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Japan International
Cooperation Agency
(JICA)

National Irrigation Administration
(NIA)

THE FEASIBILITY STUDY
ON
THE WESTERN LEGAZPI IRRIGATION AND RURAL DEVELOPMENT PROJECT
IN
THE REPUBLIC OF THE PHILIPPINES

Volume II

ANNEXES

DECEMBER 1996

Nippon Koei Co., Ltd.
Aero Asahi Corporation

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ANNEX A

METEOROLOGY, HYDROLOGY, AND WATER RESOURCE DEVELOPMENT

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ANNEX A

METEOROLOGY, HYDROLOGY, AND WATER RESOURCE DEVELOPMENT

ANNEX A
METEOROLOGY, HYDROLOGY, AND WATER RESOURCE DEVELOPMENT

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1. DATA COLLECTION

Rainfall and meteorological data were collected from Philippine Atmospheric Geophysical and Astronomical Service Administration (PAGASA). In addition, rainfall data were also collected from Philippine Coconut Authority. It has available data for the period of 1956 to 1983 in Guinobatan.

Streamflow data have been compiled by Natural Water Resources Council (NWRC) from 1946 to 1973. This function was transferred to the Bureau of Research and Standards (BRS), DPWH. Further, NIA has conducted the river discharge measurements in the Study Area by use of a current meter. The data collected are compiled.

2. METEOROLOGY

2.1 Coronas Climate Classification

The Northeast Monsoon prevails from October to March, bringing significant amount of rainfall to the southern Luzon where the study area is located. The Southwest Monsoon prevailing from May to October originates in the Indian Ocean and affects the area. During this period, the study area is warm and very humid with increasing rate of rainfall.

The Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) Utilizes the Coronas climate classification system in classifying the Philippine area into four (4) types (Ref. Fig. A.2.1).

The study area belongs to Type II climate which has no significant dry season with a very pronounced maximum rainfall under the influence of the Northeast Monsoon prevailing from November to January.

2.2 Meteorological Conditions in and around the Study Area

(1) Observation Stations

Meteorological observation stations in the vicinity of the Study area are shown in Figure A.2.2. The rainfall data and other meteorological data, such as temperature, relative humidity, wind speed have been observed at Legazpi and Buca, Guinobatan in Albay, and Pili, Camarines Sur stations maintained by PAGASA. The Buca meteorological station is located at the Bicol University, College of Agriculture and Forestry (BUCAF). Further, another Guinobatan rainfall station maintained by PCA and the Castilla rainfall station, Sorsogon are observed. The annual isohyet is given in Figure A.2.3.

(2) Rainfall

The annual rainfall in Albay Province varies from 2,500 mm on the western part to more than 3,000 mm on the eastern coastal area. The mean, minimum and maximum monthly rainfall in Legazpi and Guinobatan, located 6 km westward from Camalig, are presented below:

Mean Monthly Rainfall

Unit: mm

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Legazpi	307	181	183	157	175	239	259	262	266	329	478	483	3,319
Guinobatan	155	81	73	88	160	249	310	269	318	294	267	325	2,590
Buca	126	29	41	61	120	260	401	292	267	213	272	228	2,310
Pili	78	40	40	93	114	226	309	221	257	311	238	171	2,098

Source Legazpi, PAGASA (1949 - 1995)
Guinobatan, PCA (1956 - 1983)
Buca, PAGASA (1990 - 1995)
Pili, PAGASA (1976 - 1989)

On the mean monthly rainfall, the period from May to January is generally a rainy season and a large amount of rainfall occurs during the period from November to January. The relatively dry season appears from February to April, although over 150 mm rainfall is recorded in Legazpi. It can be noted that rainfall at Guinobatan in rainy season is less than that in Legazpi. The monthly rainfall data in Legazpi, Guinobatan, and Buca are shown in Tables A.2.1 to A.2.3.

The maximum and minimum annual rainfall are recorded at 4,262 mm in 1970 and 2,036 mm in 1968, respectively. The recorded maximum rainfall for the duration of 1-day is 484.8 mm at

Legazpi in November, 1967. 1-day maximum rainfall at Legazpi station is presented in Table A.2.4.

On the other hand, the Castilla rainfall gaging station, located east of the Study Area and faces Sorsogon Bay, has rainfall record of nearly consecutive 16 years. This rainfall data are shown in Table A.2.5 and outlined below.

Mean Monthly Rainfall in Castilla

Unit: mm

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Castilla	189	133	118	115	126	144	244	235	278	273	383	323	2,561

Source PAGASA (1956 - 1971)

(3) Temperature

Temperature have been observed at Legazpi, Buca, and Pili. The mean monthly temperature in Legazpi ranges from 25.5°C in January to 28.2°C in May. Mean annual temperature is 27.0°C with the average maximum temperature of 30.7°C and the average minimum temperature of 23.4°C.

The following are monthly temperature data observed at Legazpi, Buca and Pili stations.

Mean Monthly Temperature at Legazpi

Unit: °C

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Max	28.6	29.1	29.9	31.1	32.1	32.2	31.6	31.5	31.5	31.0	30.0	29.0	30.7
Mean	25.5	25.7	26.4	27.4	28.2	28.2	27.7	27.7	27.6	27.2	26.6	26.0	27.0
Min.	22.4	22.3	22.9	23.8	24.3	24.2	23.8	23.9	23.6	23.3	23.3	22.9	23.4

Source Legazpi PAGASA (1949 - 1995)

Mean Monthly Temperature at Buca

Unit: °C

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Max	29.6	30.2	31.1	32.5	32.8	32.1	31.1	31.2	31.2	30.6	30.2	29.4	31.0
Mean	25.2	25.5	25.8	27.0	27.6	28.0	27.0	27.2	27.1	26.5	26.3	25.6	26.6
Min.	20.9	20.7	20.5	21.6	22.5	23.8	23.0	23.2	23.0	22.6	22.5	21.8	22.2

Source Buca PAGASA (1990 - 1995)

Mean Monthly Temperature at Pili

Unit: °C

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Max	29.6	30.3	32.1	33.3	33.9	32.9	32.0	31.7	31.7	31.5	30.9	30.2	31.7
Mean	25.3	25.4	26.6	27.8	28.8	28.6	27.8	28.0	27.7	27.4	26.7	26.1	27.2
Min.	21.0	20.6	21.1	22.3	23.7	24.2	23.8	24.2	23.6	23.1	22.6	21.9	22.7

Source Pili PAGASA (1976 - 1989)

Tables A.2.6 to A.2.8 show mean, maximum, and minimum temperature data of Legazpi. The records at Buca station are tabulated in Tables A.2.9 to A.2.11.

(4) Relative Humidity

Relative humidity have been observed at Legazpi, Buca, and Pili as shown below. The relative humidity is generally high and fluctuates very slightly throughout the year. The Buca record indicates higher value than those at the other two stations.

Mean Monthly Relative Humidity

Unit: %

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Legazpi	84	83	82	82	82	83	84	84	85	85	85	86	84
Buca	90	88	84	83	85	89	91	91	91	87	88	88	88
Pili	77	76	71	69	71	75	80	78	81	81	81	79	77

Source Legazpi, PAGASA (1949 - 1995)
Buca, PAGASA (1990 - 1995)
Pili, PAGASA (1976 - 1989)

The monthly relative humidity at Legazpi and Buca stations are presented in Tables A.2.12 and A.2.13, respectively.

(5) Evaporation

Evaporation rates are observed at Buca, and Pili and summarized below. It should be noted that the daily evaporation rate at Buca station seems to be high. Monthly evaporation in Buca station is shown in Table 2.14 .

Mean Monthly Evaporation

Unit: mm/day

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Buca	9.1	10.5	11.7	12.4	10.3	10.2	8.6	10.1	9.8	9.1	9.6	8.7	3,649
Pill	4.2	4.9	6.0	6.5	6.9	5.4	4.9	4.8	4.3	4.1	3.6	3.9	1,805

Source Buca, PAGASA (1990 - 1995)
Pili, PAGASA (1976 - 1989)

(6) Wind Velocity and Direction

Wind speed were observed at Legazpi, Buca, and Pili. Wind is strong from November to April and weak from May to October. Average wind speed observed at Legazpi range from a minimum of 2.4 m/sec to a maximum of 3.6 m/sec as shown below. Monthly wind speed at Legazpi and Buca stations are tabulated in Tables A.2.15 and A.2.16, respectively.

Mean Monthly Wind Speed

Unit: m/sec

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Legazpi	3.6	3.4	3.3	3.1	2.8	2.7	2.8	3.0	2.5	2.4	3.0	3.3	3.0
Buca	1.6	1.9	1.4	1.3	1.0	1.1	0.6	0.6	1.0	1.1	1.3	1.2	1.2
Pili	5.2	6.0	5.7	5.0	5.2	5.2	5.0	5.6	4.6	4.6	5.4	6.4	5.3

Source Legazpi, PAGASA (1949 - 1995)
Buca, PAGASA (1990 - 1995)
Pili, PAGASA (1976 - 1989)

(7) Sunshine Duration

Cloudiness were observed at Legazpi station in oktas (0 to 8) and its mean annual value is 5.8. Monthly cloudiness data at Legazpi are shown in Table A.2.17 and summarized below.

Mean Monthly Cloudiness

Unit: Oktas

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Legazpi	5.8	5.5	5.1	4.9	5.1	5.8	6.3	6.4	6.3	6.0	6.0	5.9	5.8

Source Legazpi, PAGASA (1961 - 1993)

Mean daily sunshine hours were observed at Buca and Pili stations with both having an average of 5.8 hrs/day.

Daily Sunshine Hours

Unit: hrs/day

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Buca	5.7	6.5	6.2	8.6	7.5	6.8	4.3	4.6	4.2	4.3	5.3	5.4	5.8
Pili	5.8	5.5	5.1	4.9	5.1	5.8	6.3	6.4	6.3	6.0	6.0	5.9	5.8

Source Buca, PAGASA (1990 - 1995)
Pili, PAGASA (1976 - 1989)

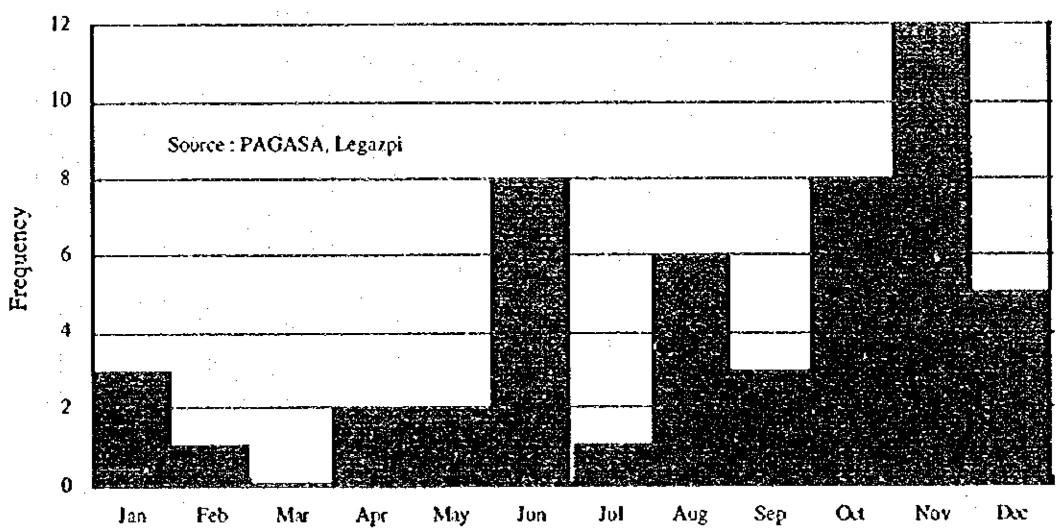
Monthly mean sunshine hours at Buca is given in Table A.2.18.

(8) Tropical Typhoon

Most of typhoons affecting the Philippines are formed in the Pacific Ocean between the Philippines and Carolines-Marianes Islands and move toward the west or northwest direction. They hit the study area any month of the year, especially from June to December.

The typhoon which move along the eastern end of the Luzon Island or cross the southern most end of the Luzon have caused heavy rain and extensive damage to lives, crops and properties. The frequency of typhoon having brought damages to the study area from 1970 to 1990 is illustrated below. The months of November, October and June show high frequency of typhoon in the study area.

Frequency of Typhoon Affecting the Study Area (1970 - 1990)



List of typhoons that affected Bicol is indicated in Table A.2.19.

2.3 Statistical Data Analysis

2.3.1 Monthly Rainfall in the Study Area

(1) Basic Approach

Since rainfall records are not available in the Study Area, the rainfall records are obliged to be estimated based on the near stations. Considering distance from the Study Area and observation period, monthly rainfall data are generated by use of the following formula;

$$RS = (RL + RG)/2$$

where;	RS:	Monthly rainfall in the Study area
	RL:	Monthly rainfall in Legazpi station
	RG:	Monthly rainfall in Guinobatan

(2) Correlation of Monthly Rainfall data

The observation records in Guinobatan rainfall station are from 1956 to 1983 while the Legazpi station has the rainfall record for the periods from 1949 to 1995. The correlation of two stations was attempted to interpolate the rainfall data in Guinobatan on monthly basis. Following are regression formula as well as the correlation coefficient for each month. The result shows that rainfall data observed at Guinobatan in have high coefficient with that of Legazpi in wet season. The correlation for each month is shown in Figure A.2.4.

Correlation of Monthly Rainfall Record between Legazpi and Guinobatan

Month	Regression Formula	Correlation Coefficient
January	Y = 0.52 X - 7.41	0.81
February	Y = 0.44 X - 3.97	0.65
March	Y = 0.47 X - 10.48	0.90
April	Y = 0.75 X - 29.97	0.86
May	Y = 0.92 X - 23.65	0.79
June	Y = 0.67 X + 92.57	0.62
July	Y = 0.57 X + 175.48	0.42
August	Y = 0.67 X + 82.82	0.67
September	Y = 0.76 X + 96.96	0.56
October	Y = 0.62 X + 77.01	0.50
November	Y = 0.38 X + 92.14	0.50
December	Y = 0.74 X - 49.93	0.90

Remarks: Y : Monthly Rainfall at Guinobatan Station
X : Monthly Rainfall at Legazpi Station

(3) Interpolated Monthly Rainfall Records of Guinobatan Station

Based on the formula described in (2), monthly rainfall record in Guinobatan were generated. The monthly records are shown in Table A.2.20 and summarized below.

Interpolated Monthly Rainfall Data in Guinobatan

Unit: mm

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	153.7	75.4	75.5	90.5	137.8	249.1	314.3	257.8	299.3	281.5	273.7	306.8	2,517.3

(4) Monthly Rainfall Record in the Study Area

According to the formula discussed in (1), monthly rainfall record in the Study Area is estimated. The result is shown in Table A.2.21 and summarized below.

Monthly Rainfall in Study Area

Unit: mm

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	230.3	128.1	129.1	123.9	156.2	244.1	285.6	260.0	282.4	305.2	375.6	395.0	2,917.9

2.3.2 Probable Annual Rainfall

The annual rainfall record at Legazpi station were plotted as shown in Figure A.2.5 . The figure indicates the annual rainfall distributes with a normal probability. Probable annual rainfall are estimated using the method at the stations of Legazpi, Guinobatan, and estimated Study Area rainfall.

Probable Rainfall

Unit: mm/year

Return Period	Observation Station					
	Legazpi		Guinobatan		Study Area	
	Exceedance	Non-exceedance	Exceedance	Non-exceedance	Exceedance	Non-exceedance
2	3,319	3,319	2,554	2,554	2,917	2,917
3	3,555	3,085	2,762	2,346	3,104	2,731
5	3,779	2,861	2,961	2,147	3,282	2,554
8	3,947	2,693	3,111	1,998	3,416	2,420
10	4,018	2,622	3,174	1,934	3,473	2,363
15	4,138	2,502	3,280	1,828	3,568	2,268
20	4,216	2,424	3,350	1,758	3,630	2,206
25	4,274	2,366	3,401	1,707	3,676	2,160
30	4,319	2,320	3,442	1,667	3,712	2,124
40	4,388	2,252	3,502	1,606	3,766	2,069
50	4,439	2,201	3,548	1,561	3,807	2,029
100	4,588	2,052	3,680	1,429	3,925	1,911
150	4,668	1,971	3,751	1,357	3,989	1,846
200	4,724	1,916	3,800	1,308	4,033	1,803
Max annual rainfall	4,262		3,554		3,843	
Min. annual rainfall	2,037		1,660		2,084	
Observation period	1949-1994		1956-1982		1949-1994	
Number of observation years	44		24		46	

2.3.3 Evapotranspiration

Potential evapotranspiration is estimated by Penman method using the data of temperature, relative humidity, wind speed, and sunshine duration. Considering the location of the Study Area and data quality, the data at Buca station were adopted as parameters for estimation of the potential evapotranspiration except the relative humidity. As for the relative humidity, the data at Legazpi station ware used because those at Buca station seems to be relatively high.

