

APPENDIX B : METEOROLOGY AND HYDROLOGY

APPENDIX-B METEOROLOGY AND HYDROLOGY

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APPENDIX-B METEOROLOGY AND HYDROLOGY

B.1 Introduction

B.1.1 Objectives of the Study

The main objective of the meteo-hydrological study is to clarify the meteo-hydrological conditions in the Study Area for the Study on Integrated Agricultural Development Plan in the Dong Thap Muoi Area (hereinafter referred to as "the Study").

The existing meteo-hydrological data and information were collected, and the field survey and investigation were carried out. Some studies and analyses were also carried out based on the data and information collected and the field survey conducted to the extent that the principal meteorological and hydrological features of the respective basins and areas were clarified.

The results of the Study are presented below.

B.1.2 Summary of the Study

(1) Field Work

The works carried out during the Field Work are summarized below.

- Data collection
 - Rainfall data (9 stations)
 - Meteorological data (6 stations)
 - Hydrological data (11 stations)
- Preliminary data analysis and technology transfer
- Other field investigations

(2) Summary of Meteorology

The meteorological parameters observed in the meteorological station at Cao Lanh in Dong Thap Province are summarized below.

Annual rainfall	:	1,000 to 1,600 mm/year
Temperature	:	27 °C (Monthly Max.: 33°C, Monthly Min.: 21 °C)
Humidity	:	80 % (Monthly Max.: 98 %, Monthly Min.: 46 %)
Evaporation (Observation)	:	3.3 mm/day

Wind Velocity : 1.3 to 1.9 m/s (Max. 10.0 to 17.0 m/s)
Sunshine : 7.8 hours/day

(3) Summary of Hydrology

The correlation coefficients of monthly rainfall were calculated for every two stations. Each station has a correlation coefficient of more than 75% with its neighboring stations.

Considering the data availability and locations, Cao Lanh, My Tho and Moc Hoa stations were selected for the rainfall analysis of the Study area. Rainfall Pattern at the stations are shown below.

Summary of Rainfall Pattern (mm)

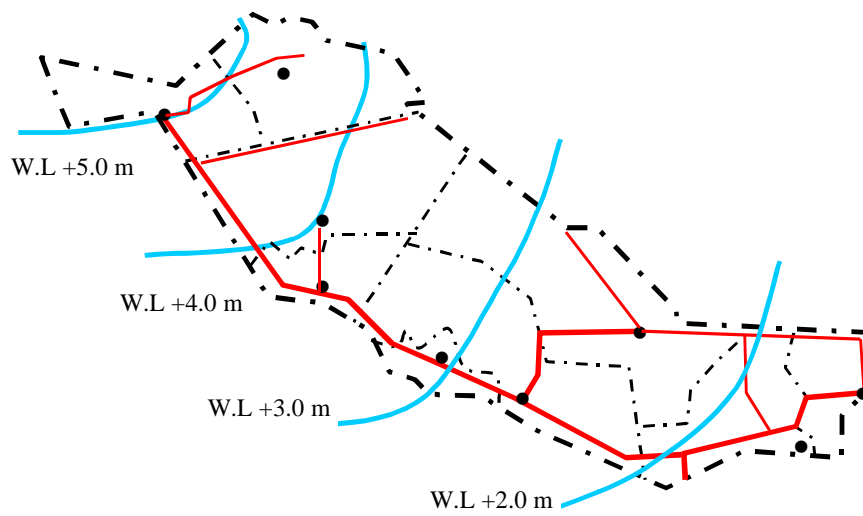
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
My Tho	5.0	0.9	4.1	31.1	144.4	185.9	162.2	195.3	211.1	257.2	102.3	30.0	1,339.1
Cao Lanh	7.4	3.8	14.8	41.7	161.2	146.2	154.6	169.0	242.9	244.6	116.2	22.1	1,294.6
Moc Hoa	11.2	4.2	15.0	50.9	188.4	166.7	183.3	167.0	258.7	307.1	142.6	35.9	1,531.1

More than 90% of the annual rainfall is expected to occur during the period from May to November, and same amount of rainfall is expected at anywhere in the Study Area

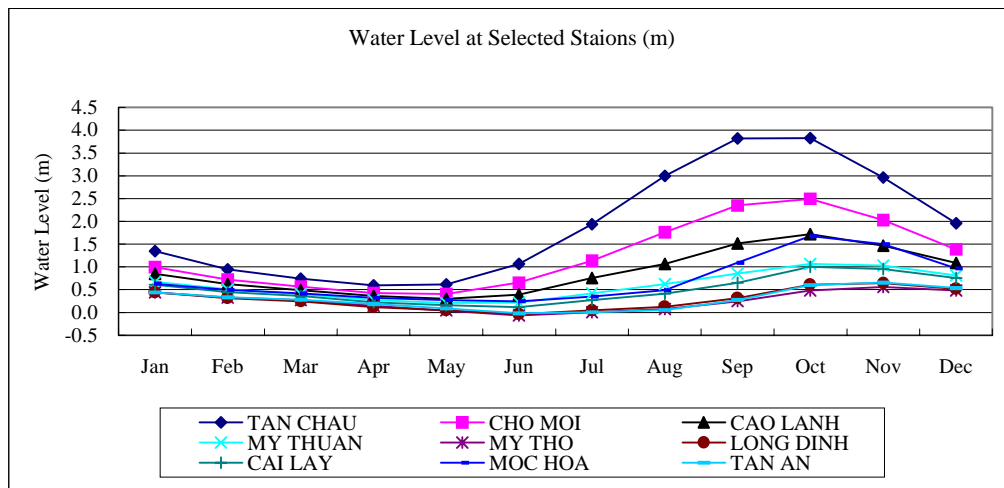
In the Study Area, there are three types of inundation occurring in rainy season (August to November). The one is caused by big amount of flooding water from the Mekong River. Usually in August, the inundation starts from northern part of the Study Area and, within around two weeks, this inundation covers all the Study Area for three to four months. The maximum water level in 1996 is illustrated as shown below.

The second type of inundation is caused by influence of tidal wave and occurs also in rainy season when river water is high. This occurs only at the Tien River side area in Southern part and continues around 10 days with 12 hours interval. The third type is caused by direct runoff of rainfall with high intensity and this occurs in the rainy season for a few hours with around 10 cm of water depth.

Water level at 9 stations are summarized below and it shows the deference of water level between dry season and rainy season is quite high at Northern part of the Study Area.



