As is apparent from the table above, dry season rice cultivation accounts for only about 6% of the whole cultivated area. Dry season cultivation is either from fully irrigated scheme or grown as a “flood recession crop”. Under the flood recession crop, low embankments are used to store floodwaters during flood recession, which are then used to subsequently irrigate the crop. The productivity of the dry season rice is more than 1 ton/ha greater than wet season rice because of greater sunshine and better water control. The dominant production system is rainfed lowland rice, which is concentrated near the Mekong, Bassac, and Tonle Sap Rivers. Deepwater and floating rice is also found around the shores of Tonle Sap River and the Great Lake, as well as the inundated areas of the Mekong and the Bassac near Vietnam. There is also small-scale dry land rice production in hilly areas of the country. Definitive data are lacking about the current water use in Cambodia. Assuming that the dry season irrigation demand amounts to 1,700 mm/ha for 104,000 ha (see Tables 4.8 and 4.19), the irrigation demand is estimated at 1,768 million m^3. Table below shows the identified potential new and upgraded cropping areas in 1994.

Table 4.20 Potential Cropping Areas and Water Resource Constraints, Cambodia

No	Catchment		Potential Crop Area (ha)				Water Resources Category
	Name	No	Wet Season	Double Cropping	Flood Recession	Total	
1	SE catchment	8	6,292	9,089	310	15,691	2
2	Stung Slakou	9	650	19,748	1,050	21,448	2
3	Prek Toul Lokok	9.1	250	2,875	600	3,707	2
4	Prek Tnol	10	3,597	26,995	550	31,142	2
5	Stung Tonle Bati	10.1	0	1,135	0	1,135	2
6	Lake side 1a	11.1	9,175	0	0	9,175	3
7	Lake side 1b	11.2	510	410	2,000	2,920	1
8	Stung Krang Punley	11.3	960	2,503	0	3,463	2
9	Stung Baribo	12	5,190	0	0	5,190	2
10	Stung Pursat	13	4,590	40,320	0	44,910	2
11	Stung Daunti	14	10,800	0	0	10,800	2
12	Stung daunti	14.1	1,317	1,345	0	2,662	2
13	Lake side 2b	15.2	4,070	4,800	0	8,870	2
14	Stung Sanker	16	2,270	25,600	0	27,870	2
15	Stung Mongkol Borey	17	2,160	55,000	0	57,160	2
16	Stung Pheas	17.1	0	11,500	0	11,500	2
17	Stung Sisophon	18	1,000	4,000	0	5,000	3
18	Stung Svay Chek	18.1	0	1,750	0	1,750	3
19	Stung Praneth Preah	18.2	0	12,000	0	12,000	3
20	Stung Sreng	19	6,050	1,100	150	7,300	3
21	Stung Siem Reap	20	2,700	13,500	100	16,300	2
22	Stung Rolous	21	5,750	0	0	5,750	2
23	Stung Chikreng	22	4,000	0	0	4,000	3
24	Stung Ataung	23	2,550	14,500	0	17,100	2
25	Stung Sen	24	6,010	4,100	0	10,110	3
26	Stung Sraka Moan	24.1	2,750	0	0	2,750	3
27	Stung Chinit	25	3,963	16,050	0	20,013	2
28	Stung Taing Krasing	25.1	0	600	0	600	2
29	Great Lake	26	1,800	960	5,695	8,455	1
30	Mekong Riverine	27	11,785	49,672	86,785	148,242	1
31	Prek Kampi	33	527	0	0	527	3
32	Prek Te	34	212	0	112	324	3
33	Prek chhlong	35	2,912	1,400	480	4,792	3
34	South catchments	36	479	18,450	2,130	21,095	3
35	Catchments unknown		4,330	0	0	4,330	-
Total			**108,640**	**339,402**	**99,962**	**543,715**	**-**

Notes: Category 1: Predominantly recession cropping. Recession cropped systems can be treated independently for the purpose of irrigation rehabilitation.
Category 2: Catchments with overall water shortage where catchments planning is recommended.
Category 3: Catchments without identified water contain.
Source: Irrigation Rehabilitation Study in Cambodia, Final Report, 1994

4.7 Current Water Use in Vietnam

The present irrigation water demand in the delta has been estimated on a yearly basis by SIWRP (Sub-Institute for Water Resources Planning) in Ho Chi Minh City by use of the developed hydraulic simulation model in which the current irrigation system network is built. The estimated water demand is on a 10-day basis. Water demands estimated in several years are available from several reports. The table below is the estimated dry season irrigation water demands in 1990, 1998 and 2000.

Table 4.21 Estimated Dry Season Irrigation Water Demand of the Mekong Delta in 1990, 1998 and 2000

1990	**Irrigation Water Demand**						**Total**
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	
million m^3	2,420	1,560	1,120	1,490	1,660	1,140	9,300
m^3/s	904	645	418	575	620	440	-

Source: Sub-Institute of Water Resources Planning and Management (SIWRPM)

1998	**Irrigation Water Demand**						**Total**
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	
million m^3	2,686	2,088	2,017	2,179	2,179	1,363	12,512
m^3/s	1,003	863	753	841	814	526	-

Source: Sub-Institute for Water Resources Planning (SIWRP)

2000	**Irrigation Water Demand**						**Total**
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	
million m^3	2,582	2,692	2,072	1,400	1,473	1,290	11,509
m^3/s	964	1,113	774	540	550	498	-

Source: Sub-Institute for Water Resources Planning (SIWRP)

The estimated total dry season irrigation demands from January to June are 9,300 million m^3 in 1990, 12, 512 million m^3 in 1998 and 11,509 million m^3 in 2000. Another estimates are available. The dry season demand in 1990 is divided into two demands in the freshwater area and the saline water area affected by saline water intrusion. They are 9,000 million m^3 in the fresh water area and 300 million m^3 in the saline water area. Considering that the Mekong flow becomes lowest in April, period of critical water usage is April. Table below shows the estimated irrigation water usage for 1985 and 1990 over the period January to June by the Mekong Delta Master Plan in 1991. The delta was divided into eight separate climatic zones. Effective rainfall was estimated on the basis of a 75% likelihood of exceedance. An irrigation efficiency of 80% was adopted.

Table 4.22 Estimated Dry Season Irrigation Water Demand of the Mekong Delta in 1985 and 1990

Year	**Irrigation Water Demand (m^3/sec)**					
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**
1985	425	310	120	140	275	190
1990	802	724	264	319	214	194

Source: Government of Vietnam, WB and UNDP (1991), Mekong Delta Master Plan, Working Paper No.3, Irrigation, Drainage and Flood Control

5. IDENTIFICATION OF LOW FLOW INCREASE DUE TO NAM NGUM HYDROPOWER DEVELOPMENT PROJECT IN NAM NGUM RIVER

5.1 Nam Ngum Hydropower Development Project

The Nam Ngum Hydropower Development Project in Lao PDR was implemented in 3 phases (stage-wise development of installed capacity) as summarized below.

Table 5.1 Stage-wise Development of Nam Ngum Hydropower Station

	Phase I	Phase II	Phase III
Period	1972-1978	1979-1984	1985- Present
Number and capacity of units	15 MW x 2 (30 MW)	40 MW x 2 (80 MW)	40 MW x 1 (40 MW)
Total installed capacity	30 MW	110 MW	150 MW
Average annual energy output	240 GWh	755 GWh	820 GWh

Source: Annual Report 1982, Mekong Secretariat, 1982

Photo: Nam Ngum Dam

To increase the energy output of the Nam Ngum power station, the Nam Song Water Diversion Project was completed in 1995 for diverting the maximum discharge of 210 m^3/s into the Nam Ngum reservoir. Further in 2000, the Nam Leuk Hydropower Project with an installed capacity of 60 MW was completed on the Nam Leuk river. The water used for power generation at the Nam Leuk station is also diverted into the Nam Ngum reservoir enhancing the power generation of Nam Ngum hydropower station. The Nam Ngum power generation system is schematically shown below.

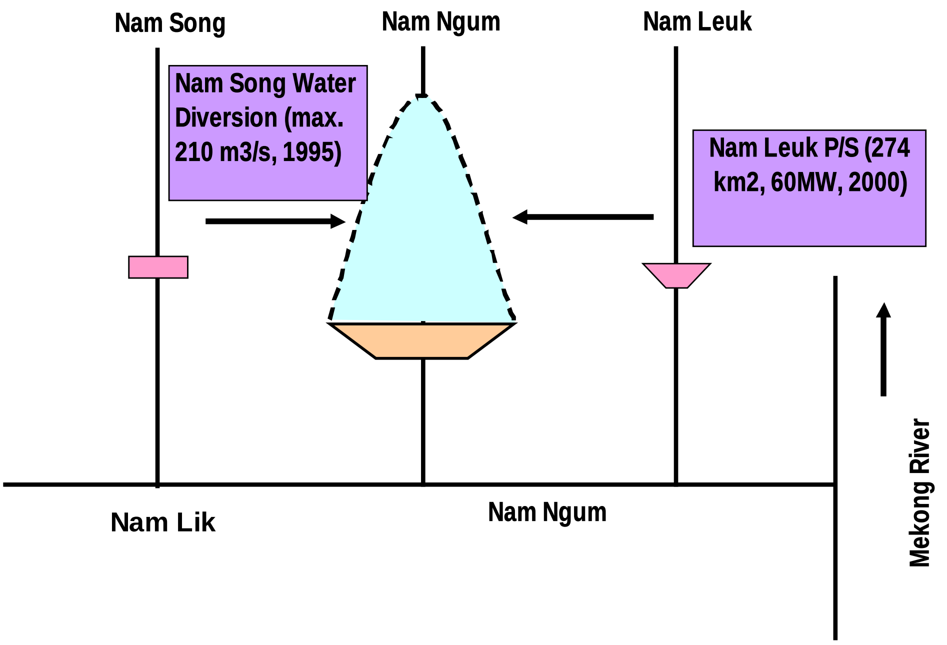


Fig. 5.1 Nam Ngum River Diversion System

5.2 Operation Records of Nam Ngum Hydropower System

Tables 5.2 to 5.5 presents the operation records of the Nam Ngum reservoir from 1972 to 2001 on the monthly basis that were obtained from the Nam Ngum power station office through LNMC. The operation schedule of Nam Ngum hydropower system in 2001 is given in Table 5.6. The monthly operation records at the Nam Leuk power station are shown in Table 5.7.

Mean monthly plant discharges (released discharge through hydropower generation) at the Nam Ngum station are compared according to its development stage as shown below.

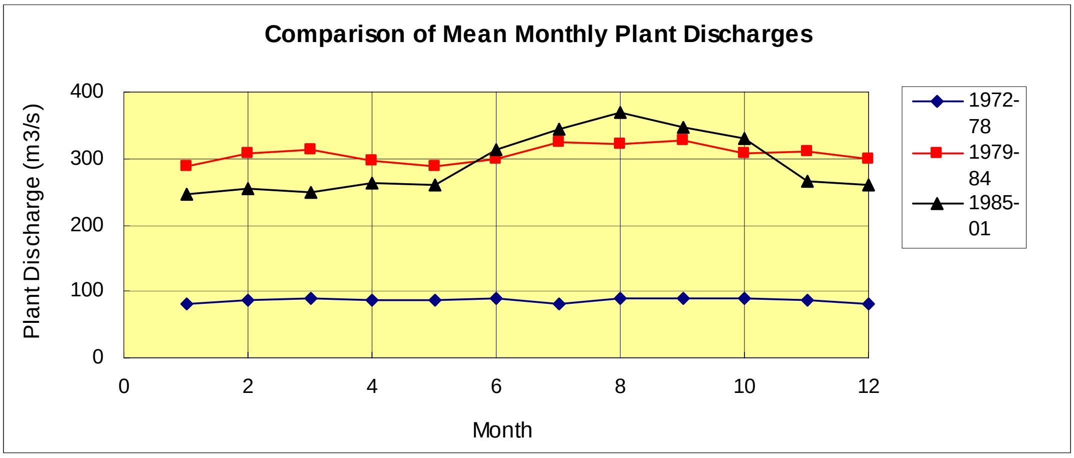


Fig. 5.2 Comparison of Mean Monthly Plant Discharges

As seen above, the mean monthly plant discharge after the completion of Phase I (30 MW of installed capacity) in 1971 is around 80-90 m^3/sec. After the Phase II (110 MW) in 1978 and Phase III (150 MW) in 1984 plant discharges have significantly increased to be around 250-370 m^3/sec. The mean monthly plant discharges in 1985-2001 in the dry season are smaller than in 1978-84. This is due to the fact that as severe hydrological droughts have occurred in several years in 1987-93, and thus energy productions have been much reduced in the dry season.

Figure 5.3 illustrates the historic change of annual spillout volume of the Nam Ngum dam from the beginning of operation in 1972. From the viewpoints of hydropower operation, the Nam Ngum reservoir inflows have been well regulated and effectively utilized for power generation since the completion of Phase III in 1985.

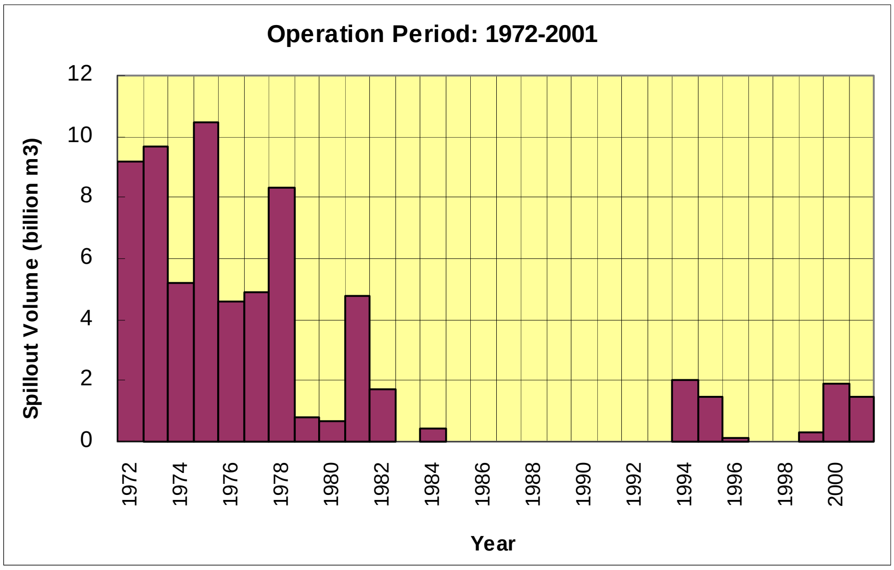


Fig. 5.3 Annual Spillout Volume from Nam Ngum Dam

5.3 Operation Pattern of Nam Ngum Hydropower Station

The Nam Ngum hydropower station is being operated to meet electric power demands at the peak and off-peak. The present typical operation pattern (operation hours) is assumed as schematically shown below.

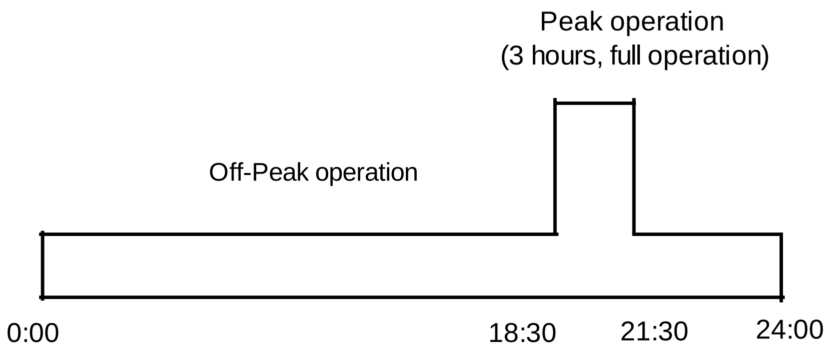


Fig. 5.4 Typical Operation Pattern at Nam Ngum Power Station

The maximum plant discharge (Qmax) at the peak operation (full operation of 150 MW) is estimated as follows:

$$Qmax = 150,000 / (9.8 \times 0.84 \times 32) = \text{approx. } 570 \ m^3/sec$$

The plant discharge (Qbase) at the off-peak operation with 40 MW is estimated:

$$Qbase = 40,000 / (9.8 \times 0.84 \times 32) = \text{approx. } 150 \ m^3/sec$$

The average plant discharge on daily basis (Qfirm) is thus estimated as follows:

Qfirm = (570 x 3 + 150 x 21) / 24 = approx. 200 m^3/sec

where, 9.8 : Acceleration of gravity (m/s^2)
0.84 : Combined efficiency of power plant
32 : Rated head (m)

The expected average daily release discharges due to power generation are estimated varying power generation units for the off-peak demands as follows:

Table 5.8 Expected Daily Plant Discharge of Nam Ngum Hydropower Station

Case	Peak Operation (3 hours)	Off-peak Operation (21 hours)	Approx. Total Plant Discharge (m^3/s)
1	150 MW	30 MW	170
2	150 MW	40 MW	200
3	150 MW	70 MW	300
4	150 MW	80 MW	340

Source: WUP-JICA Study Team

The recent hourly operation record of the Nam Ngum hydropower station on 12-15 November 2001 was obtained from EDL (Electricite du Laos) as given below.

Table 5.9 Daily Operation of Nam Ngum Station (November 12-15, 2001)

Time	Duration (hour)	Operating Unit and Capacity (MW)
00:00 – 06:00	6.0	15.5 MW x 1 + 45 MW x 1 = 105.5 MW
06:00 – 17:00	11.0	15.0 MW x 1 + 38 MW x 3 = 129.0 MW
17:00 – 21:30	4.5	15.5 MW x 2 + 45 MW x 3 = 166.0 MW (peak operation)
21:30 – 24:00	2.5	15.0 MW x 2 + 40 MW x 2 = 110.0 MW

Source: Nam Ngum Hydropower Station

The daily power operation in this period is graphically shown below.

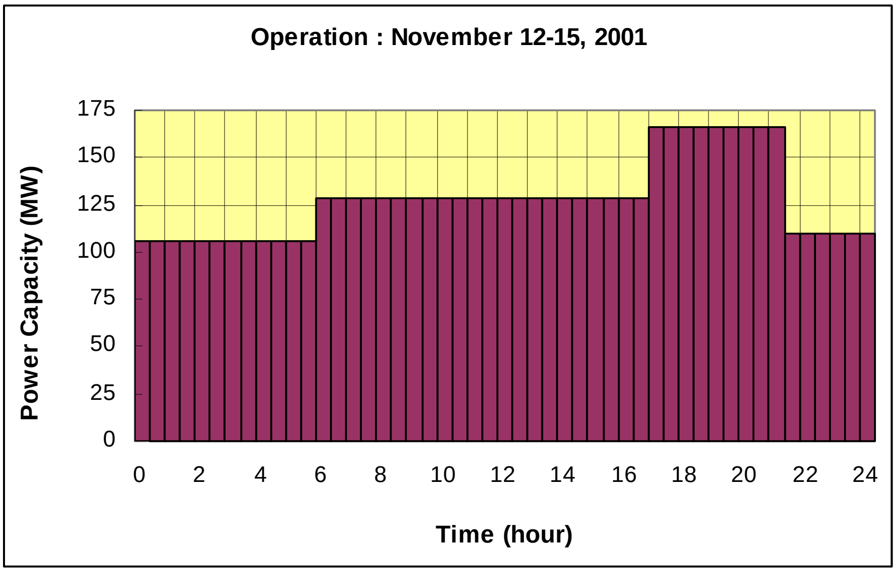


Fig. 5.5 Daily Operation Record of Nam Ngum Hydropower Station in November 12-15, 2001

The time period of peak operation (full load) has recently been extended by 4.5 hours from 17:00 to 21:30 and the off-peak operation has been made exceeding 100 MW. Table 3.5 shows the operation schedule of Nam Ngum hydropower station in 2001 as well as the expected water diversion from the Nam Song River and the Nam Luek reservoir, which was prepared in October 2000.

Below is the annual power output of the Nam Ngum hydropower station from 1972 to 2000.

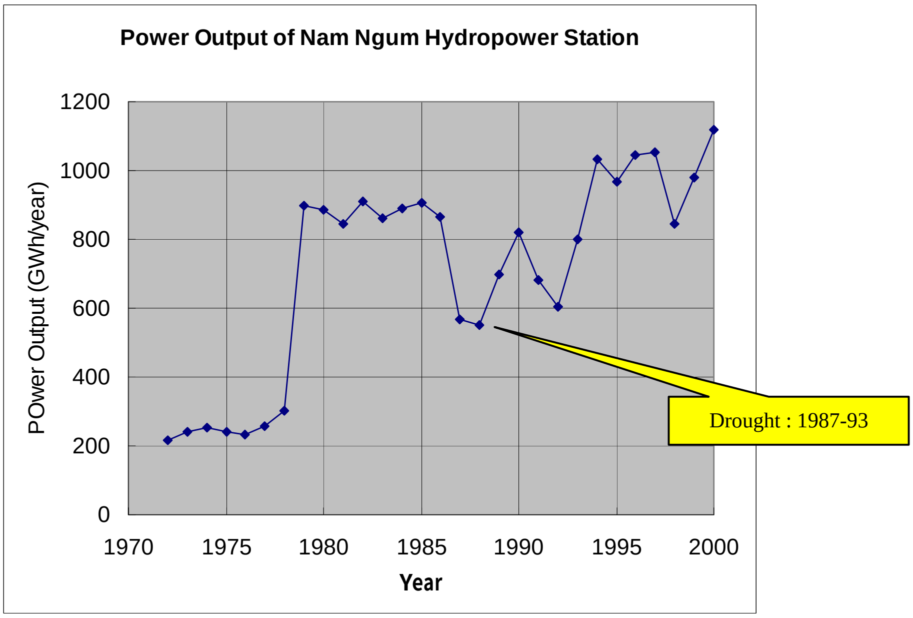


Fig. 5.6 Annual Power Output of Nam Ngum Power Station

Severe drought occurred several times in 1987–1993. Energy production was seriously decreased to around 60% of designed energy output. It is reported that in these drought years no spill-out had been made all year round. It is observed that the Nam Song Water Diversion Project has been increasing annual power output by around 100 GWh/year from 1994 onwards.

The seasonal regulation rate of the Nam Ngum reservoir is estimated to be 47.2% as follows:

Annual inflow volume (1972-2000) = 9,964 million m^3

Effective storage capacity = 4,700 million m^3

Seasonal regulation rate = 4,700 / 9,964 x 100 = 47.2%

5.4 Low Flow Increase in the Nam Ngum River

The dry season low flows of the Nam Ngum River downstream of the Nam Ngum reservoir would be increased due to the plant discharge released from the Nam Ngum reservoir. The low flow regime of the Nam Ngum River has been thus changed after the completion of the Nam Ngum hydropower development project.

The low flow increase in the dry season was verified in terms of the available monthly mean records at the existing four hydrological stations. The low flow increase was examined in two approaches:

(1) Comparison of monthly mean discharge hydrographs in the dry season (January-May) at the selected hydrological stations; and

(2) Comparison of time-series of monthly mean discharges in the dry season (the 3 months of February, March and April) at the hydrological stations.

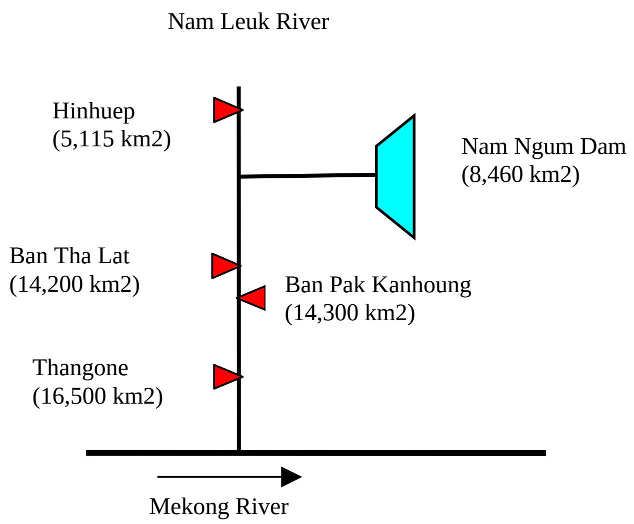


Fig. 5.7 Location Map of Selected Hydrological Stations in Nam Ngum River

Tables 5.10 to 5.13 presents the monthly mean discharges at the selected four stations.

Photo: Ban Pak Kanhoung Station in Nam Ngum River

Figure 5.8 shows the results of comparison of monthly mean discharge hydrographs, while Fig. 5.9 shows the results of comparison of time-series of monthly mean discharges. Table 5.14 presents the comparison of monthly mean discharges of four stations.

This preliminary analysis leads to the following summary observations and implications:

(1) The Nam Ngum Hydropower Development Project (seasonal flow regulation by a large-scale reservoir) has made very significant influences on the low flow regime of the lower mainstream from Nam Ngum Dam. Due to the released flows through power generation, the dry-season flows from January to May have significantly increased. The Nam Ngum reservoir provided with seasonal regulating capacity would enable dry-season flows to be significantly supplemented and droughts to be alleviated in the Nam Nugm River. The historic plant discharges in the dry season are around 250–370 m^3/s. Such additional flow increases in the dry season have been adequately measured and detected at the downstream hydrological stations in the Nam Ngum River as shown Figs. 5.10 and 5.11.

(2) As indicated above, the dry-season flows at the downstream stations have increased according to the stage-wise development of Nam Ngum hydropower station. In conclusion the low flow regime of the Nam Ngum River is dominated by the turbine release of Nam Ngum hydropower station.

(3) In 1977 unusual spill outs were made from the Nam Ngum reservoir. The monthly spill-out discharges were recorded at 414 m^3/s in March and 313 m^3/s in April (see Table 5.5). As a result, significant low flow increases were satisfactorily observed at the Thangone gauging station, although the flows observed at the Ban Tha Lat station show relatively smaller increases.

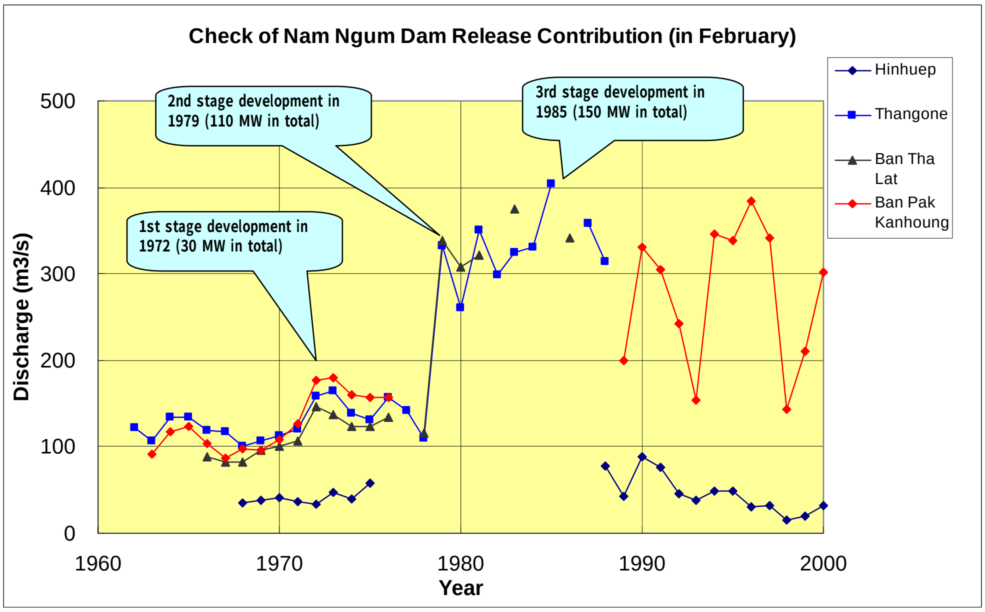


Fig. 5.10 Low Flow Increases in February in Nam Ngum River

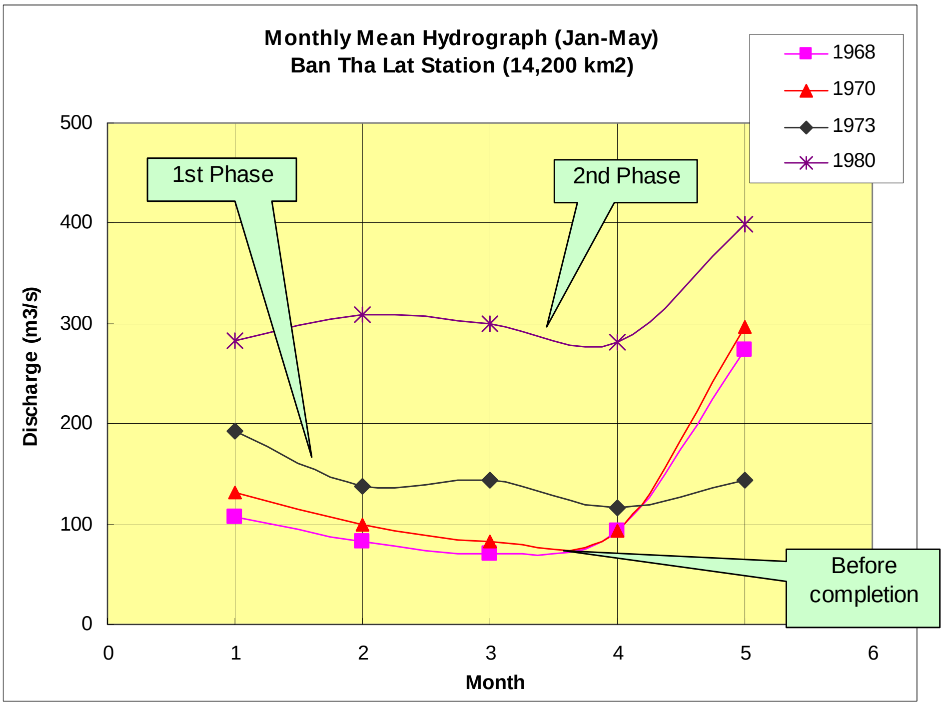


Fig. 5.11 Low Flow Increases in Dry Season in Nam Ngum River

(3) Table 5.15 shows the comparison results of low flow increases at hydrological stations. Both stations of Ban Tha Lat and Thangone have been non-operational since 1989. The Ban Pak Kanhoung station would be the monitoring station for the released discharge of the Nam Ngum reservoir. Table 5.16 below gives the summary of low flow increases due to the Nam Ngum plant discharges at the Ban Pak Kanhoung station.

Table 5.16 Hydrological Data Analysis at Ban Pak Kanhoung Station

Period	Mean Monthly Discharge (m^3/s)			Flow Increase due to Plant Release (m^3/s)		
	Feb.	Mar.	Apr.	Feb.	Mar.	Apr.
1963-71	106	88	88	68	55	54
1972-78	166	154	145	122	111	100
1979-84	-	-	-	-	-	-
1985-93	246	243	276	187	190	235
1994-00	295	301	362	262	273	331

Note: Flow increase due to plant release = Mean monthly discharge at Ban Pak Kanhoung Station – Mean monthly discharge at the Hinhuep Station

Period; 1963-71: Before completion of Nam Ngum Project
1972-78 : After completion of Phase I of Nam Ngum Project (30 MW)
1979-84 : After completion of Phase II of Nam Ngum Project (110 MW)
1988-93 : After completion of Phase III of Nam Ngum Project (150 MW) covering the drought period of 1987-93
1994-00 : After completion of Phase III of Nam Ngum Project (150 MW)

(4) The changes in low flow regime in the Nam Ngum River are indicated by the increase of dry season flows attributable to the Nam Ngum plant discharge as seen above. The average net (actual) increase of dry season flow is estimated by means of the following equation:

***Net flow increase** due to Nam Ngum Dam* = ***Flow** at the Ban Pak Kanhoung station **after** the completion of Nam Ngum Dam (**Affected flow**)* - ***Flow** at the Ban Pak Kanhoung station **before** the completion of Nam Ngum Dam (**Natural flow**)*

(5) The natural flow is usually defined as the river flow that is not affected by any water uses and water resources developments in a watershed. In this sense it might be said that the natural flow at the Ban Pak Kanhoung Station is the observed flow before the completion of the Nam Ngum Hydropower Development Project. Thus the average net flow increase in the dry season in 1989-2000 is obtained:

Table 5.17 Mean Dry Season Flow Increase in the Nam Ngum River

Period	Mean Monthly Discharge (m^3/s)		
	Feb.	Mar.	Apr.
Affected Flow (1989-2000)	275	277	326
Natural Flow (1963-1971)	106	88	88
Flow Increase (1989-2000)	169	189	238

Source: WUP-JICA Study Team

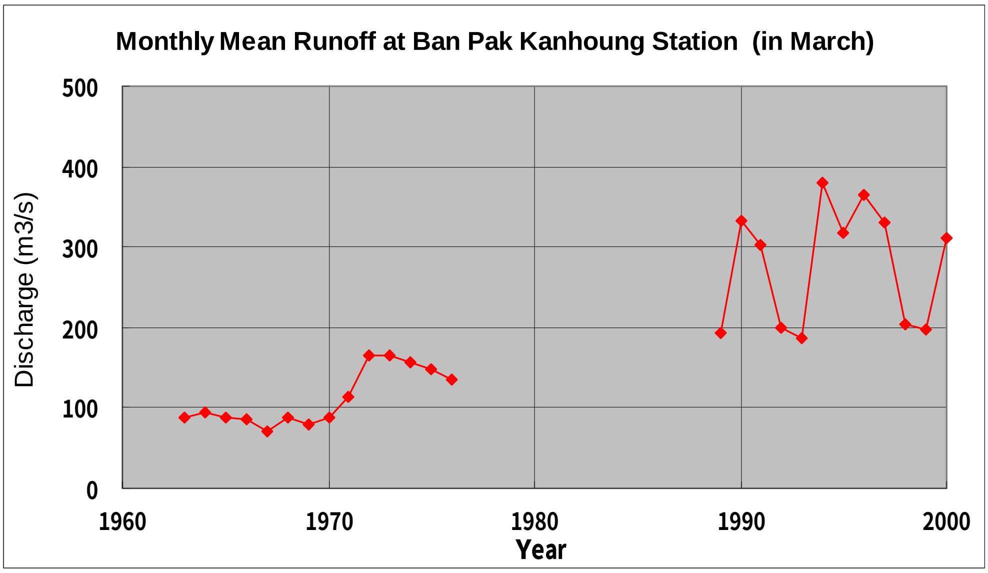


Fig. 5.12 Time-Series of Monthly Mean Discharges in March at Ban Pak Kanhoung in Nam Ngum River

(6) Another approach was made for estimating the changes in low flow regime of the Nam Ngum River from the reservoir operation data at the Nam Ngum dam. The average net increase of the dry season flow as a result of the Nam Ngum Hydropower Development is obtained as follows:

Net flow increase** due to Nam Ngum Dam* = ***Nam Ngum Reservoir Outflow (Affected flow) - ***Nam Ngum Reservoir Inflow (Natural flow)***

Table 5.18 Mean Dry Season Flow Increase in the Nam Ngum River

Period	**Mean Monthly Discharge (m^3/s)**		
	Feb.	**Mar.**	**Apr.**
Reservoir Outflow (1979-2001)	269	265	272
Reservoir Inflow (1979-2001)	81	76	88
Flow Increase (1979-2001)	188	189	184

Source: WUP-JICA Study Team

The relationship of flows above is graphically shown in the figure below.

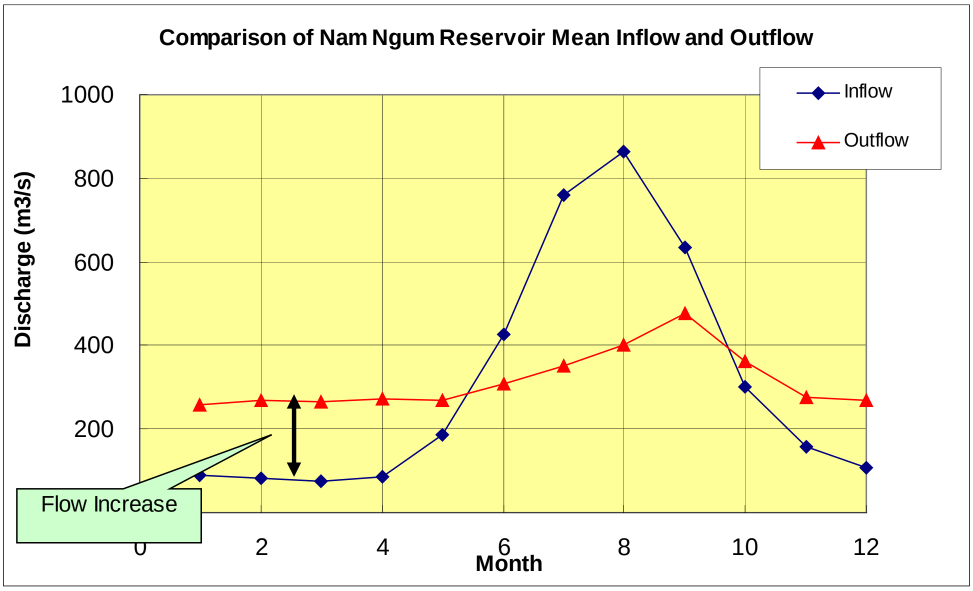


Fig. 5.13 Flow Regime Change in Nam Ngum River in terms of Difference between Mean Inflow and Outflow at Nam Ngum Dam

Changes in the flow regime of the Nam Ngum River are also verified in terms of flow duration curves of inflow and outflow, as shown below.

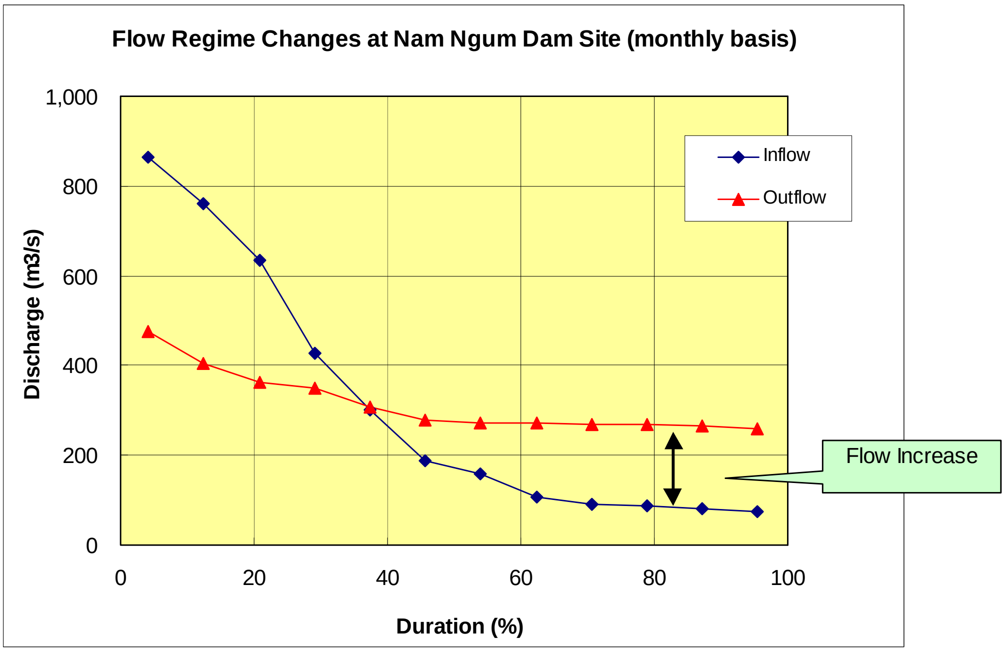


Fig. 5.14 Flow Regime Change in Nam Ngum River in terms of Duration Curves of Inflow and Outflow at Nam Ngum Dam

6. IDENTIFICATION OF LOW FLOW CHANGE OF NAM MUN-CHI RIVER DUE TO INTENSIVE WATER RESOURCES DEVELOPMENT

6.1 Nam Mun-Chi River Basin in North-eastern Thailand

In North-eastern Thailand, the Mekong River drains an area of 170,000 km^2, which amounts to about 22% of the Mekong River basin and one-third of the total area of the country. The easterly flowing Nam Mun River and its major tributary, Nam Chi River (together known as the Nam Mun-Chi River) drain the southern two-thirds of the Mekong River basin (120,000 km^2), while the remaining one-third of the Mekong River catchment (50,000 km^2) is drained by a series of northerly and easterly flowing tributaries. The Nam Mun-Chi River basin consists of a shallow saucer-shaped plateau (part of the Korat Plateau of North-eastern Thailand), which has an average height of 100-200 m above sea level.

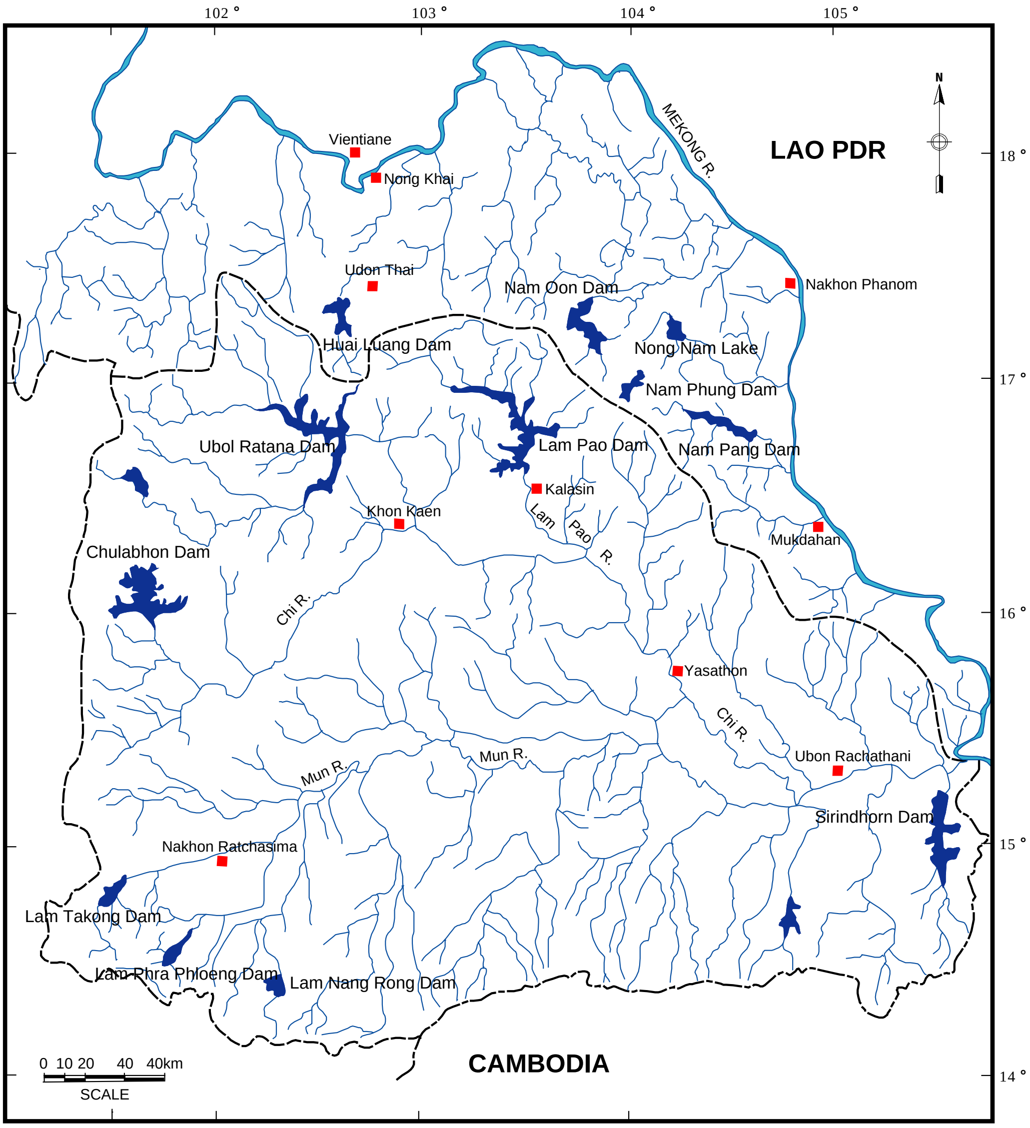


Fig. 6.1 Location Map of Existing Large-Scale Reservoirs in North-Eastern Thailand

In this North-eastern Thailand, farmland covers about 43% of the total area, of which paddy fields account for about two-thirds (27%). Forests cover only 21% of the total area. Most surface water development projects in this area are based on the three rivers: the Nam Mun, Nam Chi and the Makong Rivers.

6.2 Large Scale Water Resources Development Projects in North-Eastern Thailand

The water resources of the Mekong River basin in Thailand are intensively used for irrigation, hydropower generation and fisheries. The agriculture sector is the highest water user. Irrigation is essential for cultivated crops. Supplementary irrigation is still necessary for the wet season and in the dry season irrigation is virtually depending on the stored water. There are numerous irrigation reservoirs in north-eastern Thailand varying from small scale (pond) to large scale ones. There are ten large-scale seasonal-regulation reservoirs in north-eastern Thailand (see Table 2.1 for the salient features). All reservoirs supply irrigation water, some of which are provided with hydropower generating facilities as a multipurpose project. The total effective storage of existing reservoirs amounts to around 5,462 million m^3.

Table 6.1 Summary of Existing Reservoirs and Irrigation Service Area in Thailand

Basin Area	Total Effective Storage (million m^3)	Irrigation Area (ha)
Nam Mun river basin	1,626	56,097
Nam Chi river basin	3,100	100,716
Mekong tributaries	736	83,168
Total	**5,462**	**239,981**

Source: WUP-JICA Study Team

The seasonal regulation rate of all of the existing reservoirs to the mean annual flow volume of north-eastern Thailand is estimated to be around 6.9% as follows:

Average annual flow volume (million m^3) = 475,000 x 0.18 x (170,000 / 184,000)
= 78,995

Seasonal regulation rate = 5,462 / 78,995 x 100 = 6.9%

Note: Average annual flow volume of 475,000 million m^3 of the whole Mekong River Basin and other parameters in the above are from the Mekong River Basin Diagnostic Study, MRC, 1997. The parameter “0.18” is the average annual flow rate of the Thailand territory (184,000 km^2) to the entire Mekong River Basin. The catchmment area of north-eastern Thailand is 170,000 km^2.

Along this line, the seasonal regulation rates in sub-basin areas are roughly estimated as follows:

Table 6.2 Seasonal Regulation Rates in North-eastern Thailand

River Basin Area	Drainage Area (km^2)	Mean Annual Flow (million m^3)	Effective Storage (million m^3)	Regulation Rate (%)
Mun River	71,000	32,992	1,626	4.9
Chi River	49,000	22,769	3,100	13.6
Mekong tributaries	50,000	23,234	736	3.2
Total	**170,000**	**78,995**	**5,462**	**6.9**

Source: WUP-JICA Study Team

Data on the current and historical water uses in the basin as well as the operational record of the existing reservoirs are not available at MRC. The simplified water supply system diagram in north-eastern Thailand together with the existing key hydraulic stations is shown below.

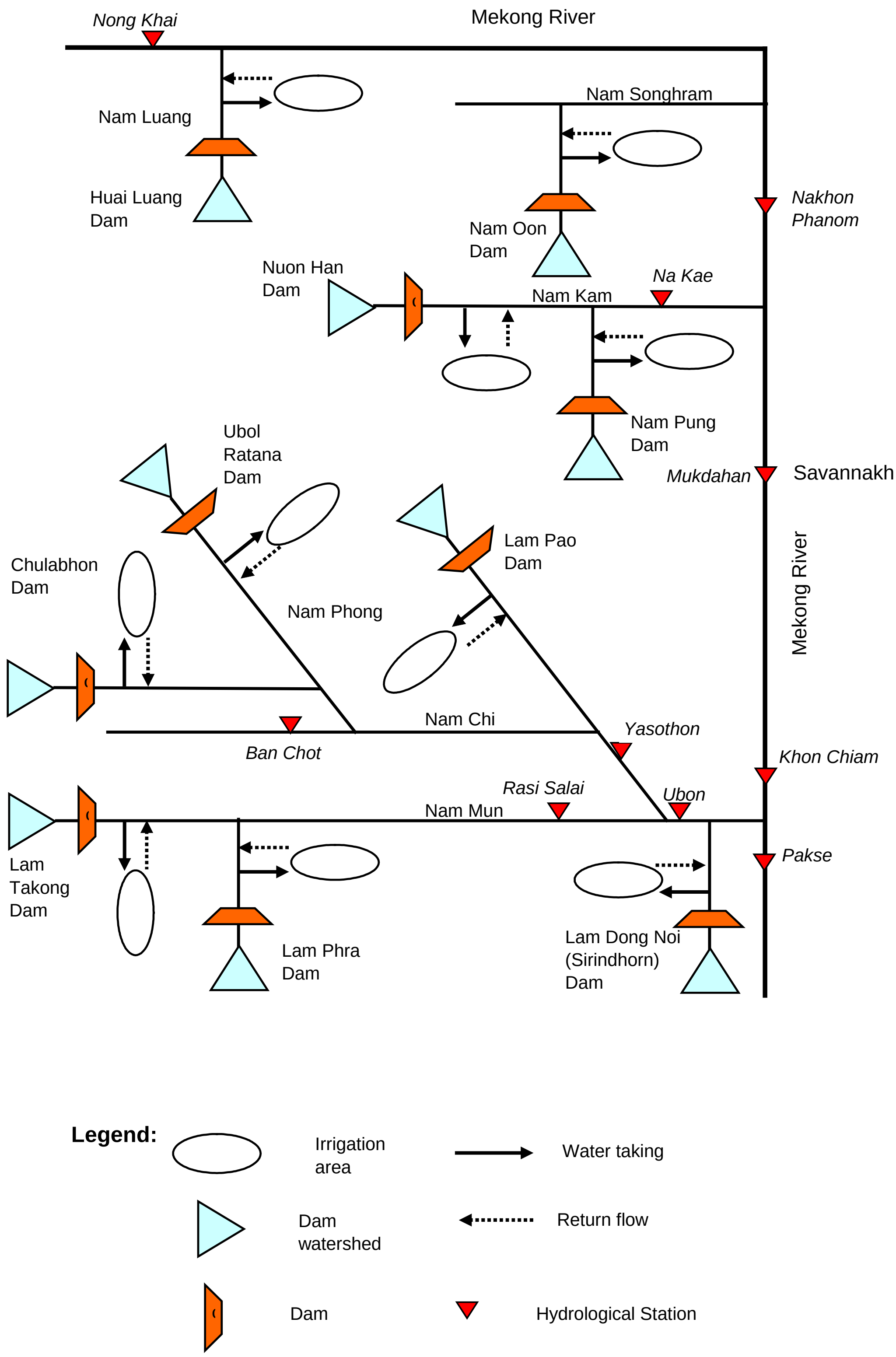


Fig. 6.2 Diagram of Large Reservoirs in North-Eastern Thailand

6.3 Changes in Low Flow Regime of the Nam Mun-Chi River

The dry season low flows of the Nam Mun-Chi River have been more or less influenced due to various water resources development projects in this basin. The low flow change in the dry season was investigated based on the measured discharge records at the selected four hydrological stations by the following two approaches:

(1) Comparison of monthly mean runoff hydrographs in the dry season (January-June) at the hydrologic stations

(2) Comparison of time-series of monthly mean discharges in the dry season (3 months of February, March and April) at the hydrologic stations

The location of selected four hydrological stations is illustrated below.

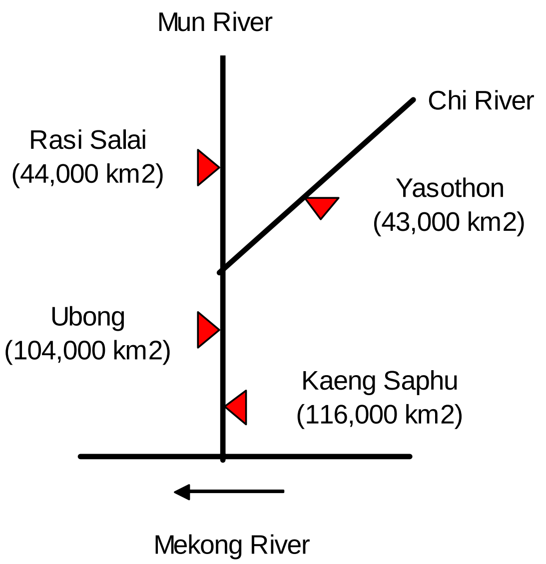


Fig. 6.3 Location Map of Selected Hydrological Stations in Nam Mun-Chi River

Photo: Ubon Hydrological Station

Tables 6.3 to 6.6 present the monthly mean discharges at the selected four stations.

The following observations and implications can be made with regard to the changes in low flow regimes in the Nam Mun-Chi River:

(1) Table 6.7 shows the summary of monthly mean discharges in the dry season at the stations. The time-series of monthly mean discharges in from February to April at four stations are plotted for comparison as shown in Fig. 6.4.

(2) Almost the same trends are observed at all stations with an exception of the Rasi Salai station on the Nam Mun River where the extremely small and constant flows are seen. From the mid 1960s to the mid 1970s, these three stations show clear upward trends in monthly mean flows, and from the mid 1980s onwards almost level trends are seen. This significant flow increasing trends are almost coincide with the progress of various water resources developments in the basin (see Fig. 2.5 showing the accumulation of developed reservoir storage in North-eastern Thailand).

(3) In conclusion this upward flow trends are indicative that intensive water resources development made significant impacts on the low flow regimes in the Nam Mun-Chi River (flood water is stored in reservoirs and the low flow is thus increased due to water release from reservoirs for water sector uses in the dry season). Almost stable level trends from the mid 1980s onwards seem to be as a result of water use for basin-wide irrigation.

(4) The figures below are the comparison results of monthly mean runoff hydrographs in the dry season (January-June) at both the Yasothon and Ubon hydrologic stations. Significant changes in the dry season flows are clearly observed compared to the discharge hydrographs both in 1962. The results of comparison for other stations are presented in Fig. 6.5 and low flow increases at Yasothon and Ubon are as follows:

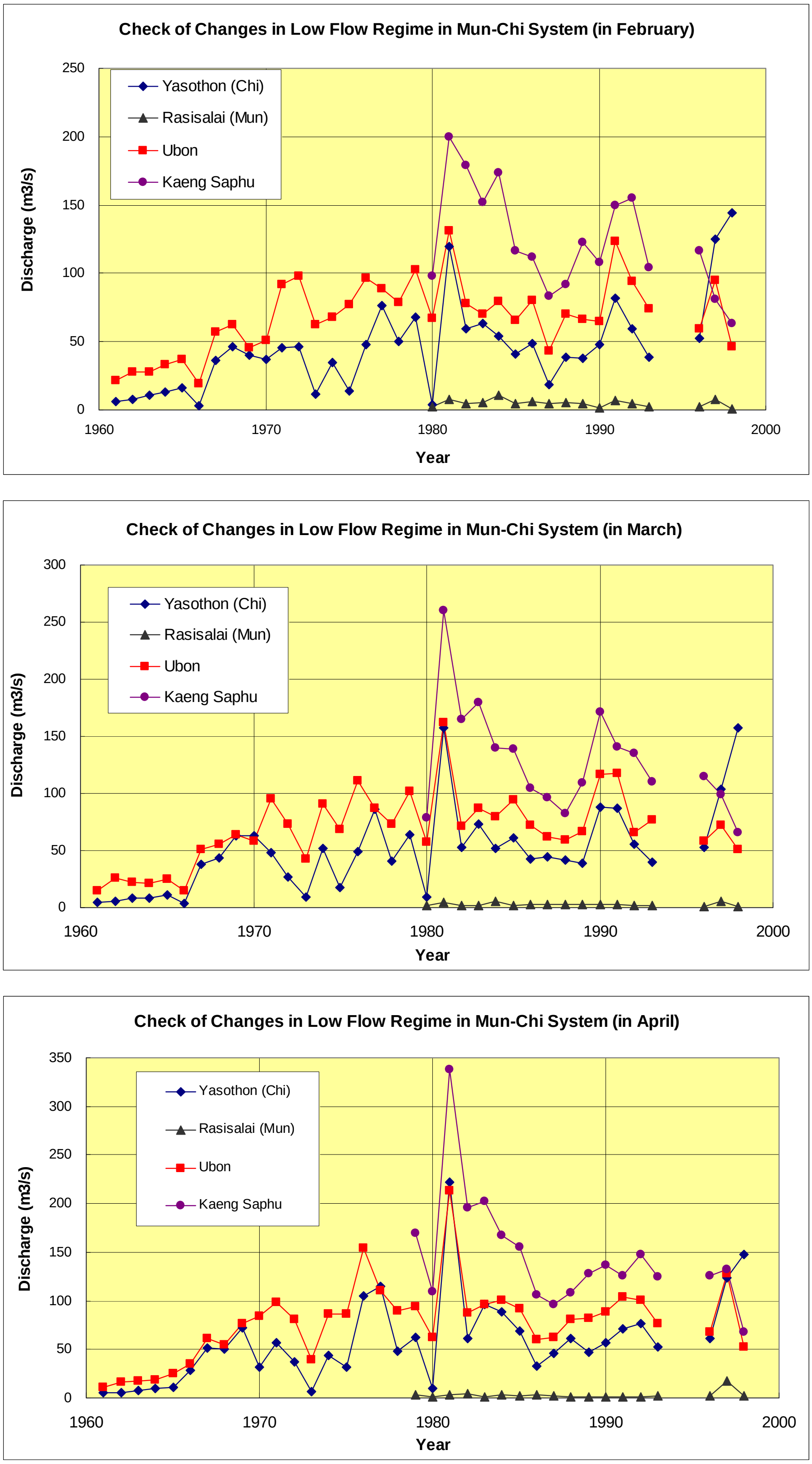


Fig. 6.4 Comparison of Time-Series of Monthly Mean Discharges in Nam Mun-Chi River

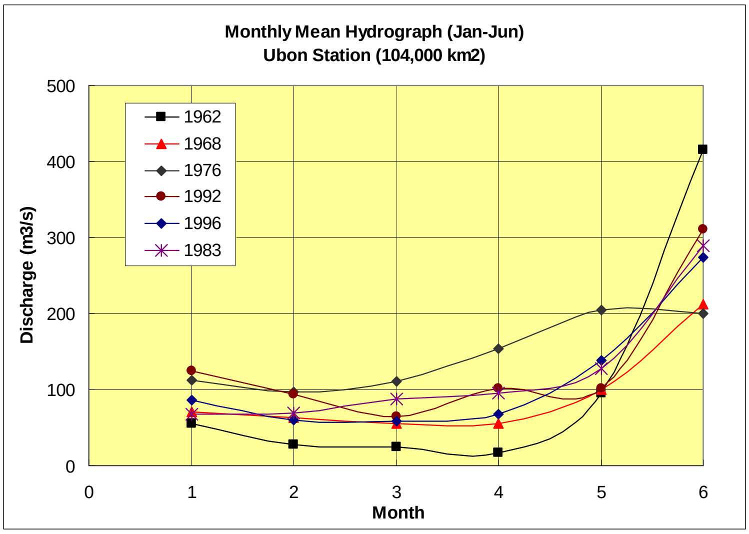


Fig. 6.6 Low Flow Increases in Dry Season in Nam Mun-Chi River

(5) Clarification of different trends on the time-series of monthly discharges in the dry season above shall be made duly provided with basin-wide historic water usage, particularly irrigation water uses (contribution of irrigation return flows), as well as the performance data of the existing large reservoirs. Intensive water uses in the basin might have significant impacts on the low flow regime of the Nam Mun-Chi River. At present the necessary information at MRC is extremely limited.

(6) The Yasothon station with a drainage area of 43,000 km2 is located on the Nam Chi River, and the Rasi Salai station is located on the Nam Mun River with a drainage area of 44,000 km2. Both hydrological stations are situated near the junction of both rivers with almost same watershed areas. However there are very large differences in these monthly mean figures as given below. The dry season flow in the Nam Mun River is extremely small compared to that in the Nam Chi River.

Table 6.8 Comparison of Mean Monthly Discharges of Nam Mun and Nam Chi Rivers

	Yasothon Station (43,000 km^2, 1980-98, Chi River)			Rasi Salai Station (44,000 km^2, 1980-98, Mun River)		
	Feb.	Mar.	Apr.	Feb.	Mar.	Apr.
Mean Monthly Discharge (m^3/s)	60.8	68.1	77.8	4.9	2.7	2.8
Specific Discharge (m^3/s/100 km^2)	0.141	0.158	0.181	0.011	0.006	0.006

Source: WUP-JICA Study Team

(7) According to the study report “Development of the Lower Mun Basin” in June 1982, the runoff coefficients of both the Nam Mun and Nam Chi Rivers are very low, 0.12 and 0.15, which is due to the low average rainfall over the basins (1,000-1,200 mm per annum) and the generally flat topography. Despite this low runoff, both rivers swell to a major tributary of the Mekong River on account of its large catchment area. The relation between annual rainfall and runoff for the Nam Mun-Chi River basin at Ubon (the data period of 1962-1978) is shown below.

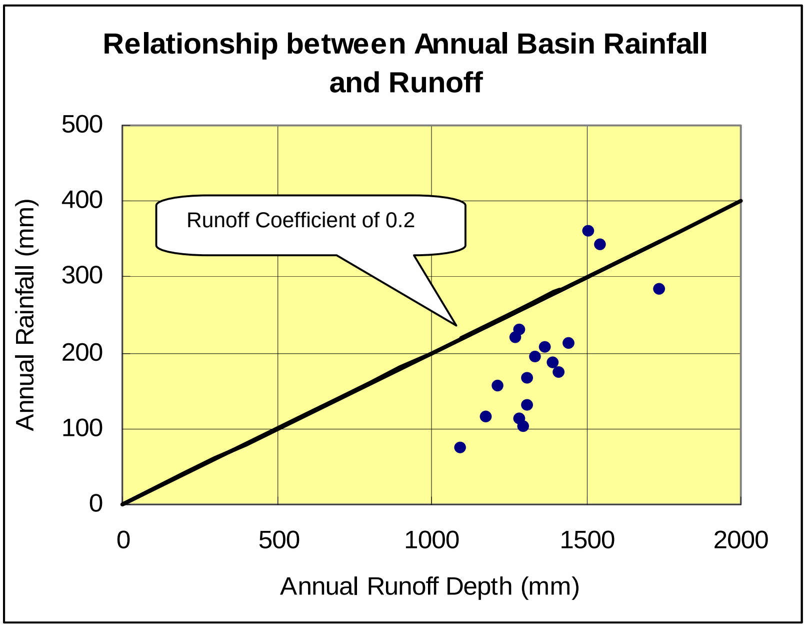


Fig. 6.7 Relation between Annual Basin Rainfall and Runoff at Ubon

(8) The following table shows the comparison of total capacity of the existing large reservoirs within the drainage areas at both two hydrologic stations.

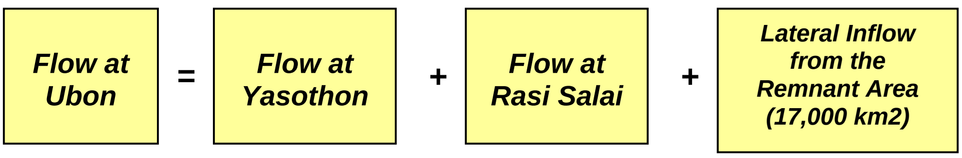
Table 6.9 Comparison of Large Reservoir Storage in Nam Mun and Nam Chi Rivers

Hydrologic Station	Reservoir	Storage (million m^3)
Yasothon (Nam Chi River)	Nam Pong	1,695
	Nam Phrom	145
	Lam Pao	1,260
	Total	**3,100**
Rasi Salai (Nam Mun River)	Lam Phra Ploeng	145
	Lam Takong	290
	Total	**435**

Source: JICA Study Team

(9) The most likely explanation for such large differences seems to be that the existence of large reservoirs in the Nam Chi River basin causes significantly higher flows in the dry season compared to the dry season flows in the Nam Mun River.

(10) The relationship between the Nam Mun and Nam Chi River flows was also verified in terms of the estimated Ubon discharge. The monthly mean discharge at the Ubon station was estimated and compared with the observed monthly mean discharges as given below.



(11) The lateral inflow is estimated applying the estimated mean monthly specific discharges at the Yasothon station. The results are shown below.

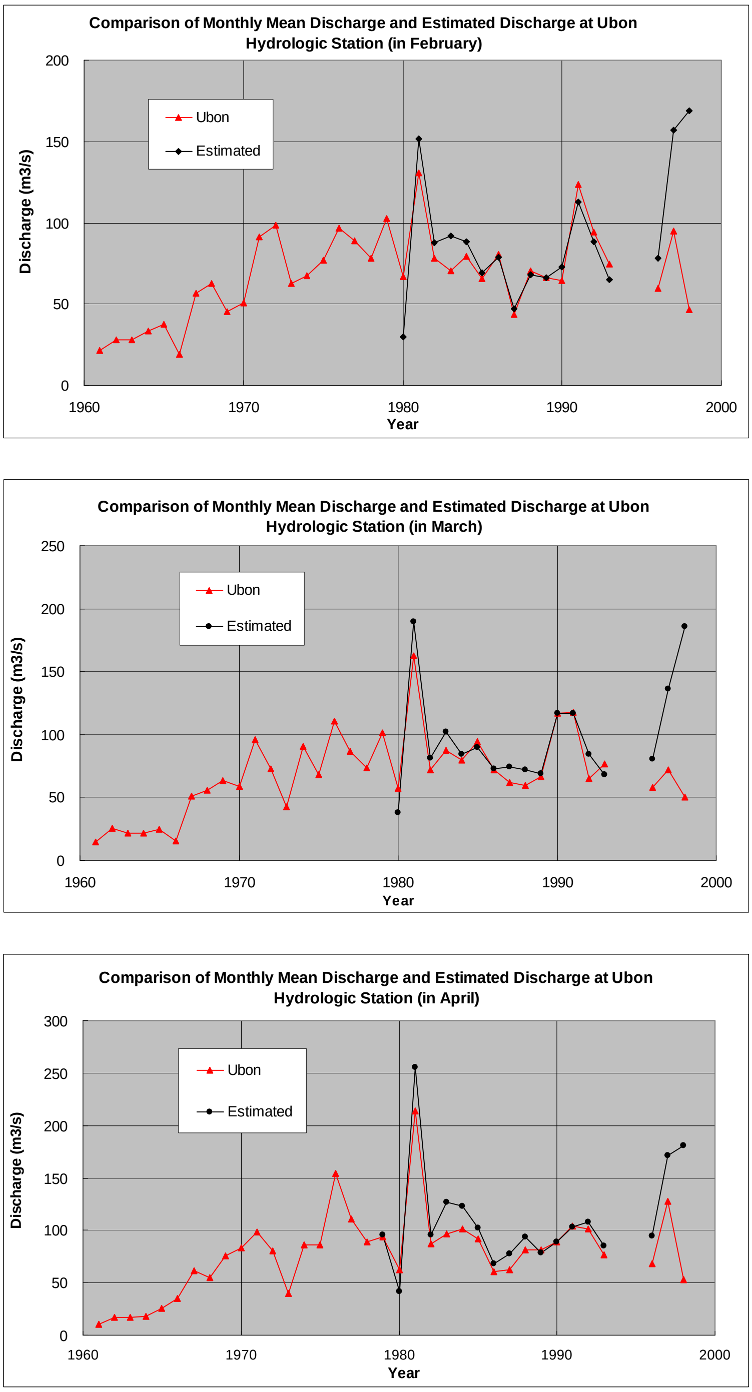


Fig. 6.8 Comparison of Actual and Estimated Monthly Mean Discharges at Selected Stations in Nam Mun-Chi River

(12) As seen above, the estimated discharges are almost well fitted to the monthly mean discharges at the Ubon station in 1980s and up to the mid-1990s. After the mid-1990s, the

estimated discharges are far over the Ubon discharges because the Yasothon discharges with a catchment area of 43,000 km^2 are higher than those at the Ubon station having the catchment area of 104,000 km^2.

6.4 Low Flow Check at the Confluence with Mekong Mainstream

The relationship between the flows of the Nam Mun-Chi River and Mekong River is evaluated by means of the monthly mean discharges at related hydrologic stations. The Nam Mun-Chi River joins to the Mekong River near Khong Chiam. The Khong Chiam hydrologic station is located on the Mekong mainstream about 1 km upstream from the confluence of the Nam Mun-Chi River. The Pakse hydrologic station is also located on the Mekong mainstream about 40 km downstream from the confluence as illustrated in the figure below.

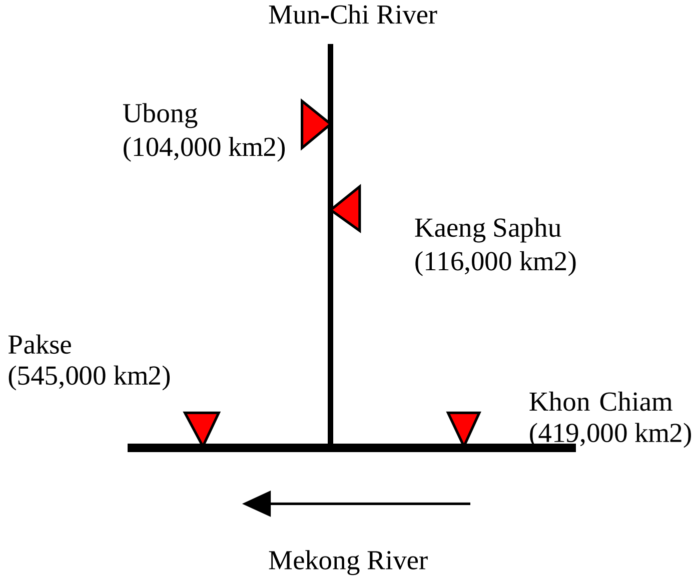
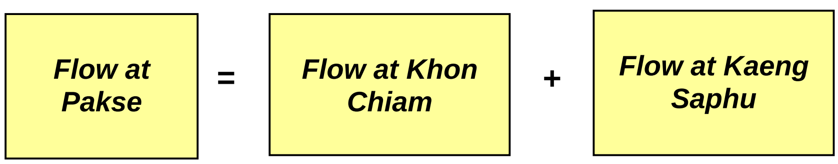


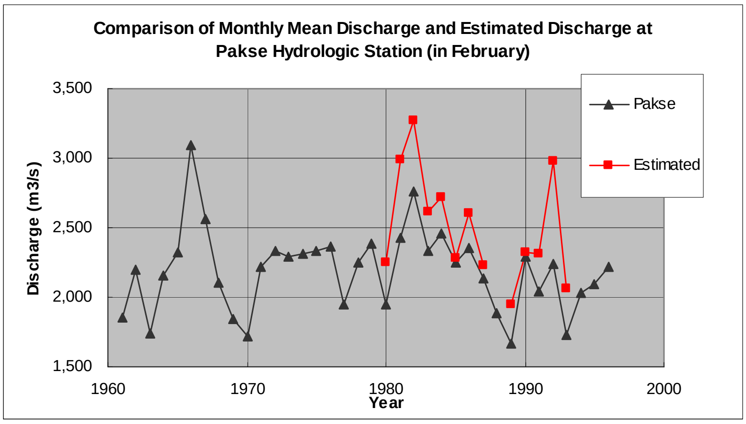
Fig. 6.9 Location Map of Selected Hydrological Stations at the Confluence of Mekong River

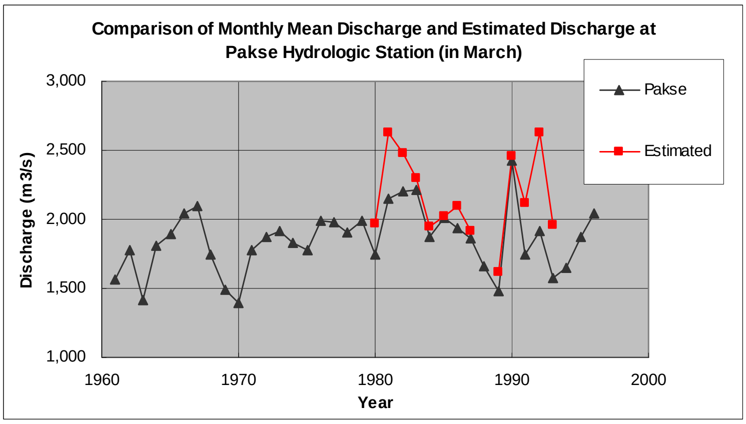
The time-series of low flows (monthly mean discharge in the dry season) at the Pakse hydrologic station are estimated by the sum of low flows at both the Khon Chiam and Kaeng Saphu (on the Nam Mun-Chi River) stations considering that the localized flow contributions from the remnant catchment with an area of 10,000 km^2 is negligibly small compared to the entire drainage area at the Pakse of 545,000 km^2.



