

Chay River

Map of River

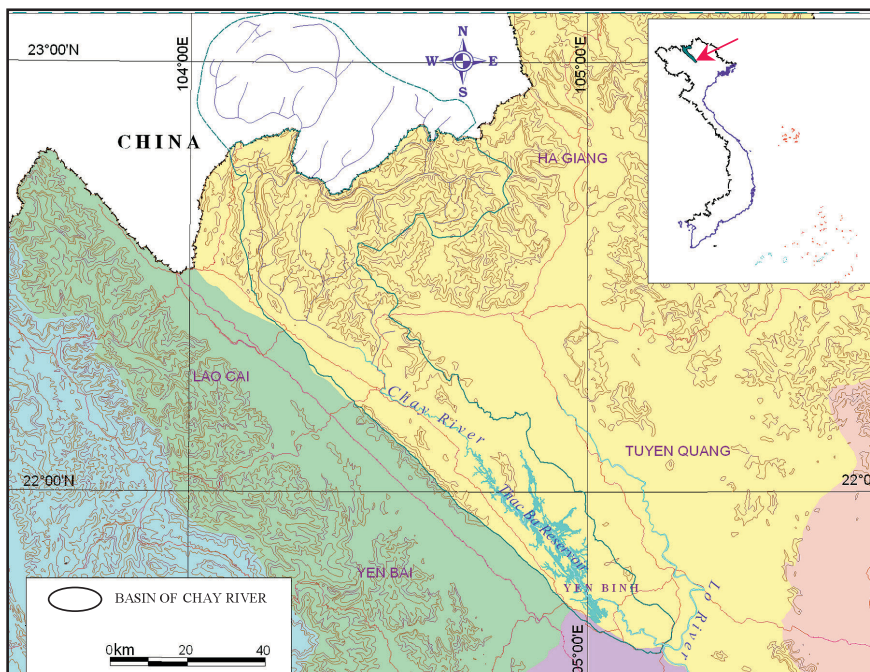


Table of Basic Data

Name: Chay River		Serial No. : Viet Nam-7
Location: Dong Bac Province, Viet Nam	N 21° 30' - 23° 10'	E 104° 00' - 105° 15'
Area: 6,500 km ²	Length of main stream: 319 km	
Origin: Mt. Ha Tao	Highest point: Mt. Tay Con Linh (2,419 m)	
Outlet: Lo River (Doan Hung)	Lowest point:	
Main geological features: Gneiss, Amphibole - biotite schist, Amphibolite, Migmatite. Biotite granite, Binary granite, Shale, Chert, Limestone, Rhyolite, Orthopyre, Manganese, Iron ore.		
Main tributaries: Nam Khoc River (105 km ²), Ma Le Ha River (299 km ²), Pai Ho River (145 km ²), Moc Kouen River (116 km ²), Ngoi Phong River (260 km ²), Nghia Do River (223 km ²), Ngoi Biec River (342 km ²)		
Main lakes: None		
Main reservoirs: Thac Ba reservoirs (2,940 x 10 ⁶ m ³), N = 108 MW		
Mean annual precipitation: 1,731.2 mm at Bac Ha (1961 ~ 2002)		
Mean annul runoff: 140 m ³ /s (4.42 x 10 ⁶ km ³) at Bao Yen (4,960 km ²)		
Population: about 579,600 (1999)	Main cities: Yen Bai	
Land use: Forest (18.3 %), Rice paddy (3.22 %), Other agriculture (19.3 %)		

1. General Description

The Chay River is the second largest tributary of the Lo River. It originates from Ha Tao and passes in the western slope of the Tay Con Linh mountain range that has a peak height of 2,419 m, in the Hoang Su Phi district, Ha Giang province. The river flows towards to the west in the upstream, to the southeast in the middle and lower reaches and finally enters the Lo River at Doan Hung.