Maximum Water Level in 1996



Based on the water level record at Tan chaou, Cao lanh and Cai Lay stations water level was analyzed and the results are summarized as shown below;

Return period	Probability	Maximum Water Level (m)			Minimum Water Level (m)		
		Tan Chau	Cao Lanh	Cai Lay	Tan Chau	Cao Lanh	Cai Lay
1/2	50.00	4.09	2.08	1.23	-0.17	-0.86	-1.13
1/5	80.00	4.57	2.26	1.48	-0.29	-0.96	-1.27
1/10	90.00	4.89	2.38	1.65	-0.34	-1.01	-1.32
1/20	95.00	5.20	2.50	1.81	-0.38	-1.04	-1.36
1/25	96.00	5.29	2.54	1.86	-0.39	-1.05	-1.38
1/50	98.00	5.59	2.65	2.02	-0.42	-1.08	-1.41

B.2 Data Collection and Data Availability

B.2.1 Data Collection

There are 6 meteorological stations and 11 hydrological stations in and around the Study Area as shown below.

Meteorological Data in and around the Dong Thap Muoi Project

No	Station	Data	Period	Long.	Lat.	Source of data
1	Cao Lanh	Rainfall	1962-1965, 1974-1993	105.39	10.25	Southern Hydro-Meteorological Center in HCM. City (SHMC)
		Temperature	1962-1974, 1974-1993			
		Humidity	1962-1974, 1974-1993			
		Evaporation	1962-1974, 1974-1993			
		Wind	1962-1974, 1974-1993			
		Sunshine	1962-1974, 1974-1993			
2	Hung Thanh	Rainfall	1984-1993	105.46	10.38	
3	Cai Lay	Rainfall	1979-1993	106.06	10.26	
4	Tan Chau *	Rainfall	1978-1994, 1996	105.14	10.48	
5	My Tho *	Rainfall	1960-1994	106.22	10.21	
		Temperature	1962-1974, 1976-1994			
		Humidity	1962-1974, 1976-1994			
		Evaporation	1962-1974, 1976-1994			
		Wind	1962-1974, 1976-1994			
		Sunshine	1962-1974, 1976-1994			
6	Moc Hoa *	Rainfall	1960-1997	105.56	104.46	
		Temperature	1962-1974, 1976-1991			
		Humidity	1962-1974, 1976-1991			
		Evaporation	1962-1974, 1976-1991			
		Wind	1962-1974, 1976-1991			
		Sunshine	1962-1974, 1976-1991			

* Outside the project

Water level, Discharge and Sediment Data

No	Station	Data	Period	Long.	Lat.	Source of data
1	Cao Lanh	Water level	1979-1985, 1991-1997	105.39	10.25	SHMC
2	Hung Thanh	Water level	1984-1993	105.46	10.38	SHMC
3	Hong Ngu	Water level	1979-1997	105.21	10.45	DTARD
4	Tram Chim	Water level	1982-1997	105.34	10.39	DTARD
5	My An	Water level	1982-1993	105.51	10.30	DTARD
6	Tan Chau *	Water level	1960-1997	105.14	10.48	SHMC
		Discharge	1978-1997			
		Sediment	1991-1996			
7	Cai Lay	Water level	1982-1994	106.06	10.26	SHMC
8	My Tho *	Water level	1960-1997	106.22	10.21	SHMC
9	Moc Hoa *	Water level	1960-1997	105.56	10.46	SHMC
10	My Thuan *	Water level	1978-1997	105.54	10.15	SHMC
11	Cho Moi *	Water level	1960-1993	105.24	10.32	SHMC

* Outside the project

SHMC: Southern Hydro-Meteorological Center in HCM. City

DTARD: Dong Thap Agriculture and Rural Development service

Discharge Measurement Campaigns (in the Low Flow and Flood Flow)

No	Station	Period	Source of data
1	Hong Ngu Bridge	28 Apr. – 13 May ,1996 and 6 – 21 Apr. , 1997 Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP SHMC
2	So 4 Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
3	Thong Binh	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
4	Binh Thanh Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
5	Thong Nhat Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
6	Cau Sat	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
7	Sa Rai Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
8	Tan Thanh Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
9	Thong Binh Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
10	An Binh Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
11	An Long Bridge	28 Apr. – 13 May ,1996 and 6 – 21 Apr. , 1997 Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP SHMC
12	Ba Rang Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP
13	Doc Vang Thuong Bridge	28 Apr. – 13 May ,1996 and 6 – 21 Apr. , 1997 Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP SHMC
14	Doc Vang Ha Bridge	28 Apr. – 13 May ,1996 and 6 – 21 Apr. , 1997 Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP SHMC
15	Cai Dau Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP
16	Phong My Bridge	28 Apr. – 13 May ,1996 and 6 – 21 Apr. , 1997 Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP SHMC
17	Trau Trang Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
18	Ong Kho Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
19	Can Lo Bridge	28 Apr. – 13 May ,1996 and 6 – 21 Apr. , 1997 Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP SHMC
20	Rach Mieu Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
21	Long An Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
22	Tan Truong Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
23	Cai Beo Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
24	Cai Sap Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
25	Cai Bung Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
26	Cai Sao Ha Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
27	Long Hiep Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
28	Bay Du Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
29	Cai Lan Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
30	Rach Ruong Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
31	Rach Dao Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
32	Ba Tu Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
33	Rach Chanh Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
34	Ba Lam Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
35	Co Co Bridge	28 Apr. – 13 May ,1996 and 6 – 21 Apr. , 1997 Aug. – Nov. ,1996 and Aug. – Nov. 1997	AIWRP SHMC
36	Rach Mieu Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
37	My Duc Tay Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
38	Ong Ve Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
39	My Thien Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
40	Tra Lot Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
41	Thong Luu Bridge	28 Apr. – 13 May ,1996 and 6 – 21 Apr. , 1997 Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP SHMC
42	An Cuu Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
43	Ba Dat Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
44	Ba Ton Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
45	Binh Phu Bridge	Aug. – Nov. ,1996 and Aug. – Nov. 1997	SHMC
46	Cai Lay Bridge	28 Apr. – 13 May ,1996 and 6 – 21 Apr. , 1997 Aug. – Nov. ,1996 and Aug. – Nov. 1997	SIWRP SHMC

