

Song Ba

Map of River

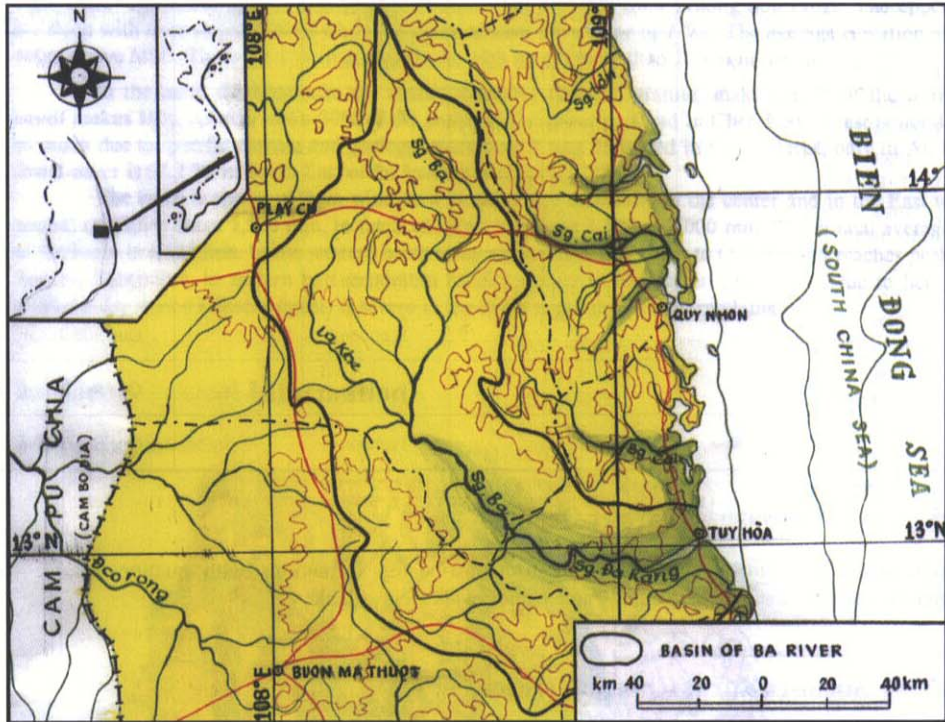
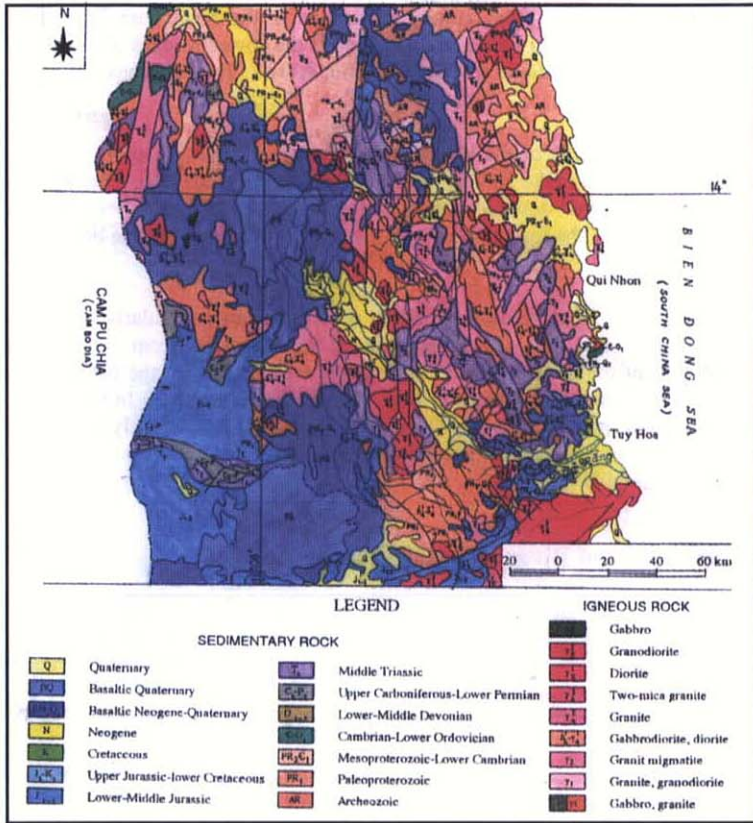