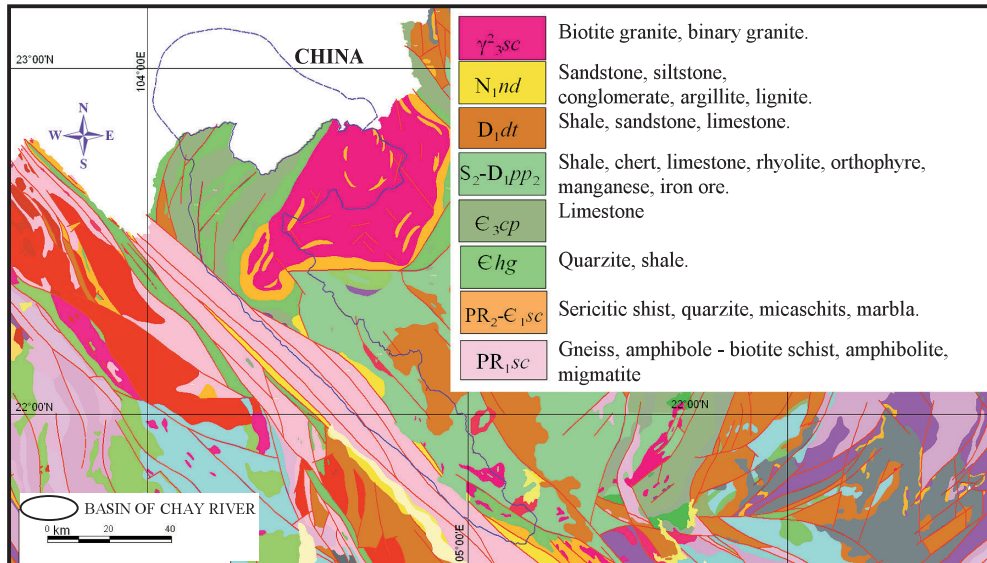
The Chay River basin lies between high mountain ranges: in the north is a range of 1,500-2,000 m height, on the west is the Con Voi mountain range and on the east and south east is the Tay Con Linh range (the highest range in the northeast of Vietnam). The Chay River basin is wider in the upstream reaches and tapers to an elongated shape in the middle and lower reaches. The basin falls from the north and northwest to southeast. More than 60% of the basin is higher than 400 m.

Some characteristics of the Chay River basin are: basin area is 6,500 km² (1,920 km² of this is located in China); river length is 319 km; basin width is 26 km; the average basin altitude is 858 m; mean basin slope is 24.6 %; and the river network density is 1.09 km/km².

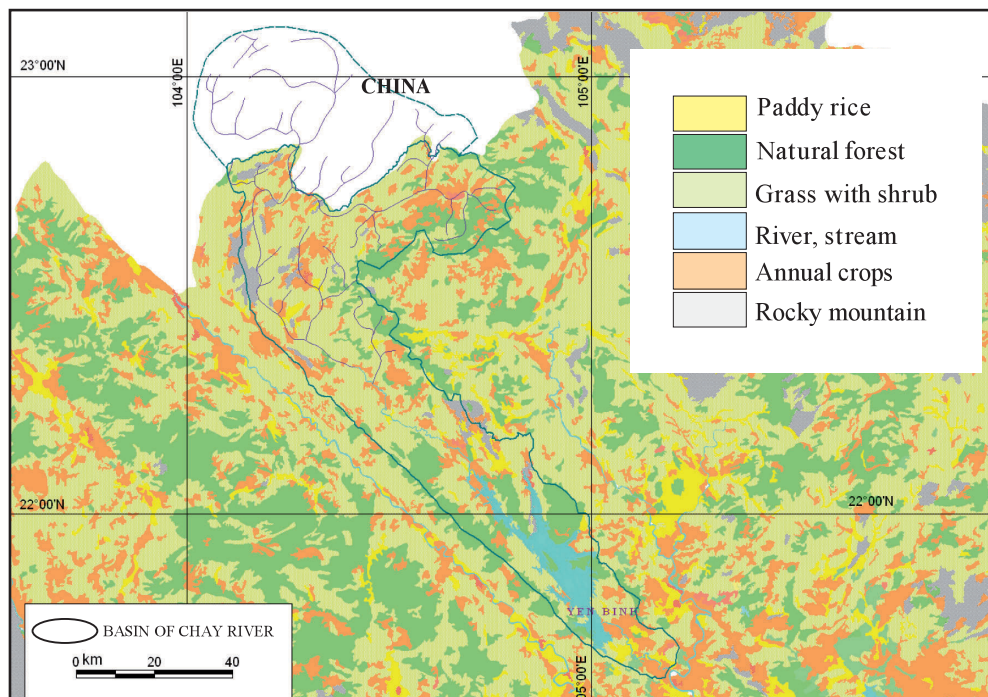
Annual rainfall varies from 1,500 mm to 3,000 mm in the basin. Rainfall is higher on the southeast and southwest slopes of the Tay Con Linh mountain range and lower than 1,500 mm in the river valley of the upstream area. Rainy season starts in May and ends in October; rainfall in the wet season makes up 75 - 85 % of the total yearly amount.