Mean Monthly Temperature

Unit: °C

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Buca	25.2	25.5	25.8	27.0	27.6	28.0	27.0	27.2	27.1	26.5	26.3	25.6	26.6

Source Buca PAGASA (1990 - 1995)

Mean Monthly Relative Humidity

Unit: %

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Legazpi	84	83	82	82	82	83	84	84	85	85	85	86	84

Source Legazpi, PAGASA (1949 - 1995)

Mean Monthly Wind Speed

Unit: m/sec

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Buca	1.6	1.9	1.4	1.3	1.0	1.1	0.6	0.6	1.0	1.1	1.3	1.2	1.2

Source Buca, PAGASA (1990 - 1995)

Daily Sunshine Hours

Unit: hrs/day

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Buca	5.7	6.5	6.2	8.6	7.5	6.8	4.3	4.6	4.2	4.3	5.3	5.4	5.8

Source Buca, PAGASA (1990 - 1995)

By use of the above data, the potential evapotranspiration was calculated. The result is shown below.

Potential Evapotranspiration

Unit: mm/day

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
	3.5	4.1	4.4	5.5	5.1	4.8	3.8	4.0	3.8	3.6	3.5	3.2

3. HYDROLOGY

3.1 River System

(1) General

As per zoning by the National Water Resources Board (NWRB), Region V is divided into two major river basins. One is the Bicol River Basin, which covers Camarines Norte, Camarines Sur, Catanduanes, and western part of Albay Provinces, and another is the Albay and Sorsogon River Basin, which includes eastern part of Albay and Sorsogon Provinces. The Study Area also covers two river basins. Northern part of the Study Area belongs to the upstream area of the Bicol River Basin, bordered by administrative boundary Daraga and Camalig in east, and by the Kikuinan Mountain Range, Camalig Centro in south. The remaining Study Area belongs to the Albay Sorsogon River Basin. The location of hydrological stations near the Study Area is given in Figure A.3.1. Further, the river system in the Study Area is shown in Figure A.1.1.

(2) Bicol River Basin

The Ligban River, is the major stream in the Study Area. The river consists of two tributaries. One named Iraya River rises at southern slope of the Mayon Volcano, where the altitude is approximately 300 m, and follows a southerly course joining another tributary named Tinago River near a bridge on the National Road (Daan Maharlika) at Camalig. The Tinago River has some tributaries which rise both at the Mayon Volcano side and the Kikuinan Mountain Range. The Ligban River flows southward until it reaches the Barangay Tagaytay. The river flows then, northwestward and joins some tributaries. It flows into the Quinali River, that flows into the Lake Bato.

Although no gaging station available within the Study Area, there are two stations near it. They are Nasisi Station, Ligao in the Nasisi River, and Benanuan Station in the Ugsong River both in Ligao, which have drainage area of 39 km^2, and 11 km^2, respectively. Monthly runoff at Nasisi and Ugsong Rivers are given in Tables A.3.1 and A.3.2.

<u>Mean Monthly Runoff</u>

Unit: m^3/sec

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Nasisi River	2.64	1.96	1.87	1.76	1.70	1.72	1.53	1.68	1.73	1.98	2.73	3.10	2.03
Ugsong River	1.13	0.93	0.81	0.82	0.97	1.23	1.07	1.08	1.33	1.77	1.74	1.46	1.19

Source Philippine Water Resources Summary Data, NWRB & BRS
Nasisi (1952 - 1978)
Ugsong (1956 - 1986)

Further, NIA conducted the discharge measurements in 1988 at the Ligban River, where its drainage area is 13 km^2. The measurements were carried out once a month for one year. The records are shown below and the mean annual runoff is at 1.01 m^3/sec.

<u>Discharge Measurement in Ligban River</u>

Unit: m^3/sec

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Ligban River	1.47	1.16	0.75	0.99	0.91	0.58	0.72	0.79	0.88	1.01	1.45	1.42	1.01

Source NIA PIO, Ligao, Albay (1988)

(3) Albay Sorsogon River Basin

The Study Area in the Albay - Sorsogon River Basin is categorized into four river basins. They are the Yawa River, the Donsol River, the Ogod River, and Kapantaran River. The Yawa River flows southward until it reaches the alluvial plain, follows a easterly course, and discharges into the Tobacco Bay. The Donsol River and the Ogod River flow southward into the Burias Pass in Sorsogon Province.

The Donsol River has two major tributaries in the Study Area, such as the Taladong River and the Jovellar River. The Taladong River rises in Barangay Taladong where the altitude is approximately 300 m and follows a southwesterly course and joins the Abgao River at Barangay Comun. On the other hand, the Jovellar River rises in Barangay Namantao, where the altitude is approximately 70 m, and flows westwards. Joining two tributaries near Jovellar, the flow is named the Donsol River. The river flows southward, and discharge into the Burias Pass near Donsol.

The Ogod River drains in the southern part of the study area. The river rises in Barangay Anislag, where the altitude is approximately 90 m, and follows westerly course. Then, the river flows southward and discharges into the Burias Pass near Ogod.

The Kapantaran River rises in hilly area, where is located in the south of the Legazpi City and its altitude is approximately 260 m. The river drains in east part of the Study Area and follows a southerly course along the Daraga - Sorsogon National Road until it flows into the Tobacco Bay.

Although no gauging station is yet installed within the study area, following four stream flow data are available near the Study Area:

List of Gauging Station in Sorsogon

Name of River	Location		Drainage Area
	Barangay	Municipality	(km^2)
Cumadcad River	Cumadcad	Castilla	13
Malbog River	Cumadcad	Castilla	8
Pili River	San Isidro	Castilla	18
Cawayan River	Basud	Sorsogon	15

Source: Philippine Water Resources Summary Data, NWRB & BRS

Those rivers rise in the hilly area in Sorsogon Province and flows southwards until they discharge into the Sorsogon bay. The mean monthly runoff are as follows:

Mean Monthly Runoff in Sorsogon

Unit: m^3/sec

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Cumadcad River	1.43	1.02	0.57	0.33	0.34	0.47	0.90	0.76	1.07	1.35	1.74	1.77	0.98
Malbog River	0.98	0.38	0.31	0.15	0.14	0.21	0.47	0.46	0.64	0.76	1.37	1.09	0.58
Pili River	2.41	1.15	0.97	0.32	0.25	0.18	0.30	0.40	0.52	0.78	2.08	2.80	1.01
Cawayan River	2.59	1.79	1.41	0.86	0.74	0.69	0.99	0.63	0.69	1.02	2.20	2.80	1.37

Source Philippine Water Resources Summary Data, NWRB & BRS
Cumadcad (1957 - 1989)
Malbog (1955 - 1968)
Pili (1953 - 1972)
Cawayan (1954 - 1982)

The Monthly discharge records of the above stations are tabulated in Tables A.3.3 to A.3.6.

3.2 The Study Area

(1) General

Throughout the field investigations, six water resource sites were identified. The locations of them are illustrated in Figure A.1.1. The hydrological descriptions of each site are shown in proceeding sections.

(2) Camalig Diversion Dam Site

The identified Camalig Diversion Dam site is located at the Tinago River, approximately 50 m upstream from confluence with the Iraya River. The drainage area is 8 km^2. The river has three tributaries upstream. Two of them rise from springs near the Daraga - Camalig National Road. The other rises from the Kikuinan Mountain Range and gathers water from some springs. The spring water contributes to the rather steady flow of Tinago River. Some 0.4 m^3/sec of discharge is recorded by the JICA Study Team in November, 1995. The drainage area is consisted of coconut land, grass land, build-up area, and paddy field. Along the river, considerable sediment is observed.

(3) No.1 Dam Site

The No.1 Dam site is located in Barangay Taladong. The water source is Taladong Creek. It is also called Quibaris Creek in local name The Taladong River, tributary of Donsol River, rises in Barangay Taladong and follows a southwesterly course and joins the Abgao River at Barangay Comun. The drainage area is 2.3 km^2. It is covered with coconut land. Since because there of the existence of some spring upstream of the site, small amount of flows are observed even during dry season. The JICA Study Team estimated the base flow at about 60 lit/sec based on the discharge measurement.

(4) No.2 Dam Site

The Abgao River is the water resource of the No.2 Dam site, located in Barangay Inarado. The river rises at hilly area where the altitude is approximately 300 m and follows a southwesterly course and joins the Taladong River at Barangay Comun. The surface of the drainage area is mostly coconut land. The drainage area is 1.8 km^2. Some springs are found upstream of the site. The base flow observed is estimated at 20 lit/sec by the JICA Study Team.

(5) No.3 Dam Site

The No.3 Dam is located at Barangay Gabowan. Its water resource in the Subok River, a tributary of the Kapantaran River. The river rises from the hilly area with an altitude of about 260 m. It flows westerly course for about 2.0 km and then take a southward course along the Daraga - Sorsogon National Road. The drainage area is 1.1 km^2. Base flow caused by upstream spring is estimated at some 30 lit/sec based on the JICA Study Team's observation. The drainage area is mainly coconut land and some rainfed paddy fields at and near the dam site.

(6) No.4 Dam Site

The No.4 Dam site is located at Barangay Bascaran about 2.5 km downstream of No.3 Dam Site. The drainage area is about 4.9 km^2 and is mainly coconut land. The JICA Study Team estimates the base flow at about 100 lit/sec based on the discharge measurement. It flows southward for about 4 km and then, it flows a westward to join the Kapantaran River.

(7) No.5 Dam Site

The No.5 Dam site is located at Barangay San Ramon. The water resource is the Ogod River. The river is also called Cagnanaga Creek in local name. The river rises in Barangay Anislag at the altitude of about 90 m and flows southwesterly. The drainage area is 8.0 km^2 and mainly coconut land. Although some 170 lit/sec discharge was observed on October, 1995 by the JICA Study Team during the dry season flows are considered very little because of limited base flow due to the geological condition.

3.3 Surface Runoff

3.3.1 Runoff in the Camalig Diversion Dam

(1) Basic Approach

Although NIA have conducted discharge measurement at Ligban River in 1988, about a km downstream of the proposed site, those data are insufficient to analyze the hydrological characteristics of the Ligban River Accordingly, JICA Study Team attempted to apply the rainfall - runoff relationship to the Ligban River with the data obtained from the adjacent rainfall and streamflow stations.

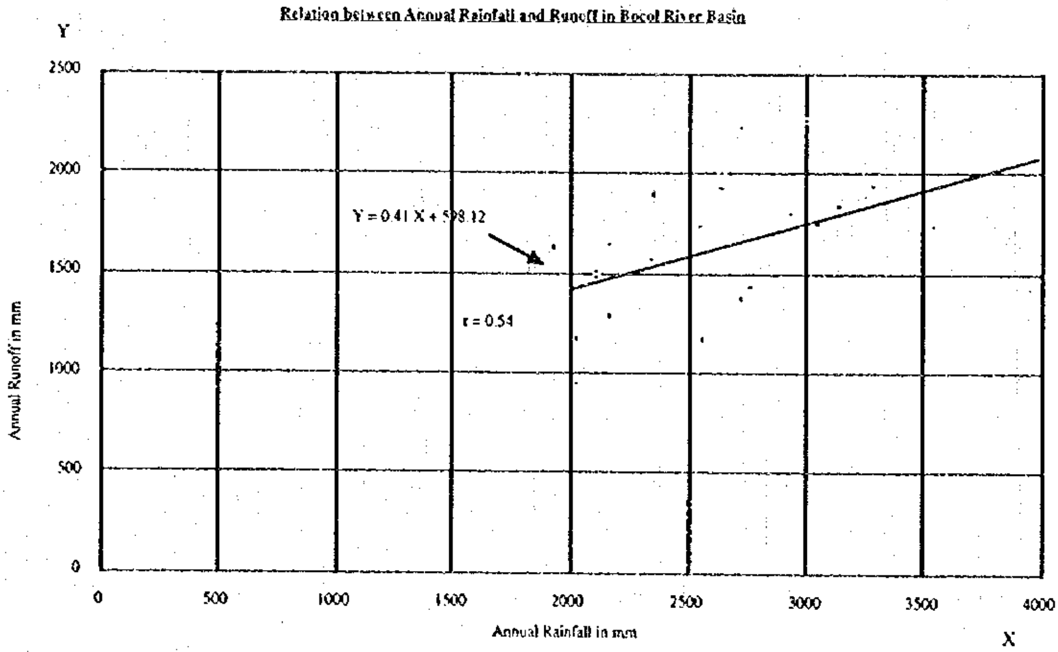
(2) Selection of Stations for Analysis

Two stream flow gauging stations, located in Nasisi River, and Ugsong River are selected because these areas appear to have similar characteristics with the Camalig diversion dam site in terms of drainage area size and vegetation. On the other hand, the Guinobatan rainfall gauging station, located in the west of the Study Area, has rainfall record of nearly consecutive 27 years and can be considered to represent the catchment rainfall in two stream flow gauging stations. Data in the stations described above are used to the analysis.

(3) Rainfall - Runoff Relationship

Based on annual rainfall data in Guinobatan, and stream flow data in two gauging stations, the relationship between rainfall and runoff is analyzed. First, years with available both the annual rainfall data and annual runoff data available are selected in each gauging station. Secondly, annual discharge data are converted to the depth in mm based on each drainage area. Finally, those data are plotted in the X - Y Plot graph, that indicates the annual rainfall depth in X axis, and the annual runoff depth in Y axis, respectively.

Relation between Annual Rainfall and Runoff in Bocol River Basin



The above graph indicates that the annual rainfall and the annual runoff are correlative with the coefficient of 0.54. The relationship can be expressed as follows:

Annual runoff (mm) = 0.41x Annual Rainfall (mm) - 598.12

(4) Generation of Annual Runoff at the Camalig Diversion Dam Site

As for generating the annual runoff for the Camalig diversion dam site, the estimated monthly rainfall records in the Study Area are used. Then, the formula mentioned in section (3) is applied to estimate the runoff in depth and then converted to runoff in cubic meters by multiplying the drainage area. The following table summarizes mean monthly runoff at the Camalig diversion dam site (see Table A.3.7):

Mean Monthly Runoff at Camalig Diversion Dam Site

Unit: 1000 m^3

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Camalig diversion dam	1,131	625	629	610	765	1,211	1,420	1,292	1,405	1,509	1,851	1,928	14,356

3.3.2 Runoff in the Small Water Impounding Ponds

(1) Basic Approach

As for the southern part of the Study Area, where the small water impounding pond sites were identified, there has been no record of discharge. Accordingly, runoff in the proposed dam sites are estimated by generating the relationship between rainfall and runoff records near the sites.