Monthly mean discharges at the selected Khon Chiam and Pakse stations are shown in Tables 7.11 and 7.12. Main points of implications drawn from comparison results are as follows:

(1) Comparison results are shown below. Although both time-series of dry season monthly mean flows are showing almost similar pattern, the estimated monthly mean discharge are higher than the published monthly mean discharges at the Pakse hydrologic station.





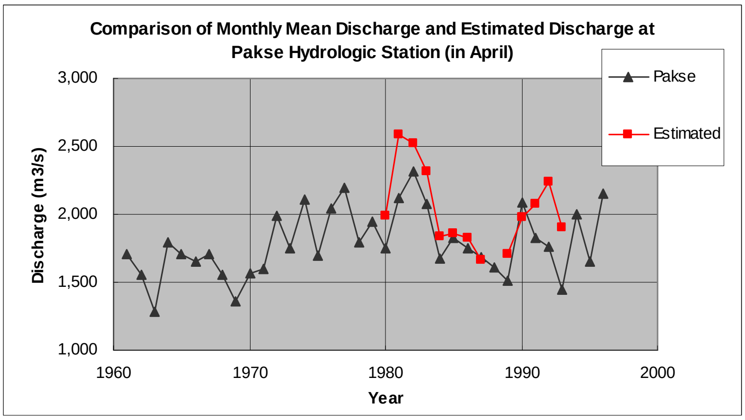


Fig. 6.10 Comparison of Actual and Estimated Monthly Mean Discharges at Pakse on Mekong River

(2) The above results are directly attributed to the fact that mean monthly discharges in the dry season at the Khon Chiam are higher than those at the Pakse station. The comparison results are summarized below. Such "upstream and downstream flow balance inconsistency" is to be discussed in detail in the succeeding chapter.

Table 6.10 Comparison of Mean Monthly Discharges (1980-1993)

Month	Khon Chiam (m^3/s)	Kaeng Saphu (m^3/s)	Estimated (m^3/s)	Pakse (m^3/s)	Difference (m^3/s)	Error (%)
Feb	2,370	132	2,505	2,181	302	13.8
Mar	2,023	137	2,164	1,913	231	12.1
Apr	1,883	153	2,039	1,817	206	11.3

Source : WUP-JICA Study Team

6.5 Effect of Existing Reservoirs on River Runoff

The changes in the Nam Mun-Chi flows due to water resources development projects were analyzed in the study of Development of the Lower Mun Basin undertaken by the Interim Mekong Committee in 1982. The study was based on the comparison of the observed discharge data and estimated natural flows at two key stations in the Nam Mun and Chi River basins. The results are quoted below.

Table 6.11 Influence of Large Reservoirs on the Flow in the Nam Mun-Chi River

(Unit: 10^6 m^3)

Flow	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Nam Mun River at Rasi Salai (1967-1972)													
Natural flow	45.2	12.5	18.9	6.6	19.0	115	395	569	1,515	2,454	684	195	6,029
Observed flow	46.7	15.2	21.4	7.2	18.1	120	400	579	1,425	2,424	689	193	5,939
Change in flow	+1.5	+2.7	+2.5	+0.6	-0.9	+5	+5	+10	-90	-30	+5	-2	-90
Change in flow (%)	3	22	13	9	-5	4	1	2	-6	-1	1	-1	-1
Nam Chi River at Yasothon (1966-1972)													
Natural flow	8.0	4.2	8.5	17.9	88.9	567	927	1,134	2,135	1,692	400	57	7,039
Observed flow	104	88.1	101	124	209	451	733	964	1,640	1,587	504	175	6,680
Change in flow	+96	+83.9	+92.9	+106	+120	-116	-194	-170	-945	-105	+104	+118	-359
Change in flow (%)	1,200	2,000	1,093	592	135	-20	-21	-15	-23	-6	26	207	-5

Source: Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1982), Development of the Lower Mun Basin, Feasibility Study: Volume II, Annex A-E

The discharge data used were both until 1972. As mentioned in Section 4.3, the developed reservoir storage volume until 1972 was 3,100 million m^3 in the upstream watershed of Yasothon in the Nam Chi River, while in the Nam Mun River it was only 435 million m^3 from Rasi Salai. The study concluded that the storage reservoirs in the Nam Mun River have no significant influence on the river flow; however, the flow in the Nam Chi greatly increased by about 100 million m^3 per month (equivalent to around 40 m^3/s) in the dry season and decreased by 15-20% on average in the wet season. The mean dry season natural flow of 4.2 million m^3 (1.7 m^3/s) in February of the Nam Chi River increased significantly to be around 88.1 million m^3 (36.4 m^3/s).

6.6 Low Flow Increases due to Existing Large Reservoirs

Tables 6.12 to 6.20 give the monthly-basis operation records of the existing nine large-scale reservoirs in North-eastern Thailand. The changes of low flow regime of the Nam Chi-Mun River due to seasonal regulation of these reservoirs are graphically shown respectively as follows:

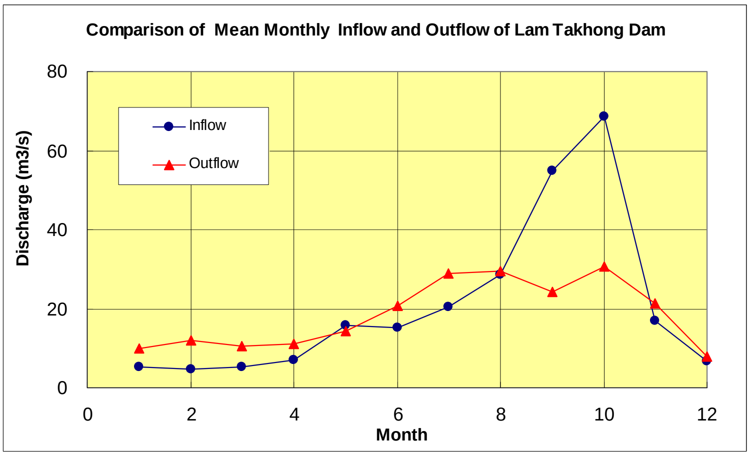


Fig. 6.11 Average Flow Regime Change in Terms of Difference between Mean Monthly Inflow and Outflow of Lam Thakhong Dam

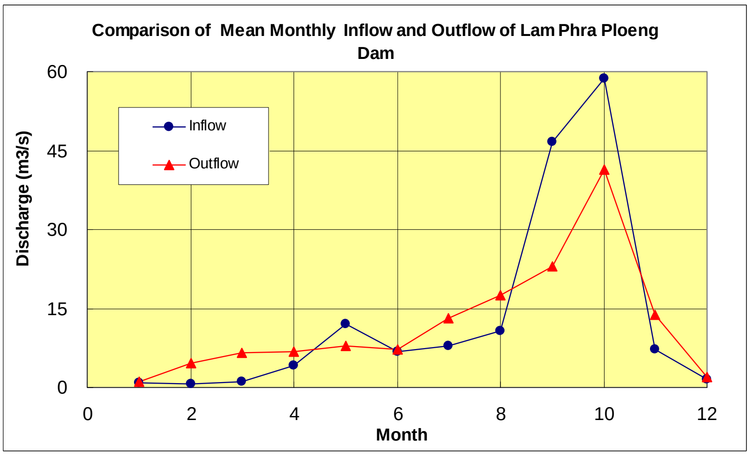


Fig. 6.12 Average Flow Regime Change in Terms of Difference between Mean Monthly Inflow and Outflow of Lam Phra Ploeng Dam

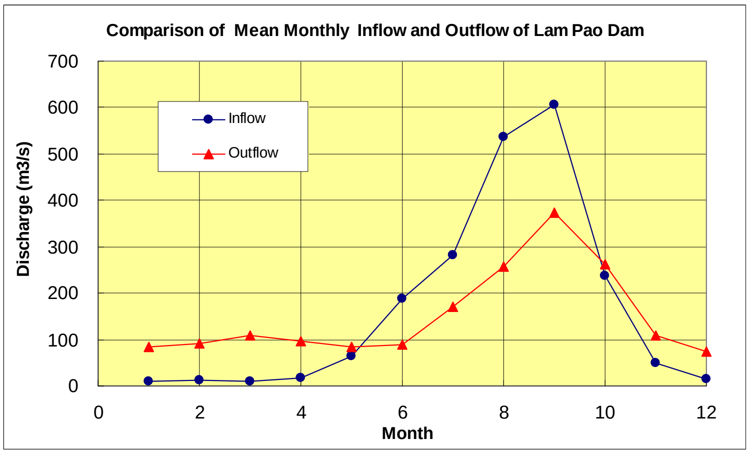


Fig. 6.13 Average Flow Regime Change in Terms of Difference between Mean Monthly Inflow and Outflow of Lam Pao Dam

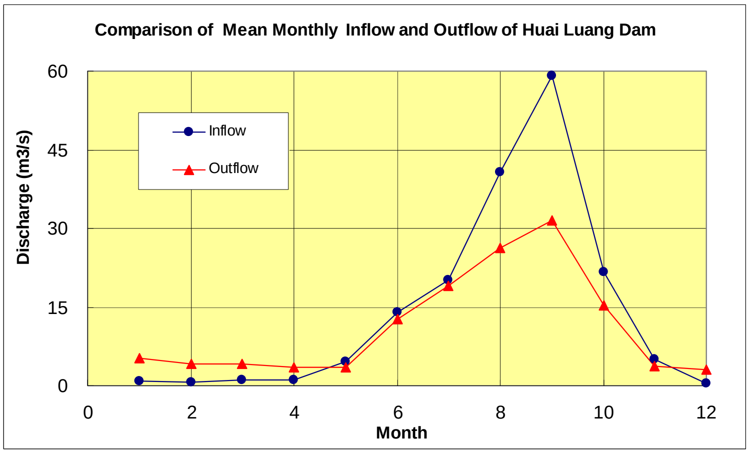


Fig. 6.14 Average Flow Regime Change in Terms of Difference between Mean Monthly Inflow and Outflow of Huai Luang Dam

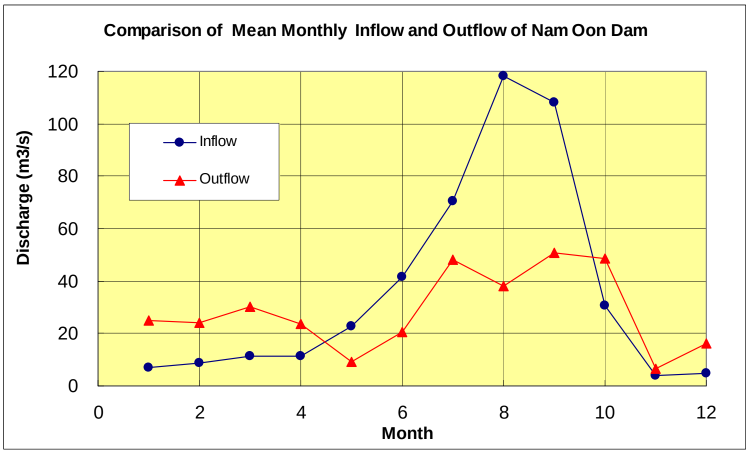


Fig. 6.15 Average Flow Regime Change in Terms of Difference between Mean Monthly Inflow and Outflow of Nam Oon Dam

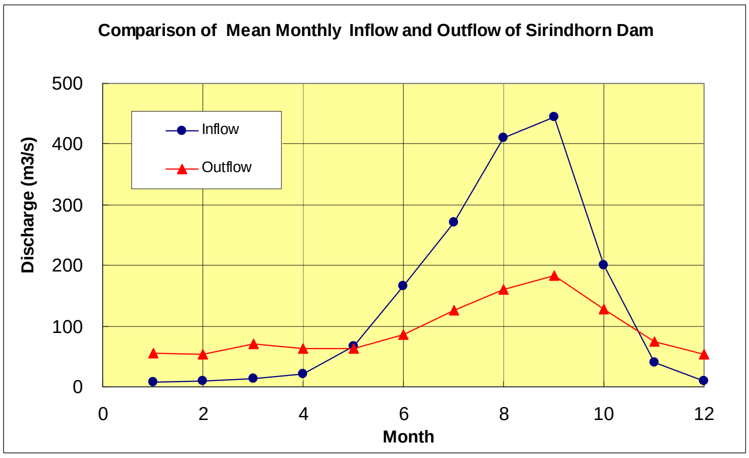


Fig. 6.16 Average Flow Regime Change in Terms of Difference between Mean Monthly Inflow and Outflow of Sirindhorn Dam

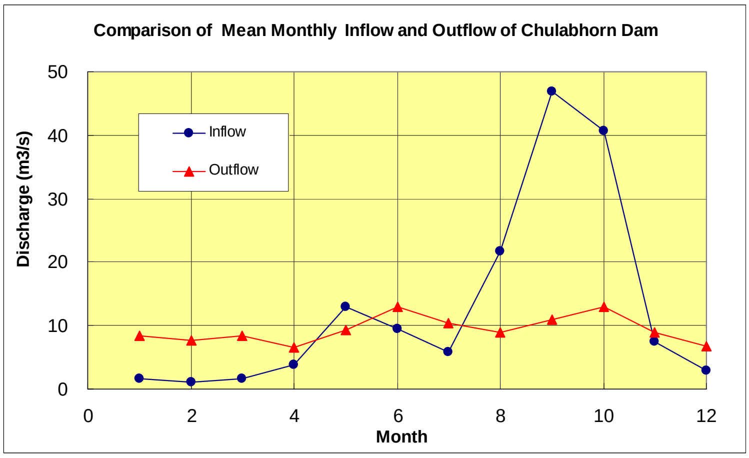


Fig. 6.17 Average Flow Regime Change in Terms of Difference between Mean Monthly Inflow and Outflow of Chulabhorn Dam

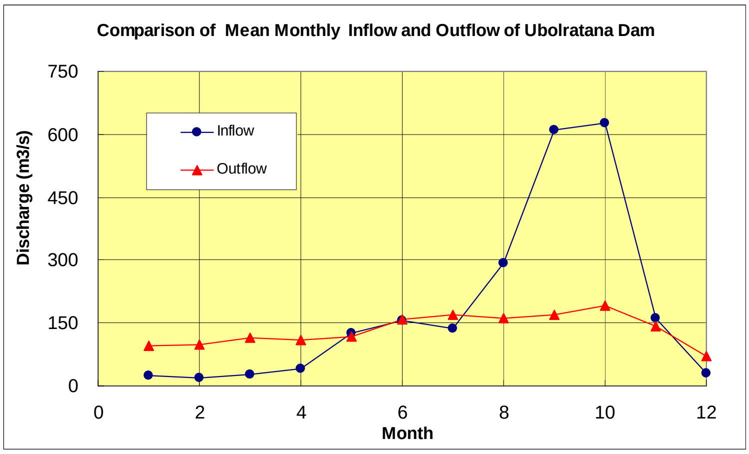


Fig. 6.18 Average Flow Regime Change in Terms of Difference between Mean Monthly Inflow and Outflow of Ubolratana Dam

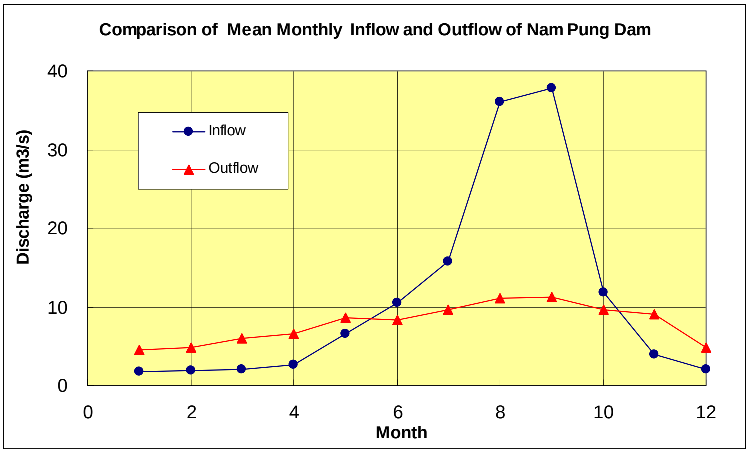


Fig. 6.19 Average Flow Regime Change in Terms of Difference between Mean Monthly Inflow and Outflow of Nam Pung Dam

The table below gives a summary of the average low flow increases due to seasonal regulation of nine large-scale reservoirs.

Table 6.21 Summary of Average Low Flow Increases in the Nam Mun-Chi River due to Seasonal Regulation of Large Reservoirs

(Unit: m^3/sec)

Dam	Jan	Feb	Mar	Apr	May
Lam Takhong	4.8	7.3	5.5	4.2	-1.7
Lam Phra Ploeng	0.2	4.0	5.5	2.7	-4.3
Lam Pao	74.0	81.4	99.0	80.1	20.6
Huai Luang	4.5	3.5	3.1	2.4	-1.0
Nam Oon	17.9	15.3	18.6	12.3	-13.8
Sirindhorn	47.4	44.4	58.7	43.1	-4.6
Chulabhorn	6.7	6.5	6.8	2.8	-3.7
Ubolratana	72.6	79.3	89.1	69.9	-9.8
Nam Pung	2.7	2.9	4.0	3.9	2.1
Total	**230.8**	**244.6**	**290.3**	**221.4**	**-16.2**

Source : WUP-JICA Study Team

As is apparent from the table above, significant changes in the dry season flows are observed due to seasonal regulation of large-scale reservoirs. The mean low flow increases are in the range of 220-290 m^3/sec from January to April. The total volume of low flow increase is estimated to be around 2,561 million m^3 in this period.

Preliminary estimate of average low flow increase in the dry season from January to April is made at the outfall point of Nam Mun-Chi River into the Mekong mainstream in terms of rough water balance calculation as follows:

- Low flow increase due to the release flow of large reservoirs: 2,561 million m^3
- Return flow rate of irrigation water use: 30% (see Table 4.10)
- Total consumption of irrigation use: 2,561 million m^3 x 70% = 1,793 million m^3
- Total volume of return flows: 2,561 million m^3 x 30% = 768 million m^3
- Average low flow increase at the confluence with the Mekong River
  = (768 million m^3 x 1,000,000) / 86,400 / (31+28+31+30) = 74.1 m^3/sec

The average low flow increase of the Nam Mun-Chi River in the dry season is roughly estimated at around 74 m^3/sec at the confluence point to the Mekong mainstream.

In addition to the above, the average low flow increase in the Nam Chi River from January to April was roughly estimated by use of the reservoir operation records of the existing three Lam Pao (completed in 1971), Chulabhorn (in 1971) and Ubolratana (in 1966) dams. It is assumed that the released flows from dam are fully used for dry season irrigation and 30% of its water use returns to the river as an irrigation return flow. The estimated low flow increase is as follows:

Table 6.22 Estimated Average Low Flow Increases in the Nam Chi River due to Seasonal Regulation of Large Reservoirs

(Unit: m3/sec)

	Jan	Feb	Mar	Apr
Monthly Discharge (m^3/s)	46.0	50.2	58.5	45.8
Monthly Volume (million m^3)	123.2	121.3	156.6	118.8

Source : WUP-JICA Study Team

Fig. 6.20 give the time-series of monthly mean discharges in February, March and April at Yasothon and Ubon stations in the Nam Chi River (see the location map in Fig. 6.3). Significant increases of low flows due to seasonal regulation of large reservoirs were observed in two decades from 1960s.

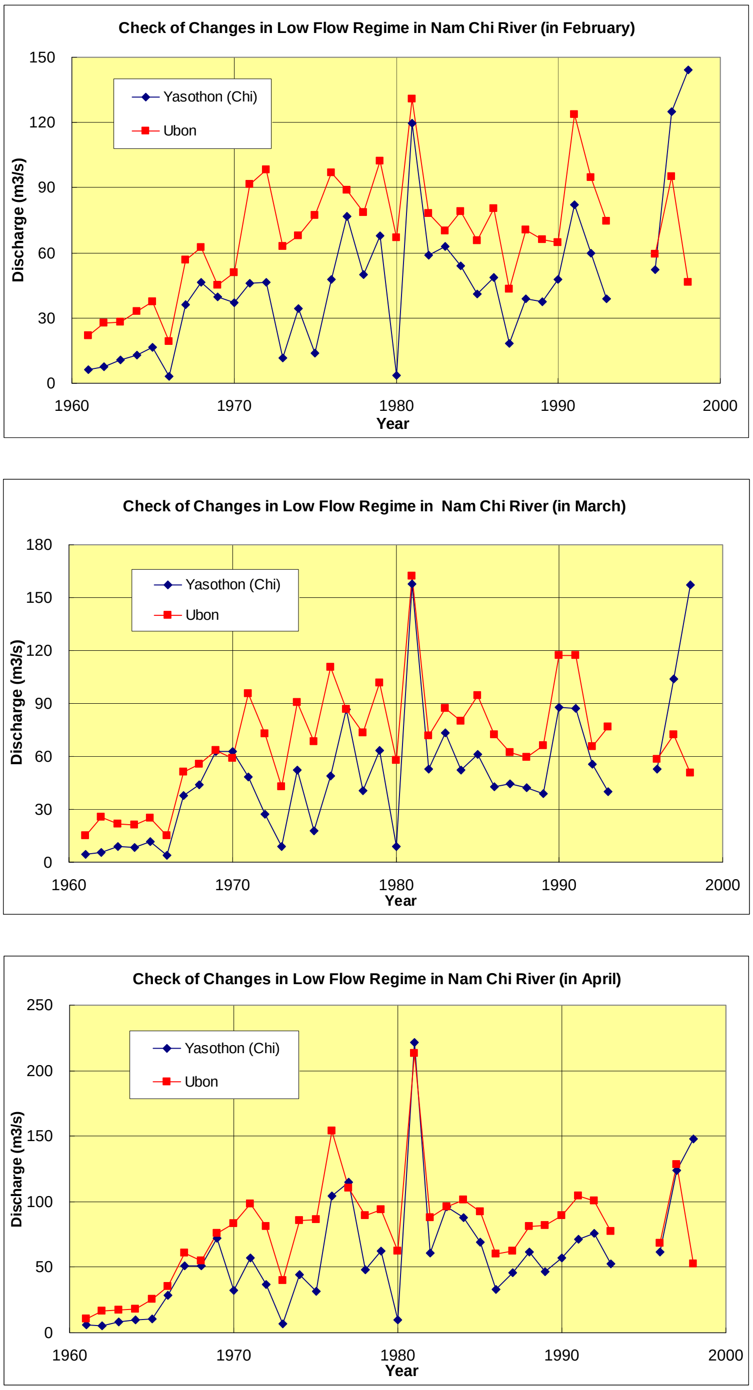


Fig. 6.20 Comparison of Time-Series of Monthly Mean Discharges at Yasothon and Ubon in the Nam Chi River

7. ASSESSMENT OF LOW FLOW INCREASE DUE TO LATERAL INFLOWS ALONG THE MEKONG MAINSTREAM

7.1 Hydrological Network Stations

At the beginning of the year 2001, the number of hydrological stations in the entire Lower Mekong River Basin reached 432 in total. In March 2001 the Strategic Master Scheme for Hydro-Meteorological Network in the Mekong River Basin was established by MRC. One of purposes of this study was to classify the existing hydrological stations in view of the network improvement goal that "The network of hydro-meteorological stations shall provide timely, sufficient and reliable data and information to water management and water-related programmes and projects in both the regional and national levels". The network classification is as follows:

Table 7.1 Classification of Network Hydrological Station

Classification	Thailand	Lao PDR	Cambodia	Vietnam	Total
Key	7	5	8	5	**25**
Primary	4	4	3	8 (1)	**19**
Basic	12	23 (1)	23 (6)	13 (2)	**71**
Sub-Total	***23***	***32***	***34***	***26***	***115***
Local	157	107	35	28	**327**
Total	**180**	**138**	**63**	**51**	**432**

Note: Figures in parenthesis are planned for new installation, and included in the total number. "Local" classification does not include planned new station installations; hence "Total" does not include the planned new station installations.

Source: Strategic Master Scheme for Hydro-Meteorological Network in the Mekong River Basin, MRC, March 2001

Network classifications are shown below.

Table 7.2 Classification and Objectives of Network Station

Classification	Objectives
Key	- To facilitate real-time coordination and forecasting activities. - To Monitor long-term trend in quantity and quality of river hydrological conditions. - To provide data/information for major project planning on the mainstream and major tributaries.
Primary	- To Monitor long term trend in quantity and quality of river hydrological conditions. - To provide data/information for major project planning on the main stream and major tributaries.
Basic	- To provide data/information for medium-scale project, research and management works to meet short/medium term needs including for high accuracy purposes.
Local	- To provide data/information for small-scale projects and monitoring operation for medium/small-scale projects to meet local needs.

Source: Strategic Master Scheme for Hydro-Meteorological Network in the Mekong River Basin, MRC, March 2001

7.2 Selected Hydrological Network Stations for Assessment

As discussed in Chapter 6, the low flow regime of the Nam Ngum River has changed due to the implementation of the Nam Ngum Hydropower Development Project. It appears that the Nam Ngum low flows have significantly increased as a result of historic power generation. The low flows of the Mekong mainstream are thus expected to increase due to the increased lateral inflows from the Nam Ngum River.

Changes of low flow regime on the Mekong mainstream were examined in terms of lateral inflows from the tributaries. The lateral inflows were estimated based on the flow balance between hydrologic stations on the Mekong mainstream. Out of 25 key network stations in the entire Lower Mekong Basin, 13 stations including two primary stations on the Mekong mainstream were selected for the preliminary assessment. This assessment is based on the proposal that the key stations are of great importance in view of the future monitoring framework and evaluation of the hydrologic flow regime on the Mekong mainstream within the context of the 1995 Mekong Agreement.

The selected hydrologic stations are listed in Table 7.3 below. Hydrologic stations downstream from Chroui Changvar, at the confluence of the Tonle Sap River in Phnom Penh, are not applied because of limited availability of discharge data due to hydraulic complexity. The location map of the selected stations is shown in Fig. 7.1.

Table 7.3 Selected Hydrological Stations on the Mekong Mainstream

No.	Station Name	Classification	Drainage Area (km^2)
1	Chiang Saen	Key	189,000
2	Luang Prabang	Key	268,000
3	Chiang Khan	Key	292,000
4	Vientiane	Primary	299,000
5	Nong Khai	Key	302,000
6	Nakhon Phanom	Key	373,000
7	Mukdahan	Key	391,000
8	Khon Chiam	Key	419,000
9	Pakse	Key	545,000
10	Stung Treng	Key	635,000
11	Kratie	Key	646,000
12	Kompong Cham	Key	660,000
13	Chroui Changvar	Primary	663,000

Source: WUP-JICA Study Team

Tables 7.4 to 7.16 present the monthly mean discharges of the selected stations, and the data availability is shown in Table 7.17. These data are retrieved from the HYMOS database system at MRC.

Fig. 7.1 Location Map of Selected Hydrological Stations for Flow Balance Calculation on Mekong Mainstream

Table 7.17 Data Availability of Selected Hydrological Stations

No.	Station	Country	Availability of Monthly Data																																							
			61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01
1	Chiang Saen	Thailand	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			
2	Luang Prabang	Lao PDR	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	
3	Chiang Khan	Thailand								○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			
4	Vientiane	Lao PDR	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	
5	Nong Khai	Thailand										○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			
6	Nakhon Phanom	Thailand	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			
7	Mukdahan	Thailand	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			
8	Khong Chiam	Thailand						○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		○	○	○	○	○	○	○	○	○	○			
9	Pakse	Lao PDR	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	
10	Stung Treng	Cambodia	○	○	○	○	○	○	○	○	○	○																					○	○	○	○	○		○	○			
11	Kratie	Cambodia	○	○	○	○	○	○	○	○	○	○																															
12	Kompong Cham	Cambodia				○	○	○	○	○	○	○	○	○	○	○																											
13	Chroui Changvar	Cambodia	○	○	○	○	○	○	○	○	○	○	○	○																													

Source: WUP-JICA Study Team

7.3 Basic Conditions for Assessment

The low flow increases due to lateral inflows between the selected stations on the Mekong mainstream were assessed from the following technical considerations:

(1) The low flow increases due to lateral inflows is verified by means of the flow balance of monthly mean discharges at the upstream and downstream hydrologic stations. Flow balance calculation is illustrated in Fig. 7.2 below.

(2) Current major water extractions from the Mekong mainstream are for domestic water supply (see Section 2.4) and pumping irrigation (see Section 3.4). However water extractions were not taken into account in the flow balance calculation because no historic water extraction data is available and water extractions are evaluated too small to make a significant impact to the calculation.

(3) Flow balance calculation is made for the dry season discharges from January to May in the period of 1961-2000. The monthly mean discharges during January to May are used for assessment considering that the river flows in these months reflect the “base flow” almost without any contribution of local flood inflows from the contributing catchment between stations. In this period subsurface and groundwater outflows are predominant in the localized flow contributions.

(4) The flow balance calculation is applied to twelve river reaches. The contributing catchment areas of lateral inflows into the river reaches are listed in Table 7.18 below.

Table 7.18 Contributing Catchment Area of Objective River Reaches

No.	Station Name	Catchment Area (km^2)
1	Chiang Saen – Luang Prabang	79,000
2	Luang Prabang – Chiang Khan	24,000
3	Chiang Khan – Vientiane	7,000
4	Vientiane – Nong Khai	3,000
5	Nong Khai – Nakhon Phanom	71,000
6	Nakhon Phanom - Mukdahan	18,000
7	Mukdahan – Khong Chiam	28,000
8	Khong Chiam – Pakse	126,000
9	Pakse – Stung Treng	90,000
10	Stung Treng – Kratie	11,000
11	Kratie – Kompong Cham	14,000
12	Kompong Cham – Chruoi Changvar	3,000

Source: WUP-JICA Study Team

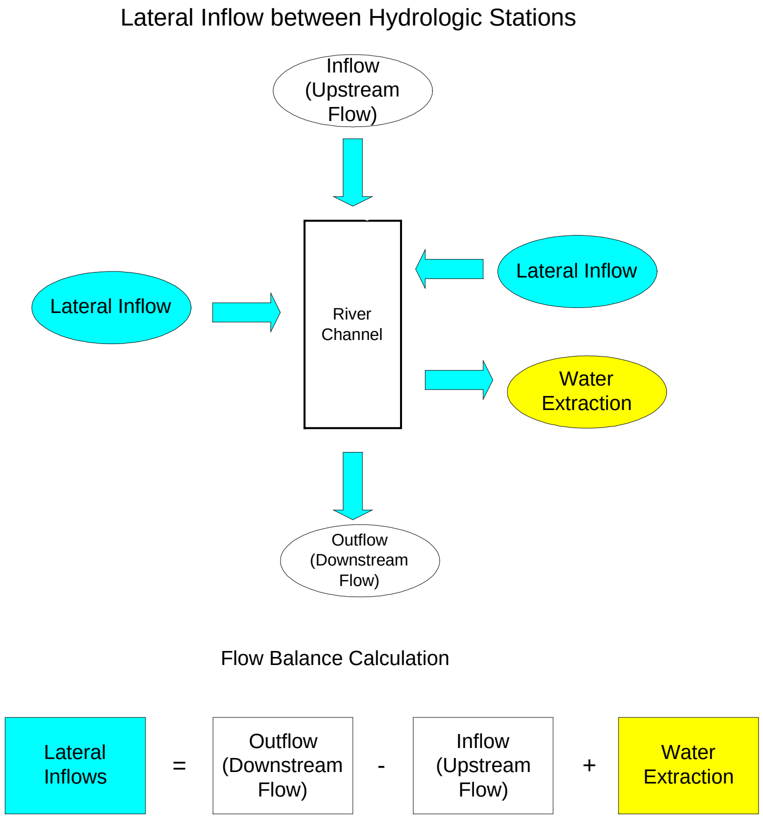


Fig. 7.2 Illustration of Flow Balance Calculation

7.4 Results of Assessment

The following major observations and implications can be drawn with regard to the low flow increases due to lateral inflows along the Mekong mainstream:

Table 7.19 gives the comparison of monthly mean discharges from January to May at all stations. Specific mean monthly discharges in both March and April at respective stations were firstly estimated as listed below.

Table 7.20 Specific Discharges in Dry Season at Hydrologic Stations

Key Station	In March		In April	
	Mean (m^3/s)	Specific Discharge ($m^3/s/100km^2$)	Mean (m^3/s)	Specific Discharge ($m^3/s/100km^2$)
Chiang Saen	835	0.44	915	0.48
Luang Prabang	1,065	0.40	1,112	0.42
Chiang Khan	1,043	0.36	1,053	0.36
Vientiane	1,167	0.39	1,194	0.40
Nong Khai	1,176	0.39	1,215	0.41
Nakhon Phanom	1,548	0.42	1,526	0.41
Mukdahan	1,600	0.41	1,569	0.40
Khon Chiam	1,903	0.46		0.44
Pakse	1,852	0.34	1,819	0.33
Stung Treng	2,209	0.35	2,114	0.33
Kratie	2,320	0.36	2,275	0.35
Kompong Cham	2,047	0.31	1,849	
Chroui Changvar	1,964	0.30		0.29

Source: WUP-JICA Study Team

"Upstream and downstream flow inconsistencies (mean monthly discharge at the upstream station is larger than that at the downstream station where no significant water extractions are made)" are both observed at the Chiang Khan, Khon Chiam, Kompong Cham and Chrui Changvar stations. Specific discharges both in March and April at Chiang Khan show somewhat smaller compared to those at Luang Prabang, Vientiane, Nong Khai, Nakhon Phanom and Mukdahan stations where lateral inflows from watersheds in Lao PDR might be similarly predominant. Both Kompong Cham and Chrui Changvar stations in Cambodia show smaller discharges than at Kratie in the upstream.

On the other hand, the Khon Chiam station shows larger specific discharges. Considering that the major incremental watershed at Khon Chiam is in Lao PDR, this suggests that the monthly mean discharges in the dry season may have been overestimated. Although the specific discharge at Pakse seems smaller compared to specific discharges at other stations, it might be in a reasonable range because the Nam Mun-Chi River with a drainage area of 120,000 km^2 in Thailand joins to the Mekong mainstream in the upstream of Pakse. The flow contribution of the Nam Mun-Chi River on the low flow regime of the Mekong mainstream is much smaller compared with major tributaries entering from Lao PDR (see discussions in Chapter 6).

Figure 7.3 presents the comparison of time-series of monthly mean discharges both in March and April at the stations. Figures 7.4 to 7.8 show the analysis results of estimated monthly mean lateral inflows in the period of January to May.

7.4.1 Chiang Saen-Luang Prabang

In the river reaches of Chiang Sean–Luang Prabang with a remnant area of 79,000 km2, the average lateral inflows in March for the period 1961-1998 is estimated at 236 m^3/s, equivalent to the specific discharge of 0.30 $m^3/s/100km^2$. The results of flow balance between the two stations in March are shown below.

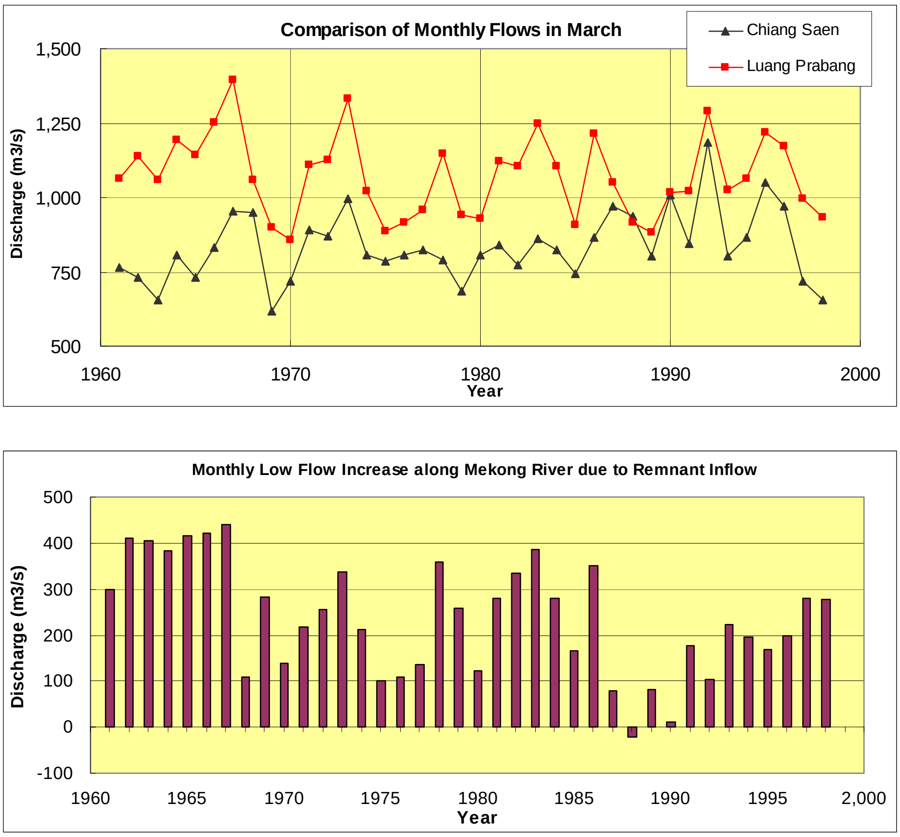


Fig. 7.9 Low Flow Balance in Chien Saen-Luan Stretch Prabang in March

The time-series of monthly mean flows show almost similar flow tendency at both stations. These flows at the two stations show a high correlation with each other. The estimated lateral inflows became smaller in 1987-1990. This is due to the fact that severe droughts had continuously occurred in this period. In drought years, the lateral dry season inflows tend to extremely decline because of seriously reduced groundwater recharge in watershed. Except drought years, no "upstream and downstream flow balance inconsistencies" have occurred from January to May.

7.4.2 Luang Prabang-Chiang Khan

The figures below are the analysis results for the Luang Prabang-Chiang Khan stretch. The contributing area of lateral inflow is 24,000 km^2. It would be difficult to estimate the monthly mean lateral inflows and specific discharges because of the occurrence of "upstream and downstream flow balance inconsistencies" between the two stations in many years.

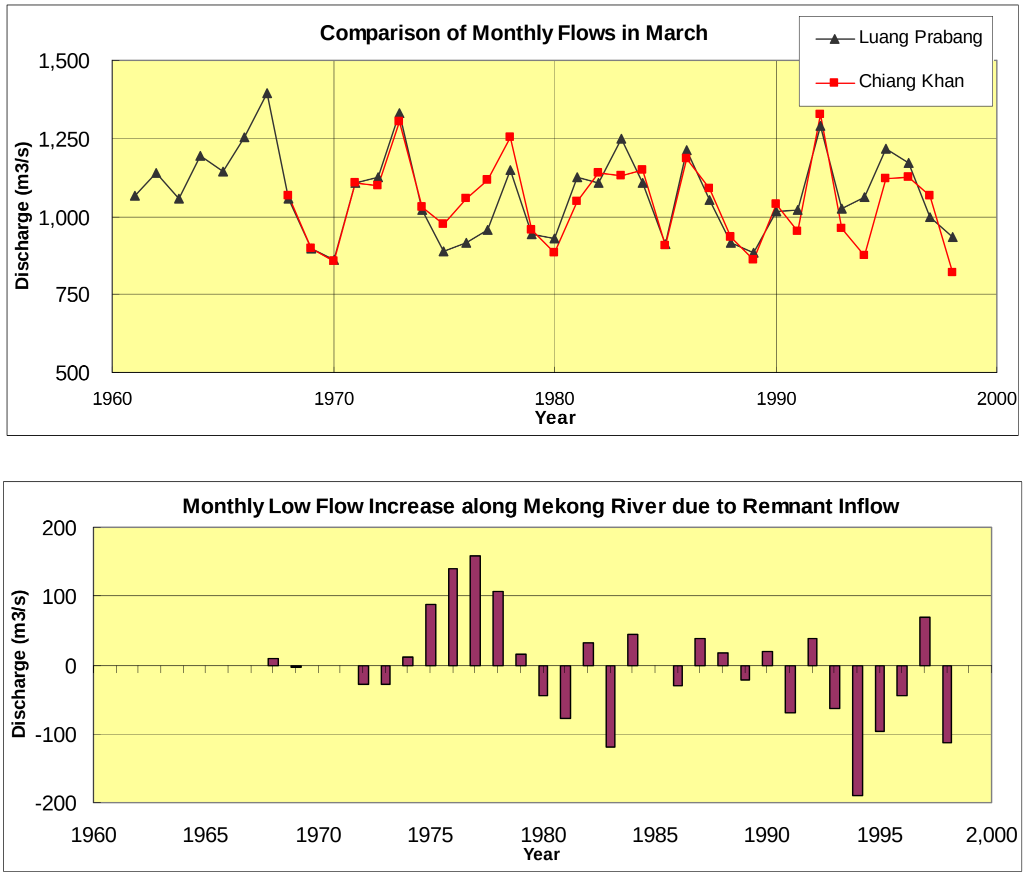


Fig. 7.10 Low Flow Balance in Luang Prabang-Chiang Khan Stretch in March

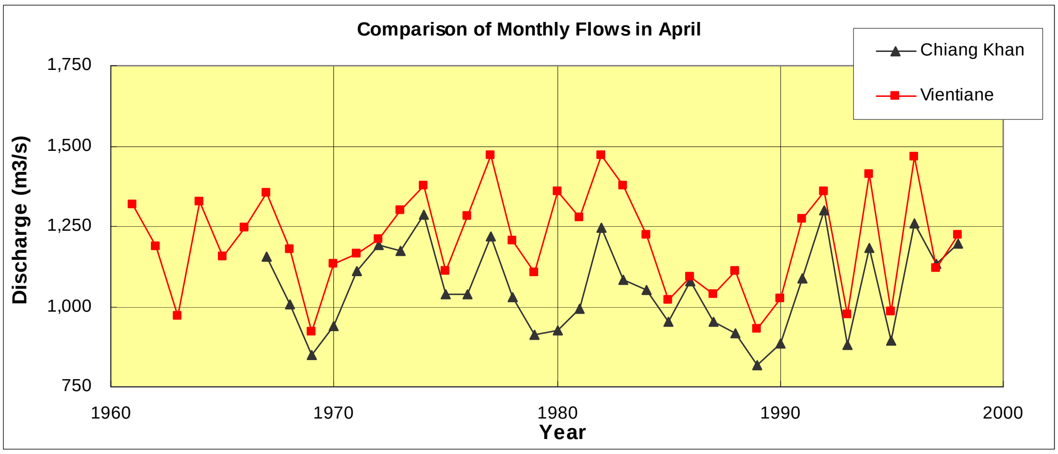
The time-series above show almost the same flow pattern at both stations although in 1990s the monthly mean discharges at the upstream station (Luang Prabang) are larger than at the downstream station (Chiang Khan). The maximum difference is observed at around 200 m^3/s in 1994.

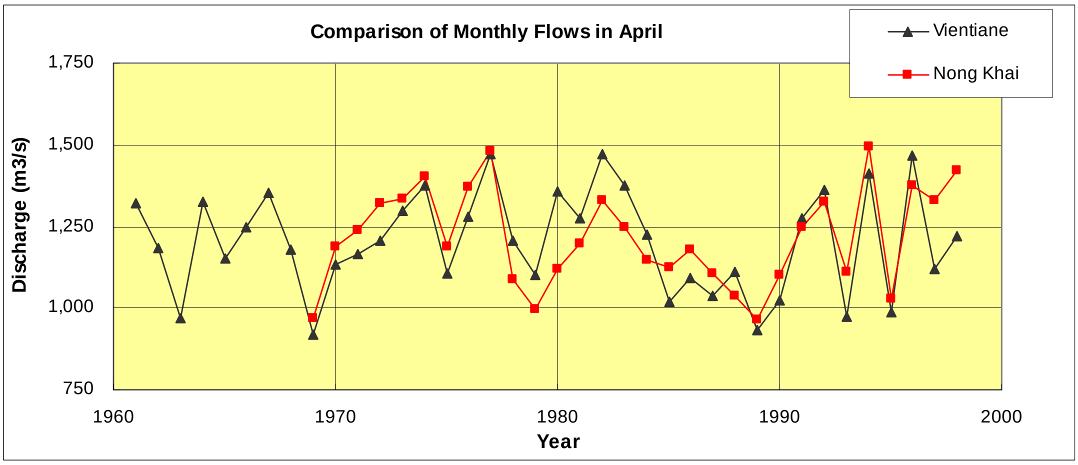
The flow balance shows that positive and negative lateral inflows appear almost alternately in 1980s. At present there are no large-scale water extraction facilities on the Mekong mainstream. If any, there are minor pumping-up facilities for irrigation and domestic purposes. The occurrence of such "flow balance inconsistencies" might be due to the size of the contributing area of lateral inflows as small as 24,000 km^2 and the practicalities of rating curves applied at both stations. The lateral flow in March is roughly estimated at around 70 m^3/s applying the estimated specific discharge of 0.30 $m^3/s/100km^2$ in the Chang Saen-Luang Prabang stretch.

At the moment allowable error ranges of rating curves are unknown. Hence, the likelihood of such flow balance inconsistencies needs to be clarified based on applied rating curves. The practicalities of rating curves are therefore subject to investigation in detail.

7.4.3 Chiang Khan-Vientiane and Vientiane-Nong Khai

Vientiane and Nong Khai stations are located near each other. The remnant area between the two stations is only 3,000 km^2. The expected lateral inflows in the dry season might be very small beyond the allowable error range of rating curves at both stations. In this view, low flow balance was applied to three stretches; the Chiang Khan-Vientiane, the Vientiane-Nong Khai and the Chiang Khan-Nong Khai. Low flow balances in April are compared as follows:





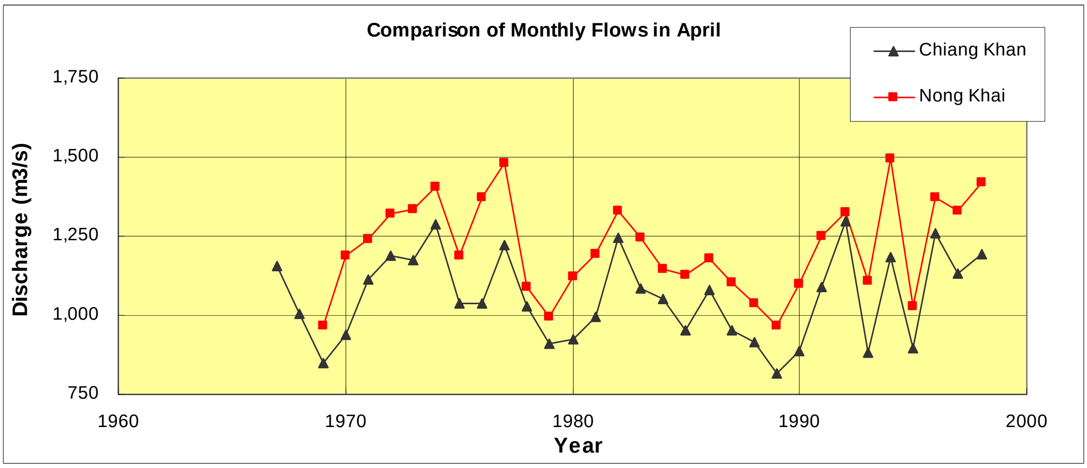
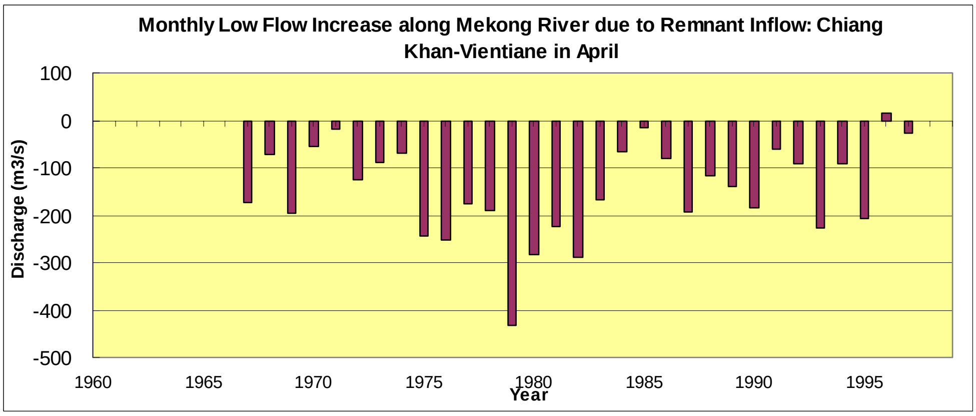
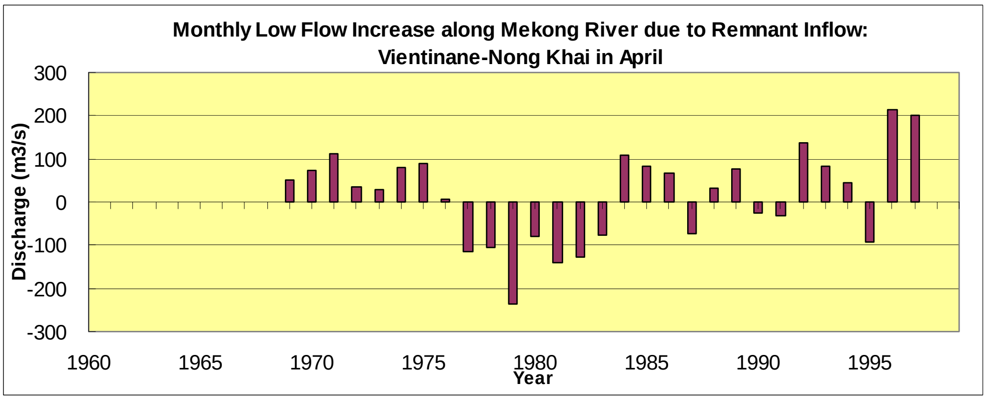


Fig. 7.11 Comparison of Low Flows in April at Chiang Khan, Vientiane and Nong Khai





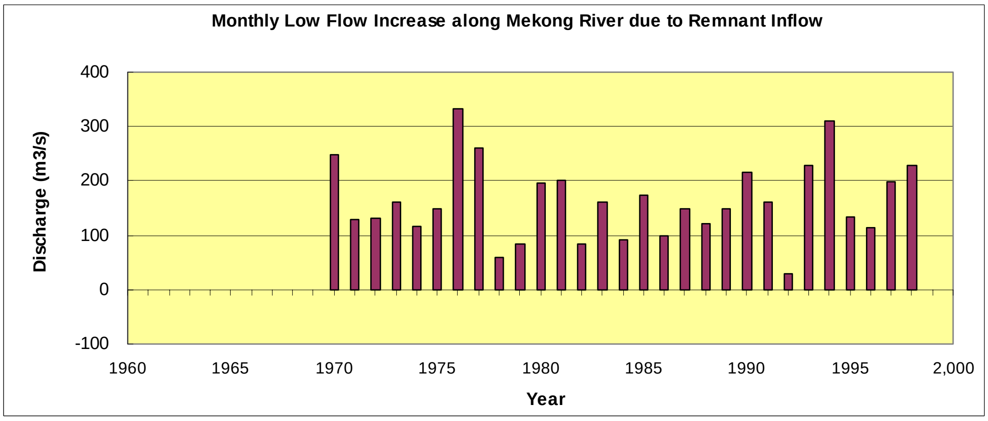
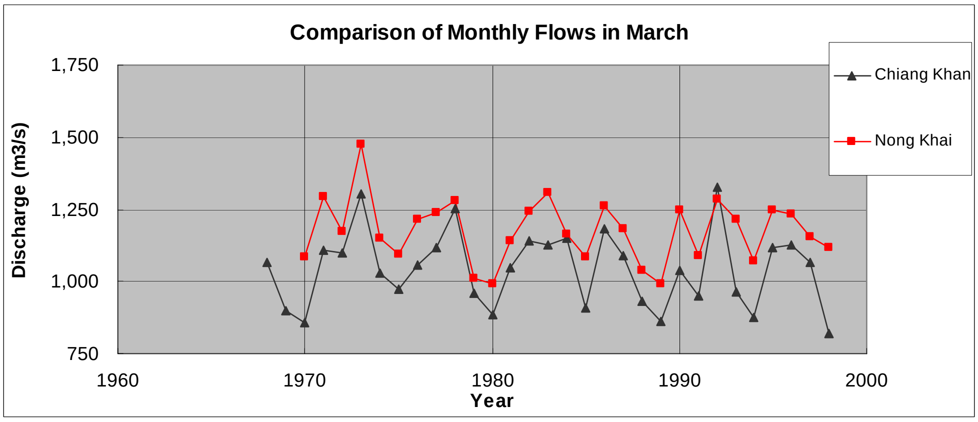


Fig. 7.12 Comparison of Low Flow Balances in April at Chiang Khan, Vientiane and Nong Khai

Together with the above, below is the compared time-series of the monthly mean flows in March at Chiang Khan and Nong Khai hydrologic stations. The flow contributing area between the two stations is only 10,000 km^2.



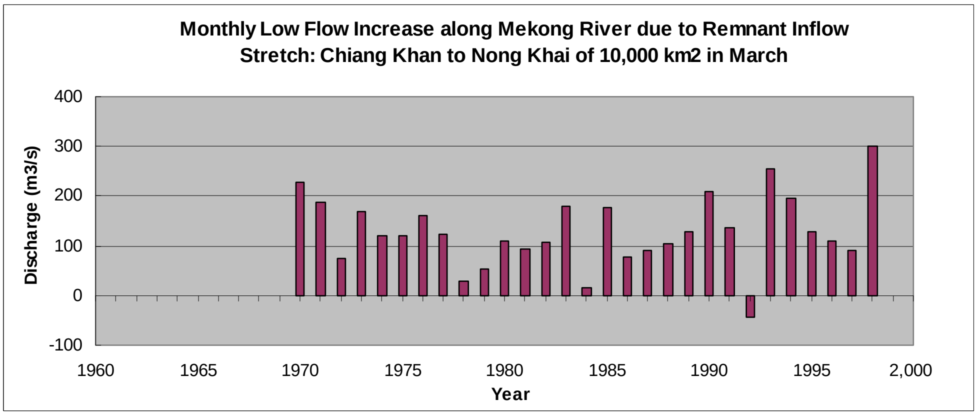
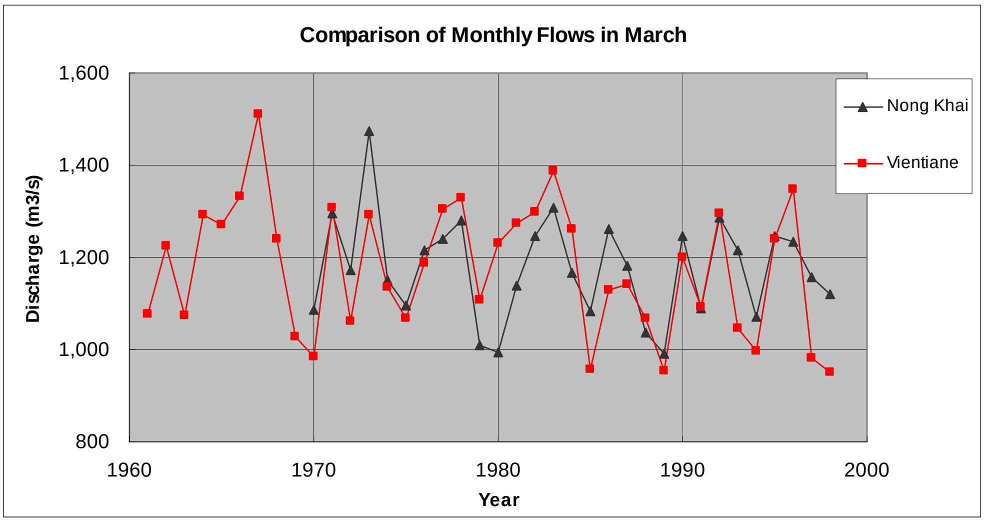


Fig. 7.13 Low Flow Balance in Chiang Khan-Nong Khai Stretch in March

The time-series of monthly mean flows at both stations show almost a similar tendency. There are no "inflow balance inconsistencies" with exception of 1992. Monthly mean flows at both stations indicate high correlation. From hydrological viewpoints, there seems to be a reasonable relationship between the two stations. However, the estimated mean lateral inflow in the period 1970-1998 is around 130 m^3/s, or 1.3 m^3/s/100 km^2, which seems to be unreasonably large compared to the 0.30 m^3/s/100km^2 estimated for the Chiang Sean–Luang Prabang reaches.

The specific discharge in March is estimated 0.36 m^3/s/100km^2 at the Chiang Khan station. This specific discharge seems to be somewhat small compared to 0.44 m^3/s/100km^2 at Chiang Saen and 0.40 m^3/s/100km^2 at Luang Prabang. No significant tributaries with areas of extensive natural wetlands enter the Mekong mainstream. In conclusion the monthly flow at Chiang Khan seems somewhat small and needs hydrological adjustment. The high lateral inflow of 1.3 m^3/s/100km^2 in March is attributable to the lower monthly mean flows at the Chiang Khan station. Further discussion is made in the next paragraph.

The Vientiane hydrologic station is categorised as a primary network station. The Nong Khai station that is classified as the key network station to be incorporated in the future telemetry network is located in the downstream from Vientiane. The lateral flow contributing area between the two stations is only 3,000 km^2. Considering the size of contributing area, dry season monthly mean discharges are expected to be almost the same at both stations. The time-series of monthly mean discharges in both March and April are compared as follows:



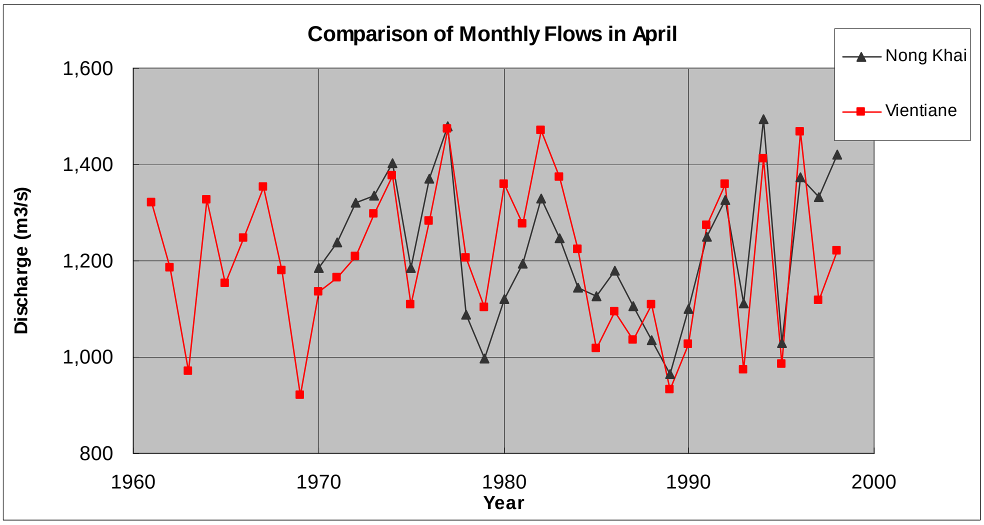
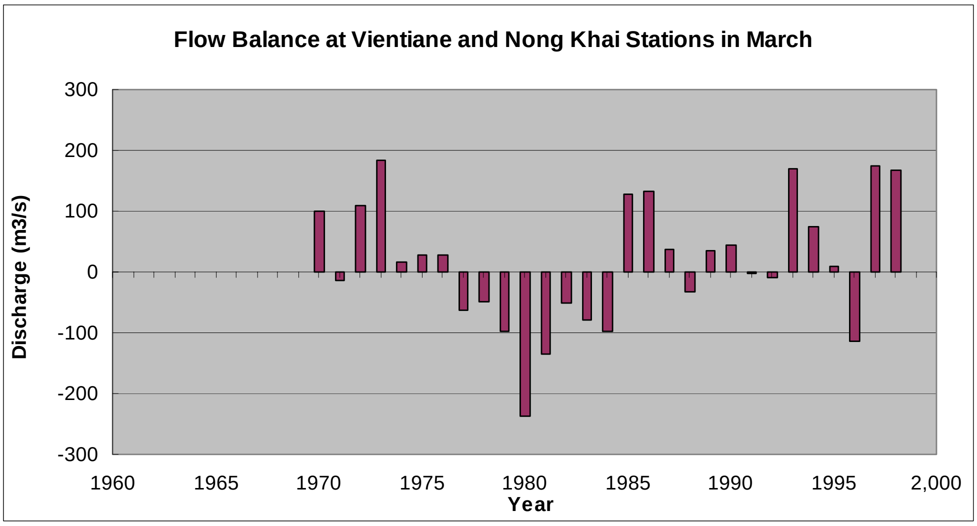


Fig. 7.14 Comparison of Low Flows in March and April at Vientiane and Nong Khai

Flow balances at the two stations are also presented below.



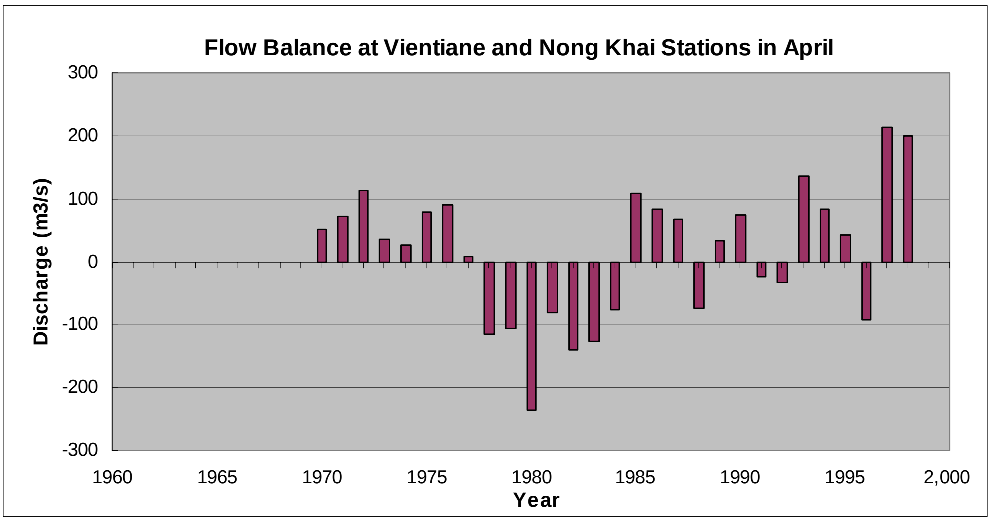


Fig. 7.15 Comparison of Low Flow Balances in Vientiane-Nong Khai Stretch in March and April

As seen above, the years when flow balance inconsistencies occur are almost the same in both months. Particularly in the period 1978-1984, the Vientiane discharges are extremely larger than those at Nong Khai. By applying 0.30 $m^3/s/100km^2$ in the Chiang Sean-Luang Prabang stretch, the expected lateral inflow is only around 9 m^3/s. It might be said that wide-ranging flow balances from -200 to 200 m^3/s are mainly attributable to errors of rating curve at both stations. The dry season flows at two stations are compared as follows:

Table 7.21 Specific Discharges at Vientiane and Nong Khai Stations

Key Station	In March		In April	
	Mean (m^3/s)	Specific Discharge ($m^3/s/100km^2$)	Mean (m^3/s)	Specific Discharge ($m^3/s/100km^2$)
Vientiane	1,176	0.39	1,203	0.40
Nong Khai	1,176	0.39	1,224	0.41

Source: WUP-JICA Study Team

Flow balance calculation results in the two river reaches of Chiang Khan-Vientiane and Chiang Khan-Nong Khai are compared as follows:

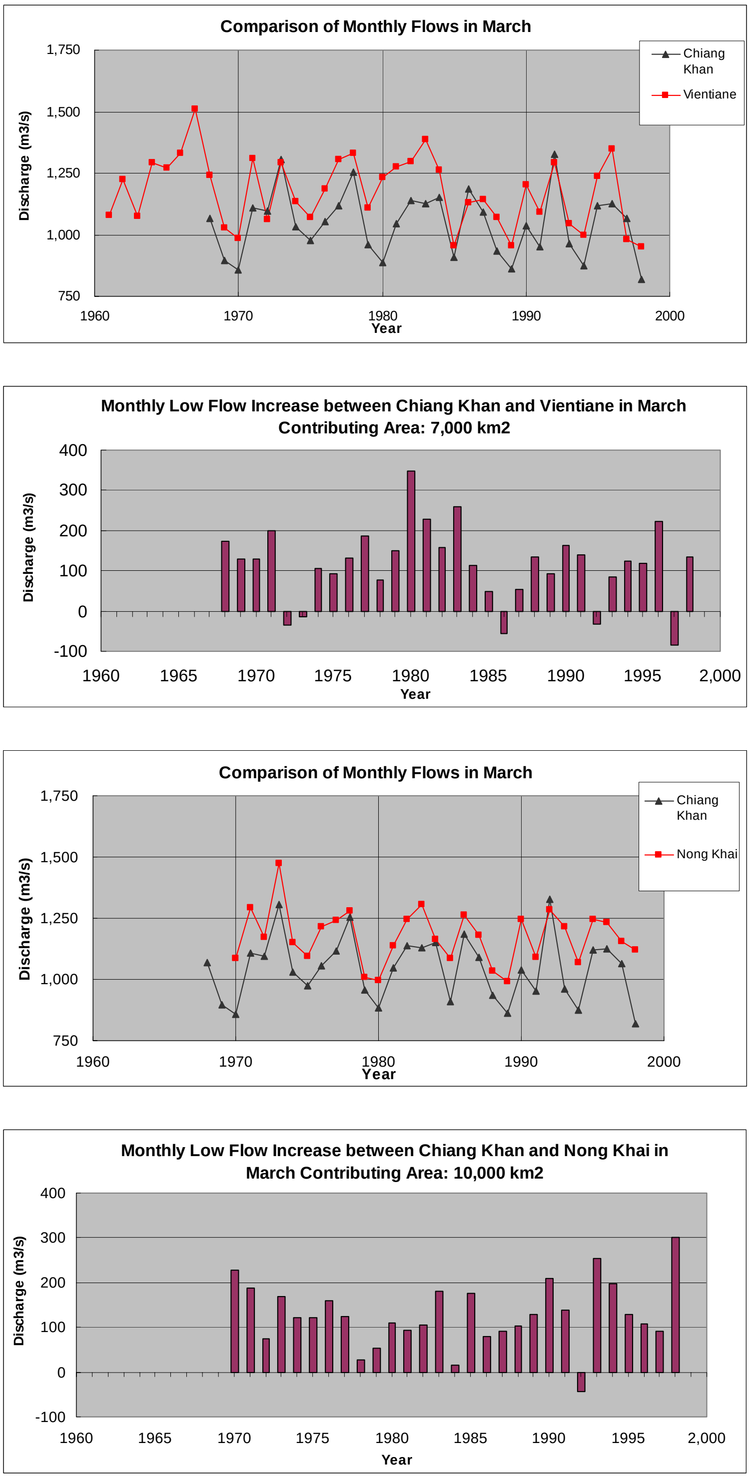
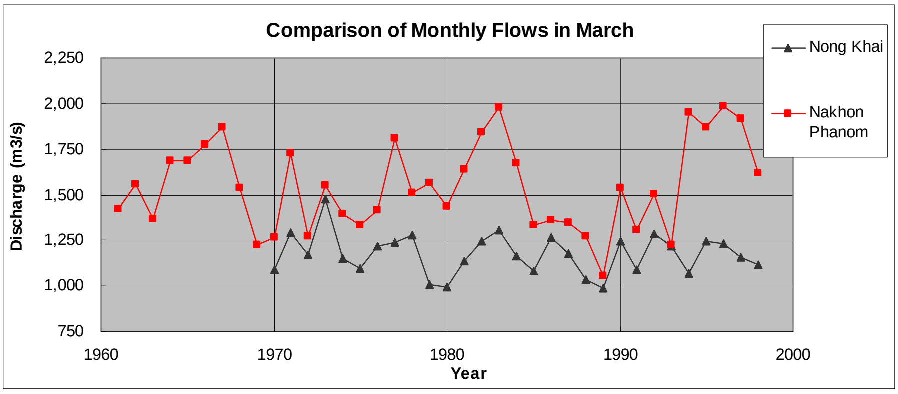


Fig. 7.16 Low Flow Balances in Chiang Khan-Vientiane Stretch in March and April

The lateral inflow to the Chiang Khan-Vientiane with a contributing area of 7,000 km^2 is estimated to be around 110 m^3/s, or 1.6 m^3/s/100km^2. This specific discharge is unreasonably large. This high lateral inflow is due to the somewhat lower monthly mean flows at the Chiang Khan station.

7.4.4 Nong Khai-Nakhon Phanom

The results of flow balance in March between the Nong Khai and Nakhon Phanom stations are shown below. The contributing area is 71,000 km^2. The estimated average lateral inflow in March is around 366 m^3/s, or 0.52 m^3/s/100km^2.