2. Geographical Information

2.1 Geological Map



2.2 Land User Map

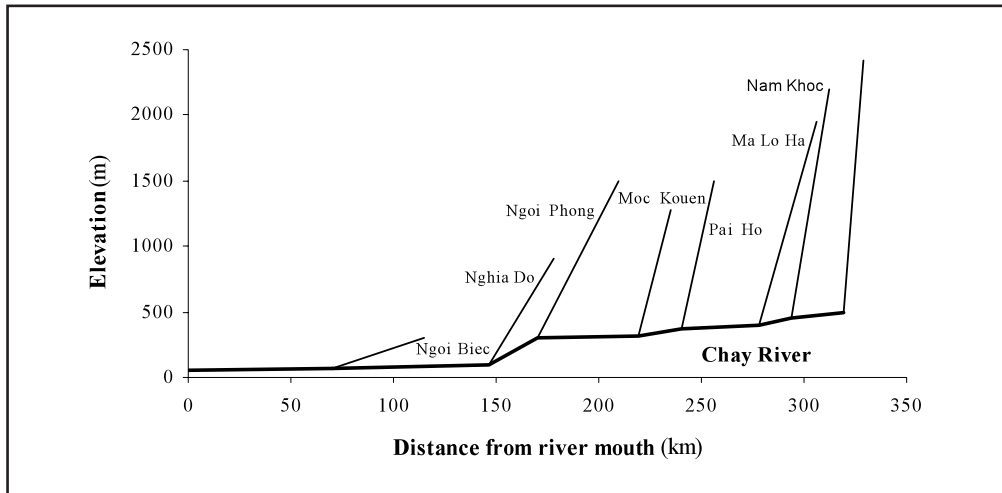


2.3 Characteristics of River and Main Tributaries

No.	Name of river	Length [km] Catchment area [km ²]	Highest peak [m] Lowest point [m]	Cities Population	Land use [%]
1	Chay (Main river)	319 6,500	2,419		A (19.3) F (18.3) P (3.22)
2	Nam Khoc (Tributary)	18 105	2,200		
3	Ma Le Ha (Tributary)	28 299	1,950		
4	Pai Ho (Tributary)	16 145			
5	Moc Kouen (Tributary)	16 116	1,275		
6	Ngoi Phong (Tributary)	40 260			
7	Nghia Do (Tributary)	32 223	900		
8	Ngoi biee (Tributary)	44 342	200		

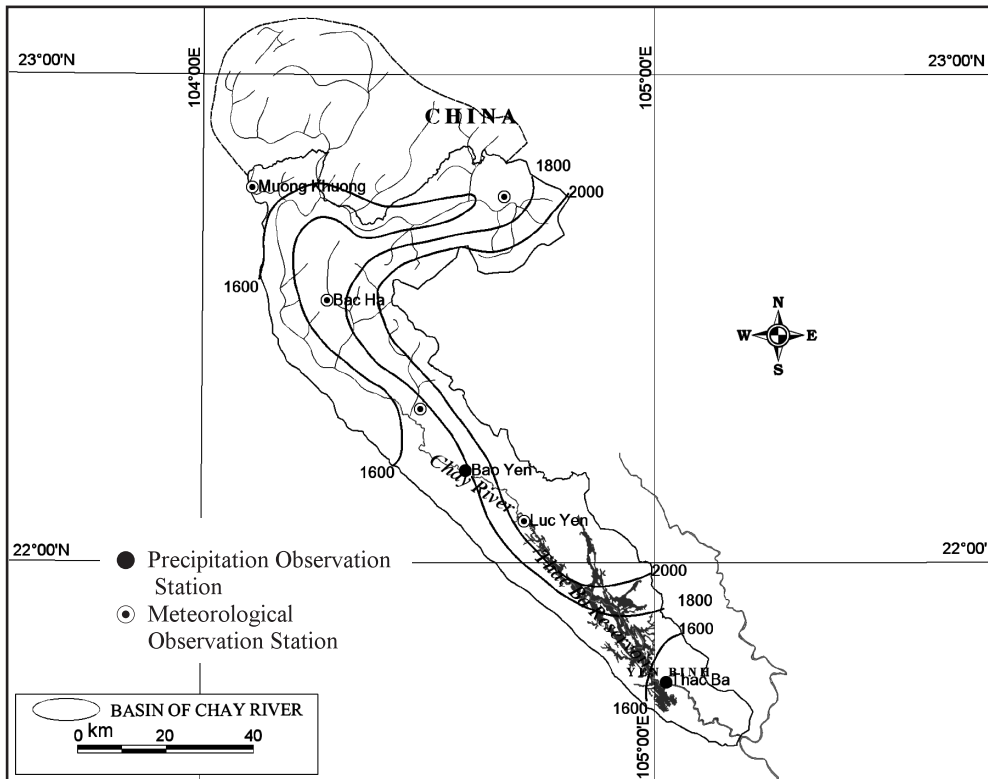
A: Other agriculture land F: Forest G: Grass P: Paddy field

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
48/31	Hoang Su Phi	553	N: 22° 45' E: 104° 41'	(P) 1961 ~ (E) 1961 ~	1,662.4	926.9	DS, E, P
-	Muong Khuong	772	N: 22° 46' E: 104° 07'	(P, E) 1961 ~ 1978	2,038.7	487.5	DS, E, P
48/30	Bac Ha	957	N: 22° 32' E: 104° 17'	(P) 1961 ~ (E) 1961 ~	1,731.2	568.1	DS, E, P
48804	Pho Rang	97.785	N: 22° 14' E: 104° 27'	(P) 1975 ~ (E) 1974 ~	1,586.1	697.5	DS, E, P
48/35	Luc Yen	105.468	N: 22° 06' E: 104° 43'	(P) 1961 ~ (E) 1961 ~	2,036.1	694.2	DS, E, P