SIWRP: Sub-Institute of Water Resources Planning

SHMC: Southern Hydro-Meteorological Center in HCM. City

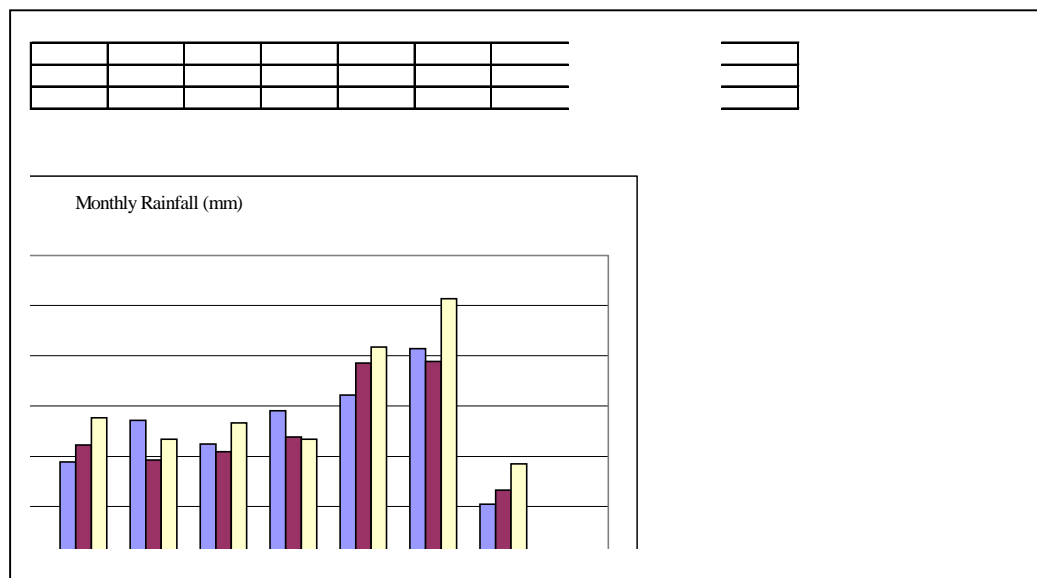
B.2.2 Availability of Meteo-hydrological Data

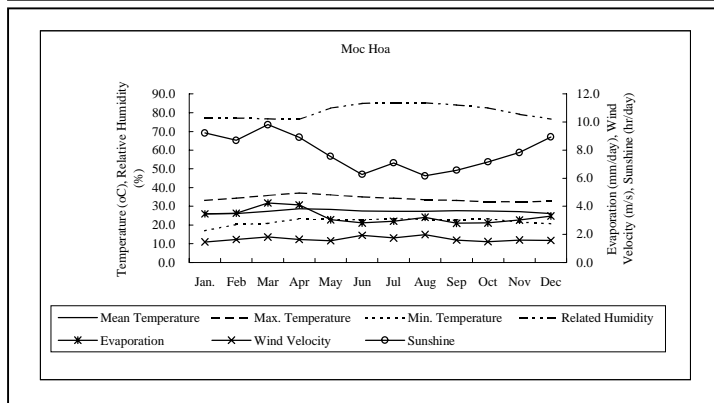
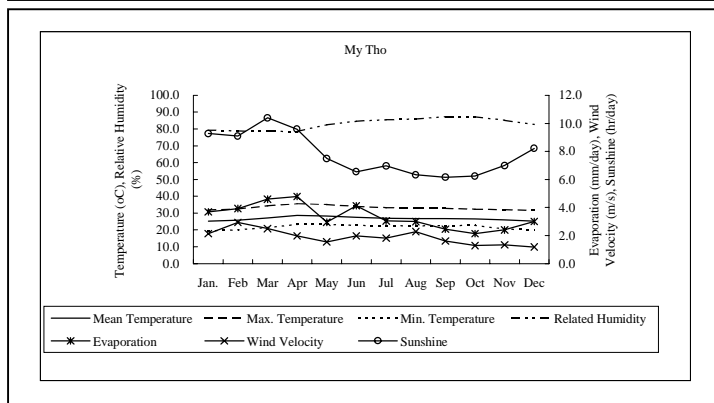
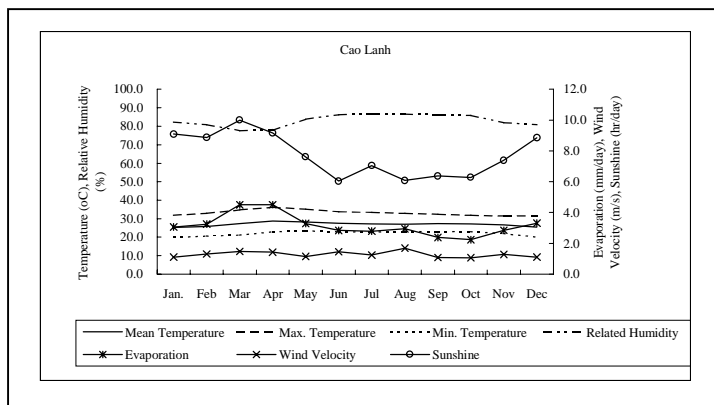
The monthly meteorological and hydrological parameters for those stations were collected. Collected data and availability of meteo-hydrological data are shown below.

		Data Availability																																											
Station	parameter	59	60	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					
Tan Chau	Rainfall																																												
Cao Lanh																																													
My Tho																																													
Cai Lay																																													
Moc Hoa																																													
Hung Thanh																																													
Tram Chim																																													
Hong Ngu																																													
Cho Moi																																													
Cao Lan		Temperature																																											
	Related Humidity																																												
	Evaporation																																												
	Wind Velocity																																												
	Sunshine																																												
My Tho	Temperature																																												
	Related Humidity																																												
	Evaporation																																												
	Wind Velocity																																												
	Sunshine																																												
Moc Hoa	Temperature																																												
	Related Humidity																																												
	Evaporation																																												
	Wind Velocity																																												
	Sunshine																																												
Tan Chau	Water Level																																												
Cho Moi																																													
Cao Lanh																																													
My Thuan																																													
My Tho																																													
Cai Lay																																													
Tan An																																													
Moc Hoa																																													
Kien Binh																																													
Hung Thanh																																													
Tram Chim																																													
Tuyen Nhon																																													
Hong Ngu																																													

B.3 Meteorology

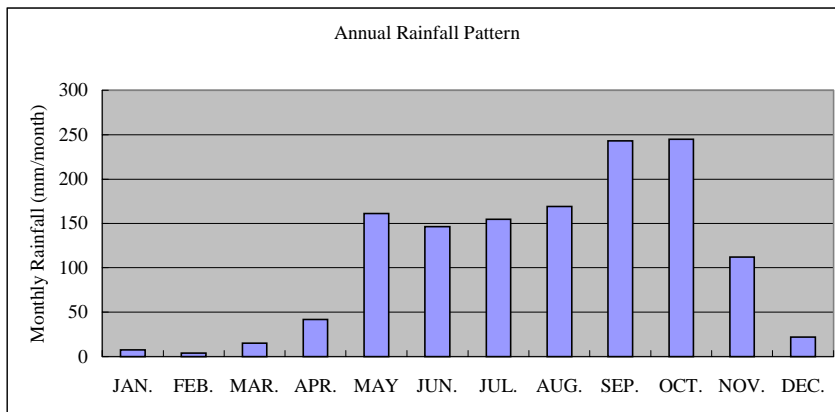
Summary of climate conditions at Cao Lanh, My Tho and Moc Hoa is shown below;





B.3.1 Rainfall

Annual rainfall pattern in the Study Area as shown in the figure is divided into two seasons (rainy season from May to November, dry season from December to April). More than 90 % of annual rainfall is concentrated in rainy season.



