

## Tra Khuc River

### Map of River



### Table of Basic Data

<b>Name:</b> Tra Khuc River		<b>Serial No. :</b> Vietnam-6
<b>Location:</b> Quang Ngai, Province, Viet Nam	N 14° 33' - 15° 15'	E 108° 07' 30" - 108° 51' 30"
<b>Area:</b> 3,240 km <sup>2</sup>	<b>Length of the main stream:</b> 135 km	
<b>Origin:</b> Mt. Kon Plong (1,000 m)	<b>Highest point:</b> Mt. Ngoc Linh (2,299 m)	
<b>Outlet:</b> Co Luy	<b>Lowest point:</b> River mouth (0 m)	
<b>Main geological features:</b> Neogene - Quaternary, Paleoproterozoic, Quaternary, Granite		
<b>Main tributaries:</b> Dac Se Lo River (1,760 km <sup>2</sup> ), Nuoc Lac River (96 km <sup>2</sup> ), Giang River (100 km <sup>2</sup> ), Dac Leng River (93 km <sup>2</sup> )		
<b>Main lakes:</b> None		
<b>Main reservoirs:</b> Thach Nham Dam (2,830x10 <sup>6</sup> m <sup>3</sup> ), Nuoc Trong Reservoir (324x10 <sup>6</sup> m <sup>3</sup> )*		
<b>Mean annual precipitation:</b> 2,463 mm at Quang Ngai (1958 ~ 2000)		
<b>Mean annual runoff:</b> 198 m <sup>3</sup> /s at Son Giang (2,440 km <sup>2</sup> ) (1979 ~ 2000)		
<b>Population:</b> about 650,000 (1999)	<b>Main cities:</b> Quang Ngai	
<b>Land use:</b> Forest (38.2%), Rice paddy (15%), Grass (0.7%), Other agriculture (46.1%)		

\* Under construction

## 1. General Description

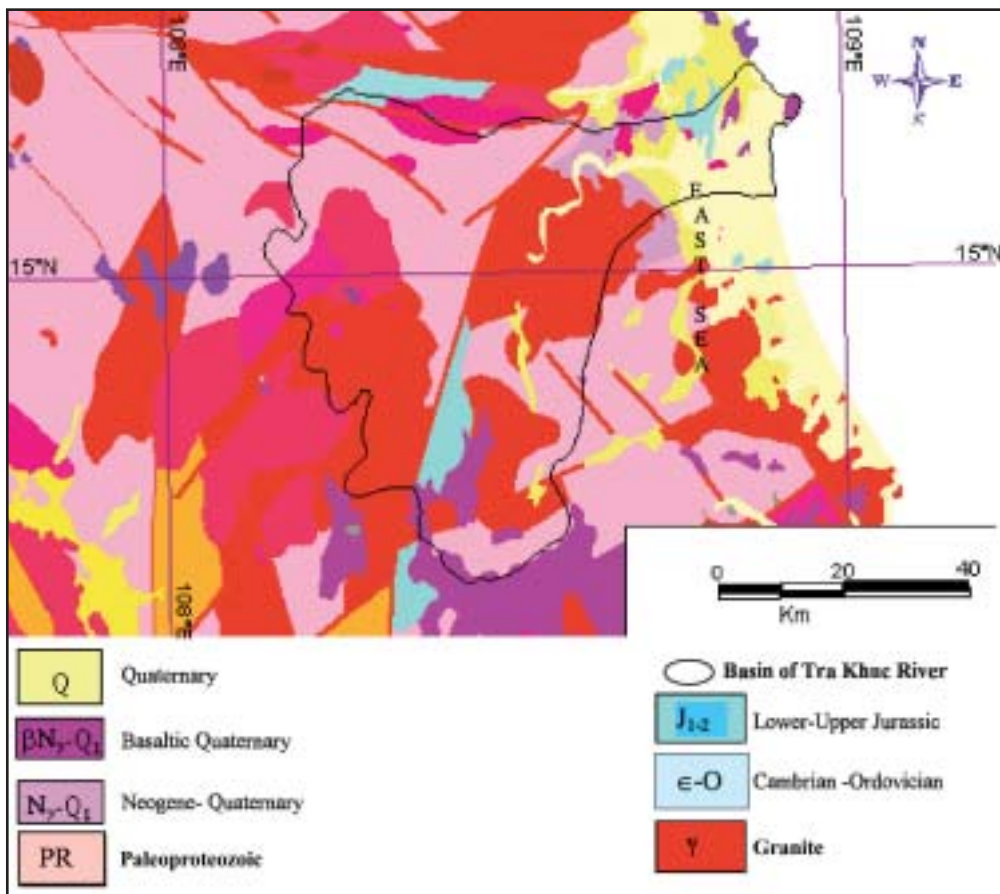
The Tra Khuc River drains the eastern slopes of the Ngoc Linh mountain range and originates at Dakrobao Mountain (2,299 m). The Dak Se Lo River is the largest tributary of the Tra Khuc River which discharges to the sea at Co Luy. From Kahok (Son Giang) to the upper reaches there are three significant tributaries, the Nuoc Ong, the Se Le and the Re. The Tra Khuc River is 135 km long, with a catchment area of 3,240 km<sup>2</sup>. The lower part of the river channel has small slopes and a widening channel.