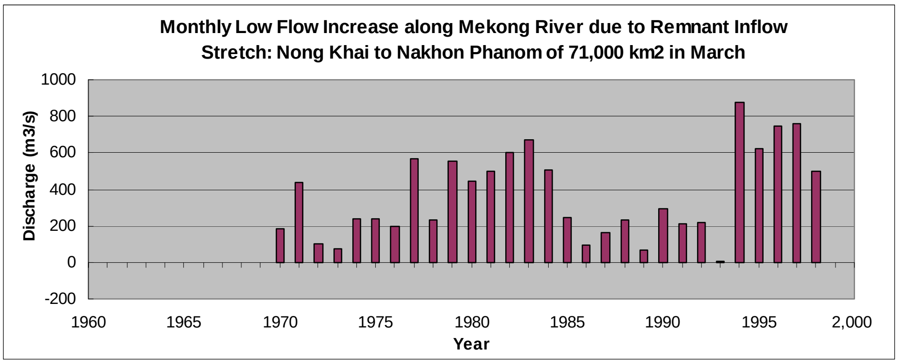


Fig. 7.17 Low Flow Balances in Nong Khai-Nakhong Phanom Stretch in March

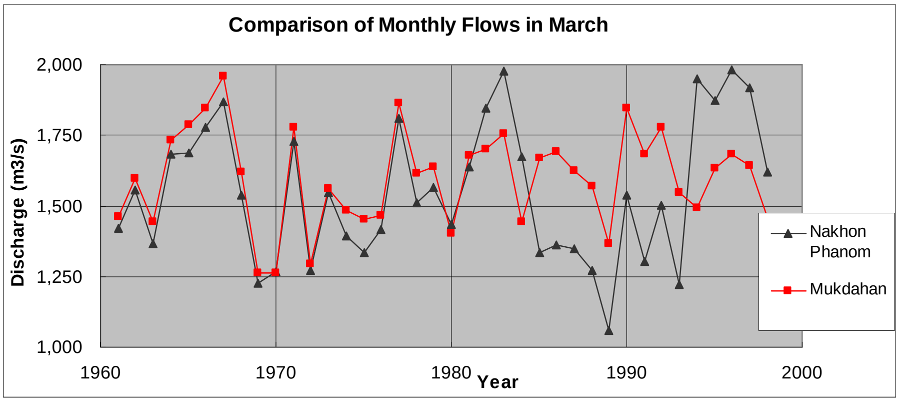
In these river reaches, two large tributaries in Lao PDR join the Mekong mainstream. They are the Nam Ngum (17,170 km^2) and Nam Ca Dinh (14,900 km^2) rivers. As discussed in Chapter 5, the low flow regime of the Nam Ngum River was significantly influenced as a result of completion of the Nam Ngum Hydropower Development Project. The low flow increase is verified to be around 190 m^3/s in the Nam Ngum River.

The low flow in the Mekong River is therefore expected to increase due to the low flow increase of the Nam Ngum River. The flow balance result shows the sudden increase of lateral inflow in 1979 when the Phase II of Nam Ngum was completed and the installed capacity was increased from 30 MW to 110 MW. It is noted that the sudden increase of lateral inflow in 1977 was caused by an unusual release of the Nam Ngum reservoir (reportedly 414 m^3/s in March on monthly mean basis as presented in Table 5.5). However in the period 1985-1993, lateral inflows become unreasonably smaller although droughts occurred in 1987-1993.

Furthermore, significant flow increases start again in 1994. As to be discussed in the next subsection, high lateral inflows are resultant from unreasonably high monthly mean discharge at the Nakhon Phanom station from 1994 onwards.

7.4.5 Nakhon Phanom-Mukdahan

Below is the flow balance between Nakhom Phanom and Mukdahan stations in March. The contributing area is 18,000 km^2. This river stretch is also small. The significant tributary entering this river reaches is only the Se Bang Fai River from Lao PDR with a watershed of 10,200 km^2.



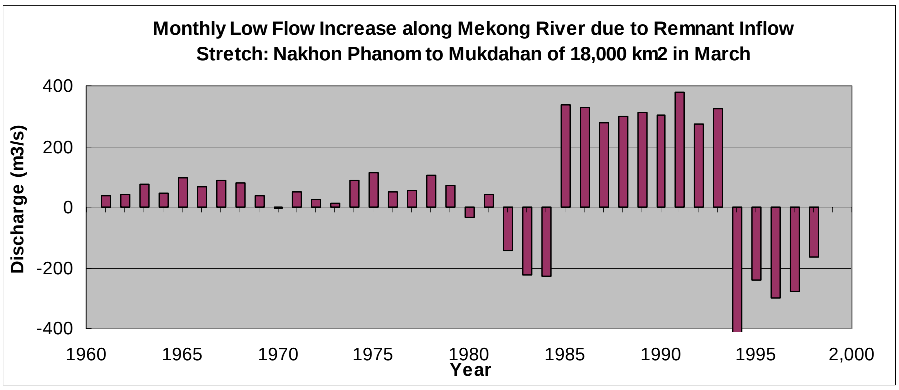


Fig. 7.18 Low Flow Balances in Nakhon Phanom-Mukdahan Stretch in March

Four patterns of lateral inflow are regularly observed as summarized below.

Table 7.22 Comparison of Lateral Inflows in March

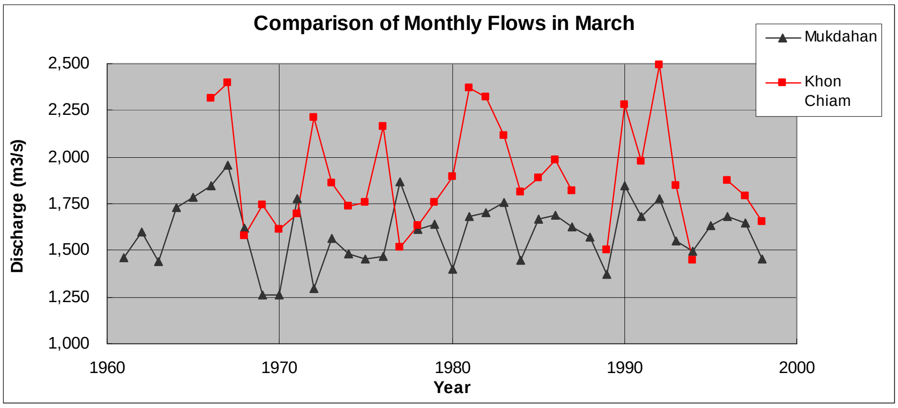
Period	Lateral Inflow Condition	Average (m^3/s)	Specific Lateral Inflow (m^3/s/100km^2)
1961 – 1981	Positive flows	62	0.34
1982 – 1984	Negative flows	-199	-1.11
1986 – 1993	High positive flows	315	1.75
1994 – 1998	High negative flows	-287	-1.59

Source: WUP-JICA Study Team

Flow balance inconsistencies in terms of negative lateral inflow occur in both periods of 1982-1984 and 1994-1998. These phenomena are hydrologically unreasonable. Hence there is no large-cale water extraction facility on this mainstream reaches as well as tributaries. This is due to unreasonable high monthly mean flows of the Nakhon Phanom station in these periods.

7.4.6 Mukdahan-Kong Chiam

Below is the water balance in March at the Mukdahan and Khong Chiam hydrologic stations. The contributing area between the two stations is 28,000 km^2. The major tributary entering this river reach is the Se Bang Hieng River with a watershed area of 19,300 km^2.



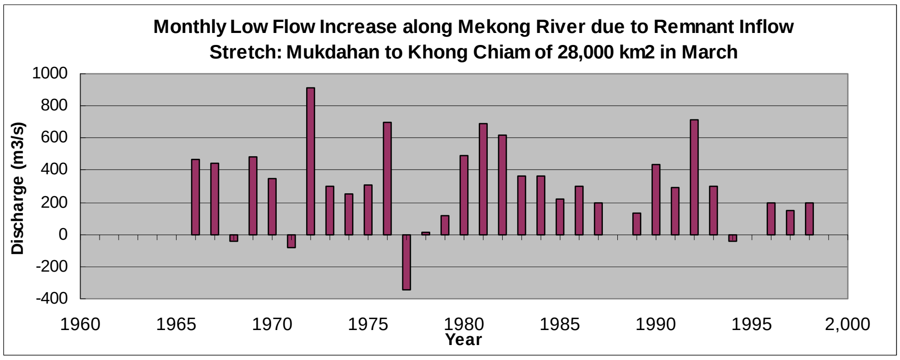


Fig. 7.19 Low Flow Balances in Mukdahan-Khong Chiam Stretch in March

The average lateral inflow into the river reach in March is estimated to be around 356 m^3/s, and its specific discharge is 1.27 m^3/s/100km^2 (negative inflows are excluded). This specific discharge seems to be somewhat larger compared to specific discharges in other stretches, as estimated below.

Table 7.23 Comparison of Specific Discharge of Lateral Inflows in March

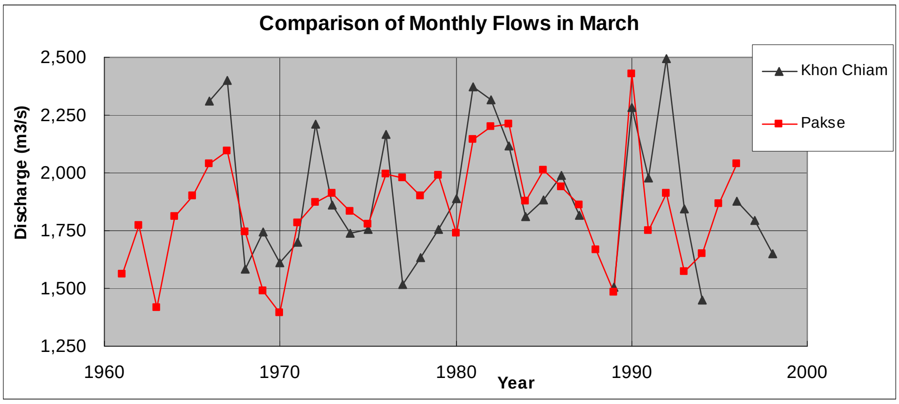
River Reaches	Area of Lateral Inflow (km^2)	Specific Inflow (m^3/s/100km^2)	Period
Chiang Sean-Luang Prabang	79,000	0.30	1961-1998
Nong Khai-Nakhon Phanom	71,000	0.36	1970-1978
Nakong Phanom-Mukdahan	18,000	0.34	1961-1981

Source: WUP-JICA Study Team

In conclusion the monthly mean flows at the Khon Chiam station seem to be unreasonably too high in several years as discussed in the subsection.

7.4.7 Khon Chiam-Pakse

The comparison of time-series of the monthly mean flows at the Khon Chiam and Pakse hydrologic stations in March are shown below. The lateral flow from the contributing area between the two stations is 126,000 km^2. In this river reaches, the Nam Mun-Chi River, the largest single tributary with a catchment area of 120,000 km^2 enters from the territory of Thailand. The Nam Mun-Chi River basin occupies 95% of the whole contributing area of this river reaches.



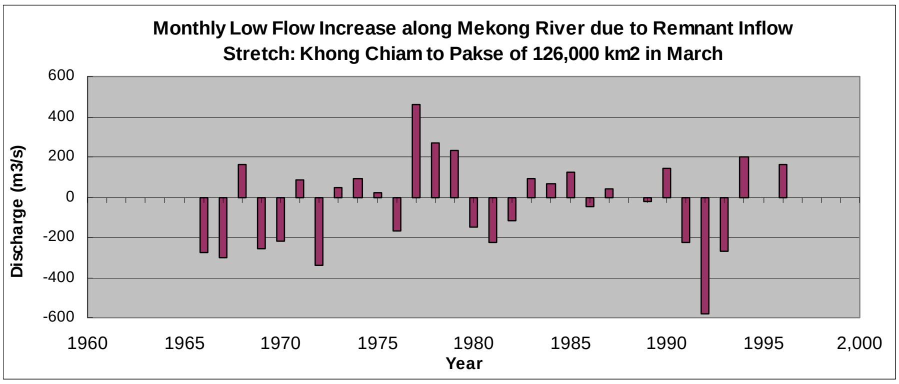


Fig. 7.20 Low Flow Balances in Khong Chiam-Pakse Stretch in March

The Khong Chiam hydrologic station is located on the Mekong mainstream about 1 km upstream from the confluence with the Nam Mun-Chi River. The water resources in this basin have been developed almost completely for irrigation. In view of future monitoring on the flow regime change of Mun-Chi River as well as the various inner water uses in the basin, both hydrologic stations are of primary importance.

However, because of sharper fluctuation of monthly mean discharges at the Khong Chiam station, flow-balance inconsistencies have frequently occurred. As a result, the mean monthly discharge at the Pakse station is smaller than at the Khon Chiam station, as listed below.

Table 7.24 Specific Discharges at Khon Chiam and Pakse Stations

Key Station	In March		In April	
	Mean (m^3/s)	Specific Discharge ($m^3/s/100km^2$)	Mean (m^3/s)	Specific Discharge ($m^3/s/100km^2$)
Khon Chiam	1,905	0.46	1,846	0.44
Pakse	1,850	0.34	1,785	0.33

Source: WUP-JICA Study Team

Such significant hydrological issues shall need to be addressed and reasonably treated as part of the basin modeling development process under the WUP. Presumably the practicalities of rating curve at the Khong Chiam station will be necessary for detailed investigation.

7.4.8 Pakse-Stung Treng

Results of low flow balances in the Pakse-Stung Treng stretch for March and April is shown below. The contributing catchment between Pakse and Stung Treng is 90,000 km^2. The Se San River with a catchment area of 78,600 km^2 enters in this stretch.

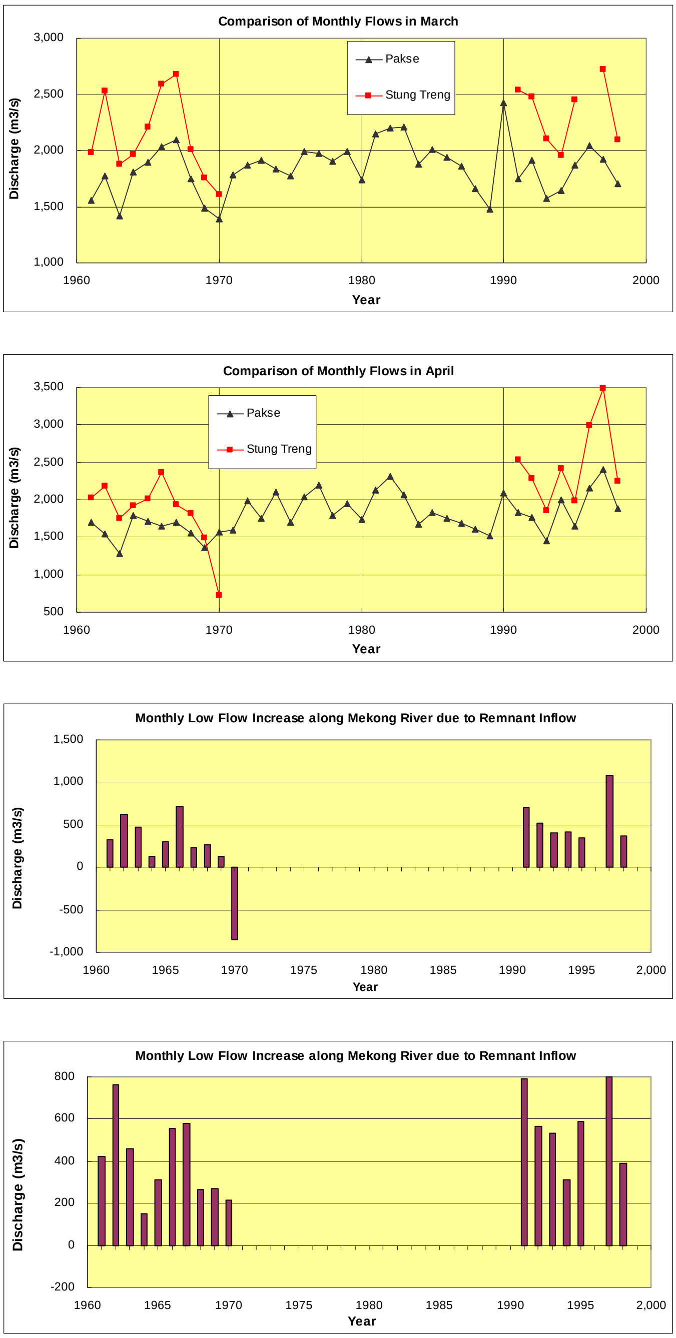


Fig. 7.21 Low Flow Balances in Pakse-Stung Treng Stretch in March and April

The mean lateral inflows are estimated to be around 468 m^3/s in March and 440 m^3/s in April (negative inflow in 1970 is excluded). Specific discharges are 0.52 $m^3/s/100km^2$ and 0.49 $m^3/s/100km^2$, respectively.

7.4.9 Stung Treng-Kratie

Results of low flow balances in the Stung Treng-Kratie stretch for March and April is shown below. The contributing remnant catchment between the two stations is 11,000 km^2.

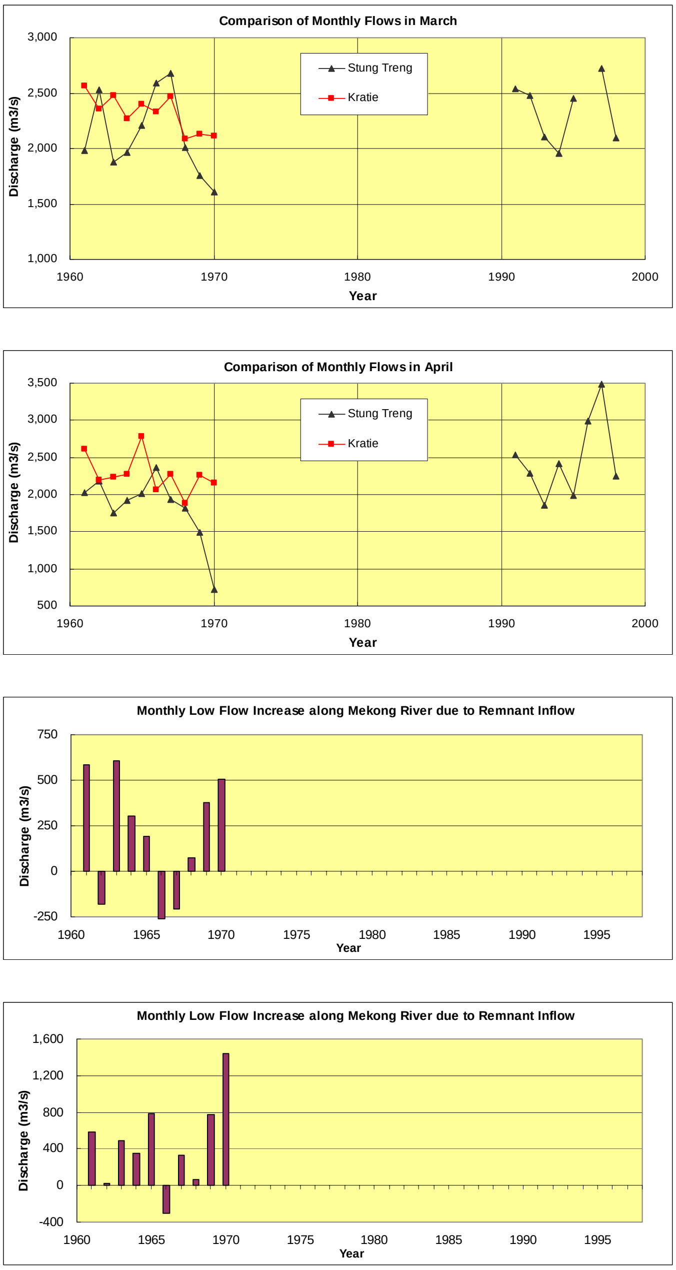


Fig. 7.22 Low Flow Balances in Stung Treng-Kratie Stretch in March and April

The mean lateral inflows are eatimated to be around 376 m^3/s in March and 537 m^3/s in April. Specific discharges are 3.42 $m^3/s/100km^2$ and 4.88 $m^3/s/100km^2$, respectively. These specific discharges seem to be unreasonably high compared to those in the upstream triburary basins.

7.4.10 Kratie-Kompong Cham

Results of low flow balances in the Kratie-Kompong Cham stretch for March and April is shown below. The contributing remnant catchment between two stations is 14,000 km^2.

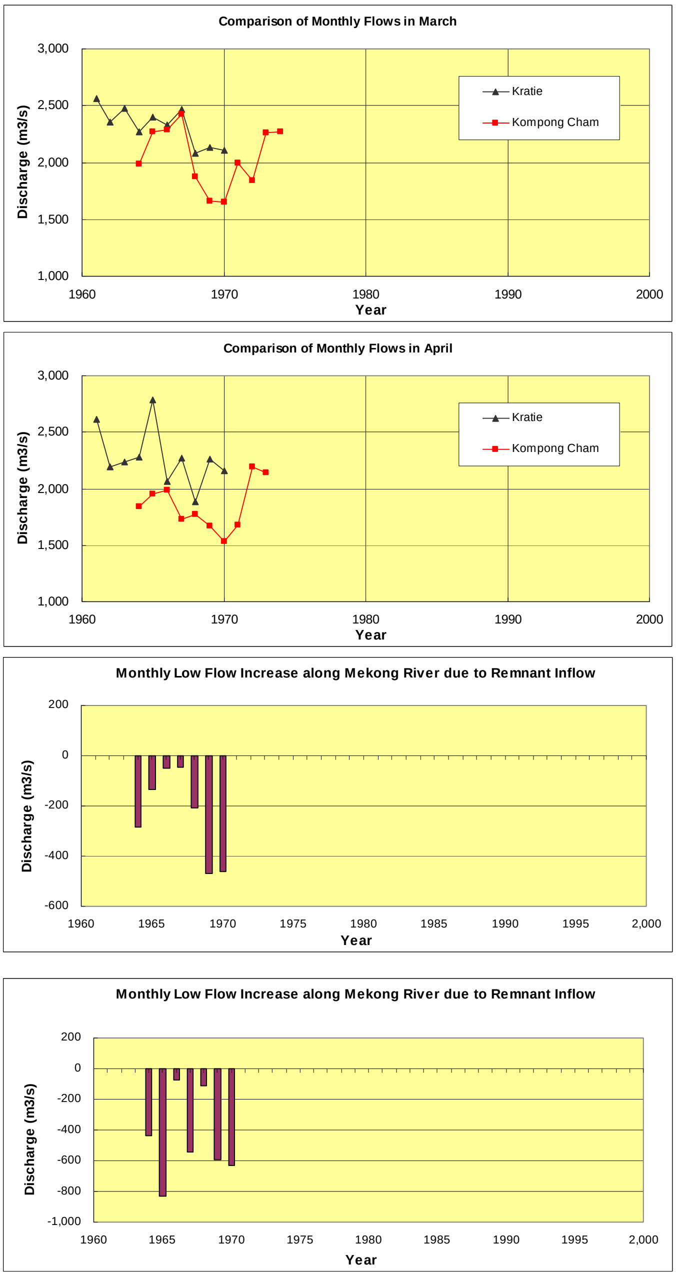
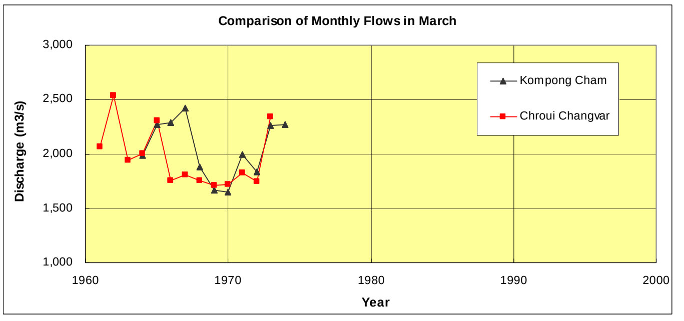


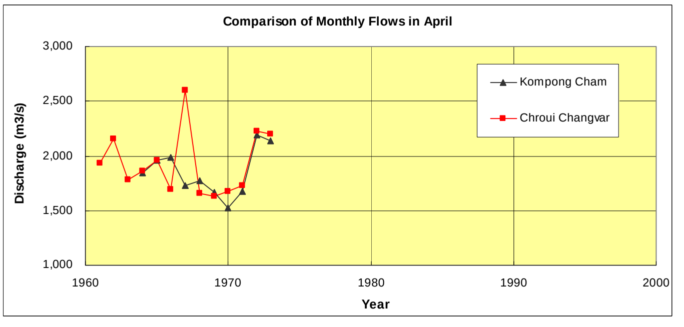
Fig. 7.23 Low Flow Balances in Kratie-Compong Cham Stretch in March and April

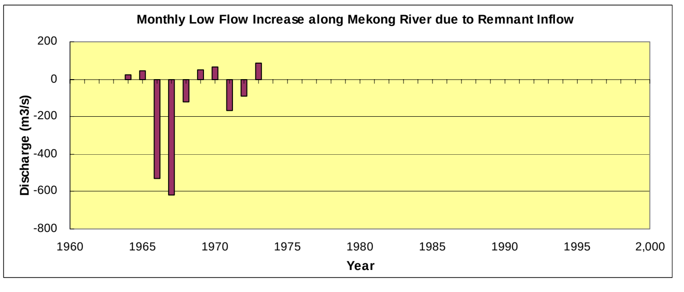
As seen above, flow inconsistencies are observed in all the observation periods.

7.4.11 Kompong Cham-Chroui Changvar

Results of low flow balances in the Kompong Cham-Chroui Changvar stretch for March and April is shown below. The contributing remnant catchment between the two stations is only 3,000 km^2.







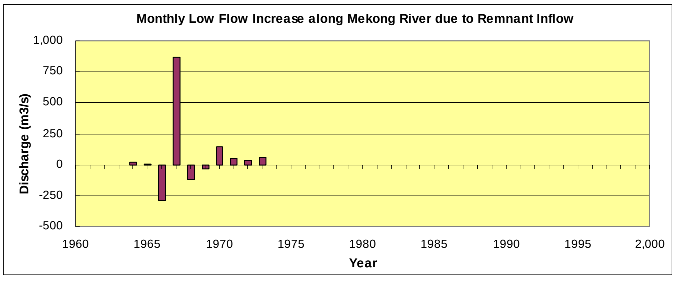


Fig. 7.24 Low Flow Balances in Compong Cham-Chrui Changvar Stretch in March and April

Similarly observed in the Kratie-Compong Cham stretch is that flow inconsistencies have occurred in several years.

REFERENCES

(1) Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1982); Development of the Lower Mun Basin, Feasibility Study: Volume II, Annex A-E

(2) Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1984); Lower Mekong Basin: Water Balance Study, Phase 2 Report, Institute of Hydrology, Wallingford, UK

(3) Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1988); Perspectives for Mekong Development, Revised Indicative Plan (1987) for the Development of Land, Water and Related Resources of the Lower Mekong Basin

(4) Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1988); Water Balance Study Phase 3 Report and Appendices, Investigation of Dry Seasons Flows, Institute of Hydrology, Wallingford, UK

(5) ESCAP, United Nations (1991); Assessment of Water Resources and Water Demand by User Sectors in Thailand

(6) Government of Vietnam, World Bank, Mekong Secretariat and UNDP (1993); Master Plan for the Mekong Delta in Vietnam, A Perspective for Sustainable Development of Land and Water Resources

(7) MRC Secretariat (1997); Mekong River Basin Diagnostic Study, Final Report

(8) Government of Vietnam, World Bank, Mekong Secretariat and UNDP (October 1993); Mekong Master Plan, Thematic Study on Management of Water Resources, Volume 1: Optimal Use of Water Resources

(9) Government of Vietnam, World Bank, Mekong Secretariat and UNDP (October 1993); Mekong Master Plan, Thematic Study on Management of Water Resources, Volume 2: Flood Control

(10) Government of Vietnam, World Bank, Mekong Secretariat and UNDP (October 1991); Mekong Master Plan, Working Paper No. 1, Surface Water Resources and Hydrulic Modelling, Volume 2: Appendices

(11) Yunnan Provincial Science and Technology Commission and Yunnan Institute of Geography, People's Republic of China (1993); Investigation and Study of the Current Status of the Lancang River-Mekong River, Draft Workshop Review, Mekong Development Reserch Network, Part of a Six-country Study of the Mekong River Basin, supported by the International Research Development Center of Canada

(12) MRC Secretariat (2001); MRC Hydropower Development Strategy

(13) MRC Secretariat; Lower Mekong Hydrologic Yearbooks

(14) MRC Secretariat (2001); Strategic Master Scheme for Hydro-Meteorological Network in the Mekong River Basin

(15) MRC Secretariat (2001); Water Utilization Project Component A: Development of Basin Modelling Package and Knowledge Base, Working Paper No. 1 - Hydrological Review

(16) MRC Secretariat (2001); Water Utilization Project Component A: Development of Basin Modelling Package and Knowledge Base, Working Paper No. 2 - Review of Historic Water resources Development and Water Use

(17) MRC Secretariat (2003); Water Utilization Project Component A: Development of Basin Modelling Package and Knowledge Base, Working Paper No. 14 - Model Development and Calibration

(18) MRC Secretariat (2002); Land Resources Inventory for Agriculture Development Project, Technical Report Parts 1 to 3

(19) The Office of National Economic and Social Development Board (NESDB) (1994); Study of Potential Development of Water Resources in the Mae Khong River Basin, Final Main Report, Water Resources Engineering Program, Asian Institute of Technology, Bangkok, Thailand

(20) The Office of National Economic and Social Development Board (NESDB) (1994), Study of Potential Development of Water Resources in the Chi River Basin, Final Main Report, Institute of Water Resources and Environment, Department of Engineering, Konkaen University, Bangkok, Thailand

(21) Asian Development Bank (1998); Se Kong-Se San and Nam Theun River Basins Hydropower Study, Initial Environmental Examination Report

(22) The Office of National Economic and Social Development Board (NESDB) (1994); Study of Potential Development of Water Resources in the Mun River Basin, Final Main Report, Institute of Water Resources and Environment, Department of Engineering, Konkaen University, Bangkok, Thailand

(23) International Research Centre of Canada (1995); State-of-the-art Study of the Mekong River and the River Basin Area in Thailand, Working Paper, Part of a Six-Conuntry Study of the Mekong River Basin

(24) Mekong Secretariat; Irrigation Rehabilitation Study in Cambodia (1994), Final Report, Main Report

(25) Mekong Secretariat; Irrigation Rehabilitation Study in Cambodia (1994), Final Report, Inventory & Analysis of Existing Systems

(26) Department of Planning and Statistics, Ministry of Agriculture (1993); Bulletin of Statistics and Agricultural Studies No 1

(27) Government of Vietnam, World Bank, Mekong Secretariat and UNDP (1992); Mekong Delta Master Plan, Thematic Study on Management of Water Resources, Volume 1: Optimal Use of Water Resources

(28) Government of Vietnam, World Bank, Mekong Secretariat and UNDP (1992); Mekong Delta Master Plan, Thematic Study on Management of Water Resources, Volume 3: Tidal Irrigation and Drainage

(29) Government of Vietnam, World Bank, Mekong Secretariat and UNDP (1991);, Mekong Delta Master Plan, Working Paper No. 3, Irrigation, Drainage and Flood Control

(30) Electricite du Laos, Nam Ngum HPP; Nam Ngum Hydro Power Plant Hydrological Operation Statistic 1982-1991

(31) Electricite du Laos, Nam Ngum HPP;, Nam Ngum Hydro Power Plant Hydrological Operation Statistic 1992-2001

(32) WUP-JICA (February, 2002); The Study on Hydro-Meteorological Monitoring for Water Quantity Rules in Mekong River Basin, Progress Report

(33) WUP-JICA (August, 2002); The Study on Hydro-Meteorological Monitoring for Water Quantity Rules in Mekong River Basin, Working Paper II

(34) WUP-JICA (February, 2003); The Study on Hydro-Meteorological Monitoring for Water Quantity Rules in ; Mekong River Basin, Interim Report (Vol. 2)

(35) Mekong Secretariat (1991); Mekong Irrigation Program, Volume 1, Development of Pump Irrigation on the Mekong Phase II, Lao PDR

(36) Mekong Secretariat (1991); Mekong Irrigation Program, Volume 3, Water Management Supporting Programme Stage II, Thailand

(37) Mekong Secretariat (1991); Mekong Irrigation Program, Volume 5, Study of a Water Resources Development Plan for Northeast Thailand

(38) United Nations, Economic Commission for Asia and the Far East, and Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1973); Effects of Proposed Irrigation on Water Quality and Return Flows, Khorat Plateau Thailand and Laos

(39) David Blake (2001); China's Mekong Dam Plants

(40) Mekong Secretariat, Swiss Development Cooperation Grant (December 1981); Feasibility Study of Nam Suai Basin, Main Report

(41) Royal Irrigation Department, Thailand (September 1991); Upper Chi Development Feasibility Study

(42) Development of the Lower Mun Basin, June 1982

(43) Biwater (November 1987); Investigation and Preparation of a Water Resource Development Programme for North East Thailand, Final Report, Water Resources

(44) Mekong Secretariat; Mekong Irrigation Programme (May 1991), Volume 5, Study of a Water Resources Development Plan for Northeast Thailand

(46) Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1987); The Feasibility Study of Huai Pa Thao Multipurpose Project for Land and Water Resources Development in Thailand

(46) Interim Committee for Coordination of Investigations of the Lower Mekong Basin (1970); Report on Indicative Basin Plan, A Proposed Framework for the Development of Water and Related Resources of The Lower Mekong Basin

(47) Mekong Secretariat; Mekong Irrigation Programme (June 1990), Mekong Irrigation Programme, Development of Pump Irrigation on the Mekong Phase II, Lao PDR

(48) Feasibility Study Report; Hydraulic Construction: Reservoir Huoi Saa, October 2001

(49) Prek Thnot Pioneer Agricultural Project, Khmer Republic (January,1975);; Project Preparation, Volume I, Main Report

(50) Australian Catholic Relief (ACR); Prek Thnot Multipurpose Project, Reappraisal Report, December 1991

(51) MRC (2002); Basin Development Plan, Regional Sector Overview, Agriculture and Irrigation

(52) MRC (2002); Basin Development Plan, Working Paper, The State of Agriculture and Forestry in the Lower Mekong Basin, Part A: Agriculture and Part B: Forestry

(53) MRC (2002); Land Resources Inventory for Agriculture Development Project, Technical Report Part I and Part II

Table 2.11 Monthly Operation Record at Houay Ho Hydropower Station

A. Power Output

(Unit: MWh)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1999	-	-	-	-	-	-	-	-	40.3	56.7	51.0	48.0	196.0
2000	50.5	53.2	59.6	60.9	68.4	47.9	31.1	40.5	54.3	60.9	58.2	41.4	626.9
2001	49.0	54.3	48.7	50.5	65.9	58.4	39.7	-	-	-	-	-	366.5
Mean	49.8	53.8	54.2	55.7	67.2	53.2	35.4	40.5	47.3	58.8	54.6	44.7	396.5

Source: Electricite du Laos (EDL)
Note: Power generation commenced in September 1999.

B. Tubine Discharge (Diverted water volume into Se Kong Mainstream)

(Unit: million m3)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1999	-	-	-	-	-	-	-	-	21.64	30.43	27.40	25.79	26.32
2000	27.18	28.66	32.14	32.91	36.98	25.96	16.63	21.88	29.23	32.79	31.32	22.33	28.17
2001	26.20	29.38	26.39	27.35	35.76	31.76	21.57	-	-	-	-	-	28.34
Mean	26.69	29.02	29.27	30.13	36.37	28.86	19.10	21.88	25.44	31.61	29.36	24.06	27.65

Source: Electricite du Laos (EDL)
Note: Power generation commenced in September 1999.

C. Tubine Discharge (Diverted discharage into Se Kong Mainstream)

(Unit: m3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1999	-	-	-	-	-	-	-	-	8.35	11.36	10.57	9.63	9.98
2000	10.15	11.44	12.00	12.70	13.81	10.02	6.21	8.17	11.28	12.24	12.08	8.34	10.70
2001	9.78	12.14	9.85	10.55	13.35	12.25	8.05	-	-	-	-	-	10.86
Mean	9.96	11.79	10.93	11.62	13.58	11.13	7.13	8.17	9.81	11.80	11.33	8.98	10.52

Source: Electricite du Laos (EDL)
Note: Power generation commenced in September 1999.

D. Reservoir Waterlevel in the Morning at the End of Month

(Unit: masl)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1997	-	-	-	-	855.30	859.70	863.00	867.59	859.52	870.64	870.74	870.68	864.65
1998	870.61	870.53	870.41	870.39	870.53	870.76	871.09	871.94	873.92	874.49	874.64	874.59	871.99
1999	874.52	874.41	874.36	874.60	875.31	877.07	878.91	881.33	881.97	881.64	881.08	880.20	877.95
2000	879.33	878.32	877.18	876.06	874.88	875.05	877.78	879.12	880.27	879.80	878.84	878.00	877.89
2001	877.07	875.90	875.03	873.89	872.96	872.43	-	-	-	-	-	-	874.55
Mean	875.38	874.79	874.25	873.74	869.80	871.00	872.70	875.00	873.92	876.64	876.33	875.87	874.12

Source: Electricite du Laos (EDL)
Note: Power generation commenced in September 1999.

Table 3.27 Summary of Pumped Irrigation Schemes in North-Eastern Thailand

Province	Source	No. of Schemes	Project Area (ha)		Irrigated Area (ha)		Dry Season Areas (ha)						Total Pump Capacity (m3/s)	
							1980		1981		1982			
Nong Khai	Mekong	55	25,824		9,024	(15)	1,370	(41)	1,767	(33)	1,930	(21)	16	(4)
	Nam Mong	3	1,440		800		236		140		179		0.9	
Nakhon Phanom	Mekong	29	13,360	(1)	4,511	(10)	507	(15)	660	(16)	725	(12)	2	(23)
	Nam Oon	2	960		432		6	(1)	21	(1)	16	(1)	.3	(1)
	Nam Kam	1	480		320		72		61		58		n.a.	
Mukdahan	Mekong	15	6,688	(1)	2,948	(2)	216	(6)	262	(4)	254	(3)	0.3	(14)
	Huai Bung	1	480		192		n.a.		n.a.		n.a.		0.3	
Ubon	Nam Chi	12	5,760		1,536	(4)	n.a.		n.a.		107	(8)	2	(4)
	Nam Mun	8	3,712		1,392	(1)	7	(7)	16	(7)	36	(6)	2	(1)
	Lam Se Bai	4	1,920		672	(1)	26	(1)	39	(2)	53	(1)	1	
	Lam Dom Yai	1	480		192		n.a.		n.a.		25		0.3	
	Mekong	1	480		192	(1)	n.a.		n.a.		n.a.		n.a.	
Sisaket	Nam Mun	15	7,200		2,928	(1)	149	(11)	116	(11)	287	(5)	n.a.	
Khon Kaen	Nam Chi	5	2,400		1,008		107	(2)	173	(1)	161	(1)	1	(1)
	Nam Pong	3	1,440		384		n.a.		n.a.		145	(1)	0.6	(1)
Surin	Nam Mun	1	480		192		n.a.		n.a.		n.a.		n.a.	
Buriram	Nam Mun	4	1,920		752		n.a.		n.a.		n.a.		n.a.	
Loei	Nam Heung	3	1,136		544		n.a.		n.a.		21	(1)	n.a.	
	Nam Loei	3	1,408		240		12	(2)	6	(2)	11	(2)	n.a.	
	Mekong	1	480		192		n.a.		n.a.		7		n.a.	
Korat	Nam Mun	1	480		192		n.a.		n.a.		n.a.		n.a.	
	Nam Chi	2	960		n.a.		n.a.		n.a.		n.a.		n.a.	
	Lam Ta Kong	1	480		n.a.		n.a.		n.a.		n.a.		n.a.	
Roi Et	Nam Mun	2	960		384		n.a.		n.a.		n.a.		n.a.	
	Nam Chi	33	15,840		6,016		270	(28)	425	(25)	1,008	(16)	0.6	(31)
Yasothon	Nam Chi	20	9,312		2,881	(5)	390	(15)	280	(15)	477	(12)	4.6	(5)
Maha Sarakham	Nam Chi	21	9,376	(1)	4,080	(3)	99	(18)	321	(15)	1132	(3)	1.8	(15)

Notes: (1) n.a. means not available
(2) Numbers in brackets give the number of schemes for which no data were available to compute the group totals.
(3) The irrigated areas and calculated only from the data available in each case.

Source: Lower Mekong Basin Water Balance Study, Phase 2 Report, May 1984

Table 4.6 Collected Diversion Requirements in Thailand (1/7)

(Unit: mm/month)

Module	**T1 (Mekong Tributaries)**			**Average (T1)**	
Season	**Wet**			**Wet**	
Crop	**Rice (HYV)**	**Rice (Floating)**	**Peanuts**	**Rice**	**Field Crop**
Jan					
Feb					
Mar					
Apr					
May	20	20		20	
Jun	101	101	60	101	60
Jul	65	63	15	64	15
Aug	61	56	31	59	31
Sep	76	76	43	76	43
Oct	228	238	149	233	149
Nov	155	253	43	204	43
Dec		148		74	
Total	**706**	**954**	**340**	**831**	**340**
Irrigation Efficiency	0.80	0.80	0.80	0.80	0.80

Table 4.6 Collected Diversion Requirements in Thailand (2/7)

(Unit: mm/month)

Module	**T1 (Mekong Tributaries)**				**Average (T1)**	
Season	**Dry**				**Dry**	
Crop	**Rice (HYV)**	**Mung Bean**	**Tobacco**	**Vegetables**	**Rice**	**Field Crop**
Jan	157	182	141		157	108
Feb	242	140	143	203	242	162
Mar	295	201	198	174	295	191
Apr	234	91	159	124	234	125
May	113		30	43	113	24
Jun	52				52	
Jul	32				32	
Aug						
Sep						
Oct						
Nov						
Dec	99	74	148		99	74
Total	**1,224**	**688**	**818**	**544**	**1,224**	**684**
Irrigation Efficiency	0.80	0.80	0.80	0.80	0.80	0.80

Table 4.6 Collected Diversion Requirements in Thailand (3/7)

(Unit: mm/month)

Module	**T2 (Chi Basin)**				**Average (T2)**	
Season	**Wet**				**Wet**	
Crop	**Rice (HYV)**	**Rice (Local)**	**Maize**	**Vegetables**	**Rice**	**Field Crop**
Jan						
Feb						
Mar						
Apr						
May				151		76
Jun	64	262	84	153	163	119
Jul	277	209	184	171	243	178
Aug	221	202	184	140	212	162
Sep	42	24	9	33	33	21
Oct	19	120		58	70	29
Nov						
Dec						
Total	**623**	**818**	**462**	**707**	**721**	**585**
Irrigation Efficiency	0.45	0.45	0.45	0.45	0.45	0.45

Note: Irrigation Efficiency=0.45 (gravity), 0.50 (pumped)

Table 4.6 Collected Diversion Requirements in Thailand (4/7)

(Unit: mm/month)

Module	**T2 (Chi Basin)**			**Average (T2)**	
Season	**Dry**			**Dry**	
Crop	**Rice 1 (HYV)**	**Soya Bean**	**Vegetables**	**Rice**	**Field Crop**
Jan	658	351	349	658	350
Feb	433	322	429	433	376
Mar	618	109	229	618	169
Apr	296			296	
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec		149	340		245
Total	**2,005**	**931**	**1,347**	**2,005**	**1,140**
Irrigation Efficiency	0.45	0.45	0.45	0.45	0.45

Note: Irrigation Efficiency=0.45 (gravity), 0.50 (pumped)

Table 4.6 Collected Diversion Requirements in Thailand (5/7)

(Unit: mm/month)

Module	T3 (Mun Basin)		
Season	**Wet**	**Dry**	**Dry**
Crop	**Rice**	**Rice**	**Field Crop**
Jan		357	77
Feb		436	226
Mar		401	290
Apr		242	285
May		12	108
Jun	213		7
Jul	157		
Aug	15		
Sep	26		
Oct	161		
Nov	135		
Dec			
Total	**707**	**1,448**	**993**
Irrigation Efficiency	0.47-0.69	0.47–0.72	0.47

Table 4.6 Collected Diversion Requirements in Thailand (6/7)

(Unit: mm/month)

Module		T4 (Northeast)		
Season		**Wet**		**Dry**
Crop		**Rice**	**Field Crop**	**Field Crop**
Chi B.	Kalasin	1,154	214	684
	Khon Kaen	1,280	274	662
	Chaiyaphum	1,398	352	712
	Mahasarakham	1,134	186	672
	Yasothon	1,092	152	702
	Roi Et	1,150	184	696
Mun B.	Nakhon Ratchasima	1,178	242	618
	Buri Ram	1,048	168	662
	Si Sa Ket	1,196	220	694
	Surin	1,110	172	692
	Ubon Ratchathani	1,018	144	704
Mekong	Nakhon Phanom	858	130	646
	Nongkhai	970	174	616
	Muk Dahan	1,096	176	692
	Loei	1,350	324	632
	Sakon Nakhon	1,096	194	664
	Udon Thani	1,246	270	618
Irrigation Efficiency		0.50	0.50	0.50

Table 4.6 Collected Diversion Requirements in Thailand (7/7)

(Unit: mm)

Module	**T5 (Northeast)**							
Season	**Field Irrigation Req.**			**(E)**	**Diversion Req.**			
	Wet	**Dry**			**Wet**	**Dry**		
Crop	**Rice**	**Rice**	**Field Crop**	**(%)**	**Rice**	**Rice**	**Field Crop**	**(*) Average**
Large Scale	400	1,200	400	50	800	2,400	800	1,760
Medium Scale	400	--	400	50	800	--	800	800
Small Scale	400	--	400	70	570	--	570	570
Pumping	400	1,200	400	70	570	2,400	570	1,255

Note (*)

	Rice:	Field Crop
Large Scale	60	40 (%)
Medium Scale	0	100
Small Scale	0	100
Pumping	60	40

Table 4.7 Collected Diversion Requirements in Lao PDR

(Unit: mm/month)

Module	**L1**		**L2**		**Average (L1 & L2)**	
Season	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**
Crop	**Rice(Loc)**	**Rice(HYV)**	**Rice**	**Rice**	**Rice**	**Rice**
Jan		214		467		341
Feb		348		437		393
Mar		348		503		426
Apr		30		286		158
May	68		1		35	
Jun	89		541		315	
Jul	0		155		78	
Aug	0		107		54	
Sep	0		147		74	
Oct	89		198		144	
Nov				8		4
Dec		483		794		639
Total	**246**	**1,423**	**1,149**	**2,495**	**700**	**1,961**
Irrigation efficiency	0.68	0.68	0.40	0.50	0.54	0.59

Table 4.8 Collected Diversion Requirements in Cambodia (1/2)

(Unit: mm/month)

Module	C1				
Soils	Acid Paddy		Alkali Paddy		
Season	Wet	Dry	Wet		Dry
Crop	Rice (IR)	Rice (IR)	Rice (Local)	Rice (IR)	Rice (IR)
Jan		393			339
Feb		446			452
Mar		348			491
Apr					114
May	59				
Jun	232		168		
Jul	220		111	275	
Aug	184		132	216	
Sep	14		29	93	
Oct	0		0	20	
Nov					
Dec		318			200
Total	**709**	**1,505**	**440**	**604**	**1,596**
Irrigation Efficiency	0.56	0.56	0.56	0.56	0.56

Table 4.8 Collected Diversion Requirements in Cambodia (2/2)

(Unit: mm/month)

Module	C2			Average (C1 & C2)		
Season	Wet	Dry	3rd	Wet	Dry	3rd
Crop	Rice	Rice (HYV)	Rice (HYV)	Rice	Rice	Rice (*)
Jan		246	398		326	330
Feb		409	245		436	203
Mar		574	106		471	88
Apr	49	501		12	205	
May	119	125		45	42	
Jun	262	136		166	45	
Jul	275	12		220	4	
Aug	287		33	205		27
Sep	50		147	47		122
Oct	75		246	24		204
Nov	113		405	28		336
Dec	85	97	478	21	205	397
Total	**1,315**	**2,100**	**2,056**	**768**	**1,734**	**1,707**
Irrigation Efficiency	0.55	0.55	0.55	0.56	0.56	0.56

(*) The ratio 0.83= (Average Dry Rice 1,734 mm)/(C2 Dry Rice 2,100 mm) is applied to (C2 3rd Rice)

Table 4.9 Collected Diversion Requirements in Vietnam (1/4)

(Unit: mm/month)

Mod.	**V1**								**Zone Ave.**
Season	**Triple Rice**								
Zone	**Zone 1**	**Zone 2**	**Zone 3**	**Zone 4**	**Zone 5**	**Zone 6**	**Zone 7**	**Zone 8**	
Jan	231	226	196	218	252	257	251	230	233
Feb	199	241	253	158	238	248	191	178	213
Mar	149	146	149	207	144	159	161	254	171
Apr	139	134	92	202	170	134	157	145	147
May	102	136	0	101	97	0	0	4	55
Jun	122	89	0	24	45	0	9	0	36
Jul	0	1	40	0	0	12	0	0	7
Aug	46	17	23	13	20	0	0	0	15
Sep	83	1	158	0	21	0	0	0	33
Oct	4	0	78	0	0	0	0	0	10
Nov	39	36	8	28	0	72	20	2	26
Dec	133	113	69	157	156	107	98	140	121
Total	**1,247**	**1,139**	**1,067**	**1,108**	**1,142**	**989**	**887**	**953**	**1,067**
Irrigation Efficiency	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Table 4.9 Collected Diversion Requirements in Vietnam (2/4)

(Unit: mm/month)

Mod.	**V1**								**Zone Ave.**
Season	**Double Rice**								
Zone	**Zone 1**	**Zone 2**	**Zone 3**	**Zone 4**	**Zone 5**	**Zone 6**	**Zone 7**	**Zone 8**	
Jan	279	249	229	247	217	254	273	175	240
Feb	252	283	244	156	181	75	128	0	165
Mar	30	73	66	0	129	0	0	0	37
Apr	128	92	31	6	0	0	0	0	32
May	122	87	0	55	38	15	3	0	40
Jun	128	106	0	35	19	3	1	0	37
Jul	4	89	0	28	92	5	27	0	31
Aug	0	0	0	0	27	19	1	0	6
Sep									
Oct									
Nov	0	0	0	25	10	78	29	39	23
Dec	110	111	97	197	108	217	190	196	153
Total	**1,053**	**1,089**	**667**	**749**	**821**	**665**	**653**	**410**	**764**
Irrigation Efficiency	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Table 4.9 Collected Diversion Requirements in Vietnam (3/4)

(Unit: mm/month)

Mod.	**V1**								**Zone Ave.**
Season	**Field Crop**								
Zone	**Zone 1**	**Zone 2**	**Zone 3**	**Zone 4**	**Zone 5**	**Zone 6**	**Zone 7**	**Zone 8**	
Jan	0	0	0	0	7	12	16	0	4
Feb	72	88	74	68	83	116	140	84	91
Mar	202	206	172	192	197	207	226	206	201
Apr	156	190	156	206	213	218	217	191	193
May	43	39	0	15	7	0	0	8	14
Jun	0	0	0	0	0	0	0	0	0
Jul									
Aug									
Sep									
Oct									
Nov									
Dec									
Total	**473**	**522**	**401**	**481**	**508**	**554**	**599**	**489**	**503**
Irrigation Efficiency	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Table 4.9 Collected Diversion Requirements in Vietnam (4/4)

(Unit: mm/month)

Mod.	**V1**								**Zone Ave.**
Season	**Perennial Crop**								
Zone	**Zone 1**	**Zone 2**	**Zone 3**	**Zone 4**	**Zone 5**	**Zone 6**	**Zone 7**	**Zone 8**	
Jan	98	89	83	82	85	88	91	90	88
Feb	102	99	99	99	104	106	111	102	103
Mar	113	110	95	108	120	114	121	111	112
Apr	53	84	61	99	103	112	102	84	87
May	3	9	0	0	0	0	0	0	2
Jun	0	0	0	0	0	0	0	0	0
Jul	5	0	0	0	0	0	0	0	1
Aug	1	0	0	0	0	0	0	0	0
Sep	1	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0	0
Nov	23	27	0	9	17	38	5	3	15
Dec	59	66	43	68	61	78	61	36	59
Total	**457**	**485**	**381**	**465**	**490**	**535**	**491**	**426**	**467**
Irrigation Efficiency	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Table 5.2 Monthly Mean Reservoir Inflow of Nam Ngum Dam

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1972	95.9	82.2	45.9	52.1	77.3	265.2	758.0	1,575.0	729.5	391.9	223.3	115.7	367.7
1973	104.3	73.0	64.2	26.8	139.5	252.4	798.7	1,049.8	1,458.1	426.2	178.1	111.2	390.2
1974	72.0	52.0	31.4	64.9	108.4	294.5	417.3	685.8	725.9	368.7	154.5	104.4	256.6
1975	97.9	54.0	47.8	28.8	145.4	317.6	968.1	1,340.2	1,163.9	460.8	200.7	111.9	411.4
1976	57.5	52.6	31.7	51.2	122.1	285.0	603.3	775.5	572.7	447.2	266.1	85.4	279.2
1977	79.6	51.5	174.7	189.2	124.8	143.4	657.3	611.4	509.2	173.5	96.2	65.3	239.7
1978	52.4	43.9	61.6	58.3	135.9	652.4	980.2	1,319.4	876.7	245.7	120.3	74.3	385.1
1979	107.1	81.0	70.8	93.1	249.3	393.4	387.3	912.3	628.9	227.0	130.4	76.5	279.8
1980	83.3	84.3	99.7	127.9	166.8	368.6	969.7	709.7	884.9	282.0	164.7	88.8	335.9
1981	103.2	70.7	116.1	101.6	190.5	573.5	1,382.4	1,130.1	875.9	612.2	192.0	117.2	455.4
1982	105.7	104.2	117.7	129.8	167.8	410.8	560.3	1,215.2	806.0	409.9	196.7	145.2	364.1
1983	131.6	157.6	122.1	120.6	163.8	223.3	668.7	826.5	613.1	362.7	166.3	138.9	307.9
1984	128.4	125.4	94.6	77.7	169.4	233.2	950.7	913.6	568.8	334.4	203.7	114.5	326.2
1985	117.8	99.9	68.0	65.8	150.8	373.1	552.9	799.5	631.5	219.1	145.5	106.2	277.5
1986	78.4	65.5	56.1	78.0	330.8	606.7	794.4	578.5	448.7	202.0	122.4	87.5	287.4
1987	61.0	64.0	50.2	96.5	89.9	228.1	314.0	785.9	441.0	266.8	195.2	118.2	225.9
1988	82.8	73.2	49.5	94.1	156.2	162.7	340.3	712.6	374.7	215.3	103.0	86.7	204.2
1989	58.2	40.7	41.8	52.8	146.3	481.3	532.2	692.9	490.9	298.5	158.3	98.1	257.7
1990	84.4	51.1	75.5	70.3	166.2	517.5	883.6	627.2	532.9	274.0	152.8	107.9	295.3
1991	77.2	55.3	61.4	59.1	101.1	298.7	620.3	709.4	463.0	213.1	128.8	85.7	239.4
1992	87.3	145.8	64.5	69.3	92.8	195.5	616.2	523.3	347.7	158.6	74.7	67.5	203.6
1993	48.8	41.5	34.5	39.5	143.8	448.7	1,045.9	735.8	492.9	244.4	118.2	92.5	290.5
1994	85.3	82.4	93.2	80.4	213.0	594.9	985.6	1,194.8	727.8	368.6	164.3	129.8	393.3
1995	85.3	71.1	56.1	77.1	141.2	362.5	708.1	1,399.1	857.6	243.9	140.6	126.7	355.8
1996	91.7	88.7	73.4	100.9	160.1	389.6	811.0	1,188.4	740.7	335.5	262.7	149.2	366.0
1997	91.3	82.9	69.7	100.6	158.6	256.1	989.9	800.1	921.1	366.0	189.6	136.5	346.9
1998	111.2	97.5	82.1	113.1	119.2	342.5	808.0	652.6	471.5	160.0	103.6	63.9	261.8
1999	49.5	40.4	42.8	98.0	376.7	795.2	658.7	872.1	668.5	361.8	177.5	120.7	356.9
2000	88.2	78.0	75.2	105.1	355.0	857.4	900.1	840.2	864.4	361.4	171.4	120.6	403.2
2001	95.3	63.9	143.9	63.2	302.5	679.7	1,013.6	1,025.7	755.5	418.5	196.3	-	285.2
Mean	87.1	75.8	73.9	82.9	172.2	400.1	755.9	906.8	688.1	315.0	163.3	105.1	315.0
Max	131.6	157.6	174.7	189.2	376.7	857.4	1,382.4	1,575.0	1,458.1	612.2	266.1	149.2	455.4
Min	48.8	40.4	31.4	26.8	77.3	143.4	314.0	523.3	347.7	158.6	74.7	63.9	203.6

Source: Nam Ngum Hydropower Station Office

Table 5.3 Monthly Mean Turbine Release of Nam Ngum Dam

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1972	83.4	87.2	89.2	85.6	66.4	93.2	47.0	80.4	85.2	89.9	65.3	68.6	78.5
1973	70.5	89.9	93.2	94.5	95.6	92.2	92.3	89.9	89.6	72.4	78.6	85.7	87.0
1974	93.8	94.9	97.4	98.9	97.5	96.6	92.3	92.5	90.7	91.9	90.3	74.8	92.6
1975	62.9	80.6	89.1	97.3	90.0	80.7	89.6	90.8	91.3	92.5	92.9	94.5	87.7
1976	95.4	93.1	85.9	51.2	85.1	78.9	84.6	82.9	80.0	80.4	80.5	68.5	80.5
1977	79.3	84.1	86.5	93.6	94.7	95.0	94.2	86.6	85.8	83.3	83.0	75.5	86.8
1978	78.1	72.3	81.9	85.0	84.2	80.5	71.8	97.3	106.8	121.4	120.3	102.9	91.9
1979	241.2	295.2	309.0	327.6	296.9	281.8	279.8	258.9	316.5	296.2	295.0	267.8	288.8
1980	246.1	287.7	308.5	295.7	329.3	314.1	331.0	335.9	335.4	325.5	316.9	307.2	311.1
1981	326.9	335.5	321.3	235.8	267.7	325.9	339.4	340.8	321.0	231.2	254.6	250.5	295.9
1982	260.1	259.8	322.8	339.8	283.6	297.2	337.6	345.7	351.7	353.2	339.7	326.3	318.1
1983	320.0	331.4	348.4	349.2	237.0	257.0	349.3	346.1	330.1	322.8	318.9	320.5	319.2
1984	329.2	338.0	262.9	238.8	321.5	320.8	314.0	308.8	308.9	317.2	332.5	329.2	310.2
1985	379.5	354.9	345.6	278.6	241.9	323.9	295.5	305.5	339.4	314.1	284.7	271.6	311.3
1986	279.0	287.6	230.6	230.9	282.2	327.3	445.2	423.5	426.7	323.6	288.8	218.2	313.6
1987	216.1	215.4	214.4	218.3	220.7	252.4	174.6	179.0	58.7	245.6	258.4	327.6	215.1
1988	246.9	274.7	222.8	222.3	217.3	256.4	203.3	239.3	192.5	206.1	175.2	138.6	216.3
1989	149.4	148.4	142.1	166.0	170.2	232.3	276.8	293.2	409.2	353.2	307.5	263.8	242.7
1990	321.5	297.4	272.0	218.6	202.2	294.7	306.8	311.1	281.6	304.4	243.9	272.0	277.2
1991	214.0	228.6	240.7	322.9	213.6	270.4	328.5	331.0	195.7	174.1	213.0	155.6	240.7
1992	193.3	235.4	193.3	250.2	250.8	271.5	309.2	281.4	183.1	185.5	141.1	134.2	219.1
1993	153.3	154.7	170.6	197.8	185.2	266.7	364.8	447.5	432.7	330.7	196.1	249.4	262.5
1994	245.8	256.0	271.9	287.7	280.4	305.3	415.3	421.0	428.2	427.0	292.5	292.7	327.0
1995	243.4	265.1	251.7	290.7	289.5	318.5	326.3	447.7	471.0	370.3	296.4	309.0	323.3
1996	263.1	301.9	287.4	293.1	315.2	371.3	384.9	463.8	457.6	430.9	326.7	380.2	356.3
1997	268.2	272.7	261.8	320.5	309.4	359.7	422.8	443.9	444.9	448.7	342.9	312.8	350.7
1998	300.9	302.1	296.1	325.4	332.4	353.0	398.7	425.2	304.4	211.1	187.8	190.4	302.3
1999	184.5	206.0	191.1	199.5	246.4	345.0	409.2	408.7	425.9	435.2	306.9	322.4	306.7
2000	271.8	262.4	290.0	291.3	324.7	386.3	384.2	422.8	425.7	432.2	320.8	312.7	343.7
2001	277.7	287.4	331.3	349.9	324.0	374.4	409.8	421.1	423.8	429.2	342.1	-	361.0
Mean	216.5	226.7	223.7	228.6	225.2	257.4	279.3	294.1	283.2	270.0	233.1	224.9	247.3
Max	379.5	354.9	348.4	349.9	332.4	386.3	445.2	463.8	448.7	448.7	342.9	380.2	361.0
Min	62.9	72.3	81.9	51.2	66.4	78.9	47.0	80.4	72.4	72.4	65.3	68.5	78.5

Source: Nam Ngum Hydropower Station Office

Table 5.4 Monthly Nam Ngum Water Level at 24:00 of the End of Month

(Unit: masl)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1972	202.80	202.50	202.30	201.90	202.10	203.40	206.40	208.80	204.90	204.90	204.10	203.50
1973	203.20	202.80	202.50	201.90	202.30	203.40	206.30	208.20	205.00	205.00	203.90	203.30
1974	202.80	202.40	201.80	201.50	201.60	203.20	204.90	206.50	204.60	204.60	203.60	203.20
1975	203.10	202.70	202.30	201.70	202.13	204.30	206.90	208.30	205.00	205.00	203.90	203.25
1976	202.90	202.50	202.00	202.00	202.00	203.60	205.80	210.60	211.30	211.30	209.70	208.90
1977	208.90	208.48	205.80	204.06	203.53	203.44	206.19	207.27	208.90	208.90	209.01	208.92
1978	208.70	208.50	208.30	208.10	208.50	212.20	211.80	212.10	212.00	212.00	212.10	211.90
1979	210.80	209.40	207.50	205.60	205.20	206.10	207.00	212.10	211.60	211.60	210.40	208.90
1980	207.60	205.90	204.10	202.50	201.00	201.50	207.10	210.10	211.90	211.90	210.80	209.10
1981	207.30	205.30	203.50	202.28	201.60	203.80	212.65	212.82	212.20	212.20	211.70	210.70
1982	209.50	208.40	206.70	205.00	204.00	204.95	206.10	211.98	212.03	212.03	210.97	209.56
1983	208.02	206.65	204.68	202.67	202.00	201.73	204.60	208.77	211.25	211.25	210.14	208.70
1984	207.06	205.39	203.94	202.51	201.09	200.92	206.16	211.14	212.08	212.08	211.04	209.38
1985	207.29	205.40	203.11	201.42	200.53	201.06	203.17	207.43	209.01	209.01	207.95	206.57
1986	204.93	203.27	201.80	200.43	200.99	203.48	206.52	207.78	206.86	206.86	205.69	204.57
1987	203.31	202.19	200.80	199.43	197.94	197.67	199.25	204.75	207.98	207.98	207.20	205.46
1988	204.10	202.55	201.12	199.76	199.02	198.04	199.58	203.50	205.39	205.39	204.83	204.24
1989	203.50	202.71	201.87	200.98	200.71	202.77	204.87	208.16	208.35	208.35	207.16	205.79
1990	203.84	202.08	200.25	198.59	198.20	200.75	205.51	208.10	209.85	209.85	209.14	207.78
1991	206.66	205.38	203.90	201.79	200.84	201.09	203.50	206.61	209.07	209.07	208.40	207.83
1992	207.22	206.10	205.04	203.60	202.29	201.68	204.22	206.21	207.29	207.29	206.77	206.21
1993	205.36	204.52	203.40	202.14	201.19	203.23	208.85	211.21	210.99	210.99	210.37	209.08
1994	207.76	206.47	205.00	203.35	202.78	205.10	209.79	213.28	211.80	211.80	210.37	209.44
1995	208.14	206.69	205.09	203.39	202.17	202.52	205.66	213.36	211.06	211.06	209.82	208.32
1996	206.91	205.27	203.51	201.98	200.60	200.81	204.36	210.32	211.49	211.49	210.98	209.08
1997	207.71	206.30	204.72	202.97	201.73	200.88	205.57	208.50	211.61	211.61	210.39	208.94
1998	207.38	205.36	204.10	202.41	200.53	200.41	203.94	205.81	206.72	206.72	206.05	205.01
1999	203.90	202.67	201.45	200.51	201.71	205.28	207.33	211.01	211.73	211.73	210.70	209.04
2000	207.53	206.11	204.34	202.87	203.11	206.86	209.82	211.72	211.67	211.67	210.48	208.90
2001	207.40	205.74	204.20	201.92	201.74	204.17	209.13	211.61	212.04	212.04	210.88	-
Mean	206.19	204.99	203.64	202.31	201.77	202.94	206.10	209.27	209.52	209.52	208.62	207.43
Max	210.80	209.40	208.30	208.10	208.50	212.20	212.65	213.36	212.20	212.20	212.10	211.90
Min	202.80	202.08	200.25	198.59	197.94	197.67	199.25	203.50	204.60	204.60	203.60	203.20

Source: Nam Ngum Hydropower Station Office

Table 5.5 Monthly Mean Spillout Discharges of Nam Ngum Dam

(Unit: m3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1972	67.0	30.0	0.0	0.0	0.0	15.0	374.0	1,202.0	1,011.0	421.0	254.0	113.0
1973	66.0	31.0	3.0	0.0	0.0	37.0	370.0	733.0	1,480.0	628.0	230.0	90.0
1974	32.0	5.0	0.0	0.0	0.0	17.0	134.0	402.0	91.0	395.0	180.0	0.0
1975	40.0	21.0	2.0	0.0	0.0	72.0	559.0	1,081.0	1,271.0	572.0	239.0	73.0
1976	32.0	5.0	0.0	0.0	0.0	55.0	265.0	0.0	0.0	421.0	414.0	88.0
1977	0.0	24.0	414.0	313.0	95.0	59.0	228.0	394.0	312.0	0.0	0.0	0.0
1978	0.0	0.0	5.0	0.0	0.0	70.0	952.0	1,208.0	770.0	124.0	0.0	0.0
1979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	312.0	0.0	0.0	0.0
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	257.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	0.0	0.0	0.0	38.0	77.0	655.0	339.0	0.0	0.0
1982	0.0	0.0	0.0	0.0	0.0	0.0	79.6	123.6	246.0	258.3	0.0	0.0
1983	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	103.8	53.6	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	349.5	349.3	70.5	0.0	0.0
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	542.1	0.0	0.0	0.0
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.3	3.1	0.0	0.0
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0
1998	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.9	59.8	31.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	156.4	185.4	322.4	48.4	0.0	0.0
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	304.7	211.5	53.0	0.0	0.0
Mean	7.90	3.87	14.13	10.43	3.17	10.83	105.20	202.84	267.61	114.03	43.90	12.13
Max	67.00	31.00	414.00	313.00	95.00	72.00	952.00	1,208.00	1,480.00	628.00	414.00	113.00
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Nam Ngum Hydropower Station Office

Table 5.6 Operation Schedule of Nam Ngum Hydropower System in 2001

Starting RWL on January 1st : 209.00 m

	Power Output	Nam Ngum Reservoir			Water Diversion from Nam Song		Water from Nam Leuk Reservoir		Turbine Discharge of Nam Ngum	
	(GWh)	Inflow Vol. (10^6 m^3)	Ave. Inflow (m^3/sec)	end WL (El. m)	Inflow Vol. (10^6 m^3)	Ave. Inflow (m^3/sec)	Inflow Vol. (10^6 m^3)	Ave. Inflow (m^3/sec)	Volume (10^6 m^3)	Average (m^3/sec)
Jan	72.0	222.5	83.1	207.32	45.6	17.0	18.3	6.8	770.4	287.6
Feb	65.0	171.6	70.9	205.65	33.0	13.6	17.4	7.2	715.0	295.6
Mar	73.0	164.6	61.5	203.60	30.0	11.2	19.3	7.2	832.2	310.7
Apr	65.0	234.1	90.3	201.96	29.5	11.4	18.1	7.0	767.0	295.9
May	63.0	482.7	180.2	201.08	110.0	41.1	23.1	8.6	768.6	287.0
Jun	65.5	1,400.1	540.2	202.93	230.0	88.7	47.9	18.5	799.1	308.3
Jul	98.0	2,297.5	857.8	206.46	232.0	86.6	76.9	28.7	1,146.6	428.1
Aug	110.5	2,385.2	890.5	210.12	430.0	160.5	90.5	33.8	1,193.4	445.6
Sep	107.0	1,690.9	652.4	211.93	435.0	167.8	86.3	33.3	1,102.1	425.2
Oct	111.0	1,059.8	395.7	211.74	322.0	120.2	49.8	18.6	1,121.1	418.6
Nov	83.0	532.2	205.3	210.78	170.0	65.6	15.3	5.9	846.6	326.6
Dec	85.0	318.9	119.0	209.04	80.0	29.9	17.4	6.5	884.0	330.0
Total/ Average	**998.0**	**10,960.0**	**345.6**	-	**2,147.1**	**67.8**	**480.3**	**15.2**	**10,946.1**	**346.6**

Source: Nam Ngum Power Station (Oct. 2000)

Table 5.7 Monthly Operation Record at Nam Leuk Hydropower Station

A. Power Output

(Unit: MWh)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	98	3,067	5,817	7,671	4,915	5,787	6,863	5,630	3,170	1,707	1,698	46,423
2001	3,095	1,294	1,498	1,625	4,253	7,638	8,855	5,571	5,840	3,005	-	-	42,674
Mean	3,095	696	2,283	3,721	5,962	6,277	7,321	6,217	5,735	3,088	1,707	1,698	44,549

Source: Electricite du Laos (EDL)

Note: Power generation commenced in February 2000.

B. Tubine Discharge (Diverted water volume into the Nam Ngum reservoir)

(Unit: million m3)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	0.96	31.77	62.53	85.53	53.82	79.06	93.54	91.04	31.95	15.26	15.53	51.00
2001	29.37	12.48	16.20	17.97	50.10	86.08	91.65	93.81	81.29	27.53	12.34	-	47.17
Mean	29.37	6.72	23.99	40.25	67.82	69.95	85.36	93.68	86.17	29.74	13.80	15.53	46.86

Source: Electricite du Laos (EDL)

Note: Power generation commenced in February 2000.

C. Tubine Discharge (Diverted discharage into the Nam Ngum reservoir)

(Unit: m3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	0.38	11.86	24.12	31.93	20.76	29.52	34.92	35.12	11.93	5.89	5.80	19.30
2001	10.97	5.16	6.05	6.93	18.71	33.21	34.22	35.02	31.36	10.28	4.76	-	17.88
Mean	10.97	2.77	8.95	15.53	25.32	26.99	31.87	34.97	33.24	11.10	5.32	5.80	17.74

Source: Electricite du Laos (EDL)

Note: Power generation commenced in February 2000.

