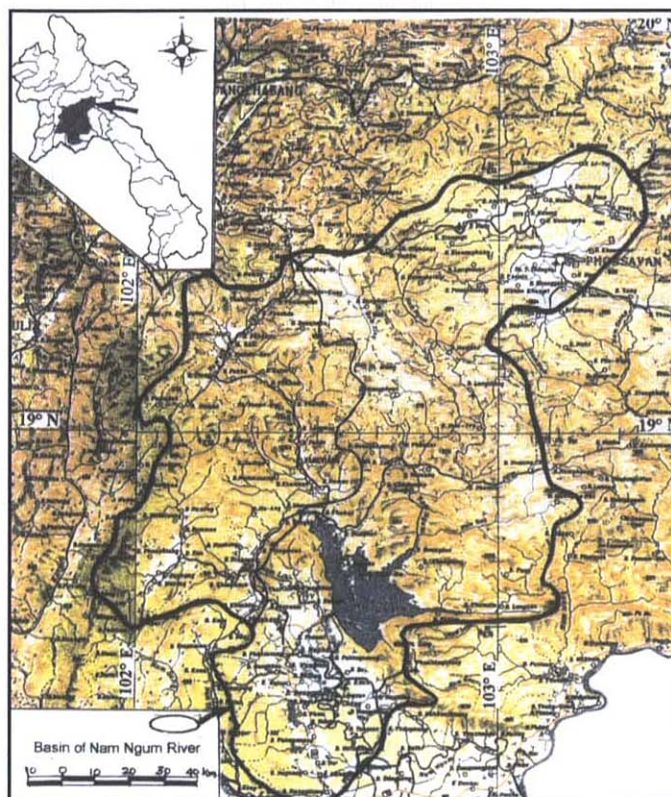


# Nam Ngum

## Map of River

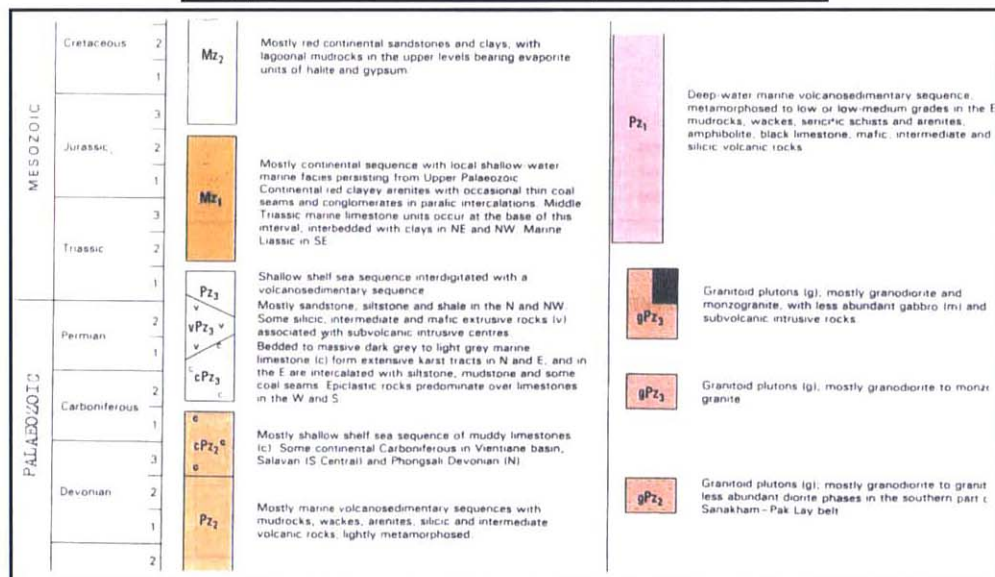
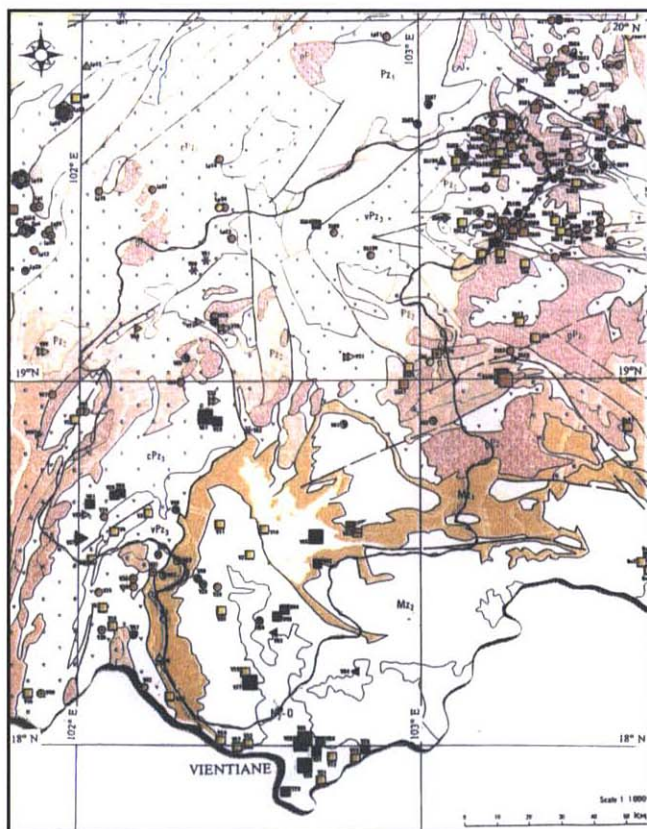