B.3.2 Temperature

The monthly temperature data at Cao Lanh, My Tho and Moc Hoa are summarized as below:

Summary of Temperature (°C)

Cao Lan (°C)													
	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Temperature	25.4	25.9	27.4	28.7	28.2	27.5	27.2	27.1	27.3	27.2	26.7	25.4	27.0
Max. Temperature	31.9	32.8	34.8	36.1	35.2	33.8	33.4	32.8	32.4	31.8	31.5	31.6	33.2
Min. Temperature	19.8	20.6	21.1	22.9	23.4	22.9	22.8	23.0	23.1	23.0	22.0	20.0	22.0
My Tho (°C)													
	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Temperature	25.3	25.7	27.1	28.6	28.4	27.5	27.0	26.8	26.7	26.5	26.0	25.2	26.7
Max. Temperature	31.9	32.5	34.3	35.6	35.1	33.9	33.2	32.9	32.9	32.4	32.0	31.7	33.2
Min. Temperature	19.5	20.1	21.4	23.3	23.3	22.7	22.5	22.5	22.7	22.7	20.5	20.0	21.8
Moc Hoa (°C)													
	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Anyual
Mean Temperature	25.9	26.2	27.3	28.7	28.4	27.6	27.3	27.3	27.6	27.6	27.1	26.1	27.3
Max. Temperature	33.1	34.3	35.8	37.1	36.1	35.0	34.3	33.5	33.1	32.5	32.5	32.6	34.2
Min. Temperature	16.9	20.3	20.9	23.3	23.0	22.8	23.4	23.0	22.7	23.4	21.5	20.7	21.8

The mean, maximum and minimum annual temperature was estimated as around 27 °C, 33 °C and 21 °C respectively. The temperature does not vary much throughout the year.

B.3.3 Other Parameters

(1) Relative Humidity

The monthly average relative humidity (%) in Study Area was estimated as shown below.

Summary of Relative Humidity (%)

Station	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Cao Lanh	82.2	80.8	77.6	77.8	83.8	86.3	86.5	86.5	86.3	85.8	81.9	80.8	83.0
My Tho	79.3	78.9	78.7	78.6	82.6	84.7	85.4	85.9	87.3	87.3	85.1	82.8	83.0
Moc Hoa	77.1	77.1	76.7	76.3	82.4	85.0	85.3	85.2	84.1	82.6	79.2	76.6	80.6

The mean annual relative humidity was estimated as 80 to 83%. The relative humidity seems not to vary much throughout a year.

(2) Sunshine

The monthly average of sunshine duration (hr/day) in the Study Area is shown below.

Summary of Sunshine (hr/day)

Station	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Cao Lanh	9.1	8.9	10.0	9.2	7.6	6.0	7.0	6.1	6.4	6.3	7.4	8.9	7.7
My Tho	9.3	9.1	10.4	9.6	7.5	6.6	7.0	6.3	6.2	6.2	7.0	8.2	7.8
Moc Hoa	9.2	8.7	9.8	8.9	7.5	6.3	7.1	6.2	6.6	7.2	7.8	8.9	7.8

The mean annual duration of sunshine was estimated as 7.8 hr/day. The mean monthly duration of sunshine is generally higher during the period from December to March than other months.

(3) Wind Velocity

The average monthly mean wind velocity (m/sec) in the Study Area is calculated as shown below.

Summary of Wind Velocity (m/s)

Station	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Cao Lanh	1.1	1.3	1.5	1.4	1.2	1.5	1.2	1.7	1.1	1.1	1.3	1.1	1.3
My Tho	2.1	2.9	2.5	2.0	1.6	2.0	1.8	2.3	1.6	1.3	1.3	1.2	1.9
Moc Hoa	1.5	1.6	1.8	1.6	1.5	1.9	1.7	2.0	1.6	1.5	1.6	1.6	1.7

The mean annual wind velocity was estimated as 1.3 to 1.9 m/sec. The wind velocity during the period from June to October is higher than that of other months.

(4) Evaporation

The annual mean monthly evaporation (mm/day) in the Study Area is shown below.

Summary of Evaporation (mm/day)

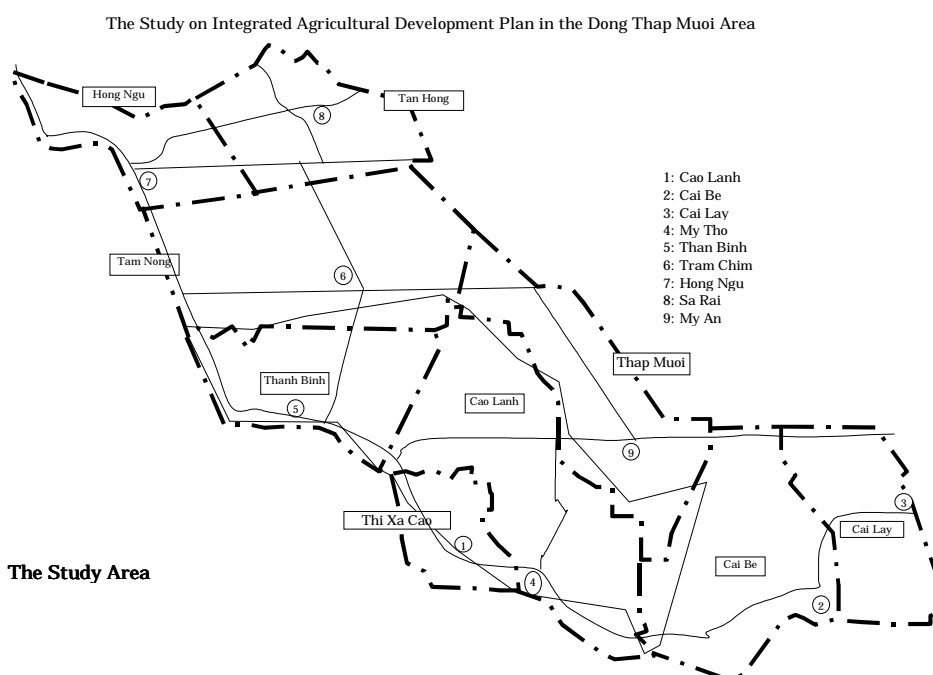
Station	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Cao Lanh	3.1	3.2	4.5	4.5	3.3	2.8	2.8	2.9	2.4	2.2	2.9	3.3	3.2
My Tho	3.7	3.9	4.6	4.8	3.0	4.1	3.0	3.0	2.5	2.1	2.4	3.0	3.3
Moc Hoa	3.5	3.5	4.2	4.1	3.0	2.8	2.9	3.2	2.8	2.8	3.0	3.3	3.3

The mean annual evaporation is estimated as 3.3 mm/day. The mean monthly evaporation is higher during the period from March to April than that of other months.