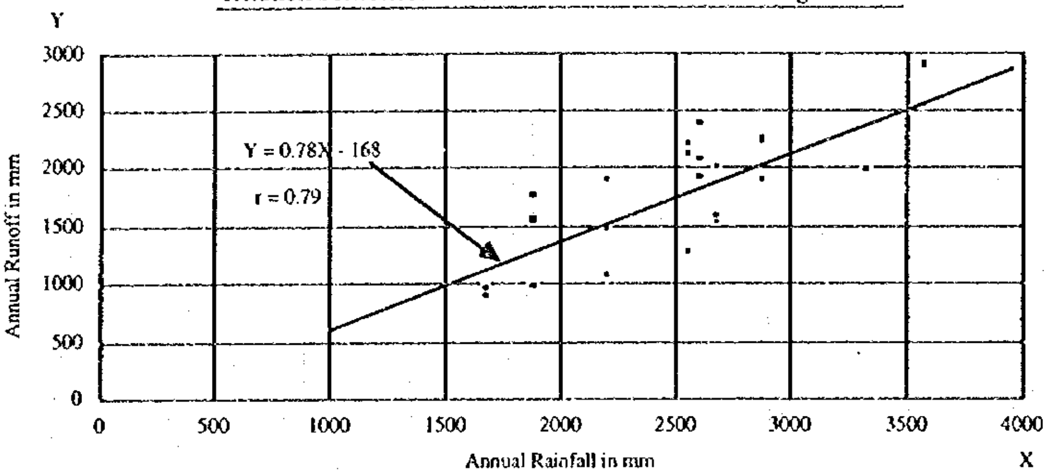
(2) Selection of Stations for Analysis

Three stream flow gauging stations, located in Cumadcad River, Malbog River, and Pili River in Castilla, Sorsogon, are selected because these areas appear to have similar characteristics with the identified sites in terms of drainage area size and vegetation. On the other hand, the Castilla rainfall gauging station, located in the east of the Study Area and faces the Sorsogon Bay, has rainfall record of nearly consecutive 16 years and can be considered to represent catchment rainfall in three stream flow gauging stations. Data in the stations described above are used to the analysis.

(3) Rainfall - Runoff Relationship

Based on annual rainfall data in Castilla, and stream flow data in three gauging stations, the relationship between rainfall and runoff is analyzed. First, years with available both annual rainfall data and the annual runoff data are selected in each gauging station. Secondly, annual discharge data are converted to depth in mm based on each drainage area. Finally, those data are plotted in the X - Y Plot graph, that indicating the annual rainfall depth in X axis, and the annual runoff depth in Y axis, respectively.

Relation between Annual Rainfall and Runoff in Sorsogon



The above graph indicates that the annual rainfall and the annual runoff are correlative with the coefficient of 0.79. The relationship can be expressed as follows:

Annual runoff (mm) = 0.78 x Annual Rainfall (mm) - 168

(4) Generation of Annual Runoff at Each Site

As for generating the annual runoff for each dam site, the estimated monthly rainfall records in the Study Area are used. Then, the formula mentioned in section (3) is applied to estimate the runoff in depth and then converted to runoff in cubic meters by multiplying the drainage area. The following table summarizes mean monthly runoff at each dam site (see Tables A.3.8 to A.3.12).

Mean Monthly Runoff at Each Dam Site

Unit: 1,000 m^3

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
No.1 Dam	383	213	215	206	260	405	473	431	468	506	624	657	4,848
No.2 Dam	300	167	168	161	203	317	371	337	366	396	488	515	3,794
No.3 Dam	183	102	103	98	124	194	226	206	224	242	298	314	2,319
No.4 Dam	632	352	355	340	429	669	782	712	773	837	1,031	1,086	8,010
No.5 Dam	1,331	742	748	716	904	1,408	1,647	1,499	1,627	1,762	2,170	2,287	16,863

3.4 Flood Analysis

3.4.1 Procedure of Analysis

The purpose of the flood analysis is to determine the design flood discharge for the design of various structures such as spillway, diversion tunnel, etc. Because of no enough flood records which can be used for the estimate of flood discharge on longer return periods, synthetic unit hydrograph method is employed to estimate the probable flood discharge and pattern of the flood in various return periods in this study.

3.4.2 Design Rainfall

(1) Probable Rainfall Intensity

Probable rainfall intensity duration frequency curves were calculated based on the probable rainfall at Legazpi station analyzed by the Hydrology and Flood Forecast Center, PAGASA.

Rainfall Intensity Curve (Legazpi, Less than 60 minutes)

Return Period	Duration 5 (min)	10 (min)	15 (min)	20 (min)	30 (min)	45 (min)	60 (min)	Intensity Curve (mm/hr)
2	176.4	129.6	109.2	95.1	78.4	62.7	52.4	$I=716/(t^{0.608}+1.423)$
5	270.0	186.0	157.2	136.8	113.2	90.8	76.6	$I=551/(t^{0.480}-0.116)$
10	331.2	223.8	188.4	164.4	136.2	109.5	92.7	$I=514/(t^{0.430}-0.438)$
15	366.0	244.8	206.4	180.0	149.2	120.0	101.8	$I=505/(t^{0.409}-0.547)$
20	391.2	259.8	218.8	191.1	158.2	127.5	108.1	$I=489/(t^{0.392}-0.624)$
25	409.2	271.2	228.4	199.5	165.2	133.1	113.0	$I=506/(t^{0.391}-0.633)$
50	466.8	306.0	258.0	225.3	186.8	150.7	128.0	$I=529/(t^{0.382}-0.719)$
100	524.4	341.4	287.6	251.1	208.2	168.0	143.0	$I=575/(t^{0.385}-0.782)$

Source: The Hydrology and Flood Forecast Center, PAGASA

Rainfall Intensity Curve (Legazpi, More than 60 minutes)

Return Period	Duration 60 (min)	80 (min)	100 (min)	120 (min)	150 (min)	3 (hrs)	6 (hrs)	12 (hrs)	24 (hrs)	Intensity Curve (mm/hr)
2	52.4	45.5	40.4	36.8	32.3	29.2	19.2	11.7	6.8	$I=94/(t^{0.818}+0.822)$
5	76.6	67.5	60.6	55.3	48.8	44.4	31.1	19	10.6	$I=140/(t^{0.765}+0.855)$
10	92.7	82.1	74.0	67.6	59.6	54.5	38.9	23.8	13.2	$I=178/(t^{0.774}+0.942)$
15	101.8	90.4	81.5	74.5	65.8	60.2	43.4	26.5	14.6	$I=201/(t^{0.773}+0.998)$
20	108.1	96.1	86.8	79.3	70.1	64.2	46.5	28.4	15.6	$I=213/(t^{0.767}+0.982)$
25	113.0	100.6	90.8	83.1	73.1	67.3	48.8	29.9	16.4	$I=222/(t^{0.767}+0.982)$
50	128.0	114.2	103.4	94.6	83.6	76.7	56.2	34.4	18.7	$I=253/(t^{0.758}+0.985)$
100	143.0	127.9	115.9	106.0	93.8	86.1	63.5	38.8	21.1	$I=284/(t^{0.755}+0.999)$

Source: The Hydrology and Flood Forecast Center, PAGASA

The point rainfall at each dam site is assumed to be the same with that at Legazpi station considering the size of drainage area.

(2) Design Storm Pattern

To estimate the design rainfall pattern in the Study Area, the probable hyetgraph is produced from the probable rainfall depth - duration - frequency curve at Legazpi constructed in the previous section. To produce a hyetgraph, the following assumptions are set up;

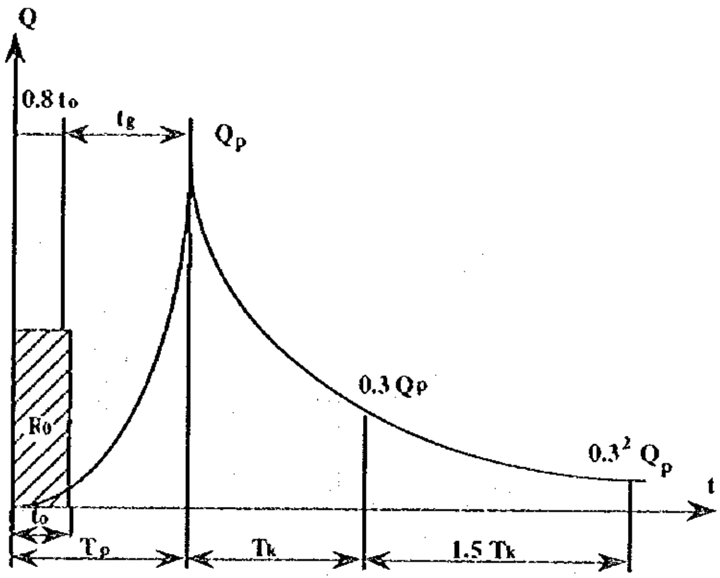
- the rainfall duration is 24 hours.
- the runoff coefficient in the flood time is 0.8.
- Peak hourly rainfall occurs at 12 hours after rain starts.

The probable hyetgraph for each return period are shown in Figure A.3.2.

3.4.3 Unit Hydrograph

Because of insufficient hourly rainfall data corresponding with flood records, construction of the unit hydrograph from actual rainfall-runoff relationship is impossible. Therefore, the synthetic unit hydrograph method developed by Nakayasu is applied. It is broadly used in Japan. This method can be applied to rivers in the Study Area which have similar characteristics in terms of gradient and vegetations.

The Nakayasu's unit hydrograph is described as follows:



(a) Flood peak

$$Qp = \frac{AR}{3.6} \cdot \frac{1}{(0.3\,Tp + Tk)}$$

(b) Rising curve ($0 \leq t \leq Tp$)

$$Q/Qp = (T/Tp)^{2.4}$$

(c) Recession curve

i) $0.3 \leq Q/Qp \leq 1$
$Q/Qp = 0.3^{(T-Tp)/Tk}$

ii) $0.09 \leq Q/Qp \leq 0.3$
$Q/Qp = 0.3 \times 0.3^{(T-Tp-Tk)/1.5\,Tk}$

iii) $Q/Qp < 0.09$
$Q/Qp = 0.3^2 \times 0.3^{(T-Tp+2.5\,Tk)/2.0\,Tk}$

where,
- Q : Discharge of unit hydrograph at time T (m^3/sec)
- Qp : Peak discharge (m^3/sec)
- A : Catchment area (km^2)
- Ro : Unit rainfall in unit time (mm)
- Tp : Rising time from beginning to peak (hour)
- Tk : Recession time from peak to 0.3 Qp (hour)

Tp and Tk are determined using the following empirical equations developed by Nakayasu.

$$Tp = Tg + 0.8\,To$$
$$Tk = 0.47 \cdot (A \cdot L)^{0.25}$$
$$Tg = 0.4 + 0.058 \cdot L \quad \text{(if } L > 15 \text{ km)}$$
$$Tg = 0.21 \cdot L^{0.7} \quad \text{(if } L \leq 15 \text{ km)}$$

where,
- Tg : Basin lag time (hour)
- To : Duration of unit rainfall (hour)
- L : Length of river course (km)

Figures A.3.3 shows the unit hydrograph of each dam site for a storm with duration of 0.5 hour and intensity of 10 mm/hour.

3.4.4 Probable Flood

(1) Probable Flood for Camalig Diversion Dam

Probable floods with various return periods and probable maximum flood for the Camalig diversion dam are estimated using unit hydrograph method. The result is shown in Figure A.3.4 and peak flood discharges are summarized as follows:

Probable Peak Flood at Camalig Diversion Dam

Unit: m^3/sec

Return Period (Year)	2	5	10	25	50	100
Probable Peak Flood	32	48	59	72	82	93

(2) Probable Flood for the Impounding Ponds

Probable floods with various return periods and probable maximum flood for the impounding ponds are estimated using unit hydrograph method as shown in Figures A.3.5 to A.3.9 .

Probable Peak Flood at the Dam No.1 to No. 5

Unit: m^3/sec

	Return Period (Year)					
	2	5	10	25	50	100
Dam No.1	9	13	16	20	23	26
Dam No.2	7	11	14	17	19	21
Dam No.3	5	7	9	11	12	13
Dam No.4	19	29	35	43	49	56
Dam No.5	31	47	58	71	81	91

(3) Examination of Result

Figure A.3.10 illustrates the 100 years probable flood discharge in Region V as well as the estimated flood discharge in the study. The calculated value are expected to be within a reasonable range.

3.5 Sedimentation Yield

3.5.1 Previous Study

Sediment load is one of the major factors to define the reservoir dimension, such as dead storage capacity. In order to examine the sediment load, information provided by NIA is given below for specific annual sediment yield for rivers in Luzon.

Specific Annual Sediment Yield in Luzon

	Drainage Area (km^2)	Yield ($m^3/year/km^2$)	Record
Ibulao R., Hapid	606	292	1972-73
Siffu R., Munoz	686	292	1965-70
Chico R., Pasonglao	1,987	580	1963-70
Bokod R., Bokod	48	274	1963-69
Anbayoan R., Sta. Maria	281	379	1963-71
Agno R., Carmen Rosales	2,209	38	1964-71
Camaling R., Nambalan	142	131	1963-69
Pila R., Pacalay	126	31	1963-71
Purac R., Valdez	118	669	1963-71
Santor R., Cuyago	89	15	1965-72
Cabu R., Cabu	143	798	1963-72
Pampanga R., San Antonio	2,851	798	1963-72
Pampanga R., San Vicente	3,467	441	1963-72
Rio Chico R., Sto. Rosario	1,177	167	1963-72
Pampanga R., San Agustin	6,487	317	1963-71
Quinali R., Busac	233	442	1954-78

Source: NIA

As seen in the above table, the sediment load of the Quinali River in the Bicol River Basin is estimated at 442 $m^3/year/km^2$, that was analyzed by the Master Plan for Mayon Volcano Sabo and Flood Control Project, in 1981 and 1983, JICA.

On the other hand, in connection with small water impounding management (SWIM) projects, DPWH adopted empirical formula for sedimentation volume estimation expressed below:

Sediment Volume (m^3) = 20,900 (DA) $^{0.687}$ per 25 years

Where: DA = drainage area (km^2)
0.687 is an exponential constant

3.5.2 Data Analysis

For the estimate of sediment transport at proposed dam sites, sediment load is divided into two (2) components of bed load and suspended load including wash load.

There are seven (7) actual measurements of suspended load at Cumadcad gauging station by BRS, DPWH, as shown below:

Measurement of Sediment Load at Cumadcad River

Sampling Date	Discharge (m^3/sec)	Weight of sample (g)	Weight of sediment (g)	Concentration by weight (ppm)	Sediment discharge (ton/day)
June 9, 1994	0.6992	327	0.0023	7.033	0.42
Oct. 19, 1994	0.5695	357	0.0027	7.563	0.37
Nov. 16, 1994	0.3608	358	0.0028	7.821	0.24
March 12, 1995	4.2300	356	0.0014	3.932	1.44
June 16, 1995	0.1660	358	0.0009	2.513	0.04
Aug. 21, 1995	0.6253	360	0.0008	2.222	0.12
Sep. 19, 1995	1.2716	318	0.0034	10.691	1.17

Source: BRS, DPWH

The results of the measurement are plotted on Figure A.3.11 and an equation is obtain which indicates the relationship between the water discharge and the suspended load discharge as follows;

$$Qs = 0.46\ Q^{1.12}$$

where, Qs : Suspended sediment discharge (ton/day), and
Q : Water discharge (m^3/sec)

The annual suspended load amount is calculated by converting the daily discharge into the daily suspended load using the equation explained above and then, suspended load rating curve. The following table shows the annual sediment loads estimated based on the actual river conditions for the Cumadcad River for twelve (12) years:

Estimated Annual Sediment Load

Year	Suspend load (ton)	Sediment load (suspended + bed load) (ton/year)	Sediment load (suspended + bed load) (m^3/year)	Specific sediment load (m^3/year/km^2)
1956	130	156	130	10.0
1957	86	103	86	6.6
1958	89	107	89	6.9
1959	66	79	66	5.1
1961	114	137	114	8.8
1962	103	123	103	4.8
1963	63	76	63	4.9
1964	101	122	101	7.8
1965	167	200	167	12.9
1966	190	228	190	14.6
1967	169	203	169	13.0
1968	37	44	37	2.9
Average	110	132	110	8.2

Source: JICA Team's Estimate

The mean annual sediment loads are estimated at 132 ton/year at Cumadcad gauging station, that consists of 110 ton/year of the suspend load, and 22 ton/year of the bed load. The specific sediment load is 8.2 m^3/year/km^2.

However, it should be taken into account that the data are not sufficient and the suspended load rating curves were on the data below 4 m^3/sec water discharge. So, no sample data with large discharge is included, though the suspended load with large discharge easily affect the amount of total sediment load.

On the other hand, in accordance with the design standard of dam issued by the Ministry of Agriculture, Forestry and fishery, specific standard load is estimated at 50 to 100 m^3/km^2/year in case of drainage area of less than 100 km^2 with similar topography and vegetation. Taking this into consideration, the total sediment load at proposed dam site is estimated as 100 m^3/km^2/year adding some safety allowance.