Table 5.10 Monthly Mean Discharge at Hinhuep in Nam Ngum River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1967	-	-	-	34	63	305	600	413	866	331	114	67	310
1968	47	35	31	35	123	340	352	656	810	295	134	73	244
1969	53	38	32	30	49	589	915	888	507	261	144	78	299
1970	55	41	34	35	159	487	668	1,213	1,125	229	105	67	351
1971	45	37	35	34	91	346	938	1,488	484	223	97	60	323
1972	41	33	29	38	48	178	324	835	419	270	145	86	204
1973	55	47	48	31	73	216	694	557	969	316	111	69	266
1974	49	40	32	54	84	223	389	541	556	262	153	120	209
1975	76	57	42	33	101	496	830	1,148	2,490	1,128	818	683	659
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	60	69	207	595	739	1,016	653	335	254	-	436
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	1,061	902	1,058	676	252	-	790
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	594	958	771	387	-	-	678
1984	-	-	-	-	-	-	882	695	510	360	-	-	612
1985	-	-	-	-	-	301	456	612	609	287	-	-	453
1986	-	-	-	-	346	368	-	526	629	-	-	-	467
1987	-	-	-	140	151	306	272	709	604	310	217	195	323
1988	90	77	70	69	137	193	384	589	391	241	107	68	201
1989	48	43	51	16	74	529	526	567	525	267	95	39	232
1990	103	89	93	79	325	439	583	561	617	327	206	115	295
1991	100	76	39	39	62	146	318	486	457	285	128	70	184
1992	72	46	49	44	84	166	315	363	370	180	81	63	153
1993	45	39	30	26	67	230	674	451	453	190	95	69	197
1994	56	48	50	49	140	459	484	740	721	258	111	82	266
1995	59	49	40	39	64	184	622	1,206	763	202	110	46	282
1996	33	31	37	45	53	129	244	638	498	189	131	67	175
1997	42	32	26	28	58	90	724	454	945	190	82	47	226
1998	25	15	8	20	23	106	318	376	298	104	54	31	115
1999	27	21	16	26	160	339	304	589	782	231	111	64	223
2000	41	32	17	13	165	496	448	634	727	210	106	-	262
Mean	**55**	**44**	**40**	**43**	**116**	**318**	**559**	**718**	**711**	**305**	**158**	**103**	**325**
Max	**103**	**89**	**93**	**140**	**346**	**595**	**1,061**	**1,488**	**2,490**	**1,128**	**818**	**683**	**790**
Min	**25**	**15**	**8**	**13**	**23**	**90**	**244**	**363**	**298**	**104**	**54**	**31**	**115**

Source: MRC HYMOS Database

Table 5.11 Monthly Mean Discharge at Ban Pak Kanhoung in Nam Ngum River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	-	-	-	-	-	-	-	-	-	-	-	-	
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	120	91	87	77	124	551	1,708	2,299	1,845	677	523	313	701
1964	162	118	95	104	211	903	1,279	1,412	1,832	751	333	201	617
1965	145	123	88	86	147	1,310	1,712	1,455	1,157	532	432	195	615
1966	131	104	86	85	243	890	1,830	2,558	1,867	416	256	161	719
1967	114	87	71	100	143	690	1,354	1,159	2,023	772	260	161	578
1968	121	98	88	95	272	786	852	1,656	1,609	550	291	173	549
1969	126	95	79	72	121	1,436	2,236	2,270	812	579	337	-	742
1970	142	109	87	98	308	1,090	2,040	2,680	3,016	615	312	210	892
1971	154	127	113	76	113	434	1,088	2,066	1,395	688	368	255	573
1972	224	177	165	165	150	323	803	2,262	1,606	829	481	294	623
1973	212	181	164	161	196	403	1,301	1,465	2,906	1,119	449	276	736
1974	195	160	156	161	207	362	677	1,118	1,561	796	428	229	504
1975	171	157	148	153	-	-	-	-	-	-	-	-	-
1976	251	157	135	86	203	502	782	1,363	1,389	1,119	711	258	579
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	214	200	193	206	277	618	800	800	1,026	670	419	334	480
1990	352	332	333	317	532	1,201	1,389	1,300	1,239	973	738	645	779
1991	341	304	303	379	333	439	760	1,128	937	443	345	215	494
1992	161	242	199	250	279	510	838	1,014	664	624	222	168	431
1993	173	154	187	230	276	574	1,186	957	1,030	588	279	286	493
1994	342	346	380	402	532	933	1,051	1,583	1,682	904	521	484	764
1995	357	338	319	356	398	599	1,176	2,248	2,174	842	480	420	809
1996	371	384	366	474	445	588	720	1,207	1,235	778	578	572	643
1997	364	342	330	381	407	477	1,106	934	1,328	446	267	238	552
1998	161	143	203	359	389	490	738	878	653	322	250	235	402
1999	195	211	198	216	446	723	769	1,072	1,492	729	351	361	563
2000	317	302	311	347	491	895	971	1,289	1,647	686	426	372	671
2001	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**216**	**195**	**188**	**209**	**290**	**709**	**1,167**	**1,527**	**1,525**	**698**	**402**	**294**	**620**
Max	**371**	**384**	**380**	**474**	**532**	**1,436**	**2,236**	**2,680**	**3,016**	**1,119**	**738**	**645**	**892**
Min	**114**	**87**	**71**	**72**	**113**	**323**	**677**	**800**	**653**	**322**	**222**	**161**	**402**

Source: MRC HYMOS Database

Table 5.12 Monthly Mean Discharge at Ban Tha Lat in Nam Ngum River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	-	-	-	-	-	-	-	-	-	-	-	-	
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-	-
1966	113	89	72	82	232	865	1,802	2,548	1,815	402	247	141	701
1967	104	83	67	86	133	682	1,323	1,135	1,940	748	249	151	558
1968	107	82	70	93	273	733	826	1,527	1,506	561	291	173	520
1969	129	95	78	73	117	1,428	2,168	2,216	837	543	320	179	682
1970	132	100	83	94	296	1,070	1,950	2,448	2,772	555	269	180	829
1971	130	106	92	54	99	347	945	1,868	1,247	624	325	206	504
1972	190	147	139	140	134	284	773	2,152	1,425	721	217	162	540
1973	193	138	143	116	144	367	1,199	1,369	2,630	983	380	219	657
1974	151	123	120	134	165	293	627	1,196	1,424	726	375	184	460
1975	124	124	111	105	169	561	1,625	2,225	2,329	1,114	480	254	768
1976	162	134	117	81	161	298	320	1,065	-	-	-	144	-
1977	45	45	176	180	87	82	379	472	453	181	185	136	202
1978	120	117	116	140	330	786	1,804	2,304	1,688	542	236	144	694
1979	303	339	339	353	452	638	690	892	1,317	470	399	362	546
1980	283	309	299	281	399	746	1,291	1,341	1,638	604	375	375	662
1981	332	322	360	276	433	804	1,900	2,312	2,053	1,304	493	491	923
1982	-	-	-	414	334	511	778	1,221	1,364	1,062	503	387	731
1983	371	375	351	352	308	-	1,060	1,432	1,238	715	432	369	637
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	333	318	583	793	974	-	-	-	-	-
1986	280	341	269	264	559	954	1,060	-	-	-	-	-	-
1987	-	-	-	307	315	620	588	967	829	687	541	468	-
1988	-	-	-	-	-	-	796	1,039	748	513	325	258	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**182**	**170**	**167**	**189**	**260**	**633**	**1,123**	**1,557**	**1,540**	**687**	**350**	**249**	**624**
Max	**371**	**375**	**360**	**414**	**559**	**1,428**	**2,168**	**2,548**	**2,772**	**1,304**	**541**	**491**	**923**
Min	**45**	**45**	**67**	**54**	**87**	**82**	**320**	**472**	**453**	**181**	**185**	**136**	**202**

Source: MRC HYMOS Database

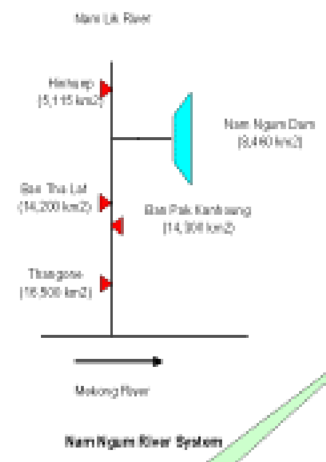
Table 5.13 Monthly Mean Discharge at Thangone in Nam Ngum River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	-	-	-	-	-	-	-	-	-	-	-	-	
1962	162	122	92	99	163	635	1,158	1,935	1,296	631	285	182	563
1963	136	107	94	82	117	494	1,626	2,711	2,164	791	567	261	763
1964	179	134	110	117	217	939	1,376	1,461	1,950	847	371	215	660
1965	163	134	101	95	154	1,341	1,831	1,606	1,266	564	483	206	662
1966	150	119	93	96	250	937	2,108	2,721	2,804	643	335	211	872
1967	149	117	95	90	138	693	1,278	1,275	2,030	1,052	313	185	618
1968	132	100	88	97	284	781	1,005	1,857	1,840	762	377	187	626
1969	132	106	89	83	126	1,472	2,297	2,930	1,237	713	386	210	815
1970	152	113	93	99	332	1,136	2,395	3,093	3,190	853	346	235	1,003
1971	156	120	108	83	117	466	1,583	2,493	2,078	899	408	245	730
1972	206	159	147	144	122	291	835	2,260	1,845	1,003	525	329	656
1973	202	165	149	129	157	363	1,278	1,627	2,963	1,237	425	247	745
1974	168	139	130	136	168	331	647	1,337	1,771	835	431	216	526
1975	153	132	120	124	185	791	1,502	2,243	2,788	1,289	515	284	844
1976	191	157	135	93	174	465	705	1,480	1,521	1,266	705	290	598
1977	155	142	450	380	235	216	728	1,165	1,401	469	261	149	479
1978	128	110	114	124	327	816	1,908	2,774	2,009	793	278	138	793
1979	293	333	322	326	430	642	762	1,059	1,597	603	369	282	585
1980	256	261	267	274	365	799	1,274	1,906	2,205	796	428	357	766
1981	347	351	333	259	450	835	2,202	2,471	2,414	1,411	514	378	997
1982	327	299	335	-	-	-	882	1,597	1,557	1,411	471	370	805
1983	339	324	330	326	280	388	936	1,673	1,597	852	510	363	660
1984	343	330	257	255	379	526	1,497	1,491	1,342	884	473	432	684
1985	445	404	390	337	-	-	-	1,168	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	376	359	331	328	350	492	472	832	815	648	429	429	488
1988	315	314	241	247	335	471	748	1,081	845	515	314	204	469
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**221**	**198**	**193**	**177**	**244**	**680**	**1,321**	**1,856**	**1,861**	**871**	**421**	**264**	**696**
Max	**445**	**404**	**450**	**380**	**450**	**1,472**	**2,395**	**3,093**	**3,190**	**1,411**	**705**	**432**	**1,003**
Min	**128**	**100**	**88**	**82**	**117**	**216**	**472**	**832**	**815**	**469**	**261**	**138**	**469**

Source: MRC HYMOS Database

Table 5.14 Comparison of Monthly Mean Discharges in Dry Season at Hydrologic Stations in Nam Ngum River



Year	Month: February Hinheup	February Ban Tha Lat	February Ban Pak Kanhoung	February Thangone	Month: March Hinheup	March Ban Tha Lat	March Ban Pak Kanhoung	March Thangone	Month: April Hinheup	April Ban Tha Lat	April Ban Pak Kanhoung	April Thangone
1960												
1961												
1962				122				92				99
1963			91	107			87	94			77	82
1964			118	134			95	110			104	117
1965			123	134			88	101			88	95
1966		89	104	119		72	86	93		82	85	96
1967		83	87	117		67	71	95	34	86	100	90
1968	35	82	96	100	31	70	88	68	35	93	95	97
1969	38	95	95	106	32	78	79	69	30	73	72	83
1970	41	100	109	113	34	83	87	93	35	94	98	99
1971	37	106	127	120	35	92	113	108	34	54	78	83
1972	33	147	177	159	29	139	165	147	38	140	165	144
1973	47	138	161	165	48	143	164	149	31	118	161	129
1974	40	123	160	139	32	120	156	130	54	134	161	136
1975	57	124	157	132	42	111	148	120	33	105	153	124
1976		134	157	157		117	135	135		81	86	93
1977				142		176		450		180		380
1978		117		110	60	116		114	69	140		124
1979		339		333		339		322		353		326
1980		309		261		299		267		281		274
1981		322		351		360		333		276		259
1982				299				335		414		
1983		375		324		351		330		352		326
1984				330				257				255
1985				404				390		333		337
1986		341				269				264		
1987				359				331	140	307		328
1988	77			314	70			241	69			247
1989	43		200		51		193		16		206	
1990	69		332		93		333		79		317	
1991	78		304		39		303		39		379	
1992	48		242		49		199		44		250	
1993	39		154		30		187		26		230	
1994	48		340		50		380		49		402	
1995	49		338		40		319		39		356	
1996	31		384		37		368		45		474	
1997	32		342		26		330		28		381	
1998	15		143		6		203		20		359	
1999	21		211		16		198		26		216	
2000	32		302		17		311		13		347	

1st stage development: 15 MW x 2 (30 MW)

2nd stage development: 40 MW x 2 (110 MW)

3rd stage development: 40 MW x 1 (140 MW)

Table 5.15 Summary of Low Flow Increase in Dry Season in Nam Ngum River

A. Monthly Mean Discharge

Month: February (Unit: m3/s)

Period	Hinhuep	Ban Tha Lat	Ban Pak Kanhoung	Thangone
1961-71	38	93	106	117
1972-78	44	130	166	143
1979-84	(45)	336	-	316
1985-00	46	341	275	359

Month: March (Unit: m3/s)

Period	Hinhuep	Ban Tha Lat	Ban Pak Kanhoung	Thangone
1961-71	33	77	88	96
1972-78	42	132	154	178
1979-84	(42)	337	-	307
1985-00	41	269	277	321

Month: April (Unit: m3/s)

Period	Hinhuep	Ban Tha Lat	Ban Pak Kanhoung	Thangone
1961-71	34	81	88	94
1972-78	45	128	145	161
1979-84	(45)	335	-	288
1985-00	45	301	326	304

Note: The figues in bracket are estimated from linear interpolation.

B. Increse of Monthly Discharge

Month: February (Unit: m3/s)

Period	Increase (Ban Tha Lat - Hinhuep)	Increase (Ban Pak Kanhoung - Hinhuep)	Increase (Tangone - Hinhuep)
1961-71	55	68	79
1972-78	86	122	99
1979-84	291	-	271
1985-00	295	229	313

Month: February (Unit: m3/s)

Period	Increase (Ban Tha Lat -	Increase (Ban Pak Kanhoung - Hinhuep)	Increase (Tangone - Hinhuep)
1961-71	44	55	63
1972-78	89	111	136
1979-84	295	-	265
1985-00	229	236	280

Month: February (Unit: m3/s)

Period	Increase (Ban Tha Lat -	Increase (Ban Pak Kanhoung - Hinhuep)	Increase (Tangone - Hinhuep)
1961-71	47	54	60
1972-78	83	100	116
1979-84	290	-	243
1985-00	256	281	259

Period: 1961-71: before completion of Nam Ngum Project
1972-78 : after completion of Phase I of Nam Ngum Project (30 MW)
1979-84 : after completion of Phase II of Nam Ngum Project (110 MW)
1985-00 : after completion of Phase III of Nam Ngum Project (150 MW)

Table 6.3 Monthly Mean Discharge at Ubon in Nam Mun-Chi River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	49	22	15	11	52	283	707	754	2,165	3,282	1,529	160	752
1962	56	28	25	17	95	416	984	1,570	2,053	3,725	2,008	207	932
1963	50	28	22	17	29	111	198	1,121	1,579	1,651	1,514	540	572
1964	72	33	21	18	137	367	338	509	1,004	3,110	2,213	557	698
1965	67	37	25	26	57	530	894	557	1,018	930	339	68	379
1966	32	19	15	35	458	1,284	663	1,639	3,477	2,811	402	137	914
1967	75	57	51	61	70	94	155	290	1,055	1,993	247	93	354
1968	71	63	56	55	100	212	133	684	1,910	1,057	197	82	385
1969	49	45	64	76	97	319	882	1,039	1,482	2,162	1,110	173	625
1970	65	51	59	84	94	318	781	1,322	1,686	1,323	515	231	544
1971	139	92	96	98	141	367	1,469	1,319	1,997	1,555	585	186	670
1972	106	98	73	81	107	263	624	1,038	1,513	2,462	1,184	253	650
1973	103	63	43	40	57	126	307	407	538	894	306	94	248
1974	55	68	91	86	146	262	180	815	1,780	1,056	438	203	432
1975	80	77	68	86	111	442	899	753	1,650	2,425	1,308	254	679
1976	112	97	111	154	205	200	242	1,146	1,738	2,672	2,286	757	810
1977	142	89	87	110	167	176	121	339	2,783	1,895	272	109	524
1978	93	78	73	89	112	192	1,232	2,168	2,633	5,578	1,862	213	1,194
1979	117	102	101	94	192	849	1,743	1,597	843	1,572	165	79	621
1980	69	67	58	62	81	455	1,184	922	2,121	3,700	2,726	477	993
1981	149	131	162	213	216	457	929	2,205	1,095	610	360	148	556
1982	78	78	72	87	92	153	151	252	2,968	3,173	1,133	214	704
1983	68	70	87	96	127	290	909	1,602	1,902	2,290	2,131	597	848
1984	142	79	80	101	206	415	536	952	2,328	1,567	895	224	627
1985	81	66	94	92	209	440	591	1,584	2,018	1,516	861	282	653
1986	81	80	72	60	250	474	398	1,008	1,810	834	387	107	464
1987	76	44	62	62	82	112	355	574	2,141	1,747	673	227	513
1988	84	70	60	81	180	1,302	700	606	446	1,024	938	292	482
1989	89	66	66	82	116	264	391	1,216	1,376	753	408	132	413
1990	70	65	117	89	115	325	615	1,411	2,225	2,293	1,557	481	780
1991	154	124	117	104	120	155	220	519	2,415	3,062	1,551	199	728
1992	124	94	65	101	101	311	370	1,208	1,994	1,027	315	116	485
1993	83	74	77	77	73	151	387	403	919	482	141	70	245
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	86	60	58	68	139	274	373	326	1,356	2,714	2,321	1,009	732
1997	124	95	72	128	157	228	917	1,474	1,070	977	337	149	477
1998	68	46	51	53	66	176	304	295	666	414	211	130	207
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**88**	**68**	**68**	**78**	**132**	**355**	**608**	**990**	**1,715**	**1,954**	**984**	**257**	**608**
Max	**154**	**131**	**162**	**213**	**458**	**1,302**	**1,743**	**2,205**	**3,477**	**5,578**	**2,726**	**1,009**	**1,194**
Min	**32**	**19**	**15**	**11**	**29**	**94**	**121**	**252**	**446**	**414**	**141**	**68**	**207**

Source: MRC HYMOS Database

Table 6.4 Monthly Mean Discharge at Yasothon in Nam Mun-Chi River

(Unit: m³/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	20	7	9	12	133	266	464	489	1,300	1,450	874	123	429
1962	23	9	7	12	174	241	779	627	1,200	1,920	1,100	133	519
1963	28	13	11	12	39	148	389	845	735	943	962	498	385
1964	44	17	10	13	164	277	141	166	1,490	1,370	1,250	559	458
1965	40	19	15	19	117	460	559	333	828	569	131	17	259
1966	7	4	6	33	637	734	367	742	1,370	964	228	109	433
1967	52	37	42	55	70	85	116	133	811	862	162	67	208
1968	47	49	51	59	93	171	80	195	804	440	102	75	180
1969	43	65	77	88	90	255	702	627	886	937	776	111	388
1970	54	43	84	64	105	152	116	187	549	583	215	69	185
1971	61	52	57	63	133	112	395	432	337	483	234	82	203
1972	57	56	31	52	78	68	116	82	94	188	151	30	84
1973	17	14	11	15	12	63	54	53	235	298	46	23	70
1974	26	59	63	61	113	144	84	103	109	150	99	35	87
1975	21	27	24	49	61	92	170	118	421	592	538	107	185
1976	53	50	57	124	139	150	158	233	384	528	716	469	255
1977	114	80	109	131	201	201	64	143	582	427	86	62	183
1978	61	60	49	59	84	90	452	680	961	1,380	559	150	382
1979	93	78	75	77	112	440	334	480	461	460	43	50	225
1980	18	8	15	18	60	636	639	440	936	1,340	1,230	205	462
1981	119	132	178	257	258	409	1,130	1,040	620	410	234	66	404
1982	58	67	60	74	122	180	85	117	952	1,300	877	200	341
1983	50	106	85	108	135	608	873	1,040	984	750	486	217	454
1984	84	71	63	136	190	190	260	674	671	674	455	255	310
1985	49	66	83	86	122	271	258	788	446	452	381	132	261
1986	41	55	51	43	244	437	321	606	724	272	142	28	247
1987	30	46	52	63	70	139	142	518	758	664	471	119	256
1988	37	52	56	90	223	567	424	352	276	569	479	176	275
1989	57	50	61	70	117	227	292	687	746	606	395	97	284
1990	39	78	111	66	89	254	364	733	982	871	736	370	391
1991	115	104	112	81	113	138	207	1,000	1,280	1,060	874	140	435
1992	98	76	116	110	113	226	475	842	928	566	199	51	317
1993	56	47	48	70	66	105	140	141	501	446	70	20	143
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	56	58	62	74	171	300	273	232	1,200	1,180	748	655	417
1997	398	172	153	141	141	153	462	584	719	296	169	65	288
1998	102	167	168	149	151	153	318	416	519	252	126	132	221
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**63**	**58**	**63**	**73**	**137**	**254**	**339**	**469**	**744**	**729**	**454**	**158**	**295**
Max	**398**	**172**	**178**	**257**	**637**	**734**	**1,130**	**1,040**	**1,490**	**1,920**	**1,250**	**655**	**519**
Min	**7**	**4**	**6**	**12**	**12**	**63**	**54**	**53**	**94**	**150**	**43**	**17**	**70**

Source: MRC HYMOS Database

Table 6.5 Monthly Mean Discharge at Rasi Salai in Nam Mun-Chi River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	-	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-	-	-	-	-	-	-
1967	-	-	-	-	-	-	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	3	15	224	580	258	139	546	38	9	201
1980	5	2	2	1	3	72	284	146	478	1,322	910	220	287
1981	24	8	5	3	9	45	315	797	290	123	81	54	146
1982	12	5	2	4	2	6	6	61	1,792	1,160	291	57	283
1983	11	5	2	1	4	28	100	704	616	1,182	1,464	325	370
1984	35	11	5	4	11	166	153	81	645	487	256	44	158
1985	12	5	2	2	33	98	125	434	543	661	345	132	199
1986	21	6	3	4	39	24	17	261	584	243	148	39	116
1987	12	5	3	2	2	7	9	6	474	538	184	100	112
1988	20	6	3	1	8	266	140	77	39	157	282	122	93
1989	19	5	3	1	2	10	75	198	352	129	89	30	76
1990	9	2	3	1	5	10	39	378	603	690	579	192	209
1991	23	7	3	1	1	5	9	26	425	1,105	517	32	179
1992	10	5	2	1	1	12	27	201	451	282	88	29	92
1993	6	2	2	2	5	26	162	167	233	143	31	3	65
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	4	2	1	2	14	74	112	37	301	933	1,155	470	259
1997	7	8	5	17	34	12	359	537	265	433	138	6	152
1998	1	1	1	2	29	24	33	34	130	172	81	80	49
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**14**	**5**	**3**	**3**	**12**	**62**	**141**	**245**	**464**	**573**	**371**	**108**	**169**
Max	**35**	**11**	**5**	**17**	**39**	**266**	**580**	**797**	**1,792**	**1,322**	**1,464**	**470**	**370**
Min	**1**	**1**	**1**	**1**	**1**	**5**	**6**	**6**	**39**	**123**	**31**	**3**	**49**

Source: MRC HYMOS Database

Table 6.6 Monthly Mean Discharge at Kaeng Saphu in Nam Mun-Chi River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	-	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-	-	-	-	-	-	-
1967	-	-	-	-	-	-	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	153	187	637	1,010	688	744	522	130	98	463
1980	74	85	64	88	107	218	1,260	956	1,590	3,770	1,420	259	824
1981	179	169	236	258	281	339	889	1,800	723	645	365	176	505
1982	154	154	154	160	181	246	189	255	884	2,200	655	214	454
1983	135	124	165	170	212	229	889	895	1,610	2,040	1,340	369	682
1984	187	135	126	126	243	434	496	456	1,760	1,420	671	168	519
1985	113	108	121	134	196	366	660	702	1,840	1,240	640	176	525
1986	96	98	95	91	121	287	378	828	1,660	578	324	117	389
1987	89	70	73	78	100	98	395	215	1,470	1,130	487	165	364
1988	90	82	73	77	73	419	633	498	437	755	582	169	324
1989	108	104	94	93	86	244	351	836	1,300	673	282	119	357
1990	97	96	139	124	114	263	810	1,490	2,160	2,190	1,300	284	756
1991	169	127	129	121	139	173	274	508	1,920	2,950	431	176	593
1992	162	141	112	133	121	187	313	987	2,310	583	225	143	451
1993	92	98	98	96	87	182	381	480	613	334	129	69	222
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	99	102	96	106	122	134	280	208	294	2,080	2,000	352	489
1997	80	78	78	85	102	96	288	940	732	672	276	212	303
1998	59	60	63	65	66	180	116	119	334	210	92	70	119
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**117**	**108**	**113**	**120**	**141**	**263**	**534**	**715**	**1,243**	**1,333**	**630**	**185**	**463**
Max	**187**	**169**	**236**	**258**	**281**	**637**	**1,260**	**1,800**	**2,310**	**3,770**	**2,000**	**369**	**824**
Min	**59**	**60**	**63**	**65**	**66**	**96**	**116**	**119**	**294**	**210**	**92**	**69**	**119**

Source: MRC HYMOS Database

Table 6.7 Comparison of Monthly Mean Discharges in Dry Season at Hydrologic Stations in Nam Mun-Chi River

Month: February

(Unit: m3/s)

Year	Yasothon (Chi)	Rasisalai (Mun)	Ubon	Kaeng Saphu
1960				
1961	6		22	
1962	8		28	
1963	11		28	
1964	13		33	
1965	17		37	
1966	3		19	
1967	36		57	
1968	46		63	
1969	40		45	
1970	37		51	
1971	46		92	
1972	47		98	
1973	12		63	
1974	34		68	
1975	14		77	
1976	48		97	
1977	77		89	
1978	50		78	
1979	68		102	
1980	4	2.5	67	98
1981	120	8.0	131	200
1982	59	4.7	78	179
1983	63	5.2	70	152
1984	54	10.8	79	174
1985	41	4.5	66	116
1986	49	6.2	80	112
1987	18	4.9	44	83
1988	39	5.5	70	91
1989	38	4.9	66	123
1990	48	1.6	65	108
1991	82	6.7	124	149
1992	60	5.0	94	155
1993	39	2.2	74	104
1994				
1995				
1996	52	2.0	60	116
1997	125	8.0	95	81
1998	144	1.2	46	63
1999				
2000				

Month: March

(Unit: m3/s)

Year	Yasothon (Chi)	Rasisalai (Mun)	Ubon	Kaeng Saphu
1960				
1961	4		15	
1962	6		25	
1963	9		22	
1964	9		21	
1965	11		25	
1966	4		15	
1967	38		51	
1968	44		56	
1969	63		64	
1970	63		59	
1971	49		96	
1972	27		73	
1973	9		43	
1974	52		91	
1975	18		68	
1976	49		111	
1977	87		87	
1978	40		73	
1979	64		101	
1980	9	1.6	58	79
1981	158	5.0	162	260
1982	53	2.0	72	165
1983	73	2.3	87	180
1984	52	5.2	80	140
1985	61	2.1	94	139
1986	43	2.6	72	105
1987	44	3.1	62	96
1988	42	2.8	60	82
1989	39	2.7	66	110
1990	88	2.7	117	171
1991	87	3.2	117	141
1992	55	2.1	65	136
1993	40	1.6	77	110
1994				
1995				
1996	53	1.1	58	115
1997	104	5.1	72	99
1998	157	1.3	51	66
1999				
2000				

Month: April

(Unit: m3/s)

Year	Yasothon (Chi)	Rasisalai (Mun)	Ubon	Kaeng Saphu
1960				
1961	6		11	
1962	5		17	
1963	8		17	
1964	10		18	
1965	11		26	
1966	29		35	
1967	51		61	
1968	51		55	
1969	72		76	
1970	32		84	
1971	57		98	
1972	37		81	
1973	7		40	
1974	44		86	
1975	31		86	
1976	105		154	
1977	115		110	
1978	48		89	
1979	62	2.8	94	170
1980	10	1.3	62	109
1981	222	3.1	213	338
1982	61	3.9	87	196
1983	96	0.6	96	203
1984	88	3.8	101	168
1985	69	2.0	92	155
1986	33	3.7	60	106
1987	45	1.7	62	96
1988	62	1.3	81	108
1989	47	1.2	82	128
1990	57	0.8	89	136
1991	71	1.2	104	126
1992	76	0.8	101	148
1993	52	2.2	77	125
1994				
1995				
1996	62	2.0	68	126
1997	124	17.0	128	133
1998	148	1.8	53	67
1999				
2000				

Table 6.12 Monthly Operation Record of Lam Takhong Dam (1/2)

Reservoir Inflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1963	3.0	2.0	3.0	3.0	3.0	4.0	17.0	30.0	57.0	87.0	25.0	10.0	20.3
1964	7.0	4.0	3.0	3.0	53.0	19.0	25.0	23.0	50.0	112.0	23.0	9.0	27.6
1965	6.0	6.0	6.0	4.0	9.0	22.0	31.0	64.0	81.0	69.0	20.0	10.0	27.3
1966	6.0	5.0	4.0	5.0	26.0	14.0	22.0	49.0	34.0	19.0	10.0	6.0	16.7
1967	4.0	4.0	4.0	5.0	15.0	15.0	16.0	22.0	22.0	49.0	7.0	4.0	13.9
1968	3.0	2.0	3.0	4.0	24.0	8.0	11.0	12.0	16.0	18.0	5.0	2.0	9.0
1969	4.0	2.0	4.0	2.0	1.0	19.0	38.0	33.0	110.0	38.0	15.0	8.0	22.8
1970	7.0	6.0	8.0	8.0	7.0	14.0	22.0	17.0	36.0	40.0	9.0	9.0	15.3
1971	5.0	5.0	4.0	6.0	14.0	11.0	23.0	15.0	28.0	18.0	6.0	6.0	11.8
1972	2.0	7.0	6.0	5.0	0.0	6.0	17.0	24.0	192.0	168.0	33.0	15.0	39.6
1973	13.0	13.0	9.0	12.0	16.0	11.0	12.0	19.0	70.0	47.0	6.0	6.0	19.5
1974	5.0	10.0	16.0	15.0	18.0	18.0	19.0	22.0	32.0	75.0	46.0	13.0	24.1
1975	11.0	10.0	11.0	8.0	19.0	38.0	39.0	39.0	92.0	107.0	18.0	10.0	33.5
1976	10.0	12.0	8.0	13.0	20.0	24.0	30.0	59.0	82.0	99.0	43.0	15.0	34.6
1977	6.0	6.0	10.0	10.0	16.0	11.0	28.0	22.0	35.0	20.0	7.0	7.0	14.8
1978	4.0	5.0	6.0	14.0	10.0	19.0	35.0	36.0	39.0	57.0	8.0	4.0	19.8
1979	5.0	3.0	2.0	7.0	10.0	9.0	24.0	29.0	61.0	53.0	7.0	6.0	18.0
1980	4.0	4.0	3.0	5.9	5.5	24.8	19.6	18.1	41.9	84.8	17.4	5.7	19.6
1981	4.4	3.8	2.0	11.0	16.1	22.6	27.5	31.8	43.6	33.8	27.2	4.6	19.0
1982	0.0	3.0	5.3	4.4	6.4	8.8	21.7	28.7	70.2	38.9	11.4	4.8	17.0
1983	4.2	2.3	0.6	1.6	4.5	7.5	12.9	46.5	58.9	231.4	40.0	16.0	35.5
1984	10.4	14.2	7.2	11.7	8.2	8.4	24.5	32.1	41.5	83.6	15.8	7.5	22.1
1985	8.5	4.2	1.5	9.2	26.7	30.8	32.3	31.2	45.8	51.0	16.7	6.6	22.0
1986	5.9	2.0	4.4	11.1	24.3	10.2	15.0	14.6	29.9	77.9	11.0	5.6	17.7
1987	1.8	3.7	1.8	7.9	12.8	10.7	8.9	12.2	73.9	44.8	17.0	5.1	16.7
1988	5.8	7.1	2.9	5.5	22.6	16.6	14.3	29.7	87.4	105.8	15.6	9.7	26.9
1989	7.5	4.9	7.4	1.6	20.1	7.7	8.9	9.8	19.9	25.2	3.6	2.1	9.9
1990	3.9	1.7	4.8	3.0	11.1	9.3	10.5	12.0	18.2	167.5	27.7	8.1	23.2
1991	5.9	6.2	4.0	3.0	8.1	17.8	19.6	46.5	37.7	60.8	5.9	2.7	18.2
1992	4.3	0.0	0.0	0.0	0.0	0.5	3.9	16.8	8.0	27.3	5.7	0.9	5.6
1993	0.2	0.0	2.7	2.3	2.3	3.2	2.2	17.7	57.0	30.8	6.6	2.1	10.6
1994	1.9	1.4	4.4	3.1	13.6	38.2	42.7	46.1	36.9	28.0	3.2	1.9	18.5
1995	2.8	1.5	4.6	3.6	7.9	5.1	11.8	37.3	102.4	54.2	11.2	6.5	20.7
1996	2.4	1.7	7.1	8.3	40.9	25.8	17.3	26.4	117.8	139.5	62.1	9.5	38.2
1997	9.3	4.7	9.2	10.5	13.8	7.4	4.5	14.3	4.1	30.7	4.4	2.2	9.6
1998	1.3	0.3	2.7	5.8	11.9	4.4	9.9	13.4	39.3	43.1	8.3	4.1	12.0
1999	2.5	0.1	1.0	10.8	45.0	27.4	20.9	23.6	62.5	93.3	38.0	5.1	27.5
2000	7.0	8.7	5.5	21.1	36.1	25.9	30.5	60.7	88.3	122.2	17.2	7.1	35.9
2001	7.8	2.4	11.2	3.7	21.0	13.7	23.6	36.1	20.2	24.3	7.8	2.5	14.5
Mean	**5.2**	**4.6**	**5.1**	**6.9**	**15.9**	**15.1**	**20.3**	**28.7**	**54.9**	**68.6**	**17.0**	**6.7**	**20.8**
Max	**13.0**	**14.2**	**16.0**	**21.1**	**53.0**	**38.2**	**42.7**	**64.0**	**192.0**	**231.4**	**62.1**	**16.0**	**39.6**
Min	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.5**	**2.2**	**9.8**	**4.1**	**18.0**	**3.2**	**0.9**	**5.6**

Source: Royal Irrigation Dept. (RID)

Table 6.12 Monthly Operation Record of Lam Takhong Dam (2/2)

Reservoir Outflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1963	3.0	2.0	3.0	3.0	3.0	4.0	17.0	30.0	57.0	87.0	25.0	10.0	20.3
1964	7.0	4.0	3.0	3.0	53.0	19.0	25.0	23.0	50.0	112.0	23.0	9.0	27.6
1965	6.0	6.0	6.0	4.0	9.0	22.0	31.0	64.0	81.0	69.0	20.0	10.0	27.3
1966	6.0	5.0	4.0	5.0	26.0	14.0	22.0	49.0	34.0	19.0	10.0	6.0	16.7
1967	4.0	4.0	4.0	5.0	15.0	15.0	16.0	22.0	22.0	49.0	7.0	4.0	13.9
1968	3.0	2.0	3.0	4.0	24.0	8.0	11.0	3.0	6.0	4.0	11.0	4.0	6.9
1969	3.0	3.0	5.0	5.0	5.0	5.0	18.0	30.0	9.0	13.0	14.0	7.0	9.8
1970	4.0	11.0	11.0	7.0	12.0	18.0	32.0	17.0	10.0	8.0	9.0	3.0	11.8
1971	6.0	9.0	8.0	8.0	7.0	24.0	25.0	25.0	15.0	25.0	18.0	4.0	14.5
1972	8.0	5.0	5.0	5.0	14.0	17.0	21.0	19.0	6.0	95.0	29.0	7.0	19.3
1973	14.0	19.0	21.0	23.0	32.0	35.0	30.0	24.0	23.0	11.0	13.0	7.0	21.0
1974	8.0	11.0	11.0	7.0	19.0	32.0	36.0	29.0	24.0	19.0	12.0	5.0	17.8
1975	10.0	12.0	10.0	13.0	16.0	32.0	38.0	52.0	41.0	89.0	29.0	8.0	29.2
1976	13.0	12.0	14.0	10.0	27.0	46.0	46.0	42.0	44.0	41.0	30.0	11.0	28.0
1977	15.0	14.0	16.0	16.0	21.0	47.0	51.0	47.0	31.0	27.0	26.0	6.0	26.4
1978	12.0	17.0	28.0	48.0	7.0	15.0	27.0	43.0	18.0	15.0	25.0	5.0	21.7
1979	7.0	6.0	7.0	6.0	4.0	6.0	34.0	35.0	16.0	25.0	25.0	6.0	14.8
1980	5.0	12.0	8.0	7.7	6.8	8.6	31.7	26.8	16.2	1.9	18.5	5.7	12.4
1981	8.5	10.7	10.7	8.3	5.3	23.0	34.7	35.1	42.8	26.4	20.6	6.9	19.4
1982	5.3	17.1	6.8	10.0	8.0	23.6	36.8	32.1	11.6	19.4	20.6	6.6	16.5
1983	13.2	12.6	10.7	10.4	16.2	21.1	27.1	14.0	15.7	49.7	37.7	10.7	19.9
1984	13.5	20.9	11.6	9.7	18.7	25.1	29.8	64.4	44.3	18.8	38.9	18.7	26.2
1985	24.4	10.4	10.7	11.5	8.7	21.6	43.5	43.6	21.2	21.6	22.0	10.7	20.8
1986	11.1	24.0	16.1	15.6	16.9	32.0	40.3	24.1	25.9	17.4	25.9	13.8	21.9
1987	12.1	22.5	15.6	10.8	14.9	25.6	37.3	20.7	10.8	11.0	17.5	9.3	17.3
1988	12.3	13.3	12.2	13.0	7.9	28.4	34.6	32.1	13.0	7.3	18.1	11.3	17.0
1989	12.6	17.0	13.8	12.5	16.2	28.3	29.4	36.5	23.5	18.0	23.2	8.6	20.0
1990	11.6	11.4	10.8	13.1	10.8	20.9	25.4	14.0	16.4	2.6	14.6	8.1	13.3
1991	13.9	19.4	12.1	15.6	12.8	14.5	33.9	32.0	23.7	9.8	20.5	9.8	18.2
1992	10.2	20.7	11.8	14.4	13.1	16.1	32.7	23.5	20.3	7.8	12.3	5.5	15.7
1993	5.1	5.4	5.4	5.2	5.4	5.2	5.4	6.1	4.3	6.9	18.7	10.0	6.9
1994	10.5	11.6	6.1	9.7	7.0	8.5	24.4	37.4	17.6	23.2	35.4	7.3	16.6
1995	10.5	9.6	8.9	8.3	7.3	8.8	11.8	9.5	4.8	4.8	15.0	4.9	8.7
1996	12.9	11.8	12.3	11.9	7.4	13.0	19.9	21.3	41.1	127.9	62.1	10.7	29.4
1997	1.5	23.0	21.4	24.0	26.8	32.8	30.6	26.8	18.3	12.1	23.3	9.9	20.9
1998	18.9	12.4	9.9	12.6	9.9	19.5	26.8	22.0	9.7	3.7	16.5	5.4	13.9
1999	9.0	7.0	11.4	5.5	3.9	12.8	16.1	23.9	13.7	9.8	5.7	5.4	10.4
2000	17.1	13.7	15.2	11.6	23.0	36.4	51.8	21.9	39.6	71.7	29.1	16.2	28.9
2001	21.3	18.0	13.8	18.1	14.0	18.1	28.9	24.4	25.1	19.5	7.3	5.4	17.8
Mean	**10.0**	**12.0**	**10.6**	**11.1**	**14.2**	**20.6**	**29.0**	**29.4**	**24.3**	**30.8**	**21.3**	**8.0**	**18.4**
Max	**24.4**	**24.0**	**28.0**	**48.0**	**53.0**	**47.0**	**51.8**	**64.4**	**81.0**	**127.9**	**62.1**	**18.7**	**29.4**
Min	**1.5**	**2.0**	**3.0**	**3.0**	**3.0**	**4.0**	**5.4**	**3.0**	**4.3**	**1.9**	**5.7**	**3.0**	**6.9**

Source: Royal Irrigation Dept. (RID)

Table 6.13 Monthly Operation Record of Lam Phra Ploeng Dam (1/2)

Reservoir Inflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1955						24.0	10.0	8.0	20.0	21.0	14.0	2.0	14.1
1956	1.0	1.0	1.0	1.0	3.0	2.0	9.0	11.0	24.0	47.0	4.0	1.0	8.8
1957	0.3	0.1	1.0	2.0	0.1	1.0	2.0	8.0	31.0	122.0	5.0	1.0	14.5
1958	0.2	0.1	0.0	0.0	1.4	8.0	5.0	6.0	36.0	23.0	2.0	0.5	6.9
1959	0.1	0.0	0.0	0.1	0.5	0.6	2.0	2.0	87.0	86.0	2.0	1.0	15.1
1960	0.2	0.0	0.1	0.1	0.1	0.1	0.8	0.3	11.0	124.0	2.0	1.0	11.6
1961	0.2	0.0	0.0	1.0	8.2	2.0	3.0	4.0	6.0	12.0	1.0	0.1	3.1
1962	0.0	0.0	0.0	1.0	3.0	1.0	6.0	6.0	45.0	56.0	2.0	0.4	10.0
1963	0.0	0.0	0.0	1.0	0.0	0.0	4.0	13.0	35.0	51.0	15.0	1.0	10.0
1964	0.0	0.0	0.0										
1965													
1966													
1967													
1968													
1969								4.0	96.0	29.0	8.0	2.0	27.8
1970	0.1	0.3	0.0	5.0	0.0	0.0	0.0	2.0	11.0	9.0	3.0	3.0	2.8
1971	0.0	1.0	2.0	4.0	13.0	12.0	14.0	1.0	42.0	14.0	1.0	1.0	8.8
1972	0.0	1.0	0.0	2.0	0.0	0.0	0.0	0.0	112.0	89.0	20.0	4.0	19.0
1973	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	42.0	37.0	0.0	0.0	6.9
1974	0.0	0.0	1.0	0.0	2.0	1.0	0.0	1.0	12.0	75.0	45.0	3.0	11.7
1975	1.0	0.0	0.0	0.0	1.0	5.0	22.0	0.0	48.0	76.0	6.0	0.0	13.3
1976	0.5	0.0	2.0	1.0	0.0	0.0	4.0	37.0	66.0	79.0	22.0	5.0	18.0
1977	5.0	5.0	0.0	4.0	14.0	3.0	4.0	7.0	38.0	12.0	0.0	2.0	7.8
1978	0.9	0.0	0.0	2.4	20.0	8.7	78.6	18.4	51.3	45.2	0.0	0.0	18.8
1979	2.1	0.0	0.0	4.6	7.6	6.8	7.0	0.0	48.2	16.1	0.0	0.0	7.7
1980	0.5	0.0	0.2	6.4	9.3	20.1	0.0	2.8	57.3	93.8	7.2	1.8	16.6
1981	0.0	0.0	0.0	10.6	3.8	0.7	0.1	0.0	12.0	23.3	5.7	2.8	4.9
1982	0.4	1.0	7.8	3.5	12.0	1.2	0.0	0.0	65.8	43.9	3.4	5.0	12.0
1983	2.0	0.0	0.0	0.0	8.4	7.8	1.6	93.2	95.3	188.8	19.7	2.1	34.9
1984	1.8	2.2	0.0	4.0	6.4	3.5	2.7	1.7	4.6	103.2	2.0	2.1	11.2
1985	3.1	0.0	0.0	10.4	56.5	12.6	22.9	5.5	49.5	33.8	6.6	4.9	17.2
1986	1.8	0.0	0.0	10.1	42.8	7.8	0.2	1.3	41.2	114.0	4.3	2.0	18.8
1987	1.4	0.0	0.0	1.9	11.9	2.0	0.0	0.0	102.9	26.3	10.3	1.5	13.2
1988	1.4	0.8	0.0	0.0	10.9	5.9	8.9	0.0	56.1	90.1	2.9	0.5	14.8
1989	0.6	0.0	0.0	0.0	6.4	13.5	10.2	11.5	30.7	22.6	0.9	0.7	8.1
1990	0.0	0.0	4.1	7.8	13.2	8.7	0.0	0.0	29.4	179.0	14.3	0.0	21.4
1991	1.2	0.0	0.0	0.0	19.7	18.1	8.1	19.3	67.9	68.5	0.7	1.3	17.1
1992	1.2	0.0	0.0	0.0	5.2	4.9	13.7	39.2	10.0	59.2	10.0	0.2	12.0
1993	0.9	0.0	1.3	11.4	4.3	6.0	0.0	0.0	73.6	46.5	0.0	0.0	12.0
1994	0.0	0.0	1.8	2.5	36.5	21.5	30.2	14.0	22.2	12.6	0.0	0.0	11.8
1995	0.0	0.0	0.0	2.3	8.0	6.2	10.9	22.5	85.7	30.3	4.0	1.1	14.3
1996	0.7	2.8	3.2	6.1	25.3	13.1	10.1	14.7	97.0	84.7	6.9	2.1	22.2
1997	1.1	1.7	2.8	7.1	7.8	2.9	2.4	12.9	38.3	18.1	1.5	0.9	8.1
1998	0.5	0.7	1.4	1.9	12.9	1.6	3.1	20.8	25.2	23.2	3.0	1.4	8.0
1999	1.0	0.9	2.2	11.1	65.6	15.5	6.8	17.9	58.7	81.4	32.3	2.1	24.6
2000	1.6	3.4	1.9	32.3	33.0	23.2	18.7	40.5	60.0	79.5	8.0	1.6	25.3
2001	1.2	4.5	11.2	3.6	7.2	3.0	2.0	8.2	17.2	20.0	6.7	0.8	7.1
Mean	**0.8**	**0.6**	**1.1**	**4.1**	**12.1**	**6.7**	**7.9**	**10.8**	**46.7**	**58.7**	**7.2**	**1.5**	**13.6**
Max	**5.0**	**5.0**	**11.2**	**32.3**	**65.6**	**24.0**	**78.6**	**93.2**	**112.0**	**188.8**	**45.0**	**5.0**	**34.9**
Min	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**4.6**	**9.0**	**0.0**	**0.0**	**2.8**

Source: Royal Irrigation Dept. (RID)

Table 6.13 Monthly Operation Record of Lam Phra Ploeng Dam (2/2)

Reservoir Outflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1955						24.0	10.0	8.0	20.0	21.0	14.0	2.0	14.1
1956	1.0	1.0	1.0	1.0	3.0	2.0	9.0	11.0	24.0	47.0	4.0	1.0	8.8
1957	0.3	0.1	1.0	2.0	0.1	1.0	2.0	8.0	31.0	122.0	5.0	1.0	14.5
1958	0.2	0.1	0.0	0.0	1.4	8.0	5.0	6.0	36.0	23.0	2.0	0.5	6.9
1959	0.1	0.0	0.0	0.1	0.5	0.6	2.0	2.0	87.0	86.0	2.0	1.0	15.1
1960	0.2	0.0	0.1	0.1	0.1	0.1	0.8	0.3	11.0	124.0	2.0	1.0	11.6
1961	0.2	0.0	0.0	1.0	8.2	2.0	3.0	4.0	6.0	12.0	1.0	0.1	3.1
1962	0.0	0.0	0.0	1.0	3.0	1.0	6.0	6.0	45.0	56.0	2.0	0.4	10.0
1963	0.0	0.0	0.0	1.0	0.0	0.0	4.0	13.0	35.0	51.0	15.0	1.0	10.0
1964	0.3	0.0	0.0	0.1	23.0	1.0	14.0	2.0	32.0	73.0	5.0	2.0	
1965	2.0	0.2	0.0										
1966													
1967													
1968													
1969								2.0	4.0	15.0	11.0	0.1	6.4
1970	0.0	1.0	0.2	3.0	3.0	5.0	18.0	12.0	11.0	7.0	4.0	1.0	5.4
1971	0.1	0.0	2.0	3.0	3.0	6.0	8.0	18.0	10.0	14.0	14.0	1.0	6.6
1972	1.0	1.0	1.0	1.0	9.0	8.0	14.0	17.0	3.0	67.0	19.0	5.0	12.2
1973	1.0	5.0	6.0	6.0	9.0	7.0	15.0	20.0	15.0	8.0	12.0	2.0	8.8
1974	1.0	4.0	7.0	6.0	10.0	11.0	18.0	17.0	12.0	3.0	3.0	1.0	7.8
1975	2.0	5.0	7.0	6.0	6.0	6.0	12.0	24.0	16.0	39.0	12.0	1.0	11.3
1976	1.0	6.0	7.0	8.0	9.0	17.0	12.0	22.0	20.0	61.0	28.0	4.0	16.3
1977	4.0	10.0	10.0	12.0	12.0	16.0	19.0	28.0	21.0	19.0	21.0	3.0	14.6
1978	0.3	3.0	2.0	2.0	1.0	1.1	12.8	32.6	29.8	44.8	25.8	1.0	13.0
1979	1.6	7.0	10.8	10.5	9.2	2.9	13.4	30.9	13.2	14.8	18.2	1.8	11.2
1980	0.8	0.9	1.9	1.9	1.1	4.4	21.6	19.6	3.2	7.6	8.4	0.6	6.0
1981	2.3	9.9	11.8	12.1	12.1	9.9	9.8	22.9	24.1	13.2	12.3	0.3	11.7
1982	0.7	0.4	3.1	2.8	0.9	1.2	19.3	19.0	6.5	9.8	16.4	0.8	6.7
1983	0.5	6.4	10.4	12.8	9.4	2.9	14.1	15.9	70.4	196.7	22.0	1.7	30.3
1984	0.7	10.6	14.2	13.5	11.0	6.6	13.2	23.3	21.0	18.4	22.0	3.6	13.2
1985	0.9	7.9	15.8	10.2	14.4	18.3	21.0	29.2	21.3	23.6	17.3	1.7	15.1
1986	0.5	6.6	9.8	8.8	14.4	20.0	21.4	16.3	19.4	58.8	18.8	7.0	16.8
1987	0.4	3.5	16.7	13.0	12.5	12.2	12.5	19.8	16.4	14.1	11.6	1.0	11.1
1988	0.5	7.8	15.4	14.4	8.2	10.2	13.4	18.4	14.1	38.0	17.8	3.0	13.4
1989	0.8	12.4	18.2	18.6	13.5	6.3	6.2	18.1	17.7	11.9	15.6	3.4	11.9
1990	1.0	3.9	1.9	5.3	0.7	4.7	17.2	20.1	7.6	86.9	15.6	3.0	14.0
1991	2.3	15.6	18.8	16.0	18.1	1.0	14.9	20.4	28.0	45.0	18.8	0.6	16.6
1992	3.6	15.8	22.2	21.9	19.3	2.7	0.3	14.1	22.9	19.8	18.8	7.7	14.1
1993	0.2	3.1	2.9	2.3	3.0	6.2	19.7	21.9	18.6	19.1	19.9	4.3	10.1
1994	1.7	3.4	1.6	3.4	2.8	9.8	32.0	20.4	19.7	18.0	22.7	6.6	11.8
1995	0.4	3.9	3.3	2.6	7.3	6.4	17.5	17.4	18.2	12.9	13.0	0.2	8.6
1996	2.0	5.5	9.7	5.3	6.6	20.0	22.6	23.2	37.9	93.2	7.6	1.0	19.6
1997	0.0	5.5	13.1	10.6	11.2	8.0	12.9	36.2	19.7	12.4	17.3	0.9	12.3
1998	2.6	2.9	1.9	1.5	1.6	0.7	9.5	17.6	21.4	12.4	14.2	0.5	7.2
1999	2.9	0.5	3.4	0.9	1.0	12.4	22.2	27.2	25.5	68.5	38.1	1.2	17.0
2000	0.7	8.6	13.6	15.6	23.0	21.5	24.5	31.5	52.8	82.0	21.4	1.0	24.7
2001	0.1	15.6	10.4	19.9	16.8	3.0	7.0	20.0	21.1	12.7	5.6	1.5	11.1
Mean	**1.0**	**4.6**	**6.6**	**6.8**	**7.8**	**7.3**	**13.1**	**17.6**	**23.0**	**41.5**	**13.8**	**1.9**	**12.2**
Max	**4.0**	**15.8**	**22.2**	**21.9**	**23.0**	**24.0**	**32.0**	**36.2**	**87.0**	**196.7**	**38.1**	**7.7**	**30.3**
Min	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.3**	**3.0**	**3.0**	**1.0**	**0.1**	**3.1**

Source: Royal Irrigation Dept. (RID)

Table 6.14 Monthly Operation Record of Lam Pao Dam

Reservoir Inflow

(Unit: m3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1970				15.0	21.0	654.0	310.0	782.0	1,120.0	380.0	31.0	2.0	368.3
1971	0.0	0.0	0.0	2.0	35.0	73.0	736.0	607.0	475.0	390.0	44.0	7.0	197.4
1972	0.0	6.0	0.0	19.0	5.0	102.0	208.0	279.0	79.0	94.0	20.0	1.0	67.8
1973	0.0	1.0	0.0	0.0	34.0	108.0	317.0	470.0	291.0	247.0	13.0	14.0	124.6
1974	0.0	11.0	0.0	2.0	30.0	69.0	62.0	897.0	705.0	256.0	80.0	5.0	176.4
1975	13.0	0.0	13.0	6.0	18.0	321.0	539.0	556.0	636.0	684.0	72.0	33.0	240.9
1976	6.0	7.0	0.0	2.0	38.0	48.0	109.0	211.0	326.0	150.0	55.0	20.0	81.0
1977	1.0	0.0	0.0	6.0	50.0	12.0	100.0	133.0	670.0	84.0	0.0	13.0	89.1
1978	0.0	17.0	2.0	8.0	32.0	123.0	392.0	1,233.0	1,192.0	509.0	149.0	53.0	309.2
1979	33.0	16.0	25.0	21.0	105.0	274.0	332.0	515.0	383.0	27.0	0.0	0.0	144.3
1980	21.0	47.0	45.0	43.0	91.0	429.0	345.0	302.0	1,207.0	248.0	54.0	18.0	237.5
1981	40.0	24.0	40.0	69.0	88.0	453.0	958.0	731.0	311.0	237.0	66.0	5.0	251.8
1982	0.0	56.0	18.0	47.0	50.0	82.0	71.0	120.0	670.0	475.0	122.0	28.0	144.9
1983	28.0	57.0	67.0	23.0	19.0	168.0	92.0	494.0	456.0	209.0	0.0	30.0	136.9
1984	30.0	0.0	0.0	19.0	44.0	38.0	218.0	582.0	553.0	376.0	77.0	20.0	163.1
1985	20.0	9.0	0.0	25.0	54.0	94.0	135.0	326.0	209.0	121.0	32.0	6.0	85.9
1986	6.0	0.0	0.0	21.0	153.0	415.0	259.0	423.0	541.0	58.0	22.0	7.0	158.8
1987	0.0	3.0	3.0	6.0	25.0	91.0	73.0	734.0	606.0	231.0	68.0	5.0	153.8
1988	0.0	0.0	0.0	0.0	205.0	372.0	184.0	203.0	145.0	160.0	16.0	16.0	108.4
1989	0.0	0.0	0.0	29.0	8.0	56.0	99.0	454.0	567.0	389.0	52.0	0.2	137.9
1990	0.0	0.0	0.0	0.0	6.0	307.0	412.0	1,005.0	906.0	352.0	102.0	26.0	259.7
1991	10.0	0.0	0.0	0.0	34.0	27.0	62.0	509.0	614.0	157.0	26.0	9.0	120.7
1992	0.0	0.0	28.0	0.0	11.0	231.0	262.0	752.0	429.0	117.0	0.0	7.0	153.1
1993	0.0	5.0	0.0	0.0	71.0	51.0	173.0	66.0	259.0	13.0	0.0	0.0	53.2
1994	0.0	11.0	13.0	0.0	35.0	97.0	109.0	294.0	844.0	204.0	23.0	4.0	136.2
1995	19.0	0.0	0.0	0.0	22.0	83.0	382.2	703.7	570.0	110.7	16.4	21.4	160.7
1996	13.8	5.1	17.9	11.5	49.3	143.2	145.0	154.6	897.9	309.6	213.4	44.1	167.1
1997	23.3	24.0	21.2	26.5	57.5	69.0	406.2	748.8	481.9	222.6	32.4	5.6	176.6
1998	10.6	24.0	11.6	22.4	25.4	54.0	109.6	115.1	452.9	52.6	18.9	6.9	75.3
1999	7.7	0.0	10.3	63.1	330.7	330.6	248.2	224.4	755.4	308.4	103.1	6.0	199.0
2000	15.2	20.4	15.4	54.4	216.3	280.0	859.1	484.9	683.8	210.0	49.5	29.7	243.2
2001	12.6	4.5	6.0	13.3	77.5	374.0	285.6	2,050.1	1,358.8	217.6	19.5	52.0	372.6
Mean	**10.0**	**11.2**	**10.9**	**17.3**	**63.8**	**188.4**	**281.0**	**536.2**	**606.1**	**237.5**	**49.3**	**15.5**	**171.7**
Max	**40.0**	**57.0**	**67.0**	**69.0**	**330.7**	**654.0**	**958.0**	**2,050.1**	**1,358.8**	**684.0**	**213.4**	**53.0**	**372.6**
Min	**0.0**	**0.0**	**0.0**	**0.0**	**5.0**	**12.0**	**62.0**	**66.0**	**79.0**	**13.0**	**0.0**	**0.0**	**53.2**

Source: Royal Irrigation Dept. (RID)

Reservoir Outflow

(Unit: m3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1970	0.0	0.0	105.0	147.0	48.0	82.0	214.0	433.0	1,049.0	670.0	217.0	194.0	263.3
1971	70.0	55.0	87.0	88.0	115.0	42.0	70.0	336.0	512.0	454.0	227.0	115.0	180.9
1972	58.0	65.0	73.0	78.0	105.0	56.0	91.0	139.0	113.0	120.0	113.0	8.0	84.9
1973	9.0	15.0	9.0	15.0	4.0	27.0	168.0	159.0	192.0	162.0	119.0	22.0	75.1
1974	50.0	85.0	69.0	44.0	114.0	84.0	88.0	88.0	587.0	385.0	238.0	46.0	156.5
1975	55.0	90.0	93.0	134.0	166.0	80.0	118.0	289.0	529.0	698.0	267.0	126.0	220.4
1976	67.0	75.0	131.0	116.0	147.0	142.0	91.0	86.0	30.0	47.0	7.0	27.0	80.5
1977	41.0	35.0	39.0	56.0	108.0	116.0	60.0	59.0	52.0	159.0	86.0	18.0	69.1
1978	47.0	58.0	63.0	62.0	95.0	161.0	125.0	477.0	1,005.0	821.0	286.0	181.0	281.8
1979	156.0	152.0	174.0	101.0	96.0	161.0	199.0	210.0	217.0	139.0	52.0	5.0	138.5
1980	128.0	156.0	97.0	120.0	109.0	103.0	180.0	250.0	668.0	513.0	159.0	99.0	215.2
1981	174.0	176.0	171.0	172.0	130.0	163.0	290.0	694.0	413.0	236.0	144.0	61.0	235.3
1982	109.0	144.0	172.0	170.0	156.0	97.0	88.0	85.0	24.0	219.0	241.0	97.0	133.5
1983	48.0	123.0	202.0	180.0	136.0	138.0	103.0	85.0	212.0	204.0	162.0	184.0	148.1
1984	114.0	32.0	37.0	67.0	152.0	69.0	30.0	110.0	290.0	299.0	164.0	68.0	119.3
1985	29.0	93.0	118.0	152.0	169.0	128.0	152.0	80.0	62.0	80.0	8.0	0.0	89.3
1986	49.0	100.0	93.0	51.0	19.0	152.0	261.0	269.0	330.0	194.0	14.0	14.0	128.8
1987	60.0	61.0	116.0	112.0	78.0	76.0	107.0	146.0	351.0	306.0	97.0	55.0	130.4
1988	68.0	73.0	108.0	108.0	130.0	210.0	279.0	290.0	158.0	104.0	7.0	24.0	129.9
1989	67.0	41.0	43.0	46.0	11.0	16.0	76.0	62.0	192.0	347.0	142.0	55.0	91.5
1990	81.0	93.0	148.0	104.0	0.0	10.0	221.0	424.0	968.0	350.0	104.0	80.0	215.3
1991	182.0	148.0	159.0	127.0	54.0	55.0	117.0	91.0	180.0	74.0	13.0	74.0	106.2
1992	96.0	95.0	141.0	133.0	48.0	59.0	271.0	272.0	280.0	165.0	38.0	65.0	138.6
1993	127.0	113.0	119.0	68.0	19.0	36.0	164.0	124.0	102.0	117.0	48.0	7.0	87.0
1994	6.0	9.0	8.0	7.0	8.0	11.0	116.0	126.0	81.0	226.0	61.0	49.0	59.0
1995	97.0	116.0	143.0	97.0	53.0	44.0	106.0	389.6	471.9	166.4	51.9	50.4	148.9
1996	133.4	140.5	131.8	80.3	14.3	52.0	296.3	147.0	107.1	174.5	152.3	168.4	133.2
1997	148.6	175.2	136.5	129.9	122.1	105.5	202.6	317.5	342.3	205.6	60.0	65.9	167.6
1998	135.3	118.6	126.2	73.0	31.3	89.2	180.8	116.5	107.4	19.4	34.6	11.3	87.0
1999	12.9	12.1	29.6	21.6	95.3	191.4	308.3	258.4	170.1	234.6	42.6	47.0	118.7
2000	108.0	164.8	207.6	160.0	120.1	66.0	430.8	590.7	434.3	143.7	99.2	113.0	219.8
2001	162.0	149.1	164.5	97.6	45.5	37.9	244.5	1,060.1	1,684.0	330.6	64.5	221.8	355.2
Mean	**84.0**	**92.6**	**109.8**	**97.4**	**84.3**	**89.4**	**170.3**	**258.2**	**372.3**	**261.4**	**110.0**	**73.5**	**150.3**
Max	**182.0**	**176.0**	**207.6**	**180.0**	**169.0**	**210.0**	**430.8**	**1,060.1**	**1,684.0**	**821.0**	**286.0**	**221.8**	**355.2**
Min	**0.0**	**0.0**	**8.0**	**7.0**	**0.0**	**10.0**	**30.0**	**59.0**	**24.0**	**19.4**	**7.0**	**0.0**	**59.0**

Source: Royal Irrigation Dept. (RID)

Table 6.15 Monthly Operation Record of Huai Luang Dam

Reservoir Inflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1978								137.9	117.4	44.8	3.4	1.1	60.9
1979	2.6	0.3	1.9	3.9	5.2	51.2	15.9	26.5	0.0	4.3	0.0	0.0	9.3
1980	0.5	1.7	0.9	1.9	7.9	50.2	54.7	22.9	131.5	11.7	3.5	0.0	24.0
1981	0.7	1.2	0.5	1.3	7.5	10.2	32.6	47.1	7.2	15.5	9.0	0.0	11.1
1982	0.3	0.4	0.9	0.8	2.5	0.9	6.9	11.7	62.5	40.5	5.9	0.2	11.1
1983	0.8	0.0	0.2	0.0	1.3	10.8	4.4	40.2	63.3	9.6	1.7	0.0	11.0
1984	2.6	1.2	1.7	0.0	5.1	1.6	32.6	26.4	33.7	30.0	1.2	3.7	11.7
1985	2.9	0.0	5.2	5.6	5.1	16.9	18.5	40.0	9.1	16.9	3.2	0.0	10.3
1986	0.0	1.2	0.0	0.0	9.0	8.2	7.5	17.8	35.2	7.6	6.7	1.1	7.9
1987	0.0	0.7	2.3	0.0	0.0	7.5	4.4	29.2	37.1	28.9	5.1	0.0	9.6
1988	1.3	0.6	0.0	0.0	10.8	19.3	31.5	17.2	26.2	18.5	0.0	0.0	10.5
1989	0.5	1.0	1.5	0.0	0.4	6.8	7.2	11.1	50.8	26.1	0.0	0.0	8.8
1990	1.9	0.5	0.0	0.0	10.0	25.5	23.6	61.6	91.2	74.5	0.0	0.1	24.1
1991	0.0	0.0	0.3	1.5	3.3	0.2	3.0	16.0	54.4	17.8	1.3	0.0	8.2
1992	0.2	0.0	0.0	0.0	3.1	9.0	14.6	41.9	46.8	4.7	0.0	0.0	10.0
1993	0.0	0.0	2.7	0.0	1.5	0.0	2.8	1.8	12.5	0.0	0.0	0.0	1.8
1994	0.5	0.7	1.2	0.0	1.7	2.8	8.0	10.3	90.1	15.9	0.0	0.0	10.9
1995	0.0	1.0	1.0	0.0	1.3	4.7	28.9	70.3	69.3	13.9	1.9	0.9	16.1
1996	1.4	2.7	2.5	2.4	1.9	17.4	7.4	12.5	241.2	48.0	68.4	1.8	34.0
1997	1.1	0.4	0.9	2.2	3.4	12.8	13.0	31.2	46.1	36.1	2.4	0.7	12.5
1998	0.5	0.4	0.2	0.7	1.7	5.0	3.5	11.3	5.0	1.5	0.5	0.3	2.6
1999	0.3	0.2	0.4	0.9	8.7	5.2	2.4	10.3	67.8	10.2	8.0	0.0	9.5
2000	0.0	0.0	0.0	4.2	12.3	19.3	120.8	34.3	27.2	18.2	0.1	0.0	19.7
2001	0.0	0.0	0.0	0.0	0.0	36.7	19.1	247.7	92.2	23.7	0.0	0.0	35.0
Mean	**0.8**	**0.6**	**1.1**	**1.1**	**4.5**	**14.0**	**20.1**	**40.7**	**59.1**	**21.6**	**5.1**	**0.4**	**15.4**
Max	**2.9**	**2.7**	**5.2**	**5.6**	**12.3**	**51.2**	**120.8**	**247.7**	**241.2**	**74.5**	**68.4**	**3.7**	**60.9**
Min	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.4**	**1.8**	**0.0**	**0.0**	**0.0**	**0.0**	**1.8**

Source: Royal Irrigation Dept. (RID)

Reservoir Outflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1978								108.8	98.1	65.0	3.0	2.3	55.4
1979	6.1	3.2	5.8	4.8	11.7	26.2	20.1	26.5	13.6	21.9	4.3	0.0	12.0
1980	0.4	2.0	2.1	1.9	1.9	0.9	10.5	42.4	105.8	9.4	0.9	0.5	14.9
1981	1.2	1.7	1.6	2.1	8.8	22.7	19.7	33.4	13.7	8.0	0.0	1.4	9.5
1982	3.3	3.6	3.9	3.8	7.3	13.7	12.1	10.1	0.0	7.9	4.8	2.0	6.0
1983	3.3	1.2	3.0	2.6	9.9	20.0	14.7	10.4	51.1	12.8	0.5	2.6	11.0
1984	5.3	3.6	5.5	3.4	2.3	15.6	20.4	12.3	8.9	5.5	0.4	7.7	7.6
1985	8.6	2.8	6.1	11.2	12.2	12.9	15.2	7.9	11.4	12.3	0.0	4.2	8.7
1986	4.1	5.0	4.6	2.4	3.3	6.7	12.3	11.5	6.9	15.1	0.0	0.4	6.0
1987	0.8	0.8	0.6	2.3	1.8	11.5	14.6	3.8	0.8	1.9	1.1	2.6	3.6
1988	9.4	5.5	5.4	3.7	0.4	6.0	16.9	14.3	9.8	9.3	1.0	5.0	7.2
1989	11.1	6.6	6.0	3.8	2.0	17.7	10.8	11.3	5.1	3.0	1.6	7.0	7.2
1990	11.9	6.3	2.6	3.5	1.2	5.7	7.4	51.6	69.6	65.0	0.8	6.0	19.3
1991	10.5	9.2	9.3	6.3	2.0	18.9	11.0	3.3	2.8	6.4	0.8	3.5	7.0
1992	4.2	4.9	5.1	4.6	2.9	6.3	9.9	1.3	20.4	13.9	0.9	2.5	6.4
1993	7.8	8.0	6.4	5.6	2.7	2.4	12.2	10.3	0.0	7.5	0.9	1.7	5.5
1994	1.5	1.4	2.5	1.3	1.7	0.0	2.7	3.3	6.9	4.4	1.7	2.3	2.5
1995	5.1	5.6	7.2	5.3	3.6	6.3	15.3	38.5	67.1	21.4	0.8	3.8	15.0
1996	8.1	3.6	2.9	0.7	1.0	2.7	16.9	15.2	151.7	43.3	65.7	4.0	26.3
1997	3.6	3.7	3.9	1.9	2.9	36.8	17.1	11.2	16.9	8.6	0.5	4.1	9.3
1998	5.1	2.8	2.9	1.6	0.5	12.6	13.4	10.0	3.8	5.9	0.3	0.0	4.9
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.1
2000	5.1	5.7	6.1	3.2	0.0	25.3	132.1	12.9	12.2	8.3	0.3	5.1	18.0
2001	5.4	6.5	2.4	5.5	0.2	21.7	30.4	182.1	80.9	9.5	0.0	1.5	28.8
Mean	**5.3**	**4.1**	**4.2**	**3.5**	**3.5**	**12.7**	**18.9**	**26.4**	**31.6**	**15.3**	**3.8**	**3.0**	**12.2**
Max	**11.9**	**9.2**	**9.3**	**11.2**	**12.2**	**36.8**	**132.1**	**182.1**	**151.7**	**65.0**	**65.7**	**7.7**	**55.4**
Min	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**

Source: Royal Irrigation Dept. (RID)