B.4 Hydrology

B.4.1 General

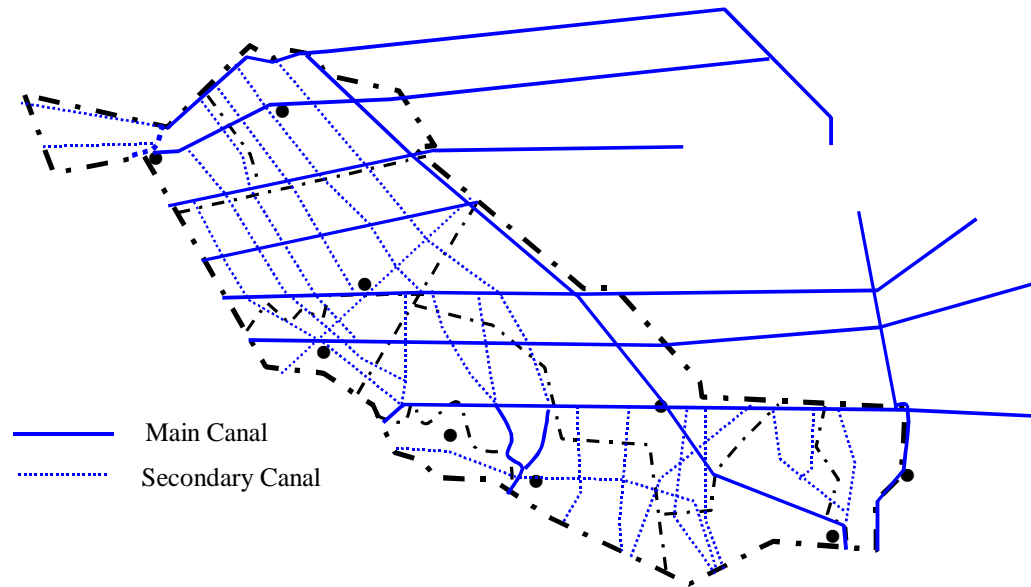
The Study Area is a land of 298,500 ha, surrounded by national border line with Cambodia at the northern part, the Tien River flowing in western and southern parts and several canals constructed in eastern part (Phasc Nuyen, Tong Doc Loc, Ba Rai canals). Parts of Dong Thap Province (6 districts and 1 town) and Tien Giang Province (2 districts) are included in the Study Area.



The altitude of the Study Area varies from 0.3 to 4.0 m a.s.l. and the land is gradually sloping down from North-West to South-East topographically. In general, river water from the Tien River is flowing from West to East or North to South through the several canals. However, depending on the river water level, direct runoff of rainfall in the area is drained to canals and flowing into the nearest river connecting point. The water levels in the canals are influenced by tidal wave of the South China Sea and vary approximately 3.0 m/day (at Southern part) to 0.6 m/day (at Northern part) in dry season. The influence of tidal wave is reduced in the rainy season by high river water flow.

The canal networks are established consisting of 11 main canals and 21 secondary canals in the Study Area. Most of those have been constructed from the middle of 1960s to 1980s and used as drainage canals as well as irrigation water sources. Total length of main canals is 695 km with 10 to 30 m width and that of secondary canal is 487 km with around 10 m width. These canals cover 476,800 ha of irrigation area and 667,500 ha of catchment area including those in the outside of the Study Area. Basically, the water from

the Tien river is flowing from West to East or North to South through the canal network. However, depending on the river water level, direct runoff from rainfall in the area is drained to canals and flowing into the nearest river connecting point.



Canal Net Work in The Study Area

Though there is enough water for irrigation even in dry season, it is necessary to pump up from main or secondary canals to tertiary canals. There is a few public pumping stations covering approximately 5 % of irrigation area and most of farmers are using the private pumps. Those pumps are operated based on the farmers' requests and farmers pay to pump owner under coordination of farmers' organization such as agricultural collectives. Those pumps are also used for drainage particularly at the end of inundation season (November) for land preparation of winter-spring crop. 550,000 to 750,000 VND per ha as pumping fee are paid by farmers for each crop. Most of the pumps have been used more then 20 years and their capacity is not enough especially when the canal water level is low. In the area with small dike system, it is necessary to cut dike for irrigation in dry season and to embank again for mitigation of inundation in rainy season.

B.4.2 Rainfall Analysis

(1) Correlation Coefficient of Monthly Rainfall among the Stations

The correlation coefficients of monthly rainfall were calculated for every two stations as shown below. Each station has a correlation coefficient of more than 75% with its neighboring stations.

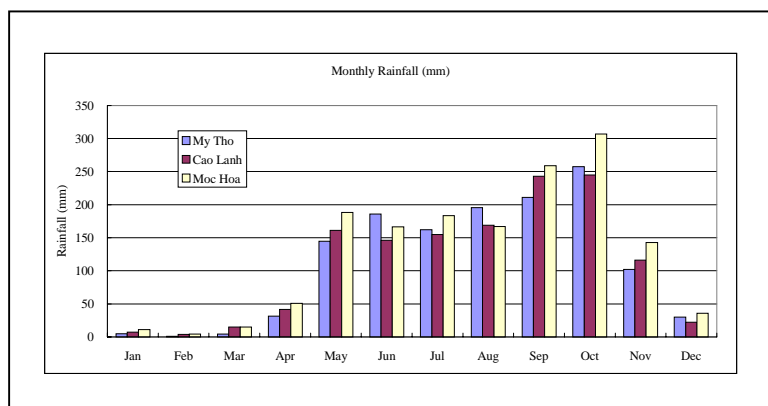
Correlation Coefficient of Monthly Rainfall among the Stations

	Cao Lanh	Hung Thanh	Hong Ngu	Tram Chim	My An	Tan Chau	Cai Lay	My Tho	Moc Hoa	My Thuan	Cho Moi
Cao Lanh		81.0%	83.2%	84.6%	90.9%	86.8%	87.3%	81.3%	93.0%	88.5%	90.4%
Hung Thanh			78.5%	90.7%	77.9%	85.9%	86.8%	75.6%	80.6%	82.0%	84.5%
Hong Ngu				93.6%	80.6%	80.2%	86.4%	76.4%	78.9%	80.2%	79.7%
Tram Chim					91.6%	91.1%	94.4%	88.9%	93.4%	90.0%	92.3%
My An						80.5%	85.8%	81.9%	94.1%	91.4%	89.7%
Tan Chau							87.1%	75.0%	85.3%	82.9%	82.9%
Cai Lay								75.3%	88.1%	89.0%	88.3%
My Tho									82.2%	79.0%	78.5%
Moc Hoa										94.3%	92.9%
My Thuan											94.1%
Cho Moi											