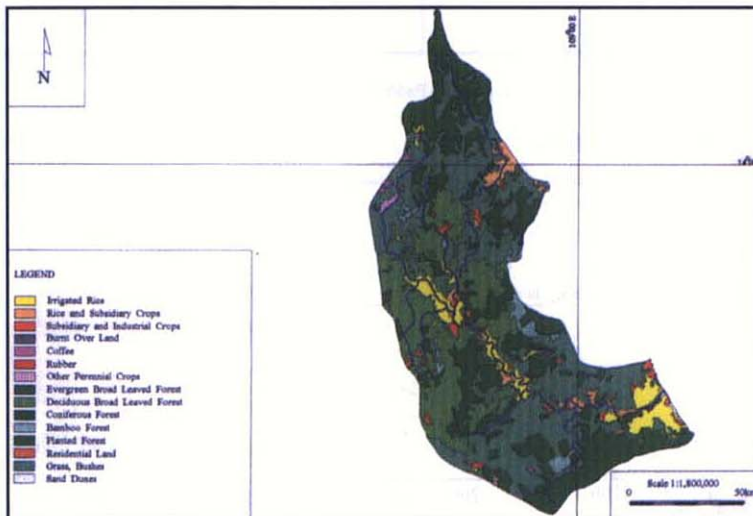
Table of Basic Data

Name: Ba River		Serial No.: Vietnam-3
Location: Phu Khanh Province, Vietnam	N 12° 38' ~ 14° 34'	E 108° 06' ~ 109° 20'
Area: 13 800 km ²	Length of main stream: 388 km	
Origin: Mt. Cong Pong Dung (1 200 m)	Highest point: Mt. Chu Ho Mu (2 051 m)	
Outlet: Bien Dong Sea (South China Sea)	Lowest point: River mouth (0 m)	
Main geological features: Extrusive Rhyolite, Granite (60%), Basalt (10%), Sedimentary (30%)		
Main tributaries: Ia ADun River (2 950 km ²), Krong H'Nang River (1 840 km ²), Hinh River (1 048 km ²)		
Main lakes: None		
Main reservoirs: Lower Ia Dun Reservoir (253 x 10 ⁶ m ³), Upper Ia Dun Reservoir (9.5 x 10 ⁶ m ³), Ea Ur Reservoir (3.3 x 10 ⁶ m ³)		
Mean annual precipitation: 1 625 mm		
Mean annual runoff: 273 m ³ /s at Cung Son (12 800 km ²) (1977~1992)		
Population: 350 000	Main cities: Tuy Hoa	
Land use: Forest (50.8%), Rice paddy (8.5%), Other agriculture (2.4%), Grass (37.4%)		

2. Geographical Information
2.1 Geological Map



2.2 Land Use Map



1. General Description

The Ba River (or Da Rang), 388 km long and draining an area of 13 800 km² is the sixth largest river system in Vietnam. It originates from Truong Son range in the Kom Tum Province. The upper reaches of the river are steep with slopes of 20% while the lower reaches are relatively flat with slopes of 2%. The average elevation of the basin is about 400 m. The basin has 105 rivers and creeks with lengths in excess of 10 km.

In the basin, approximately 60% of the baserocks are mostly extrusive Rhyolite and granite, while about 10% are basalt. Alluvia make 30% in the lower part and in Cheo Reo. Due to specific climate and geology, forests are not well developed, and furthermore, they have also been destroyed in many places. Only in An Khe area, the forest cover is 67.7%. In the south-east of the basin, it is only about 20%.

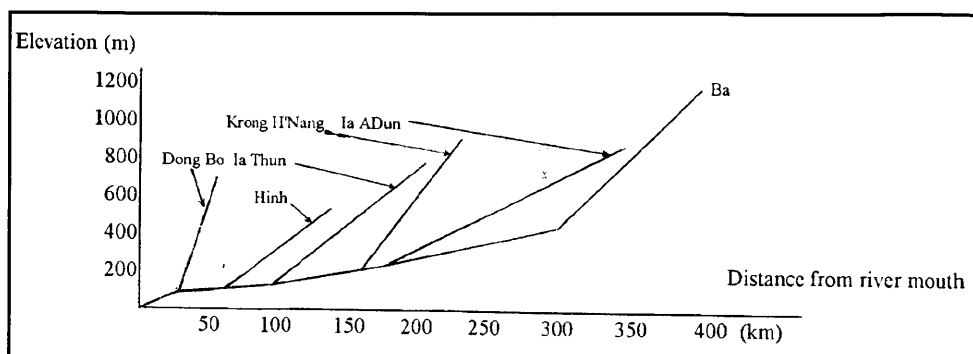
The basin is sheltered from wind, resulting in rather dry conditions particularly in the east where the annual rainfall is about 1 500 mm. In the south-east, rainfall varies from 1 500-2 000 mm. The average annual rainfall of the basin is 1 625 mm. In the western part of the basin, the rainy season lasts from May to October and reach peaks in July, August and September. In the eastern part of the basin, rainfall peaks occur in November and December. Due to hot dry westerly winds, the dry season (June - August) is severe in the lower areas and in eastern plains.