## Table of Basic Data

<b>Name:</b> Nam Ngum		<b>Serial No.:</b> Lao-2
<b>Location:</b> Northern-Central Lao	N 17° 40' ~ 19° 35'	E 101° 45' ~ 103° 25'
<b>Area:</b> 16,500 km <sup>2</sup>	<b>Length of main stream:</b> 1,403 km	
<b>Origin:</b> Xieng Khouang Plateau (150 m)	<b>Highest point:</b> Phou Miang (2,455 m )	
<b>Outlet:</b> Confluence with the Mekong	<b>Lowest point:</b> Vientiane plain, Tha Ngone (170 m)	
<b>Main geological features:</b> Mesozoic sandstone and conglomerate		
<b>Main tributaries:</b> Nam Lik (5,115 km <sup>2</sup> )		
<b>Main lakes:</b> None		
<b>Main reservoirs:</b> Nam Ngum Dam (7.030x10 <sup>9</sup> m <sup>3</sup> , 1978), at FRL 212 msl (Full reservoir level)		
<b>Mean annual precipitation:</b> 2,000 mm (1929-1990)		
<b>Mean annual runoff:</b> 730 m <sup>3</sup> /s at Tha Ngone (16,500 km <sup>2</sup> , 1960-1971)		
<b>Population:</b> 741,196 (1996)	<b>Main cities:</b> Phone Hong, Tha Ngone	
<b>Land use:</b> Forest (41%), Rice field (10%), Urban (1%), Other (48%) (1995)		

## 2. Geographical Information

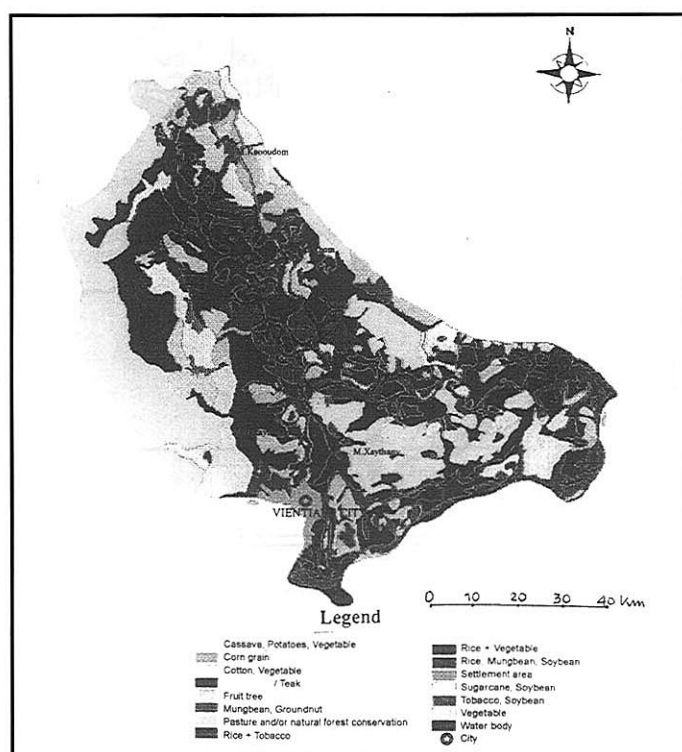
### 2.1 Geological Map



## 1. General Description

The Nam Ngum, with a total length of 1,403 km and draining an area of 17,000 km<sup>2</sup>, is the largest river of Xieng Khouang and Vientiane provinces and one of the major tributaries of Mekong in Lao P.D.R. The river source is located in the Plain of Jars about 1,000-1,100 m above mean sea level. It flows down for about 240 km to reach the Nam Ngum Dam, the No. 1 project constructed in 1971 with a full reservoir area of about 400 km<sup>2</sup> at an elevation of 212 m. The Nam Lik is the largest tributary of Nam Ngum, with a catchment area of 5,115 km<sup>2</sup> at Hine Heup gauging station. After joining with the Nam Lik, the Nam Ngum flows down into the Vientiane Plain for about 80 km in the southerly direction to reach Tha Ngone, and then for another 80 km in an easterly direction to join the Mekong River at Pak Ngum. The drainage area of the river at Tha Ngone gauging station is 16,500 km<sup>2</sup>. The basin has an annual precipitation of 2,000 mm. The annual discharge at Tha Ngone before and after the dam construction have been 734.4 m<sup>3</sup>/s (1960-1971) and 680 m<sup>3</sup>/s (1972-1988) respectively.