3.6 Water Quality

3.6.1 Test and Analysis

The water quality survey was carried out so as to verify the availability of water applicable for irrigation and domestic water use. Thirty locations were selected and sampled: fifteen locations for surface water, and fifteen locations for groundwater. The survey including sampling, field test, and laboratory test, was entrusted to the local consultant. The water sampling and field test, such as measurement of pH, temperature, total dissolved solid, and electric conductivity, were carried out on November 13 and 14. The water sampling locations are presented in Figure A.3.12 and given below:

Location of Water Sampling

Surface water Sampling locations		Groundwater Sampling locations		
No.	Location	No.	Barangay	Municipality
1	Camalig Diversion Dam Site 1	1	Ligban	Camalig
2	Camalig Diversion Dam Site 2	2	Tagaytay	Camalig
3	Camalig Diversion Dam Site 3	3	Baligang	Camalig
4	Camalig Diversion Dam Site 4	4	Comun	Camalig
5	Ligban River in Tagaytay	5	Cotmon	Camalig
6	No.1 Dam Site 1	6	Del Rosario	Camalig
7	No.1 Dam Site 2	7	Inarado	Daraga
8	No.2 Dam Site	8	Tabon Tabon	Daraga
9	Abgao River in Comun	9	Namantao	Daraga
10	No.3 Dam Site 1	10	Anislag	Daraga
11	No.3 Dam Site 2	11	Mayon	Daraga
12	No.4 Dam Site	12	San Ramon	Daraga
13	No.5 Dam Site	13	San Ramon #	Daraga
14	Yawa River in Gapo	14	Anislag	Daraga
15	Jovellar River in Panoypoy	15	Del Rosario #	Camalig

Note: # (No. 13 and No.15 in groundwater sampling) means that water shall be sampled from bore holes of groundwater survey

Meanwhile, the laboratory test, such as Chloride, Fluoride, Calcium, Magnesium, Phosphorus, Total Nitrogen, Bacteria (Coliform), and so on, were carried out in Manila. All laboratory test were carried out into consideration the "Rules & Regulations of the National Pollution Commission (1978), Section 69 on water quality criteria. In order to assess surface water quality, the Class "D" category, which is for agriculture, irrigation and livestock use, was adopted. Meanwhile, with regards to groundwater assessment, the Class "GA" category for domestic use was applied. The water quality criteria for "GA" and "D" categories are given in Tables A.3.13 and A.3.14, respectively.

3.6.2 Data Assessment

Data assessment on the water quality in the Study Area was based on the results of the physical and chemical analysis performed on the fifteen (15) surface water samples and fifteen (15) groundwater samples taken from rivers and wells.

(1) Surface Water

The water quality test result for surface water is shown in Table A.3.15. Since the standard for Class "D" water does not specify the limit except for fluoride, the nutrients - phosphates as phosphorous, and nitrate nitrogen, the remaining parameters were attempted to be compared to their equivalent standard limits for Class "GA" waters. All the three (3) parameters conform to the said limits and signify absence of active pollution in these surface waters as detected amounts are in mg/ml. Further, the other parameters were found to conform with them. It is, therefore, that all of the fifteen (15) surface water samples can be used as Class "D" water, meaning that they are fit for purposes in agriculture, irrigation, livestock, watering, and so on.

(2) Groundwater

The water quality test result for groundwater is shown in Table A.3.16. Most of the groundwater samples in the Study Area contain chloride which is a characteristic of groundwater in humid regions and where sedimentary and pyroclastic rocks comprise the parent rocks. The average chloride content of groundwater in sampled area is 27 mg/l which is tolerable and very much below the standard limit of 200 mg/l. The calcium content of groundwater in the Study Area is found not exceeding 75 mg/l standard limit for Class "GA" waters except three (3) samples. The magnesium content of groundwater is also generally below the standard limit of 50 mg/l for Class "GA" waters except three (3) samples.

The bacteriological examinations for all samples show contamination with coliform bacteria. Especially, out of fifteen (15) wells, nine (9) well are reported to be contaminated by Fecal Coliform Bacteria in spite of the deep wells. Following measures can be taken in order to prevent the inhabitants from water borne diseases in the Study area:

- to instruct the inhabitants not to drink water from wells directly but to boil water before drinking;
- to provide of disinfection and chlorination facilities whenever the level II water supply systems are constructed or rehabilitated so as to ensure portability of the water at all times.

4. WATER BALANCE STUDY

4.1 Camalig Diversion Weir Site

(1) Location and Topography

The Camalig Diversion dam site is located at the Tinago River. At the right bank is the flat plain of the foot of Mayon Volcano and on the left bank a steep hill side.

(2) Water Resources

As described in Section 3.3.1, the mean monthly runoff at the Camalig Diversion Weir site is estimated as follows;

Mean Monthly Runoff at Camalig Diversion Dam Site

Unit: 1000 m^3

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Camalig diversion dam	1,131	625	629	610	765	1,211	1,420	1,292	1,405	1,509	1,851	1,928	14,356

(3) Methodology for Water Balance Study

The water balance study is made by the following water balance condition:

I - O = Bt

Where,

I : Total inflow to the reservoir during the monthly period (m^3)

O : Total outflow from the reservoir during the monthly period, consisting of water releases for all purposes, such as irrigation, hydropower, water supply, existing water rights, if any, river maintenance flow, end evaporation losses and spill out of the reservoir.

B : Water balance during the monthly period (m^3)
if $B > 0$: Success
if $B < 0$: Failure

1) Inflow

Generated monthly discharge at the proposed dams for 46 years from 1949 to 1994 is used for the calculation.

2) Irrigation water demand

The irrigation requirement in the beneficiary area is shown as follows. In this study, the cropping pattern is set up at 200% of cropping intensity (Paddy - Paddy) tentatively:

Irrigation Requirement

Unit: m^3/sec/ha

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
	0.69	1.04	0.49	0	0.35	1.21	0.57	0.56	0	0	0	0.40

Source: JICA Team's Estimate

The maximum potential irrigable area is set up at 130 ha considering the land potential.

Water Demand to meet 80% dependability of irrigation water reservoir capacity will be determined.

3) Other water demand

The other water demands, such as hydropower, domestic water supply, and inland fishery, are not taken into account. In the absence of record on the existing water rights downstream of the dam site, it is not considered in the balance study. Further, no river maintenance flow from reservoir is taken into consideration because the proposed dam site has the small drainage area and its storage may not affect the characteristics of whole river systems.

(4) Result of Water Balance Study

The optimum development scale of proposed Camalig Diversion Dam coincided with the maximum development scale considering the agricultural development plan. By developing available water resources of the Tinago river through construction of the Camalig Diversion Weir, irrigation water can be supplied to the existing paddy field of 130 ha in net for the both seasons. The result of water balance study is given in Table A.4.1.

4.2 Small Impounding Pond Sites

(1) Location and Topography

The location and general description of topography of each dam site are as follows:

Dam Site	Location and Topography
Dam No.1	Dam site is located at the Taladong River in the Barangay Taladong where is located on the hill side. At the dam site, the valley has a width of 10 to 20 m while both banks are approximately 6 to 7 m high from river bed.
Dam No.2	Dam site is located at Abgao River in Barangay Inarado, originating at the northern hilly area and flows through the gentle hills. The valley, where two creeks flow is developed with approximate width of 170 to 190 m .
Dam No.3	Dam site is located at the Subok River in Barangay Gabawan which flows through the north side of hilly area. The identified dam site is at a wide and shallow valley and about 30 m downstream from the confluence of three streams. The dam axis abuts on the south end of the thin ridge of the right bank, and on the moderate slope of the left bank.
Dam No.4	Dam site is located at the Subok River in Barangay Bascaran, and 2 km downstream of the No. 3 dam site. The site forms relatively steep hills in the east side, and moderate to gentle hills in the other side. The identified dam axis is located at the steep valley 40 to 60 m wide.
Dam No.5	Dam site is located at the Ogod River in Barangay San Ramon. The site is composed of gentle to moderately sloping hills . The identified dam axis connects the end of thin ridge on the left bank and at the slope of the gentle hill on the right bank. The river joins creek at 30 m downstream from the dam axis. The shallow valley 70 to 80 m wide at the dam axis could lead to secure very limited reservoir storage capacity.

(2) Water Resources

As described in Section 3.3.2, the mean monthly runoff at the each dam site is estimated as follows;

Mean Monthly Runoff at Each Dam Site

Unit: 1,000 m^3

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
No.1 Dam	383	213	215	206	260	405	473	431	468	506	624	657	4,848
No.2 Dam	300	167	168	161	203	317	371	337	366	396	488	515	3,794
No.3 Dam	183	102	103	98	124	194	226	206	224	242	298	314	2,319
No.4 Dam	632	352	355	340	429	669	782	712	773	837	1,031	1,086	8,010
No.5 Dam	1,331	742	748	716	904	1,408	1,647	1,499	1,627	1,762	2,170	2,287	16,863

(3) Methodology for Water Balance Study

The water balance study is made by the following water balance condition:

$I - O = St+1 - St$
$Smin \leq St+1,\ St \leq Smax$

Where,

I : Total inflow to the reservoir during the monthly period (m^3)
O : Total outflow from the reservoir during the monthly period, consisting of water releases for all purposes, such as irrigation, hydropower, water supply, existing water rights, if any, river maintenance flow, end evaporation losses and spill out of the reservoir.

S_{t+1}, St : Storage at times (t+1) and (t), (m^3)
Smin : dead storage capacity, (m^3)
Smax : maximum storage capacity subject to the specified crest elevation of spillway

1) Inflow

Generated monthly discharge at the proposed dams for 46 years from 1949 to 1994 is used for the calculation.

2) Reservoir storage curve

Reservoir storage curve with surface area is shown in Figures A.5.1 to A.5.4 in relation to the elevation at the proposed dam sites.

3) Irrigation water demand

The irrigation requirement in the beneficiary area by the impounding pond is shown below. In this study, the cropping pattern is set at 200% cropping intensity (Paddy - Paddy) tentatively:

Irrigation Requirement

Unit: m^3/sec/ha

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
	0.46	0.79	0.32	0	0.32	1.04	0.32	0.33	0	0	0	0.27

Source: JICA Team's Estimate

The potential irrigable area is set as follows considering the land resources for each beneficiary area:

Maximum Irrigable Area

Unit: ha

Dam Site	Maximum land availability
No.1 Dam	33
No.2 Dam	240
No.3 Dam	85
No.4 Dam	110

Source: JICA Team's Estimate

Water Demand to meet 80% dependability of irrigation water reservoir capacity will be determined.

4) Other water demand

The other water demands, such as hydropower, domestic water supply, and inland fishery, are not taken into account. In the absence of record of the water rights at the downstream of the dam sites, it is not considered in the balance study. Further, no river maintenance flow from reservoir is taken into consideration because the proposed dam site has small drainage area and storage that may not affect the characteristics of whole river systems.

5) Evaporation losses

The evaporation from the reservoir surface can be assumed to be 110% of the potential evapotranspiration, which is calculated by the Modified Penman Method.

6) Spill out discharge of reservoir

Spill out discharge is the excess storage which exceeds the maximum storage of dam.

(4) *Result of Water Balance Study*

The result of water balance study for the respective dam is presented hereinafter.

1) No.1 Dam

The optimum development scale of proposed No.1 Dam coincides with the maximum development scale considering the tentative agricultural development plan. The optimum development scale is thus in line with the height of 5.5 m and effective storage capacity of 7,000 m^3. The result of reservoir operation is shown in Figure A.5.5. By developing the water resource of Taladong Creek through construction of No.1 Dam, irrigation water can be supplied to the existing paddy field of 33 ha in net for both seasons.

2) No.2 Dam

The optimum scale of No.2 Dam is decided by the considering limitation offer topography and geological condition at the proposed site. The development scale is thus in line with the maximum height of 17.0 m and effective storage capacity of 636,000 m^3. The result of reservoir operation is shown in Figure A.5.6. By developing available water resource of the Abgao River through construction of the No.2 Dam at the optimum scale, irrigation water can be supplied to existing paddy field of 190 ha in net for both season.

3) No.3 Dam

The optimum development scale of proposed No.3 Dam coincides with the maximum development scale considering the tentative agricultural development plan. The optimum development scale is thus in line with the height of 13.0 m and effective storage capacity of 230,000 m^3. The result of reservoir operation is shown in Figure A.5.7. By developing available water resource of the Subok River through construction of No.3 Dam, irrigation water can be supplied to the existing paddy field of 85 ha in net for both seasons.

4) No.4 Dam

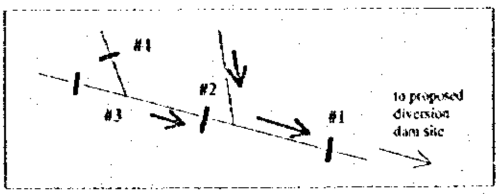
The optimum development scale of proposed No.4 Dam coincides with the maximum development scale considering the tentative agricultural development plan. The optimum development scale is thus in line with the height of 11.5 m and effective storage capacity of 49,000 m^3. The result of reservoir operation is shown in Figure A.5.8. By developing available water resource of the Patagok River through construction of No.4 Dam, irrigation water can be supplied to the existing paddy field of 110 ha in net for both seasons.

**THE FEASIBILITY STUDY ON
THE WESTERN LEGAZPI IRRIGATION AND
RURAL DEVELOPMENT PROJECT IN THE PHILIPPINES**

TABLES

Table A.1.1 Discharge Measurement

Date	Time	River Source & Location	Computed Discharge (m3/s)	Remarks
1995/10/25	10:00 AM	Tinago River, Diversion Point, Camalig Site	0.461	
1995/10/26	10:15 AM	Tinago River, Diversion Point, Camalig Site	0.426	
1995/10/27	4:45 PM	Tinago River, Diversion Point, Camalig Site	1.169	Rainfall experienced at 3:00 pm
1995/11/8	4:00 PM	Tinago River, Diversion Point, Camalig Site	0.827	First measurement after Typhoon Rosing
1995/11/9	2:00 PM	Tinago River, Diversion Point, Camalig Site	0.801	
1995/11/15	1:00 PM	Tinago River, Diversion Point, Camalig Site	0.473	
1995/11/16	12:10 PM	Tinago River, Diversion Point, Camalig Site	0.435	
1995/10/25	10:15 AM	Ligban River (about 20 m D/S of confluence (Tinago + Iraya), Camalig Site	0.538	
1995/10/26	10:30 AM	Ligban River (about 20 m D/S of confluence (Tinago + Iraya), Camalig Site	0.612	
1995/11/8	4:20 PM	Ligban River (about 40 m D/S of confluence (Tinago + Iraya), Camalig Site	1.638	First measurement after Typhoon Rosing
1995/11/9	2:20 PM	Ligban River (about 40 m D/S of confluence (Tinago + Iraya), Camalig Site	1.081	
1995/11/15	1:20 PM	Ligban River (about 40 m D/S of confluence (Tinago + Iraya), Camalig Site	0.781	
1995/11/16	12:30 PM	Ligban River (about 40 m D/S of confluence (Tinago + Iraya), Camalig Site	0.751	
1995/11/9	2:45 PM	Ligban River (about 25 m U/S of Diversion Dam)	1.172	
1995/11/15	2:00 PM	Ligban River (about 25 m U/S of Diversion Dam)	0.964	
1995/11/16	1:15 PM	Ligban River (about 25 m U/S of Diversion Dam)	0.937	
1995/10/26	11:15 AM	Tinago River (about 500 m U/S of Diversion Point)	0.422	#1
1995/10/26	11:30 AM	Tinago River (about 30 m D/S of Confluence of 2 creeks draining to Tinago River)	0.212	#2
1995/10/26	11:45 AM	Creek from Villa Gomar Resort, draining to Tinago River	0.093	#3
1995/10/26	12:00 PM	Creek from Salugan, draining to Tinago River	0.119	#4