DS: Duration of sunshine observed by Helioscope

E: Evaporation by Piche tube

P: Precipitation observed by Pluviometer

3.3 Monthly Climate Data

Station: Hoang Su Phi

Observation items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	14.4	15.9	19.3	22.9	25.3	26.2	26.2	25.8	24.5	21.9	18.5	15.3	21.3	1961 ~
Precipitation [mm]	17.0	23.5	45.8	86.1	193.7	295.8	335.2	319.5	163.8	108.6	52.6	20.9	1,662.4	1961 ~
Evaporation [mm]	59.7	65.3	93.1	101.9	105.1	83.4	76.6	71.5	71.8	70.5	66.7	61.2	926.9	1961 ~
Duration of sunshine [hr]	90.1	88.8	132.4	166.1	172.7	145.7	151.5	162.8	151.0	127.9	121.1	111.0	1,621.2	1979 ~

Station: Bac Ha

Observation items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	11.3	12.5	16.1	19.8	22.5	23.7	23.8	23.3	21.8	19.4	15.7	12.4	18.5	1961 ~
Precipitation [mm]	23.7	32.8	56.9	124.5	197.2	242.3	286.5	337.0	212.4	130.1	64.3	23.5	1,731.2	1961 ~
Evaporation [mm]	31.4	32.6	46.9	55.1	65.4	56.4	53.3	50.1	49.7	48.3	41.6	37.3	568.1	1961 ~
Duration of sunshine [hr]	82.1	81.9	117.8	149.4	163.6	136.0	134.9	139.5	121.6	108.4	104.8	105.0	1,445.1	1971 ~

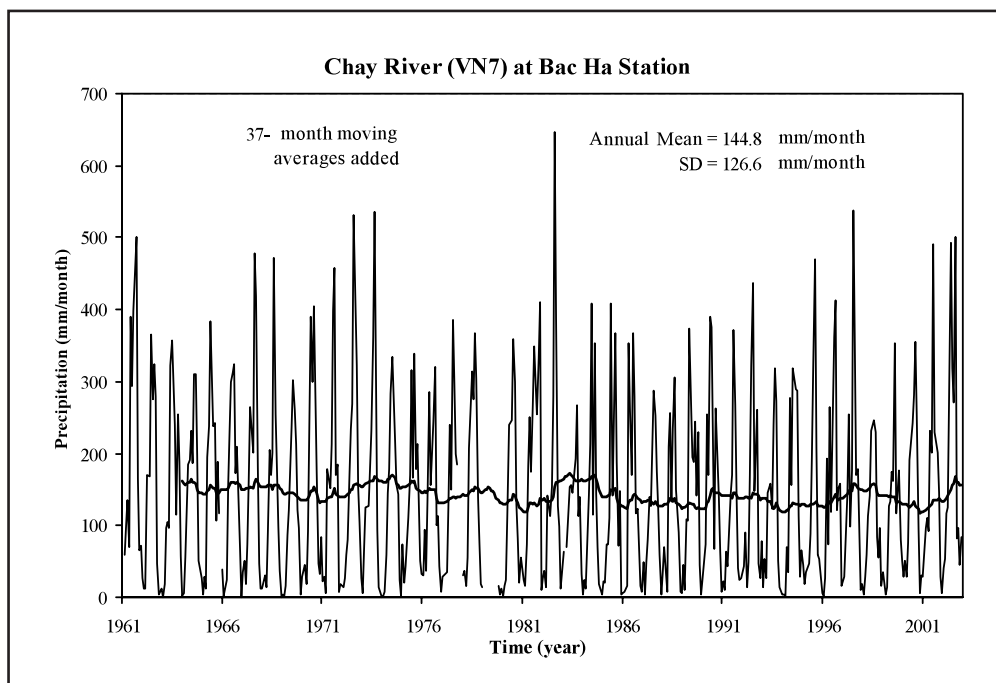
Station: Pho Rang

Observation items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	15.9	16.9	20.3	23.9	26.5	28.0	28.0	27.7	26.2	23.6	19.9	16.6	22.8	1974 ~
Precipitation [mm]	27.8	37.5	59.7	131.6	193.8	211.5	237.9	304.0	195.4	120.2	48.8	17.8	1,586.1	1975 ~
Evaporation [mm]	39.4	42.4	61.7	69.4	79.3	76.2	73.5	64.4	55.0	50.0	44.0	42.2	697.5	1974 ~
Duration of sunshine [hr]	57.0	55.2	79.5	119.0	157.3	152.5	168.6	176.7	155.5	122.8	129.6	99.4	1,473.2	1974 ~