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	Ba (Main river)	388 13 900	1 200 -----	Tuy Hoa -----	A (2.4) F (50.8)
2	IaADun (Tributary)	175 2 950	850 -----		G (37.4) P (8.5)
3	Ia Thun (Tributary)	48 370	800 -----		
4	KrongH'Nang (Tributary)	130 1 840	900 -----		
5	Hinh (Tributary)	88 1 040	550 -----		
6	Dong Bo (Tributary)	27 144	700 -----		

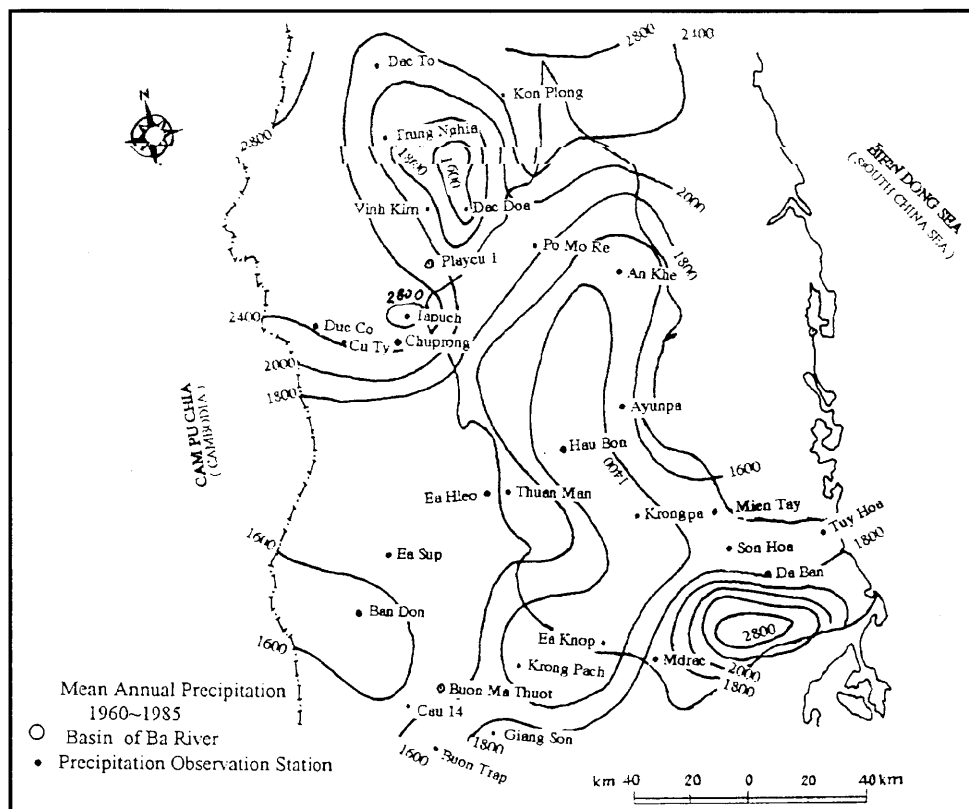
A: Other agricultural field F: Forest G: Grass P: Paddy field

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 ¹⁾
311	Mien Tay	-	N 13° 12' E 108° 57'	(E) 1976~1980	-	1 068	DS, E, P
312	Tuy Hoa	12	N 13° 05' E 109° 13'	(P) 1933~ (E) 1976~	1 651	1 321	DS, E, P
313	Son Hoa	-	N 13° 03' E 108° 59'	(P) 1976~ (E) 1976~	1 635	1 506	DS, E, P
314	An Khe	-	N 13° 57' E 108° 38'	(P) 1980~ (E) 1980~	1 507	1 468	DS, E, P
315	M'Drac	478	N 12° 41' E 108° 47'	(P) 1930~ (E) 1977~	2 214	1 388	DS, E, P
316	Ayunpa	150	N 13° 25' E 108° 26'	(P) 1930~ (E) 1978~	1 301	1 657	DS, E, P