Date	Time	River Source & Location	Computed Discharge (m3/s)	Remarks
1995/10/26	1:05 PM	No.1 Taladong Creek (Quibaris Creek, Local Name) at Dam Axis, Barangay Taladong	0.058	
1995/10/26	2:10 PM	Buntag River (about 50 m D/S of Taladong - Comun Boundary Bridge)	0.122	
1995/10/25	2:00 PM	No.2-Abgao Creek at Dam axis, Barangay Inarado	0.014	
1995/10/26	3:10 PM	No.2-Abgao Creek at Dam axis, Barangay Inarado	0.053	
1995/10/26	4:00 PM	Abgao River at Comun Bridge, Barangay Comun	0.273	
1995/11/9	12:05 PM	No.3-Subok River (about 50 D/S of Dam axis), Barangay Gabawan	0.030	
1995/11/9	10:00 AM	No.4 - Patagok River (about 80 m D/S of Staff Gauge Center Line), Barangay Bascara	0.095	
1995/11/8	2:30 PM	No.5-Cagnanaga River (about 50 m U/S of Dam Axis), Barangay San Ramon	0.174	
1995/11/8	10:30 AM	No.6-Pagsabangan River (about 20 m D/S of Dam Axis), Barangay Panoypoy	0.629	

Source : JICA Team's Measurement

Table A.2.1 Monthly Rainfall Record in Legazpi

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1949	99.1	29.2	177.3	170.2	153.2	92.7	179.6	120.1	237.2	310.6	533.4	707.4	2,810.0
1950	579.1	228.1	394.7	81.5	107.2	259.3	137.4	141.2	533.6	222.0	416.0	222.0	3,322.1
1951	255.3	151.6	86.6	246.1	352.6	320.8	123.7	232.4	191.3	187.7	593.9	539.7	3,281.7
1952	498.9	309.4	212.3	186.2	46.5	132.8	259.8	359.7	92.7	279.4	289.1	638.8	3,305.6
1953	261.1	218.2	201.2	100.1	62.7	239.3	148.6	175.8	175.5	469.9	509.8	522.5	3,084.7
1954	238.5	133.3	651.3	97.0	306.3	141.5	149.1	258.1	105.9	226.6	572.5	891.5	3,771.6
1955	470.4	112.3	182.1	225.3	137.4	299.2	171.2	279.9	212.3	299.0	855.7	284.2	3,529.0
1956	267.5	220.5	325.1	497.6	259.1	87.1	173.7	261.6	516.1	211.1	493.3	829.6	4,142.3
1957	364.5	98.6	168.7	191.8	163.6	195.6	191.0	221.0	240.3	337.3	332.7	246.1	2,751.2
1958	342.6	236.0	310.6	74.9	145.0	200.4	235.2	320.3	187.2	768.9	432.8	96.5	3,350.4
1959	254.0	291.6	411.5	73.4	338.3	72.6	157.2	193.8	176.5	247.4	511.0	613.2	3,340.5
1960	197.1	252.5	83.1	310.4	296.2	396.2	192.8	196.8	308.9	483.4	516.4	236.5	3,470.3
1961	100.6	48.8	118.0	130.6	180.2	284.1	207.0	345.0	161.1	300.1	276.1	276.4	2,428.0
1962	280.1	181.3	163.8	91.8	405.1	142.5	393.0	343.0	462.0	174.9	410.0	173.3	3,220.8
1963	82.9	158.0	44.9	41.9	146.4	291.8	249.5	733.3	120.9	142.7	405.8	355.3	2,773.4
1964	305.0	253.3	96.6	435.2	166.1	151.2	247.0	257.2	295.3	210.1	359.8	642.2	3,419.0
1965		198.1	242.7	158.4	189.6	311.9	478.4	308.4	257.0	318.1	486.6	536.9	
1966	592.1	101.7	155.9	87.8	216.3	167.5	424.5	209.1	266.8	400.3	452.0	814.5	3,891.5
1967	490.5	148.9	215.3	139.5	47.2	122.2	124.0	388.2	193.9	219.8	723.4	281.1	3,094.0
1968	403.3	78.5	118.3	49.4	19.4	136.6	105.9	235.1	321.3	117.4	269.7	181.6	2,036.5
1969	48.2	24.1	73.1	143.7	31.6	149.7	203.3	168.1	443.5	158.5	333.7	541.4	2,318.9
1970	269.6	329.9	292.2	172.2	134.5	203.5	358.3	424.6	219.4	540.2	758.1	559.2	4,261.7
1971	391.3	307.6	423.3	137.9	407.8	189.9	394.2	169.3	173.0	473.9	322.0	836.0	4,226.2
1972	659.2	132.9	267.1	95.8	151.0	393.0	174.7	300.7	225.3	185.7	611.7	373.4	3,570.5
1973	169.2	101.2	83.0	108.0	98.7	183.3	317.3	316.6	185.2	511.0	773.6	978.3	3,825.4
1974	237.9	368.9	92.3	65.6	259.3	518.9	438.5	161.3	74.6	458.6	565.7	518.4	3,760.0
1975	356.7	210.7	122.0	376.1	151.4	154.2	196.5	228.5	318.6	139.3	372.9	1,548.8	4,175.7
1976	668.8	160.9	251.7	104.9	423.0	210.3	155.3	390.6	215.2	294.7	410.0	845.2	4,130.6
1977	239.3	217.3	141.9	114.1	245.3	107.3	378.1	233.7	391.6	219.7	657.2	175.6	3,121.1
1978	55.1	90.7	152.5	124.4	206.8	292.3	193.4	385.5	353.3	559.4	261.3	494.6	3,169.3
1979	137.7	241.2	69.9	272.7	129.3	302.3	244.8	148.4	464.6	234.9	321.8	248.4	2,816.0
1980	222.7	289.1	298.0	86.1	64.4	535.9	298.5	350.8	282.7	652.4	313.2	288.4	3,682.2
1981	463.6	168.5	61.8	150.2	138.6	349.5	238.8	255.6	352.6	491.2	862.8	477.7	4,010.9
1982	227.3	346.4	250.2	121.4	180.5	135.5	391.6	250.4	568.6	247.5	386.0	394.8	3,500.2
1983	137.2	11.4	33.4	52.2	22.0	283.5	532.9	112.8	269.5	271.9	466.9	471.0	2,664.7
1984	402.2	191.4	225.8	33.7	107.5	387.2	167.4	357.8	170.2	438.6	663.5	180.2	3,325.5
1985	305.9	182.2	181.7	181.8	140.4	263.5	313.2	68.9	240.9	386.5	417.9	261.2	2,944.1
1986	226.9	152.2	92.9	366.7	90.2	183.7		216.4	272.5	484.9	337.5	165.4	
1987	110.7	65.8	42.9	113.2	43.1	138.3	246.6	245.2	200.1	227.5	653.6	602.6	2,689.6
1988	266.3	119.6	85.9	287.2	118.8	186.7	174.1	93.2	147.0	693.5	897.1	295.2	3,364.6
1989	549.8	676.7	331.4	251.9	260.7	393.6	163.4	211.8	327.7	220.4	232.4	389.0	4,008.8
1990	447.1	104.9	32.9	63.4	266.4	384.9	199.2	276.2	207.2	442.7	396.0	358.3	3,179.2
1991	180.8	140.8	202.1	104.6	273.6	519.9	314.9	292.6	170.2	212.0	388.8	470.3	3,270.6
1992	233.2	134.5	54.2	46.9	128.0	120.5	327.7	275.7	209.3	184.4	294.5	351.8	2,360.7
1993	161.1	112.2	150.5	35.9	119.4	216.9	393.5	375.4	293.7	366.7	702.0	847.6	3,774.9
1994	590.4	76.0	169.0	277.7	134.2	195.7	377.2	65.1	253.8	170.5	127.9	464.2	2,901.7
1995	274.5	92.6	45.2	113.4	140.2	197.8	348.0	372.0	392.9	261.1			
Average	306.9	180.9	182.7	157.3	174.6	239.2	258.5	262.3	265.5	328.8	477.6	483.2	3,319.9
Max	668.8	676.7	651.3	497.6	423.0	535.9	532.9	733.3	568.6	768.9	897.1	1,548.8	4,261.7
Min	48.2	11.4	32.9	33.7	19.4	72.6	105.9	65.1	74.6	117.4	127.9	96.5	2,036.5

Source : PAGASA, Legazpi

Table A.2.2 Monthly Rainfall Record at Guinobatan

Unit: mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1956	100.5	166.3	140.1	454.5	180.2	136.7	450.7	220.1	398.6	140.4	376.9	778.8	3543.8
1957	245.8	61.0	79.0	175.4	27.3	229.8	273.1	375.9	254.7	285.0	251.7	97.8	2356.5
1958	161.7	91.8	93.0	21.1	121.5	194.8	245.1	274.5	329.9	881.4	286.4	66.0	2767.2
1959	143.9	97.3	204.2	35.1	229.5	120.0	303.3	260.7	248.1	340.2	474.5	595.2	3052.0
1960	106.8	99.6	53.8	250.3	254.7	270.5	273.3	208.9	267.0	569.0	378.1	204.3	2936.3
1961	13.7	0.0	67.8	32.2	224.3	209.8	335.5	254.5	193.5	323.6	169.6	112.4	1936.9
1962	123.4	92.5	113.0	39.8	339.5	356.0	400.8	250.8	338.0	91.5	329.8	77.2	2552.3
1963	12.9	55.5	11.4	15.4	117.6	365.1	152.7	594.5	248.4	184.0	175.6	186.8	2119.9
1964	146.8	65.7	56.9	160.5	50.7	248.7	127.8	168.1	412.8	220.6	269.8	426.4	2354.8
1965	249.7	76.8	57.2	111.0	172.7	364.9	561.9	186.3	277.5	187.8	207.9	271.8	2725.5
1966	226.9	35.1	66.7	28.9	178.7	152.2	328.2	158.1	190.4	260.9	369.4	569.3	2564.8
1967	419.4	90.7	96.8	72.1	42.1	108.1	317.0	293.4	427.1	172.0	76.0	61.1	2175.8
1968	128.9	74.1	22.9	***	***	***	***	***	854.0	819.9	399.0	408.3	***
1969	180.8	97.5	10.4	16.4	68.3	220.6	328.0	179.1	315.4	81.3	190.1	342.0	2029.9
1970	125.1	215.3	104.2	66.2	43.6	110.6	506.5	376.8	269.3	568.4	528.6	221.8	3136.4
1971	255.6	170.7	210.4	120.2	460.9	217.3	429.3	107.6	135.8	400.1	180.6	593.6	3282.1
1972	480.7	33.8	141.4	21.5	134.9	364.0	275.1	372.1	248.2	75.2	228.4	273.4	2648.7
1973	116.9	11.3	21.9	10.2	60.2	157.7	144.3	417.8	252.8	545.9	492.4	745.2	3006.6
1974	57.9	120.7	39.0	71.7	80.5	473.6	***	98.3	98.4	445.0	356.7	359.1	***
1975	190.0	41.9	8.2	186.2	68.4	220.5	303.6	208.1	289.2	199.3	***	1006.4	***
1976	288.6	88.6	115.4	11.6	532.8	301.8	132.0	342.7	323.7	146.5	257.2	593.4	3134.3
1977	105.3	98.7	17.7	56.5	166.3	72.8	419.1	307.5	339.8	8.6	352.8	25.2	1970.3
1978	24.9	12.0	92.4	123.8	156.7	297.9	239.1	310.9	234.2	348.0	61.3	203.6	2104.8
1979	36.2	8.6	11.6	265.0	172.1	248.9	283.5	347.4	501.5	199.8	144.2	198.0	2416.8
1980	146.5	27.3	83.9	0.0	51.8	237.5	461.5	200.1	181.2	157.6	66.7	46.3	1660.4
1981	141.7	68.9	0.0	0.0	191.3	767.8	85.6	122.7	162.8	99.3	197.9	198.0	2036.0
1982	108.1	268.2	119.2	35.3	190.0	149.8	368.1	336.0	784.0	193.9	124.2	110.3	2787.1
1983	8.6	0.0	0.0	0.0	0.0	127.2	322.3	***	***	***	***	***	***
Average	155.3	81.1	72.8	88.2	159.9	249.1	310.3	269.3	317.6	294.3	267.1	324.9	2589.8

Source : PCA, Guinobatan

Table A.2.3 Monthly Rainfall at Buca, Guinobatan

Unit: mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1990	180.1	18.4	12.0	20.9	175.9	438.8	293.4	253.8	159.9	262.8	319.4	127.3	
1991	36.6	14.7	116.8	51.2	65.1	376.0	296.1	340.1	236.8	154.6	292.0	164.3	
1992	100.2	21.7	12.5	35.7		146.7	356.6	177.1					
1993	70.8	55.0	48.4	25.6	40.8	152.7	563.4	531.5	315.2	269.3	450.2		
1994	294.9	22.1		181.1	206.0	242.9	497.6	154.8	354.2	164.8	28.0	392.5	
1995	72.5	43.4	17.5	54.1	113	201.6							
Average	125.9	29.2	41.4	61.4	120.2	259.8	401.4	291.5	266.5	212.9	272.4	228.0	2311

Source : PAGASA, Buca, Guinobatan

Table A.2.4 Maximum Daily Rainfall at Legazpi Station

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	39.9	11.7	39.9	34.0	43.7	64.3	42.4	83.8	44.2	54.6	43.5	55.4	83.8
1962	149.1	56.9	71.4	15.7	189.7	30.2	56.9	62.7	57.9	33.0	113.5	46.2	189.7
1963	20.6	39.6	8.4	25.4	43.2	125.0	74.9	432.3	17.3	28.2	68.3	96.3	432.3
1964	61.0	47.8	21.9	131.8	49.8	64.2	53.8	95.3	117.4	47.0	61.4	172.5	172.5
1965		50.1	50.6	42.0	68.8	89.3	174.0	50.5	62.8	41.2	89.5	84.8	174.0
1966	236.3	29.0	31.8	19.8	88.4	56.2	132.6	50.3	82.6	89.9	183.4	127.6	236.3
1967	85.7	33.9	71.6	73.7	19.8	39.2	21.7	133.8	40.1	75.6	484.6	73.3	484.6
1968	173.5	30.8	26.9	22.1	7.9	38.1	70.0	45.2	127.5	46.3	61.8	38.4	173.5
1969	8.7	5.4	27.2	45.0	10.9	31.2	36.1	26.4	61.0	33.5	74.2	116.2	116.2
1970	127.3	127.6	50.5	49.3	35.0	41.0	102.4	56.7	57.9	112.8	106.8	130.9	130.9
1971	163.1	52.6	209.2	51.3	120.9	53.3	92.7	31.8	26.7	108.7	59.4	203.9	209.2
1972	145.6	41.4	70.4	24.7	33.3	236.6	46.2	74.3	36.5	20.9	74.2	88.6	236.6
1973	38.1	26.4	39.1	26.9	23.6	58.4	45.7	82.1	36.0	92.3	190.8	128.3	190.8
1974	75.8	98.2	10.5	21.8	60.7	247.6	187.6	28.7	24.6	93.0	206.3	123.9	247.6
1975	91.0	52.0	48.5	107.9	25.4	46.0	55.2	45.5	107.3	28.2	147.4	458.6	458.6
1976	120.0	38.7	63.1	24.4	155.8	78.2	37.8	78.4	46.7	83.3	71.4	274.8	274.8
1977	51.6	76.9	27.2	29.5	55.4	42.4	113.1	47.2	102.8	44.4	137.2	37.5	137.2
1978	11.9	19.2	80.8	42.7	36.1	67.0	32.7	55.4	109.6	171.5	55.1	106.6	171.5
1979	52.7	130.4	32.3	86.8	33.0	49.2	31.4	29.6	161.2	41.6	86.4	99.0	161.2
1980	73.8	127.2	203.6	30.6	29.5	79.7	128.4	80.2	43.3	235.0	73.8	42.4	235.0
1981	170.4	58.0	26.1	23.4	35.2	220.4	84.4	129.6	50.6	172.4	114.4	95.0	220.4
1982	76.0	176.4	57.2	36.1	50.0	71.8	118.4	55.4	214.4	43.6	82.7	69.8	214.4
1983	24.0	6.0	9.0	13.8	4.2	92.0	239.4	26.0	47.6	39.3	174.8	105.8	239.4
1984	74.4	48.4	105.8	14.0	25.4	88.0	48.2	68.6	35.8	55.4	144.8	38.2	144.8
1985	69.4	64.4	38.2	56.2	32.6	48.0	73.0	12.6	57.0	68.0	81.8	48.0	81.8
1986	52.5	58.5	16.2	139.9	43.0	47.6	0.0	38.0	60.8	85.7	75.6	52.0	139.9
1987	28.6	14.6	7.4	35.4	18.8	29.0	109.4	97.6	45.4	70.2	111.0	94.4	111.0
1988	52.0	25.4	17.4	49.7	76.9	25.0	29.6	37.4	59.8	117.8	207.4	59.0	207.4
1989	194.8	254.4	56.3	146.9	92.2	107.4	34.2	81.4	103.2	114.0	77.4	73.1	254.4
1990	158.3	52.0	18.6	24.6	38.6	82.4	40.0	79.0	70.0	46.8	77.0	80.4	158.3
1991	51.4	32.7	124.6	27.6	67.5	111.0	105.2	60.7	72.9	59.8	112.0	180.0	180.0
1992	121.6	55.4	10.8	12.2	35.8	23.6	88.6	62.3	55.4	43.0	138.8	100.4	138.8
1993	34.4	17.5	28.2	14.2	37.2	51.6	123.2	86.0	72.8	70.4	81.8	147.9	147.9
1994	229.5	31.0	30.4	80.4	67.8	71.5	55.6	24.6	68.0	51.0	17.8	203.2	229.5
1995	65.4	22.8	10.0	28.4	39.4	72.6	107.0	43.1	69.4	34.8			107.0
Max	236.3	254.4	209.2	146.9	189.7	247.6	239.4	432.3	214.4	235.0	484.6	458.6	484.6