Station: Luc Yen

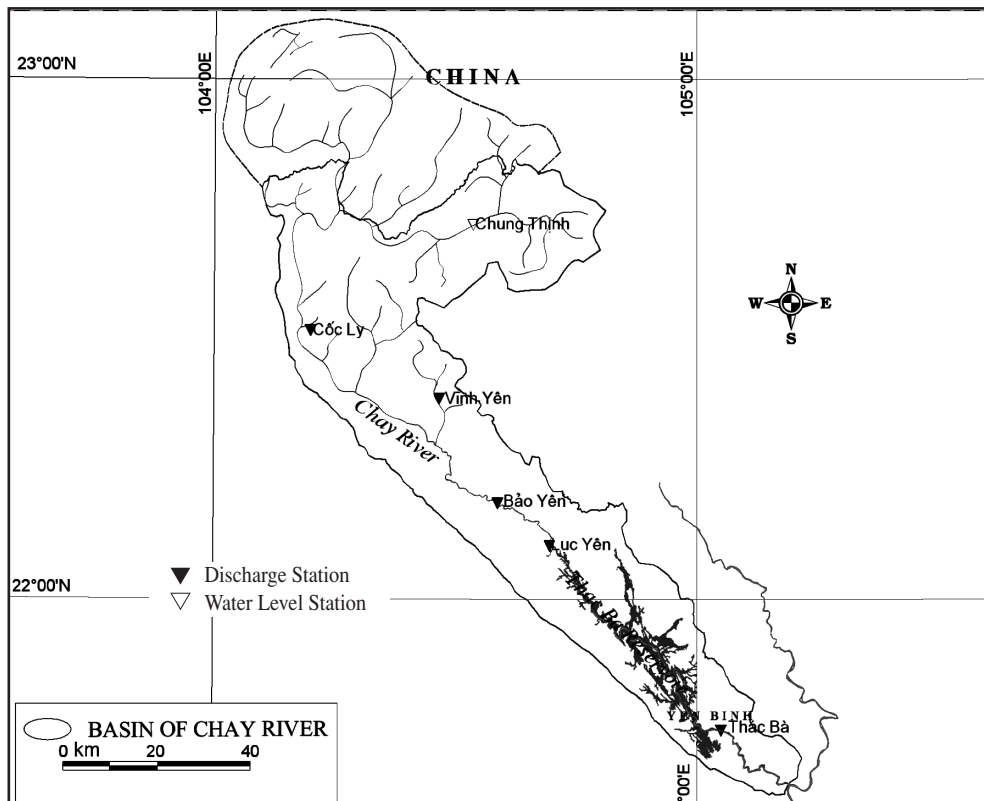
Observation items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	15.6	16.8	20.0	23.6	26.6	27.9	28.0	27.6	26.4	23.8	20.2	16.9	22.8	1961 ~
Precipitation [mm]	33.7	43.3	74.1	137.3	216.0	292.0	328.1	407.7	255.9	155.0	63.1	29.9	2,036.1	1961 ~
Evaporation [mm]	38.5	38.8	49.9	58.0	78.8	72.7	70.6	67.0	63.8	59.2	51.3	45.7	694.2	1961 ~
Duration of sunshine [hr]	51.7	50.7	63.9	99.4	155.0	151.0	169.0	174.8	162.2	130.7	108.8	100.7	1,417.7	1972 ~

3.4 Long - term Variation of Monthly Precipitation



4. Hydrological Information

4.1 Map of Streamflow Observation Stations



4.2 List of Hydrological Observation Station

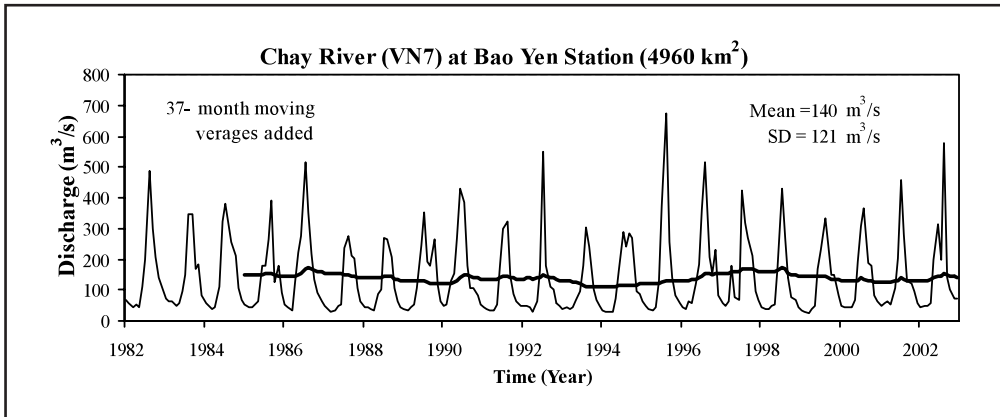
No.	Station	Location	Catchment area (A) [km ²]	Observation period	Observation items ¹⁾ (frequency)
156	Chung Thinh	N: 22° 45' E: 104° 32'	-	1964 ~ 1977	H
157	Coc Ly	N: 21° 31' E: 104° 12'	3,480	1961 ~ 1969	H, Q
74121	Bao Yen	N: 22° 10' E: 104° 35'	4,960	1982 ~ 2003	H, Q, S
159	Luc Yen	N: 22° 06' E: 104° 41'	5,030	1961 ~ 1973 *	H, Q, S
74130	Thac Ba	N: 21° 44' E: 105° 03'	6,170	1959 ~ 1975	H, Q, S, WQ
161	Vinh Yen	N: 22° 22' E: 104° 28'	138	1960 ~ 2003	H, Q, S