(2) Rainfall Pattern at Cao Lanh, My Tho and Moc Hoa

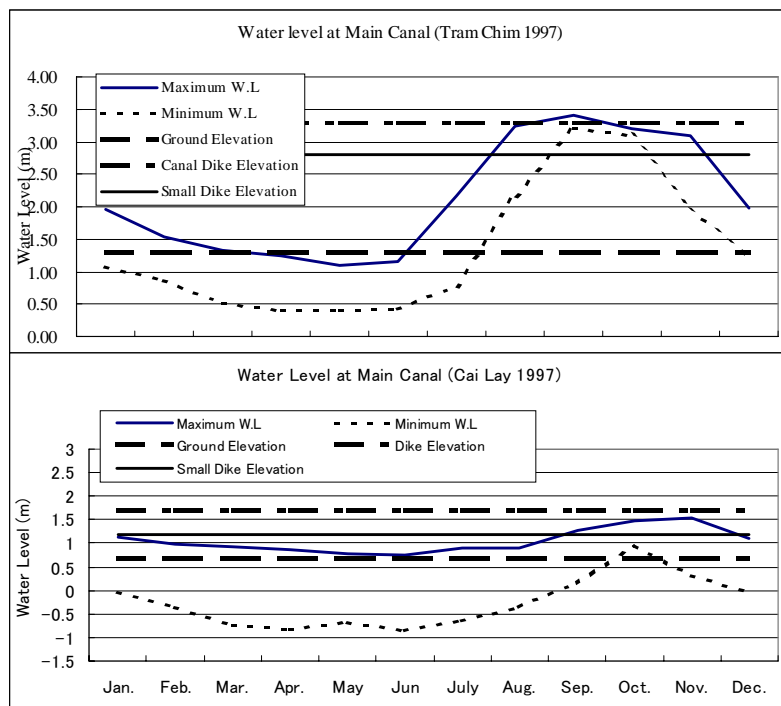
Considering the data availability and Locations, Cao Lanh, My Tho and Moc Hoa Stations were selected for the rainfall analysis for the Study area. Rainfall Pattern at these stations are shown below.

More than 90% of the annual rainfall is expected to occur during the period from May to November, and same amount of rainfall is expected at anywhere in the Study Area



B.4.3 Runoff Analysis

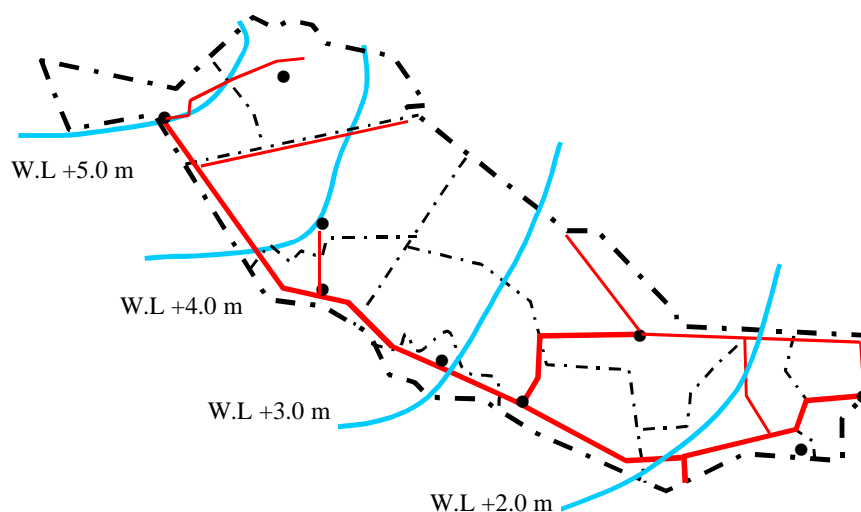
(1) Characteristics of Inundation



In the Study Area, there are three types of inundation occurring in rainy season (August to November). The one is caused by big amount of flood water from the Mekong River.

Usually in August, the inundation starts from northern part of the Study Area and, within around two weeks, this inundation covers all the Study Area for three to four months. The

water depth of inundation is approximately more than 4.0 m (Northern part) to 0.5 m (Southern part) and this is one of the biggest constrains for agricultural activities. The dikes with 1.0 m to 4.0 m height are installed along the most of main and secondary canals. In addition, small dike systems with 0.5 m to 3.0m height for 50 ha to 300 ha have been improved in around 60 % of the agricultural land since early 1980. The inundation can be mitigated by this small dike system in August for securing the harvest of summer-autumn paddy crop. Only around 5 % of small dike systems can prevent inundation throughout the year (the case in 1996 is exceptional). Since these dike systems do not have structures such as spillway and water gate, farmers are now doing pumping operation and cutting dike to drain the water inside of dike system. The maximum water level in 1996 is illustrated as shown below.

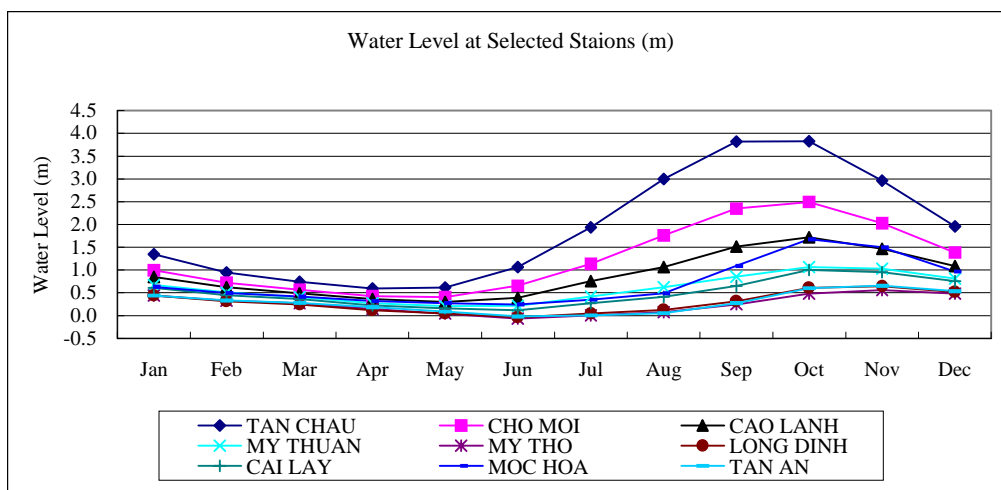


Maximum Water Level in 1996

The second type of inundation is caused by influence of tidal wave and occurs also in rainy season when river water is high. This occurs only at the Tien River side area in Southern part and continues around 10 days with 12 hours interval. The third type is caused by direct runoff of rainfall with high intensity and this occurs in the rainy season for a few hours with around 10 cm of water depth.

(2) Water Level at Selected Stations

Water level at 9 stations are summarized below and it shows that the deference of water level between dry season and rainy season is quite high at Northern part of the Study Area.