The average annual rainfall varies strongly in the Tra Khuc River basin. In some places it is as high as 3,600 mm, while the minimum value is 1,800 mm. The wet season in this basin runs from late September to December, during which 65 - 85% of the total annual precipitation occurs.

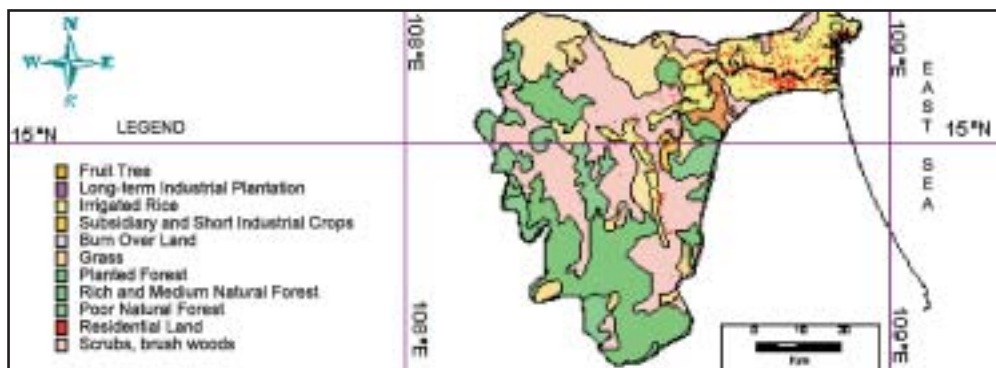
Hydraulic structures have been developed in Quang Ngai province to provide protection against floods and reduce the impacts of droughts.