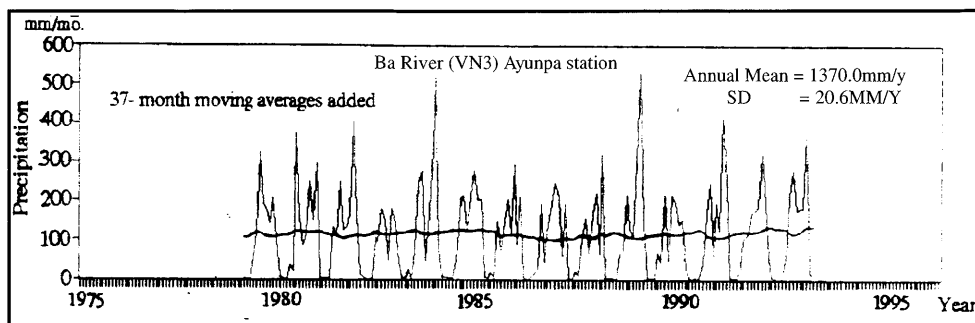
DS: Duration of sunshine observed by Helioscope
E: Evaporation observed by Piche tube

P: Precipitation observed by Pluviometer

3.3 Monthly Climate Data

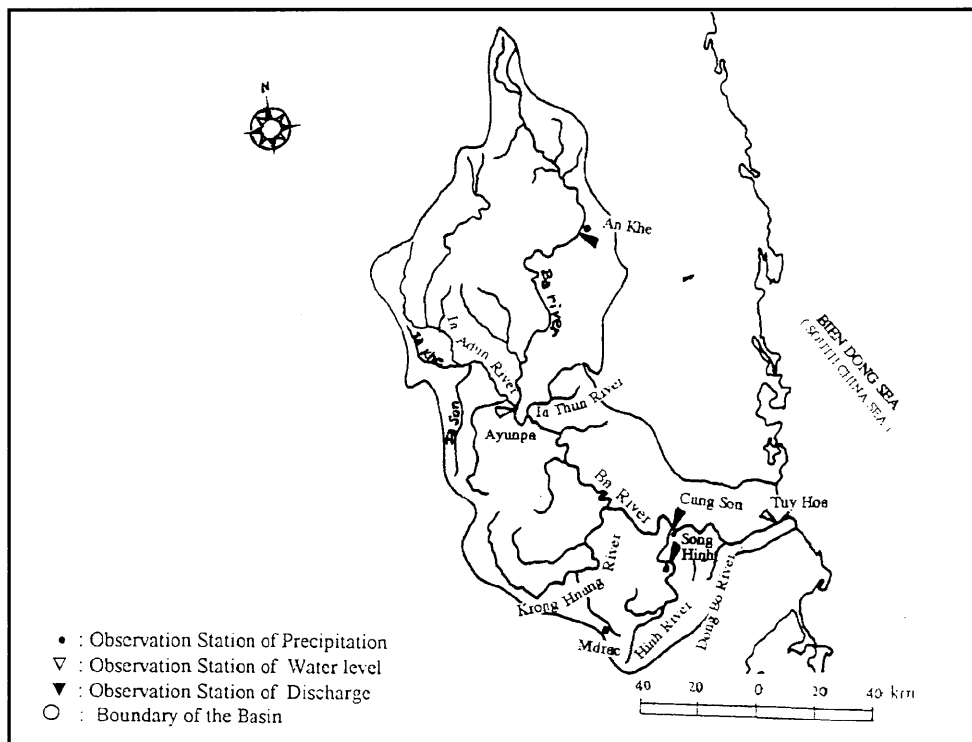
Observation item	Observation station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	Ayunpa	22.0	24.1	26.8	28.5	28.3	27.1	27.0	26.6	26.1	25.2	23.8	22.0	25.6	1961-1990
Precipitation [mm]	Ayunpa	2.1	4.0	10.0	70.0	149.1	149.5	140.8	164.5	219.8	239.7	123.5	27.7	1 301	1913-1990
Evaporation [mm]	Ayunpa	136.3	149.0	230.0	217.8	178.0	136.9	144.7	126.5	83.8	71.9	78.9	103.2	1 657	1978-1990
Duration of sunshine [hr]	Ayunpa	201.2	234.6	270.1	263.6	256.8	199.1	234.5	176.3	188.5	174.2	157.2	165.6	2 522	1981-1990