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Monthly maximum and minimum water level are summarized below;

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
TAN CHAU	Hmax	1.81	1.48	1.34	1.21	1.27	1.88	2.58	3.60	4.04	4.06	3.57	2.50	4.06
	Hmin	0.64	0.19	-0.10	-0.19	-0.15	0.15	1.18	2.21	3.48	3.44	2.31	1.27	-0.19
	D	1.17	1.29	1.44	1.40	1.42	1.73	1.40	1.39	0.55	0.62	1.25	1.23	4.25
CHO MOI	Hmax	1.58	1.39	1.27	1.16	1.16	1.44	1.76	2.28	2.64	2.73	2.46	1.90	2.73
	Hmin	0.17	-0.29	-0.55	-0.63	-0.60	-0.40	0.33	0.92	1.89	2.12	1.40	0.57	-0.63
	D	1.41	1.68	1.82	1.80	1.75	1.84	1.43	1.36	0.75	0.60	1.06	1.33	3.36
CAO LANH	Hmax	1.51	1.36	1.28	1.17	1.12	1.24	1.50	1.72	1.96	2.08	1.93	1.66	2.08
	Hmin	-0.19	-0.58	-0.82	-0.89	-0.90	-0.78	-0.32	0.11	0.77	1.14	0.67	0.17	-0.90
	D	1.71	1.94	2.10	2.06	2.01	2.02	1.81	1.61	1.19	0.94	1.26	1.50	2.98
MY THUAN	Hmax	1.41	1.31	1.27	1.18	1.11	1.12	1.27	1.46	1.59	1.70	1.65	1.52	1.70
	Hmin	-0.56	-0.88	-1.04	-1.08	-1.15	-1.11	-0.84	-0.56	-0.19	0.17	0.13	-0.30	-1.15
	D	1.98	2.19	2.31	2.26	2.25	2.23	2.11	2.01	1.77	1.53	1.52	1.82	2.84
MY THO	Hmax	1.49	1.49	1.44	1.36	1.19	1.14	1.18	1.31	1.48	1.62	1.57	1.50	1.62
	Hmin	-1.25	-1.39	-1.49	-1.47	-1.64	-1.79	-1.73	-1.58	-1.33	-1.02	-0.99	-1.17	-1.79
	D	2.74	2.87	2.93	2.84	2.83	2.93	2.91	2.89	2.81	2.64	2.56	2.67	3.41
LONG DINH	Hmax	1.10	1.05	1.02	0.94	0.84	0.83	0.90	0.96	1.09	1.22	1.21	1.15	1.22
	Hmin	-0.82	-1.08	-1.29	-1.33	-1.36	-1.55	-1.41	-1.28	-1.04	-0.48	-0.31	-0.58	-1.55
	D	1.92	2.13	2.31	2.27	2.20	2.38	2.31	2.23	2.13	1.70	1.52	1.73	2.77
CAI LAY	Hmax	0.98	0.91	0.88	0.77	0.75	0.74	0.80	0.87	1.07	1.28	1.19	1.08	1.28
	Hmin	-0.29	-0.69	-0.96	-1.12	-1.09	-1.15	-0.85	-0.65	-0.41	0.43	0.46	-0.01	-1.15
	D	1.27	1.60	1.84	1.89	1.84	1.89	1.65	1.52	1.47	0.86	0.74	1.09	2.44
MOC HOA	Hmax	0.87	0.82	0.80	0.72	0.70	0.73	0.74	0.90	1.52	1.87	1.74	1.23	1.87
	Hmin	0.13	-0.34	-0.55	-0.64	-0.71	-0.70	-0.46	-0.33	0.11	1.35	1.21	0.51	-0.71
	D	0.74	1.16	1.35	1.36	1.42	1.43	1.20	1.23	1.41	0.52	0.54	0.73	2.59
TAN AN	Hmax	1.19	1.14	1.12	1.07	0.98	0.96	0.97	1.02	1.18	1.32	1.31	1.25	1.32
	Hmin	-1.08	-1.28	-1.34	-1.33	-1.47	-1.74	-1.70	-1.64	-1.42	-0.77	-0.63	-0.92	-1.74
	D	2.27	2.43	2.46	2.39	2.46	2.70	2.67	2.66	2.60	2.09	1.94	2.17	3.07

D: Hmax-Hmin

(3) Probability Analysis

Based on the water level record at Tan Chaou, Cao lanh and Cai Lay stations water level was analyzed and the results are summarized as shown below;

Return period	Probability	Maximum Water Level (m)			Minimum Water Level (m)		
		Tan Chau	Cao Lanh	Cai Lay	Tan Chau	Cao Lanh	Cai Lay
1/2	50.00	4.09	2.08	1.23	-0.17	-0.86	-1.13
1/5	80.00	4.57	2.26	1.48	-0.29	-0.96	-1.27
1/10	90.00	4.89	2.38	1.65	-0.34	-1.01	-1.32
1/20	95.00	5.20	2.50	1.81	-0.38	-1.04	-1.36
1/25	96.00	5.29	2.54	1.86	-0.39	-1.05	-1.38
1/50	98.00	5.59	2.65	2.02	-0.42	-1.08	-1.41

B.4.4 Hydrological Measurement Campaign

To obtain the hydrological conditions especially the flow condition in the canal network in dry season, the hydrological measurement campaign was conducted during the Phase-2 Field Survey on April 2000. The measurement was conducted at the following sites: The locations of the measurement sites are shown in Fig. B.4.1.

In block No.4 (Dong Thap province):

- Binh Tan (Q1) station, on Binh Thanh 4 Canal, belong to Binh Tan village, Thanh Binh district, Dong Thap province , about 500m from An Phong - My Hoa canal.
- Gao Giong (Q2) station, on Gao Giong canal, belong to Gao Giong commune, Cao Lanh district, Dong Thap province ; 2000m from An Phong - My Hoa canal.
- Phuong Thinh (Q3) Station, on Giua canal, belong to Gao Giong commune, Thanh Binh district, Dong Thap province, 500m from An Phong - My Hoa Canal.

In block No.8 (in Tien Giang province):

- Kenh 7 (Q4) station : on Canal No7 , belong to Hau My Bac A commune, Cai Be district, Tien Giang province, about 500m from Nguyen van Tiep canal.
- Kenh 9 (Q5) Station : on Canal No9 belong to My Thanh Bac Commune, Cai Lay district, Tien Giang Province ; about 450m from Nguyen van Tiep canal.
- Kenh 10 (Q6) Station : on Canal No10, belong to My Thanh Bac Commune, Cai Lay district, Tien Giang Province ; 500m from Nguyen van Tiep canal.