Note: * Indicate missing data in some years

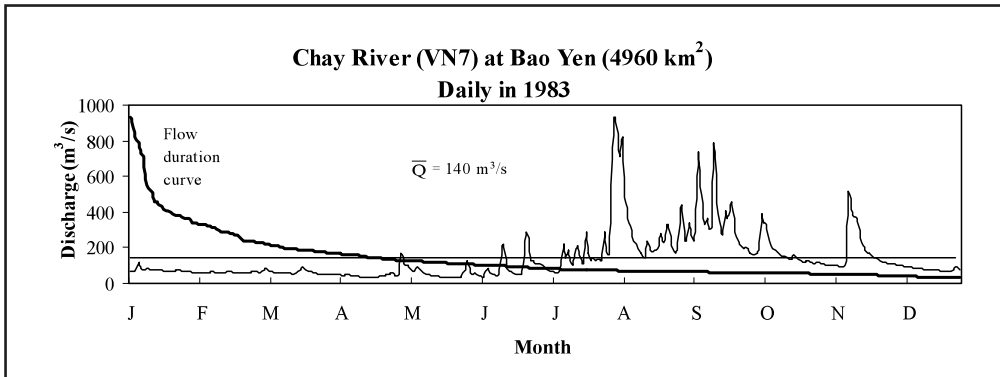
No.	$\bar{Q}^{2)}$ [m ³ /s]	Qmax ³⁾ [m ³ /s]	$\bar{Q}max^{4)}$ [m ³ /s]	$\bar{Q}min^{5)}$ [m ³ /s]	\bar{Q}/A [m ³ /s/100km ²]	Qmax/A [m ³ /s/100km ²]	Period of statistics
74121	140	3,250	458	72.1	2.82	65.5	1982 ~
74130	198	2,460	454	100	3.22	39.9	1959 ~ 75
161	7.68	374	49.4	4.46	5.56	271	1960 ~
157	104	2,700	399	53.3	2.98	77.6	1961 ~ 69
159	160	2,210	459	-	3.18	43.9	1961 ~ 73

- 1) H: Water level
- P: Precipitation (daily)
- Q: Discharge
- S: Sediment concentration
- WQ: Water quality
- 2) Mean annual discharge
- 3) Maximum discharge
- 4) Mean maximum discharge
- 5) Mean minimum discharge

4.3 Long- term Variation of Monthly Discharge



4.4 Annual Pattern of Discharge



4.5 Annual Maximum and Minimum Discharge

At Bao Yen [4,960 km²]