3.4 Long-term Variation of Monthly Precipitation



4. Hydrological Information

4.1 Map of Streamflow Observation Stations



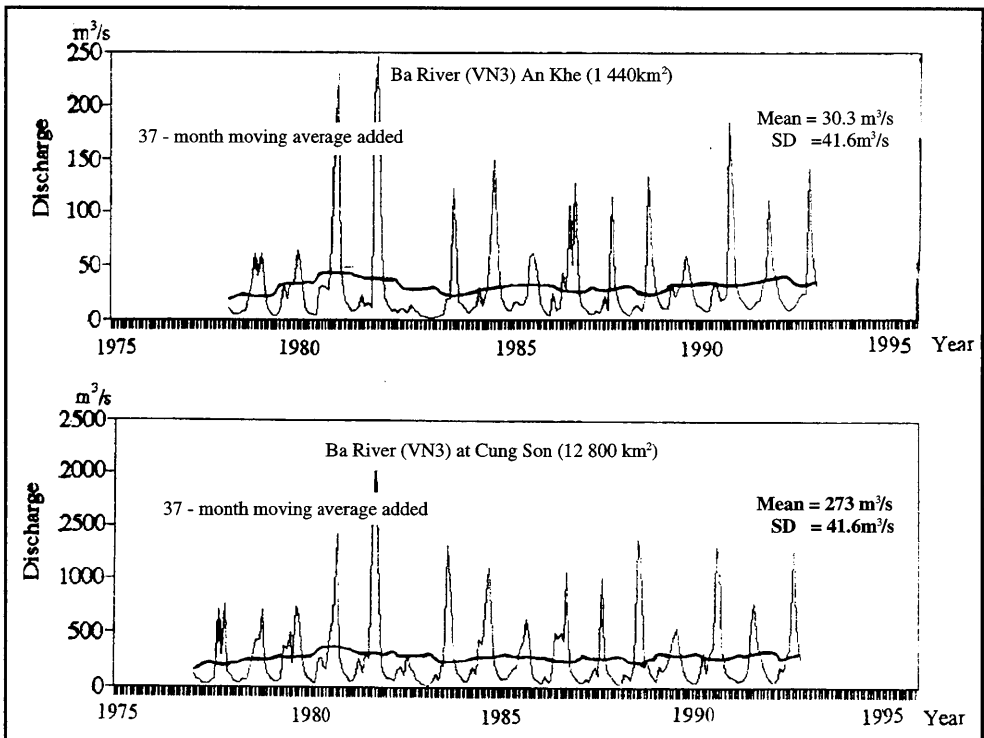
4.2 List of Hydrological Observation Stations

No.	Station	Location	Catchment area (A) [km ²]	Observation period	Observation items ¹⁾ (frequency)
324	An Khe	N 13° 57' E 108° 39'	1 440	1977~	H, P, Q, S
321	Song Hinh	N 12° 55' E 108° 57'	752	1979~1992	H, P, Q, S
322	Cung Son	N 13° 02' E 108° 59'	12 800	1977~	H, P, Q, S

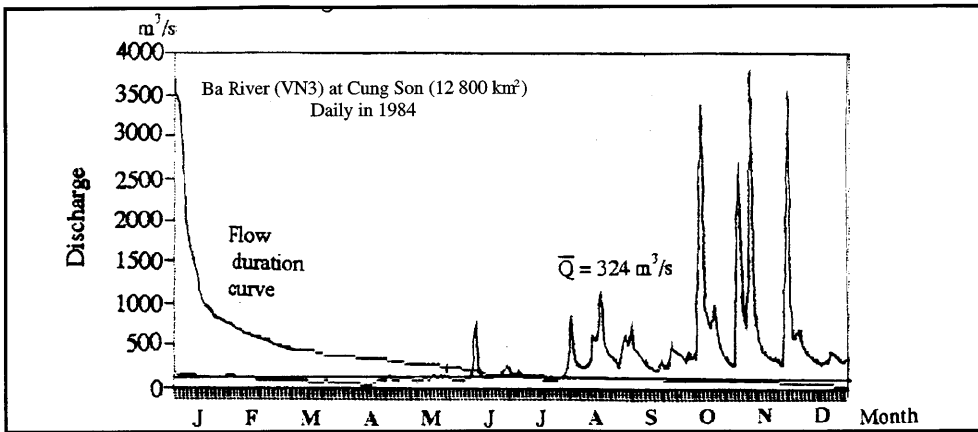
No.	\bar{Q} ²⁾ [m ³ /s]	Q max ³⁾ [m ³ /s]	\bar{Q} max ⁴⁾ [m ³ /s]	\bar{Q} min ⁵⁾ [m ³ /s]	\bar{Q} / A [m ³ /s/100km ²]	Q max / A [m ³ /s/100km ²]	Period of statistics
324	30.3	2 440	1 260	3.14	2.1	169	1977 ~ 1992
321	46.4	3 510	2 099	4.57	6.2	470	1980 ~ 1992
322	273.0	10 500	6 680	26.30	2.1	82	1977 ~ 1992