Table 6.16 Monthly Operation Record of Nam Oon Dam

Reservoir Inflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1974				8.0	2.0	10.0	11.0	208.0	85.0	11.0	0.0	0.0	37.2
1975	0.0	4.0	7.0	4.0	13.0	57.0	107.0	127.0	103.0	31.0	0.0	1.0	37.8
1976	4.0	11.0	9.0	17.0	31.0	29.0	30.0	57.0	50.0	37.0	2.0	0.0	23.1
1977	3.0	1.0	2.0	8.0	15.0	0.0	18.0	29.0	89.0	0.0	0.0	0.0	13.8
1978	0.0	2.0	8.0	15.0	12.0	25.0	76.0	206.0	97.0	0.0	0.0	0.0	36.8
1979	2.0	10.0	7.0	17.0	90.0	140.0	58.0	133.0	66.0	9.0	0.0	11.0	45.3
1980	8.0	5.0	7.0	8.0	19.0	39.0	52.0	39.0	173.0	15.0	2.0	0.0	30.6
1981	9.0	11.0	0.0	5.0	16.0	130.0	186.0	78.0	33.0	38.0	1.0	3.0	42.5
1982	6.0	10.0	26.0	9.0	15.0	19.0	23.0	37.0	143.0	65.0	9.0	0.0	30.2
1983	4.0	4.0	6.0	2.0	8.0	15.0	22.0	57.0	76.0	17.0	1.0	0.0	17.7
1984	4.0	4.0	3.0	7.0	13.0	9.0	62.0	189.0	116.0	64.0	8.0	0.0	39.9
1985	2.0	10.0	3.0	7.0	16.0	40.0	56.0	87.0	32.0	26.0	4.0	0.0	23.6
1986	4.0	4.0	6.0	11.0	22.0	63.0	43.0	101.0	107.0	16.0	2.0	3.0	31.8
1987	6.0	10.0	10.0	16.0	8.0	29.0	24.0	252.0	113.0	46.0	2.0	5.0	43.4
1988	12.0	18.0	15.0	13.0	53.0	87.0	29.0	73.0	45.0	46.0	2.0	9.0	33.5
1989	15.0	10.0	13.0	15.0	7.0	21.0	52.0	81.0	90.0	63.0	10.0	7.0	32.0
1990	12.0	12.0	18.0	9.0	10.0	58.0	141.0	292.0	193.0	51.0	18.0	10.0	68.7
1991	17.0	18.0	24.0	19.0	16.0	17.0	43.0	123.0	124.0	33.0	0.0	10.0	37.0
1992	16.0	14.0	13.0	7.0	8.0	46.0	35.0	143.0	100.0	12.0	0.0	11.0	33.8
1993	7.0	9.0	10.0	8.0	55.0	34.0	74.0	60.0	76.0	14.0	0.0	0.0	28.9
1994	6.0	10.0	9.0	5.0	10.0	48.0	278.0	106.0	165.0	33.0	2.0	8.0	56.7
1995	3.0	11.0	10.0	8.0	11.0	38.0	80.0	119.0	101.0	37.0	6.0	14.0	36.5
1996	7.0	9.0	17.0	17.0	29.0	26.0	48.0	71.0	195.0	35.0	13.0	16.0	40.3
1997	4.0	13.0	28.0	21.0	12.0	24.0	118.0	211.0	72.0	35.0	9.0	4.0	45.9
1998	9.0	13.0	21.0	12.0	11.0	24.0	53.0	26.0	91.0	10.0	4.0	5.0	23.3
1999	7.0	4.0	10.0	17.0	29.0	52.0	48.0	68.0	126.0	24.0	7.0	6.0	33.2
2000	11.0	9.0	11.0	20.0	94.0	67.0	169.0	99.0	159.0	45.0	6.0	6.0	58.0
2001	9.0	3.0	18.0	18.0	17.0	21.0	40.0	236.0	210.0	47.0	6.0	11.0	53.0
Mean	**6.9**	**8.9**	**11.5**	**11.5**	**22.9**	**41.7**	**70.6**	**118.1**	**108.2**	**30.7**	**4.1**	**5.0**	**36.9**
Max	**17.0**	**18.0**	**28.0**	**21.0**	**94.0**	**140.0**	**278.0**	**292.0**	**210.0**	**65.0**	**18.0**	**16.0**	**68.7**
Min	**0.0**	**1.0**	**0.0**	**2.0**	**2.0**	**0.0**	**11.0**	**26.0**	**32.0**	**0.0**	**0.0**	**0.0**	**13.8**

Source: Royal Irrigation Dept. (RID)

Reservoir Outflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1974						1.0	1.0	1.0	1.0	1.0	0.0	8.0	1.9
1975	21.0	29.0	33.0	31.0	47.0	63.0	55.0	62.0	35.0	18.0	0.4	2.0	33.0
1976	6.0	12.0	49.0	53.0	60.0	56.0	55.0	30.0	3.0	2.0	1.0	1.0	27.3
1977	1.0	1.0	2.0	1.0	3.0	4.0	10.0	11.0	4.0	14.0	7.0	5.0	5.3
1978	6.0	4.0	4.0	5.0	0.0	16.0	23.0	12.0	25.0	9.0	1.0	6.0	9.3
1979	15.0	45.0	63.0	51.0	33.0	47.0	67.0	63.0	65.0	66.0	7.0	20.0	45.2
1980	22.0	19.0	32.0	24.0	12.0	1.0	25.0	30.0	32.0	24.0	0.0	10.0	19.3
1981	19.0	19.0	29.0	19.0	10.0	7.0	44.0	72.0	66.0	41.0	1.0	12.0	28.3
1982	31.0	35.0	49.0	40.0	27.0	37.0	37.0	29.0	26.0	16.0	0.0	14.0	28.4
1983	21.0	20.0	32.0	23.0	8.0	31.0	48.0	20.0	17.0	45.0	11.0	6.0	23.5
1984	16.0	16.0	19.0	13.0	0.0	11.0	18.0	8.0	39.0	35.0	7.0	3.0	15.4
1985	11.0	7.0	35.0	53.0	10.0	10.0	49.0	45.0	51.0	56.0	5.0	10.0	28.5
1986	29.0	22.0	24.0	19.0	0.0	14.0	50.0	38.0	32.0	66.0	0.4	15.0	25.8
1987	28.0	24.0	19.0	20.0	0.0	16.0	43.0	24.0	36.0	62.0	9.1	19.0	25.0
1988	38.0	37.0	31.0	30.0	0.0	13.0	58.0	63.0	60.0	50.0	6.5	21.0	34.0
1989	41.0	37.0	26.0	28.0	0.2	12.0	38.0	21.0	31.0	52.0	10.3	24.0	26.7
1990	39.0	28.0	24.0	28.0	0.0	0.4	7.0	56.0	266.0	85.0	15.5	31.0	48.3
1991	46.0	45.0	61.0	53.0	24.0	40.0	50.0	46.0	52.0	56.0	10.0	27.0	42.5
1992	24.0	35.0	35.0	29.0	3.0	21.0	46.0	32.0	43.0	58.0	18.0	19.0	30.3
1993	29.0	28.0	33.0	19.0	0.0	21.0	28.0	51.0	54.0	60.0	16.0	17.0	29.7
1994	25.0	13.0	18.0	8.0	0.0	5.0	278.0	34.0	32.0	63.0	15.0	19.0	42.5
1995	28.0	24.0	24.0	11.0	0.0	18.0	49.0	29.5	42.7	67.9	15.0	25.5	27.9
1996	30.3	23.4	23.6	9.2	0.0	32.7	48.6	32.8	23.6	68.8	1.9	18.7	26.1
1997	24.4	23.6	33.7	24.9	8.2	39.8	33.3	61.8	48.4	74.3	15.4	24.0	34.3
1998	32.2	23.0	31.6	17.4	0.0	38.4	58.4	66.0	40.7	57.1	4.7	19.1	32.4
1999	25.7	24.3	22.1	9.0	0.0	0.0	24.2	20.6	29.8	44.3	1.2	17.0	18.2
2000	23.7	22.4	26.2	10.9	0.0	2.1	54.7	79.5	109.0	80.8	7.3	29.2	37.2
2001	38.9	35.9	34.7	14.6	0.0	21.8	46.8	24.8	160.5	86.6	0.7	30.9	41.4
Mean	**24.9**	**24.2**	**30.1**	**23.9**	**9.1**	**20.7**	**48.0**	**38.0**	**50.9**	**48.5**	**6.7**	**16.2**	**28.1**
Max	**46.0**	**45.0**	**63.0**	**53.0**	**60.0**	**63.0**	**278.0**	**79.5**	**266.0**	**86.6**	**18.0**	**31.0**	**48.3**
Min	**1.0**	**1.0**	**2.0**	**1.0**	**0.0**	**0.0**	**1.0**	**1.0**	**1.0**	**1.0**	**0.0**	**1.0**	**1.9**

Source: Royal Irrigation Dept. (RID)

Table 6.17 Monthly Operation Record of Sirindhorn Dam

Reservoir Inflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1982	3.4	14.2	9.0	34.1	27.0	113.1	209.3	351.0	948.2	116.9	23.8	11.3	155.1
1983	11.4	17.5	13.4	8.6	40.5	225.1	101.6	334.7	178.0	392.3	35.6	15.1	114.5
1984	8.2	3.0	18.3	27.9	55.1	120.6	155.1	754.8	643.6	348.8	45.6	18.6	183.3
1985	16.3	18.7	13.1	47.0	100.7	169.7	177.3	409.6	324.1	72.6	24.0	15.2	115.7
1986	15.3	6.9	11.2	15.3	121.6	189.7	376.2	658.6	336.4	160.1	35.3	13.6	161.7
1987	5.4	15.8	15.1	22.1	20.6	204.5	392.1	330.5	446.1	129.9	74.8	11.1	139.0
1988	10.3	2.1	8.0	16.8	87.4	388.3	73.5	184.7	166.1	315.0	25.4	7.8	107.1
1989	1.8	5.6	8.6	28.3	66.4	86.6	232.9	394.0	351.6	107.1	11.8	7.4	108.5
1990	0.4	4.9	20.3	10.9	105.2	371.2	216.5	376.1	526.5	341.9	77.1	3.8	171.2
1991	2.6	14.4	13.1	14.5	26.5	92.0	411.7	721.2	610.2	363.2	8.8	15.6	191.1
1992	11.9	8.0	7.5	10.8	30.2	109.4	234.8	649.3	421.3	175.3	29.9	20.4	142.4
1993	16.0	15.6	20.9	24.6	51.5	60.0	96.6	202.9	369.2	55.0	16.8	11.2	78.4
1994	14.3	8.9	12.1	7.6	77.6	190.7	211.3	284.8	646.3	142.3	20.0	11.0	135.6
1995	10.9	3.7	6.3	10.7	49.6	60.7	342.5	206.2	318.4	195.5	36.8	8.0	104.1
1996	7.3	22.1	15.5	33.8	80.9	141.2	211.0	307.3	701.4	260.0	198.1	13.8	166.0
1997	7.3	9.8	5.5	12.7	42.2	88.3	424.5	465.4	441.9	170.4	26.5	1.5	141.3
1998	3.5	13.6	4.5	11.8	57.1	27.5	78.1	266.5	223.4	97.3	25.9	1.7	67.6
1999	4.0	0.3	29.9	35.9	91.8	188.8	471.1	240.1	326.4	152.6	46.8	12.0	133.3
2000	3.2	8.5	9.3	41.0	219.8	434.2	648.9	521.7	419.8	174.8	11.1	1.3	207.8
2001	6.2	0.0	21.6	2.8	37.4	157.1	236.5	557.1	478.4	237.5	42.3	0.0	148.1
2002	0.8	0.0	5.6	7.7	33.4	73.8	371.8						
Mean	**7.6**	**9.2**	**12.8**	**20.2**	**67.7**	**166.3**	**270.1**	**410.8**	**443.9**	**200.4**	**40.8**	**10.0**	**138.6**
Max	**16.3**	**22.1**	**29.9**	**47.0**	**219.8**	**434.2**	**648.9**	**754.8**	**948.2**	**392.3**	**198.1**	**20.4**	**207.8**
Min	**0.4**	**0.0**	**4.5**	**2.8**	**20.6**	**27.5**	**73.5**	**184.7**	**166.1**	**55.0**	**8.8**	**0.0**	**67.6**

Source: Royal Irrigation Dept. (RID)

Reservoir Outflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1982	113.5	66.5	42.9	36.4	37.6	45.8	47.3	81.5	172.3	176.9	78.5	76.7	81.3
1983	61.9	54.6	38.8	64.6	80.4	69.2	124.2	121.0	118.0	66.3	88.5	48.5	78.0
1984	36.6	18.5	46.2	57.8	51.5	68.3	116.1	189.0	319.7	330.6	87.8	90.2	117.7
1985	75.0	52.0	45.9	59.8	85.8	126.0	131.0	131.6	204.7	61.8	99.0	82.2	96.2
1986	60.5	32.0	45.0	42.7	47.3	68.6	198.3	333.2	301.0	92.4	57.8	36.1	109.6
1987	47.1	47.8	57.1	68.2	63.3	61.5	212.5	136.5	328.2	118.5	62.4	81.2	107.0
1988	78.3	75.2	80.3	20.7	10.8	135.9	67.1	68.1	64.3	121.4	77.5	54.0	71.1
1989	25.8	19.6	27.6	26.9	33.2	34.7	32.7	126.5	89.0	47.0	30.6	27.5	43.4
1990	25.6	26.1	35.2	32.7	48.3	165.8	328.4	155.9	279.3	252.5	61.5	90.8	125.2
1991	134.9	66.6	48.2	42.1	40.0	104.6	187.4	232.5	324.8	305.3	84.6	51.7	135.2
1992	64.5	70.7	101.2	90.0	143.2	58.2	54.9	171.6	242.7	170.0	89.0	55.6	109.3
1993	53.8	57.1	87.9	51.0	73.3	95.9	58.8	24.9	26.9	11.4	10.4	9.6	46.7
1994	9.3	21.0	37.9	54.9	52.5	39.3	150.7	192.0	151.3	81.7	38.5	76.0	75.4
1995	31.9	42.4	95.5	60.7	57.4	64.0	28.5	106.4	100.0	69.2	43.4	42.9	61.9
1996	51.6	29.4	67.7	46.9	53.2	104.0	139.4	157.4	221.6	206.8	189.6	65.9	111.1
1997	59.4	70.2	101.8	77.5	110.1	105.2	84.2	297.5	93.9	82.2	21.4	38.3	95.2
1998	49.4	52.5	79.4	73.0	59.3	53.9	99.3	29.3	5.4	48.4	4.8	18.0	47.7
1999	7.1	10.1	37.5	92.1	70.5	93.4	190.8	309.7	139.0	14.7	23.4	8.3	83.0
2000	15.0	71.9	121.1	110.3	110.2	274.1	324.4	299.4	225.1	153.5	149.2	42.8	158.1
2001	41.3	120.7	164.3	154.2	53.0	17.5	24.9	57.9	267.6	148.9	182.1	59.3	107.6
2002	114.6	120.9	139.8	67.5	45.7	37.0	53.2						
Mean	**55.1**	**53.6**	**71.5**	**63.3**	**63.2**	**86.8**	**126.4**	**161.1**	**183.7**	**128.0**	**74.0**	**52.8**	**93.0**
Max	**134.9**	**120.9**	**164.3**	**154.2**	**143.2**	**274.1**	**328.4**	**333.2**	**328.2**	**330.6**	**189.6**	**90.8**	**158.1**
Min	**7.1**	**10.1**	**27.6**	**20.7**	**10.8**	**17.5**	**24.9**	**24.9**	**5.4**	**11.4**	**4.8**	**8.3**	**43.4**

Source: Royal Irrigation Dept. (RID)

Table 6.18 Monthly Operation Record of Chulabhorn Dam

Reservoir Inflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1982	2.0	1.0	1.7	2.8	3.8	4.6	2.7	9.1	60.4	38.0	9.5	3.2	11.6
1983	2.3	1.4	0.8	0.7	6.1	6.8	5.4	30.4	44.3	40.2	10.9	3.4	12.7
1984	2.6	2.1	2.5	2.8	3.9	18.5	4.5	5.8	40.1	49.9	6.3	2.8	11.8
1985	1.8	1.3	1.3	2.8	10.0	5.7	9.2	7.0	63.4	53.4	10.7	3.1	14.1
1986	2.3	1.3	1.1	4.5	20.1	6.1	4.3	16.0	26.7	14.1	4.6	2.3	8.6
1987	1.3	1.6	5.2	2.8	9.6	8.9	2.4	24.8	57.7	46.6	10.8	2.8	14.5
1988	2.0	1.7	0.9	6.1	26.1	23.2	4.2	13.3	31.1	124.9	9.0	3.3	20.5
1989	2.0	1.2	2.1	1.7	11.0	5.4	6.9	8.8	28.2	56.0	5.8	2.2	10.9
1990	1.1	1.5	3.3	2.0	22.1	25.4	7.6	5.1	18.3	72.0	9.4	2.7	14.2
1991	1.1	1.0	1.3	1.2	13.3	7.7	0.9	98.3	51.7	35.9	5.5	8.1	18.8
1992	5.8	0.9	2.0	1.2	3.0	2.4	5.8	26.1	47.1	20.5	3.5	2.5	10.1
1993	1.3	0.7	0.7	2.2	4.1	1.0	1.3	2.7	27.6	4.6	0.5	0.9	4.0
1994	0.4	0.6	2.1	2.2	12.5	9.8	16.8	28.4	54.3	19.3	3.6	3.2	12.8
1995	2.1	1.3	0.8	3.0	9.8	0.7	4.4	22.9	55.2	29.9	4.4	1.9	11.4
1996	1.9	2.8	2.1	4.9	14.7	6.5	5.0	13.3	70.2	29.0	27.0	3.4	15.1
1997	1.4	0.8	4.1	3.9	2.6	0.6	3.4	2.7	17.1	38.9	3.0	1.2	6.6
1998	0.7	0.7	0.2	1.7	4.9	2.0	7.6	31.4	36.1	8.4	3.5	1.1	8.2
1999	0.2	0.0	0.0	5.7	13.9	12.9	5.0	13.0	45.6	57.4	5.4	3.3	13.5
2000	2.0	0.0	0.4	24.0	55.6	40.8	15.1	37.6	135.4	48.2	9.5	3.7	31.0
2001	0.3	0.9	2.9	1.0	13.1	6.7	7.8	36.5	27.8	24.9	6.6	2.9	10.9
2002	1.4	0.0	0.0	1.4	12.2	5.0	4.2						
Mean	**1.7**	**1.1**	**1.7**	**3.7**	**13.0**	**9.6**	**5.9**	**21.7**	**46.9**	**40.6**	**7.5**	**2.9**	**13.1**
Max	**5.8**	**2.8**	**5.2**	**24.0**	**55.6**	**40.8**	**16.8**	**98.3**	**135.4**	**124.9**	**27.0**	**8.1**	**31.0**
Min	**0.2**	**0.0**	**0.0**	**0.7**	**2.6**	**0.6**	**0.9**	**2.7**	**17.1**	**4.6**	**0.5**	**0.9**	**4.0**

Source: Royal Irrigation Dept. (RID)

Reservoir Outflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1982	5.5	5.0	3.7	1.1	2.3	2.6	2.1	2.0	1.7	2.9	4.9	4.9	3.2
1983	7.9	9.2	10.1	9.6	9.9	15.4	19.6	10.8	31.1	20.8	11.5	3.8	13.3
1984	3.7	8.9	11.5	9.9	10.0	7.3	10.2	15.2	5.1	4.8	5.3	5.2	8.1
1985	5.9	10.5	5.2	8.3	8.6	14.8	6.3	2.9	5.8	20.5	24.8	21.7	11.3
1986	3.9	3.3	7.0	4.4	10.9	12.6	11.6	8.6	25.9	7.7	3.4	2.5	8.5
1987	4.4	4.1	5.2	4.9	4.3	9.9	8.6	10.0	5.4	20.8	5.5	5.2	7.3
1988	5.1	10.5	11.4	9.6	20.7	30.4	13.5	4.6	12.8	26.6	9.5	7.2	13.5
1989	7.6	3.7	4.4	9.3	20.2	16.7	6.8	8.2	4.0	19.1	6.2	2.5	9.1
1990	13.5	5.0	3.6	6.5	18.0	32.6	28.3	12.0	3.7	19.2	11.3	10.3	13.7
1991	17.1	5.8	8.6	10.2	6.6	16.7	12.8	19.2	32.0	29.2	10.9	9.6	14.9
1992	12.9	14.4	15.0	7.2	12.4	15.5	10.3	9.0	9.9	7.2	5.3	5.6	10.4
1993	7.4	6.1	9.5	3.0	5.2	6.3	5.7	4.1	3.4	2.6	3.0	1.9	4.8
1994	2.1	1.8	3.0	0.0	0.0	0.4	2.9	7.9	17.8	8.4	2.3	3.3	4.2
1995	8.7	9.1	11.7	5.0	6.3	14.8	5.0	5.5	7.0	7.2	5.1	6.4	7.6
1996	12.5	9.8	6.9	3.4	3.6	10.3	14.5	11.1	7.1	14.1	13.0	5.8	9.3
1997	12.3	11.3	12.4	7.7	7.5	11.3	10.5	11.6	4.9	3.5	2.3	3.2	8.2
1998	9.0	3.1	9.1	2.2	1.5	3.5	2.6	2.8	5.1	1.8	1.5	5.7	4.0
1999	7.1	6.7	10.6	4.2	1.6	3.9	5.2	6.7	9.0	11.0	28.1	7.0	8.4
2000	6.7	9.8	11.1	11.3	26.8	29.4	27.2	20.6	24.2	30.0	22.5	18.2	19.8
2001	12.5	11.0	6.5	11.7	12.2	9.0	7.8	6.6	4.1	2.9	2.5	6.1	7.7
2002	11.1	10.6	11.5	8.3	6.3	9.0	5.2						
Mean	**8.4**	**7.6**	**8.5**	**6.5**	**9.3**	**13.0**	**10.3**	**9.0**	**11.0**	**13.0**	**9.0**	**6.8**	**9.4**
Max	**17.1**	**14.4**	**15.0**	**11.7**	**26.8**	**32.6**	**28.3**	**20.6**	**32.0**	**30.0**	**28.1**	**21.7**	**19.8**
Min	**2.1**	**1.8**	**3.0**	**0.0**	**0.0**	**0.4**	**2.1**	**2.0**	**1.7**	**1.8**	**1.5**	**1.9**	**3.2**

Source: Royal Irrigation Dept. (RID)

Table 6.19 Monthly Operation Record of Ubolratana Dam

Reservoir Inflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1982	10.5	13.6	17.6	25.2	37.4	62.2	27.4	18.9	594.5	937.5	147.6	27.3	160.0
1983	32.5	20.3	16.2	18.3	34.8	217.4	286.5	838.0	858.3	573.6	179.8	43.7	259.9
1984	28.5	16.9	22.3	41.9	28.6	132.8	100.0	159.3	277.7	838.8	47.4	32.8	143.9
1985	18.0	23.5	12.2	25.9	70.6	73.5	81.3	70.6	216.1	358.1	147.0	55.3	96.0
1986	18.0	8.7	10.9	48.2	195.2	187.2	77.3	124.7	314.5	58.0	77.4	26.3	95.5
1987	13.3	20.1	39.4	37.7	34.9	111.3	32.5	273.8	781.7	728.1	112.5	37.3	185.2
1988	29.9	29.8	19.8	33.9	97.6	195.8	250.2	190.2	325.6	1,524.6	254.8	47.9	250.0
1989	30.0	15.4	17.2	20.9	56.4	113.7	182.9	130.8	462.2	831.5	97.6	26.4	165.4
1990	19.2	34.0	33.6	21.8	153.6	295.6	152.6	147.0	515.6	1,740.9	258.8	35.9	284.0
1991	21.8	17.8	24.3	29.4	45.7	71.8	47.8	557.4	1,254.6	834.5	52.0	46.8	250.3
1992	59.7	27.7	20.3	19.7	42.1	105.9	126.6	398.9	355.6	326.4	48.7	30.2	130.2
1993	17.8	26.6	18.2	29.7	43.0	40.2	46.8	25.5	222.4	68.8	12.3	15.3	47.2
1994	16.5	17.0	19.7	15.3	63.8	54.3	83.9	37.0	722.8	254.3	27.2	37.5	112.4
1995	15.4	11.9	7.6	24.3	50.5	60.6	194.6	674.2	982.2	369.0	51.7	20.6	205.2
1996	19.5	25.6	61.6	57.5	95.8	91.0	89.3	80.9	1,013.9	760.5	546.1	42.2	240.3
1997	31.6	26.2	55.0	63.2	50.4	53.1	57.1	65.2	137.6	277.2	44.5	18.5	73.3
1998	14.0	16.1	14.2	27.9	25.6	33.9	115.3	332.8	312.9	165.4	40.0	17.2	92.9
1999	15.0	9.9	16.8	53.5	268.8	354.7	197.8	164.5	720.5	597.0	478.1	26.1	241.9
2000	29.0	21.0	11.1	198.9	1,012.4	667.4	581.4	351.4	992.3	296.6	139.7	20.5	360.2
2001	24.7	8.8	56.3	22.6	144.5	206.3	107.1	1,234.6	1,124.3	1,009.5	443.3	20.3	366.8
2002	27.7	24.4	56.3	29.1	98.1	149.7	55.4						
Mean	**23.5**	**19.8**	**26.2**	**40.2**	**126.2**	**156.1**	**137.8**	**293.8**	**609.3**	**627.5**	**160.3**	**31.4**	**188.0**
Max	**59.7**	**34.0**	**61.6**	**198.9**	**1,012.4**	**667.4**	**581.4**	**1,234.6**	**1,254.6**	**1,740.9**	**546.1**	**55.3**	**366.8**
Min	**10.5**	**8.7**	**7.6**	**15.3**	**25.6**	**33.9**	**27.4**	**18.9**	**137.6**	**58.0**	**12.3**	**15.3**	**47.2**

Source: Royal Irrigation Dept. (RID)

Reservoir Outflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1982	29.5	26.8	26.0	25.1	31.8	31.4	53.8	55.0	9.0	16.7	9.7	27.9	28.6
1983	68.6	142.2	128.7	155.5	182.7	273.7	247.3	401.0	483.9	514.5	175.0	91.0	238.7
1984	86.7	168.1	151.0	227.5	210.0	122.0	77.9	77.8	105.9	94.4	411.6	37.9	147.6
1985	42.8	62.2	78.7	69.3	49.5	75.0	101.9	66.4	35.8	70.0	99.3	27.6	64.9
1986	54.5	68.3	59.4	56.1	77.6	157.3	113.0	118.9	40.7	116.7	18.0	14.8	74.6
1987	44.8	41.8	31.9	43.5	12.2	43.8	41.5	2.5	53.1	249.2	32.0	11.8	50.7
1988	106.8	96.9	122.3	111.5	86.3	311.1	233.1	213.6	135.7	196.0	239.4	155.9	167.4
1989	147.7	124.9	136.2	138.4	122.2	211.2	287.9	158.2	105.3	161.0	84.2	77.9	146.3
1990	134.3	126.7	152.0	148.3	79.1	235.3	280.9	161.9	112.7	336.8	337.1	123.8	185.7
1991	191.5	142.8	164.1	159.0	140.7	145.5	155.2	210.8	401.3	388.3	236.0	173.6	209.1
1992	190.7	167.6	199.8	164.3	192.9	224.9	160.4	160.8	187.0	129.8	62.0	27.7	155.7
1993	90.0	86.6	113.0	90.4	33.8	33.8	85.1	3.8	0.5	94.6	4.9	0.1	53.0
1994	8.3	0.0	0.0	0.0	0.0	0.9	52.2	0.0	10.1	77.0	30.4	7.3	15.5
1995	52.3	30.7	32.7	25.1	21.7	22.8	72.9	337.5	457.3	247.4	45.9	20.2	113.9
1996	87.3	82.7	91.9	70.7	165.4	237.3	213.0	149.4	79.9	285.8	352.5	137.3	162.8
1997	114.6	103.6	170.7	182.6	204.7	183.5	118.2	114.8	76.1	65.2	23.1	10.0	113.9
1998	66.8	39.1	81.5	62.0	13.6	6.5	115.0	80.6	35.5	101.5	10.1	15.6	52.3
1999	57.8	76.5	97.8	49.7	14.6	133.9	367.3	140.3	203.9	98.7	225.7	57.7	127.0
2000	114.1	157.7	213.8	204.8	472.9	462.4	501.9	495.9	394.5	157.7	39.9	91.9	275.6
2001	131.9	158.6	177.1	188.7	117.6	185.7	158.0	307.5	448.6	445.9	393.1	300.7	251.1
2002	197.2	176.4	194.1	140.2	214.8	239.5	150.9						
Mean	**96.1**	**99.1**	**115.4**	**110.1**	**116.4**	**158.9**	**170.8**	**162.8**	**168.8**	**192.4**	**141.5**	**70.5**	**131.7**
Max	**197.2**	**176.4**	**213.8**	**227.5**	**472.9**	**462.4**	**501.9**	**495.9**	**483.9**	**514.5**	**411.6**	**300.7**	**275.6**
Min	**8.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.9**	**41.5**	**0.0**	**0.5**	**16.7**	**4.9**	**0.1**	**15.5**

Source: Royal Irrigation Dept. (RID)

Table 6.20 Monthly Operation Record of Nam Pung Dam

Reservoir Inflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1982	1.2	2.4	1.8	3.1	3.3	2.2	1.5	6.7	29.8	24.3	6.2	1.7	7.0
1983	2.1	1.6	1.4	1.9	2.1	8.1	6.9	27.3	23.6	8.3	2.1	2.1	7.3
1984	1.9	1.1	1.2	2.0	9.3	5.9	13.4	47.1	36.2	12.9	5.8	2.6	11.6
1985	2.1	2.8	1.1	1.9	5.6	8.9	12.2	21.2	8.8	8.7	2.6	2.2	6.5
1986	1.5	1.6	1.4	2.6	6.5	8.1	6.9	25.0	30.0	7.7	4.2	1.7	8.1
1987	1.5	2.0	2.2	2.2	4.5	7.2	4.8	67.6	55.0	11.9	4.1	1.9	13.8
1988	2.2	3.2	4.2	2.6	19.1	12.7	7.6	28.6	7.4	9.4	2.6	1.7	8.4
1989	1.2	1.0	1.8	2.8	5.3	5.7	14.2	22.6	20.6	23.0	4.1	2.0	8.7
1990	1.8	2.3	2.8	2.0	6.0	13.6	16.7	75.9	78.3	11.2	6.1	2.6	18.3
1991	1.9	1.6	2.3	0.3	7.3	10.5	12.3	66.3	81.1	13.7	3.9	3.2	17.0
1992	3.1	2.4	1.5	0.4	5.0	15.3	21.7	51.5	27.6	6.6	3.2	3.9	11.8
1993	1.7	1.6	0.9	2.7	7.5	4.0	14.6	18.8	21.4	4.1	2.2	1.3	6.7
1994	1.4	2.8	2.4	2.2	4.5	19.9	16.5	45.7	63.1	20.3	5.0	2.5	15.5
1995	1.9	2.1	1.3	2.5	5.8	11.5	26.7	37.4	40.9	11.0	3.0	1.7	12.1
1996	2.0	1.5	3.3	9.5	4.3	6.3	8.9	11.3	40.5	11.1	5.6	2.1	8.9
1997	1.7	1.6	2.8	1.5	1.8	4.8	29.7	56.1	27.1	11.9	3.4	2.0	12.0
1998	1.7	3.0	1.7	1.3	1.3	7.4	10.5	9.3	24.8	5.6	2.1	1.7	5.9
1999	1.8	1.2	2.3	4.7	9.7	19.3	26.0	18.6	42.9	12.6	5.4	2.0	12.2
2000	1.3	2.0	1.3	5.7	14.7	12.0	31.7	26.7	41.6	11.1	3.0	1.3	12.7
2001	1.9	0.4	3.7	0.9	4.7	10.0	15.0	57.4	55.2	12.3	4.7	1.9	14.0
2002	1.3	1.2	1.3	1.9	9.6	25.9	34.1						
Mean	**1.8**	**1.9**	**2.0**	**2.6**	**6.6**	**10.4**	**15.8**	**36.0**	**37.8**	**11.9**	**4.0**	**2.1**	**10.9**
Max	**3.1**	**3.2**	**4.2**	**9.5**	**19.1**	**25.9**	**34.1**	**75.9**	**81.1**	**24.3**	**6.2**	**3.9**	**18.3**
Min	**1.2**	**0.4**	**0.9**	**0.3**	**1.3**	**2.2**	**1.5**	**6.7**	**7.4**	**4.1**	**2.1**	**1.3**	**5.9**

Source: Royal Irrigation Dept. (RID)

Reservoir Outflow

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1982	9.2	8.5	9.6	4.9	5.6	6.3	5.2	5.3	5.2	3.2	3.0	2.8	5.7
1983	3.0	3.3	4.5	6.3	3.0	2.9	8.2	10.1	7.2	5.5	5.5	5.6	5.4
1984	5.7	7.1	6.0	5.7	4.3	5.0	7.7	9.0	13.1	17.3	4.7	4.9	7.5
1985	4.9	4.4	3.4	4.2	5.1	5.8	5.2	10.0	4.8	3.0	5.1	5.0	5.1
1986	5.1	4.4	4.5	4.7	4.6	4.9	5.0	5.0	4.7	4.6	47.2	4.7	8.3
1987	5.7	5.0	5.0	4.8	5.0	4.9	5.2	8.1	17.8	19.5	3.4	4.8	7.4
1988	4.7	4.6	5.0	7.1	12.1	17.6	18.0	13.8	5.9	6.8	5.1	4.2	8.7
1989	3.0	2.2	2.4	2.3	5.6	5.0	5.0	5.2	4.8	4.2	7.8	4.9	4.4
1990	3.4	2.1	1.9	2.3	7.8	8.0	11.0	17.6	19.7	19.0	5.4	5.9	8.7
1991	6.3	3.3	7.1	9.4	9.8	9.0	15.0	18.4	20.2	18.9	11.2	6.3	11.2
1992	4.1	3.3	6.4	7.4	9.9	12.1	20.0	20.1	18.9	12.2	9.8	4.9	10.8
1993	2.4	5.2	7.7	6.5	6.6	6.6	6.4	6.2	6.1	5.3	7.2	7.9	6.2
1994	5.3	4.4	4.0	5.8	6.5	5.3	5.1	5.1	12.9	19.3	15.8	13.1	8.5
1995	5.7	5.3	6.5	5.9	5.7	8.1	6.8	17.9	17.5	11.8	11.5	5.6	9.0
1996	3.3	4.0	5.8	6.2	16.7	15.3	11.0	9.2	7.3	7.0	8.6	4.6	8.3
1997	4.6	4.0	3.9	3.6	4.7	3.9	4.5	17.1	14.7	9.1	10.2	3.4	7.0
1998	1.4	1.7	4.1	8.7	13.4	13.4	12.2	7.8	4.1	1.4	2.1	0.9	5.9
1999	0.8	0.7	1.0	1.1	10.7	9.6	17.8	18.0	13.6	0.7	1.2	0.0	6.3
2000	1.1	10.6	17.6	16.8	18.7	14.0	6.9	5.6	9.3	6.4	2.9	5.0	9.6
2001	7.8	8.1	10.1	14.9	17.0	7.4	8.8	13.8	17.1	16.7	14.2	3.0	11.6
2002	6.5	8.0	9.4	8.2	8.9	9.7	17.7						
Mean	**4.5**	**4.8**	**6.0**	**6.5**	**8.7**	**8.3**	**9.7**	**11.2**	**11.2**	**9.6**	**9.1**	**4.9**	**7.8**
Max	**9.2**	**10.6**	**17.6**	**16.8**	**18.7**	**17.6**	**20.0**	**20.1**	**20.2**	**19.5**	**47.2**	**13.1**	**11.6**
Min	**0.8**	**0.7**	**1.0**	**1.1**	**3.0**	**2.9**	**4.5**	**5.0**	**4.1**	**0.7**	**1.2**	**0.0**	**4.4**

Source: Royal Irrigation Dept. (RID)

Table 7.4 Monthly Mean Discharge at Chiang Saen

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	935	800	765	954	1,249	2,663	4,178	8,051	5,936	4,184	2,409	1,596	2,810
1962	1,106	920	729	796	1,220	3,375	4,120	8,786	5,636	3,439	1,959	1,196	2,773
1963	905	729	654	642	773	2,042	5,345	7,675	4,593	3,995	3,306	1,521	2,682
1964	1,072	876	808	923	1,387	2,139	6,318	7,359	6,642	4,487	2,421	1,554	2,999
1965	1,130	937	730	726	909	2,904	5,223	6,630	5,778	5,134	4,436	2,080	3,051
1966	1,426	1,050	831	838	1,151	3,145	6,150	10,991	11,573	6,041	2,999	1,802	4,000
1967	1,323	1,023	954	923	1,092	1,834	4,034	5,892	4,904	4,027	2,653	1,615	2,523
1968	1,312	1,085	951	936	1,585	2,437	4,373	6,549	6,089	5,375	3,305	1,613	2,968
1969	1,108	822	616	700	747	2,072	4,250	9,013	4,852	3,078	2,035	1,305	2,550
1970	982	776	719	936	1,782	2,908	6,943	9,236	5,154	3,331	2,543	2,585	3,158
1971	1,388	1,072	893	950	1,350	3,167	7,585	10,995	6,781	3,872	2,442	1,657	3,513
1972	1,301	1,052	869	956	1,106	1,598	2,904	4,822	3,538	2,679	2,306	2,162	2,108
1973	1,175	981	995	1,004	1,319	2,584	4,476	6,666	6,293	3,062	3,041	1,734	2,777
1974	1,133	914	807	976	1,231	2,299	4,169	7,022	6,575	3,437	2,428	1,497	2,707
1975	1,267	945	787	896	1,214	2,314	3,766	4,201	4,235	2,754	2,073	1,280	2,144
1976	994	898	805	932	1,345	2,645	3,782	6,389	4,517	3,475	2,249	1,482	2,459
1977	1,057	890	824	988	1,197	2,012	3,824	5,040	4,402	3,439	2,369	1,471	2,293
1978	1,225	928	788	846	1,730	2,960	5,153	6,911	5,165	3,663	1,865	1,249	2,707
1979	945	772	684	829	1,089	1,554	2,778	5,109	6,307	4,503	1,995	1,453	2,335
1980	1,053	889	806	1,002	1,247	2,465	4,883	7,159	5,696	4,831	2,279	1,467	2,815
1981	1,106	907	842	872	2,109	3,686	5,425	5,927	4,974	3,083	2,889	1,758	2,798
1982	1,233	993	771	948	994	2,490	4,014	6,258	3,973	3,810	1,972	1,309	2,397
1983	963	795	863	946	1,213	2,053	3,338	5,400	5,829	3,317	3,705	1,940	2,530
1984	1,507	1,110	826	915	1,080	2,272	5,955	4,542	4,529	3,279	1,996	1,346	2,447
1985	1,054	864	743	919	1,333	3,516	5,229	6,075	7,704	4,016	3,278	1,881	3,051
1986	1,313	1,016	865	951	1,437	1,925	4,411	4,578	4,015	4,254	2,377	1,615	2,396
1987	1,341	1,136	972	1,012	1,089	1,870	2,933	5,273	5,856	3,910	2,600	1,601	2,466
1988	1,177	955	937	1,010	1,702	2,227	3,255	5,404	4,768	3,236	1,900	1,412	2,332
1989	1,051	871	803	811	1,195	2,076	3,618	4,765	4,127	5,066	2,500	1,620	2,375
1990	1,225	1,064	1,007	1,001	1,968	4,099	6,428	4,940	4,304	4,156	2,265	1,489	2,829
1991	1,134	928	846	1,051	1,399	3,008	5,358	8,071	5,784	4,440	3,162	1,842	3,085
1992	1,477	1,246	1,185	1,209	1,177	1,406	3,120	2,860	2,911	3,191	1,987	1,371	1,928
1993	1,025	910	801	824	1,112	1,718	4,011	6,158	5,969	3,837	2,456	1,665	2,541
1994	1,062	916	866	1,063	1,334	3,451	4,113	5,073	4,147	3,261	1,717	1,612	2,385
1995	1,144	921	1,049	622	1,688	2,595	5,637	7,455	6,260	4,468	2,962	1,955	3,063
1996	1,272	1,038	971	1,207	1,508	2,283	5,884	7,607	4,991	3,966	2,597	1,684	2,917
1997	1,067	790	718	738	996	1,676	5,037	4,315	4,788	4,250	1,813	1,195	2,282
1998	938	731	655	912	1,497	1,633	5,994	7,077	5,777	2,711	1,711	1,085	2,560
1999	907	717	702	645	1,035	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**1,150**	**930**	**832**	**908**	**1,297**	**2,450**	**4,685**	**6,481**	**5,404**	**3,870**	**2,500**	**1,597**	**2,678**
Max	**1,507**	**1,246**	**1,185**	**1,209**	**2,109**	**4,099**	**7,585**	**10,995**	**11,573**	**6,041**	**4,436**	**2,585**	**4,000**
Min	**905**	**717**	**616**	**622**	**747**	**1,406**	**2,778**	**2,860**	**2,911**	**2,679**	**1,711**	**1,085**	**1,928**

Source: MRC HYMOS Database

Table 7.5 Monthly Mean Discharge at Luang Prabang

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	1,527	1,261	1,065	1,242	1,441	3,517	4,876	9,661	10,517	6,705	3,697	2,495	4,000
1962	1,830	1,453	1,139	1,119	1,547	4,245	5,439	10,145	7,527	4,663	2,825	1,865	3,650
1963	1,381	1,162	1,058	1,005	1,090	2,315	6,659	11,066	7,527	5,469	6,099	2,639	3,956
1964	1,786	1,367	1,193	1,236	1,688	2,560	8,794	10,218	9,792	6,361	3,623	2,530	4,262
1965	1,822	1,471	1,145	1,093	1,225	3,485	6,791	8,664	7,976	6,234	6,637	3,348	4,158
1966	2,165	1,658	1,254	1,171	1,496	3,996	7,763	14,681	16,360	7,888	4,378	2,806	5,468
1967	2,107	1,649	1,395	1,278	1,481	2,442	4,433	7,582	7,143	5,554	3,516	2,357	3,411
1968	1,762	1,294	1,059	1,015	1,657	2,706	5,104	8,175	8,148	6,263	4,003	2,143	3,611
1969	1,497	1,108	899	865	921	2,643	5,470	12,854	7,016	3,996	2,952	1,878	3,508
1970	1,314	968	859	1,014	2,131	4,038	9,341	12,990	8,807	4,905	3,377	3,364	4,426
1971	2,015	1,514	1,109	1,057	1,465	3,595	10,223	16,906	11,304	5,663	3,888	2,520	5,105
1972	1,935	1,474	1,124	1,309	1,445	2,190	3,956	9,907	6,793	5,420	4,062	3,698	3,609
1973	1,875	1,334	1,333	1,173	1,742	3,681	7,576	12,126	13,187	6,245	4,772	2,997	4,837
1974	1,841	1,318	1,020	1,271	1,609	3,123	5,063	9,527	10,399	5,351	3,450	2,078	3,838
1975	1,795	1,186	887	984	1,247	3,193	5,356	7,354	8,442	4,915	3,368	2,077	3,400
1976	1,389	1,199	915	1,006	1,482	3,224	5,209	11,436	7,254	5,740	3,669	2,240	3,730
1977	1,549	1,127	959	1,233	1,583	2,322	6,127	8,614	8,234	6,310	4,284	2,475	3,735
1978	2,153	1,395	1,147	1,067	2,296	4,107	8,628	12,036	9,791	6,844	3,448	2,225	4,595
1979	1,606	1,215	943	989	1,473	2,590	4,024	8,217	10,093	6,828	3,232	2,235	3,620
1980	1,500	1,116	929	1,063	1,383	3,165	7,343	11,210	11,074	7,390	3,741	2,485	4,367
1981	1,786	1,367	1,124	1,122	2,841	5,601	8,431	10,545	9,422	5,853	5,008	3,205	4,692
1982	2,138	1,562	1,106	1,404	1,325	3,574	5,746	11,798	7,662	7,160	3,813	2,486	4,148
1983	1,730	1,309	1,248	1,208	1,481	2,562	4,183	8,126	9,834	5,822	5,687	3,121	3,859
1984	2,378	1,592	1,106	1,101	1,343	2,872	8,368	8,548	8,435	5,818	3,533	2,005	3,925
1985	1,450	1,175	910	1,024	1,566	3,791	6,076	9,840	11,621	5,391	5,005	2,945	4,233
1986	2,235	1,716	1,214	1,028	1,958	2,665	5,654	7,384	6,181	5,669	3,250	2,082	3,420
1987	1,621	1,279	1,051	937	974	1,864	3,405	6,359	7,597	5,662	3,497	2,117	3,030
1988	1,498	1,051	917	1,146	2,101	2,680	4,312	9,109	7,346	4,693	2,748	1,945	3,295
1989	1,289	979	884	874	1,351	2,948	4,887	7,034	6,055	6,702	3,490	2,042	3,211
1990	1,391	1,093	1,017	892	1,899	5,167	8,714	8,344	6,506	5,519	3,280	1,951	3,814
1991	1,487	1,150	1,022	1,309	1,631	3,796	7,701	11,824	8,968	6,472	4,357	2,552	4,356
1992	1,855	1,408	1,288	1,368	1,300	1,597	3,687	3,934	3,911	3,941	2,722	1,983	2,416
1993	1,449	1,149	1,025	1,011	1,362	1,854	5,157	7,331	7,832	5,005	3,382	2,036	3,216
1994	1,422	1,158	1,063	1,290	1,523	4,282	7,053	9,757	7,987	5,284	2,580	2,357	3,813
1995	1,628	1,277	1,217	952	1,601	2,814	6,683	13,089	10,199	6,013	3,514	2,340	4,277
1996	1,690	1,397	1,170	1,333	1,784	2,594	7,493	13,198	8,114	5,516	3,629	2,334	4,188
1997	1,537	1,128	998	1,058	1,275	1,828	7,141	8,012	9,748	7,118	2,992	1,986	3,735
1998	1,475	1,134	932	1,228	1,768	2,194	8,071	9,724	9,090	3,760	2,609	1,742	3,644
1999	1,135	776	673	625	1,155	2,801	5,442	8,933	13,390	5,397	5,092	2,308	3,977
2000	1,747	1,380	1,223	1,364	2,878	4,844	10,552	9,478	11,733	5,587	3,594	2,372	4,729
Mean	**1,695**	**1,284**	**1,065**	**1,112**	**1,588**	**3,137**	**6,423**	**9,893**	**8,975**	**5,778**	**3,820**	**2,409**	**3,932**
Max	**2,378**	**1,716**	**1,395**	**1,404**	**2,878**	**5,601**	**10,552**	**16,906**	**16,360**	**7,888**	**6,637**	**3,698**	**5,468**
Min	**1,135**	**776**	**673**	**625**	**921**	**1,597**	**3,405**	**3,934**	**3,911**	**3,760**	**2,580**	**1,742**	**2,416**

Source: MRC HYMOS Database

Table 7.6 Monthly Mean Discharge at Chiang Khan

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	-	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-	-	-	-	-	-	-
1967	-	-	-	1,155	1,375	2,509	4,665	8,333	8,130	6,285	3,800	2,540	-
1968	1,800	1,299	1,068	1,005	1,871	2,767	5,556	8,876	8,964	6,621	4,694	2,258	3,898
1969	1,484	1,109	897	848	834	2,717	5,907	13,524	7,687	4,211	3,080	1,799	3,675
1970	1,275	1,005	857	938	2,093	4,249	10,112	14,361	10,281	5,357	3,414	3,342	4,774
1971	1,933	1,405	1,108	1,111	1,354	3,793	11,671	18,123	13,159	6,447	4,179	2,396	5,556
1972	1,810	1,389	1,097	1,190	1,363	2,179	3,661	10,607	7,435	5,877	3,989	3,680	3,690
1973	1,910	1,361	1,305	1,174	1,791	3,816	7,988	12,866	14,667	6,618	4,824	3,044	5,114
1974	1,859	1,335	1,031	1,287	1,767	3,471	5,304	10,273	11,511	5,956	3,541	2,112	4,121
1975	1,802	1,238	975	1,038	1,325	3,727	5,867	8,171	9,886	5,692	3,616	2,261	3,800
1976	1,539	1,400	1,055	1,038	1,533	3,429	5,485	12,151	8,101	6,716	3,994	2,373	4,068
1977	1,778	1,304	1,117	1,220	1,422	2,051	5,990	8,971	9,024	6,214	4,288	2,413	3,816
1978	2,131	1,457	1,253	1,030	2,152	3,930	9,488	12,941	10,661	7,376	3,340	2,116	4,823
1979	1,540	1,211	958	913	1,347	3,067	4,226	8,395	10,638	6,950	3,147	2,160	3,713
1980	1,482	1,084	885	925	1,310	3,548	7,761	11,743	12,824	7,669	3,695	2,362	4,607
1981	1,704	1,290	1,046	994	2,652	5,663	9,646	11,453	10,095	6,095	5,098	3,170	4,909
1982	2,140	1,586	1,139	1,245	1,224	3,396	5,842	10,735	7,687	7,841	3,555	2,391	4,065
1983	1,715	1,306	1,128	1,085	1,297	2,583	4,369	9,149	10,745	6,268	5,691	3,050	4,032
1984	2,327	1,602	1,151	1,054	1,339	2,632	8,626	8,743	9,028	6,156	3,557	2,238	4,038
1985	1,652	1,191	907	951	1,374	4,107	6,749	10,515	13,045	6,340	5,069	3,236	4,595
1986	2,097	1,550	1,184	1,080	2,313	3,164	6,131	8,645	7,345	6,435	3,661	2,326	3,828
1987	1,885	1,430	1,090	955	1,017	1,993	3,237	7,541	8,654	6,676	3,873	2,281	3,386
1988	1,529	1,153	933	916	2,156	3,005	5,174	10,095	8,267	5,711	3,020	2,111	3,673
1989	1,416	1,002	861	817	1,236	3,039	5,524	8,126	7,092	7,912	4,068	2,315	3,617
1990	1,597	1,136	1,037	885	1,871	6,008	9,493	9,150	7,341	6,599	3,861	2,308	4,274
1991	1,664	1,206	952	1,089	1,538	3,751	8,246	11,869	9,533	7,011	4,623	2,628	4,509
1992	2,048	1,518	1,328	1,298	1,232	1,691	4,384	5,142	7,494	4,950	3,278	2,281	3,054
1993	1,562	1,069	962	881	1,314	1,808	6,312	8,687	9,595	5,946	3,805	2,135	3,673
1994	1,484	1,117	874	1,183	1,583	5,175	8,588	12,003	10,543	6,619	3,061	2,721	4,579
1995	1,791	1,307	1,120	895	1,578	3,208	7,537	14,060	11,844	7,406	4,155	2,712	4,801
1996	1,657	1,187	1,126	1,259	2,085	2,884	7,792	14,834	9,754	6,404	4,024	2,452	4,621
1997	1,673	1,250	1,066	1,134	1,310	1,868	7,623	8,839	10,191	8,135	3,339	2,152	4,048
1998	1,606	1,175	818	1,194	1,836	2,309	7,820	9,281	9,214	3,935	2,719	1,739	3,637
1999	1,326	1,078	969	1,661	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**1,726**	**1,273**	**1,041**	**1,074**	**1,578**	**3,236**	**6,774**	**10,569**	**9,701**	**6,388**	**3,877**	**2,472**	**4,161**
Max	**2,327**	**1,602**	**1,328**	**1,661**	**2,652**	**6,008**	**11,671**	**18,123**	**14,667**	**8,135**	**5,691**	**3,680**	**5,556**
Min	**1,275**	**1,002**	**818**	**817**	**834**	**1,691**	**3,237**	**5,142**	**7,092**	**3,935**	**2,719**	**1,739**	**3,054**

Source: MRC HYMOS Database

Table 7.7 Monthly Mean Discharge at Vientiane

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	1,557	1,318	1,077	1,320	1,661	4,230	5,582	10,787	13,663	9,176	4,284	2,832	4,791
1962	1,919	1,486	1,225	1,185	1,720	4,475	6,314	11,380	9,353	6,040	3,290	2,011	4,200
1963	1,454	1,204	1,074	969	1,122	2,435	7,532	13,271	9,819	6,257	7,262	3,037	4,620
1964	1,921	1,471	1,292	1,325	2,089	3,022	9,512	11,295	12,191	8,288	4,340	2,902	4,971
1965	1,992	1,584	1,271	1,153	1,309	3,912	7,639	9,745	9,624	6,559	7,576	3,610	4,665
1966	2,345	1,750	1,331	1,246	1,660	4,254	8,562	15,803	18,832	8,704	5,241	3,349	6,090
1967	2,379	1,799	1,512	1,352	1,646	2,710	4,688	8,842	8,991	7,028	3,923	2,649	3,960
1968	1,885	1,446	1,241	1,179	2,184	2,849	5,886	9,372	10,043	7,065	5,121	2,531	4,233
1969	1,762	1,338	1,027	919	931	2,979	6,419	14,328	8,549	4,933	3,503	2,022	4,059
1970	1,474	1,190	985	1,134	2,349	4,635	10,607	15,548	12,010	6,366	3,880	3,715	5,324
1971	2,215	1,667	1,308	1,166	1,425	3,996	11,292	18,326	14,548	7,003	4,507	2,512	5,830
1972	1,780	1,351	1,062	1,208	1,357	2,236	3,764	10,785	8,147	6,315	4,192	3,702	3,825
1973	1,809	1,281	1,292	1,298	1,889	3,971	8,002	13,084	16,143	7,394	5,039	3,182	5,365
1974	1,890	1,370	1,136	1,377	1,846	3,513	5,415	11,002	12,591	6,221	3,624	2,163	4,346
1975	1,855	1,333	1,069	1,108	1,492	4,124	6,025	8,830	10,811	6,116	3,761	2,282	4,067
1976	1,609	1,508	1,186	1,281	1,769	3,633	5,798	12,739	8,922	7,629	4,573	2,593	4,437
1977	1,860	1,424	1,304	1,473	1,683	2,189	6,124	9,465	9,800	6,608	4,697	2,495	4,094
1978	2,187	1,449	1,331	1,205	2,361	4,022	9,930	14,507	11,603	7,980	3,621	2,205	5,200
1979	1,589	1,314	1,107	1,104	1,525	3,291	4,508	8,330	11,205	7,089	3,290	2,153	3,875
1980	1,527	1,333	1,232	1,358	1,780	3,849	8,061	12,729	15,286	8,202	4,113	2,496	5,164
1981	1,781	1,473	1,274	1,276	2,778	5,883	10,212	12,034	10,676	6,607	5,327	3,372	5,224
1982	2,126	1,597	1,297	1,470	1,430	3,548	6,038	12,377	9,319	8,696	3,950	2,515	4,530
1983	1,768	1,466	1,387	1,374	1,591	2,762	4,580	9,367	11,841	6,764	5,974	3,224	4,342
1984	2,317	1,612	1,263	1,223	1,459	2,673	9,006	9,306	9,858	6,744	3,950	2,281	4,308
1985	1,414	1,150	957	1,019	1,331	3,849	6,648	10,510	13,332	6,521	5,088	3,201	4,585
1986	1,978	1,398	1,129	1,094	2,287	3,233	5,765	8,913	7,623	6,278	3,655	2,163	3,793
1987	1,724	1,352	1,143	1,036	1,114	2,103	3,066	7,559	9,067	6,928	3,816	2,240	3,429
1988	1,505	1,218	1,069	1,110	2,286	3,025	5,138	10,176	8,715	5,828	2,955	1,916	3,745
1989	1,288	1,041	955	932	1,324	2,885	5,469	8,374	7,447	8,363	4,051	2,132	3,688
1990	1,553	1,231	1,201	1,025	1,920	6,015	9,232	9,363	7,658	6,739	3,882	2,242	4,338
1991	1,637	1,274	1,092	1,274	1,661	3,322	7,956	11,341	9,800	7,062	4,635	2,534	4,466
1992	1,907	1,429	1,295	1,360	1,292	1,876	4,173	5,407	5,086	4,850	3,321	2,126	2,843
1993	1,550	1,117	1,046	974	1,474	1,865	6,294	8,417	10,194	5,887	3,840	2,068	3,727
1994	1,474	1,216	997	1,411	1,709	5,114	8,384	11,749	11,155	6,932	3,147	2,725	4,668
1995	1,822	1,354	1,239	986	1,729	3,363	7,400	13,985	12,716	7,660	4,323	2,771	4,946
1996	1,883	1,513	1,348	1,467	2,301	3,118	6,843	13,139	9,911	6,919	4,381	2,652	4,623
1997	1,486	1,144	982	1,119	1,245	1,697	6,469	8,147	9,562	7,279	3,013	1,853	3,666
1998	1,366	1,111	952	1,221	1,678	2,057	7,199	9,022	9,315	3,470	2,327	1,556	3,440
1999	1,100	856	755	766	1,462	3,066	5,155	7,839	13,117	5,863	4,964	2,106	3,921
2000	1,497	1,296	1,233	1,277	2,819	4,437	9,414	8,996	11,414	5,069	2,976	1,921	4,362
Mean	**1,755**	**1,362**	**1,167**	**1,194**	**1,717**	**3,405**	**6,903**	**10,905**	**10,748**	**6,786**	**4,235**	**2,551**	**4,394**
Max	**2,379**	**1,799**	**1,512**	**1,473**	**2,819**	**6,015**	**11,292**	**18,326**	**18,832**	**9,176**	**7,576**	**3,715**	**6,090**
Min	**1,100**	**856**	**755**	**766**	**931**	**1,697**	**3,066**	**5,407**	**5,086**	**3,470**	**2,327**	**1,556**	**2,843**

Source: MRC HYMOS Database

Table 7.8 Monthly Mean Discharge at Nong Khai

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	-	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-	-	-	-	-	-	-
1967	-	-	-	-	-	-	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	-	-	-	958	969	2,975	6,821	14,922	9,186	5,107	3,484	1,925	-
1970	1,550	1,288	1,086	1,186	2,491	5,039	11,410	15,952	12,792	6,248	3,607	3,498	5,512
1971	2,153	1,639	1,295	1,239	1,553	4,104	11,918	18,761	15,244	7,051	4,549	2,701	6,017
1972	1,878	1,436	1,172	1,320	1,488	2,374	3,764	10,421	7,593	6,092	4,245	3,811	3,799
1973	2,032	1,519	1,475	1,334	1,897	4,018	8,376	13,145	16,557	7,409	5,184	3,273	5,518
1974	1,913	1,386	1,152	1,404	1,906	3,531	5,464	11,168	12,798	6,283	3,637	2,265	4,409
1975	1,886	1,356	1,096	1,187	1,563	4,220	6,233	9,110	11,131	6,169	3,816	2,361	4,177
1976	1,694	1,629	1,215	1,372	1,873	3,783	5,799	12,537	8,950	7,656	4,416	2,582	4,459
1977	1,846	1,411	1,241	1,480	1,737	2,315	6,085	9,209	9,782	6,357	4,458	2,504	4,035
1978	2,171	1,459	1,281	1,089	2,405	4,045	10,199	15,448	12,097	7,899	3,417	2,183	5,308
1979	1,631	1,301	1,011	997	1,545	3,385	4,590	8,482	11,325	6,896	3,087	2,116	3,864
1980	1,483	1,142	994	1,121	1,627	3,987	8,381	13,186	16,014	7,956	3,759	2,367	5,168
1981	1,735	1,385	1,139	1,195	2,810	5,961	10,711	12,657	10,998	6,355	5,022	3,283	5,271
1982	2,205	1,681	1,245	1,328	1,285	3,535	6,062	11,970	9,048	8,654	3,781	2,436	4,436
1983	1,626	1,315	1,308	1,246	1,450	2,734	4,499	9,466	11,839	6,655	5,936	3,170	4,270
1984	2,365	1,632	1,166	1,145	1,430	2,581	9,230	9,675	10,201	6,875	3,999	2,397	4,391
1985	1,758	1,355	1,084	1,126	1,523	4,131	6,956	10,742	13,953	6,915	5,386	3,437	4,864
1986	2,139	1,582	1,263	1,178	2,550	3,603	6,181	9,189	8,209	6,663	3,893	2,325	4,064
1987	1,882	1,445	1,181	1,105	1,280	2,304	3,336	7,851	9,129	6,805	3,867	2,306	3,541
1988	1,577	1,209	1,037	1,037	2,233	2,983	5,054	9,689	8,479	5,655	2,931	1,967	3,654
1989	1,344	1,067	990	966	1,486	3,007	5,346	8,432	7,531	8,168	3,927	2,089	3,696
1990	1,493	1,241	1,246	1,100	1,889	5,705	8,790	9,391	7,652	6,582	3,609	2,173	4,239
1991	1,633	1,309	1,089	1,249	1,630	3,379	8,227	11,826	10,008	7,007	4,561	2,515	4,536
1992	1,896	1,383	1,285	1,327	1,256	1,758	4,094	5,366	5,028	4,791	3,213	2,009	2,784
1993	1,633	1,274	1,217	1,110	1,581	1,951	6,835	9,178	11,689	6,000	3,725	1,991	4,015
1994	1,522	1,295	1,070	1,493	1,767	5,317	8,773	12,289	11,379	6,740	2,936	2,571	4,763
1995	1,773	1,349	1,247	1,029	1,730	3,382	7,559	14,486	13,475	7,277	3,961	2,683	4,996
1996	1,711	1,380	1,234	1,374	2,297	2,985	7,514	16,274	11,367	6,785	3,860	2,387	4,931
1997	1,741	1,374	1,157	1,331	1,507	2,120	7,707	9,477	11,070	8,072	3,591	2,438	4,299
1998	1,665	1,306	1,119	1,422	1,978	2,485	8,561	10,431	10,359	4,099	2,759	1,892	4,006
1999	1,428	1,167	971	991	1,878	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**1,779**	**1,377**	**1,169**	**1,208**	**1,762**	**3,457**	**7,149**	**11,358**	**10,829**	**6,707**	**3,954**	**2,522**	**4,449**
Max	**2,365**	**1,681**	**1,475**	**1,493**	**2,810**	**5,961**	**11,918**	**18,761**	**16,557**	**8,654**	**5,936**	**3,811**	**6,017**
Min	**1,344**	**1,067**	**971**	**958**	**969**	**1,758**	**3,336**	**5,366**	**5,028**	**4,099**	**2,759**	**1,892**	**2,784**

Source: MRC HYMOS Database

Table 7.9 Monthly Mean Discharge at Nakhon Phanom

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	2,147	1,722	1,422	1,576	2,136	8,497	10,884	16,994	25,663	17,063	6,072	3,577	8,146
1962	2,607	1,951	1,559	1,431	2,265	7,868	11,748	17,723	14,970	9,360	4,365	2,697	6,545
1963	2,013	1,576	1,368	1,238	1,353	6,067	15,998	25,281	20,070	9,103	8,841	3,948	8,071
1964	2,568	2,037	1,685	1,666	2,715	7,221	14,829	17,326	20,647	14,832	6,280	4,015	7,985
1965	2,696	2,186	1,690	1,560	1,883	11,756	15,323	17,987	16,403	8,273	9,091	3,634	7,707
1966	3,019	2,274	1,778	1,581	2,400	7,640	15,758	23,313	27,083	11,811	6,225	3,879	8,897
1967	2,820	2,223	1,870	1,455	2,131	4,409	7,935	13,680	16,423	10,628	3,418	2,830	5,819
1968	2,271	1,812	1,540	1,179	2,782	5,887	11,141	16,148	16,473	10,050	6,238	2,840	6,530
1969	1,912	1,585	1,225	1,155	1,274	9,027	15,942	23,890	13,676	6,971	4,776	2,996	7,036
1970	2,299	1,774	1,268	1,313	2,946	8,533	20,055	25,916	23,673	10,474	4,907	4,545	8,975
1971	2,960	2,205	1,731	1,461	1,714	6,246	20,161	26,652	22,157	10,652	5,146	2,820	8,659
1972	2,106	1,546	1,271	1,409	1,663	4,137	9,967	22,345	14,200	8,867	5,321	4,655	6,457
1973	2,437	1,684	1,550	1,406	2,356	6,002	12,918	17,945	25,847	11,354	5,785	3,876	7,763
1974	2,356	1,781	1,392	1,569	2,094	5,470	9,654	17,655	18,943	8,796	5,268	3,104	6,507
1975	2,432	1,737	1,337	1,326	2,018	7,635	11,875	18,974	20,600	10,255	5,100	3,146	7,203
1976	2,181	1,919	1,415	1,418	2,293	5,440	9,575	20,171	13,020	10,802	6,028	3,348	6,467
1977	2,348	1,718	1,810	2,034	2,086	2,906	9,020	12,630	14,307	7,468	5,227	3,016	5,381
1978	2,528	1,723	1,512	1,373	2,900	8,492	15,752	25,729	20,147	11,847	4,594	2,971	8,297
1979	2,283	1,931	1,564	1,514	2,916	6,188	10,185	15,775	16,413	8,479	4,115	2,852	6,185
1980	2,110	1,758	1,436	1,455	2,167	5,723	12,486	18,935	23,440	10,970	5,038	3,314	7,403
1981	2,500	2,009	1,636	1,559	3,369	11,113	19,994	21,635	18,403	11,536	6,292	4,248	8,691
1982	2,944	2,289	1,845	2,080	2,175	5,023	9,419	19,064	16,260	13,731	5,327	3,472	6,969
1983	2,633	2,141	1,979	1,876	2,097	3,841	7,543	15,181	17,593	10,824	6,647	4,061	6,368
1984	3,037	2,267	1,672	1,551	2,482	5,702	14,660	16,868	14,967	8,490	4,815	2,879	6,616
1985	2,167	1,763	1,333	1,235	2,000	6,905	10,861	17,784	18,657	8,421	5,624	3,888	6,720
1986	2,475	1,880	1,360	1,229	3,804	8,168	11,237	14,135	13,483	7,385	4,480	2,722	6,030
1987	2,066	1,633	1,347	1,199	1,333	3,308	5,656	13,846	13,650	8,844	4,468	2,875	5,019
1988	1,917	1,474	1,271	1,196	2,717	4,365	7,332	16,336	12,634	7,709	3,847	2,477	5,273
1989	1,632	1,254	1,057	1,049	1,865	5,871	8,480	13,726	12,059	11,298	5,199	2,801	5,524
1990	2,014	1,557	1,540	1,229	2,243	10,450	15,223	16,306	13,803	9,526	4,956	2,933	6,815
1991	2,025	1,531	1,303	1,464	1,798	4,675	12,178	18,903	15,367	8,563	5,237	3,187	6,353
1992	2,257	1,754	1,505	1,532	1,599	3,386	8,118	10,531	9,360	5,938	3,973	2,439	4,366
1993	1,774	1,287	1,224	1,108	2,022	4,618	14,444	15,974	15,141	7,113	4,485	2,562	5,979
1994	2,530	2,222	1,950	2,352	2,719	11,614	19,758	26,794	21,825	11,513	4,687	3,831	9,316
1995	2,717	2,105	1,871	1,828	2,371	6,244	14,360	26,532	26,503	11,800	5,524	4,003	8,822
1996	2,745	2,254	1,983	2,232	3,440	5,419	11,529	23,716	22,400	13,420	6,788	3,988	8,326
1997	2,675	2,186	1,919	2,295	2,438	3,949	17,171	22,861	21,997	12,129	4,829	3,126	8,131
1998	2,390	1,875	1,621	1,852	2,520	4,559	14,196	15,271	17,209	5,903	3,871	2,545	6,151
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**2,384**	**1,858**	**1,548**	**1,526**	**2,292**	**6,430**	**12,720**	**18,961**	**18,039**	**10,058**	**5,339**	**3,318**	**7,040**
Max	**3,037**	**2,289**	**1,983**	**2,352**	**3,804**	**11,756**	**20,161**	**26,794**	**27,083**	**17,063**	**9,091**	**4,655**	**9,316**
Min	**1,632**	**1,254**	**1,057**	**1,049**	**1,274**	**2,906**	**5,656**	**10,531**	**9,360**	**5,903**	**3,418**	**2,439**	**4,366**

Source: MRC HYMOS Database

Table 7.10 Monthly Mean Discharge at Mukdahan

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	2,183	1,758	1,462	1,588	2,136	9,583	12,043	18,855	28,507	19,074	6,441	3,792	8,952
1962	2,769	2,008	1,599	1,448	2,330	8,738	13,168	20,635	17,307	10,305	4,592	2,762	7,305
1963	2,042	1,654	1,443	1,286	1,380	7,441	18,066	28,703	22,363	9,975	9,166	4,180	8,975
1964	2,674	2,040	1,732	1,698	2,751	7,632	15,425	18,652	23,147	16,245	6,789	4,095	8,573
1965	2,719	2,187	1,787	1,588	1,898	13,012	16,100	18,971	17,453	8,757	9,533	4,446	8,204
1966	3,028	2,259	1,845	1,651	2,449	8,216	17,442	26,539	31,390	12,535	6,609	3,895	9,821
1967	2,849	2,282	1,959	1,578	2,132	5,884	9,334	15,823	19,307	12,596	4,614	3,274	6,803
1968	2,172	1,859	1,620	1,223	2,796	5,949	11,182	16,414	17,487	10,454	6,299	3,304	6,730
1969	2,058	1,672	1,261	1,259	1,462	9,762	17,829	25,600	14,760	7,245	4,715	2,594	7,518
1970	2,003	1,606	1,263	1,424	2,988	8,690	20,210	26,152	24,383	10,713	5,077	4,634	9,095
1971	3,035	2,221	1,780	1,458	1,657	6,950	21,703	27,274	22,340	12,298	5,582	2,880	9,098
1972	2,127	1,627	1,295	1,440	1,671	4,592	11,546	25,597	15,640	9,744	5,767	4,831	7,156
1973	2,464	1,698	1,562	1,514	2,338	6,087	13,215	18,223	27,340	11,855	5,606	3,680	7,965
1974	2,205	1,775	1,483	1,659	2,156	5,925	9,728	19,535	20,083	8,861	5,377	3,113	6,825
1975	2,489	1,812	1,451	1,419	2,027	7,781	12,047	20,065	21,710	10,341	5,265	3,169	7,465
1976	2,210	1,943	1,465	1,505	2,272	5,755	10,051	21,094	12,783	10,889	6,276	3,359	6,634
1977	2,310	1,829	1,865	2,029	2,064	2,815	8,899	12,323	14,637	7,569	5,306	2,991	5,386
1978	2,447	1,781	1,616	1,469	2,839	8,728	15,571	28,519	20,747	12,138	4,700	2,945	8,625
1979	2,253	1,949	1,637	1,546	2,997	6,581	10,700	16,264	16,523	8,627	4,008	2,642	6,310
1980	1,930	1,561	1,402	1,424	2,018	5,557	12,198	18,510	24,713	10,881	5,225	3,260	7,390
1981	2,396	1,948	1,678	1,573	3,240	11,569	20,500	22,081	18,167	11,471	6,489	4,255	8,781
1982	2,795	2,091	1,700	1,857	2,017	4,991	10,351	21,055	18,170	15,311	5,648	3,384	7,447
1983	2,402	1,919	1,754	1,704	1,994	3,944	8,100	16,810	19,757	12,326	7,085	3,809	6,800
1984	2,723	1,974	1,445	1,459	2,511	6,211	16,839	20,677	17,583	10,258	5,698	3,175	7,546
1985	2,401	1,979	1,668	1,542	2,184	8,265	12,639	20,448	20,737	10,204	6,614	4,512	7,766
1986	2,789	2,135	1,690	1,501	4,397	9,751	13,080	16,519	15,720	8,764	5,269	3,074	7,057
1987	2,327	1,928	1,624	1,449	1,616	3,810	7,438	16,696	16,163	10,274	5,175	3,283	5,982
1988	2,215	1,774	1,571	1,650	3,302	5,374	8,738	18,955	13,996	9,068	4,499	2,830	6,164
1989	1,958	1,579	1,369	1,353	2,220	7,162	10,062	16,432	14,103	13,100	6,168	3,195	6,558
1990	2,325	1,859	1,845	1,483	2,628	12,729	17,703	19,419	17,063	11,592	6,028	3,346	8,168
1991	2,368	1,930	1,684	1,845	2,177	5,327	14,419	22,929	17,867	10,654	6,555	3,541	7,608
1992	2,785	2,276	1,777	1,726	1,818	3,835	9,836	12,833	11,238	7,352	4,643	2,769	5,241
1993	2,052	1,651	1,548	1,453	2,298	4,971	15,926	17,903	16,683	7,750	4,678	2,705	6,635
1994	2,084	1,802	1,494	1,877	2,259	11,793	19,933	26,217	21,478	11,551	4,443	3,469	9,033
1995	2,479	1,861	1,632	1,457	2,248	6,430	14,057	25,317	25,547	11,481	5,532	3,658	8,475
1996	2,273	1,846	1,683	1,841	2,970	4,799	10,745	23,932	23,693	13,287	6,263	3,360	8,058
1997	2,398	1,918	1,644	1,986	2,202	3,874	17,423	23,845	21,830	11,669	4,653	2,888	8,027
1998	2,094	1,683	1,455	1,655	2,248	4,360	13,771	14,342	16,244	5,622	3,452	2,199	5,760
1999	1,751	1,502	1,343	1,514	4,098	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**2,374**	**1,876**	**1,593**	**1,567**	**2,379**	**6,970**	**13,632**	**20,530**	**19,438**	**10,864**	**5,680**	**3,403**	**7,525**
Max	**3,035**	**2,282**	**1,959**	**2,029**	**4,397**	**13,012**	**21,703**	**28,703**	**31,390**	**19,074**	**9,533**	**4,831**	**9,821**
Min	**1,751**	**1,502**	**1,261**	**1,223**	**1,380**	**2,815**	**7,438**	**12,323**	**11,238**	**5,622**	**3,452**	**2,199**	**5,241**