## 2. Geographical Information

### 2.1 Geological Map



## 2.2 Land User Map

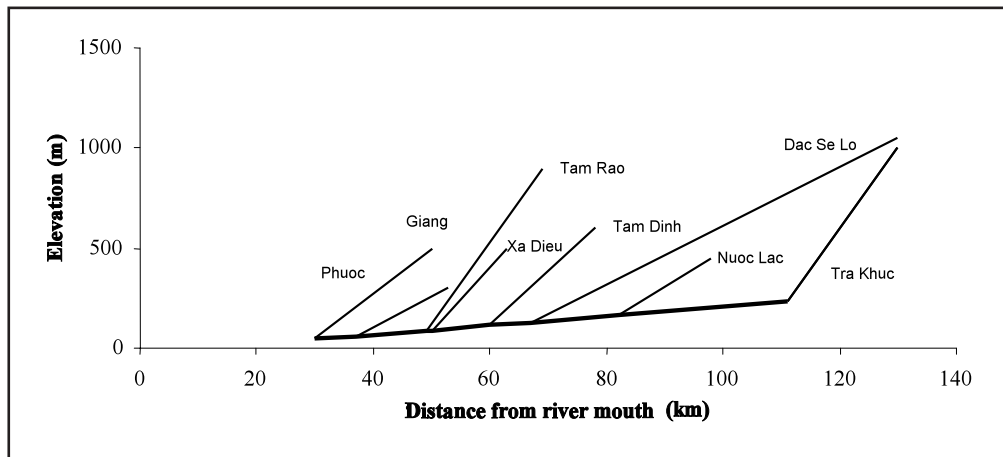


## 2.3 Characteristics of River and Main Tributaries

No.	Name of river	Length [km] Catchment area [km <sup>2</sup> ]	Highest peak [m] Lowest point [m]	Cities Population	Land use [%]
1	<b>Tra Khuc</b> (Main river)	135 3,240	900	Quang Ngai	A (46.1) F (38.2)
2	<b>Dac Se Lo</b> (Tributary)	63 1,760	1,050		G (0.7) P (15.0)
3	<b>Giang</b> (Tributary)	16 100	300		
4	<b>Dac Leng</b> (Tributary)	19 96	1,100		
5	<b>Nuoc Lac</b> (Tributary)	16 93	450		
6	<b>Tam Dinh</b> (Tributary)	18 67	600		
7	<b>Tam Rao</b> (Tributary)	20 64	900		
8	<b>Xa Dieu</b> (Tributary)	13 63	500		
9	<b>Phuoc</b> (Tributary)	20 45	500		

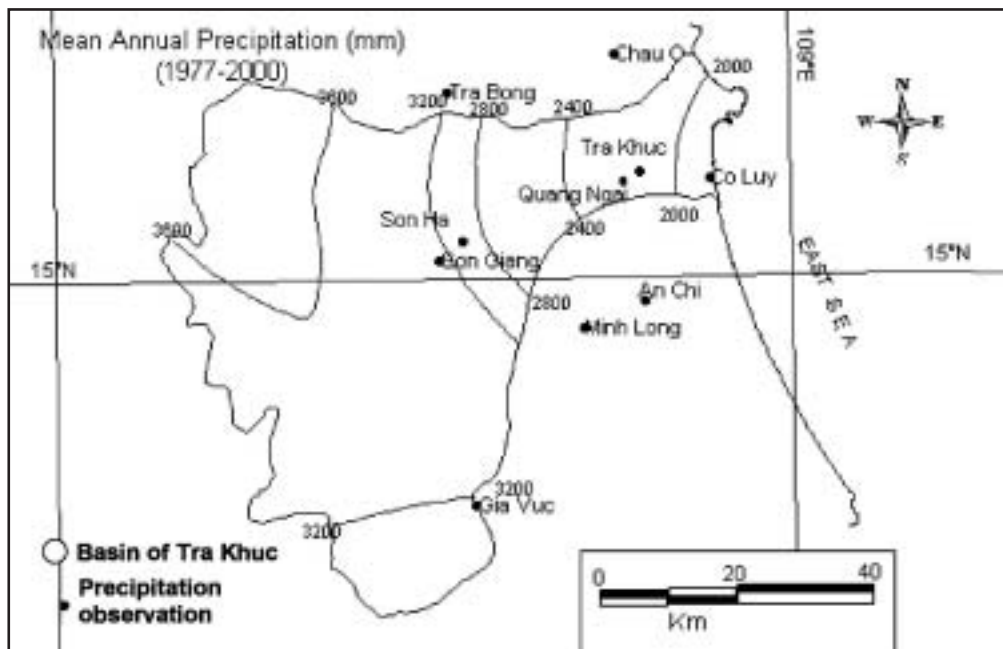
A: Other agriculture land    F: Forest    G: Grass    P: Paddy field

## 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
48863	Quang Ngai	7.16	N: 14° 46' E: 108° 44'	(P, E) 1958 ~	2,462.9	1,010.1	DS, E, P