- 1) H: Water level (twice daily, in flood season more frequent)
 P: Precipitation (daily)
 Q: Discharge (30 - 40 measurements/year)
 S: Sediment concentration (daily index sample; 20 measurements/year)
- 2) Mean annual discharge
 3) Maximum discharge
 4) Mean maximum discharge
 5) Mean minimum discharge

4.3 Long-term Variation of Monthly Discharge

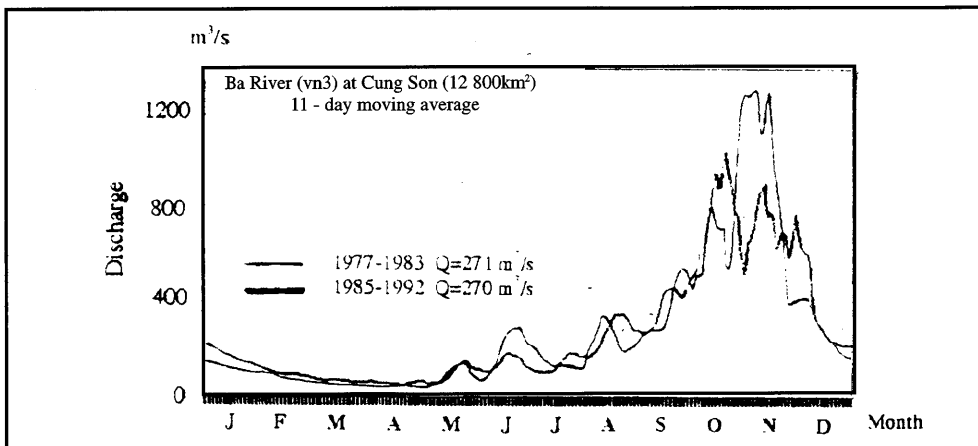


4.4 Annual Pattern of Discharge



4.5 Unique Hydrological Features

The annual discharge patterns before and after the construction of the Trung Tam Dam in 1984.



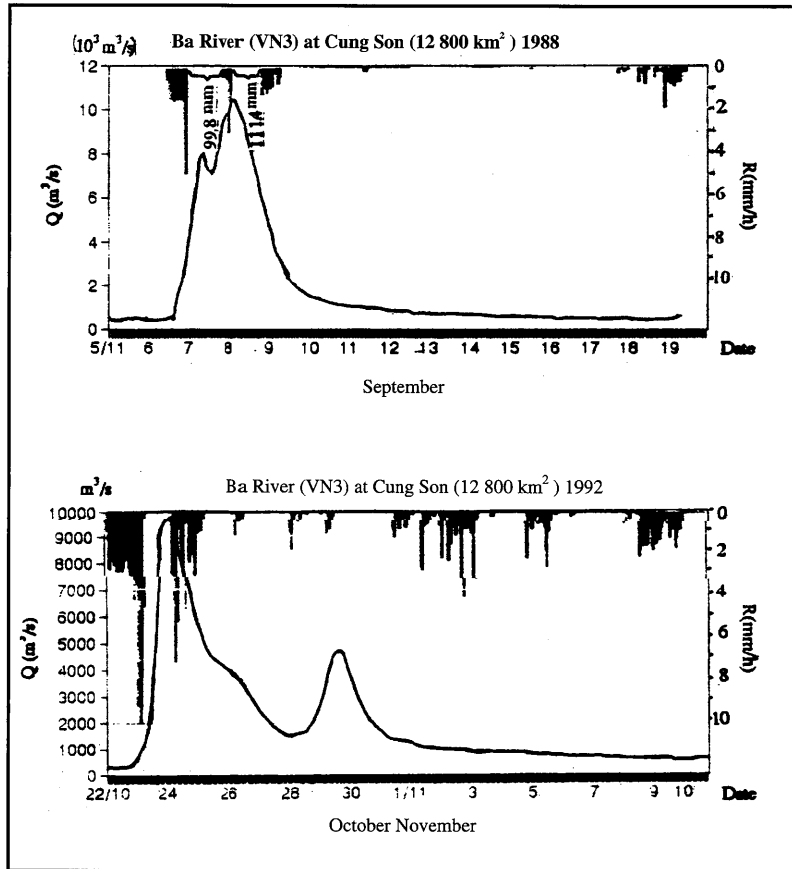
4.6 Annual Maximum and Minimum Discharges