Source: MRC HYMOS Database

Table 7.11 Monthly Mean Discharge at Khon Chiam

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	-	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-	-
1966	3,130	2,576	2,313	2,228	3,548	8,688	18,077	29,484	37,670	14,729	6,746	4,011	11,100
1967	3,108	2,638	2,400	1,685	2,368	6,530	9,949	17,042	22,427	15,690	5,704	3,932	7,789
1968	2,445	1,887	1,581	1,372	2,980	6,270	10,858	18,558	23,823	11,471	6,320	3,034	7,550
1969	2,213	1,951	1,745	1,512	1,677	9,531	19,845	26,977	18,213	9,789	6,048	3,202	8,559
1970	2,331	1,913	1,610	1,741	3,257	9,012	20,413	30,535	29,740	12,976	5,917	4,608	10,338
1971	2,859	2,050	1,698	1,606	2,400	7,969	25,361	29,165	25,297	13,584	7,055	4,682	10,310
1972	3,662	2,846	2,209	2,306	2,863	6,395	13,347	31,281	18,990	11,751	6,799	5,572	9,002
1973	3,390	2,255	1,863	1,684	2,700	6,574	14,797	20,216	30,920	13,357	7,006	4,704	9,122
1974	2,685	2,168	1,738	2,015	2,752	8,109	11,078	28,055	26,920	11,376	6,352	3,666	8,909
1975	2,905	2,223	1,755	1,641	2,645	9,698	15,232	26,281	29,433	15,445	7,480	4,260	9,917
1976	3,067	2,631	2,164	2,422	3,602	6,657	12,894	26,658	16,783	14,735	8,966	3,939	8,710
1977	2,203	1,475	1,518	1,688	1,933	3,075	9,558	15,448	23,713	10,240	6,044	3,420	6,693
1978	2,805	1,842	1,631	1,504	2,888	8,217	19,242	40,539	31,160	22,094	7,194	3,390	11,875
1979	2,559	2,110	1,755	1,648	3,552	9,691	15,115	22,783	20,557	12,783	5,125	3,569	8,437
1980	2,713	2,157	1,892	1,876	2,775	7,316	15,577	23,094	34,053	17,355	8,905	5,005	10,226
1981	3,619	2,785	2,371	2,246	4,044	17,228	26,948	31,568	23,423	14,965	8,126	5,594	11,910
1982	3,811	3,094	2,318	2,329	2,577	5,660	11,040	22,771	25,033	20,171	7,414	4,275	9,208
1983	3,134	2,464	2,115	2,115	2,366	4,987	9,397	21,868	22,963	16,006	10,121	5,371	8,576
1984	3,568	2,542	1,811	1,669	3,240	7,401	18,535	29,806	24,717	13,294	7,342	3,944	9,822
1985	2,803	2,161	1,885	1,706	2,679	12,358	14,842	27,032	26,587	13,001	7,672	5,400	9,844
1986	3,309	2,489	1,986	1,721	4,884	10,606	17,168	24,974	23,620	11,347	6,316	3,712	9,344
1987	2,642	2,148	1,817	1,562	1,845	4,450	9,435	20,513	21,697	12,777	6,282	4,051	7,435
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	2,442	1,823	1,504	1,581	2,774	8,061	11,249	20,919	17,383	14,529	7,264	4,088	7,801
1990	3,012	2,214	2,283	1,846	2,933	13,065	19,577	24,061	24,247	15,358	7,915	4,339	10,071
1991	2,970	2,165	1,975	1,955	2,192	5,516	15,330	28,697	26,223	15,113	8,154	4,163	9,538
1992	3,467	2,819	2,494	2,094	2,163	5,012	10,906	18,039	15,650	9,348	5,803	3,464	6,772
1993	2,403	1,954	1,845	1,775	2,626	4,934	15,078	17,890	18,012	8,042	4,705	2,713	6,831
1994	1,973	1,742	1,449	1,764	2,133	10,887	19,968	26,943	24,832	12,544	4,511	3,457	9,350
1995	2,537	2,010	1,835	1,620	2,282	5,890	13,383	26,040	27,319	13,426	6,470	3,893	8,892
1996	2,631	2,025	1,876	2,021	2,893	4,823	11,251	24,581	27,770	15,658	8,274	4,627	9,036
1997	2,991	2,023	1,793	2,135	2,372	3,858	18,418	28,574	23,797	13,120	5,023	3,196	8,942
1998	2,274	1,883	1,651	1,783	2,338	4,074	13,808	14,677	18,310	6,395	3,843	2,597	6,136
1999	1,935	1,727	1,616	1,789	4,317	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**2,836**	**2,206**	**1,894**	**1,838**	**2,806**	**7,579**	**15,240**	**24,846**	**24,415**	**13,515**	**6,778**	**4,059**	**9,001**
Max	**3,811**	**3,094**	**2,494**	**2,422**	**4,884**	**17,228**	**26,948**	**40,539**	**37,670**	**22,094**	**10,121**	**5,594**	**11,910**
Min	**1,935**	**1,475**	**1,449**	**1,372**	**1,677**	**3,075**	**9,397**	**14,677**	**15,650**	**6,395**	**3,843**	**2,597**	**6,136**

Source: MRC HYMOS Database

Table 7.12 Monthly Mean Discharge at Pakse

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1,961	2,371	1,850	1,559	1,704	2,607	13,344	17,448	25,845	38,530	27,423	8,908	4,071	12,138
1,962	2,908	2,203	1,772	1,549	2,836	10,867	18,239	26,819	25,027	17,442	7,376	3,156	10,016
1,963	2,220	1,743	1,418	1,282	1,476	9,065	18,499	31,977	25,310	14,108	11,007	5,149	10,271
1,964	2,841	2,154	1,813	1,795	3,287	8,776	17,090	20,861	29,140	22,477	9,748	4,922	10,409
1,965	2,950	2,325	1,899	1,710	2,137	15,514	19,790	21,839	21,387	11,309	10,152	4,671	9,640
1,966	4,350	3,098	2,038	1,652	4,142	9,872	19,275	30,807	40,031	15,616	7,727	4,669	11,940
1,967	3,383	2,567	2,096	1,704	2,505	6,789	10,388	18,365	24,190	17,266	5,835	4,046	8,261
1,968	2,565	2,103	1,746	1,557	3,284	6,081	11,634	19,955	26,040	12,185	7,068	3,559	8,148
1,969	2,370	1,841	1,488	1,362	1,646	10,062	21,200	28,658	19,680	10,433	6,339	3,198	9,023
1,970	2,190	1,723	1,393	1,568	3,035	9,821	22,661	32,635	32,153	14,195	6,522	4,972	11,072
1,971	3,138	2,217	1,781	1,600	2,082	8,827	27,645	30,965	26,870	14,345	7,186	4,009	10,889
1,972	2,956	2,330	1,870	1,988	2,197	6,875	14,230	34,271	21,223	14,113	8,192	5,860	9,675
1,973	3,245	2,288	1,911	1,751	2,879	7,099	15,861	22,055	32,207	15,864	7,570	4,832	9,797
1,974	2,950	2,318	1,831	2,105	2,936	8,978	11,249	29,071	28,173	12,621	7,193	4,059	9,457
1,975	2,977	2,333	1,777	1,696	2,627	10,464	16,439	27,526	31,023	17,568	9,221	4,051	10,642
1,976	2,731	2,370	1,994	2,042	3,280	7,221	12,867	27,690	18,057	16,542	10,085	4,658	9,128
1,977	2,645	1,946	1,978	2,196	2,420	3,210	10,427	17,016	23,733	11,683	6,800	3,673	7,311
1,978	3,135	2,250	1,901	1,795	3,122	10,594	20,203	41,940	32,333	22,971	7,971	3,914	12,677
1,979	2,911	2,385	1,990	1,945	4,066	11,449	17,332	25,330	23,493	13,726	5,365	3,456	9,454
1,980	2,479	1,950	1,741	1,745	2,648	7,693	16,042	23,342	34,647	18,026	9,459	4,431	10,350
1,981	3,030	2,426	2,145	2,125	3,883	17,551	27,171	32,523	23,507	15,558	8,677	5,489	12,007
1,982	3,561	2,765	2,201	2,319	2,645	6,111	12,286	23,284	26,027	21,110	8,125	4,370	9,567
1,983	3,020	2,336	2,208	2,071	2,395	5,391	9,611	19,874	23,633	17,219	11,023	5,517	8,692
1,984	3,494	2,462	1,877	1,674	3,305	8,158	19,548	32,023	26,960	14,719	8,183	4,082	10,540
1,985	2,908	2,245	2,008	1,828	2,666	11,753	15,861	27,445	26,873	13,999	7,964	5,298	10,071
1,986	3,023	2,358	1,937	1,747	4,752	11,619	16,037	23,426	21,140	11,206	6,729	3,763	8,978
1,987	2,521	2,135	1,859	1,685	1,918	4,414	10,806	21,029	22,263	13,416	6,394	4,046	7,707
1,988	2,641	1,889	1,665	1,607	3,444	7,513	9,557	22,813	16,327	12,045	5,722	3,142	7,364
1,989	2,061	1,667	1,482	1,513	2,642	8,690	12,358	23,158	19,307	15,971	7,562	3,684	8,341
1,990	2,680	2,294	2,425	2,091	2,898	13,719	19,984	24,058	24,637	16,419	8,239	4,211	10,305
1,991	2,802	2,039	1,748	1,827	2,159	5,821	16,916	30,206	27,700	16,565	8,809	4,091	10,057
1,992	2,887	2,236	1,910	1,762	2,014	5,262	12,076	20,006	17,513	10,544	5,961	3,119	7,107
1,993	2,324	1,731	1,575	1,449	2,451	5,822	17,959	21,619	21,793	9,996	5,783	3,147	7,971
1,994	2,264	2,029	1,647	2,005	2,440	12,853	23,240	29,495	28,234	14,985	5,425	3,984	10,717
1,995	2,819	2,089	1,868	1,650	2,586	7,004	16,014	28,826	29,962	15,751	7,708	4,266	10,045
1,996	2,813	2,218	2,041	2,154	3,583	5,730	12,887	27,095	30,453	19,705	10,927	5,459	10,422
1,997	2,898	2,282	1,919	2,402	2,677	3,397	20,953	32,941	26,737	14,856	5,541	3,312	9,993
1,998	2,557	1,975	1,707	1,881	2,636	4,811	15,019	16,150	20,111	7,400	4,510	2,921	6,807
1,999	1,982	1,734	1,502	1,778	4,907	12,556	15,425	23,823	26,175	15,073	10,416	4,646	10,001
2,000	2,880	2,399	2,349	2,427	7,202	15,348	28,706	27,451	36,393	15,178	7,561	4,099	12,666
Mean	**2,812**	**2,183**	**1,852**	**1,819**	**2,960**	**8,903**	**16,773**	**26,105**	**26,225**	**15,291**	**7,775**	**4,200**	**9,741**
Max	**4,350**	**3,098**	**2,425**	**2,427**	**7,202**	**17,551**	**28,706**	**41,940**	**40,031**	**27,423**	**11,023**	**5,860**	**12,677**
Min	**1,982**	**1,667**	**1,393**	**1,282**	**1,476**	**3,210**	**9,557**	**16,150**	**16,327**	**7,400**	**4,510**	**2,921**	**6,807**

Source: MRC HYMOS Database

Table 7.13 Monthly Mean Discharge at Stung Treng

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	3,185	2,333	1,981	2,028	4,044	16,687	27,942	38,974	49,053	37,490	12,536	5,830	16,840
1962	3,958	2,968	2,533	2,176	3,818	15,097	25,198	38,530	35,759	24,579	10,587	4,969	14,181
1963	3,022	2,249	1,877	1,751	1,879	10,513	23,135	41,689	35,660	20,935	13,922	6,557	13,599
1964	3,679	2,556	1,965	1,926	4,353	9,809	19,781	27,419	37,877	30,687	15,314	7,257	13,552
1965	3,951	2,833	2,211	2,008	2,648	19,312	26,513	28,100	30,497	15,065	12,016	5,952	12,592
1966	4,282	3,127	2,593	2,365	5,104	10,506	25,545	39,058	47,817	19,239	9,848	5,659	14,595
1967	4,148	3,168	2,677	1,936	3,320	8,413	14,704	27,761	34,017	24,316	8,215	5,272	11,496
1968	3,472	2,839	2,012	1,823	3,538	6,609	13,571	29,052	36,727	16,145	8,048	3,507	10,612
1969	3,374	2,666	1,756	1,491	1,828	10,764	28,623	37,645	32,413	16,342	8,355	4,363	12,468
1970	3,240	2,569	1,606	719	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	17,177	-	8,797	7,120	-	-	-	-
1991	4,299	3,195	2,537	2,537	3,115	7,603	22,819	43,123	42,410	26,768	11,824	6,051	14,690
1992	4,307	2,927	2,475	2,285	2,820	8,337	16,701	33,211	27,865	16,307	9,789	5,034	11,005
1993	3,506	2,385	2,106	1,852	3,233	7,303	22,427	31,573	31,901	16,801	8,372	5,875	11,445
1994	3,258	2,510	1,957	2,423	3,239	16,142	34,106	41,921	44,327	21,782	8,281	5,984	15,494
1995	4,136	3,009	2,454	1,993	3,210	8,508	20,401	37,938	43,042	23,945	11,560	6,312	13,876
1996	-	-	-	2,990	5,885	8,536	18,904	38,954	46,375	30,628	18,826	8,970	-
1997	4,979	3,726	2,719	3,492	4,113	6,685	28,246	48,151	37,759	23,194	8,846	5,232	14,762
1998	3,747	2,804	2,096	2,250	3,512	6,036	17,651	20,401	26,925	12,783	9,266	6,337	9,484
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**3,797**	**2,815**	**2,209**	**2,114**	**3,509**	**10,780**	**22,722**	**34,017**	**35,975**	**22,177**	**10,918**	**5,833**	**13,168**
Max	**4,979**	**3,726**	**2,719**	**3,492**	**5,885**	**19,312**	**34,106**	**48,151**	**49,053**	**37,490**	**18,826**	**8,970**	**16,840**
Min	**3,022**	**2,249**	**1,606**	**719**	**1,828**	**6,036**	**13,571**	**8,797**	**7,120**	**12,783**	**8,048**	**3,507**	**9,484**

Source: MRC HYMOS Database

Table 7.14 Monthly Mean Discharge at Kratie

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	4,578	3,106	2,564	2,612	4,537	15,946	26,619	44,819	47,580	32,400	12,677	6,887	17,027
1962	4,015	2,996	2,352	2,197	2,980	11,904	34,474	46,703	56,090	21,532	8,457	5,183	16,574
1963	3,731	3,015	2,481	2,235	3,416	13,430	26,645	44,426	39,400	31,406	17,817	7,798	16,317
1964	4,237	3,068	2,268	2,278	4,087	11,666	29,181	42,168	39,823	22,019	13,395	5,861	15,004
1965	3,805	2,674	2,401	2,789	3,355	14,852	24,577	35,513	44,553	26,187	12,455	5,284	14,870
1966	3,823	3,037	2,334	2,061	3,342	7,995	20,732	38,910	29,680	25,232	14,447	7,454	13,254
1967	4,260	3,058	2,469	2,270	4,686	16,622	28,119	30,229	43,937	20,135	10,548	6,219	14,379
1968	4,067	2,700	2,086	1,888	4,551	15,386	23,397	35,987	46,533	25,903	12,294	6,161	15,079
1969	3,899	2,995	2,132	2,262	6,421	11,618	32,852	37,910	45,857	23,090	10,497	5,418	15,413
1970	3,671	2,708	2,110	2,161	4,378	12,430	23,971	36,390	50,220	27,603	13,474	6,920	15,503
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**4,008**	**2,936**	**2,320**	**2,275**	**4,175**	**13,185**	**27,057**	**39,305**	**44,367**	**25,551**	**12,606**	**6,319**	**15,342**
Max	**4,578**	**3,106**	**2,564**	**2,789**	**6,421**	**16,622**	**34,474**	**46,703**	**56,090**	**32,400**	**17,817**	**7,798**	**17,027**
Min	**3,671**	**2,674**	**2,086**	**1,888**	**2,980**	**7,995**	**20,732**	**30,229**	**29,680**	**20,135**	**8,457**	**5,183**	**13,254**

Source: MRC HYMOS Database

Table 7.15 Monthly Mean Discharge at Kompong Cham

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	-	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	3,590	2,547	1,985	1,842	4,192	10,317	19,723	27,606	38,773	33,026	14,713	6,948	13,772
1965	4,041	2,907	2,268	1,956	2,473	16,624	27,768	30,565	33,453	16,474	12,137	5,793	13,038
1966	4,403	2,930	2,285	1,987	4,469	10,241	24,332	40,065	50,527	22,371	11,097	7,094	15,150
1967	4,380	3,255	2,424	1,727	2,469	8,150	15,619	29,045	38,157	29,584	9,020	5,539	12,447
1968	3,138	2,205	1,877	1,774	3,280	6,821	14,765	30,935	39,843	18,942	9,912	5,052	11,545
1969	2,733	1,955	1,662	1,666	1,634	10,714	29,261	40,655	36,480	19,352	10,560	5,310	13,499
1970	3,184	1,979	1,650	1,528	2,781	12,080	29,890	39,826	42,440	21,510	11,623	7,895	14,699
1971	4,810	2,644	1,996	1,679	1,892	12,468	33,997	37,365	36,367	21,100	11,140	6,525	14,332
1972	4,073	2,603	1,837	2,194	2,063	9,681	23,761	42,497	39,660	21,616	12,062	8,602	14,221
1973	4,627	2,706	2,260	2,140	3,364	7,943	19,965	29,003	41,447	27,355	12,883	7,260	13,413
1974	3,813	2,645	2,270	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**3,890**	**2,580**	**2,047**	**1,849**	**2,862**	**10,504**	**23,908**	**34,756**	**39,715**	**23,133**	**11,515**	**6,602**	**13,612**
Max	**4,810**	**3,255**	**2,424**	**2,194**	**4,469**	**16,624**	**33,997**	**42,497**	**50,527**	**33,026**	**14,713**	**8,602**	**15,150**
Min	**2,733**	**1,955**	**1,650**	**1,528**	**1,634**	**6,821**	**14,765**	**27,606**	**33,453**	**16,474**	**9,020**	**5,052**	**11,545**

Source: MRC HYMOS Database

Table 7.16 Monthly Mean Discharge at Chrui Changvar

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	3,488	2,497	2,065	1,933	3,462	14,691	27,900	33,719	44,187	36,394	14,300	7,213	15,987
1962	4,255	3,185	2,538	2,153	3,403	13,487	24,622	35,849	34,580	23,848	11,914	5,491	13,777
1963	3,375	2,416	1,939	1,783	1,789	8,628	20,610	37,932	34,133	21,897	13,634	7,103	12,937
1964	3,658	2,599	2,006	1,864	3,419	8,620	18,084	25,532	35,567	32,119	14,076	7,192	12,895
1965	4,132	2,934	2,311	1,958	2,369	14,872	27,271	30,190	31,143	16,635	11,820	5,668	12,609
1966	3,126	1,998	1,756	1,696	4,295	9,539	23,210	37,790	42,450	22,087	11,169	6,556	13,806
1967	3,724	2,223	1,805	2,596	3,523	7,514	13,744	27,235	35,760	24,823	9,065	5,315	11,444
1968	2,825	1,977	1,757	1,658	3,037	5,563	12,273	27,765	37,387	16,694	8,311	4,283	10,294
1969	2,296	1,841	1,712	1,630	1,691	8,367	25,390	38,016	37,303	21,445	9,553	5,042	12,857
1970	2,659	1,902	1,717	1,675	2,594	9,983	26,729	36,165	40,960	23,261	10,574	6,662	13,740
1971	3,939	2,204	1,830	1,732	2,041	10,255	30,352	35,290	37,863	23,658	10,901	6,134	13,850
1972	3,405	2,078	1,748	2,227	2,099	8,874	22,400	39,758	40,750	19,971	11,229	7,107	13,471
1973	3,974	2,748	2,345	2,201	3,629	7,313	18,563	28,271	40,533	31,348	11,749	6,925	13,300
1974	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**3,450**	**2,354**	**1,964**	**1,931**	**2,873**	**9,824**	**22,396**	**33,347**	**37,894**	**24,168**	**11,407**	**6,207**	**13,151**
Max	**4,255**	**3,185**	**2,538**	**2,596**	**4,295**	**14,872**	**30,352**	**39,758**	**44,187**	**36,394**	**14,300**	**7,213**	**15,987**
Min	**2,296**	**1,841**	**1,712**	**1,630**	**1,691**	**5,563**	**12,273**	**25,532**	**31,143**	**16,635**	**8,311**	**4,283**	**10,294**

Source: MRC HYMOS Database

Table 7.19 Comparison of Monthly Mean Discharges on Mekong Mainstream (1/5)

Month: January

Year	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nong Khai	Nakhon Phanom	Mukdahan	Khon Chiam	Pakse	Stung Treng	Kratie	Kompong Cham	Chroui Changvar
1961	935	1,527		1,557		2,147	2,183		2,371	3,185	4,578		3,488
1962	1,106	1,830		1,919		2,607	2,769		2,908	3,958	4,015		4,255
1963	905	1,381		1,454		2,013	2,042		2,220	3,022	3,731		3,375
1964	1,072	1,786		1,921		2,568	2,674		2,841	3,679	4,237	3,590	3,658
1965	1,130	1,822		1,992		2,696	2,719		2,950	3,951	3,805	4,041	4,132
1966	1,426	2,165		2,345		3,019	3,028	3,130	4,350	4,282	3,823	4,403	3,126
1967	1,323	2,107		2,379		2,820	2,849	3,108	3,383	4,148	4,260	4,380	3,724
1968	1,312	1,762	1,800	1,885		2,271	2,172	2,445	2,565	3,472	4,067	3,138	2,825
1969	1,108	1,497	1,484	1,762		1,912	2,058	2,213	2,370	3,374	3,899	2,733	2,296
1970	982	1,314	1,275	1,474	1,550	2,299	2,003	2,331	2,190	3,240	3,671	3,184	2,659
1971	1,388	2,015	1,933	2,215	2,153	2,960	3,035	2,859	3,138			4,810	3,909
1972	1,301	1,935	1,810	1,780	1,878	2,106	2,127	3,662	2,956			4,073	3,405
1973	1,175	1,875	1,910	1,809	2,032	2,437	2,464	3,390	3,245			4,627	3,974
1974	1,133	1,841	1,859	1,890	1,913	2,356	2,206	2,685	2,960			3,813	
1975	1,267	1,796	1,802	1,855	1,886	2,432	2,489	2,905	2,977				
1976	994	1,389	1,539	1,609	1,694	2,161	2,210	3,067	2,731				
1977	1,057	1,549	1,778	1,860	1,846	2,348	2,310	2,203	2,645				
1978	1,225	2,153	2,131	2,187	2,171	2,528	2,447	2,806	3,135				
1979	945	1,606	1,540	1,589	1,631	2,283	2,253	2,559	2,911				
1980	1,053	1,500	1,462	1,527	1,463	2,110	1,930	2,713	2,479				
1981	1,106	1,786	1,704	1,781	1,735	2,500	2,396	3,619	3,030				
1982	1,233	2,138	2,140	2,126	2,205	2,944	2,796	3,811	3,561				
1983	963	1,730	1,715	1,768	1,626	2,633	2,402	3,134	3,020				
1984	1,507	2,378	2,327	2,317	2,365	3,037	2,723	3,568	3,494				
1985	1,054	1,450	1,652	1,414	1,758	2,167	2,401	2,803	2,908				
1986	1,313	2,235	2,097	1,978	2,139	2,475	2,789	3,309	3,023				
1987	1,341	1,621	1,885	1,724	1,882	2,066	2,327	2,642	2,521				
1988	1,177	1,498	1,529	1,505	1,577	1,917	2,215		2,641				
1989	1,051	1,289	1,416	1,288	1,344	1,632	1,958	2,442	2,061				
1990	1,225	1,391	1,597	1,553	1,493	2,014	2,325	3,012	2,680				
1991	1,134	1,487	1,664	1,637	1,633	2,025	2,368	2,970	2,802	4,299			
1992	1,477	1,855	2,048	1,907	1,896	2,257	2,785	3,467	2,887	4,307			
1993	1,025	1,449	1,562	1,560	1,633	1,774	2,052	2,403	2,324	3,506			
1994	1,062	1,422	1,484	1,474	1,522	2,530	2,084	1,973	2,264	3,258			
1995	1,144	1,628	1,791	1,822	1,773	2,717	2,479	2,537	2,819	4,136			
1996	1,272	1,690	1,657	1,883	1,711	2,745	2,273	2,631	2,813				
1997	1,067	1,537	1,673	1,486	1,741	2,675	2,398	2,991	2,898	4,979			
1998	938	1,475	1,606	1,366	1,665	2,390	2,094	2,274	2,557	3,747			

Table 7.19 Comparison of Monthly Mean Discharges on Mekong Mainstream (2/5)

Month: February

Year	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nong Khai	Nakhon Phanom	Mukdahan	Khon Chiam	Pakse	Stung Treng	Kratie	Kompong Cham	Chroui Changvar
1961	800	1,261		1,318		1,722	1,758		1,850	2,333	3,106		2,497
1962	920	1,453		1,486		1,951	2,008		2,203	2,968	2,986		3,185
1963	729	1,162		1,204		1,576	1,654		1,743	2,249	3,015		2,416
1964	876	1,367		1,471		2,037	2,040		2,154	2,556	3,068	2,547	2,599
1965	937	1,471		1,584		2,186	2,187		2,325	2,833	2,674	2,907	2,934
1966	1,050	1,658		1,750		2,274	2,259	2,576	3,098	3,127	3,037	2,930	1,998
1967	1,023	1,649		1,799		2,223	2,282	2,638	2,567	3,168	3,058	3,255	2,223
1968	1,085	1,294	1,299	1,446		1,812	1,859	1,887	2,103	2,839	2,700	2,205	1,977
1969	822	1,108	1,109	1,338		1,585	1,672	1,951	1,841	2,696	2,985	1,955	1,841
1970	776	968	1,005	1,190	1,288	1,774	1,606	1,913	1,723	2,569	2,708	1,979	1,902
1971	1,072	1,514	1,405	1,667	1,639	2,205	2,221	2,050	2,217	-		2,644	2,204
1972	1,052	1,474	1,389	1,351	1,436	1,546	1,627	2,846	2,330	-		2,603	2,078
1973	981	1,334	1,361	1,281	1,519	1,684	1,698	2,255	2,288	-		2,706	2,748
1974	914	1,318	1,335	1,370	1,386	1,781	1,775	2,168	2,318	-		2,645	
1975	945	1,186	1,238	1,333	1,356	1,737	1,812	2,223	2,333	-			
1976	898	1,199	1,400	1,508	1,629	1,919	1,943	2,631	2,370	-			
1977	890	1,127	1,304	1,424	1,411	1,718	1,829	1,475	1,946	-			
1978	928	1,395	1,457	1,449	1,459	1,723	1,781	1,842	2,250	-			
1979	772	1,215	1,211	1,314	1,301	1,931	1,949	2,110	2,385	-			
1980	889	1,116	1,084	1,333	1,142	1,758	1,561	2,157	1,950	-			
1981	907	1,367	1,290	1,473	1,385	2,009	1,948	2,785	2,428	-			
1982	993	1,562	1,586	1,597	1,681	2,289	2,091	3,094	2,765	-			
1983	795	1,309	1,306	1,466	1,315	2,141	1,919	2,464	2,336	-			
1984	1,110	1,592	1,602	1,612	1,632	2,267	1,974	2,542	2,462	-			
1985	864	1,175	1,191	1,150	1,355	1,763	1,979	2,161	2,245	-			
1986	1,016	1,716	1,550	1,398	1,582	1,880	2,135	2,489	2,358	-			
1987	1,136	1,279	1,430	1,352	1,445	1,633	1,928	2,148	2,135	-			
1988	955	1,051	1,153	1,218	1,209	1,474	1,774	-	1,889	-			
1989	871	979	1,002	1,041	1,067	1,254	1,579	1,823	1,667	-			
1990	1,064	1,093	1,136	1,231	1,241	1,557	1,859	2,214	2,294	-			
1991	928	1,150	1,206	1,274	1,309	1,531	1,930	2,165	2,039	3,196			
1992	1,246	1,408	1,518	1,429	1,383	1,754	2,276	2,819	2,236	2,927			
1993	910	1,149	1,069	1,117	1,274	1,287	1,651	1,954	1,731	2,385			
1994	916	1,158	1,117	1,216	1,295	2,222	1,802	1,742	2,029	2,510			
1995	921	1,277	1,307	1,354	1,349	2,105	1,861	2,010	2,089	3,009			
1996	1,038	1,397	1,187	1,513	1,380	2,254	1,846	2,025	2,218	-			
1997	790	1,128	1,250	1,144	1,374	2,186	1,918	2,023	2,282	3,726			
1998	731	1,134	1,175	1,111	1,306	1,875	1,683	1,883	1,975	2,804			

Table 7.19 Comparison of Monthly Mean Discharges on Mekong Mainstream (3/5)

Month: March

Year	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nong Khai	Nakhon Phanom	Mukdahan	Khon Chiam	Pakse	Stung Treng	Kratie	Kompong Cham	Chroui Changvar
1961	765	1,065		1,077		1,422	1,462		1,559	1,981	2,564		2,065
1962	729	1,139		1,225		1,559	1,599		1,772	2,533	2,352		2,538
1963	654	1,058		1,074		1,368	1,443		1,418	1,877	2,481		1,938
1964	808	1,193		1,292		1,685	1,732		1,813	1,965	2,268	1,985	2,006
1965	730	1,145		1,271		1,690	1,787		1,899	2,211	2,401	2,268	2,311
1966	831	1,254		1,331		1,778	1,845	2,313	2,038	2,593	2,334	2,285	1,756
1967	954	1,395		1,512		1,870	1,959	2,400	2,096	2,677	2,469	2,424	1,805
1968	951	1,059	1,068	1,241		1,540	1,620	1,581	1,746	2,012	2,086	1,877	1,757
1969	616	899	897	1,027		1,225	1,281	1,745	1,488	1,756	2,132	1,662	1,712
1970	719	859	857	985	1,086	1,268	1,263	1,610	1,393	1,606	2,110	1,650	1,717
1971	893	1,109	1,108	1,308	1,295	1,731	1,780	1,698	1,781			1,996	1,830
1972	869	1,124	1,097	1,062	1,172	1,271	1,295	2,209	1,870			1,837	1,748
1973	995	1,333	1,305	1,292	1,475	1,550	1,562	1,863	1,911			2,260	2,345
1974	807	1,020	1,031	1,136	1,152	1,392	1,483	1,738	1,831			2,270	
1975	787	887	975	1,069	1,096	1,337	1,451	1,755	1,777				
1976	805	915	1,055	1,186	1,215	1,415	1,465	2,164	1,994				
1977	824	959	1,117	1,304	1,241	1,810	1,865	1,518	1,978				
1978	788	1,147	1,253	1,331	1,281	1,512	1,616	1,631	1,901				
1979	694	943	958	1,107	1,011	1,564	1,637	1,755	1,990				
1980	806	929	885	1,232	994	1,436	1,402	1,892	1,741				
1981	842	1,124	1,046	1,274	1,139	1,636	1,678	2,371	2,145				
1982	771	1,106	1,139	1,297	1,245	1,845	1,700	2,318	2,201				
1983	863	1,248	1,128	1,387	1,308	1,979	1,754	2,115	2,208				
1984	826	1,106	1,151	1,263	1,166	1,672	1,445	1,811	1,877				
1985	743	910	907	957	1,084	1,333	1,668	1,885	2,008				
1986	865	1,214	1,184	1,129	1,263	1,360	1,690	1,986	1,937				
1987	972	1,051	1,090	1,143	1,181	1,347	1,624	1,817	1,859				
1988	937	917	933	1,069	1,037	1,271	1,571		1,665				
1989	803	884	861	955	990	1,057	1,369	1,504	1,482				
1990	1,007	1,017	1,037	1,201	1,246	1,540	1,845	2,283	2,425				
1991	846	1,022	952	1,092	1,089	1,303	1,684	1,975	1,748	2,537			
1992	1,185	1,288	1,328	1,295	1,285	1,505	1,777	2,494	1,910	2,475			
1993	801	1,025	962	1,046	1,217	1,224	1,548	1,845	1,575	2,106			
1994	866	1,063	874	997	1,070	1,950	1,494	1,449	1,647	1,957			
1995	1,049	1,217	1,120	1,239	1,247	1,871	1,632		1,868	2,454			
1996	971	1,170	1,126	1,348	1,234	1,983	1,683	1,876	2,041				
1997	718	998	1,066	982	1,157	1,919	1,644	1,793	1,919	2,719			
1998	655	932	818	952	1,119	1,621	1,455	1,651	1,707	2,096			

Table 7.19 Comparison of Monthly Mean Discharges on Mekong Mainstream (4/5)

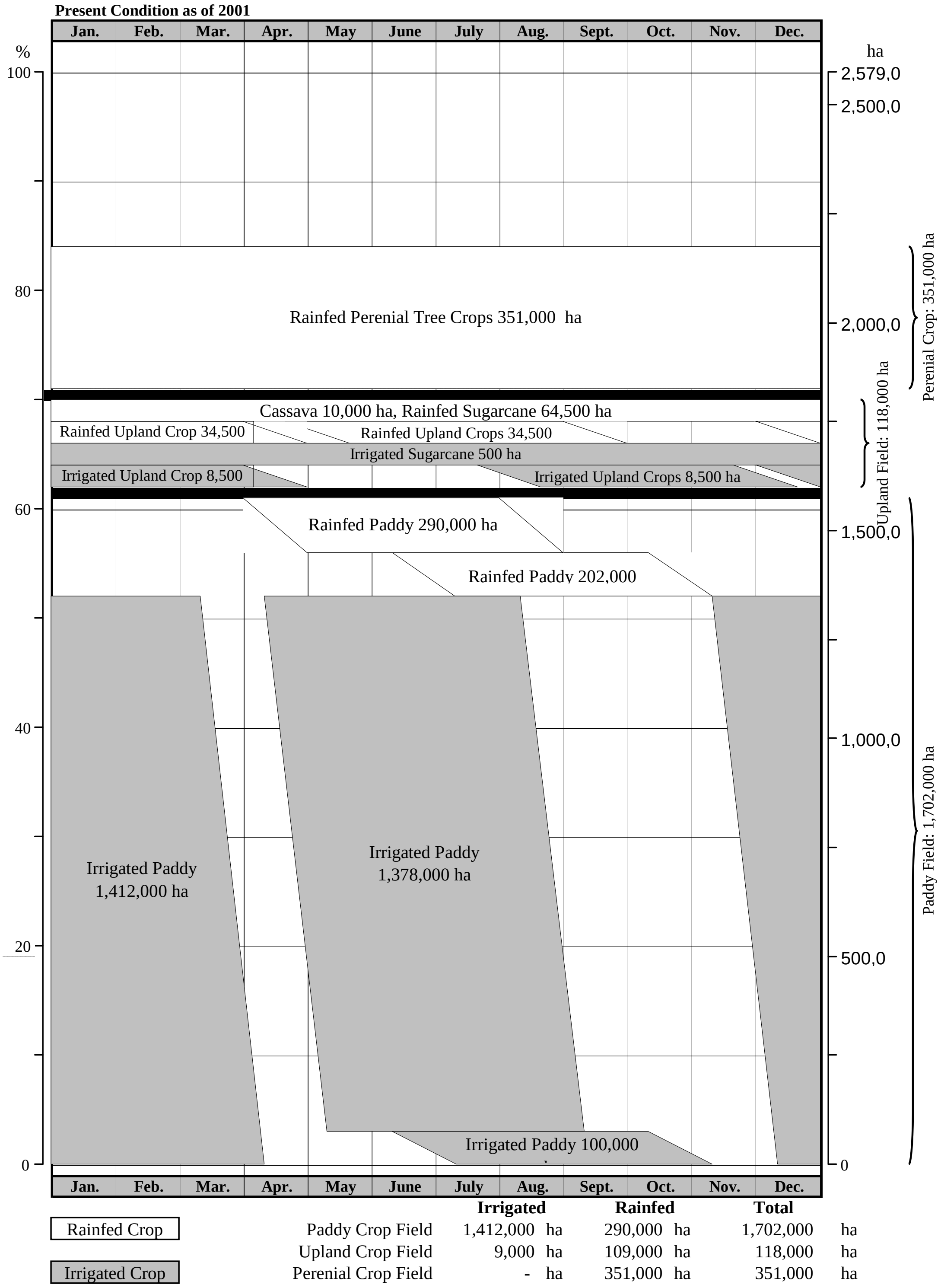
Month: April

Year	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nong Khai	Nakhon Phanom	Mukdahan	Khon Chiam	Pakse	Stung Treng	Kratie	Kompong Cham	Chroui Changvar
1961	954	1,242		1,320		1,576	1,588		1,704	2,028	2,612		1,933
1962	796	1,119		1,185		1,431	1,448		1,549	2,178	2,197		2,153
1963	642	1,005		969		1,238	1,286		1,282	1,751	2,235		1,783
1964	923	1,236		1,325		1,666	1,698		1,795	1,926	2,278	1,842	1,864
1965	726	1,093		1,153		1,560	1,588		1,710	2,008	2,789	1,956	1,958
1966	838	1,171		1,246		1,581	1,651	2,228	1,652	2,365	2,081	1,987	1,696
1967	923	1,278	1,155	1,352		1,455	1,578	1,685	1,704	1,936	2,270	1,727	2,596
1968	936	1,015	1,005	1,179		1,179	1,223	1,372	1,567	1,823	1,888	1,774	1,658
1969	700	865	848	919	969	1,155	1,259	1,512	1,362	1,491	2,262	1,666	1,630
1970	936	1,014	938	1,134	1,186	1,313	1,424	1,741	1,568	719	2,161	1,528	1,675
1971	950	1,057	1,111	1,166	1,239	1,461	1,458	1,606	1,600			1,679	1,732
1972	956	1,309	1,190	1,208	1,320	1,409	1,440	2,306	1,988			2,194	2,227
1973	1,004	1,173	1,174	1,298	1,334	1,406	1,514	1,684	1,751			2,140	2,201
1974	976	1,271	1,287	1,377	1,404	1,569	1,659	2,015	2,105				
1975	896	984	1,038	1,108	1,187	1,326	1,419	1,641	1,696				
1976	932	1,006	1,038	1,281	1,372	1,418	1,505	2,422	2,042				
1977	988	1,233	1,220	1,473	1,480	2,034	2,029	1,688	2,196				
1978	846	1,067	1,030	1,205	1,089	1,373	1,469	1,504	1,795				
1979	829	989	913	1,104	997	1,514	1,546	1,648	1,945				
1980	1,002	1,063	925	1,358	1,121	1,455	1,424	1,876	1,745				
1981	872	1,122	994	1,276	1,195	1,559	1,573	2,246	2,125				
1982	948	1,404	1,245	1,470	1,328	2,080	1,857	2,329	2,319				
1983	946	1,208	1,085	1,374	1,246	1,876	1,704	2,115	2,071				
1984	915	1,101	1,054	1,223	1,145	1,551	1,459	1,689	1,674				
1985	919	1,024	951	1,019	1,126	1,235	1,542	1,706	1,828				
1986	951	1,028	1,080	1,094	1,178	1,229	1,501	1,721	1,747				
1987	1,012	937	955	1,036	1,105	1,199	1,449	1,562	1,685				
1988	1,010	1,146	916	1,110	1,037	1,196	1,650		1,607				
1989	811	874	817	932	966	1,049	1,353	1,581	1,513				
1990	1,001	892	885	1,025	1,100	1,229	1,483	1,846	2,091				
1991	1,051	1,309	1,089	1,274	1,249	1,464	1,845	1,955	1,827	2,537			
1992	1,209	1,368	1,298	1,360	1,327	1,532	1,726	2,094	1,762	2,285			
1993	824	1,011	881	974	1,110	1,108	1,453	1,775	1,449	1,852			
1994	1,063	1,290	1,183	1,411	1,493	2,352	1,877	1,764	2,005	2,423			
1995	622	952	895	986	1,029	1,828	1,457		1,650	1,993			
1996	1,207	1,333	1,259	1,467	1,374	2,232	1,841	2,021	2,154	2,990			
1997	738	1,058	1,134	1,119	1,331	2,296	1,986	2,135	2,402	3,492			
1998	912	1,228	1,194	1,221	1,422	1,852	1,655	1,783	1,881	2,250			

Table 7.19 Comparison of Monthly Mean Discharges on Mekong Mainstream (5/5)

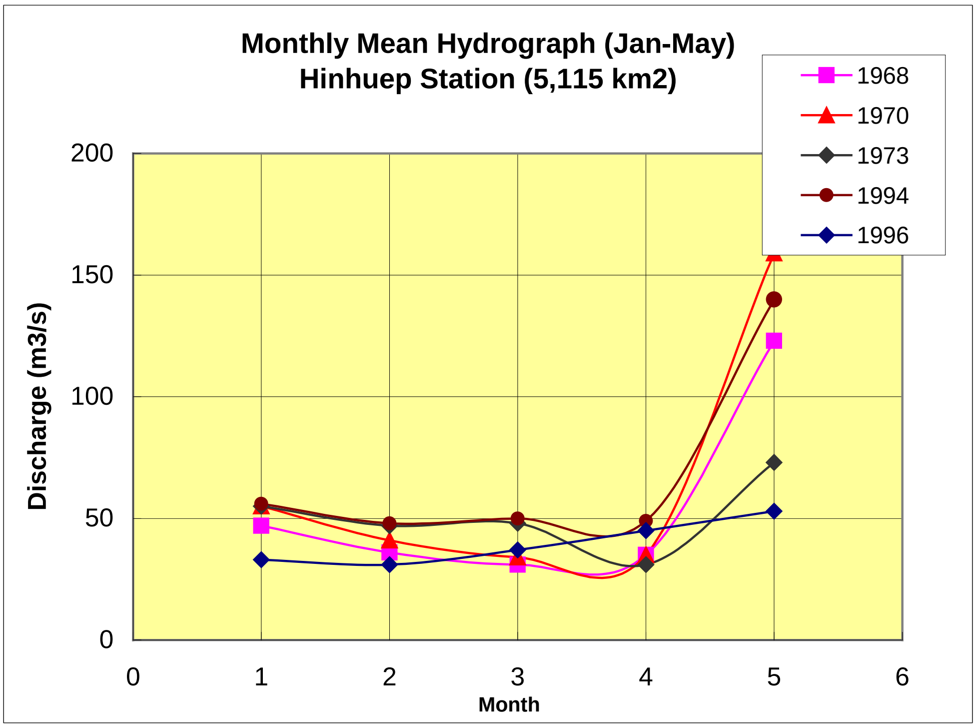
Month: May

Year	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nong Khai	Nakhon Phanom	Mukdahan	Khon Chiam	Pakse	Stung Treng	Kratie	Kompong Cham	Chroui Changvar
1961	1,249	1,441		1,661		2,136	2,136		2,607	4,044	4,537		3,462
1962	1,220	1,547		1,720		2,265	2,330		2,836	3,818	2,980		3,403
1963	773	1,090		1,122		1,353	1,380		1,476	1,879	3,416		1,789
1964	1,387	1,688		2,089		2,715	2,751		3,287	4,353	4,087	4,192	3,419
1965	909	1,225		1,309		1,883	1,898		2,137	2,648	3,355	2,473	2,369
1966	1,151	1,496		1,660		2,400	2,449	3,549	4,142	5,104	3,342	4,469	4,295
1967	1,092	1,481	1,375	1,646		2,131	2,132	2,368	2,505	3,320	4,686	2,469	3,523
1968	1,585	1,657	1,871	2,184		2,782	2,796	2,980	3,284	3,538	4,551	3,280	3,037
1969	747	921	834	931	969	1,274	1,462	1,677	1,646	1,828	6,421	1,634	1,691
1970	1,782	2,131	2,093	2,349	2,491	2,946	2,988	3,257	3,035		4,378	2,781	2,594
1971	1,350	1,465	1,354	1,425	1,553	1,714	1,657	2,400	2,082			1,892	2,041
1972	1,106	1,445	1,363	1,357	1,488	1,663	1,671	2,863	2,197			2,063	2,099
1973	1,319	1,742	1,791	1,889	1,897	2,356	2,338	2,700	2,879			3,364	3,629
1974	1,231	1,609	1,767	1,846	1,906	2,094	2,156	2,752	2,936				
1975	1,214	1,247	1,325	1,492	1,563	2,018	2,027	2,645	2,627				
1976	1,345	1,482	1,533	1,769	1,873	2,293	2,272	3,602	3,280				
1977	1,197	1,583	1,422	1,683	1,737	2,086	2,064	1,933	2,420				
1978	1,730	2,296	2,152	2,361	2,405	2,900	2,639	2,888	3,122				
1979	1,089	1,473	1,347	1,525	1,545	2,916	2,997	3,552	4,066				
1980	1,247	1,383	1,310	1,780	1,627	2,167	2,018	2,775	2,648				
1981	2,109	2,841	2,652	2,778	2,810	3,369	3,240	4,044	3,883				
1982	994	1,325	1,224	1,430	1,285	2,175	2,017	2,577	2,645				
1983	1,213	1,481	1,297	1,591	1,450	2,097	1,994	2,366	2,395				
1984	1,080	1,343	1,339	1,459	1,430	2,482	2,511	3,240	3,305				
1985	1,333	1,566	1,374	1,331	1,523	2,000	2,184	2,679	2,666				
1986	1,437	1,958	2,313	2,287	2,550	3,804	4,397	4,884	4,752				
1987	1,089	974	1,017	1,114	1,280	1,333	1,616	1,845	1,918				
1988	1,702	2,101	2,156	2,286	2,233	2,717	3,302		3,444				
1989	1,195	1,351	1,236	1,324	1,486	1,865	2,220	2,774	2,642				
1990	1,968	1,899	1,871	1,920	1,889	2,243	2,628	2,933	2,898				
1991	1,399	1,631	1,538	1,661	1,630	1,798	2,177	2,192	2,159	3,115			
1992	1,177	1,300	1,232	1,292	1,256	1,599	1,818	2,163	2,014	2,820			
1993	1,112	1,362	1,314	1,474	1,581	2,022	2,298	2,626	2,451	3,233			
1994	1,334	1,523	1,583	1,709	1,767	2,719	2,259	2,133	2,440	3,239			
1995	1,688	1,601	1,578	1,729	1,730	2,371	2,248	2,282	2,586	3,210			
1996	1,508	1,784	2,085	2,301	2,297	3,440	2,970	2,893	3,583	5,885			
1997	996	1,275	1,310	1,245	1,507	2,438	2,202	2,372	2,677	4,113			
1998	1,497	1,768	1,836	1,678	1,978	2,520	2,248	2,338	2,636	3,512			



	Irrigated		Rainfed		Total	
Paddy Crop Field	1,412,000	ha	290,000	ha	1,702,000	ha
Upland Crop Field	9,000	ha	109,000	ha	118,000	ha
Perenial Crop Field	-	ha	351,000	ha	351,000	ha
Total	**1,421,000**	**ha**	**750,000**	**ha**	**2,171,000**	**ha**

Fig. 3.9 Present Cropping Pattern in the Mekong Delta



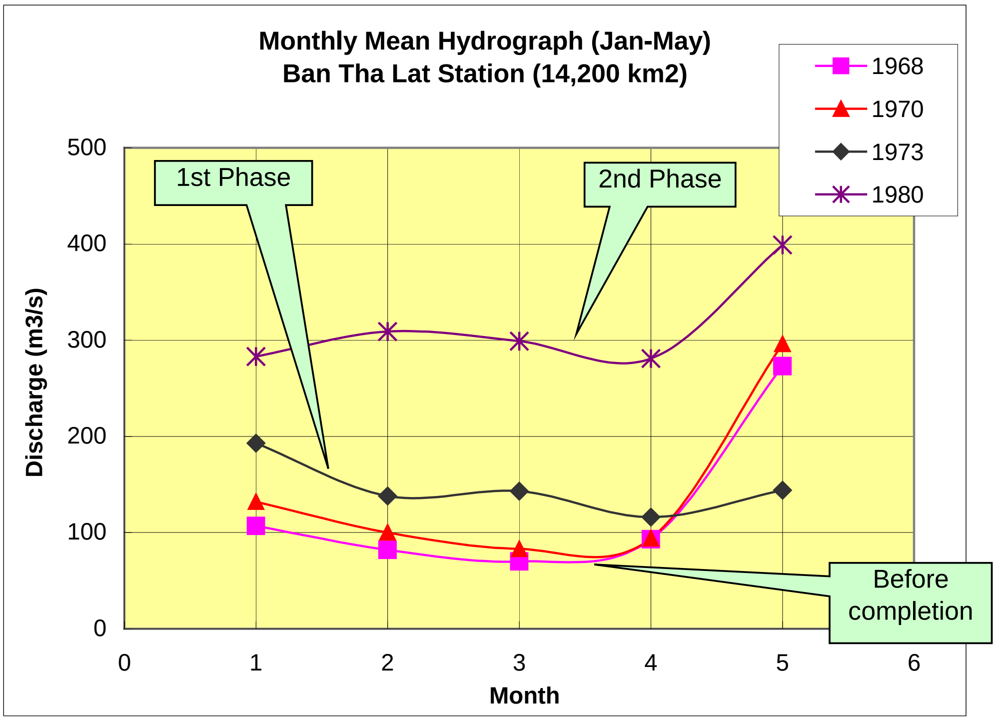
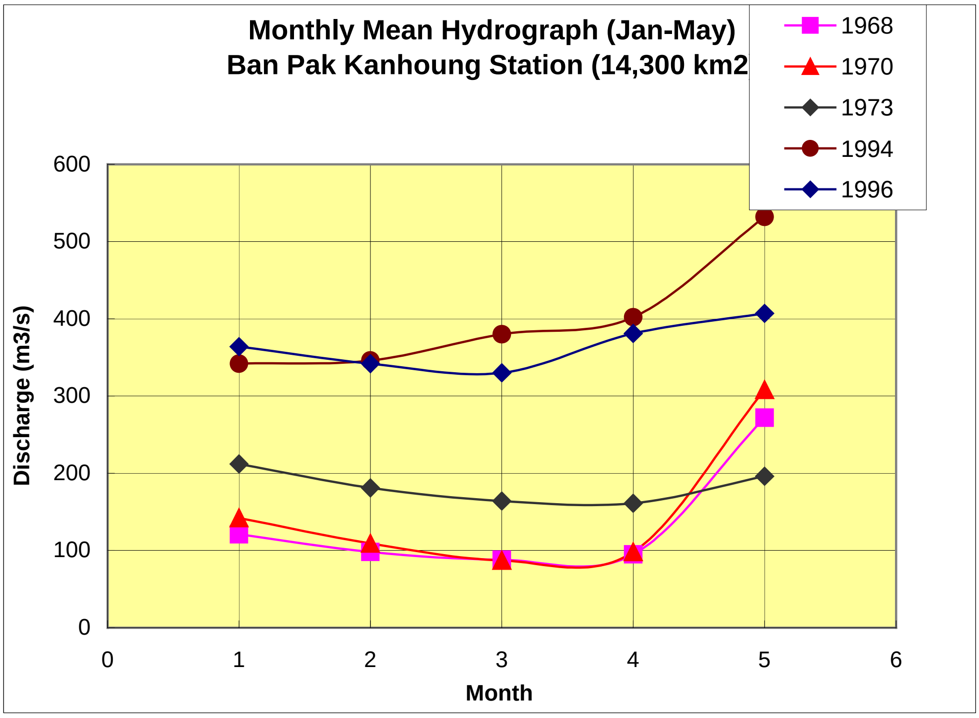


Fig. 5.8(1/2) Comparison of Dry-Season Flow Hydrographs in Nam Ngum River (1/2)



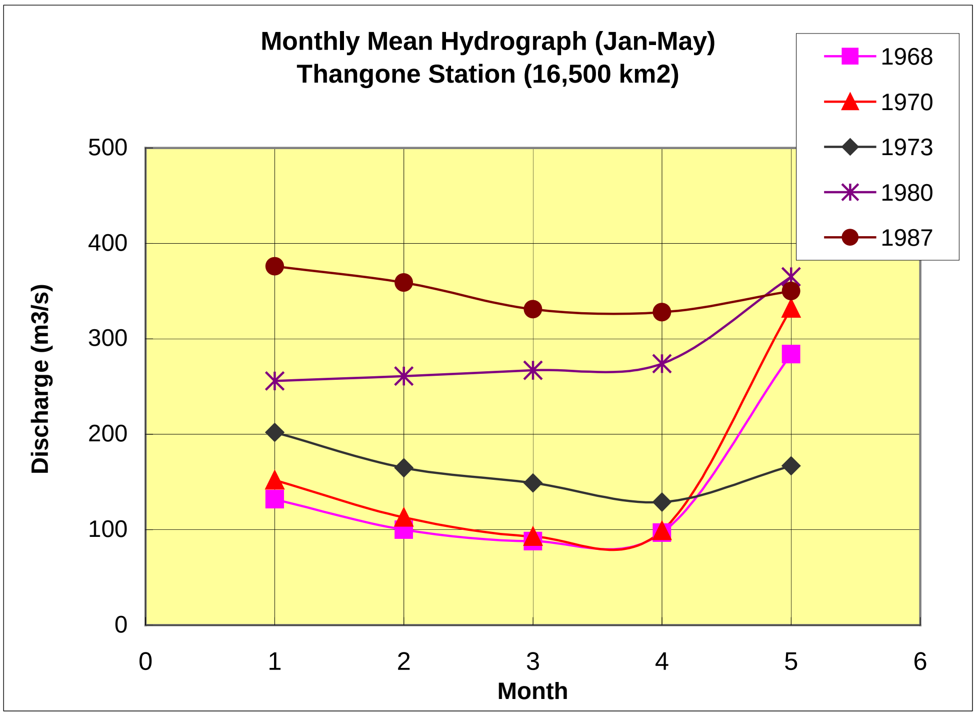


Fig. 5.8(2/2) Comparison of Dry-Season Flow Hydrographs in Nam Ngum River (2/2)

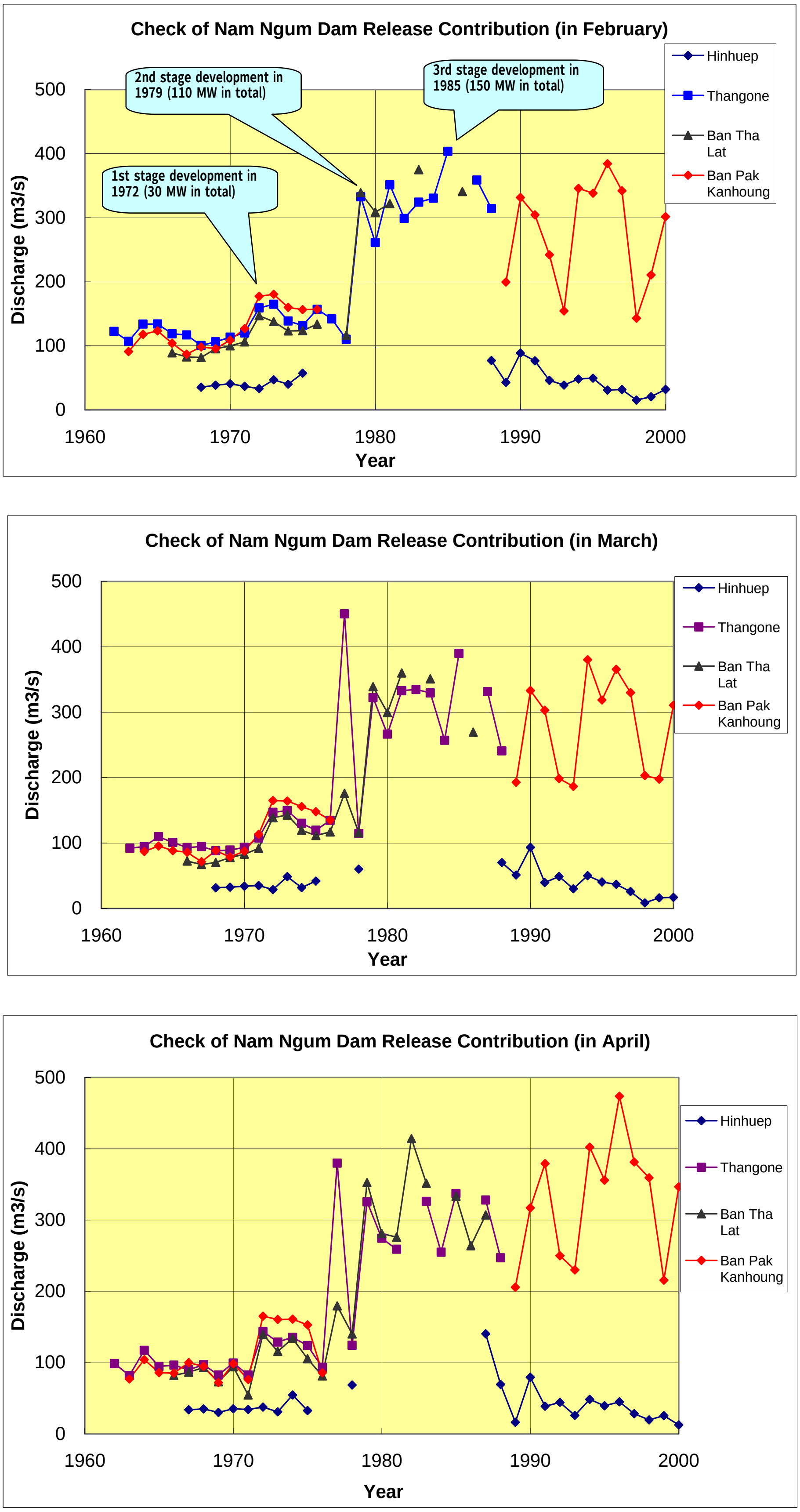
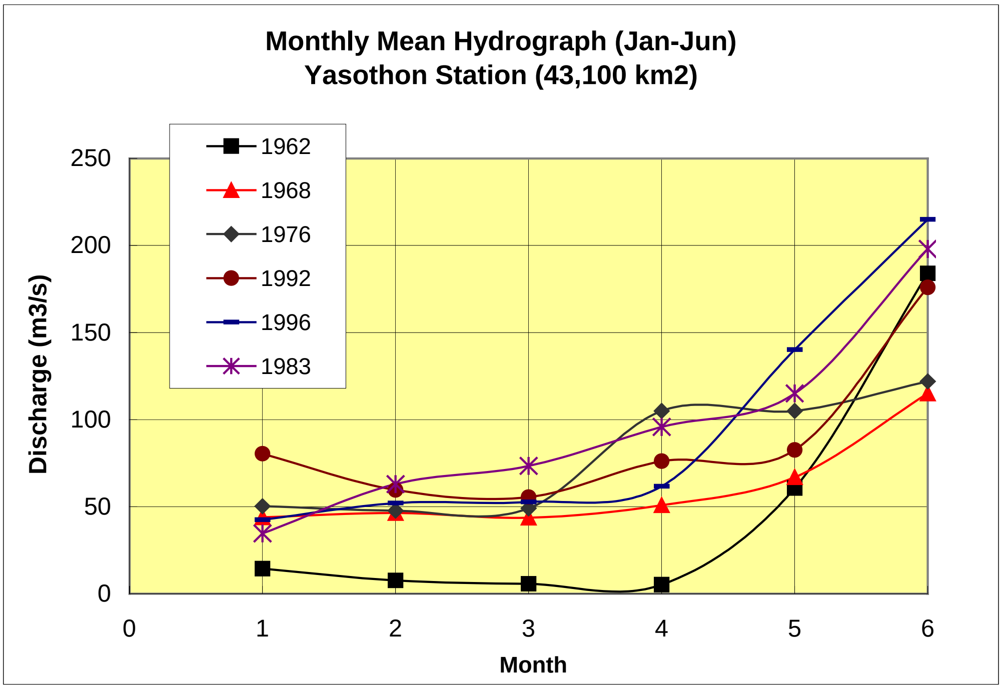


Fig. 5.9 Comparison of Time-Series of Monthly Mean Discharges in Nam Ngum River



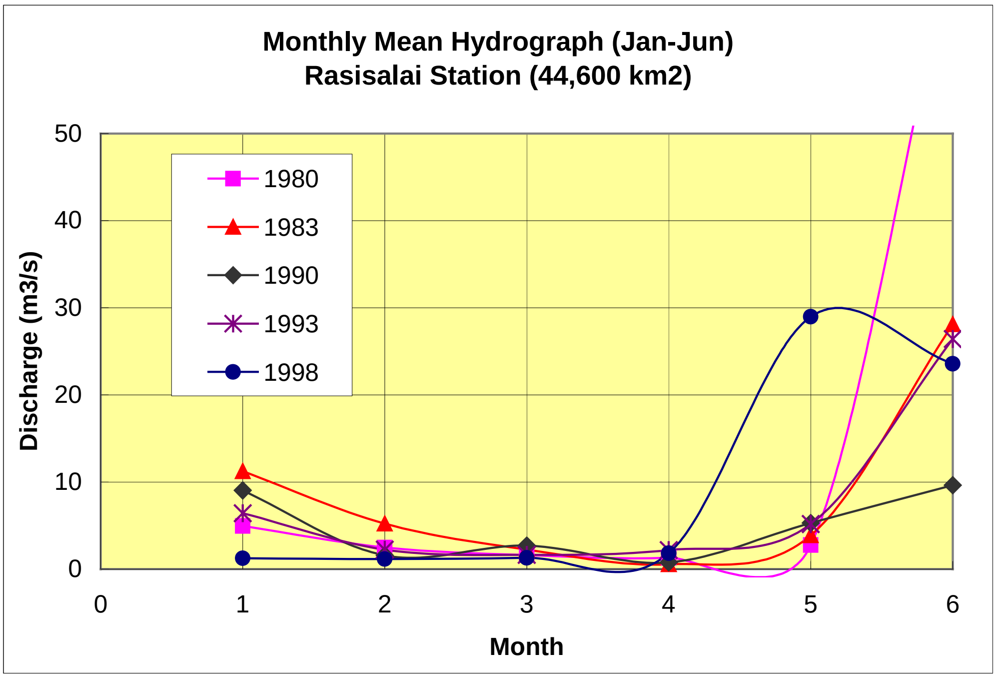
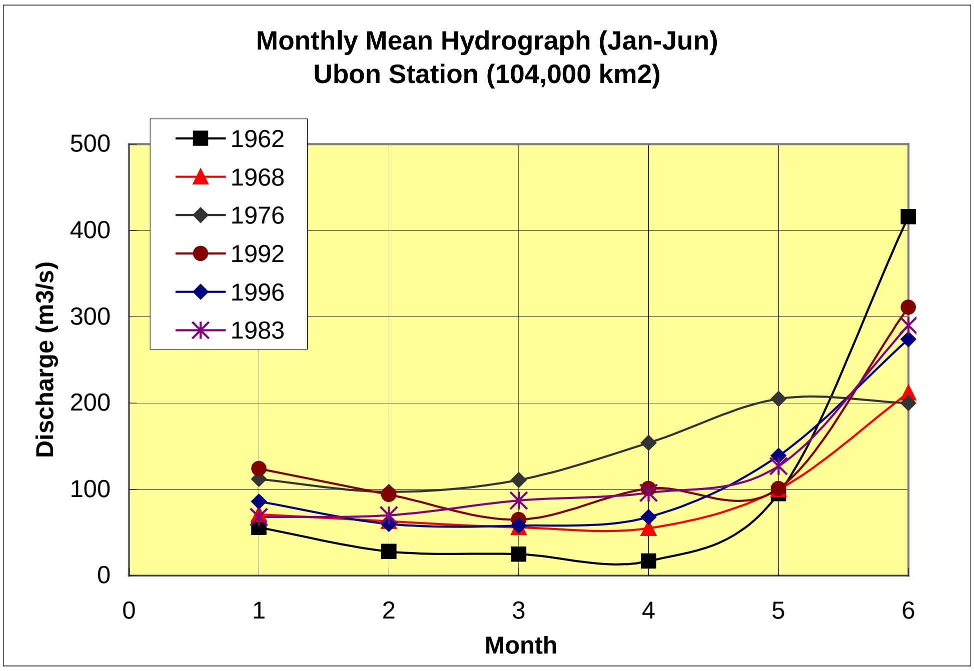


Fig. 6.5 Comparison of Dry-Season Flow Hydrographs in Nam Mun-Chi River (1/2)



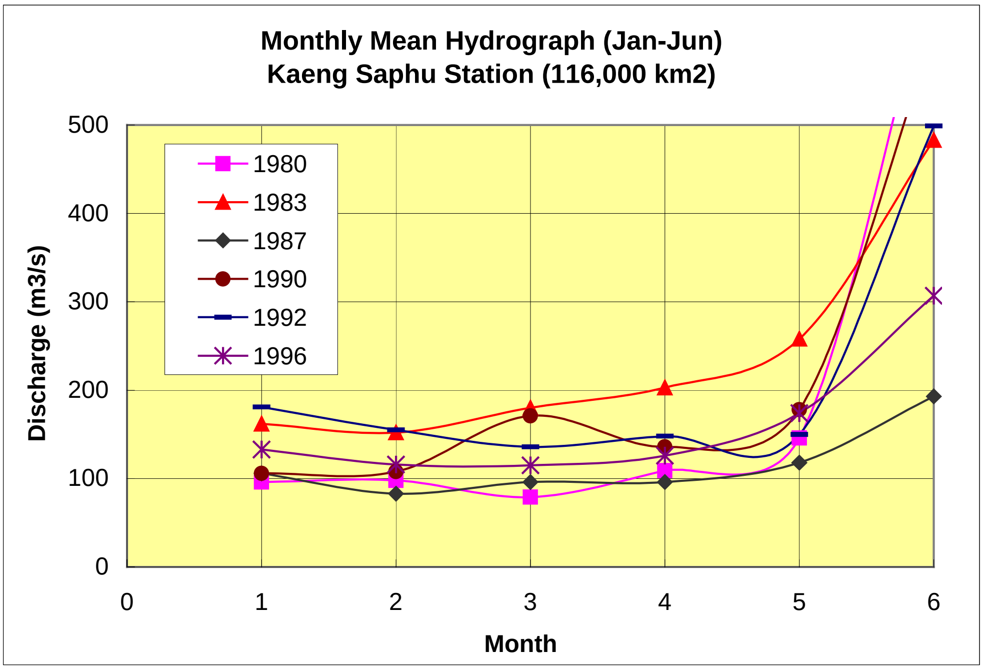


Fig. 6.5 Comparison of Dry-Season Flow Hydrographs in Nam Mun-Chi River (2/2)

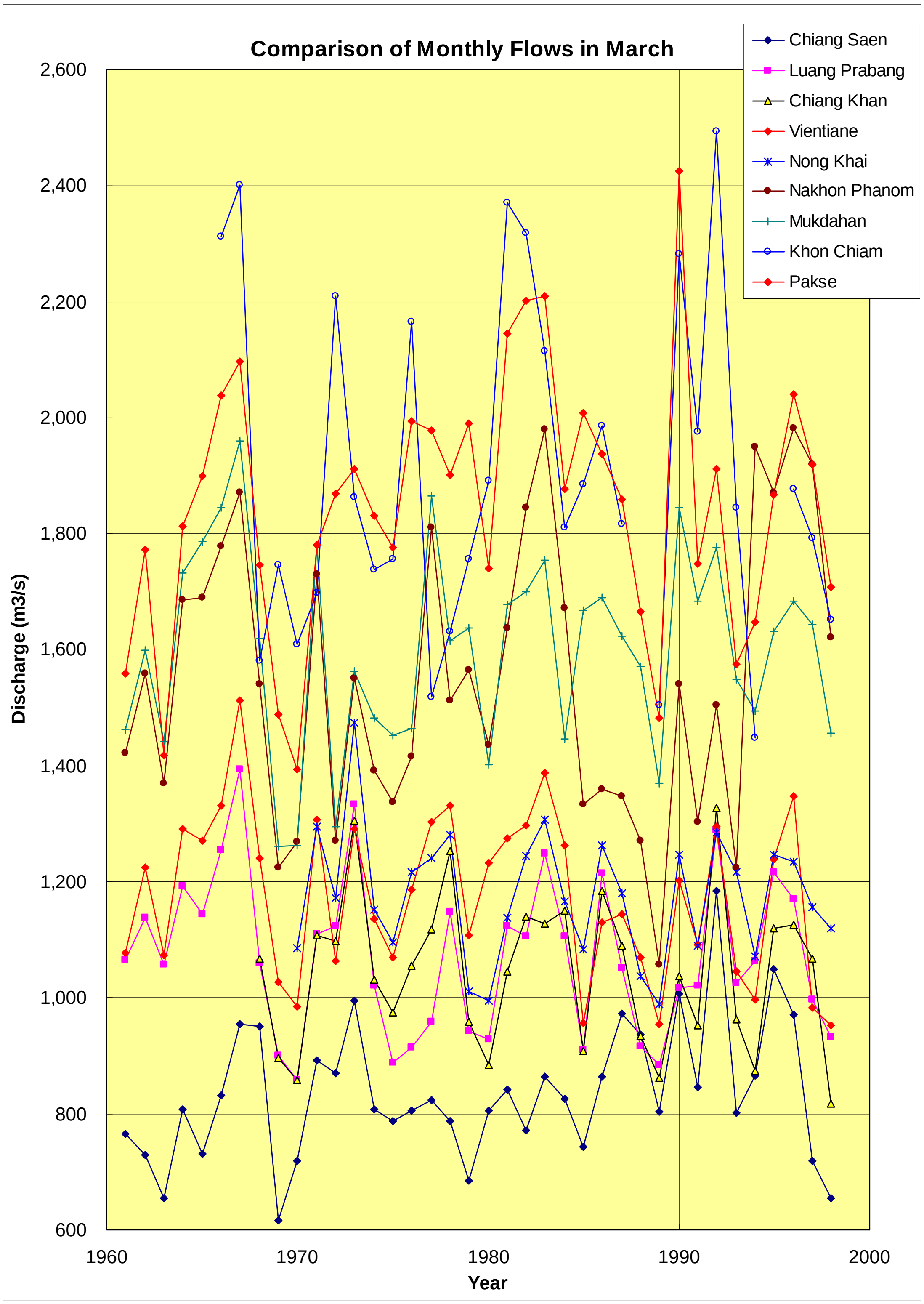


Fig. 7.3 Comparison of Monthly Mean Discharges on Mekong Mainstream (1/2)