DS: Duration of sunshine observed by Helioscope

E: Evaporation by Piche tube

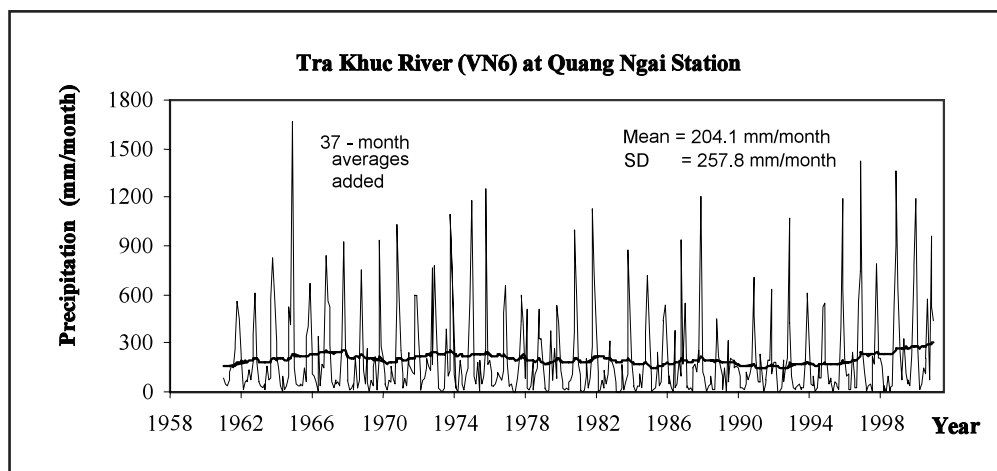
P: Precipitation observed by Pluviometer

### 3.3 Monthly Climate Data

Observation item	Observation station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	Quang Ngai	21.5	22.5	24.2	26.5	28.3	28.9	28.8	28.6	27.2	25.7	24.0	22.2	25.7	1961 ~
Precipitation [mm]	Quang Ngai	126.3	42.2	39.7	47.8	92.8	112.4	94.2	128.8	317.8	649.9	527.1	284.0	2,462.9	1958 ~
Evaporation [mm]	Quang Ngai	60.7	60.8	85.5	97.4	112.1	109.9	116.1	106.1	78.8	67.4	59.3	55.9	1,010.1	1958 ~
Duration of sunshine [hr]	Quang Ngai	122.0	154.6	208.7	232.2	259.6	238.1	250.2	232.5	191.7	156.0	109.7	88.7	2,244.0	1961 ~ *