Source : PAGASA, Legazpi

Table A.2.5 Monthly Rainfall at Castilla Station

Unit: mm

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1956	128.5	266.2	192.0	313.2	238.5	69.1	220.2	215.6	489.2	287.5	523.7	632.0	3575.7
1957	376.2	56.9	91.4	359.7	56.1	191.0	211.3	253.7	294.9	274.6	317.2	122.7	2605.7
1958	208.8	96.8	228.1	42.4	85.9	121.7	293.9	293.1	210.6	634.5	314.7	72.1	2602.6
1959	140.2	191.0	221.7	100.3	78.5	14.2	173.0	275.3	351.3	154.4	473.7	496.6	2670.2
1960	113.8	169.7	69.9	119.6	173.7	237.0	136.1	192.0	323.6	553.2	483.6	51.1	2623.3
1961	56.1	36.3	98.8	78.0	145.3	199.1	305.8	239.3	214.4	281.9	343.4	198.9	2197.3
1962	235.0	49.5	75.7	18.8	332.5	58.2	266.4	154.9	187.2	128.0	466.9	108.2	2081.3
1963	74.2	108.7	11.4	24.9	67.8	245.6	193.5	318.0	161.3	145.5	264.9	270.3	1886.1
1964	106.2	153.7	42.9	264.9	154.2	221.5	173.0	96.5	329.4	145.3	251.2	622.3	2561.1
1965	***	***	157.7	45.0	122.4	328.4	466.9	211.1	241.6	202.4	263.4	218.4	***
1966	163.3	114.8	114.3	19.6	186.2	97.0	301.8	213.1	116.3	363.2	***	574.3	***
1967	438.7	68.2	98.5	114.1	11.9	134.6	378.8	384.8	495.0	163.8	400.3	140.2	2878.9
1968	208.0	75.1	73.7	49.8	0.0	40.2	87.3	306.0	424.9	112.5	224.7	77.1	1679.3
1969	78.1	0.0	72.6	64.7	0.0	16.7	249.5	397.8	327.1	105.3	380.5	544.1	2236.4
1970	236.2	188.4	59.0	216.7	9.9	127.7	179.1	150.1	96.1	462.0	727.2	373.3	2825.7
1971	219.9	418.9	286.9	5.6	356.2	199.7	260.8	56.1	187.9	355.5	314.5	660.4	3322.4
Average	188.9	132.9	118.4	114.8	126.2	143.9	243.6	234.8	278.2	273.1	383.3	322.6	2,560.8

Source : PAGASA

Table A.2.6 Mean Monthly Temperature in Legazpi Station

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1949		25.9	25.6	26.8	27.4	28.1	27.4	27.6	27.4	26.8	25.8	26.3	26.9
1950	25.6	25.6	26.2	27.5	27.9	28.0	27.7	28.0	27.2	26.6	26.3	25.6	26.8
1951	25.8	25.7	25.2	27.2	27.6	27.6	27.5	27.8	27.4	27.5	26.9	26.2	26.9
1952	25.8	26.0	26.5	27.3	28.4	28.2	28.2	27.2	27.3	27.2	26.7	25.8	27.0
1953	25.6	26.4	26.7	27.7	28.5	27.7	27.5	27.7	27.6	27.3	26.8	26.1	27.1
1954	25.9	26.5	26.3	27.3	27.6	28.0	27.8	27.4	27.5	26.9	26.2	24.9	26.9
1955	25.5	25.5	25.0	27.1	27.9	27.7	27.7	27.7	27.7	27.5	26.5	25.2	26.8
1956	25.4	25.7	26.1	27.0	27.4	27.8	27.6	27.5	27.1	26.8	26.7	25.6	26.7
1957	25.4	25.5	26.5	27.0	28.3	28.5	27.5	27.9	27.7	27.2	26.8	26.9	27.1
1958	25.9	25.6	26.1	27.2	28.3	28.8	27.9	27.5	28.1	27.1	26.5	25.9	27.1
1959	25.5	25.8	26.3	27.4	27.9	29.1	28.1	27.8	27.9	27.6	26.9	26.4	27.2
1960	26.4	26.1	27.0	27.9	28.2	28.4	28.3	28.7	27.5	27.0	26.5	25.9	27.3
1961	24.7	26.3	27.2	27.0	28.3	28.0	27.8	27.7	27.8	27.0	26.7	26.2	27.1
1962	25.3	25.0	26.6	27.5	27.9	28.3	27.5	27.6	27.0	27.8	26.7	26.0	26.9
1963	24.2	24.3	25.4	26.9	27.9	28.1	28.1	27.6	27.6	27.1	26.9	26.2	26.7
1964	25.9	25.7	26.9	27.0	28.1	28.2	28.1	28.2	27.7	27.3	27.4	25.9	27.2
1965		25.9	26.1	27.2	27.7	28.0	27.8	27.8	27.7	27.0	27.2	26.4	27.1
1966	25.8	26.3	26.5	27.3	28.1	28.4	27.7	28.2	27.7	27.1	27.4	26.7	27.3
1967	25.4	25.5	26.0	27.1	28.6	28.4	27.9	27.4	27.5	27.2	26.5	25.4	26.9
1968	25.0	25.1	26.3	27.3	28.9	28.9	28.3	28.1	27.9	26.7	25.6	25.7	27.0
1969	25.7	25.4	26.8	27.6	29.1	28.9	27.8	27.2	27.1	26.7	26.1	25.7	27.0
1970	25.4	25.7	26.8	27.5	28.5	28.1	28.0	27.4	27.6	27.1	26.9	26.7	27.1
1971	24.7	25.1	25.1	26.8	27.4	26.2	25.8	26.6	27.1	26.1	25.6	25.1	26.0
1972	24.9	25.9	24.7	25.6	26.6	27.5	27.6	27.2	26.8	27.0	26.3	26.3	26.3
1973	25.2	25.3	26.2	27.4	28.5	28.7	27.9	27.5	27.3	27.2	27.4	25.7	27.0
1974	24.8	25.5	26.0	27.4	28.1	28.0	27.4	28.0	28.4	26.9	26.2	25.7	26.8
1975	24.6	24.7	25.6	26.4	27.9	27.7	27.3	27.3	26.9	27.0	26.4	25.3	26.4
1976	24.5	24.8	26.0	26.9	27.0	27.3	27.5	26.8	27.4	27.5	26.7	25.9	26.5
1977	26.1	25.2	26.0	27.1	28.2	28.4	27.5	28.2	27.1	27.2	26.4	25.9	26.9
1978	25.3	25.4	26.6	27.5	28.0	28.1	28.2	27.3	27.4	27.1	26.5	26.2	26.9
1979	25.4	26.3	26.8	27.8	28.6	28.1	27.9	27.7	27.8	27.4	27.0	25.9	27.2
1980	25.8	25.7	26.5	27.4	28.6	27.3	27.9	26.0	27.6	27.2	27.1	26.1	27.1
1981	24.9	25.9	25.8	27.8	28.7	28.4	27.8	28.4	28.3	27.6	27.1	26.1	27.3
1982	25.3	25.7	27.1	27.7	28.3	28.7	27.6	27.8	27.8	27.7	27.2	26.7	27.3
1983	26.4	26.3	27.4	28.2	29.2	29.5	28.4	26.6	28.2	27.8	26.7	26.1	27.7
1984	26.2	26.4	27.1	26.4	28.7	27.9	27.9	27.3	27.7	27.3	27.0	26.3	27.6
1985	25.6	26.8	27.3	27.9	28.8	28.6	27.7	28.4	27.6	27.5	27.3	26.6	27.4
1986	25.8	25.8	26.7	27.7	29.2	28.8	-	28.1	27.9	27.5	27.5	26.6	27.4
1987	26.0	25.7	27.1	28.4	29.7	29.4	28.2	28.7	28.0	28.2	27.6	26.9	27.8
1988	27.4	27.6	27.8	28.4	29.6	28.6	28.4	28.6	28.3	27.1	26.7	25.2	27.8
1989	26.2	25.8	26.3	27.9	28.2	28.0	28.0	27.9	27.7	27.4	26.6	25.4	27.1
1990	25.8	26.3	26.7	28.2	28.7	27.7	27.9	28.0	27.3	27.0	26.9	26.1	27.2
1991	26.1	25.6	26.4	27.8	28.1	27.9	27.6	28.0	28.3	27.3	26.1	25.4	27.0
1992	25.5	25.6	26.9	28.1	28.4	28.2	27.2	27.8	27.5	26.8	26.1	25.9	27.0
1993	25.2	25.3	25.6	27.4	28.1	28.5	27.6	27.4	27.1	27.0	27.2	26.4	26.8
1994	26.0	25.8	27.5	28.3	29.2	28.5	27.3	27.8	27.3	27.4	25.9	26.1	27.2
1995	25.7	25.8	25.7	27.7	28.5	29.0	27.9	27.6	27.7	27.6			27.3
Average	25.5	25.7	26.4	27.4	28.3	28.2	27.3	27.7	27.6	27.2	26.6	26.0	27.0

Source : PAGASA, Legazpi

Table A.2.7 Maximum Monthly Temperature in Legazpi Station

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1949		29.2	27.5	29.8	30.4	31.9	31.2	31.4	31.5	30.3	29.6	29.3	30.2
1950	28.3	29.1	29.2	30.9	31.8	32.8	31.4	32.1	31.1	30.3	29.4	28.6	30.4
1951	28.9	28.9	29.6	30.4	31.0	31.3	31.1	31.4	30.9	31.2	29.8	29.0	30.3
1952	28.8	28.9	27.9	30.7	31.6	32.1	32.0	30.5	31.3	31.2	30.4	28.7	30.5
1953	28.8	29.2	30.1	31.1	32.7	31.2	31.5	31.3	32.2	31.3	30.2	29.3	30.7
1954	29.6	30.3	29.5	30.8	31.3	32.5	32.8	31.4	31.9	31.6	30.2	27.3	30.8
1955	28.3	28.9	29.7	30.7	31.9	31.6	31.8	31.8	32.1	31.7	29.8	28.1	30.5
1956	28.8	29.2	29.2	30.4	30.7	31.6	31.6	31.3	30.8	30.3	30.1	28.1	30.2
1957	28.1	28.7	29.6	30.1	32.2	32.5	31.1	31.7	31.3	31.0	30.3	29.8	30.5
1958	29.0	28.9	29.3	30.6	31.9	33.0	31.6	31.1	31.9	30.4	29.5	29.4	30.6
1959	28.6	28.9	29.5	31.2	31.5	33.2	32.4	31.5	32.1	31.4	30.2	29.3	30.8
1960	29.4	29.2	30.5	31.4	31.6	32.4	32.1	32.5	31.4	30.7	29.7	29.1	30.8
1961	27.4	29.4	30.9	32.3	32.2	31.0	31.7	31.2	31.8	31.1	29.9	29.3	30.7
1962	27.9	27.9	29.8	31.3	31.5	32.7	31.0	31.6	30.7	31.8	30.2	29.0	30.5
1963	27.1	27.4	29.1	30.9	32.0	32.2	32.3	32.2	31.7	31.4	30.1	29.7	30.5
1964	29.4	28.8	31.1	30.4	32.1	32.4	32.4	32.0	31.7	31.3	31.0	29.1	31.0
1965		29.2	29.5	31.0	31.8	32.3	30.8	32.0	31.7	31.0	30.8	29.5	30.9
1966	29.1	30.0	30.3	31.7	32.4	32.6	31.9	32.7	31.7	31.3	31.4	30.0	31.3
1967	28.4	28.8	29.8	31.3	33.3	32.6	32.0	30.9	31.7	31.5	30.0	28.9	30.8
1968	28.4	29.3	29.9	31.8	33.7	34.2	32.8	32.4	32.5	31.3	29.7	29.2	31.3
1969	29.6	29.9	31.3	31.7	33.8	34.1	32.4	31.7	31.4	31.6	30.5	29.4	31.5
1970	29.4	29.8	31.2	32.1	33.6	33.1	32.9	31.8	32.1	31.1	30.8	30.2	31.5
1971	28.3	28.5	29.0	31.3	31.9	31.0	30.7	31.3	31.9	30.3	29.9	28.6	30.3
1972	28.1	29.6	28.9	30.2	31.6	32.1	31.3	31.4	31.2	31.8	29.9	30.0	30.5
1973	29.1	28.9	30.2	31.1	32.5	33.0	32.1	31.5	31.2	30.6	30.7	28.3	30.8
1974	27.8	28.7	29.5	31.3	32.0	32.1	31.4	31.8	33.2	30.8	29.6	28.7	30.6
1975	28.3	28.9	30.2	30.1	31.8	31.8	31.8	31.2	31.1	31.3	29.9	28.1	30.4
1976	27.0	27.9	29.0	30.4	30.3	30.7	31.3	30.4	31.2	31.1	30.1	28.7	29.9
1977	29.5	28.2	29.1	30.6	32.2	32.4	31.8	32.4	30.4	31.1	29.5	29.4	30.6
1978	28.6	29.1	30.2	31.2	31.7	31.8	32.1	30.7	31.0	30.8	29.7	29.2	30.5
1979	29.0	30.0	30.1	31.2	32.4	31.7	31.6	31.1	31.6	30.8	30.1	28.9	30.7
1980	28.8	28.7	29.7	30.7	32.6	30.3	31.6	32.0	31.1	30.8	30.4	28.8	30.5
1981	27.3	26.9	30.3	31.0	32.5	32.2	31.2	31.8	32.1	31.0	30.0	29.0	30.5
1982	28.1	26.4	30.4	31.0	32.1	32.3	30.9	31.4	30.9	31.2	30.0	29.7	30.5
1983	29.5	30.3	30.8	31.9	33.0	33.1	31.8	32.2	31.9	31.1	29.5	28.7	31.1
1984	28.8	29.0	30.0	31.7	32.3	31.2	31.9	30.7	31.5	30.9	30.4	29.1	30.6
1985	28.5	29.9	30.5	31.5	32.1	32.4	31.3	31.8	31.1	30.7	30.0	29.5	30.8
1986	27.9	29.1	29.7	30.8	33.4	32.8		31.4	31.7	30.9	30.7	29.7	30.7
1987	28.8	28.9	30.2	31.9	33.6	33.6	32.0	32.7	31.4	32.2	31.0	29.7	31.3
1988	30.5	30.9	31.1	32.0	33.2	32.5	32.0	33.5	32.3	30.3	29.5	27.6	31.2
1989	26.7	29.1	29.8	31.8	32.0	32.9	31.6	31.7	31.5	31.4	29.6	28.6	30.7
1990	26.7	29.6	30.3	32.3	32.3	31.3	31.7	31.8	33.2	30.7	30.3	29.0	30.9
1991	29.2	28.9	30.0	31.4	31.6	31.3	31.4	31.2	31.8	30.9	29.6	28.5	30.5
1992	29.1	29.6	30.4	32.1	32.1	31.8	30.8	31.0	31.0	30.1	29.3	28.7	30.3
1993	24.5	28.3	29.0	31.0	31.7	32.1	31.0	30.4	30.8	30.2	30.5	29.2	30.2
1994	29.0	29.0	31.1	32.0	33.1	31.9	30.1	30.8	30.3	32.1	28.1	28.8	30.4
1995	29.4	28.8	28.5	30.8	32.0	32.6	31.2	30.8	30.3	31.0			30.5
Average	28.6	29.1	29.9	31.2	32.2	32.3	31.6	31.6	31.5	31.0	30.1	29.0	30.7