At Cung Son [12 800 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]
1977	11.11	6 780	7	12.5	1985	11.25	6 060	6	30.6
1978	11.03	9 000	4	18.0	1986	12.03	9 200	5	23.2
1979	10.15	7 950	4	26.0	1987	11.20	6 410	8	24.9
1980	11.02	7 540	5	14.8	1988	11.08	10 500	5	25.8
1981	11.10	10 200	4	24.4	1989	10.19	1 710	5	41.9
1982	11.03	955	5	41.6	1990	10.18	7 470	5	20.2
1983	10.29	5 150	4	7.73	1991	10.25	2 990	5	46.8
1984	11.29	5 100	4	30.2	1992	10.24	9 860	5	32.6

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

4.7 Hyetographs and Hydrographs of Major Floods



5. Water Resources

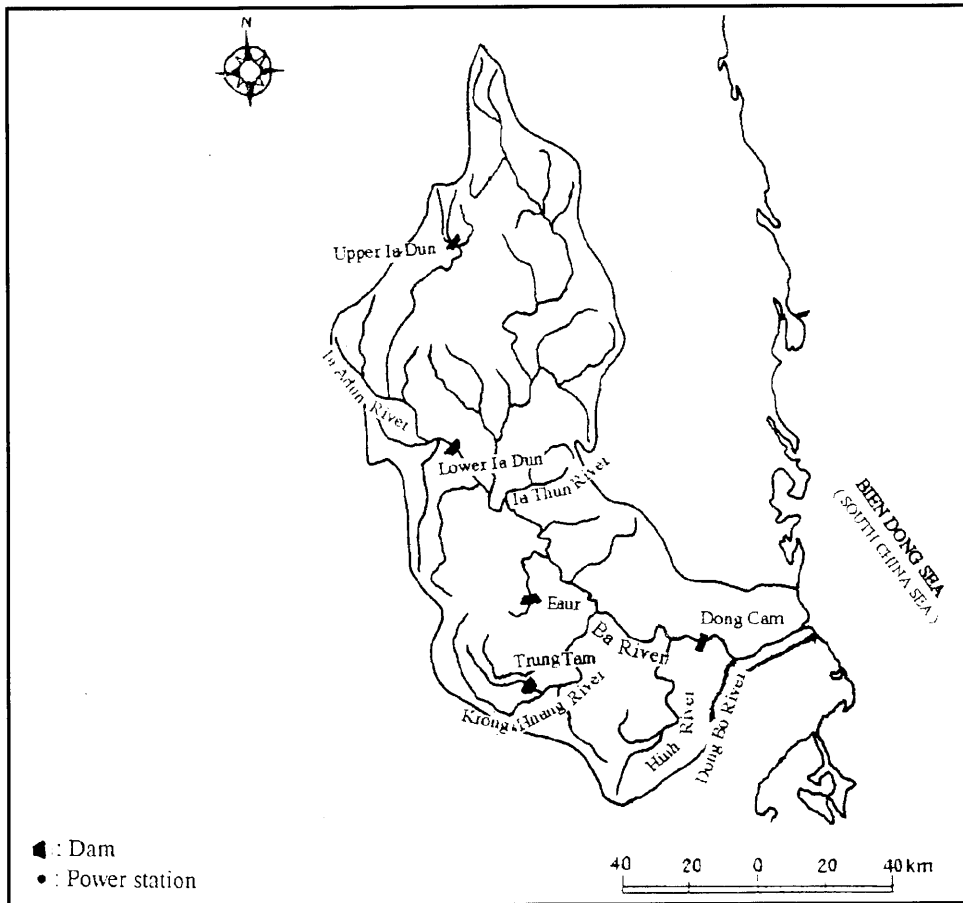
5.1 General Description

The Ba river basin is one of the driest basins in South Central Vietnam. The annual runoff of the basin is 9.39 km^3 or $0.0216 \text{ m}^3/\text{s}/\text{km}^2$. In the Hinh river, one of its tributaries, the annual specific discharge is $0.050 \text{ m}^3/\text{s}/\text{km}^2$ while in the lower reaches of the Ba river it is only less than $0.020 \text{ m}^3/\text{s}/\text{km}^2$.

At Song Hinh station (752 km^2) on Hinh river the maximum discharge by indirect measurement has been $3510 \text{ m}^3/\text{s}$, or $4.70 \text{ m}^3/\text{s}/\text{km}^2$ on November 10, 1961. The specific discharge during the lowflow period is around $0.010 - 0.022 \text{ m}^3/\text{s}/\text{km}^2$. The smallest monthly runoff in West Truong Son range occurred in April while in East Truong Son it has been in August. The smallest specific discharge at Cung Son station ($12\ 800 \text{ km}^2$) on Ba river has been $0.00062 \text{ m}^3/\text{s}/\text{km}^2$ on April 27, 1983. Saline water intrusion in the river may occur upto about 15 - 20 km from seacoast.

The major water problems in Ba river are flooding during the rainy season, water shortage in dry season, and salinity intrusion in coastal areas. Major reservoirs in the basin include the Dong Cam reservoir built in 1932 for providing water to 19 800 ha in Tuy Hoa district and for domestic use in Tuy Hoa city and the Lower ladun which is under construction for providing irrigation facilities to 13 500 ha paddy fields and for generating hydropower (2 700 kw installed capacity).