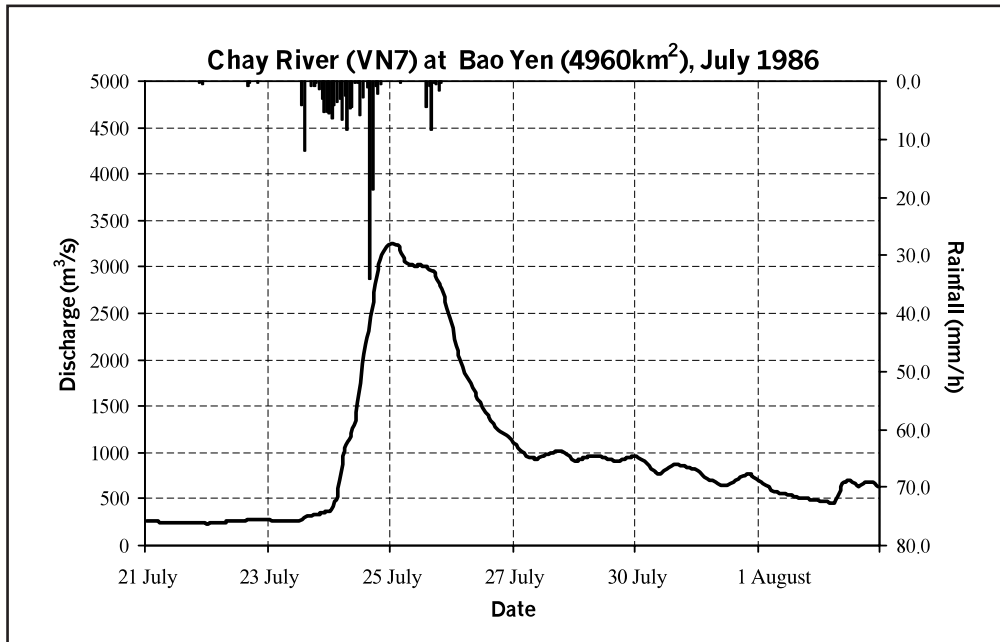
Year	Maximum ¹⁾		Minimum ²⁾		Year	Maximum ¹⁾		Minimum ²⁾	
	Date	[m ³ /s]	Month	[m ³ /s]		Date	[m ³ /s]	Month	[m ³ /s]
1982	8.21	1,380	5	31.7	1993	8.23	1,010	4	28.4
1983	8.1	1,250	5	32.2	1994	9.9	990	5	19.0
1984	8.26	1,380	4	31.7	1995	8.15	2,520	5	26.5
1985	9.9	1,820	3	33.8	1996	8.20	2,130	3	28.4
1986	7.25	3,250	4	27.9	1997	7.23	1,270	6	38.5
1987	8.21	1,260	5	23.7	1998	7.10	1,330	4	28.0
1988	7.7	732	4	30.8	1999	8.17	1,420	3	22.1
1989	10.15	1,690	2	30.2	2000	7.24	1,280	4	31.2
1990	5.23	1,970	2	40.4	2001	7.5	2,280	2	36.9
1991	7.15	1,890	5	26.9	2002	8.16	1,990	3	39.0
1992	7.25	2,770	5	21.3					

At Thac Ba [6,170 km²]

Year	Maximum ¹⁾		Minimum ²⁾		Year	Maximum ¹⁾		Minimum ²⁾	
	Date	[m ³ /s]	Month	[m ³ /s]		Date	[m ³ /s]	Month	[m ³ /s]
1959	8.1	1,430	2	37.8	1967	8.21	1,390	5	40.2
1960	7.17	1,210	5	26.1	1968	8.17	1,680	5	50.6
1961	8.9	1,130	3	18.2	1969	8.18	1,960	4	35.8
1962	8.23	1,390	4	55.3	1970	7.17	1,300	4	35.7
1963	11.8	1,220	3	46.2	1971	8.21	2,460	12	0.730
1964	8.5	1,250	3	56.0	1972	9.3	688	9	6.00
1965	7.11	1,040	4	45.0	1973	9.8	704	10	7.71
1966	8.30	1,510	5	32.0	1974	5.22	343	7	0.800
					1975	7.29	528	4	13.5

1), 2) Discharge rated according to manual observation of water level

4.6 Hyetographs and Hydrographs of Major Floods



5. Water Resources

5.1 General Description

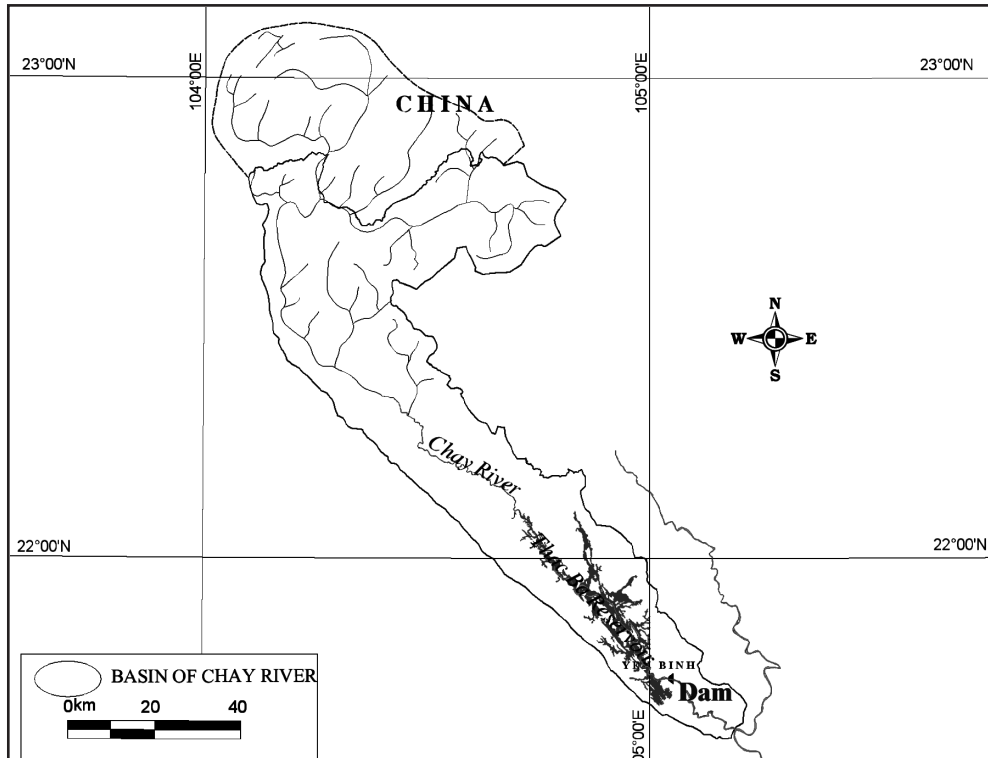
Multiyear average values of the specific annual discharges are unevenly distributed in the basin and vary from $0.02 \text{ m}^3/\text{s}/\text{km}^2$ in the upstream valley to $0.07 \text{ m}^3/\text{s}/\text{km}^2$ in the Tay Con Linh west and southeast slopes. The multiyear average runoff of the river is about $6.62 \times 10^9 \text{ m}^3/\text{year}$ corresponding to the basin average specific discharge of $0.032 \text{ m}^3/\text{s}/\text{km}^2$ and annual runoff depth of 1,020 mm. The runoff varies irregularly in the year and with the seasons. The flood season extends from June to October and contributes 70 - 80% of the yearly amount. Highest monthly runoff values are in July and August.