Source : PAGASA, Legazpi

Table A.2.8 Minimum Monthly Temperature in Legazpi Station

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1949		22.6	23.7	23.7	24.4	24.2	23.5	23.7	23.2	23.3	22.0	23.2	23.4
1950	22.8	22.1	23.1	24.0	23.9	23.8	23.9	23.9	23.3	22.8	23.2	22.6	23.3
1951	22.6	22.5	22.7	23.9	24.2	23.9	23.9	24.2	23.8	23.7	23.9	23.4	23.6
1952	22.7	23.4	23.1	23.8	25.2	24.2	24.4	23.9	23.3	23.2	22.9	22.9	23.6
1953	22.4	22.9	23.2	24.3	24.2	24.1	23.5	24.4	23.0	23.2	23.4	22.8	23.4
1954	22.2	22.7	22.7	23.8	23.9	23.4	22.7	23.3	23.0	22.1	22.2	22.5	22.9
1955	22.3	22.0	22.2	23.4	23.8	23.7	23.6	23.6	23.3	23.2	23.2	22.2	23.0
1956	22.2	22.2	23.0	23.6	24.0	24.0	23.6	23.6	23.4	23.0	23.2	23.1	23.2
1957	22.7	22.3	23.3	23.9	24.2	24.5	23.9	24.1	24.0	23.3	23.2	23.7	23.6
1958	22.8	22.3	22.9	23.8	24.6	24.5	24.1	23.9	24.3	23.7	23.4	22.4	23.6
1959	22.4	22.7	23.0	23.6	24.3	24.9	23.8	24.0	23.6	23.8	23.5	23.5	23.6
1960	23.3	22.9	23.5	24.1	24.7	24.3	24.4	24.8	23.5	23.3	23.3	22.7	23.7
1961	21.9	23.1	23.4	24.2	24.4	24.2	23.9	24.2	23.8	22.8	23.4	23.1	23.5
1962	22.3	22.0	23.4	23.6	24.2	23.8	24.0	23.5	23.3	23.7	23.1	22.9	23.3
1963	21.2	21.1	21.7	22.8	23.7	24.0	23.8	23.0	23.5	22.7	23.7	22.7	22.8
1964	22.4	22.6	22.6	23.5	24.1	24.0	23.8	24.3	23.6	23.3	23.2	22.6	23.3
1965		22.6	22.7	23.4	23.5	23.6	23.3	23.6	23.7	22.9	23.5	23.2	23.3
1966	22.4	22.6	22.6	23.7	23.8	24.1	23.4	23.7	23.7	22.9	23.3	23.3	23.3
1967	22.4	22.2	22.2	22.8	23.9	24.1	23.8	23.8	23.2	22.8	23.0	21.9	23.0
1968	21.6	20.8	22.7	22.8	24.1	23.5	23.8	23.8	23.3	22.1	23.4	22.1	22.7
1969	21.8	20.9	22.3	23.5	24.4	23.7	23.1	22.7	22.7	21.7	21.7	21.9	22.5
1970	21.3	21.6	22.3	22.8	23.4	23.1	23.1	23.0	23.0	23.1	23.0	23.2	22.7
1971	21.1	21.6	21.2	22.3	22.8	21.4	20.9	21.6	22.2	21.9	21.2	21.9	21.7
1972	21.6	22.1	20.5	21.0	21.6	22.8	23.8	22.9	22.3	22.1	22.7	22.6	22.2
1973	21.3	21.6	22.1	23.6	24.5	24.3	23.7	23.5	23.3	23.7	24.1	23.1	23.2
1974	21.7	22.2	22.4	23.4	24.1	23.8	23.4	24.2	23.5	22.9	22.7	22.7	23.1
1975	20.8	20.4	20.9	22.7	24.0	23.5	22.7	23.4	22.7	22.7	22.8	22.4	22.4
1976	22.0	21.6	22.9	23.3	23.7	23.8	23.8	23.2	23.5	23.8	23.0	23.1	23.1
1977	22.7	22.1	22.5	23.5	24.2	24.3	23.2	23.9	23.7	23.2	23.2	22.4	23.2
1978	21.9	21.7	22.9	23.7	24.3	24.3	24.3	23.9	23.7	23.4	23.3	23.1	23.4
1979	21.8	22.6	23.2	24.4	24.8	24.5	24.2	24.2	24.0	24.0	23.8	22.9	23.7
1980	22.8	22.7	23.2	24.1	24.6	24.3	24.2	23.9	24.1	23.5	23.7	23.4	23.7
1981	22.4	22.7	23.3	24.6	24.8	24.6	24.3	24.9	24.5	24.1	24.2	23.2	24.0
1982	22.5	22.9	23.7	24.4	24.5	25.1	24.3	24.1	24.6	24.1	24.3	23.7	24.0
1983	23.3	22.3	23.9	24.5	25.4	25.8	25.0	25.0	24.5	24.4	23.8	23.9	24.3
1984	23.6	23.7	24.1	25.1	25.1	24.6	23.8	24.6	23.8	23.6	23.9	23.5	24.1
1985	22.6	23.6	24.0	24.3	24.6	24.7	24.0	24.9	24.1	24.2	24.5	23.6	24.1
1986	23.7	22.5	23.7	24.6	25.0	24.7		24.8	24.1	24.1	24.3	23.5	24.1
1987	23.1	22.5	24.0	24.8	25.7	25.2	24.4	24.6	24.6	24.1	24.1	24.0	24.3
1988	24.2	24.2	24.6	24.8	25.9	24.7	24.8	24.7	24.3	23.9	23.8	22.8	24.4
1989	23.7	22.4	22.7	23.9	24.4	24.0	24.3	24.0	23.9	23.3	23.3	22.4	23.5
1990	22.9	22.9	23.0	24.1	25.0	24.1	24.1	24.2	23.2	23.3	23.4	23.4	23.6
1991	22.9	22.3	22.8	24.1	24.5	24.4	23.8	24.7	25.0	23.6	22.5	22.3	23.6
1992	21.8	21.6	23.3	24.0	24.7	24.6	23.6	24.5	23.9	23.4	22.8	23.0	23.4
1993	21.8	22.3	22.1	23.7	24.5	24.5	24.1	23.8	23.3	23.8	23.9	23.6	23.5
1994	22.9	22.5	23.8	24.5	25.2	25.0	24.5	24.7	24.3	23.7	23.7	23.4	24.0
1995	23.0	22.7	22.8	24.5	25.0	25.4	24.6	24.4	24.8	24.2			24.1
Average	22.4	22.3	22.9	23.8	24.3	24.2	23.8	23.9	23.6	23.3	23.3	22.9	23.4

Source : PAGASA, Legazpi

Table A.2.9 Mean Monthly Temperature at Buca, Guinobatan

Unit : C

Year	January	February	March	April	May	June	July	August	September	October	November	December	Average
1990	25.3	25.6	25.5	27.7	27.7	27.5	27.6	27.8	27.5	27.2	27.2	25.7	
1991	25.9	25.3	25.4	26.4	27.7	27.6	27.1	27.0	27.4	26.1	25.6	25.4	
1992	24.6	24.7	26.1	27.4		27.8	26.8	27.6					
1993	25.4	25.3	25.5	26.4	27.2	27.9	26.9	26.6	26.7	26.4	26.3		
1994	25.7	25.9	26.5	27.4	28.0	27.5	26.8	27.0	26.9	26.8	26.2	25.8	
1995	24.6	26.1	25.9	26.9	27.7	29.5							
Average	25.2	25.5	25.8	27.0	27.6	28.0	27.0	27.2	27.1	26.6	26.3	25.6	26.6

Source : PAGASA, Buca, Guinobatan

Table A.2.10 Maximum Monthly Temperature at Buca, Guinobatan

Unit : C

Year	January	February	March	April	May	June	July	August	September	October	November	December	Average
1990	30.1	31.0	31.6	33.4	32.5	31.8	31.4	31.7	32.2	31.5	30.6	29.1	
1991	30.4	29.7	30.5	31.4	32.5	32.1	31.4	30.3	31.2	29.9	29.5	29.3	
1992	28.8	29.8	31.6	33.2		32.4	30.9	32.0					
1993	30.0	29.9	30.8	32.1	32.6	33.0	30.9	30.1	30.8	29.9	30.1		
1994	29.8	31.1	31.2	32.5	33.5	32.5	30.7	31.9	30.8	31.4	30.7	29.8	
1995	28.4	29.8	30.8	32.2	32.7	31.1							
Average	29.6	30.2	31.1	32.5	32.8	32.1	31.1	31.2	31.2	30.6	30.2	29.4	31.0

Source : PAGASA, Buca, Guinobatan

Table A.2.11 Minimum Monthly Temperature at Buca, Guinobatan

Unit : C

Year	January	February	March	April	May	June	July	August	September	October	November	December	Average
1990	20.4	20.2	19.4	22.0	22.9	23.1	23.8	23.9	22.7	22.9	23.9	22.2	
1991	21.4	20.9	20.2	21.4	22.8	23.1	22.9	23.6	23.5	22.3	21.6	21.5	
1992	20.3	19.6	20.6	21.6		23.2	22.7	23.2					
1993	20.8	20.7	20.2	20.7	21.8	22.8	22.9	23.0	22.6	22.9	22.6		
1994	21.6	20.7	21.8	22.2	22.5	22.5	22.0	22.2	23.0	22.2	21.8	21.7	
1995	20.8	22.4	21.0	21.5	22.6	28.0							
Average	20.9	20.7	20.5	21.6	22.5	23.8	23.0	23.2	23.0	22.6	22.5	21.8	22.2

Source : PAGASA, Buca, Guinobatan

Table A.2.12 Mean Monthly Relative Humidity at Legazpi Station

Unit : %

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1949		82	84	82	82	82	84	86	82	85	83	85	83
1950	87	81	82	80	80	84	83	82	86	84	83	80	83
1951	84	82	81	85	85	85	85	85	88	86	87	90	85
1952	88	86	83	83	82	83	84	87	85	84	83	87	85
1953	84	84	84	82	81	84	86	86	85	86	85	87	85
1954	83	82	84	82	83	82	83	86	84	85	82	89	84
1955	85	81	81	82	82	82	82	84	83	85	86	84	83
1956	85	85	83	85	85	85	87	87	87	86	86	89	86
1957	88	84	84	85	82	84	85	84	85	84	82	83	84
1958	84	84	82	80	80	82	84	86	84	87	87	84	84
1959	85	84	84	81	84	80	84	86	86	85	85	85	84
1960	83	84	82	82	84	85	84	81	87	85	87	83	84
1961	80	81	82	83	83	82	83	85	83	85	84	84	83
1962	83	82	82	82	83	83	86	85	89	84	85	87	84
1963	85	84	83	81	81	83	86	88	88	85	87	86	85
1964	86	85	83	85	81	79	82	82	85	86	86	86	84
1965		80	83	83	81	84	85	84	85	86	86	86	84
1966	86	83	84	82	84	83	86	85	84	86	88	86	85
1967	83	80	79	81	79	81	83	83	84	84	82	83	82
1968	83	82	83	80	78	81	82	84	85	83	84	85	83
1969	83	82	80	81	79	77	80	82	86	85	83	87	82
1970	84	81	84	85	82	84	85	88	87	88	89	88	85
1971	84	87	82	85	86	87	85	84	86	88	87	91	86
1972	91	88	88	86	84	85	84	85	88	83	89	86	86
1973	81	81	77	80	78	80	83	84	86	85	85	89	82
1974	83	85	80	81	82	83	86	82	80	86	85	87	83
1975	85	84	82	86	83	83	85	84	88	86	83	87	85
1976	86	83	82	80	83	84	83	85	86	86	86	86	84
1977	86	85	81	83	82	82	85	82	87	84	88	84	84
1978	82	81	83	81	84	85	84	86	86	84	85	86	84
1979	80	81	78	81	81	84	84	85	84	83	85	83	82
1980	83	82	81	80	78	86	82	84	85	86	84	84	83
1981	82	82	79	82	81	82	84	81	83	85	87	85	83
1982	81	82	81	81	81	80	83	84	84	82	86	85	83
1983	83	77	77	75	75	77	82	81	83	86	85	86	81
1984	85	83	84	81	84	83	84	84	85	86	85	83	84
1985	82	83	83	84	83	82	86	84	86	87	87	85	84
1986	85	82	83	83	81	87		85	86	87	86	80	84
1987	82	81	81	80	79	80	83	82	84	83	87	87	82
1988	86	83	82	83	80	81	82	80	84	87	85	84	83
1989	86	88	86	84	82	84	85	83	85	84	83	84	85
1990	86	82	81	78	81	85	85	83	85	89	84	87	84
1991	85	86	82	82	84	85	85	85	84	86	85	86	85
1992	85	82	82	79	81	82	86	84	85	87	84	86	84
1993	84	84	83	80	80	82	87	87	88	86	89	89	85
1994	88	78	83	85	79	85	86	82	87	85	84	86	84
1995	86	84	84	83	85	83	87	88	89	87			86
Average	84	83	82	82	82	83	84	84	85	85	85	86	84

Source : PAGASA, Legazpi

Table A.2.13 Mean Monthly Relative Humidity In Buca, Guinobatan

Unit : %

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1990	89	83	78	77	79	86		87	83	72	80	85	
1991	85	84	84	80	82	86	89	91	91	88	87	86	
1992	88	85	79	82		83	88	88					
1993	90	88	86	84	86	92	91	93	93	93	93		
1994	94	95	92	93	92	93	95	96	97	95	91	94	
1995	93	93	90	84	86	91							
Average	89.9	87.9	84.3	83.1	85.1	88.5	90.8	91.1	90.7	87.2	87.7	88.3	87.9

Source : PAGASA, Buca, Guinobatan

Table A.2.14 Mean Monthly Evaporation at Buca, Guinobatan

Unit : mm/day

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1990	8.3	11.6	12.2	14.1	10.5	8.6	7.7						
1991							8.1	10.8	10.4	9.1	9.9	9.8	
1992	10.0	11.2	14.4	12.5		12.2	11.4	9.8					
1993	9.4	9.5	10.0					9.6	9.2	9.1	8.9		
1994	8.7	9.2	10.2	9.9	9.3	9.3	7.3			9.2	10.2	7.6	
1995	9.0	10.8	11.7	12.9	11.1	10.7							
Average	9.1	10.5	11.7	12.4	10.3	10.2	8.6	10.1	9.8	9.1	9.6	8.7	
mm/month	281	293	364	371	318	306	267	312	294	282	289	270	3619