## 2.2 Land Use Map



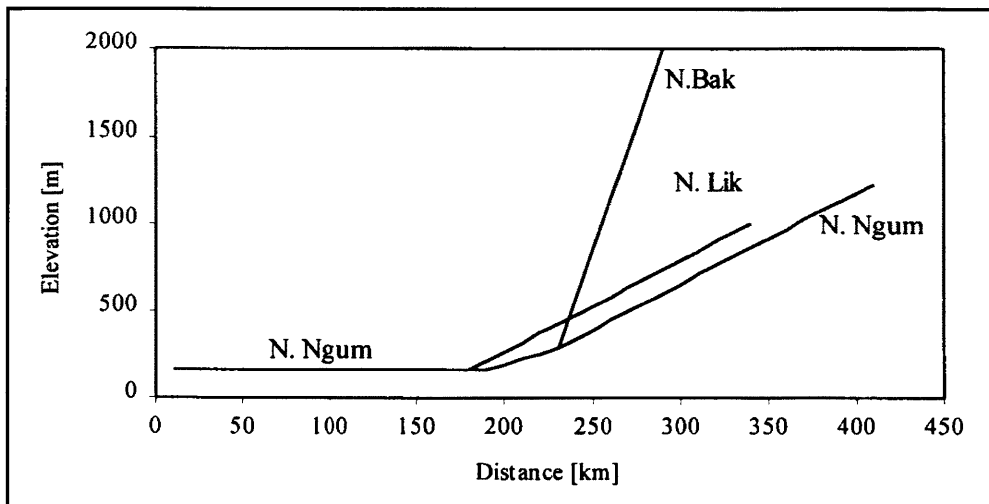
## 2.3 Characteristics of River and Main Tributaries

No.	Name of river	Length [km] Catchment area [km <sup>2</sup> ]	Highest peak [m] Lowest point [m]	Cities Population (1996)	Land use [ % ]	Representative vegetation and wildlife
1	Nam Ngum (Main river)	1,323 16,500	Phou Miang 2,455 Tha Ngone 170	Phone Hong 55,372	F (43.0) P (20.0)	Dipterocarpus anisop term. Tropical forest.
2	Nam Lik (Tributary)	810 5,115	Phou Lao Py 2,078 Hine Heup 197	Hine Heup 15,000	F (40.0) P (5.0)	Tropical forest dominated by Dipterocarpus.

F: Forest

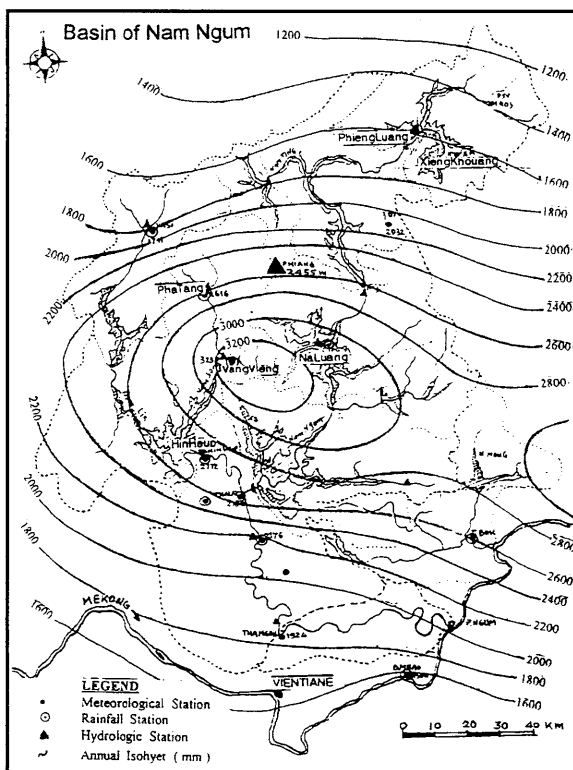
P: Paddy field

## 2.4 Longitudinal Profiles



## 3. Climatological Information

### 3.1 Annual Isohyetal Map and Observation Stations



### 3.2 List of Meteorological Observation Stations

No.	Station	Elevation [m]	Location	Observation period	Mean annual precipitation [mm]	Mean annual evaporation [mm]	Observation items <sup>1)</sup>
1	Xieng Khouang	1,050	N 19° 28' E 103° 08'	1929~1996	1,418		P, E, DS
2	Vang Vieng	296	N 18° 53' E 102° 27'	1969~1996	3,271		P, E
3	Phone Hong	170	N 18° 53' E 102° 24'	1971~1992	2,165	1,500	P, E, DS
4	Long Cheng	250	N 19° 05' 30" E 102° 52' 20"	1995~1996	2,473		P(TB)
5	Naluang	240	N 18° 54.8' E 102° 46.7'	1986~1990	2,615		P
6	Hine Heup	196	N 18° 39.8' E 102° 21.3'	1967~1996	2,174		P
7	Napheng	169	N 18° 21' E 102° 30'	1970~1980	1,828		P, E
8	Tha Ngone	169	N 18° 08' E 102° 37'	1971~1990	1,791		P, E, DS

1) DS: Duration of sunshine E: Evaporation P: Precipitation SR: Solar radiation TB: Tipping the bucket with recording chart

### 3.3 Monthly Climate Data

#### Station: Xieng Khouang

Observation item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [ °C ]	15.1	17.6	20.1	21.7	22.6	22.9	22.8	22.3	21.7	20.0	18.1	15.0	20.0	1951~1980
Precipitation [ mm ]	6.1	14.7	50.8	127.1	181.3	210.9	294.2	306.6	163.0	59.1	22.8	8.2	1,444.8	1929~1996
Evaporation Piche [ mm ]	123.7	133.4	206.7	152.6	102.6	84.8	79.6	64.8	80.8	88.6	102.5	108.7	1,328.4	1982~1989
Duration of sunshine [ hr ]	223.8	203.8	197.8	177.6	183.5	121.2	127.4	130.2	164.4	176.4	172.8	225.7	2,104.6	1983~1987