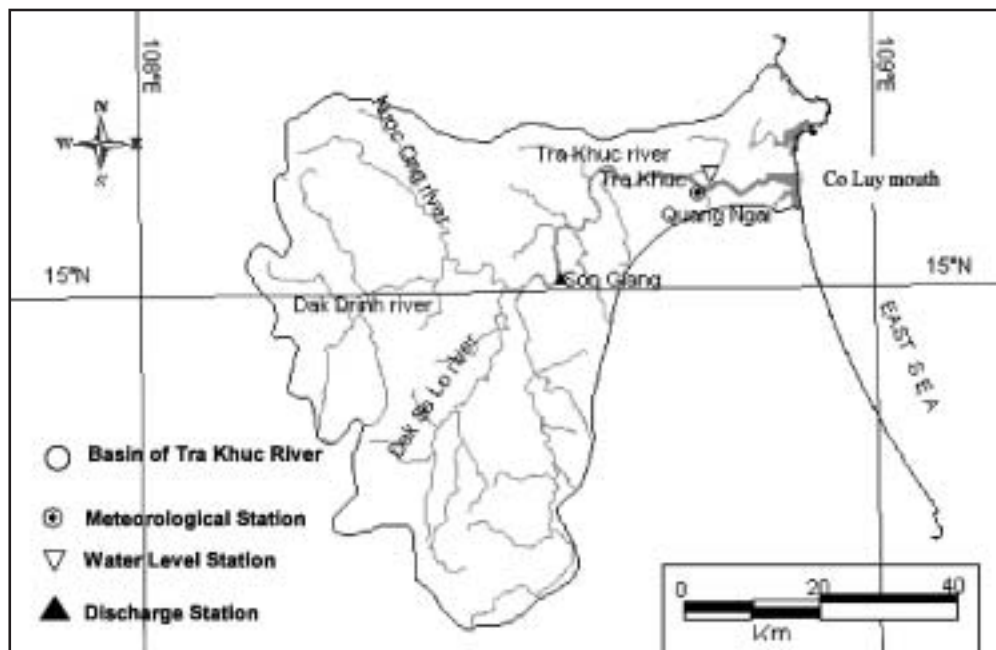
Note: \* Missing data in 1976

### 3.4 Long - term Variation of Monthly Precipitation



## 4. Hydrological Information

### 4.1 Map of Stream flow Observation Stations



### 4.2 List of Hydrological Observation Stations

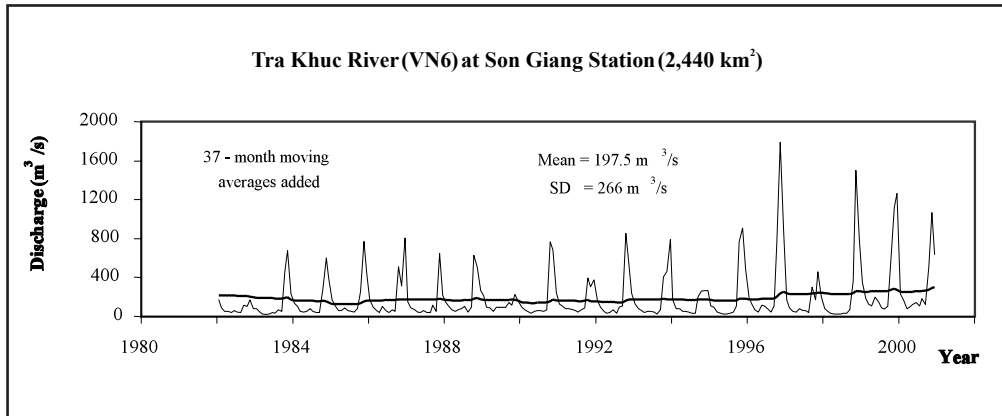
No.	Station	Location	Catchment area (A) [km <sup>2</sup> ]	Observation period	Observation items (frequency) <sup>1)</sup>
71539	Son Giang	N: 15° 08' E: 108° 31'	2,440	1979 ~	H, Q, P, S

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
71539	197.5	18,300	6,793	29.31	2.12	750	1979 ~

1) H: Water level  
P: Precipitation (daily)  
Q: Discharge  
S: Sediment concentration

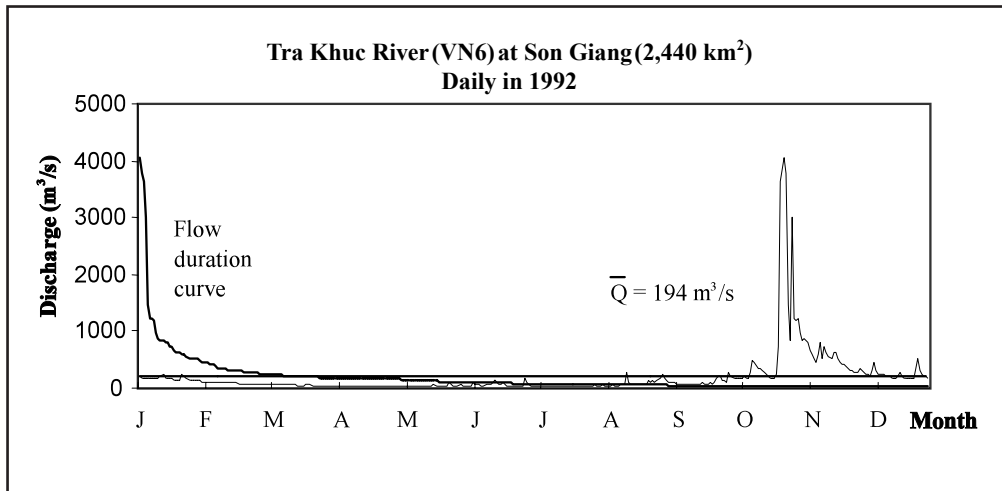
2) Mean annual discharge  
3) Maximum discharge  
4) Mean maximum discharge  
5) Mean minimum discharge

### 4.3 Long-term Variation of Monthly Discharge



Note: The data above are monthly mean flows expressed in units of m<sup>3</sup>/s