Based on the cross- sections, water level and velocity measurement data, calculation was made on the flow discharge during the measurement duration from 16 - 23.April.2000. Some hydrological characteristics as followings:

No	Station	Hmax (cm)	Hmin (cm)	H Average (cm)	Qd (m ³ /s)	Direction of flow
1	Binh Tan (Q1)	96	22	66	0.027	The flow trend: To An Phong - My Hoa Canal
2	Gao Giong (Q2)	97	29	72	0.127	The flow trend: To An Phong - My Hoa Canal
3	Phuong Thinh (Q3)	81	18	60	0.063	The flow trend: To An Phong - My Hoa Canal
4	Canal N° 7 (Q4)	80	22	61	2.65	The flow trend: from Nguyen Van Tiep canal to N° 7 canal
5	Canal N° 9 (Q5)	74	19	55	0.018	The flow trend: from Nguyen Van Tiep canal to N° 9 canal
6	Canal N°10 (Q6)	81	30	62	0.67	The flow trend: from Nguyen Van Tiep canal to N° 10 Canal

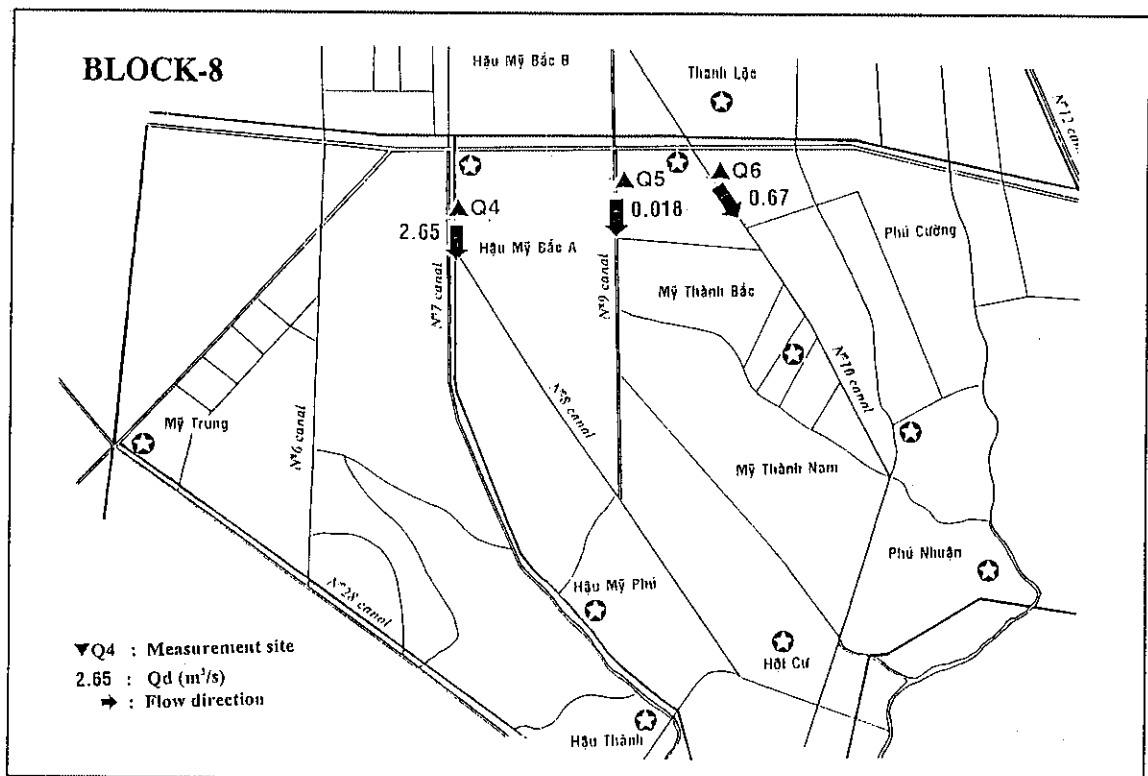
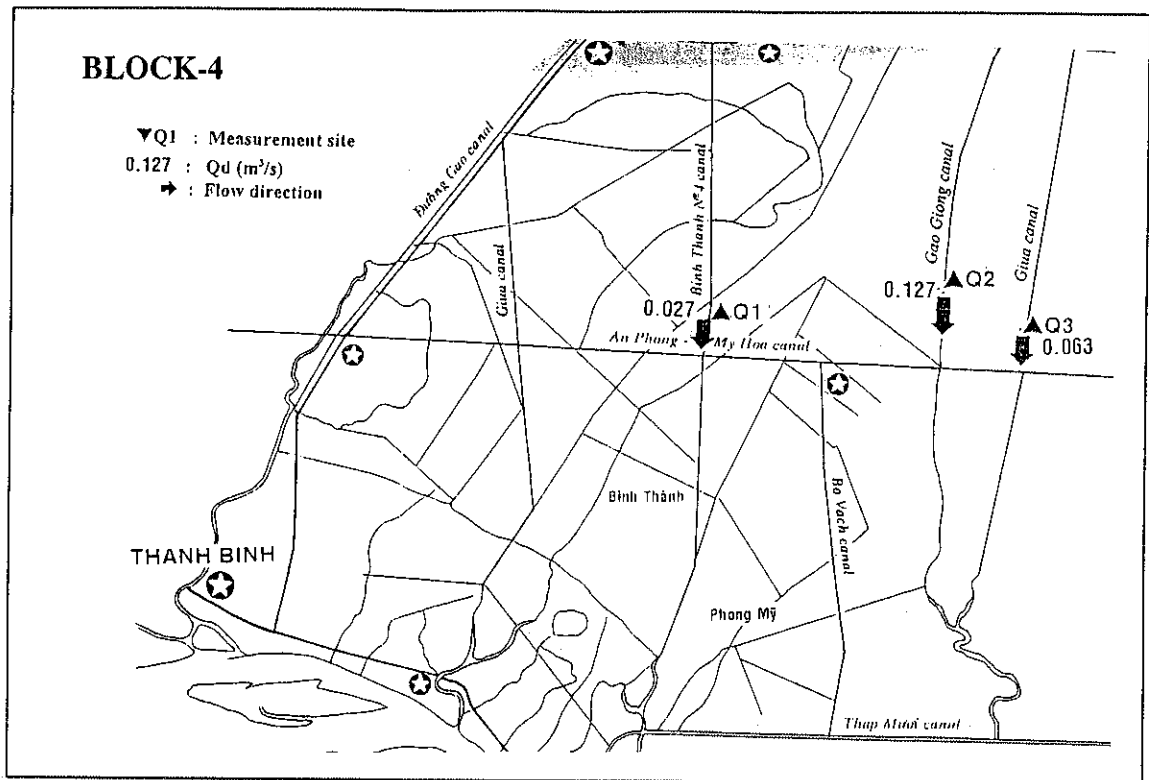


FIG. B.4.1 LOCATION OF MEASUREMENT CAMPAIGN POINT