#### Station: Vang Vieng

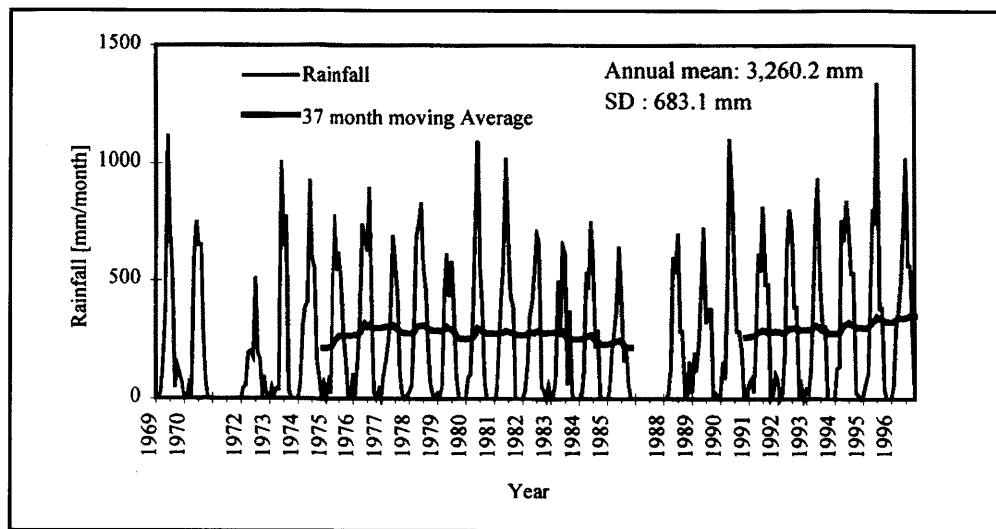
Observation item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [ °C ]	20.7	22.7	25.5	27.6	27.5	27.6	26.8	26.6	27.0	26.4	24.2	21.5	25.3	1972~1983
Precipitation [ mm ]	18.0	16.6	55.3	124.6	379.3	589.3	729.5	643.3	400.9	262.5	44.8	11.2	3,275.3	1968~1996
Evaporation Piche [ mm ]	56	72	140	151	159	154	147	140	143	142	94	74	1,472	1972~1983

#### Station: Phone Hong

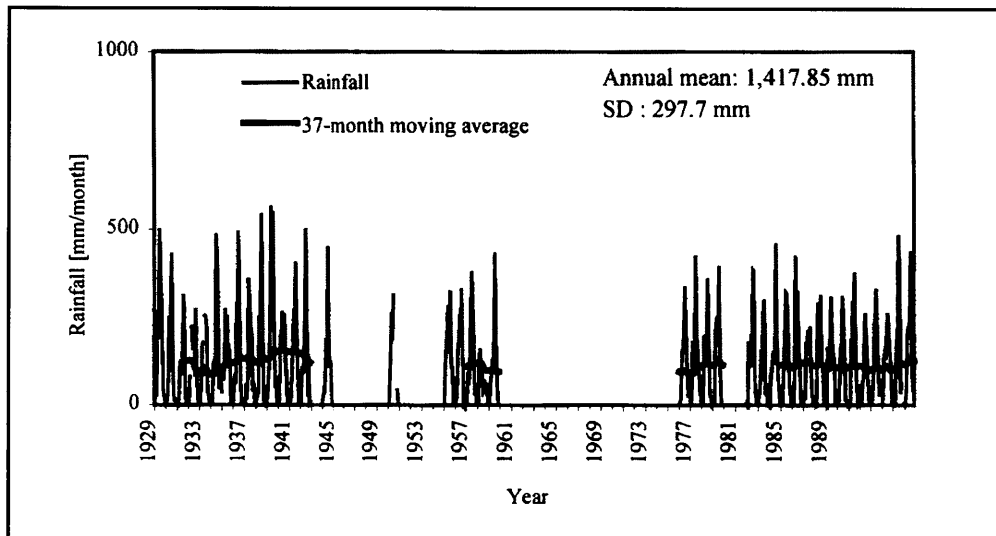
Observation item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [ °C ]	21.1	23.2	26.0	28.3	27.9	27.8	27.3	26.8	27.1	26.4	23.5	21.3	25.6	1970~1985
Precipitation [ mm ]	8.7	20.7	35.5	94.4	343	335	427.7	434.4	325	119.9	16.8	3.8	2,164.9	1971~1992
Evaporation Piche [ mm ]	68	78.2	106.3	97.0	62.9	49.8	49.0	40.0	46.6	53.9	60.4	59.6	771.7	1981~1990