5.2 Map of Water Resources Systems



5.3 List of Major Water Resources Facilities

Name of river	Name of dam	Catchment area [km ²]	Gross capacity [10 ⁶ m ³]	Effective capacity [10 ⁶ m ³]	Purpose	Year of completion
Ba	Upper Ia Dun	60.2	9.5	8.5	A	1982
	Lower Ia Dun	1 665	253	201	A, P, W	*
	Dong Cam	12 830	-	-	A, W	1932
	EaUr	38.0	3.25	2.75	A	1990
	Trung Tam	7.8	1.60	1.4	A	1984

A: Agricultural use, P: Hydropower, W: Municipal water supply, *: under construction

5.4 Major Floods and Droughts

Major Flood at Cung Son [12 800 km²]

Date	Peak discharge [m ³ /s]	Rainfall [mm] Duration	Meteorological cause	Dead and missing	Major damages (Districts affected)
1978 10.30~11.09	9 000	181.8 10.30~11.06	Typhoon		Son Binh Town
1979 10.13~10.21	7 950	426.9 10.13~10.17	Typhoon		Son Binh Town
1980 11.01~11.20	7 540	396.5 10.24~11.04	Typhoon		Son Binh Town
1981 11.06~11.29	10 200	544.8 11.30~12.06	Typhoon		Son Binh Town
1986 12.01~12.13	9 200	531.3 11.30~12.06	Typhoon		Son Binh Town
1988 11.05~11.16	10 500	270.3 11.06~11.08	Typhoon		Son Binh Town
1990 11.13~11.25	7 470	456.0 10.10~10.15. 10.17~10.18	Typhoon		Son Binh Town
1992 10.22~11.09	9 860	715.7 10.19~10.31, 11.02~11.05	Typhoon		Son Binh Town

5.5. Groundwater and Water Quality

Groundwater is abundant in unconsolidated, sedimentary, intrusive and extrusive formations with quality suitable for domestic use, but no accurate data about ground water withdrawals are available.

6. Socio-cultural Characteristics

Most of the areas in the basin are mountainous with forest and grass cover. Rice farming is practised only in coastal areas. There is hardly any industrial development in the basin area. Several interesting historical monuments such as towers, temples of cham minority ethnic group (built some hundreds of years back) can be found in the basin area.

7. References, Data Books and Bibliography (In Vietnamese)

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- State Programme N42 A Report, *Assessment of hydrometeorological natural conditions and resources in service of production and national defence with focus on agriculture*, Vol I: Meteorological data, Vol II: Hydrological data.
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