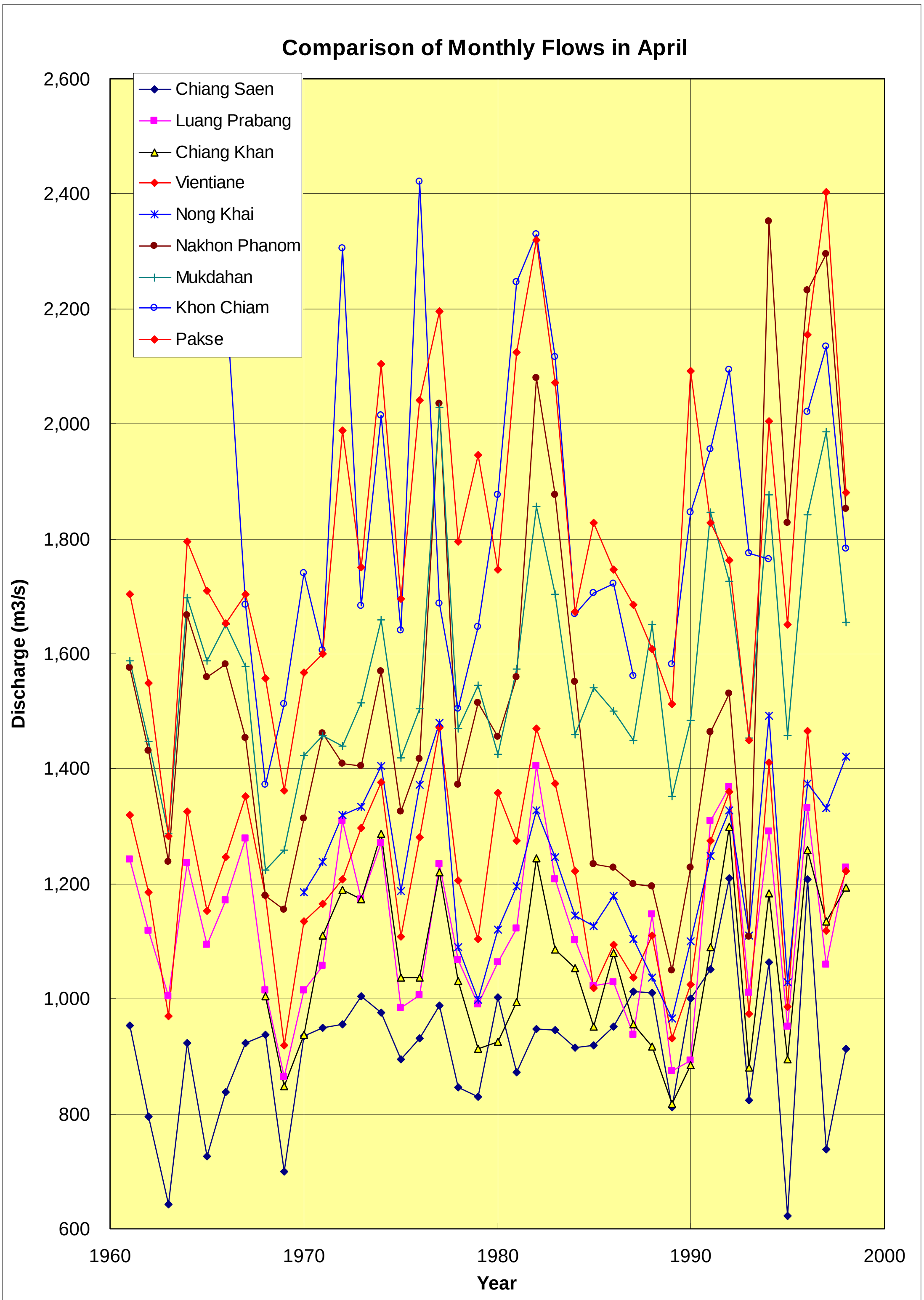
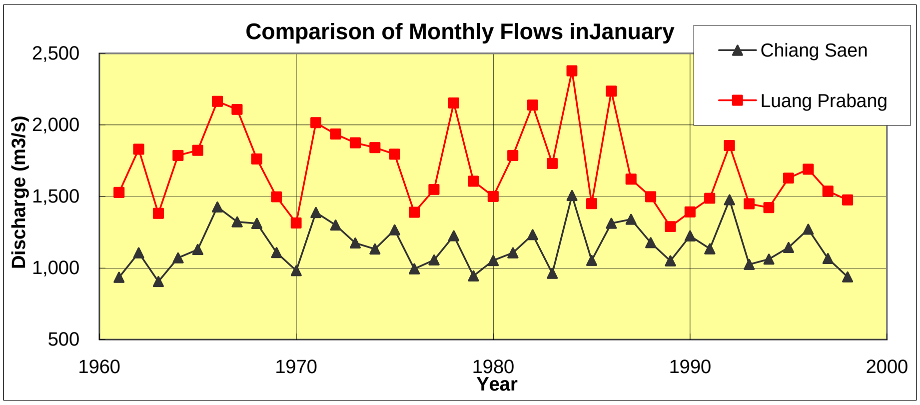
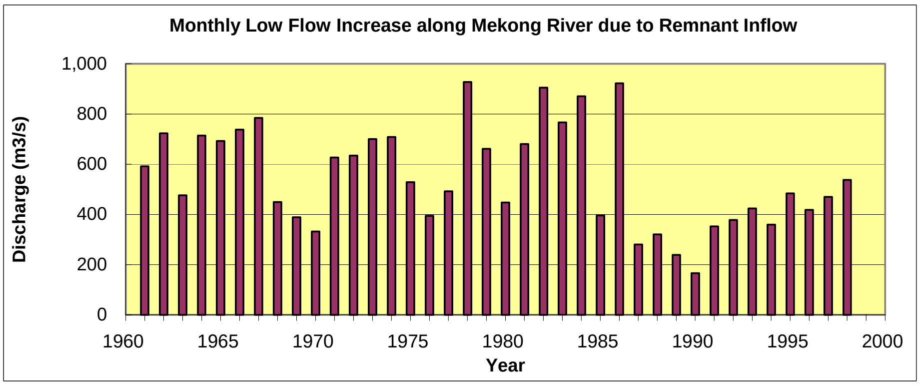


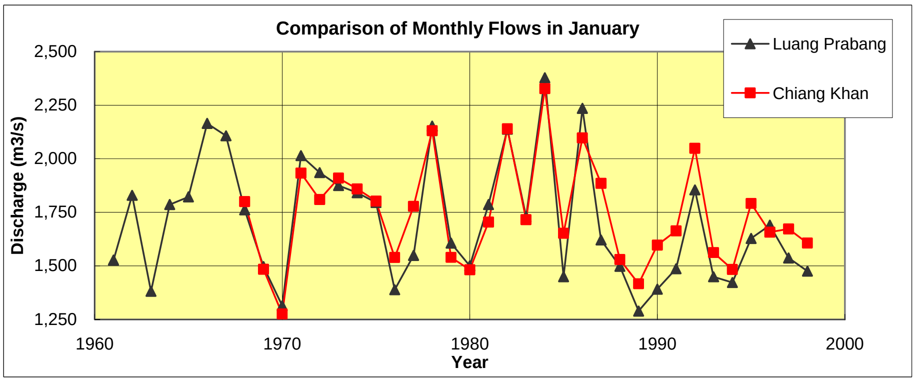
Fig. 7.3 Comparison of Monthly Mean Discharges on Mekong Mainstream (2/2)

Stretch : Chiang Sean - Luang Prabang (79,000 km2) ***Month : January***





Stretch : Luang Prabang - Chiang Khan (24,000 km2) ***Month : January***



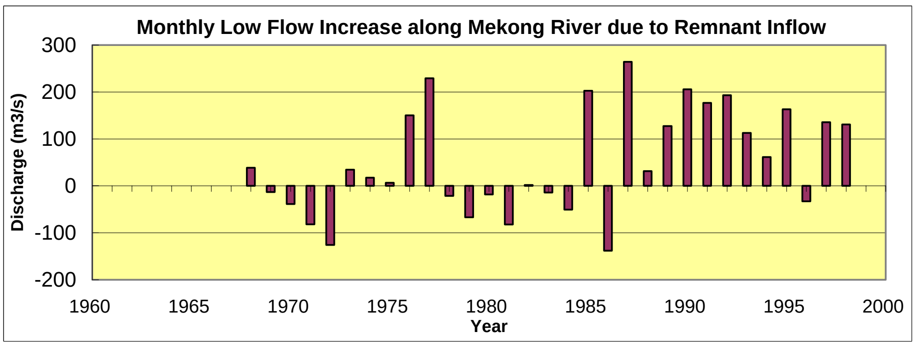
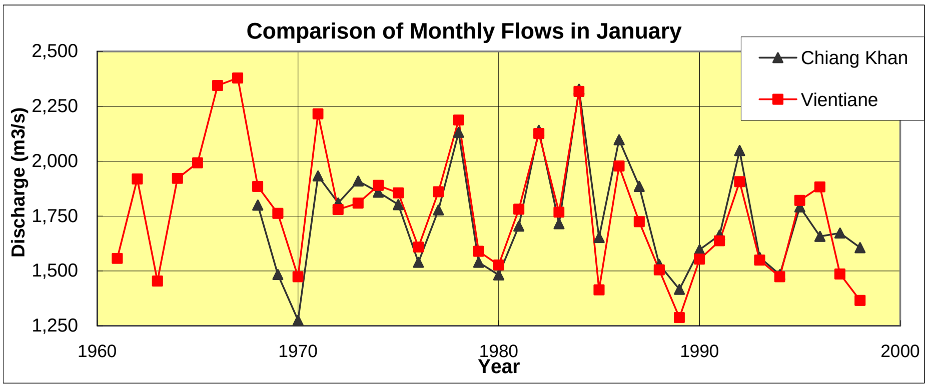
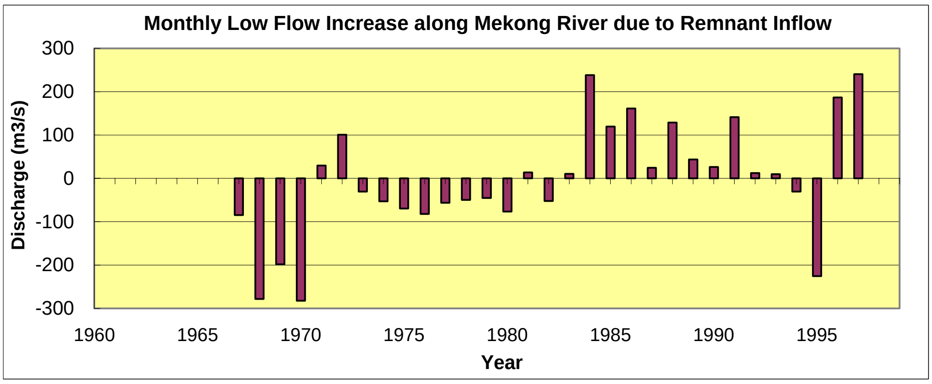


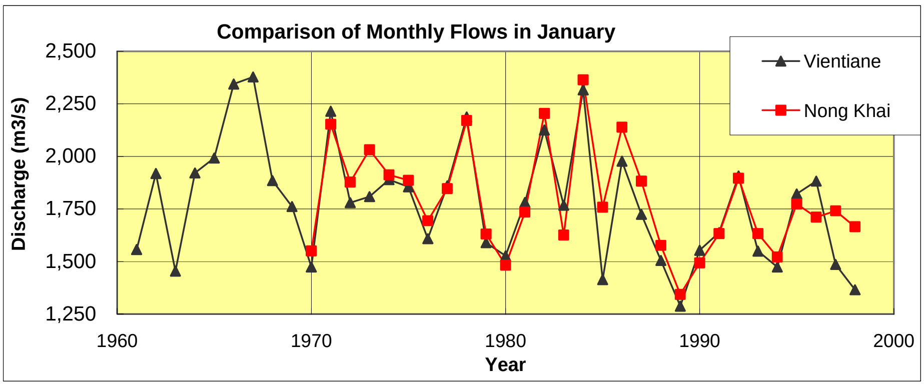
Fig. 7.4 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in January (1/6)

Stretch : Chiang Khan - Vientiane (7,000 km2) ***Month : January***





Stretch : Vientiane - Nong Khai (3,000 km2) ***Month : January***



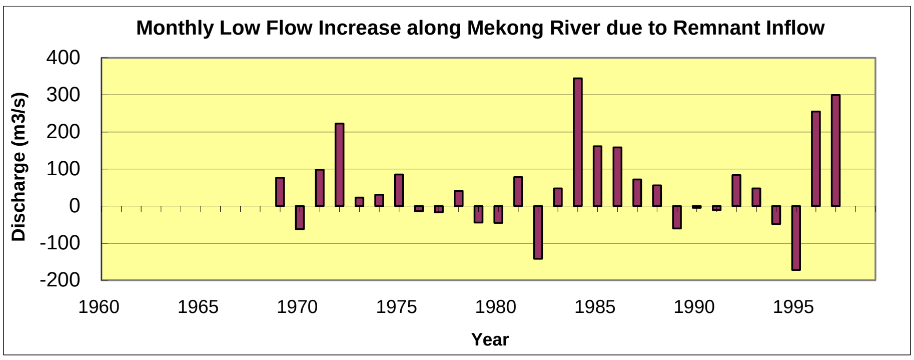
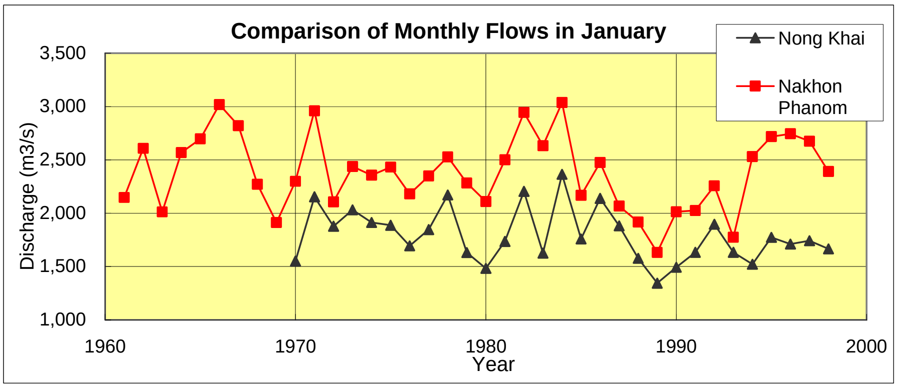
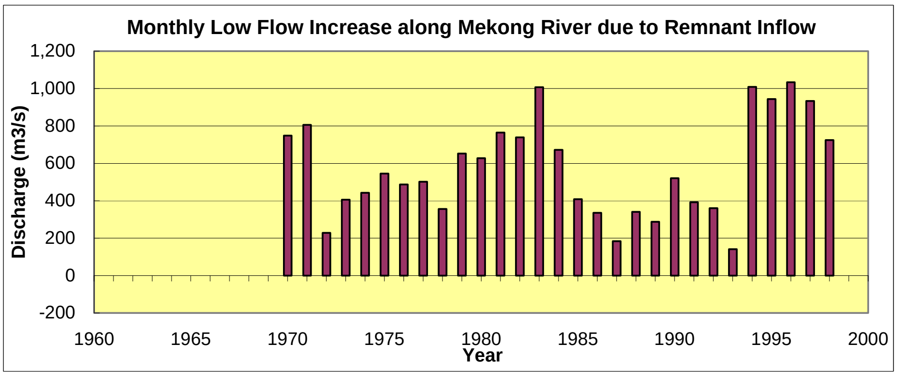


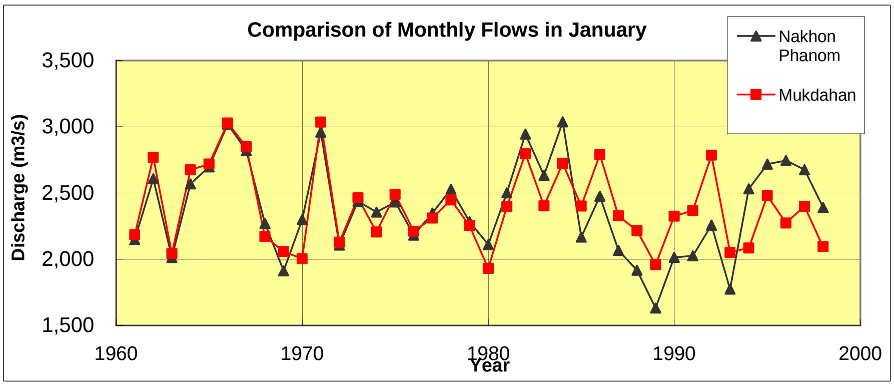
Fig. 7.4 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in January (2/6)

Stretch : Nong Khai - Nakhon Phanom (71,000 km2) ***Month : January***





Stretch : Nakhon Phanom - Mukdahan (18,000 km2) ***Month : January***



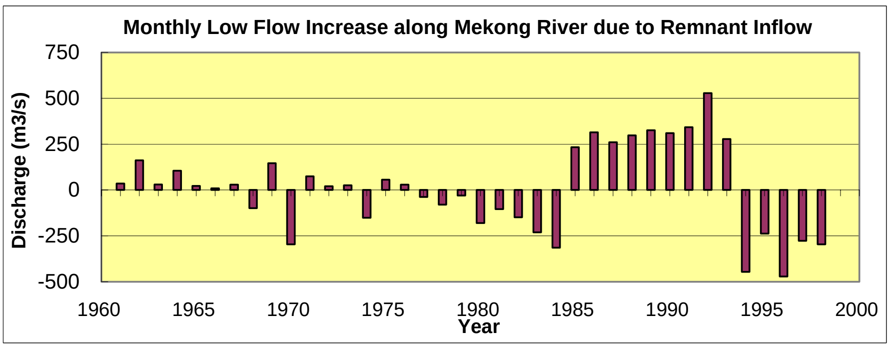
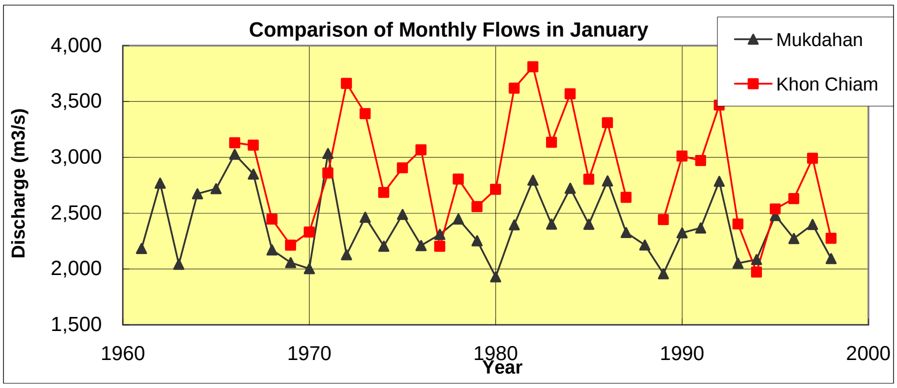
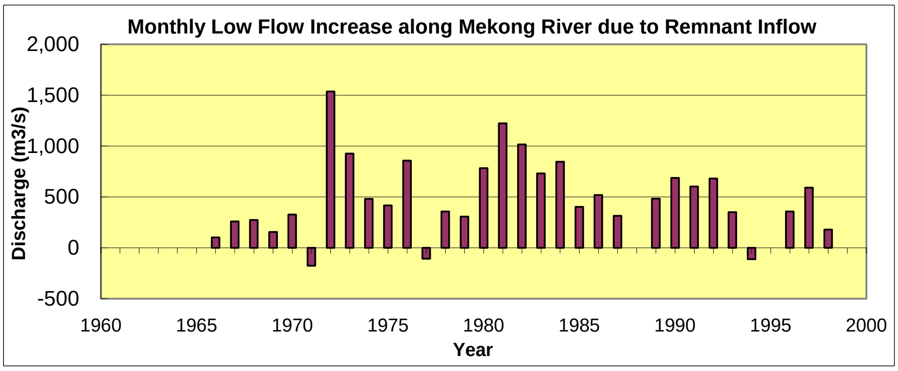


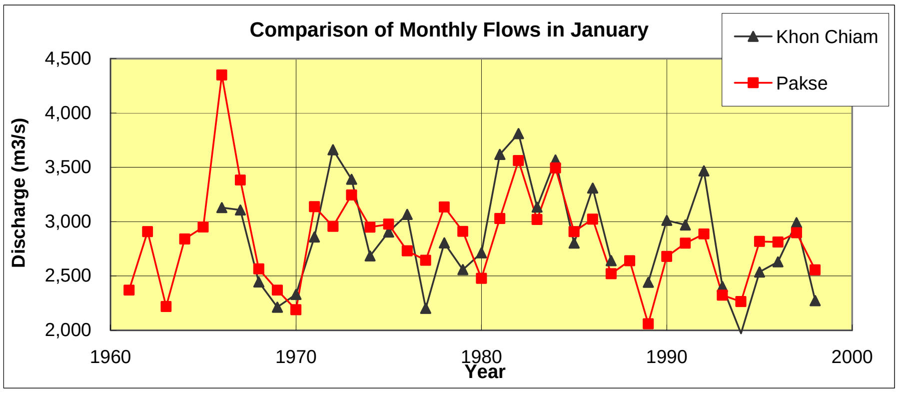
Fig. 7.4 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in January (3/6)

Stretch : Mukdahan - Khong Chiam (28,000 km2) ***Month : January***





Stretch : Khong Chiam - Pakse (126,000 km2) ***Month : January***



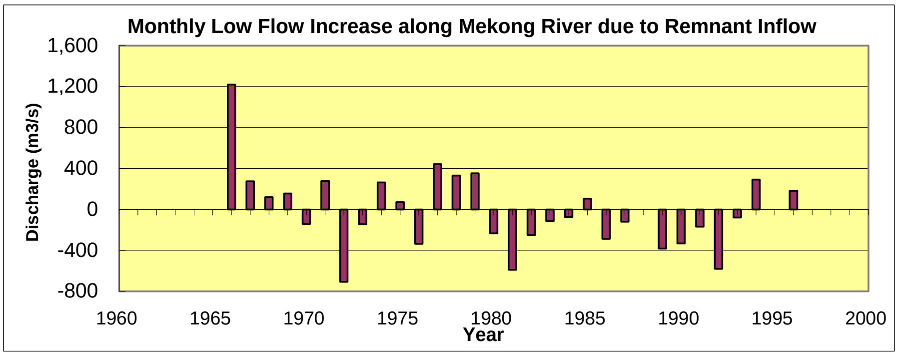
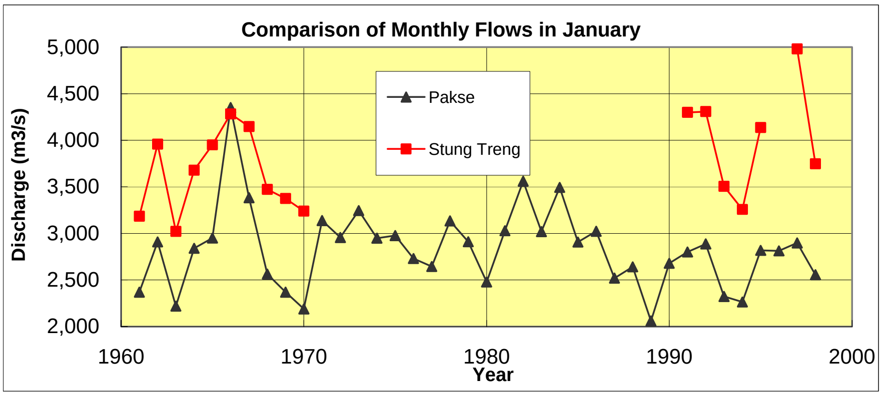
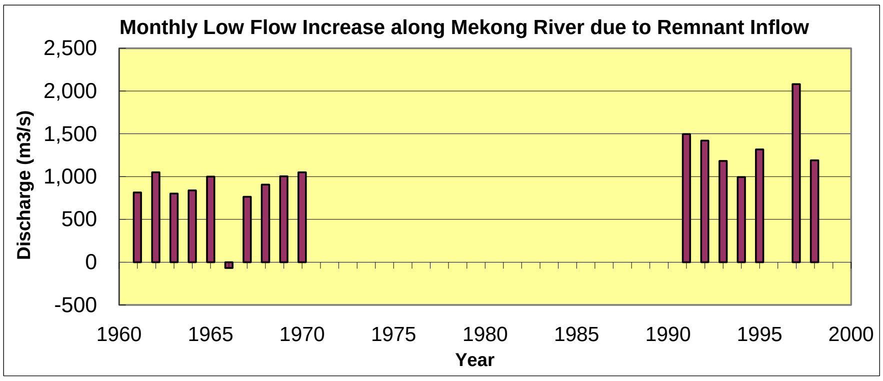


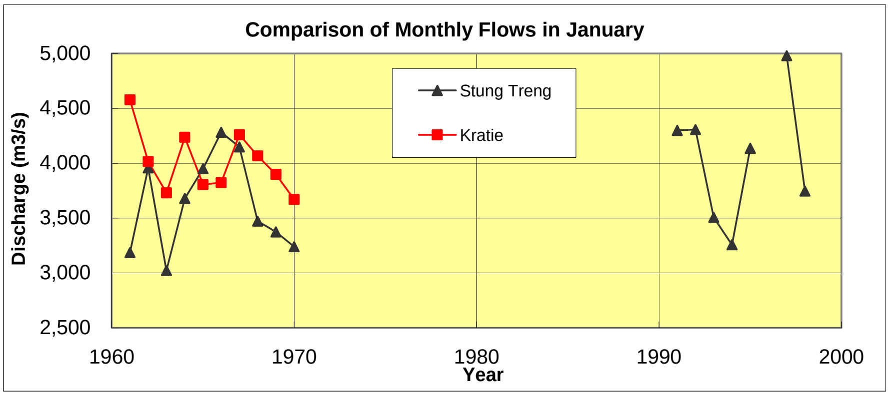
Fig. 7.4 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in January (4/6)

Stretch : Pakse - Stung Treng (90,000 km2) ***Month : January***





Stretch : Stung Treng - Kratie (11,000 km2) ***Month : January***



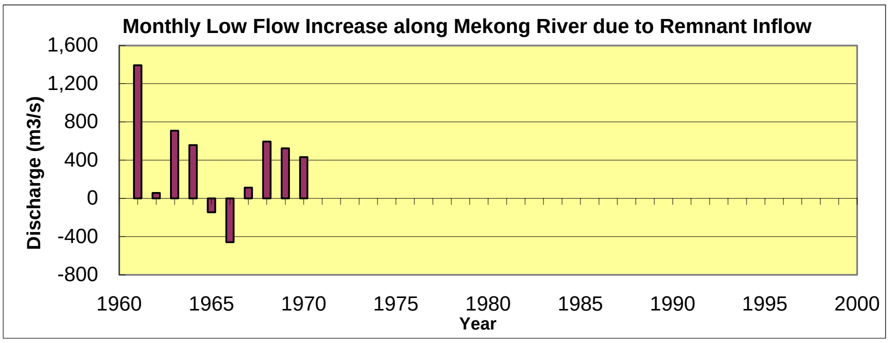
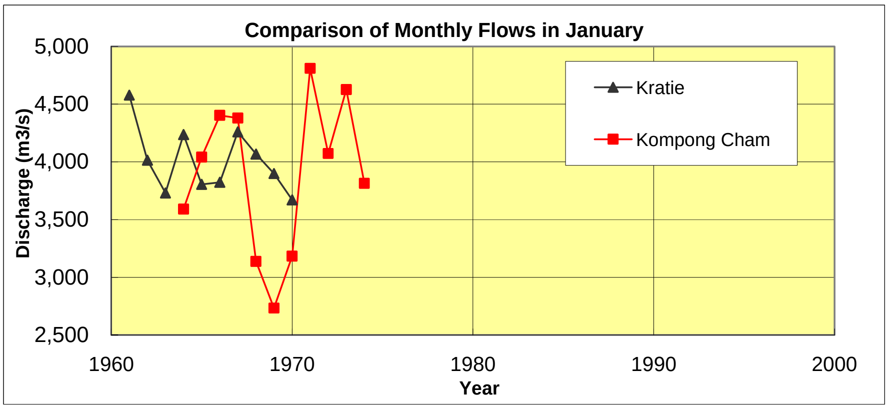
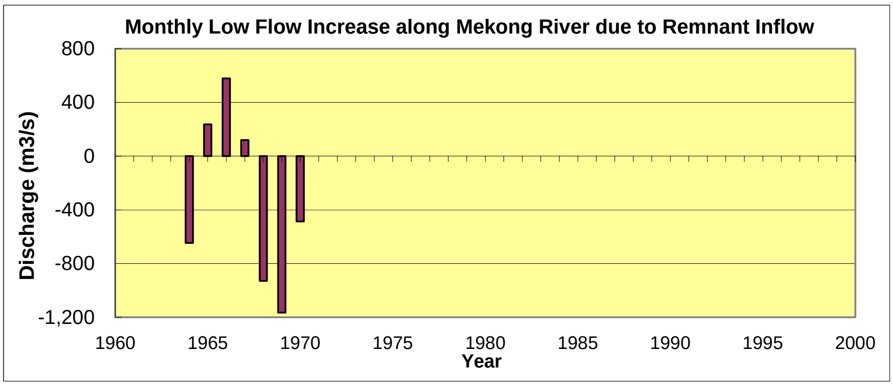


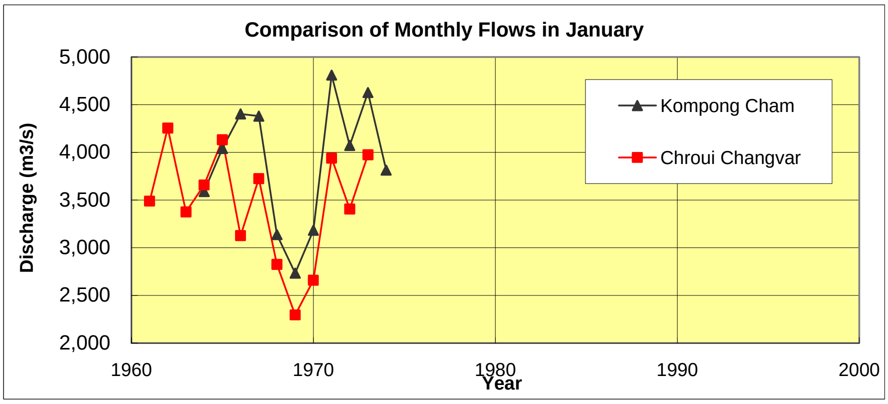
Fig. 7.4 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in January (5/6)

Stretch : Kratie - Kompong Cham (14,000 km2) ***Month : January***





Stretch : Kompong Cham - Chrui Changvar (3,000 km2) ***Month : January***



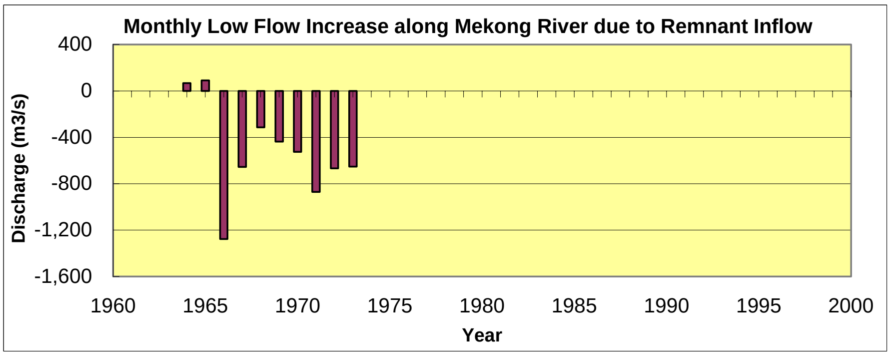
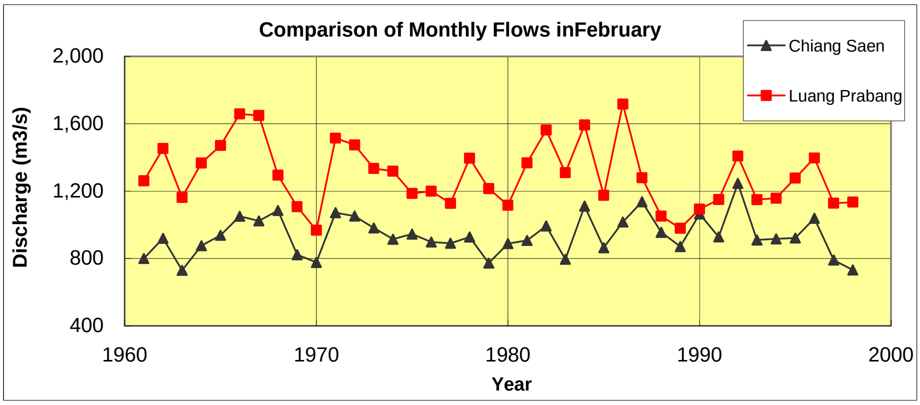
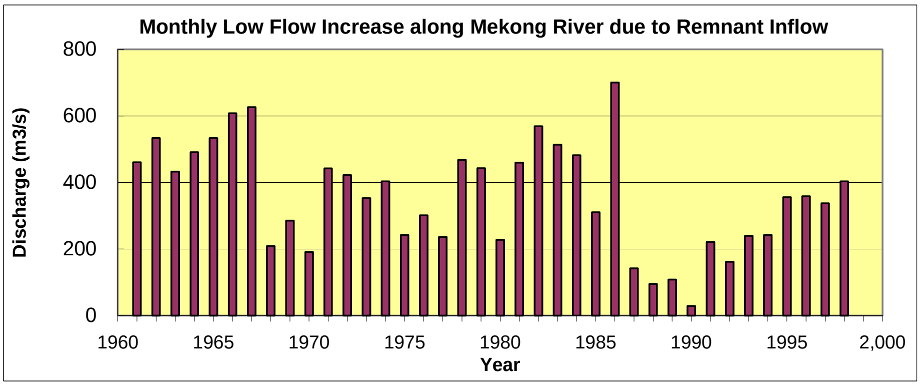


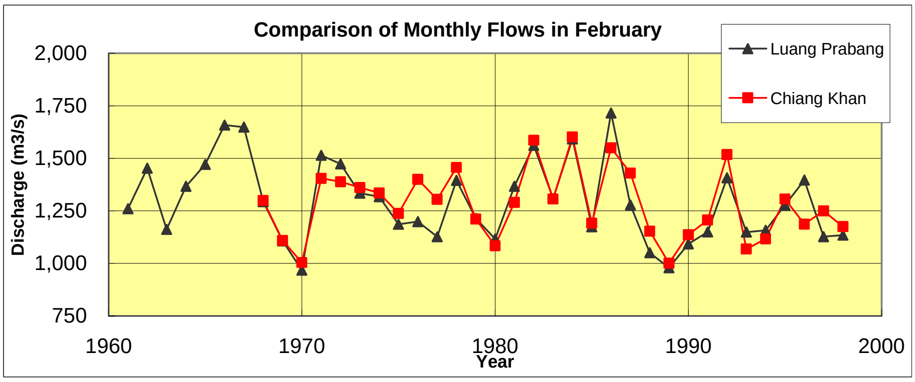
Fig. 7.4 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in January (6/6)

Stretch : Chiang Sean - Luang Prabang (79,000 km2) ***Month : February***





Stretch : Luang Prabang - Chiang Khan (24,000 km2) ***Month : February***



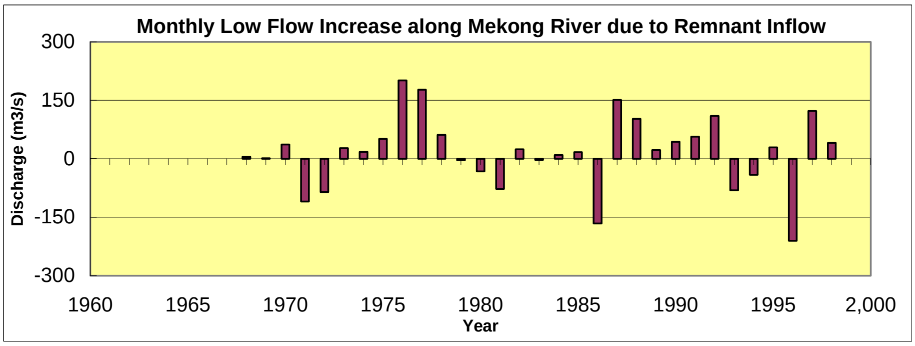
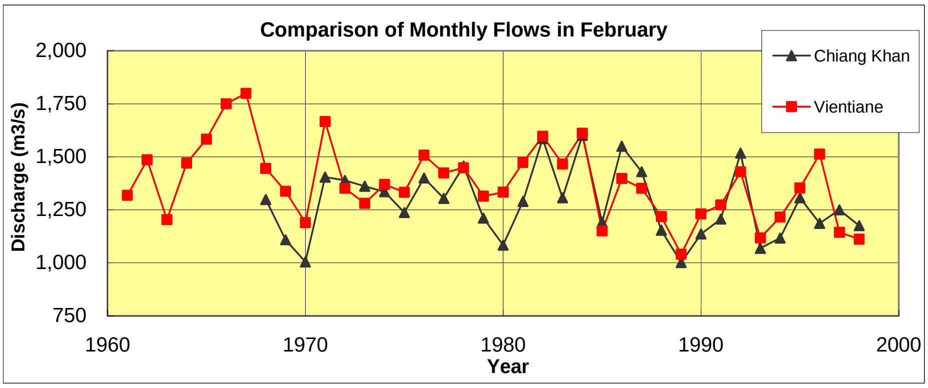
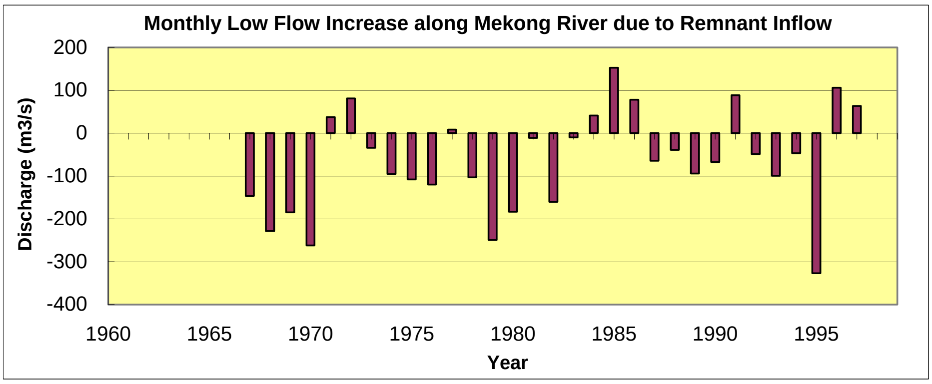


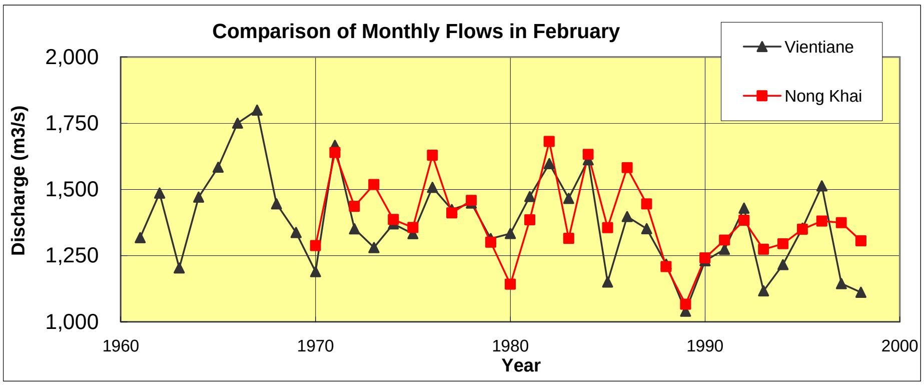
Fig. 7.5 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in February (1/6)

Stretch : Chiang Khan - Vientiane (7,000 km2) ***Month : February***





Stretch : Vientiane - Nong Khai (3,000 km2) ***Month : February***



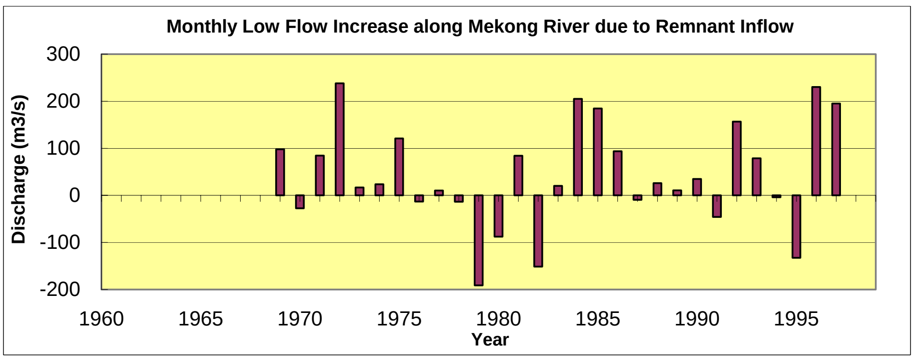
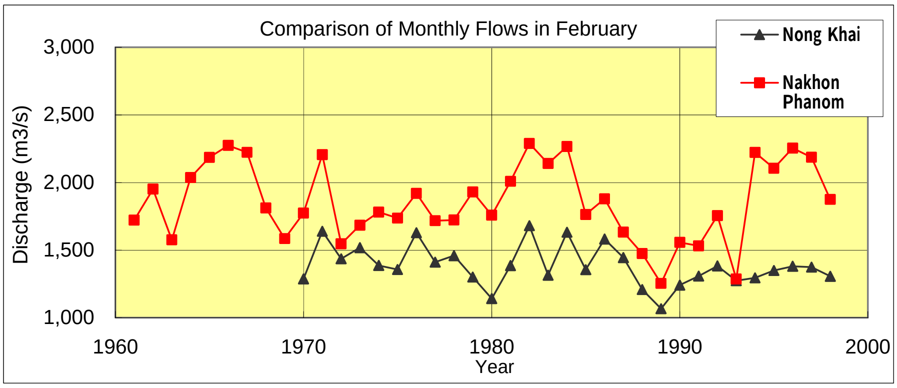
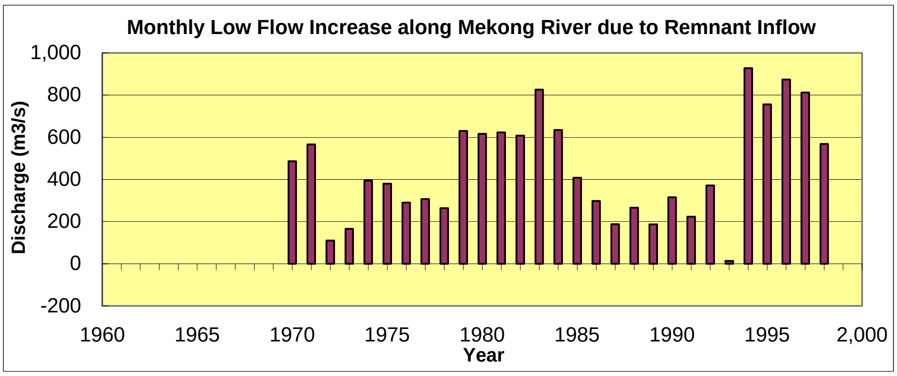


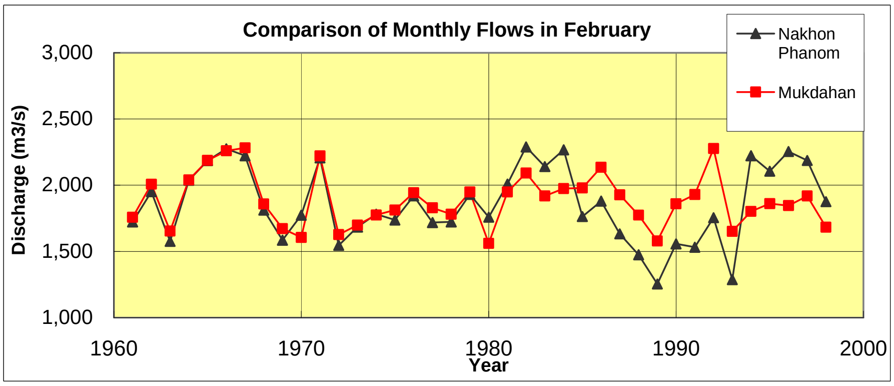
Fig. 7.5 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in February (2/6)

Stretch : Nong Khai - Nakhon Phanom (71,000 km2) ***Month : February***





Stretch : Nakhon Phanom - Mukdahan (18,000 km2) ***Month : February***



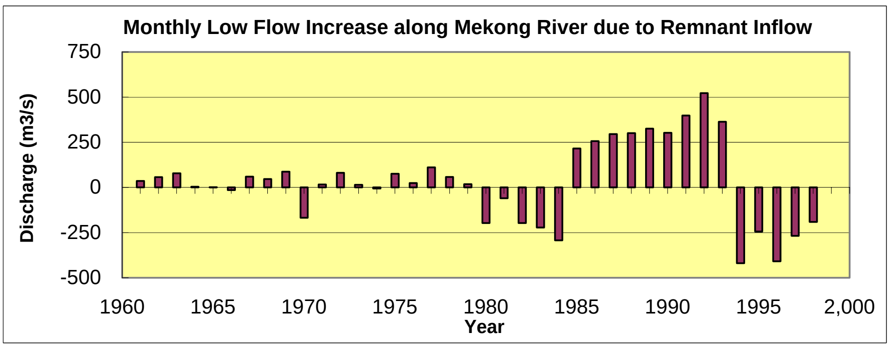
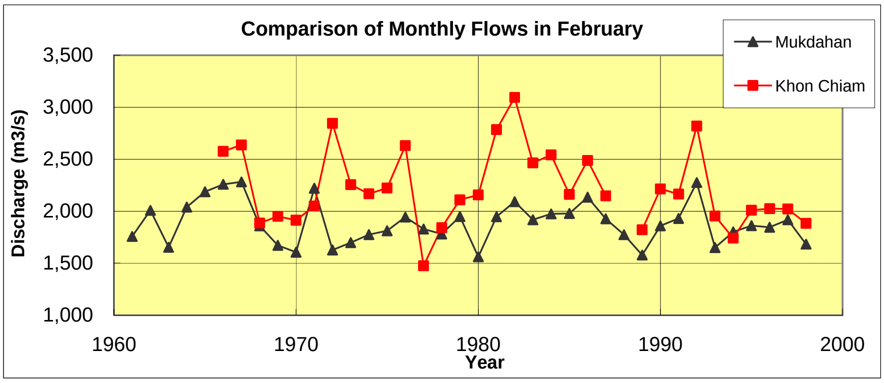
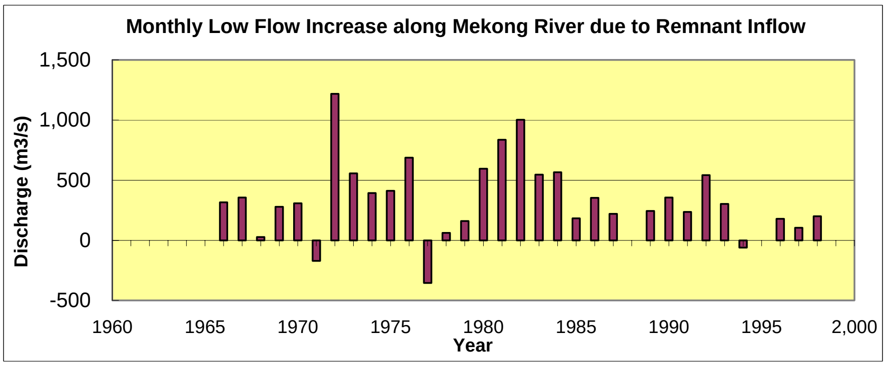


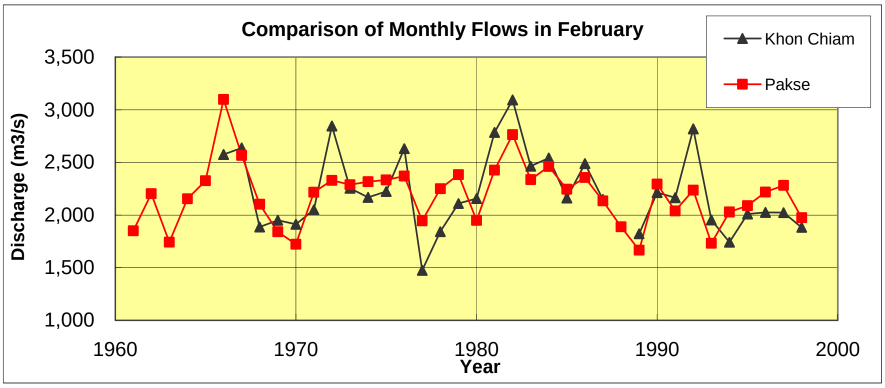
Fig. 7.5 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in February (3/6)

Stretch : Mukdahan - Khong Chiam (28,000 km2) ***Month : February***





Stretch : Khong Chiam - Pakse (126,000 km2) ***Month : February***



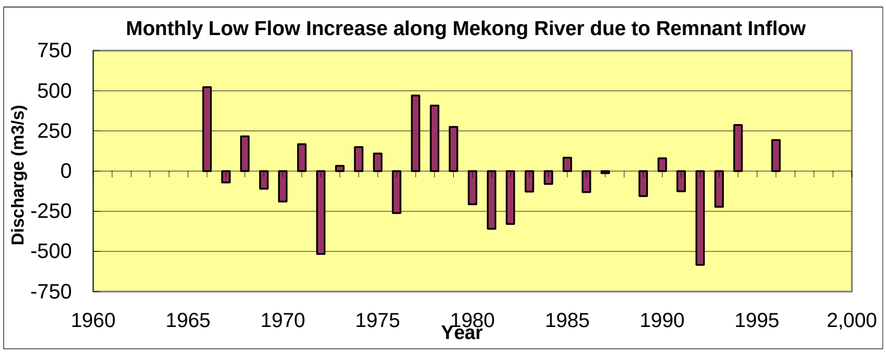
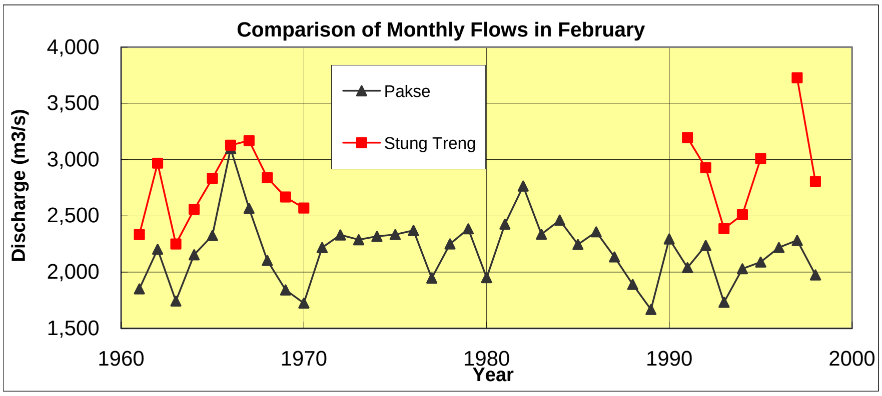
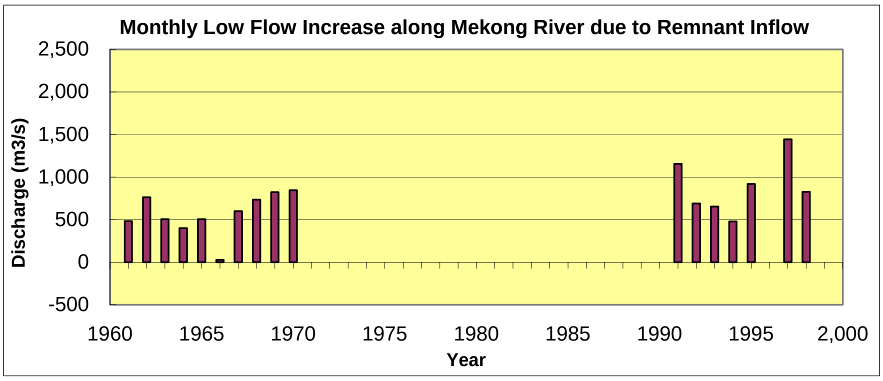


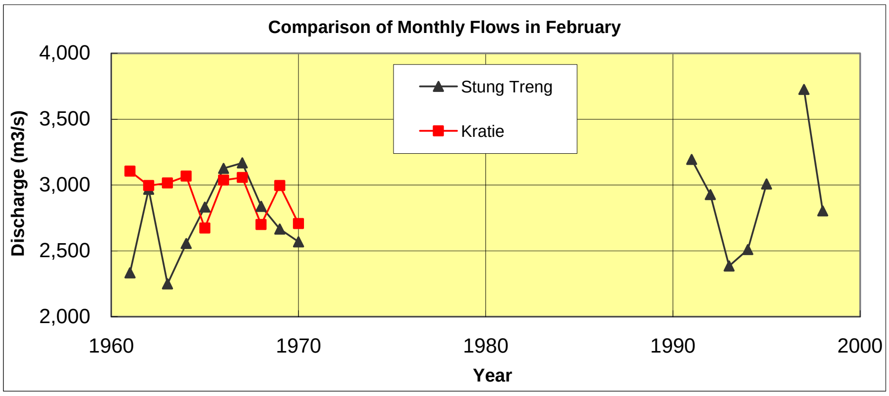
Fig. 7.5 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in February (4/6)

Stretch : Pakse - Stung Treng (90,000 km2) ***Month : February***





Stretch : Stung Treng - Kratie (11,000 km2) ***Month : February***



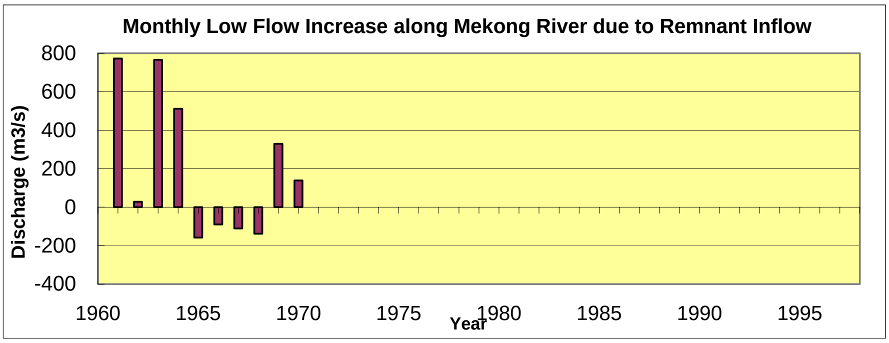
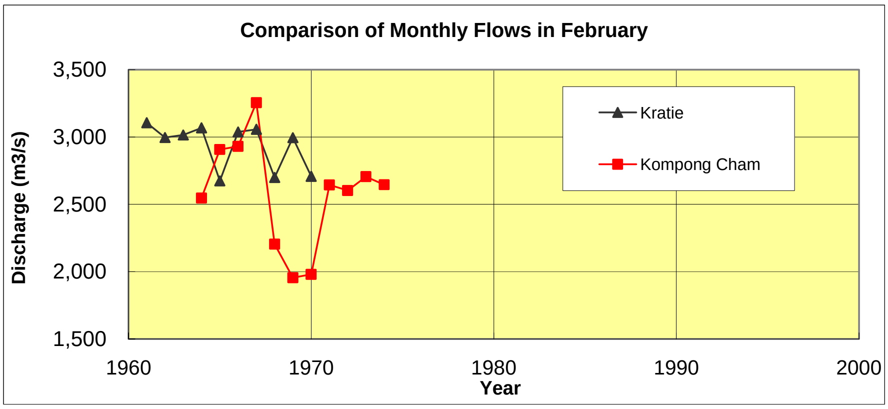
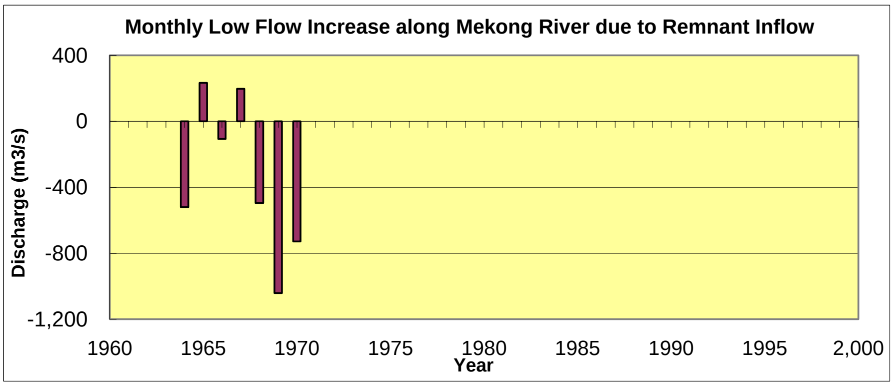


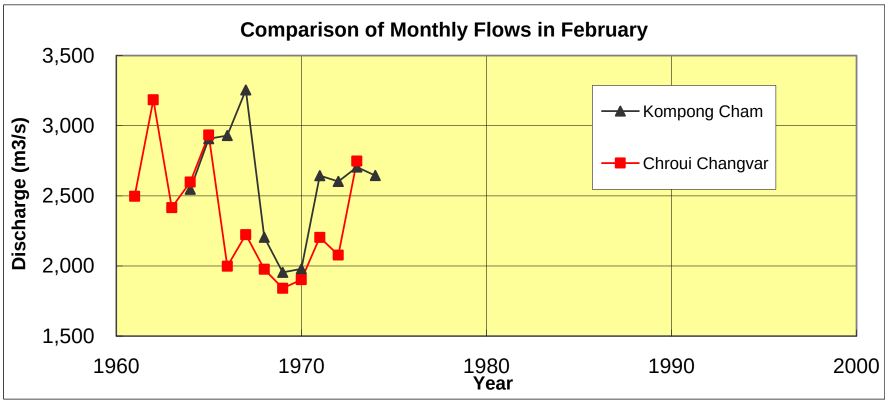
Fig. 7.5 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in February (5/6)

Stretch : Kratie - Kompong Cham (14,000 km2) ***Month : February***





Stretch : Kompong Cham - Chrui Changvar (3,000 km2) ***Month : February***



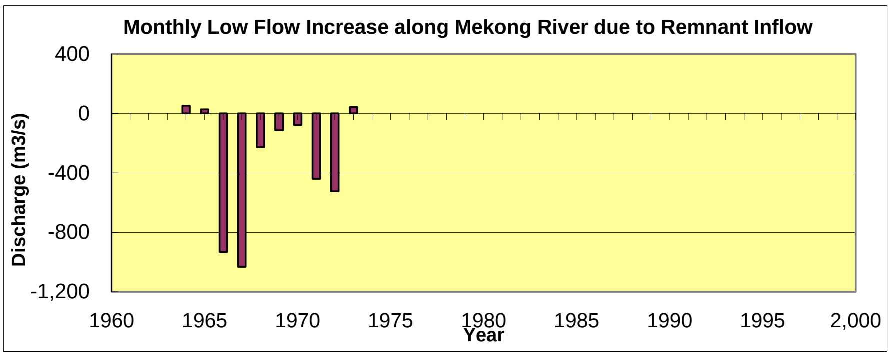
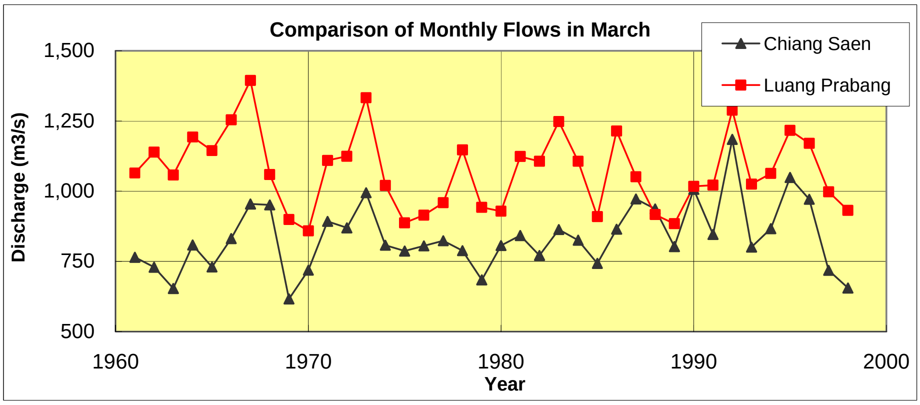
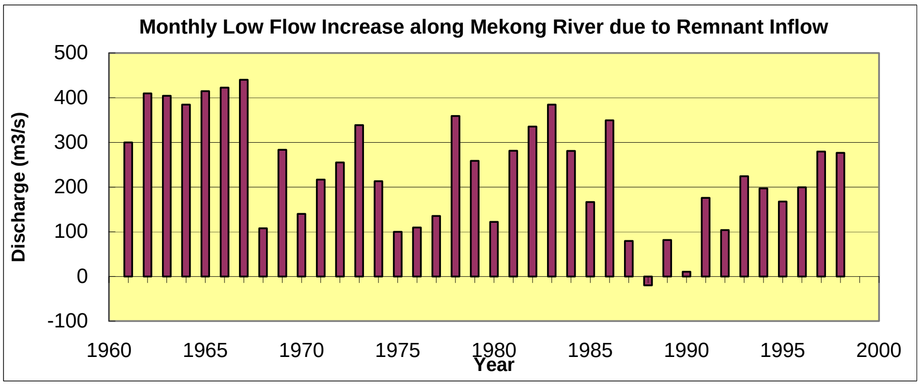


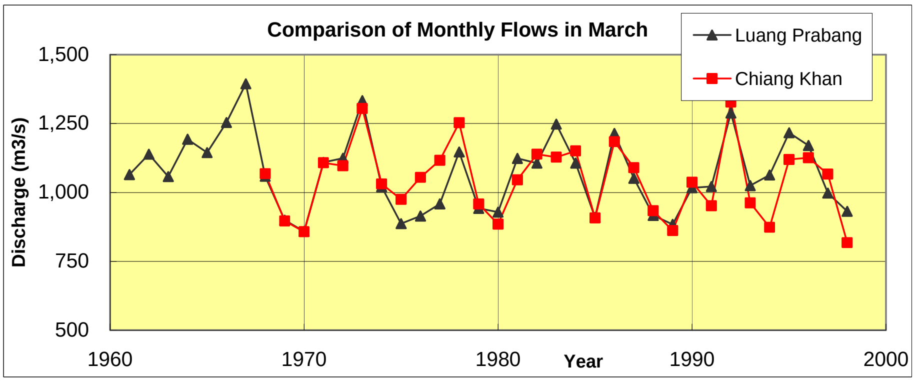
Fig. 7.5 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in February (6/6)

Stretch : Chiang Sean - Luang Prabang (79,000 km2) ***Month : March***





Stretch : Luang Prabang - Chiang Khan (24,000 km2) ***Month : March***



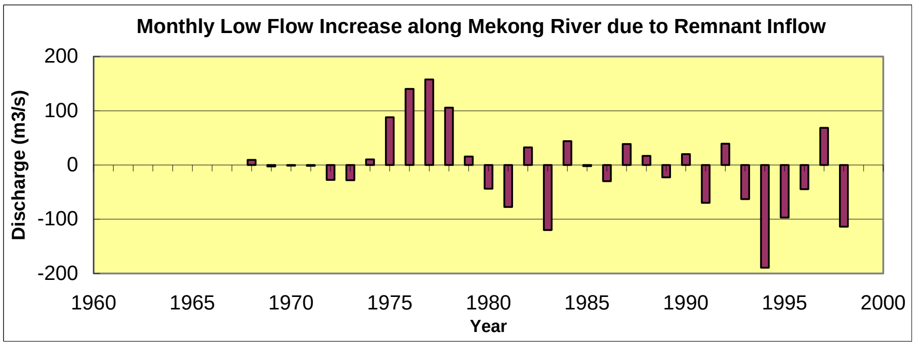
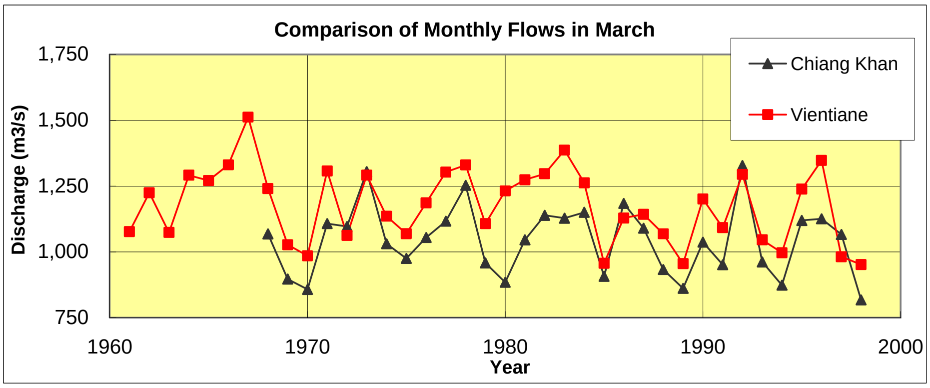
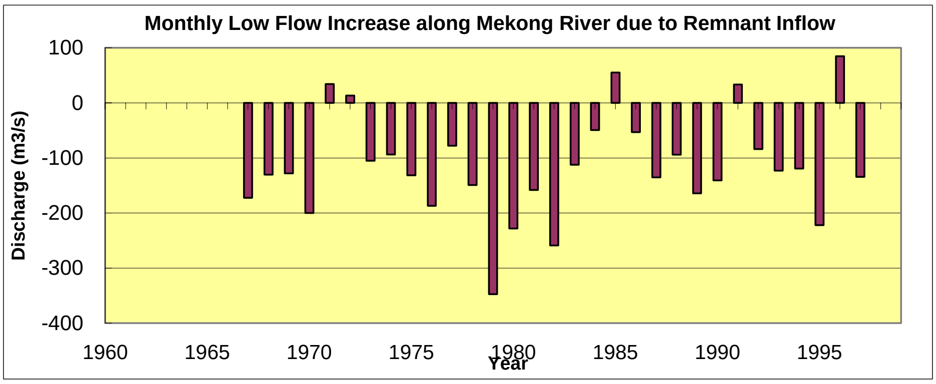


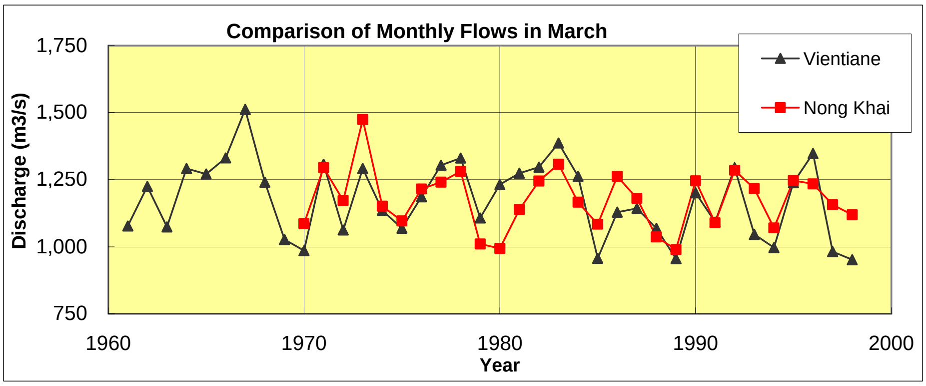
Fig. 7.6 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in March (1/6)

Stretch : Chiang Khan - Vientiane (7,000 km2) ***Month : March***





Stretch : Vientiane - Nong Khai (3,000 km2) ***Month : March***



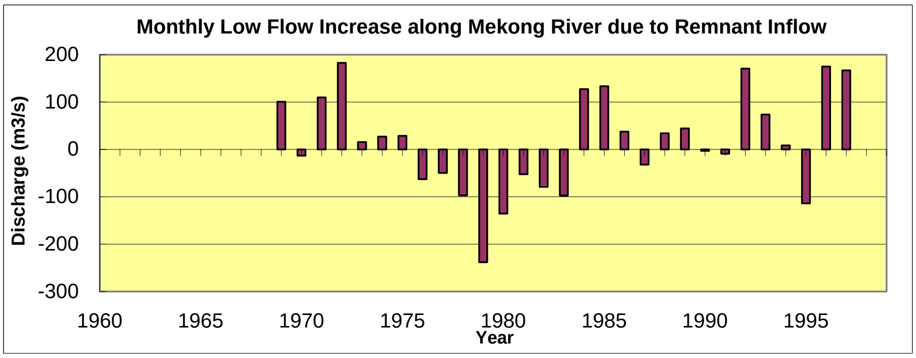
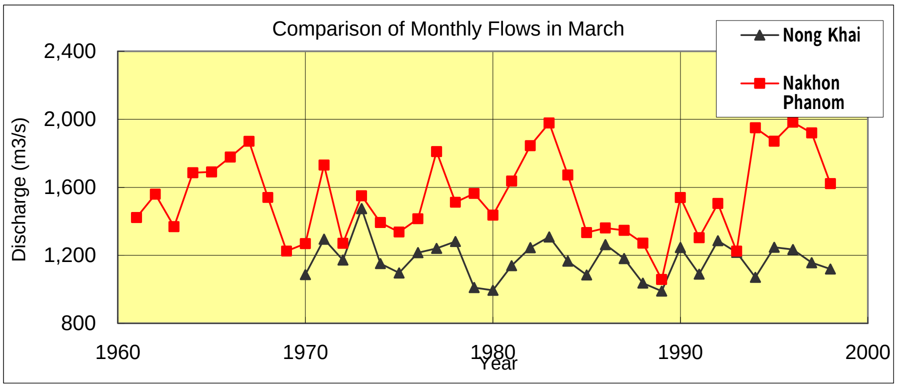
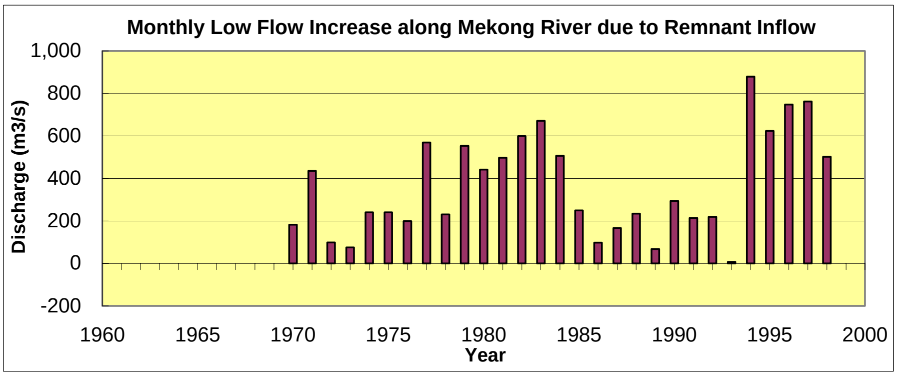