### 4.4 Annual Pattern of Discharge

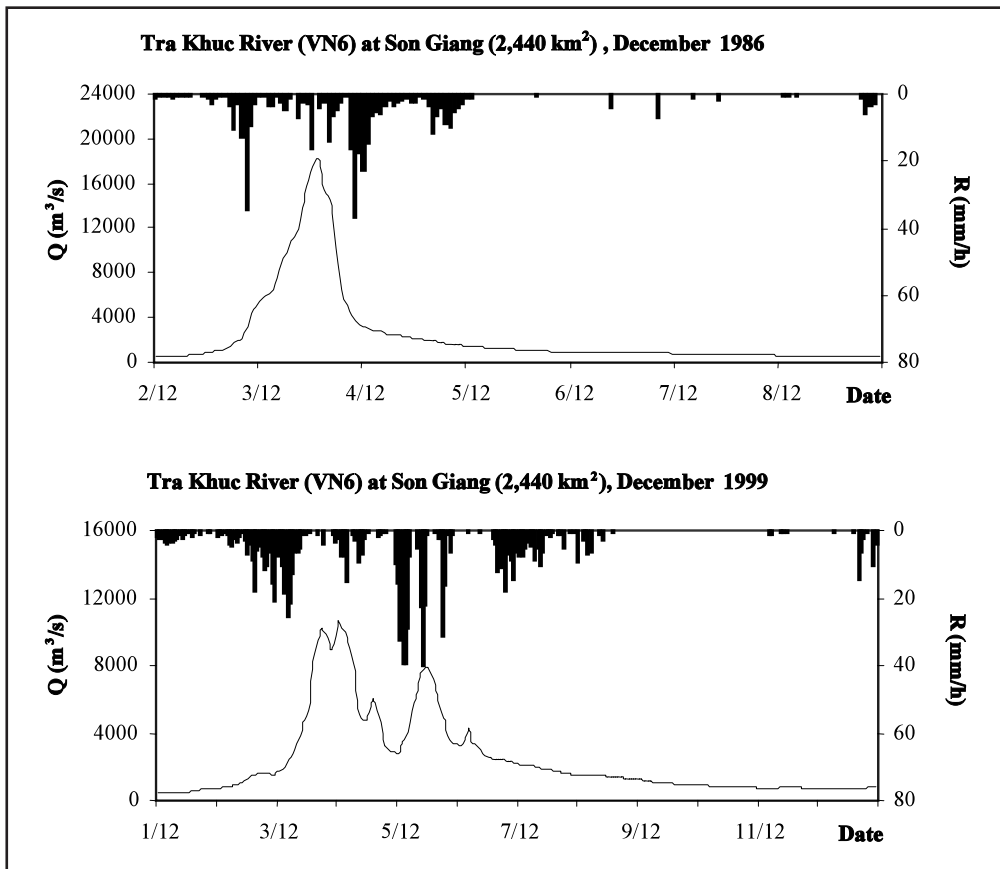


### 4.6 Annual Maximum and Minimum Discharge

Year	Maximum <sup>1)</sup>		Minimum <sup>2)</sup>		Year	Maximum <sup>1)</sup>		Minimum <sup>2)</sup>	
	Date	[m <sup>3</sup> /s]	Month	[m <sup>3</sup> /s]		Date	[m <sup>3</sup> /s]	Month	[m <sup>3</sup> /s]
1979	11.18	4,770	4	28.3	1990	11.12	7,720	5	21.8
1980	11.17	8,800	5	23.7	1991	10.24	3,610	8	36.1
1981	11.8	6,180	4	37.7	1992	10.24	6,360	4; 5; 6	25.4
1982	11.3	2,140	6	26.0	1993	11.29	3,120	8	15.3
1983	10.3	8,220	4	16.8	1994	10.2	3,940	8	21.5
1984	11.7	6,750	9	28.3	1995	11.1	6,700	6	20.5
1985	11.25	5,790	9	27.2	1996	11.3	10,100	8	41.2
1986	12.3	18,300	8	30.7	1997	11.4	6,840	9	29.9
1987	11.19	8,280	8	26.5	1998	11.22	10,100	6	16.3
1988	11.15	4,480	9	37.5	1999	12.4	10,700	8	38.4
1989	11.28	1,680	5	41.6	2000	11.17	4,860	4	54.1

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 specific discharge is unevenly distributed across the basin, from  $0.030 \text{ m}^3/\text{s}/\text{km}^2$  on the coastal plains to  $0.070 \text{ m}^3/\text{s}/\text{km}^2$  in the mountainous areas.

The runoff varies seasonally. The flood season lasts for three months from late September to December. In comparison to other areas of the country the flood season in the Central Coastal provinces and, in Tra Khuc River basin in particular, occurs later and is shorter. During the flood season 65 - 75% of the total annual runoff occurs. In November the monthly runoff usually reaches a maximum value and is 30 % of the annual runoff.