### 3.4 Long-term Variation of Monthly Precipitation

Station: Vang Vieng

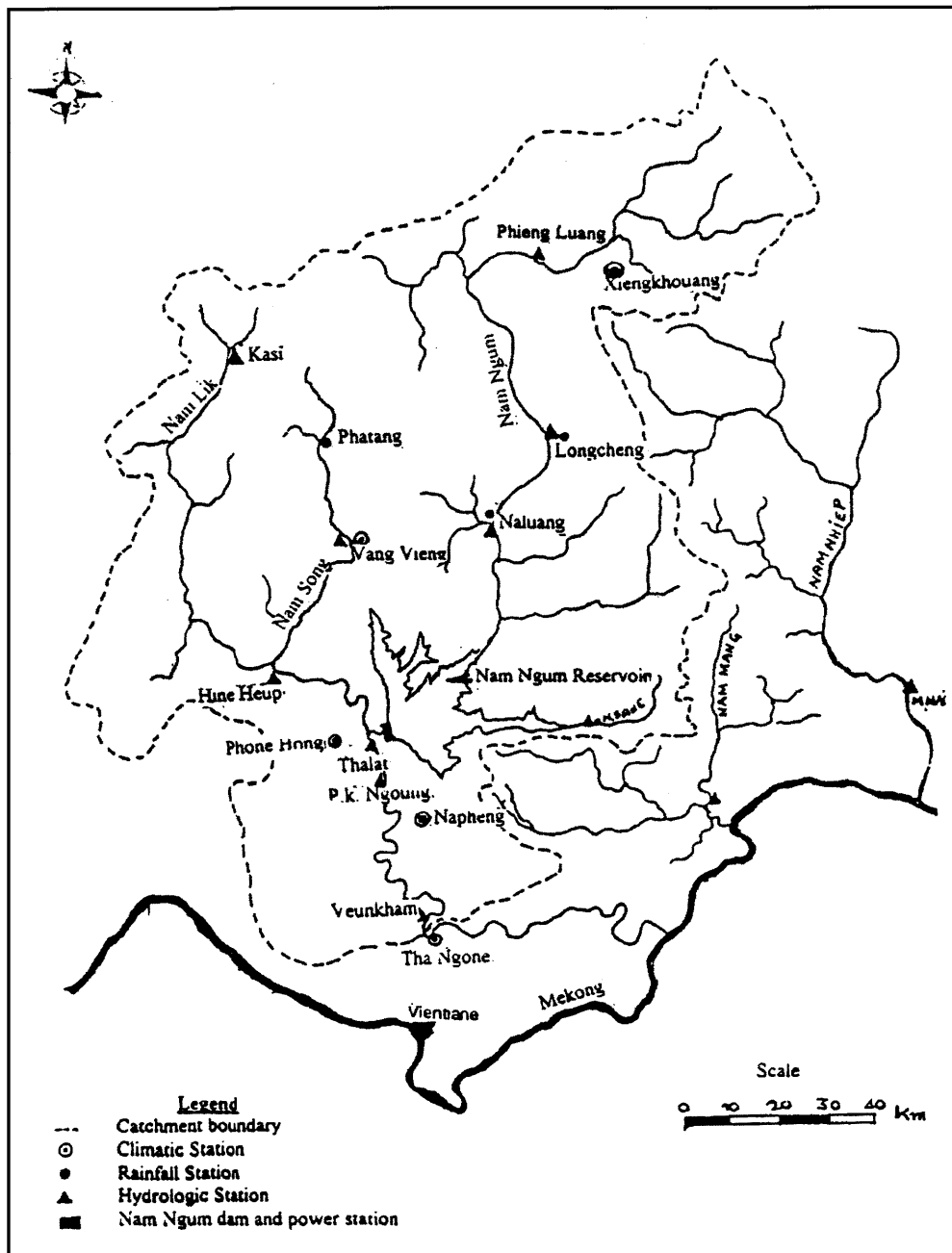


Station: Xiengkhouang



## 4. Hydrological Information

### 4.1 Map of Streamflow Observation Stations



## 4.2 List of Hydrological Observation Stations

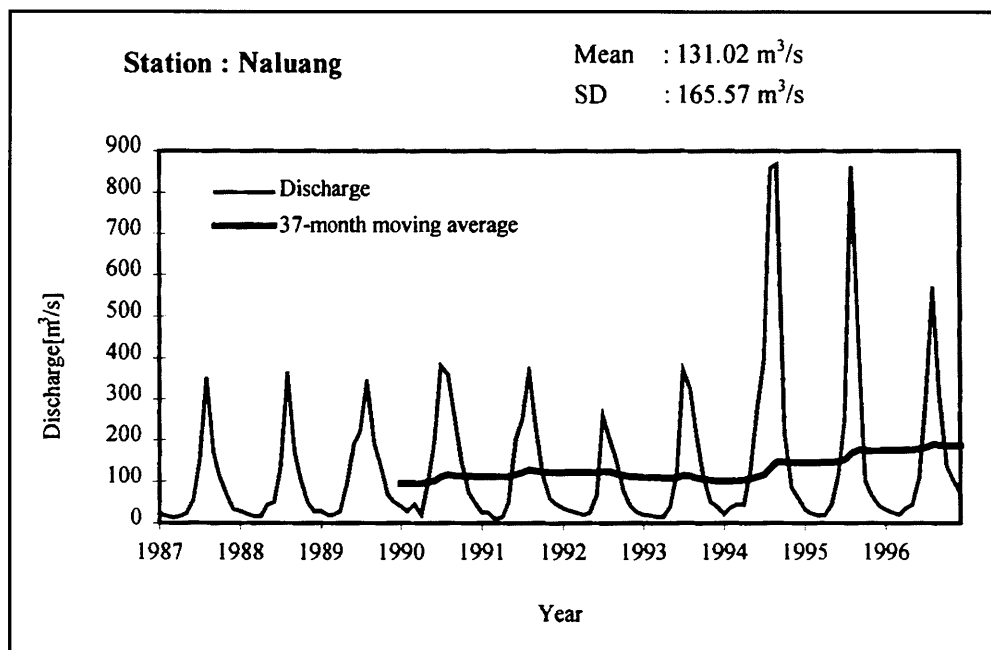
No.	Station	Location	Elevation [ m ]	Catchment area (A) [ km <sup>2</sup> ]	Observation period	Observation items <sup>1)</sup> (frequency)
1	Phieng Luang	N 19° 31.6' E 103° 03.9'	900	1,500	1986~1989	H2(d)
2	Long Cheng	N 19° 05' 30" E 102° 52' 20"	250	2,550	1995~1996	H2(d) Q(d) P(d) WQ(m)
3	Naluang	N 18° 54.8' E 102° 46.7'	240	5,220	1987~1996	H2(d) Q(d) P(d) WQ(m)
4	Hine Heup	N 18° 39.8' E 102° 21.3'	198	5,115	1967~1996	H2(d) Q(m) P(d)
5	Pakka Gnung	N 18° 25.1' E 102° 30.0'	171	14,200	1960~1996	H2(d) Q(d) P(d)
6	Tha Ngone	N 18° 08' E 102° 37'	166	16,500	1960~1988	H2(d) Q(m) P(d)