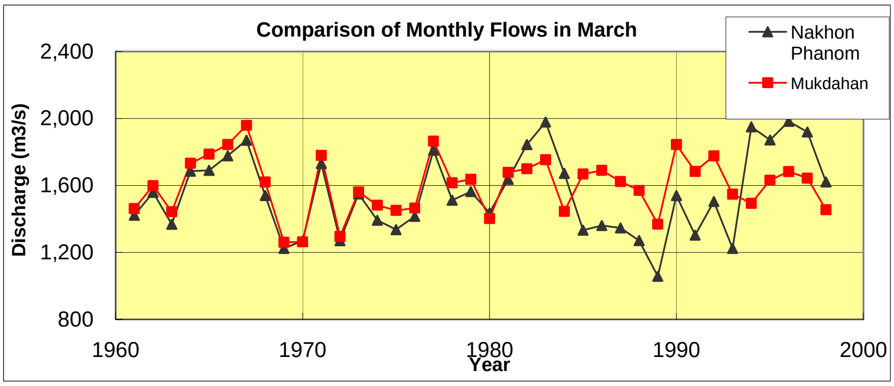
Fig. 7.6 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in March (2/6)

Stretch : Nong Khai - Nakhon Phanom (71,000 km2) ***Month : March***





Stretch : Nakhon Phanom - Mukdahan (18,000 km2) ***Month : March***



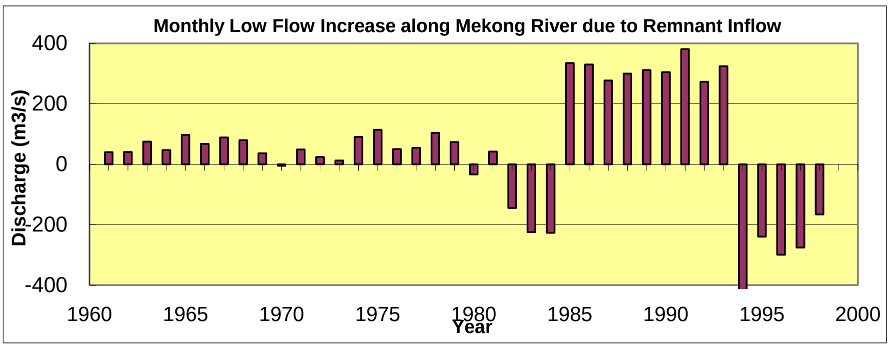
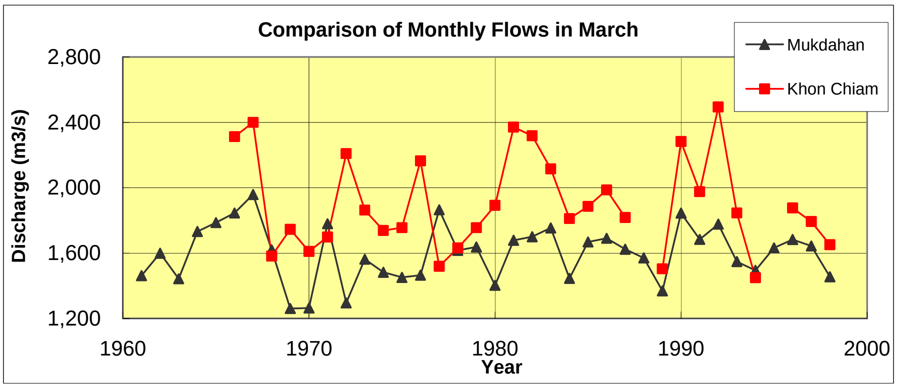
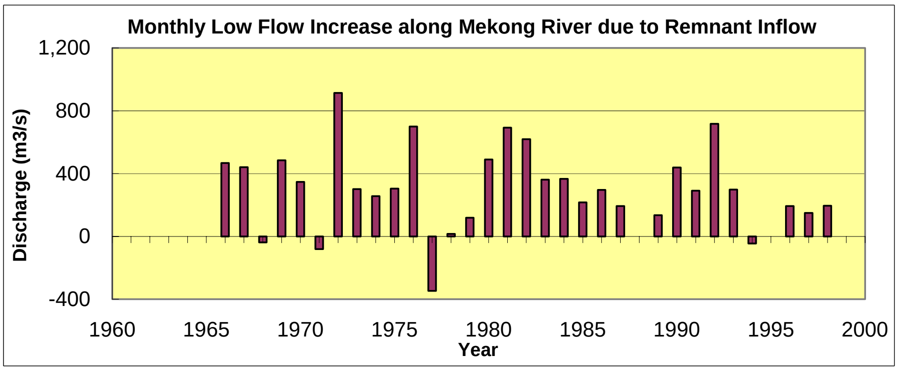


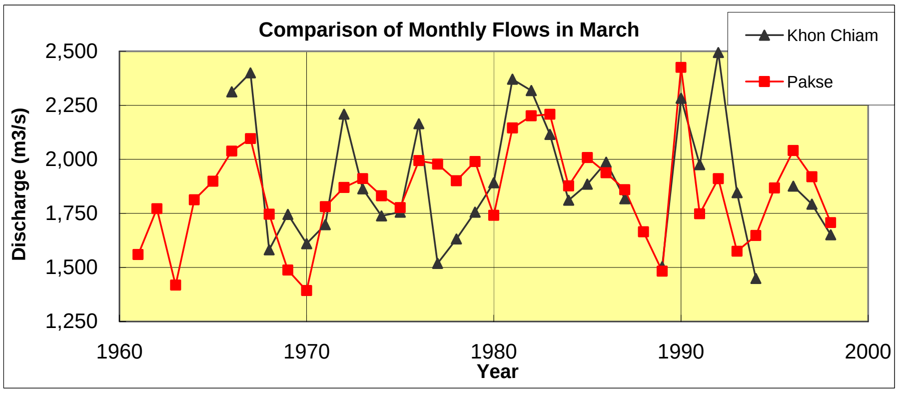
Fig. 7.6 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in March (3/6)

Stretch : Mukdahan - Khong Chiam (28,000 km2) ***Month : March***





Stretch : Khong Chiam - Pakse (126,000 km2) ***Month : March***



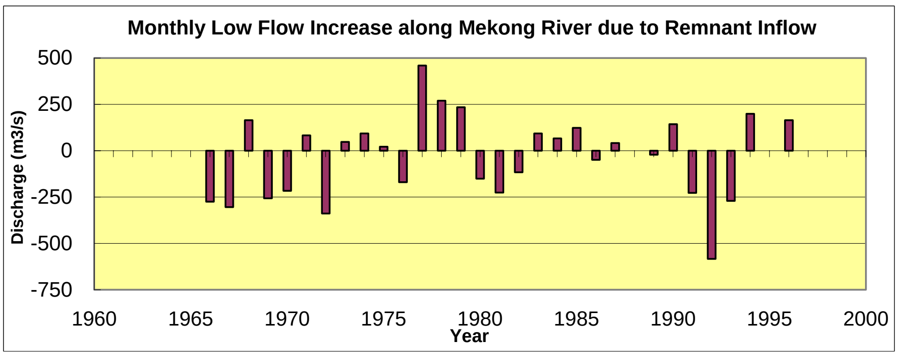
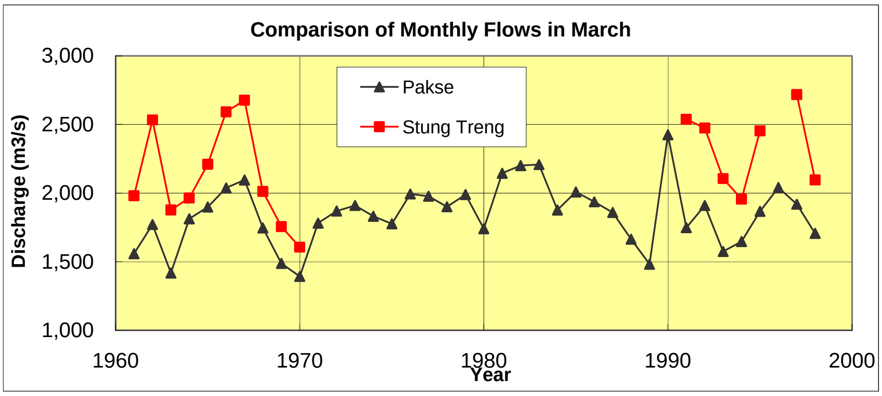
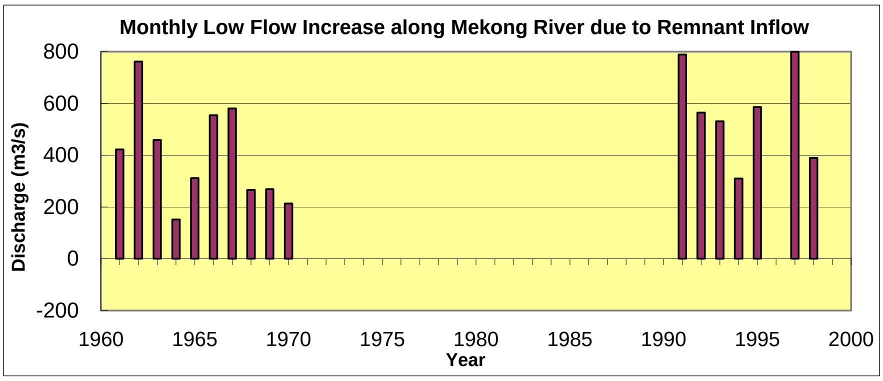


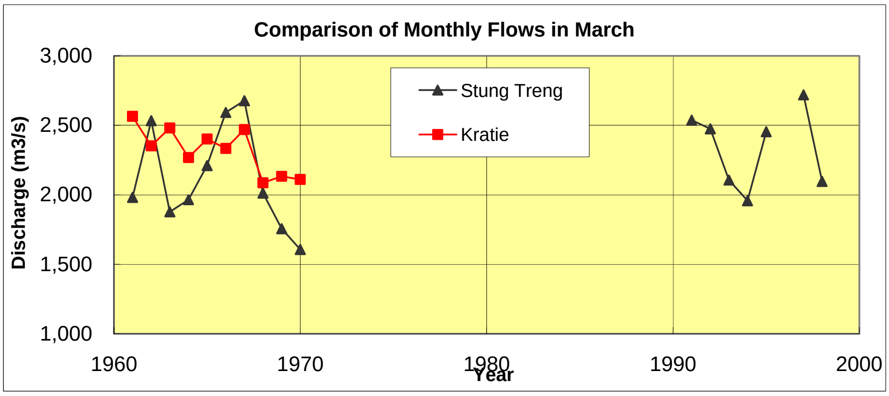
Fig. 7.6 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in March (4/6)

Stretch : Pakse - Stung Treng (90,000 km2) ***Month : March***





Stretch : Stung Treng - Kratie (11,000 km2) ***Month : March***



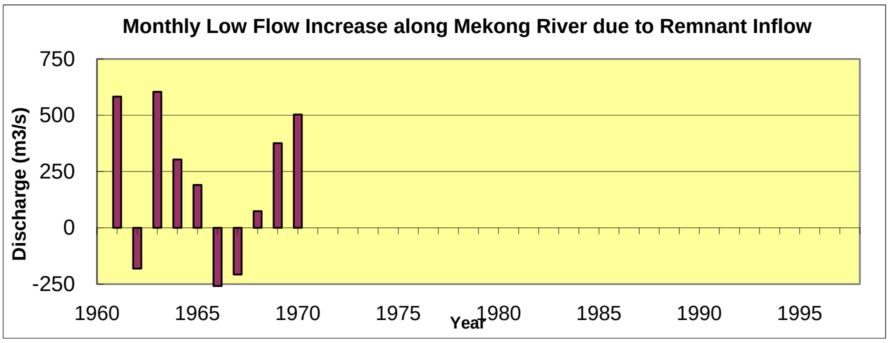
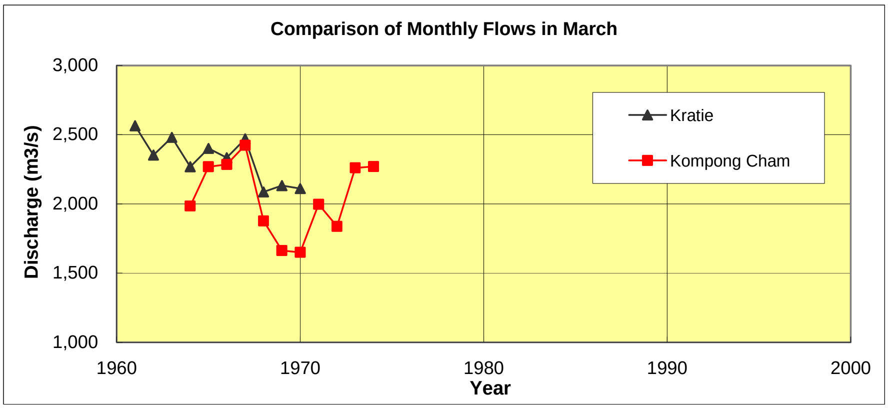
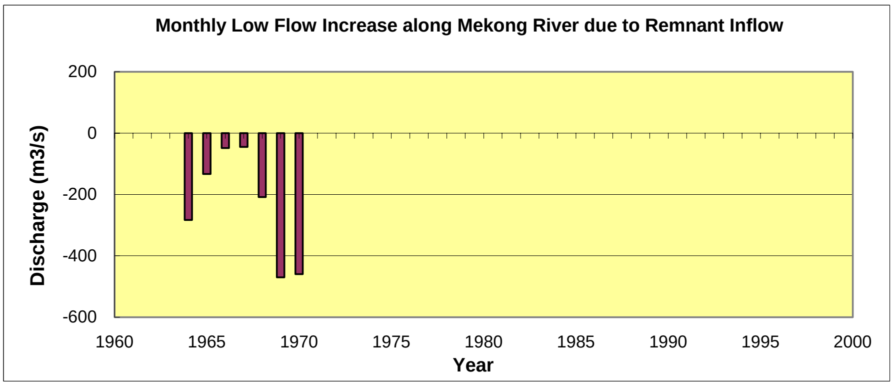


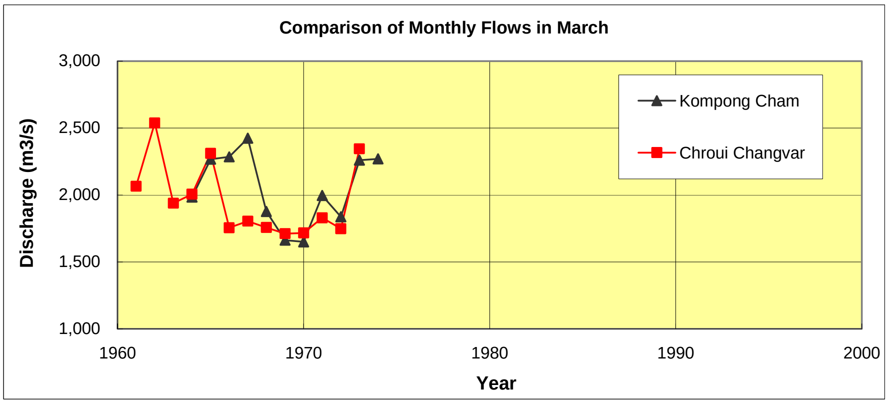
Fig. 7.6 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in March (5/6)

Stretch : Kratie - Kompong Cham (14,000 km2) *Month : March*





Stretch : Kompong Cham - Chrui Changvar (3,000 km2) *Month : March*



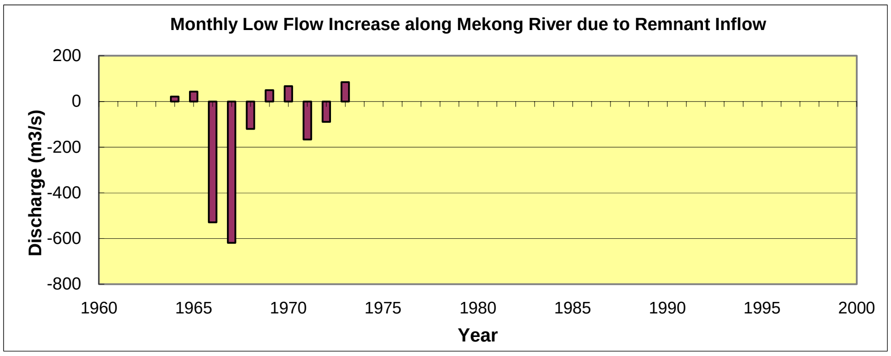
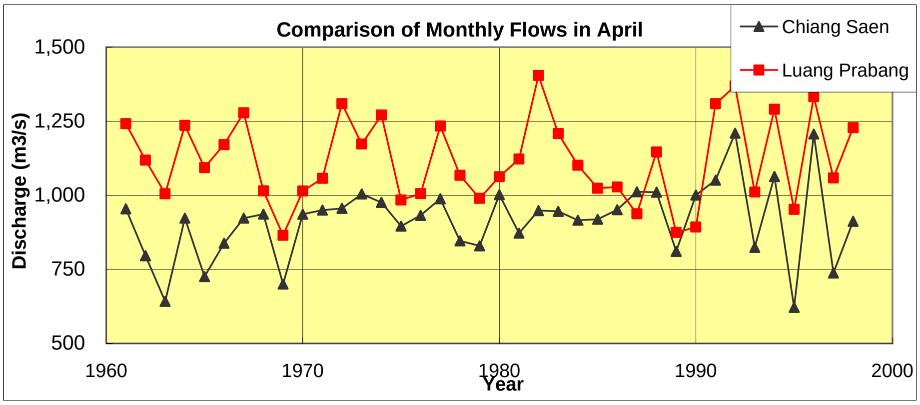
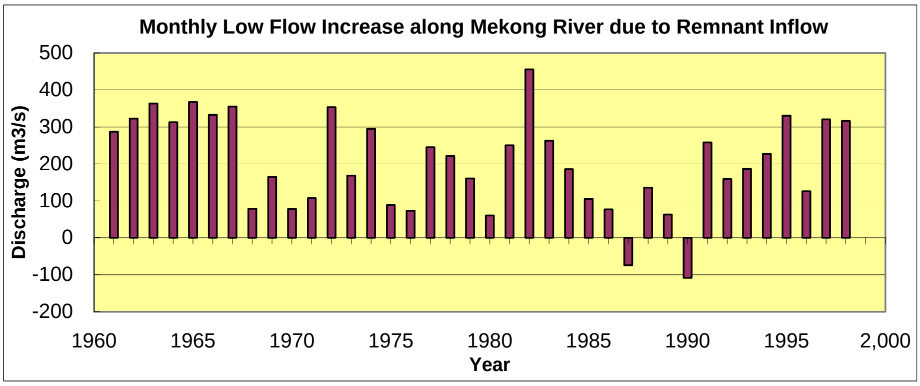


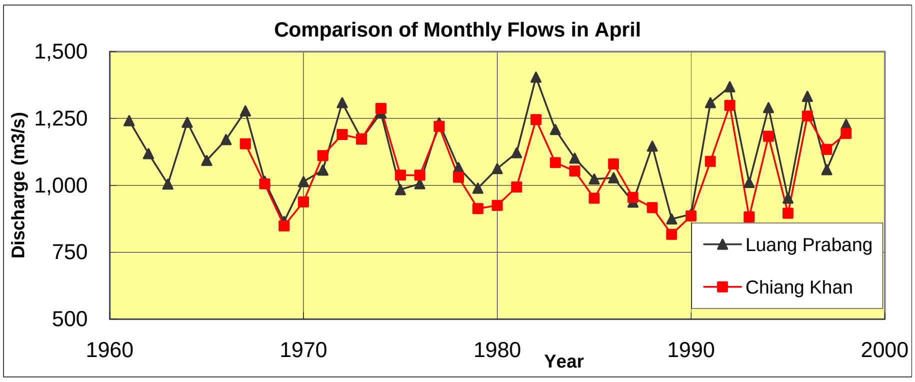
Fig. 7.6 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in March (6/6)

Stretch : Chiang Sean - Luang Prabang (79,000 km2) ***Month : April***





Stretch : Luang Prabang - Chiang Khan (24,000 km2) ***Month : April***



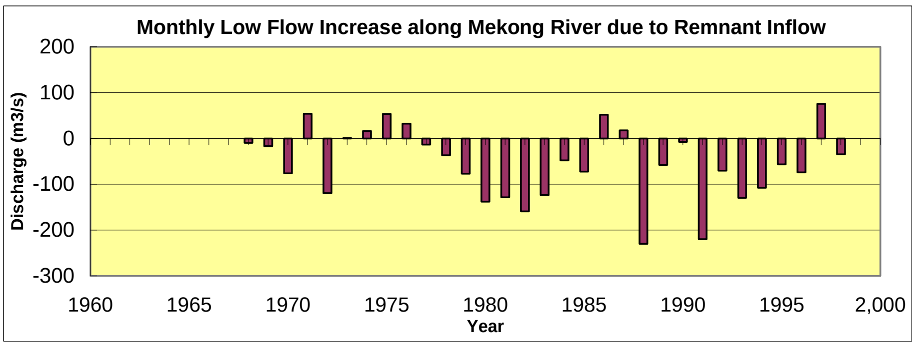
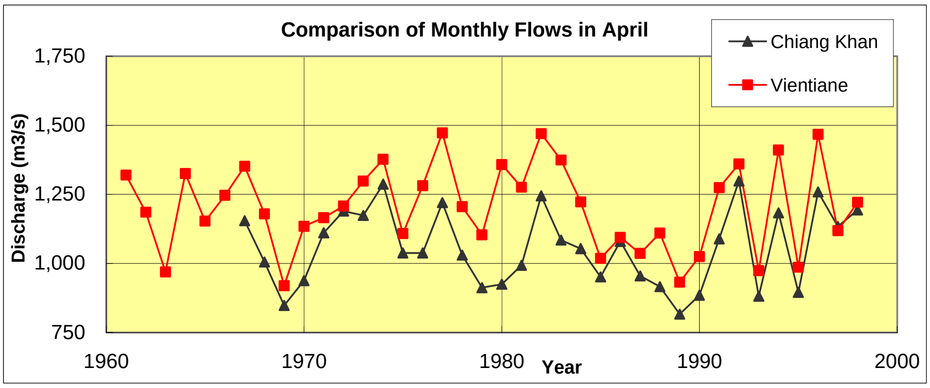
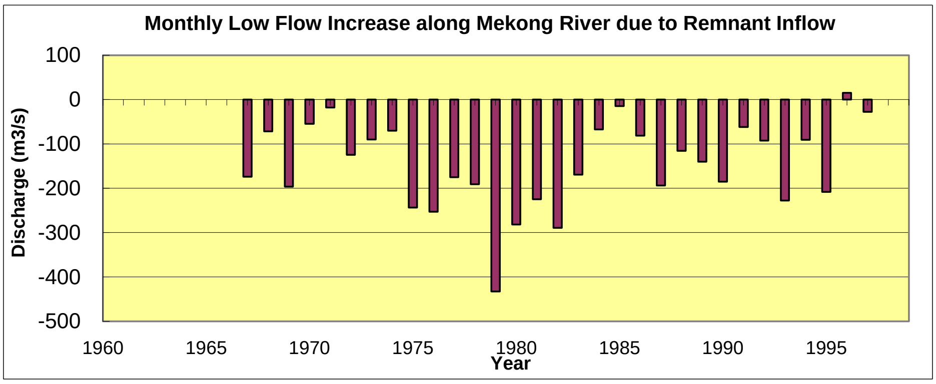


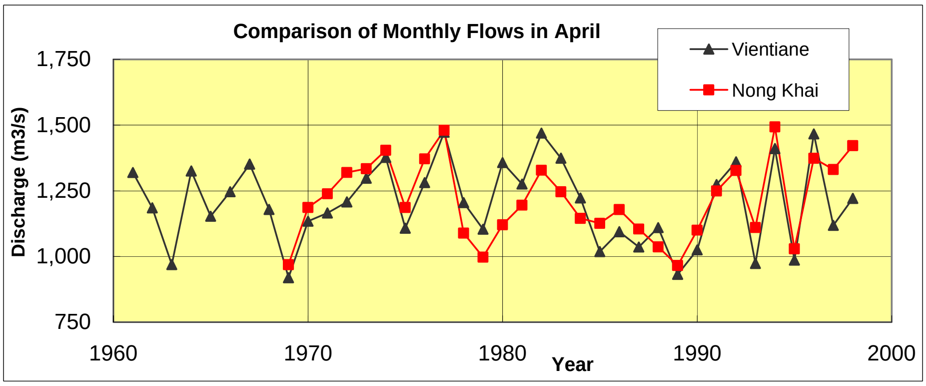
Fig. 7.7 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in April (1/6)

Stretch : Chiang Khan - Vientiane (7,000 km2) ***Month : April***





Stretch : Vientiane - Nong Khai (3,000 km2) ***Month : April***



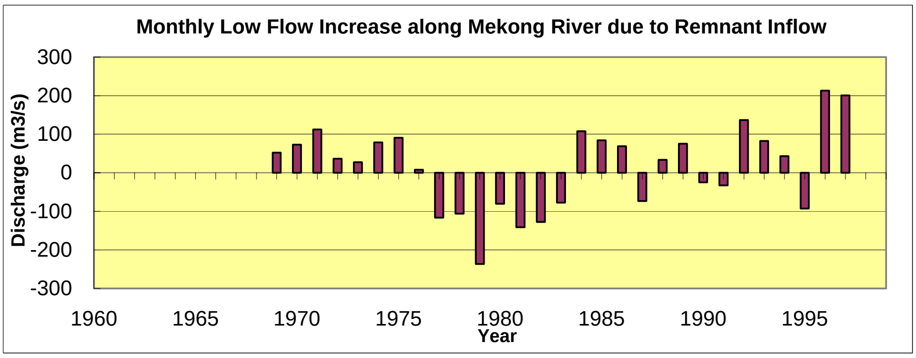
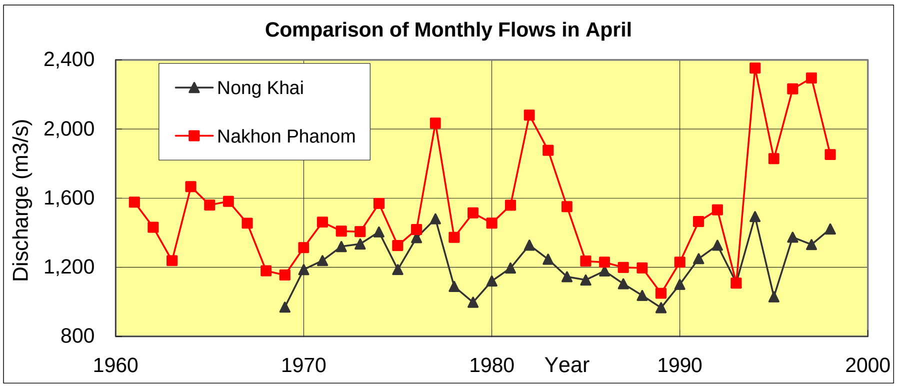
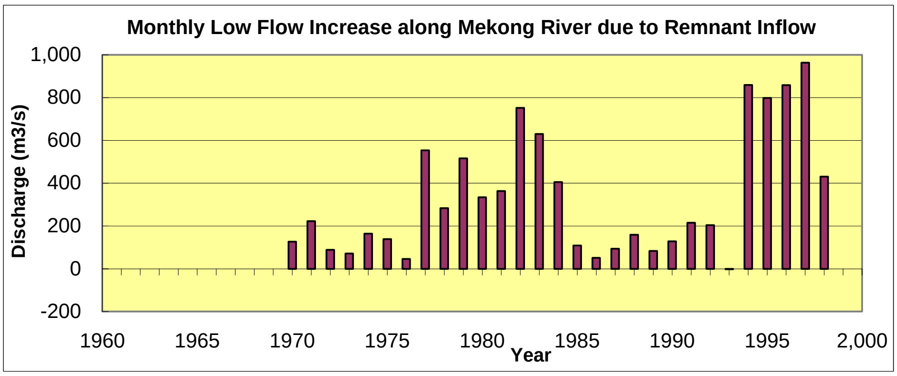


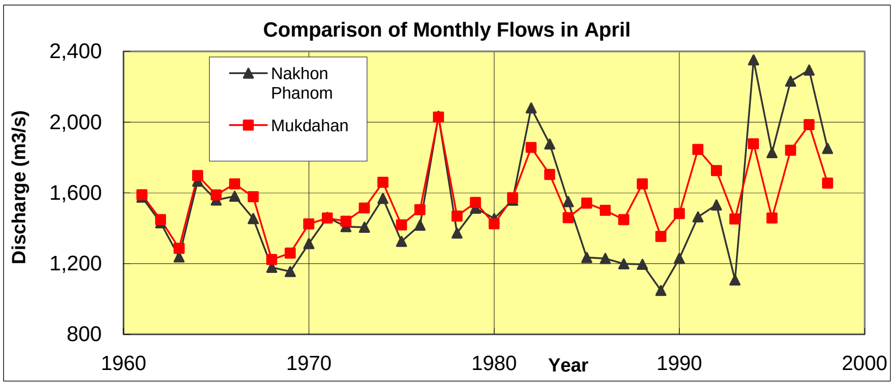
Fig. 7.7 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in April (2/6)

Stretch : Nong Khai - Nakhon Phanom (71,000 km2) ***Month : April***





Stretch : Nakhon Phanom - Mukdahan (18,000 km2) ***Month : April***



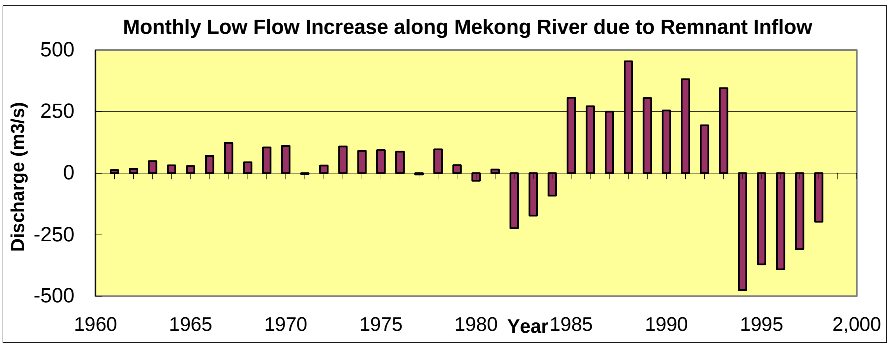
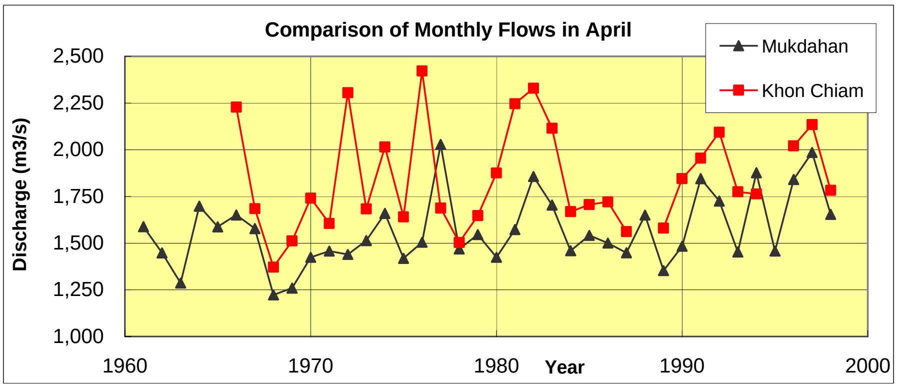
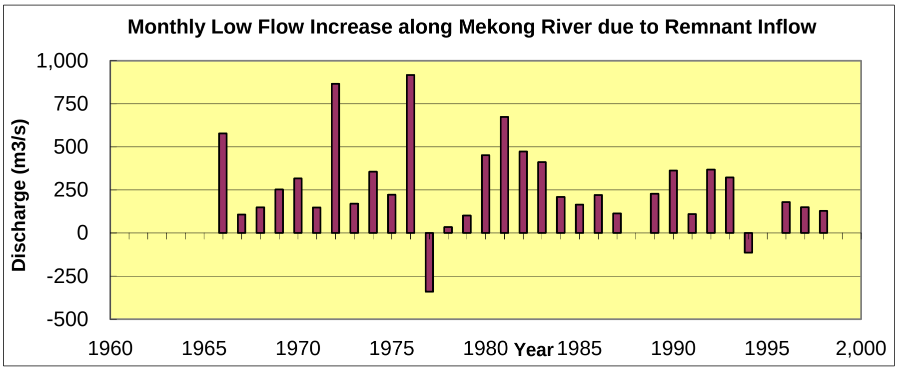


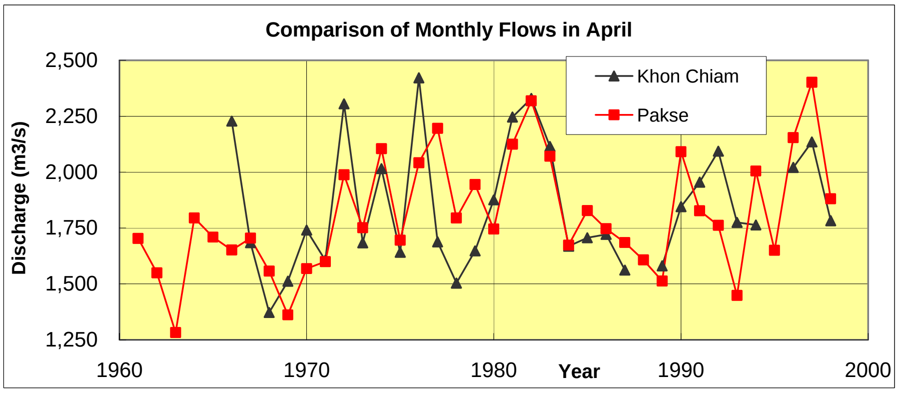
Fig. 7.7 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in April (3/6)

Stretch : Mukdahan - Khong Chiam (28,000 km2) ***Month : April***





Stretch : Khong Chiam - Pakse (126,000 km2) ***Month : April***



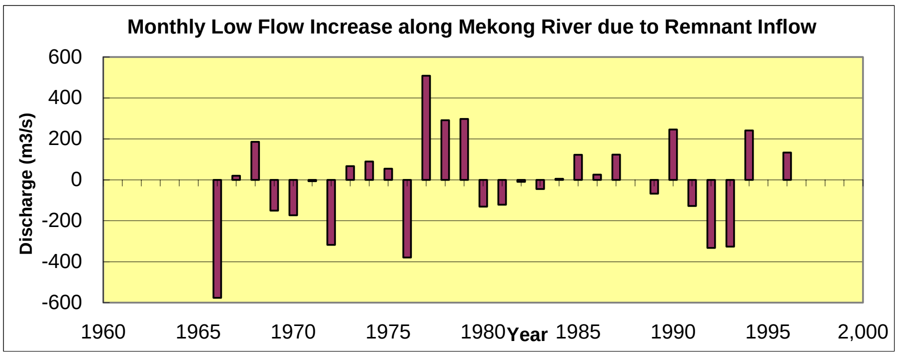
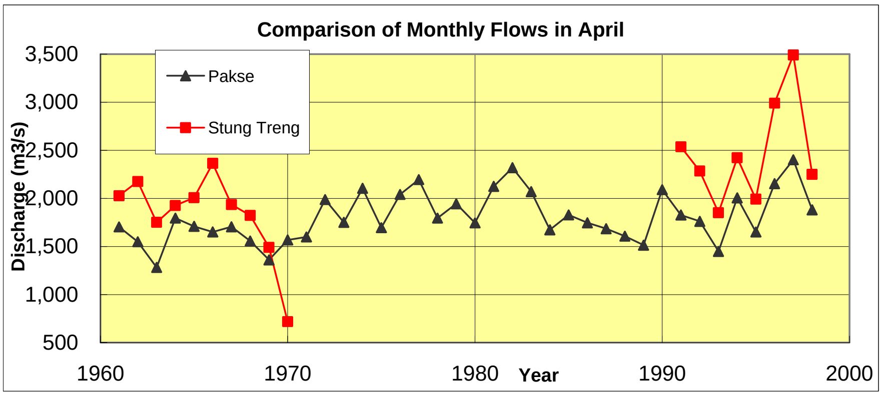
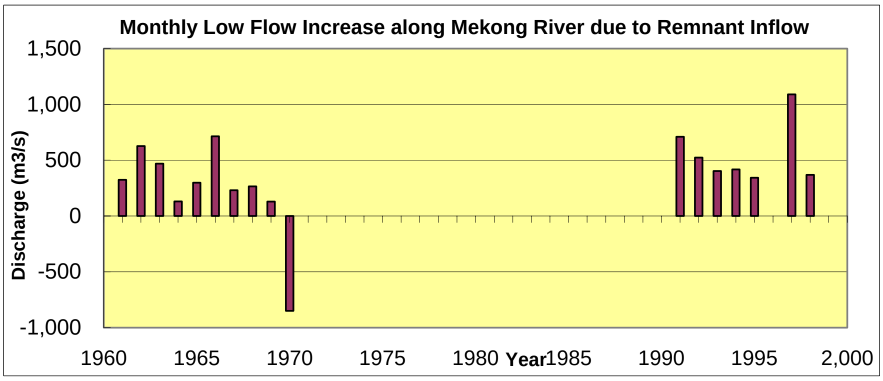


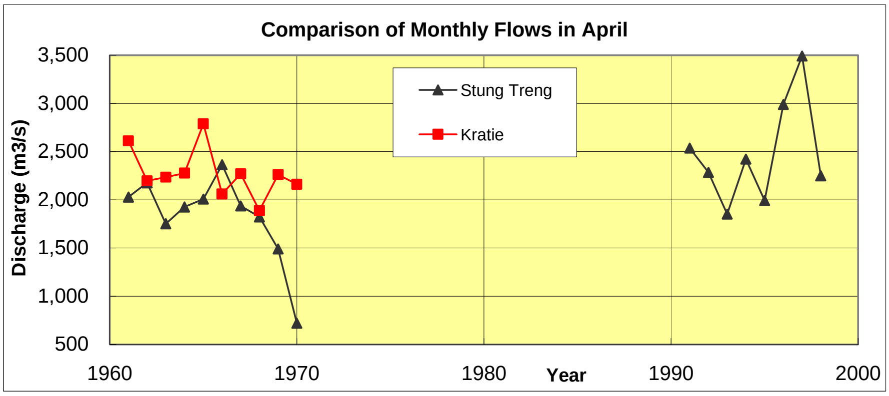
Fig. 7.7 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in April (4/6)

Stretch : Pakse - Stung Treng (90,000 km2) ***Month : April***





Stretch : Stung Treng - Kratie (11,000 km2) ***Month : April***



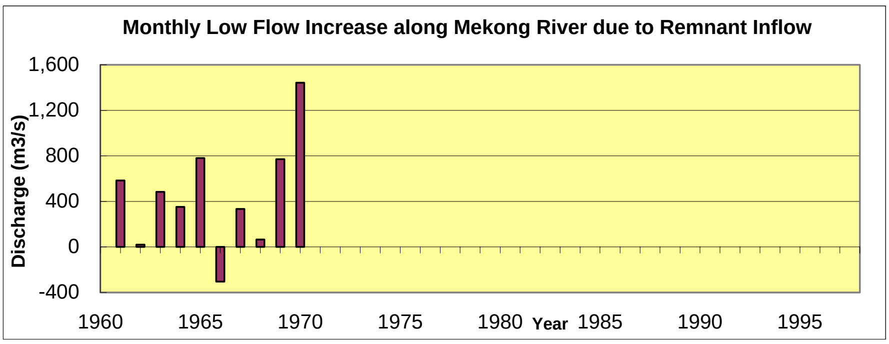
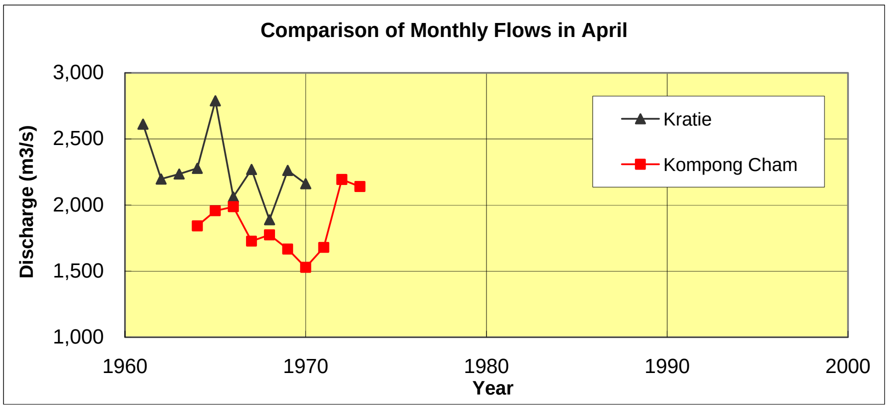
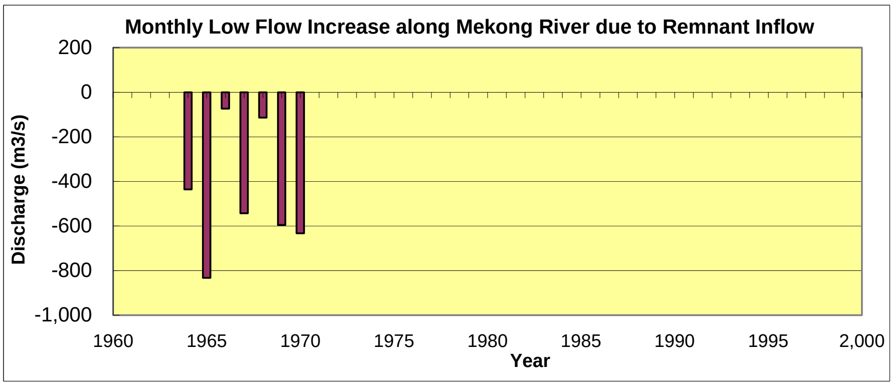


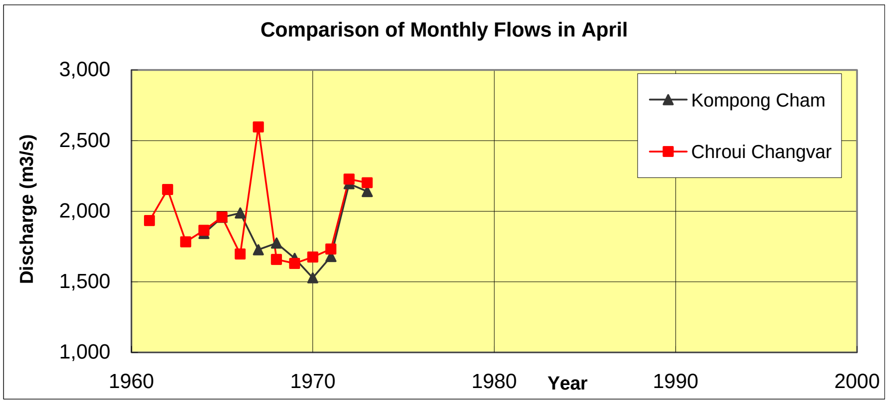
Fig. 7.7 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in April (5/6)

Stretch : Kratie - Kompong Cham (14,000 km2) ***Month : April***





Stretch : Kompong Cham - Chrui Changvar (3,000 km2) ***Month : April***



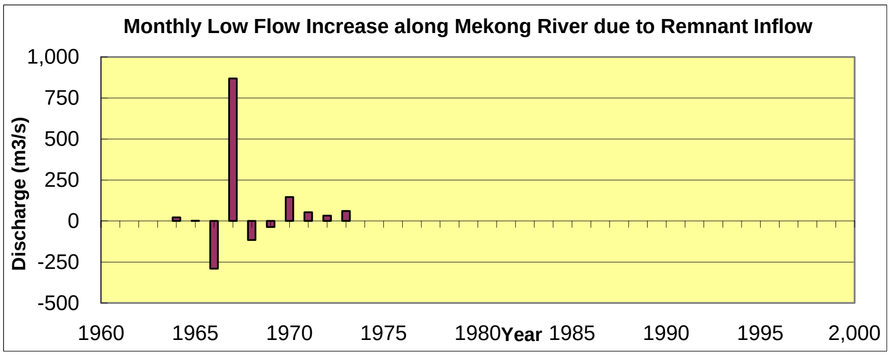
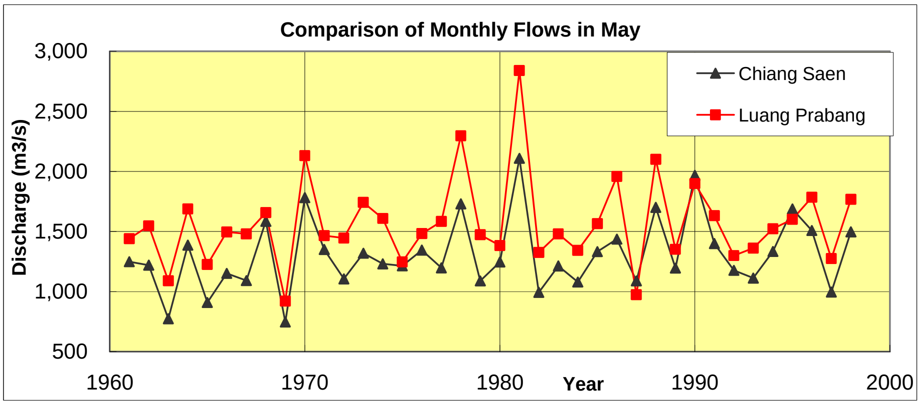
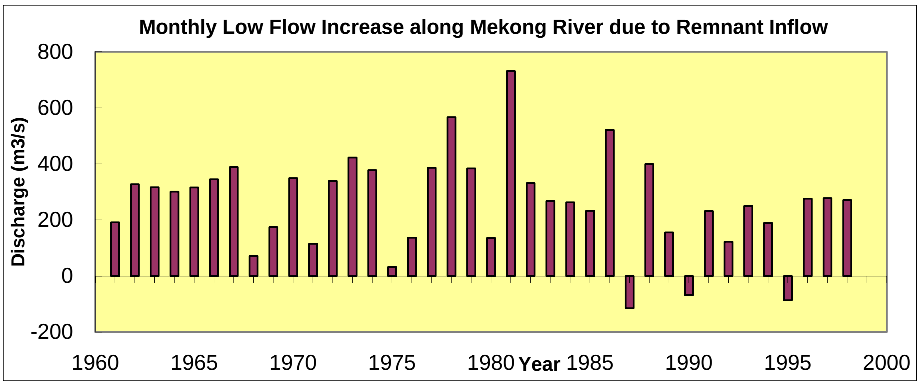


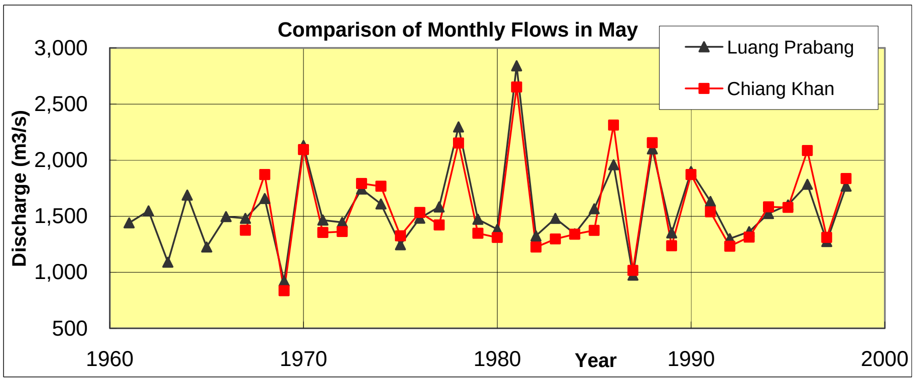
Fig. 7.7 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in April (6/6)

Stretch : Chiang Sean - Luang Prabang (79,000 km2) ***Month : May***





Stretch : Luang Prabang - Chiang Khan (24,000 km2) ***Month : May***



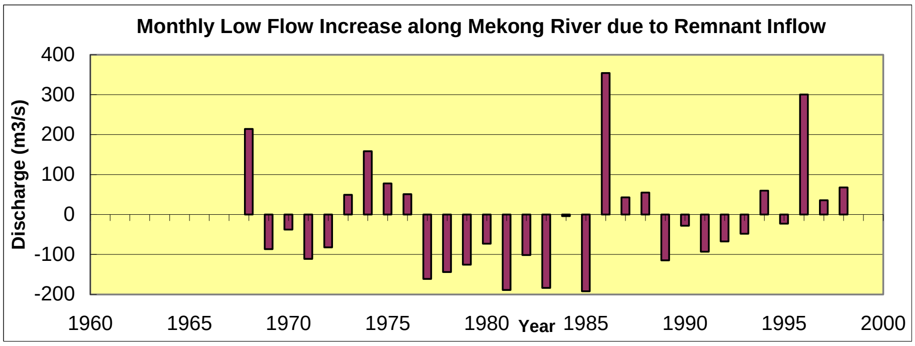
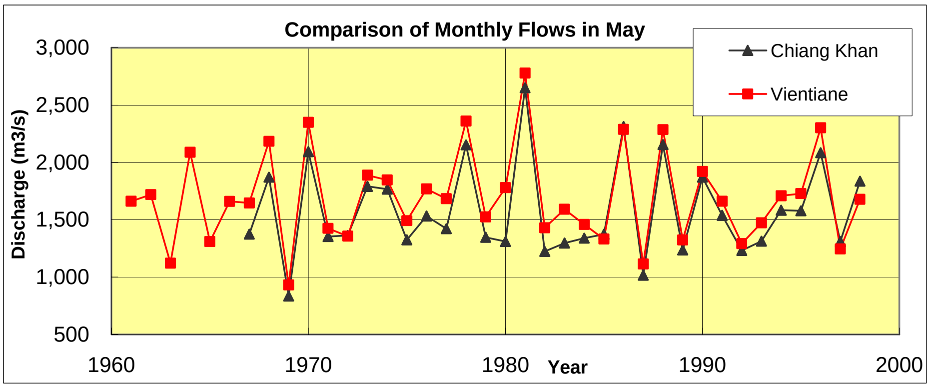
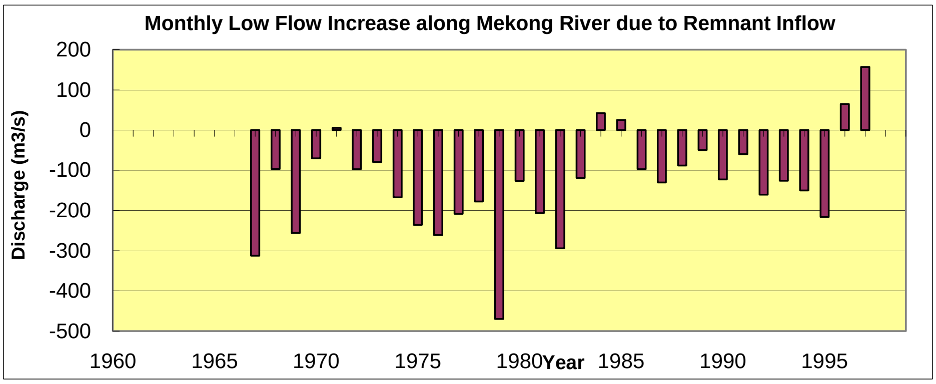


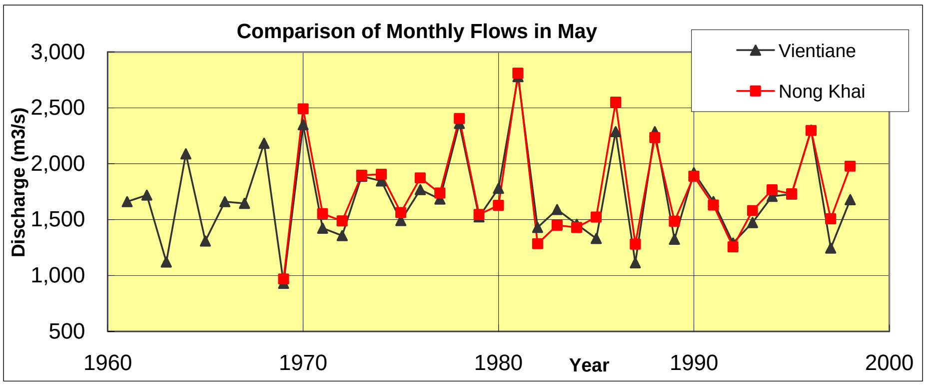
Fig. 7.8 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in May (1/6)

Stretch : Chiang Khan - Vientiane (7,000 km2) ***Month : May***





Stretch : Vientiane - Nong Khai (3,000 km2) ***Month : May***



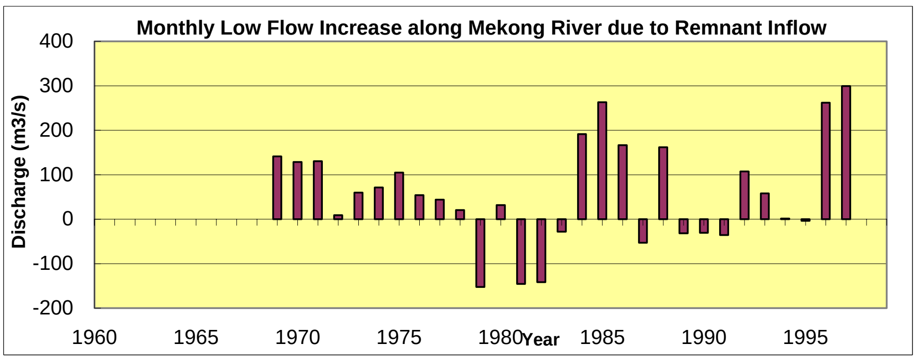
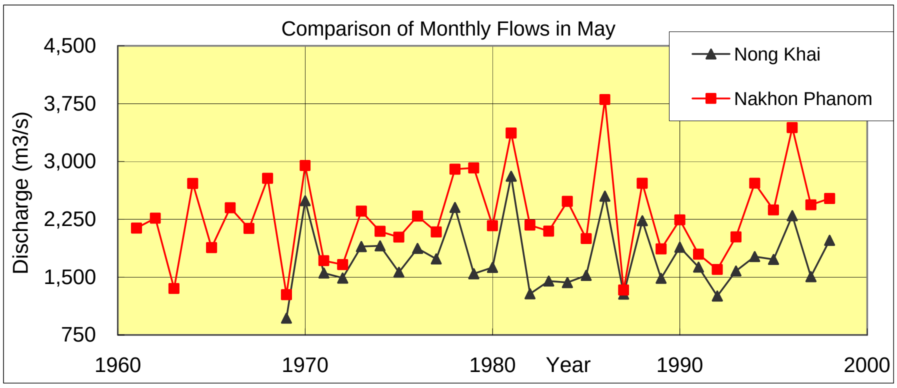
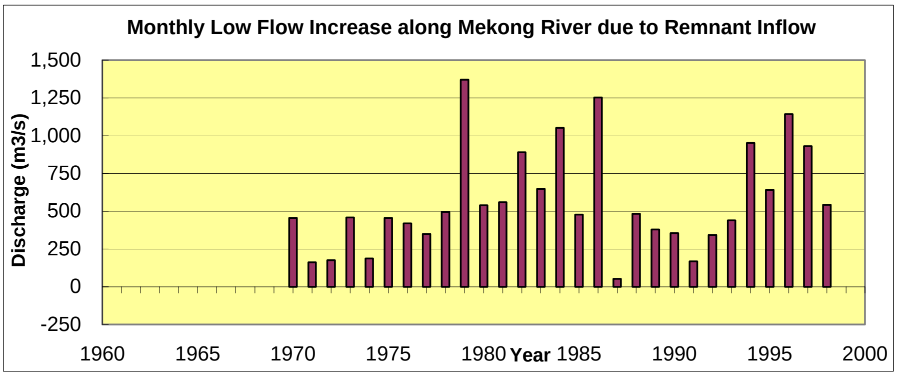


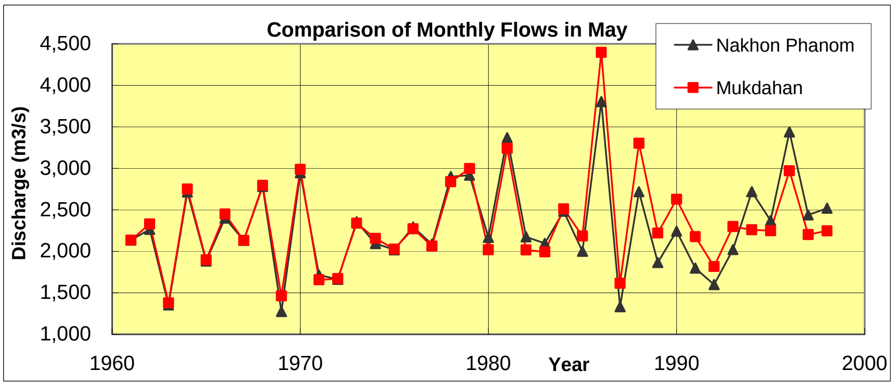
Fig. 7.8 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in May (2/6)

Stretch : Nong Khai - Nakhon Phanom (71,000 km2) ***Month : May***





Stretch : Nakhon Phanom - Mukdahan (18,000 km2) ***Month : May***



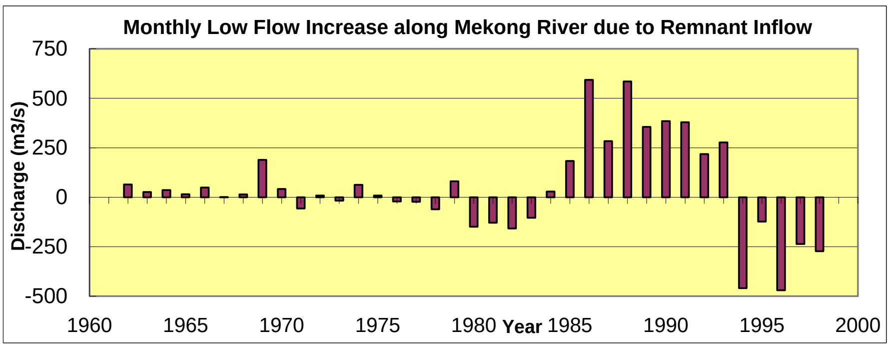
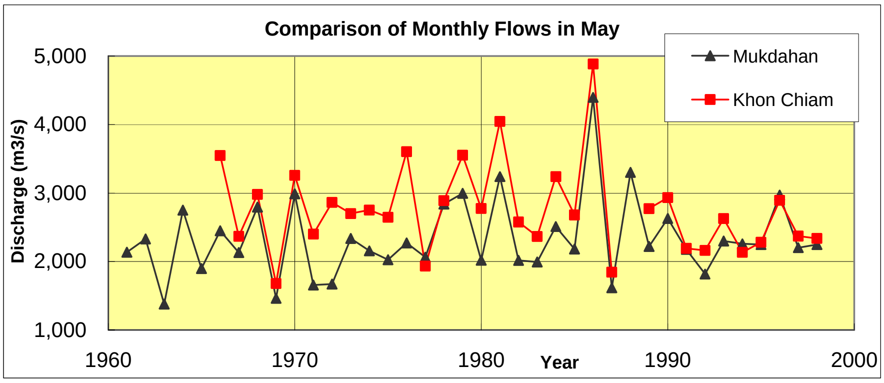
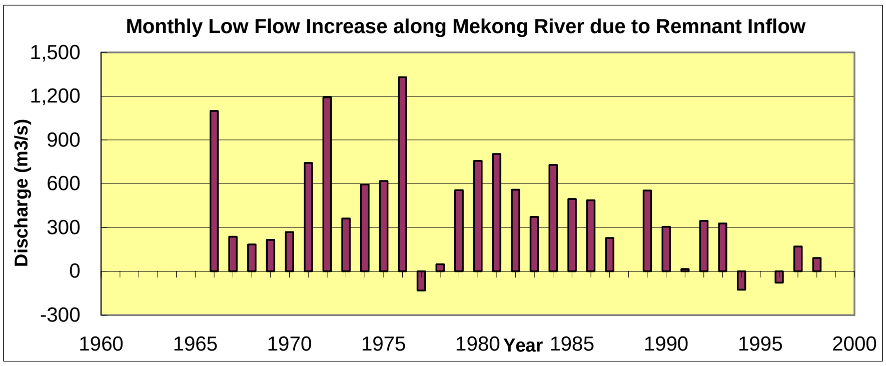


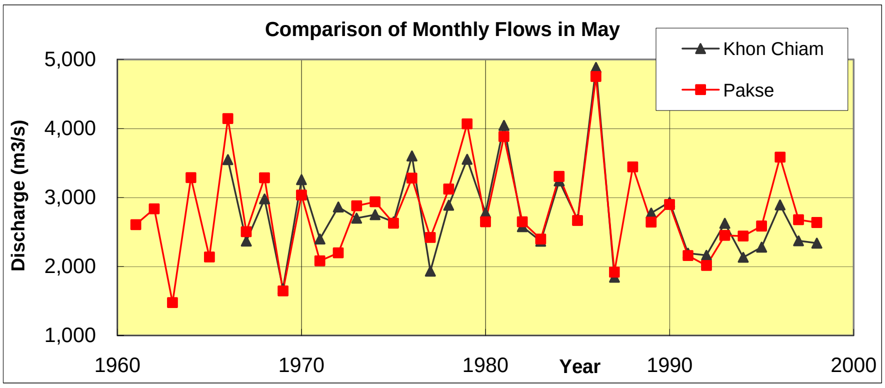
Fig. 7.8 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in May (3/6)

Stretch : Mukdahan - Khong Chiam (28,000 km2) ***Month : May***





Stretch : Khong Chiam - Pakse (126,000 km2) ***Month : May***



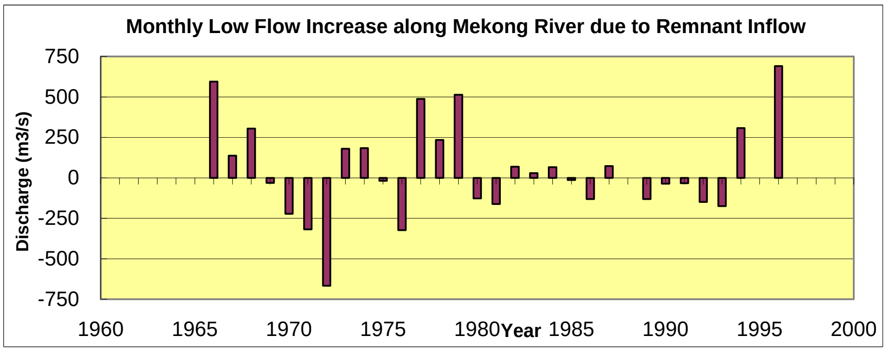
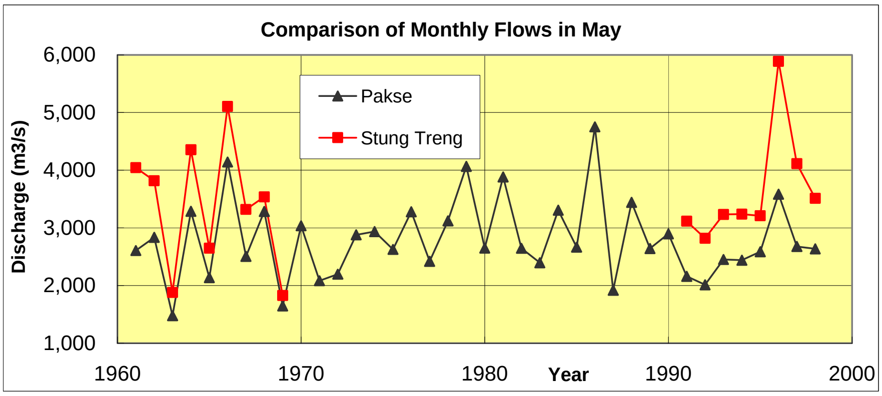
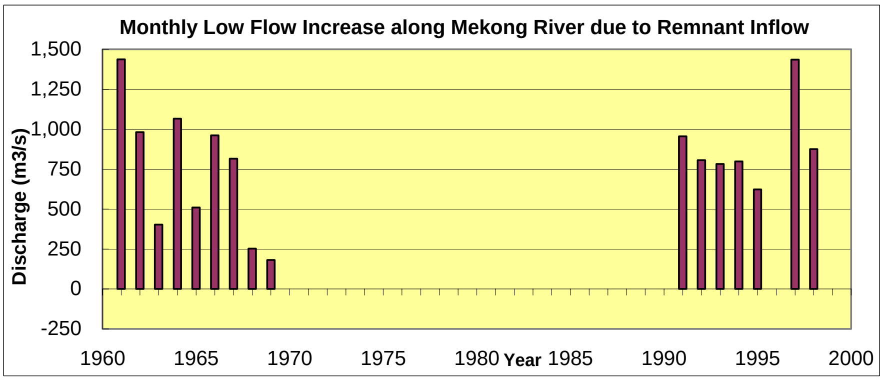


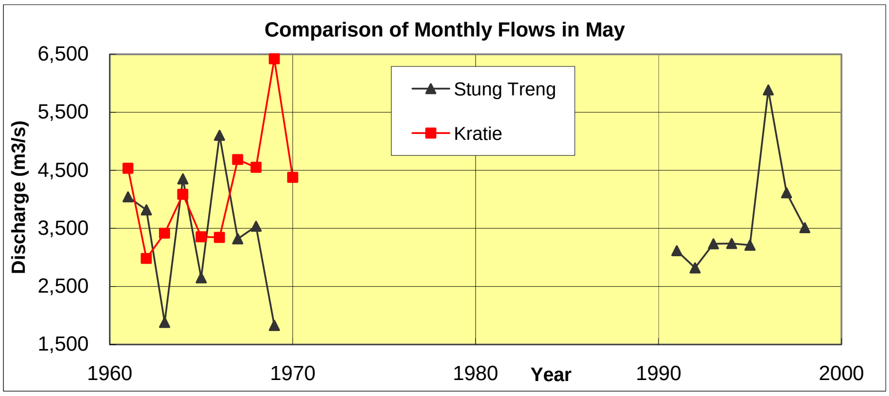
Fig. 7.8 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in May (4/6)

Stretch : Pakse - Stung Treng (90,000 km2) ***Month : May***





Stretch : Stung Treng - Kratie (11,000 km2) ***Month : May***



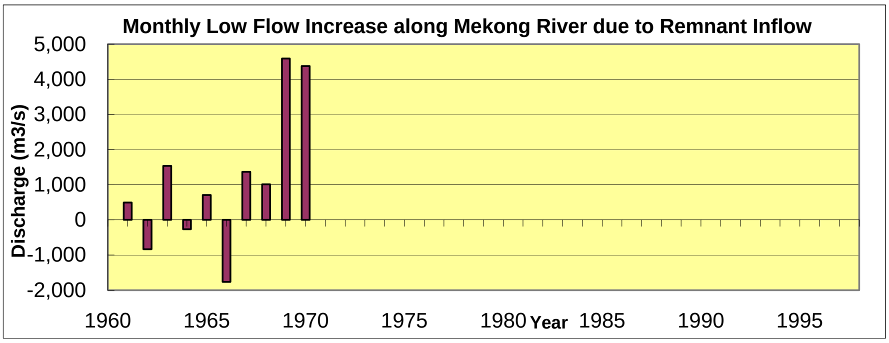
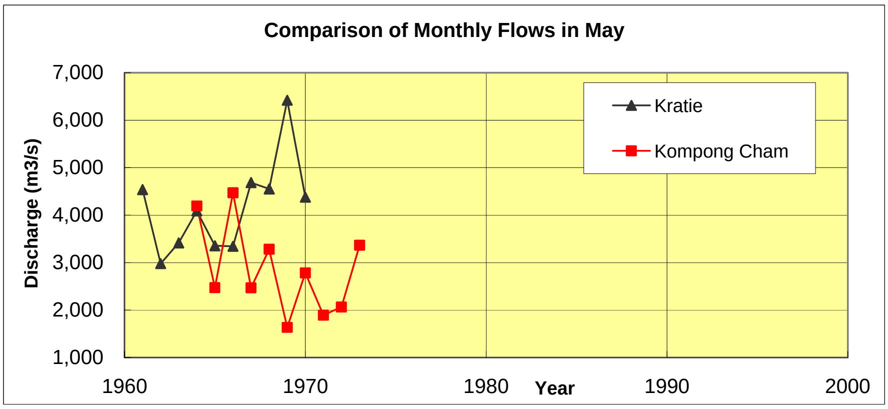
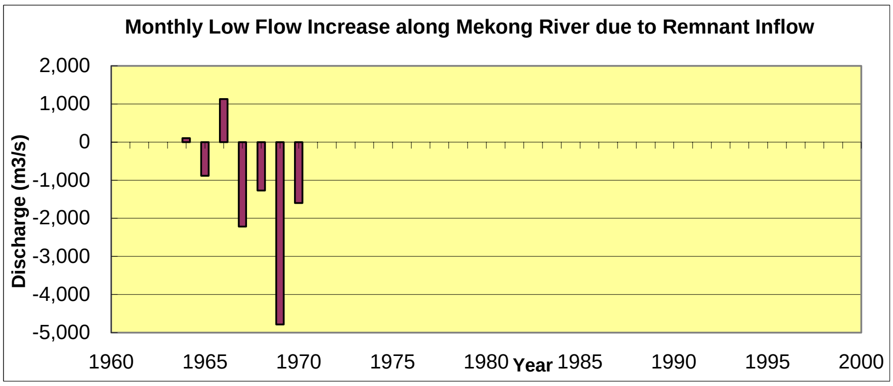


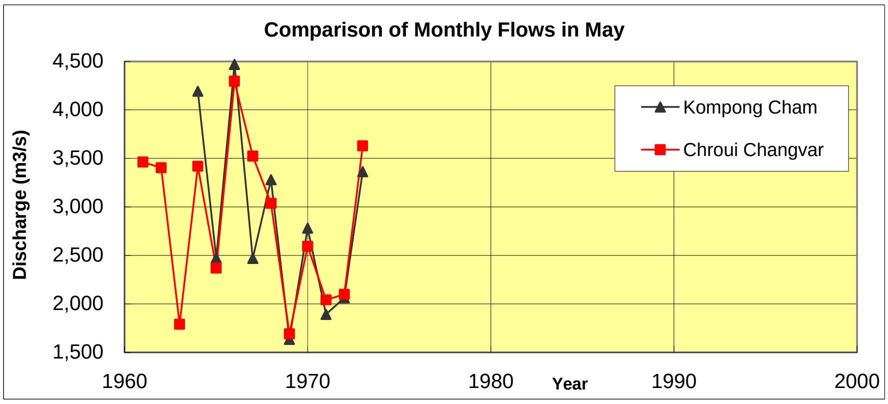
Fig. 7.8 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in May (5/6)

Stretch : Kratie - Kompong Cham (14,000 km2) ***Month : May***





Stretch : Kompong Cham - Chrui Changvar (3,000 km2) ***Month : May***



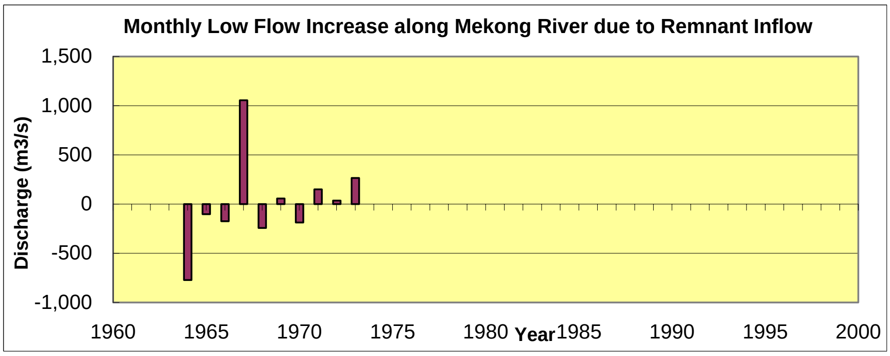


Fig. 7.8 Low Flow Increase of Mekong Mainstream due to Lateral Inflow in May (6/6)