During the 1977 - 2000 flood seasons, runoff in the Tra Khuc River at Son Giang ( $2,440 \text{ km}^2$ ) had an average value of  $1,720 \text{ m}^3/\text{s}$  (specific flood discharge,  $M = 0.769 \text{ m}^3/\text{s}/\text{km}^2$ ). An especially high flood occurred in December 1986 with a  $Q_{\max}$  of  $18,300 \text{ m}^3/\text{s}$  ( $M_{Q_{\max}} = 7.5 \text{ m}^3/\text{s}/\text{km}^2$ ) while those in December 1999, November 1996, and November 1998, had  $Q_{\max}$  of  $10,700 \text{ m}^3/\text{s}$ ,  $10,100 \text{ m}^3/\text{s}$  and  $10,100 \text{ m}^3/\text{s}$ , respectively. The historical flood of November 1964 had a  $Q_{\max}$  of  $15,100 \text{ m}^3/\text{s}$  at Thach Nham ( $2,836 \text{ km}^2$ ). The lowest flood peaks occurred in 1989, 1982 and 1993 when the  $Q_{\max}$  values were  $1,680$ ,  $2,140$  and  $3,120 \text{ m}^3/\text{s}$  respectively. Peak flood levels range from 10 to 15 m above normal levels in the Tra Khuc River with a rate of water level rise in the range 50 - 100 cm/h (in November 1999 at Son Giang it was 165 cm/h).

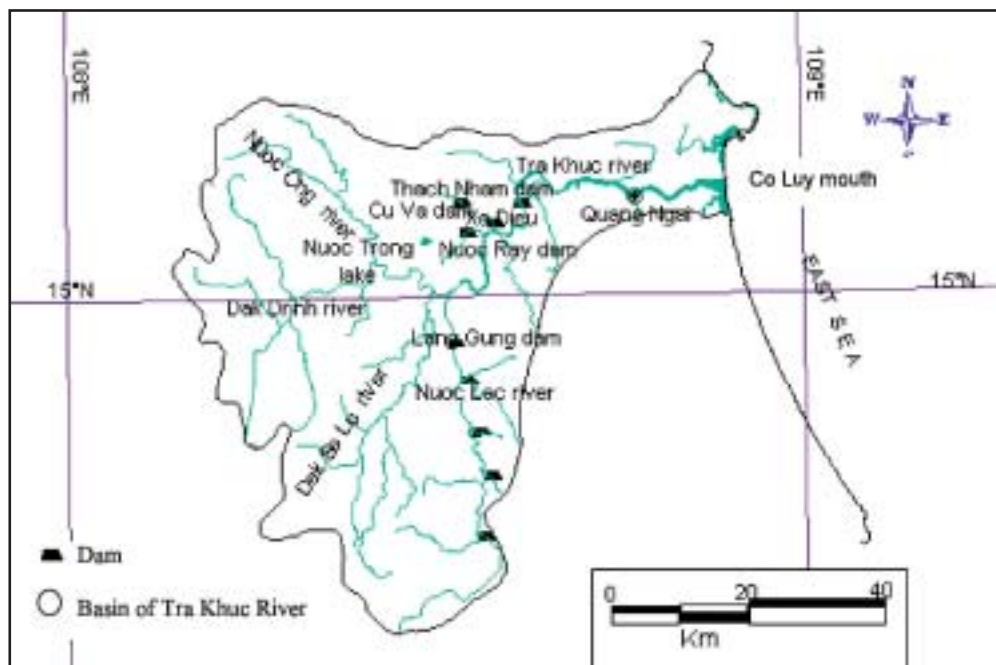
Flash floods in November and December 1999 caused landslides and mountain-sides to collapse.

Droughts occurred in 1982-1983, 1986-1987, 1993, and 1997-1998. The drought in 1997-1998 was especially severe with a  $Q_{\min}$  of  $16.3 \text{ m}^3/\text{s}$  recorded on the 23<sup>rd</sup> of September 1998, while 2 months later, on the 22<sup>nd</sup> November 1998, a significant flood occurred with a  $Q_{\max}$  of  $10,100 \text{ m}^3/\text{s}$ .