No.	$\bar{Q}$ <sup>2)</sup> [m <sup>3</sup> /s]	Q max <sup>3)</sup> [m <sup>3</sup> /s]	$\bar{Q}$ max <sup>4)</sup> [m <sup>3</sup> /s]	$\bar{Q}$ min <sup>5)</sup> [m <sup>3</sup> /s]	$\bar{Q} / A$ [m <sup>3</sup> /s/100km <sup>2</sup> ]	Q max / A [m <sup>3</sup> /s/100km <sup>2</sup> ]	Period of statistics
2	100	892	808	16.1	3.92	34.98	1995~1996
3	133.1	2,470	1,399	14.5	2.54	47.32	1987~1996
6	680	4,110	2,730	147	4.12	24.91	1972~1987
6	730.3	4,590	3,222		4.42	27.82	1960~1971

1) H1: Water level in recording chart      H2: Water level by manual  
Q: Discharge, P: Precipitation, WQ: BOD etc., S: Sedimentation  
d: daily, 10d: 10-daily, m: monthly

2) mean annual discharge  
3) maximum discharge  
4) mean annual maximum discharge  
5) mean annual minimum discharge

## 4.3 Long-term Variation of Monthly Discharge





## 4.6 Annual Maximum and Minimum Discharges

At Tha Ngone [16,500 km<sup>2</sup>]

Year	Maximum		Minimum		Year	Maximum		Minimum	
	Date	[m <sup>3</sup> /s] <sup>1)</sup>	Month	[m <sup>3</sup> /s] <sup>2)</sup>		Date	[m <sup>3</sup> /s] <sup>1)</sup>	Month	[m <sup>3</sup> /s] <sup>2)</sup>
1960	9.04	2,660	5	39	1975	9.07	3,620	3	88
1961	9.03	3,250	4	76	1976	9.24	2,440	5	105
1962	9.06	2,260	4	77	1977	9.25	1,730	4	80
1963	8.13	3,330	4	67	1978	8.01	3,200	2	73
1964	8.30	2,680	3	98	1979	9.01	2,380	1	103
1965	7.04	2,830	4	68	1980	8.01	3,010	1	232
1966	9.04	3,710	3	78	1981	9.11	4,110		
1967	9.26	2,750	4	62.4	1982	10.03	2,810	4	222
1968	8.17	3,520	4	80.8	1983	9.15	2,310	5	215
1969	8.18	4,590	4	60	1984	7.16	2,310	3	218
1970	9.21	4,100	4	78	1985	8.27	1,750	4	215
* 1971	8.24	3,470	5	52	1986	8.27	2,328		
1972	8.28	2,870	5	59	1987	8.26	1,900	3	154
1973	9.12	3,370	5	59	1988	8.20	1,800	4	146
1974	9.10	2,170	4	115	1989	9.25	1,872		

1) Observation interval: daily

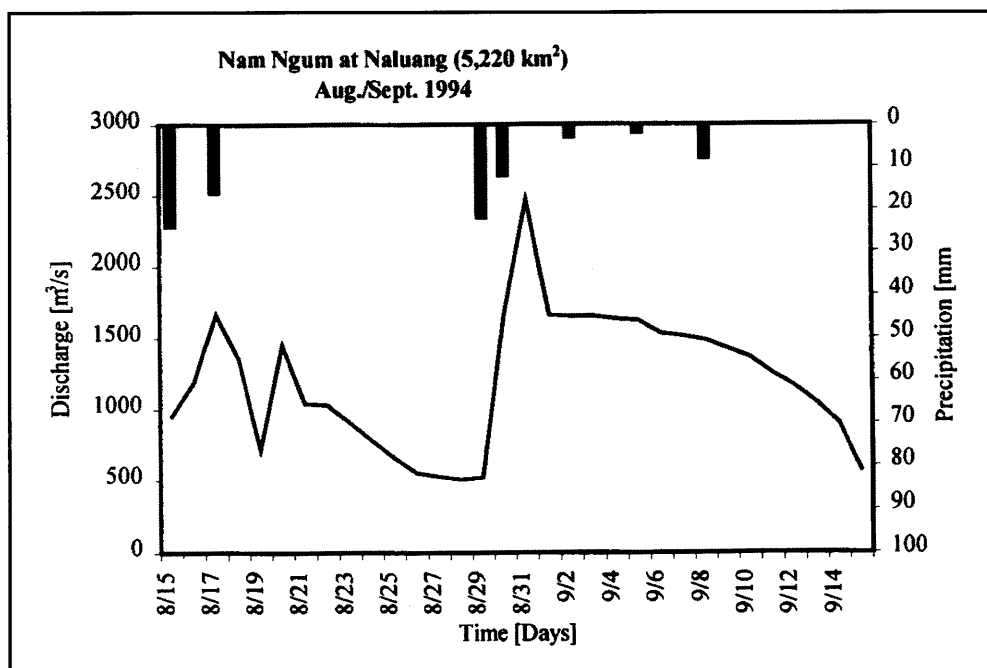
2) Observation interval: daily

\* 1971 Nam Ngum Dam completed

Since 1990, the gauging station was operated at Veun Kham 5 upstream.