The average specific minimum discharge varies from $0.005 \text{ m}^3/\text{s}/\text{km}^2$ in the upstream valley to $0.015 \text{ m}^3/\text{s}/\text{km}^2$ on the southeast slopes of the Tay Con Linh mountain range.

Observed data show the following maximum discharges; $2,520 \text{ m}^3/\text{s}$ ($M_{Q_{\max}} = 0.508 \text{ m}^3/\text{s}/\text{km}^2$) on the Chay River occurred on 15 August 1995 at the Bao Yen station (Area = $4,960 \text{ km}^2$); $3,590 \text{ m}^3/\text{s}$ ($M_{Q_{\max}} = 0.582 \text{ m}^3/\text{s}/\text{km}^2$) at the Thac Ba station (Area = $6,170 \text{ km}^2$) on August 1971; $374 \text{ m}^3/\text{s}$ ($M_{Q_{\max}} = 2.71 \text{ m}^3/\text{s}/\text{km}^2$) on 13 July 1997 at the Vinh Yen station on the Nghia Do River (Area = 138 km^2).

The Chay River water resources are used for hydropower generation, water supply for irrigation in the downstream area, for aquaculture and for waterborne navigation improvement.

5.2 Map of Water Resource Systems



5.3 List of Major Water Resources Facilities

Name of river	Name of dam (Reservoir)	Catchment area [km ²]	Gross capacity [10 ⁶ m ³]	Effective capacity [10 ⁶ m ³]	Purpose	Year of completion
Chay	Thac Ba	6,170	2,940	-	A, I, N, W	1972

A: Agriculture I: Industrial use N: Maintenance of normal flows W: Municipal water supply

5.4 Major Flood and Droughts

Date	Peak discharge [m ³ /s]	Rainfall [mm] Duration	Meteorological cause	Dead and missing	Major damages (Districts affected)
1986 7. 25	3,250	195.3 7.21 ~ 7.25	Typhoon	-	-
1995 8. 15	2,520	174.5 8.12 - 8.17	Typhoon	-	-

5.5 Water quality

Multiyear average value of suspended sediment concentration varies from 150-200 g/m³ on tributaries to 500-1,000 g/m³ on the mainstream. Annual mean of water river mineralization is about 150-200

mg/l, pH value is from 7 to 8. The river water belongs to hydrocarbonate class, calcium 1 group; the HCO_3^- concentration makes superiority among the anions, and the Ca^{++} makes superiority among the cations. In general, the Chay River water and the Thac Ba reservoir water are still clean, but at some locations in the reservoir the water becomes polluted.

6. Socio - cultural Characteristics

In the Chay River basin there live many ethnic people, such as: Viet (Kinh), Tay, Dao, Nung, Thai, Muong, Cao Lan, Kho Mu, Phu La, Giay, H'Mong.

The Thac Ba reservoir surface of 234 km² with more than 1,000 small islands covered with diverse vegetations, ecological landscapes and plentiful caves create beautiful landscapes attracting many tourists.

7. References, Data Books and Bibliography

General Department of Tourist, *Vietnamese Culture*.

General Statistical Office: *Statistical Yearbook 1999*, Statistical Publishing House.

Institute of Meteorology and Hydrology (1985): *Main Morphometric Features of Viet Nam Rivers*, Hanoi.

Tran Tuat, Tran Thanh Xuan and Nguyen Duc Nhat (1987): *Hydrogeography of Viet Nam Rivers*, Science and Technique Publishing House.

Tran Tuat and Nguyen Duc Nhat (1980): *Hydrogeographic Characteristics of Rivers in Viet Nam*, Institute of Meteorology and Hydrology.