There has been continuous development of the water resources in the Tra Khuc River basin. To date, 12 reservoirs have been built, to store water for irrigation and domestic water supply. The Thach Nham dam with a volume of  $2,830 \times 10^6 \text{ m}^3$  was built in 1984 with both north and south flowing distribution canals to convey water for irrigation and industrial production.

The Nuoc Trong reservoir, which is still under construction, will provide water for irrigation, flood protection, hydro-power generation and water for industry.

## 5.2 Map of Water Resources Systems



## 5.3 List of Major Water Resources Facilities

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> ]	Purposes	Year of completion
Tru Khuc	Thach Nham Dam	2,836	2,830	-	A, I	1984
	Xa Dien Dam	200	-	-	A	1977
	Cu Va Dam	550	-	-	A	1980
	Ba Lien Dam	150	-	-	A	1975
	Xa Trach Dam	50	-	-	A	1978
	19/5 Dam	100	-	-	A	1976
	To Dam	100	-	-	A	1976
	Nuoc Ray Dam	70	-	-	A	(1995 - 2000)*
	Nuoc Lat Dam	200	-	-	A	(1995 - 2000)*
	Lang Gung Dam	50	-	-	A	(1995 - 2000)*
Nuoc Trong	Nuoc Trong	446	324	300	A, F, P, I	(2000 - 2010)*
Tra Khuc	Lang Re	140	-	-	A	(1995 - 2000)*
	Nuoc Ray	150	-	-	A	(1995 - 2000)*
	Lang Bau	60	-	-	A	(1995 - 2000)*
	Lang Mon	120	-	-	A	(1995 - 2000)*
	Vi Tuc	65	-	-	A	(1995 - 2000)*

Name of transfer line	Names of rivers connected		Length [km]	Maximum capacity [m <sup>3</sup> /s]	Purposes	Year of completion
	From	To				
<b>Bac</b>	Thach Nham Dam	Dung Quat Industrial Zone	31	-	A	-
<b>Nam</b>	Thach Nham Dam	Liet Son Lake	35	-	A	-

A: Agriculture F: Flood Control I: Industrial P: Hydropower

\* Under construction

## 5.4 Major Floods and Droughts

Date	Peak discharge [m <sup>3</sup> /s]	Rainfall [mm] Duration	Meteorological cause	Dead and missing	Major damages (Districts affected)
<b>1980 11.17</b>	8,800	831.9 11.9 ~ 11.21	Typhoon		Quang Ngai Town
<b>1983 10.30</b>	8,220	836.6 10.25 ~ 11.4	Typhoon		Quang Ngai Town
<b>1986 12.3</b>	18,300	865.3 11.24 ~ 12.10	Typhoon		Quang Ngai Town
<b>1987 11.19</b>	8,280	557.0 11.18 ~ 11.26	Typhoon		Quang Ngai Town
<b>1996 11.3</b>	10,100	13,98.9 10.16 ~ 11.3	Typhoon		Quang Ngai Town
<b>1998 11.22</b>	10,100	1,213.4 11.18 ~ 11.26	Typhoon		Quang Ngai Town
<b>1999 12.4</b>	10,700	2,243.2 11.28 ~ 12.8	Typhoon		Quang Ngai Town

## 5.5 Groundwater and Water Quality

Measurements of surface water quality in June 1999 showed: pH in the range 6.0-8.5, iron sum in the range 0.032-0.296 mg/l, nitrogen sum in the range 0.376-0.903 mg/l, hardness in the range 8.45-34.5 mg/l, alkalinity in the range 0.45-0.90 me/l; and chemical oxygen demand in the range 5.7-26.3 mg/l. In general, the Tra Khuc River water quality is still good and suitable for agricultural, domestic and other uses.

## 6. Socio-cultural Characteristics

The Tra Khuc River basin is mostly in Quang Ngai province and partially in Kon Tum province. The Quang Ngai provincial centre is situated on the banks of the Tra Khuc River. Every year local fishermen organize the festival of Nghinh Ong to pay respect to the Ong fish .

In Tra Khuc River basin there are many historical sites and beautiful landscapes, such as Co Luy Co, My Khe Beach, and the old Chau Sa fortifications.

## 7. References, Data Books and Bibliography

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