Nature of minimum flows: daily

## 4.7 Hyetographs and Hydrographs of Major Floods

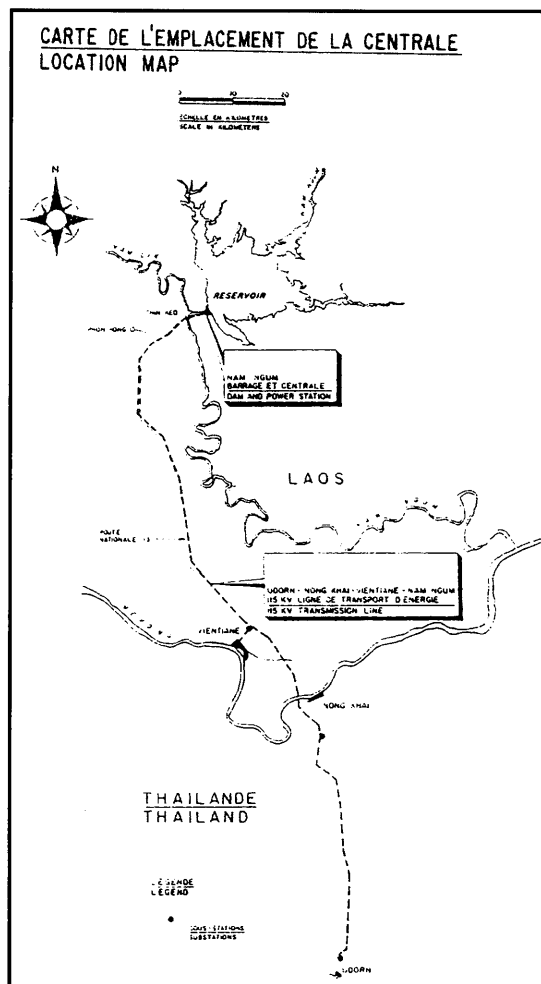


## 5. Water Resources

### 5.1 General Description

The Nam Ngum basin including Nam Lik, an important tributary, occupies a total drainage area of about 17,000 km<sup>2</sup> at the confluence with the Mekong. The Nam Ngum Project 1 was completed in 1971 creating a reservoir with a surface area of about 400 km<sup>2</sup> at the full supply level of 212 m above mean sea level. There are five rivers providing water to the local people living around the Nam Ngum reservoir who can have two to three sources of income from fish farming, livestock raising, and agro-forestry. The Nam Lik basin has a total drainage area of 5,115 km<sup>2</sup> at Hine Heup station. The basin has an average annual precipitation of 2,500 mm. This is less than the annual precipitation of 3,200 mm in the Vang Viang area located at Nam Song, a tributary of Nam Lik. During the passage of a typhoon in July 1981, a severe flashflood was observed at Hine Heup with an estimated peak discharge of about 5,000 m<sup>3</sup>/s damaging a bridge constructed in the 1930's to withstand a flood of a 100 year return period. In the Vientiane plain or Nam Ngum valley where the population density is at the highest, flood risk conditions still exist because the peak flood from Nam Lik represents about 60% of that observed from Nam Ngum under certain heavy rainstorm condition.

### 5.2 Map of Water Resources Systems



### 5.3 List of Major Water Resources Facilities

#### Major Reservoirs

Name of river	Name of dam (reservoir)	Catchment area [km <sup>2</sup> ]	Gross capacity [10 <sup>6</sup> m <sup>3</sup> ]	Effective capacity [10 <sup>6</sup> m <sup>3</sup> ]	Purpose <sup>1)</sup>	Year of completion
Nam Ngum	Nam Ngum dam	8,460	7,030	7,880 at 214 msl	P	1971
Nam Souang	Nam Souang weir				A	1985
Nam Houm	Nam Houm weir				A	1981

#### Major Inter-basin Transfer

Name of transfer line	Name of rivers and places connected		Length [km]	Maximum capacity [m <sup>3</sup> /s]	Purpose <sup>1)</sup>	Year of completion
	From	To				
Diversion	Nam Song	Nam Ngum reservoir	3	-	P Hydropower increase 45 MW	July 1996

1) A: Agricultural use, P: Hydro-power,

### 5.4 Major Floods and Droughts

#### Major Floods

Year	Station Catchment area [km <sup>2</sup> ]	Peak discharge [m <sup>3</sup> /s]	Rainfall [mm] Duration	Meteorological cause	Major damages (Districts affected)
1966	Tha Ngone 16,500	3,710	1,522 May-Sept.	Monsoon	Downstream of dam
1969	16,500	4,590	1,291 May-Sept.	Typhoon	Downstream of dam
1971	16,500	3,470	1,247 May-Sept.	Monsoon	Downstream of dam
1973	16,500	3,370	1,425	Typhoon	Downstream of dam
1980	16,500	3,010	1,619 May-Sept.	Typhoon	Downstream of dam
1981	Hine Heup 5,115	5,000	1,748 Apr.-Oct.	Typhoon Monsoon	Downstream of dam
1990	5,115	none	1,386 May-Sept.	Typhoon	Downstream of dam
1991	5,115	none	1,165 May-Sept.	Typhoon Monsoon	Downstream of dam
1994	Tha Ngone 16,500	none	2,058 May-Oct	Typhoon Monsoon	Downstream of dam

#### Major Droughts

Flood plain areas, discharges released from Nam Ngum dam

Period	Affected areas	Major damages and counteractions
1987	Lower Nam Ngum area	Damages in agriculture reduced by irrigation facilities
1992	Lower Nam Ngum area	Damages in agriculture reduced by irrigation facilities

## 5.5 Groundwater and River Water Quality

River Water Quality at Nam Ngum III Project and Meteo-Hydro. Department during 1995-1996

Date	31.08.95	30.10.96	30.11.96	29.12.96
pH	6.98	7.4	7.35	7.33
Conductivity [mS/m]	5.54	14.3	14.9	15.3
Ca [meq/l]	0.39	0.993	1.056	1.064
Mg [meq/l]	0.113	0.393	0.410	0.429
Cl [meq/l]	0.004	0.115	0.122	0.126
SO <sub>4</sub> [meq/l]	0.090	0.027	0.030	0.027
K [meq/l]	0.802	0.002	0.015	0.006
Na [meq/l]	0.045	0.228	0.143	0.119
Alkalinity [meq/l]	0.509	1.461	1.509	1.616
NO <sub>3</sub> -N [mg/l]	0.035	0.206	0.087	0.003
NH <sub>4</sub> -N [mg/l]	0.086	0.025	0.028	0.025
Tot-P [mg/l]	0.040	0.176	0.192	0.203
Tot-Fe [mg/l]	0.189	0.044	0.051	0.046
Mn [mg/l]	0.001	0.887	0.012	0.492
TSS [mg/l]	271.3	23	18	19
COD <sub>Mn</sub> [mg/l]	2.141	0.001	0.001	0.002
Discharge [m <sup>3</sup> /s]	655	81	67	51

## 5.6 Notable Features of Water Resources

The Nam Ngum hydropower scheme was conceived in 1957, feasibility study completed during the 1960's and Stage I consisting of two units of 15 MW at a full reservoir level of 205.5 m built and commissioned in 1971. Stage II with two additional 40 MW units was commissioned in 1978, raising the full reservoir level to 212 m. Commissioning of Stage III in 1984 with an additional 40 MW unit marked the completion of the project. The Nam Ngum dam is of mass concrete, 70 m high, and has created a reservoir with gross and live storage capacities of 7.030x10<sup>6</sup> m<sup>3</sup> and 4.70x10<sup>6</sup> m<sup>3</sup> respectively. The operating head for the turbines varies from 31- 48 m. With an installed capacity of 150 MW and a load factor of 0.7, it is the largest hydropower scheme in Lao. The feasibility study for Stage I was carried out by Nippon Koei of Japan. Stages II and III were carried out by Acres (Canada) and Motor Columbus (Switzerland) respectively. Project financing came from World Bank, IDA and other bilateral donors. The generated power is used for domestic use and for export to Thailand. The total annual revenue from export is about US\$20 million.

Two more hydropower development schemes (Nam Ngum II & III) are being planned by the Hydropower Project Office (HPO) just upstream of the existing Nam Ngum I and are due for completion by the year 2000. They will have smaller reservoir storage capacities compared to the existing Nam Ngum I. In the distant horizon, other potential schemes like the Nam Ngum IV and Nam Lik I & II, all located in the same basin, may materialize during the next 10-20 years.

The mean annual reservoir inflows, outflows and pre-dam flow at damsite are summarised below:

Inflow : Nam Ngum (1949-1994)	296.3 m <sup>3</sup> /s	Outflow : Turbines	213.8 m <sup>3</sup> /s
Nam Song (1949-1994)	65.5 m <sup>3</sup> /s	Spillway	84.6 m <sup>3</sup> /s
Total	361.8 m <sup>3</sup> /s	Total	298.4 m <sup>3</sup> /s
Pre-dam flow (1966-1971)	351.9 m <sup>3</sup> /s		

## 6. Socio-cultural Characteristics

The Nam Ngum in its origin has a reputation of a historic site. The plain of Jars in the former "Traininh Plateau", the Nam Ngum Dam, the largest man-made reservoir with five rivers (tributaries) feeding it and the various resources associated with them are tourist attractions which everyone is entitled to. During the past 10 years the population of the basin has doubled. Downstream of the dam the river flows through several meanders. The population living alongside this peaceful river has their traditional boat racing annually and the folklore song "Khab Ngum" is very popular.

Another tourist attraction in the Vang Vieng district is the area where the Nam Song and Nam Ka meet together in the Nam Lik river basin, about 150 km from Vientiane. The quiet atmosphere in this place has natural attractions like the Nam Song river with Tham Chang (Cave) where the beautiful stalactites and stalagmites give an impression of an extraterrestrial world.

## 7. References, Databooks and Bibliography

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