Source : PAGASA, Buca, Guinobatan

Table A.2.15 Mean Monthly Wind Speed in Legazpi Station

Unit: m/sec

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1952	4	4	3	3	3	2	3	3	2	4	3	4	3.2
1953	4	5	4	4	3	3	2	4	3	3	4	3	3.5
1954	4	4	4	4	3	2	2	4	4	3	5	5	3.7
1955	5	4	4	4	3	3	3	3	3	3	4	5	3.7
1956	4	4	5	4	4	3	3	3	4	3	4	4	3.8
1957	4	4	4	4	3	3	3	3	3	3	3	3	3.3
1958	4	4	4	4	3	3	3	3	3	3	4	4	3.5
1959	4	4	4	3	4	2	2	3	2	3	4	4	3.3
1960	3	3	3	3	3	3	2	4	2	4	3	4	3.1
1961	5	6	3	4	3	4	4	3	3	3	4	5	3.9
1962	5	5	4	4	4	2	4	3	3	3	4	4	3.8
1963	4	4	4	4	4	4	3	3	4	3	3	3	3.6
1964	3	4	4	3	3	3	2	3	2	2	3	4	3.0
1965		4	3	3	3	3	4	3	3	2	3	4	3.2
1966	4	3	3	3	3	3	2	3	4	3	3	3	3.1
1967	4	4	4	3	3	3	4	4	3	3	4	4	3.6
1968	4	3	3	3	3	2	4	4	3	3	4	4	3.3
1969	3	3	4	4	3	3	3	3	3	2	3	3	3.1
1970	3	4	4	4	3	3	3	4	3	3	3	3	3.3
1971	4	4	4	3	2	2	4	3	3	4	3	3	3.3
1972	4	3	3	3	2	2	4	2	2	2	3	3	2.8
1973	3	3	4	3	3	2	2	2	1	3	2	2	2.5
1974	3	3	3	3	2	3	2	3	2	2	3	3	2.7
1975	3	3	3	3	3	2	2	3	2	2	3	3	2.7
1976	3	2	2	2	3	3	2	3	2	2	2	3	2.4
1977	2	3	3	3	2	3	2	3	3	2	2	3	2.6
1978	3	3	3	3	3	2	3	3	2	2	2	3	2.7
1979	3	2	2	3	3	2	3	3	2	3	3	3	2.7
1980	3	3	4	4	3	2	3	2	2	2	4	3	2.9
1981	4	3	3	3	2	3	2	4	3	2	3	4	3.0
1982	4	4	4	3	3	3	3	2	3	2	2	2	2.9
1983	3	3	3	3	3	3	2	3	1	2	3	3	2.7
1984	3	3	3	3	2	3	2	4	2	2	3	2	2.7
1985	4	2	3	2	2	3	2	3	2	2	2	2	2.4
1986	6	3	3	3	2	1		3	2	2	2	4	2.8
1987	4	3	2	2	2	3	3	3	3	2	3	4	2.8
1988	3	4	4	3	3	3	3	2	2	3	5	6	3.4
1989	5	4	3	3	3	2	3	3	2	2	4	4	3.2
1990	4	4	4	4	4	4	3	5	3	2	3	4	3.7
1991	4	4	4	4	3	3	3	3	3	2	3	3	3.3
1992	3	3	3	3	2	2	1	3	2	2	3	3	2.5
1993	3	3	3	2	2	2	2	2	2	2	2	3	2.3
1994	3	3	3	8	1	1	3	3	2	2	3	3	2.9
1995	3	3	3	3	2	2	1	1	2	1			2.1
Average	3.7	3.5	3.4	3.3	2.8	2.6	2.7	3.0	2.5	2.5	3.2	3.5	3.1
km/day	317	302	291	288	241	225	233	263	219	216	273	299	264

Source : PAGASA, Legazpi

Table A.2.16 Mean Monthly Wind speed at Buca, Guinobatan

Unit : knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1990					2.4	1.5	0.5	1.5	0.7	0.5	2.5	3.3	
1991	4.5	6.3	2.7	2.2	2.7	2.0	1.8	1.8	1.6	2.1	3.2	2.7	
1992	2.2	2.2	3.1	1.9		1.6	0.9	1.8					
1993	4.2	5.4	5.1	6.0	2.4	1.5		0.5	5.1	4.9			
1994	4.7	5.1		2.6	2.5	4.7	2.3	0.7	1.3	2.3	2.7	2.1	
1995	1.9	1.6	1.5	1.2	1.3	3.4							
Average in knot	3.5	4.1	3.1	2.8	2.2	2.5	1.4	1.3	2.2	2.4	2.8	2.7	
Average in m/s	1.6	1.9	1.4	1.3	1.0	1.1	0.6	0.6	1.0	1.1	1.3	1.2	1.2

Source : PAGASA, Buca, Guinobatan

Table A.2.17 Cloudness Record in Legazpi Station

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1949		7	7	7	7	8	8	9	9	9	8	8	7.9
1950	8	7	7	7	8	9	9	8	9	8	8	8	8.0
1951	9	8	7	7	8	9	9	9	9	9	9	9	8.5
1952	8	9	8	8	7	9	9	9	9	8	9	9	8.5
1953	8	8	7	6	8	9	8	9	9	8	9	9	8.2
1954	7	8	8	7	7	8	8	9	9	9	9	9	8.2
1955	9	8	8	7	6	8	9	9	8	9	8	9	8.2
1956	8	8	7	8	8	8	8	9	9	8	9	10	8.3
1957	8	8	8	7	6	7	9	9	9	9	8	8	8.0
1958	8	8	6	6	6	8	8	10	10	9	8	7	7.8
1959	8	7	8	7	8	7	8	9	9	8	9	9	8.1
1960	8	8	7	7	8	9	9	9	9	9	9	8	8.3
1961	7	6	6	6	6	6	7	8	7	6	6	7	6.5
1962	7	7	6	7	6	5	8	7	7	6	6	7	6.6
1963	6	8	7	7	7	7	7	7	8	6	7	6	6.9
1964	5	7	5	5	5	6	6	7	7	7	7	7	6.2
1965		6	7	6	6	6	7	6	7	6	6	6	6.3
1966	6	5	5	5	7	6	6	6	6	6	6	6	5.8
1967	7	6	5	5	5	6	7	7	6	6	6	6	6.0
1968	6	5	5	5	5	6	6	7	6	5	6	6	5.7
1969	5	5	5	5	5	6	6	6	7	6	6	7	5.8
1970	6	6	6	6	5	6	6	7	7	6	6	6	6.1
1971	6	6	6	4	6	6	7	6	6	7	6	6	6.0
1972	6	5	6	5	4	6	7	6	6	4	5	5	5.4
1973	5	5	5	4	4	5	6	6	6	6	6	7	5.4
1974	6	6	5	4	4	5	6	6	5	7	6	6	5.5
1975	6	6	5	6	5	6	6	7	6	6	5	7	5.9
1976	6	5	5	5	5	5	6	6	6	6	7	6	5.7
1977	6	6	6	4	5	6	6	6	7	5	6	6	5.8
1978	6	6	5	5	6	6	6	7	7	7	6	5	6.0
1979	5	5	5	5	5	6	6	6	6	7	6	6	5.7
1980	6	5	5	5	5	7	6	6	7	6	6	7	5.9
1981	7	6	4	5	6	7	7	6	6	6	7	6	6.1
1982	6	6	6	5	5	6	7	6	7	5	6	5	5.8
1983	5	3	4	4	3	5	6	6	6	6	6	7	5.1
1984	6	5	4	4	5	6	5	7	5	6	6	5	5.3
1985	6	5	4	5	5	5	5	6	6	6	5	5	5.3
1986	6	5	5	5	5	6		6	6	6	5	4	5.4
1987	5	5	4	4	4	6	6	6	6	5	6	6	5.3
1988	5	5	4	5	5	6	6	6	6	6	7	6	5.6
1989	6	6	6	5	5	6	6	6	6	5	5	5	5.6
1990	5	4	4	3	5	6	6	6	5	6	6	5	5.1
1991	5	5	4	4	5	5	6	7	7	7	6	5	5.5
1992	5	4	4	4	5	6	6	7	6	6	6	6	5.4
1993	5	5	5	5	4	5	6	6	6	6	6	6	5.4
1994	6	5	5	4	5	5	7	6	7	6	5	6	5.6
1995	5	4	5	4	4	4	6	7	7	6			5.2
Average	5.8	5.4	5.1	4.9	5.1	5.8	6.3	6.4	6.3	6.0	6.0	5.9	5.7

Remarks: 1949-196(0-10
1961-199:0-8
Average from 1961 to 1995
Source : PAGASA, Legazpi

Table A.2.18 Mean Monthly Sunshine Hours at Buca, Guinobatan

Unit : hrs

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1990		8.1	8.3	9.7	7.1		4.6						
1991	6.9	6.6	7.8				4.4	3.7	4.5	3.3	4.9	6.1	
1992	5.6	7.0	8.5	8.8		6.6	4.7	4.9					
1993	5.5	4.9	6.2	8.7	9.0	6.6	4.5	3.9	4.5	4.1	4.4		
1994	4.9	6.1	0.0	7.2	7.2	5.1	3.0	5.8	3.5	5.4	6.5	4.8	
1995	5.6	6.3	6.4	8.4	6.7	8.7							
Average	5.7	6.5	6.2	8.6	7.5	6.8	4.3	4.6	4.2	4.3	5.3	5.4	5.8

Source : PAGASA, Buca, Guinobatan

Table A.2.19 List of Typhoons Affected Study Area

Year	Name of Typhoon	Occurance Date	
1970	Atang	Feb-23	Feb-27
	Yoning	Nov-17	Nov-20
1971	Heriming	May-25	May-27
1972	Konsing	Jan-23	Jan-26
1973	Luming	Oct-02	Oct-09
1974	Bising	Jan-08	Jan-11
	Iling	Jun-22	Jul-02
	Tening	Oct-14	Oct-17
	Aning	Nov-04	Nov-07
1976	Huaning	Jun-22	Jul-02
1977	Unding	Nov-10	Nov-17
1978	Atang	Apr-18	Apr-26
	Weling	Sep-24	Sep-28
	Yaning	Oct-07	Oct-14
	Kading	Oct-25	Oct-29
1979	Bebeng	Apr-13	Apr-19
	Etang	Jun-30	Jul-01
	Pepang	Sep-16	Sep-20
	Yayang	Nov-04	Nov-07
1980	Nitang	Jul-19	Jul-22
	Osang	Jul-22	Jul-27
	Yoning	Oct-28	Oct-30
	Aring	Nov-01	Nov-07
1981	Yeyeng	Nov-17	Nov-21
	Dinang	Dec-23	Dec-27
	Daling	Jun-28	Jul-02
1982	Miding	Aug-11	Aug-15
	Morning	Aug-20	Sep-04
1983	Bebeng	Aug-11	Aug-15
	Herming	Sep-24	Sep-26
	Warling	Nov-23	Nov-26
1984	Nitang	Aug-31	Sep-03
	Undang	Nov-01	Nov-06
	Welpring	Nov-14	Nov-16
	Yoning	Nov-18	Nov-21
1985	Kuring	Jun-20	Jun-24
	Daling	Jun-25	Jun-29
	Saling	Oct-15	Oct-20
	Tasing	Oct-23	Oct-31
	Unsing	Dec-16	Dec-23
1986	Pasing	Oct-16	Oct-16
	Weling	Nov-18	Nov-20
	Aning	Dec-20	Dec-24
	Bidang	Dec-30	Jan-01
1987	Herming	Aug-12	Aug-13
	Sisang	Nov-25	Nov-26
	Trining	Dec-16	Dec-17
1988	Asiang	Jan-14	Jan-17
	Unsang	Oct-23	Oct-24
	Yoning	Nov-03	Nov-09
1989	Rining	May-15	May-19
	Kuning	Jun-04	Jun-08
1990	Klaring	Jun-25	Jun-27
	Gading	Aug-15	Aug-20
	Puping	Nov-12	Nov-13

Source : PAGASA, Legazpi

Table A.2.20 Interpolated Monthly Rainfall at Guinobatan

Unit : mm

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1949	44.1	8.9	72.9	97.7	117.3	154.7	277.9	163.3	277.2	269.6	291.8	473.5	2351.8
1950	293.7	96.4	175.0	31.2	75.0	266.3	253.8	177.4	502.5	214.7	250.2	114.4	2450.5
1951	125.3	62.7	30.2	154.6	300.7	307.5	246.0	238.5	242.3	193.4	317.8	349.4	2568.7
1952	253.0	132.2	89.3	109.7	19.1	181.5	323.6	323.8	167.4	250.2	202.0	422.8	2473.7
1953	128.4	92.0	84.1	45.1	34.0	252.9	260.2	200.6	230.3	368.3	285.9	336.7	2318.6
1954	116.6	54.7	295.6	42.8	258.1	187.4	260.5	255.7	177.4	217.5	309.7	609.8	2765.9
1955	237.2	45.4	75.1	139.0	102.8	293.0	273.1	270.4	258.3	262.4	417.3	160.4	2534.3
1956	100.5	166.3	140.1	454.5	180.2	136.7	450.7	230.1	398.6	140.4	376.9	778.5	3543.8
1957	245.8	61.0	79.0	375.4	27.3	229.8	277.1	375.9	254.7	285.0	251.7	97.8	2356.5
1958	161.7	91.8	93.0	21.1	121.5	194.8	245.1	274.5	329.9	881.4	286.4	66.0	2767.2
1959	143.9	97.3	204.2	35.1	229.5	120.0	303.3	260.7	248.1	340.2	474.5	595.2	3052.0
1960	106.8	99.6	53.8	250.3	254.7	270.5	273.3	208.9	267.0	569.0	378.1	204.3	2936.3
1961	13.7	17.5	67.8	32.2	224.3	209.8	335.5	254.5	193.5	323.6	169.6	112.4	1954.4
1962	123.4	92.5	113.0	39.8	339.5	356.0	400.8	250.8	338.0	91.5	329.8	77.2	2552.3
1963	12.9	55.5	11.4	15.4	117.6	365.1	152.7	594.5	248.4	184.0	175.6	186.8	2119.9
1964	146.8	65.7	56.9	160.5	50.7	248.7	127.8	169.1	412.8	220.6	269.8	426.4	2354.8
1965	249.7	76.8	57.2	181.0	172.7	364.9	561.9	156.3	277.5	187.8	207.9	271.6	2725.5
1966	226.9	35.1	66.7	28.9	178.7	152.2	328.2	158.1	190.4	260.9	369.4	569.3	2564.8
1967	419.4	90.7	96.8	72.1	42.1	108.1	317.0	293.4	427.1	172.0	76.0	61.1	2175.8
1968	128.9	74.1	22.9	7.1	0.0	184.1	235.8	240.3	854.0	819.9	399.0	408.3	3374.5
1969	180.8	97.5	10.4	16.4	68.3	220.6	328.0	179.1	315.4	81.3	190.1	342.0	2029.9
1970	125.1	215.3	104.2	66.2	43.6	110.6	506.5	376.8	269.3	568.4	528.6	221.8	3136.4
1971	255.6	170.7	210.4	120.2	460.9	217.3	429.3	107.6	135.8	400.1	180.6	593.6	3283.1
1972	480.7	33.8	141.4	21.5	134.9	364.0	275.1	372.1	245.2	75.2	228.4	273.4	2648.7
1973	116.9	11.3	21.9	10.2	60.2	157.7	144.3	447.8	252.8	545.9	492.4	745.2	3006.6
1974	57.9	120.7	39.0	11.7	80.5	473.6	425.4	98.3	98.4	445.0	356.7	359.1	2526.3
1975	190.0	41.9	8.2	186.2	68.4	220.5	303.6	208.1	289.2	199.3	233.8	1006.4	2955.6
1976	268.6	88.6	115.4	11.6	532.8	301.8	132.0	342.7	323.7	146.5	257.2	593.4	3134.3
1977	105.3	98.7	17.7	56.5	166.3	72.8	419.1	307.5	339.8	8.6	352.8	25.2	1970.3
1978	24.9	12.0	92.4	123.8	156.7	297.9	239.1	310.9	234.2	348.0	61.3	203.6	2104.8
1979	36.2	8.6	31.6	265.0	172.1	248.9	283.5	347.4	501.5	199.8	144.2	198.0	2416.8
1980	146.5	27.3	83.9	34.6	51.8	237.5	461.5	200.1	181.2	157.6	66.7	46.3	1695.0
1981	141.7	68.9	18.6	82.7	191.3	767.8	85.6	122.7	162.8	99.3	197.9	198.0	2137.2
1982	108.1	268.2	119.2	35.3	190.0	149.8	368.1	336.0	784.0	193.9	124.2	110.3	2787.1
1983	8.6	1.0	5.2	9.2	0.0	127.2	322.3	158.4	301.8	245.6	269.6	298.6	1747.5
1984	201.7	80.2	95.6	0.0	75.3	352.0	270.9	322.5	226.3	348.9	344.3	83.4	2401.3
1985	151.7	76.2	74.9	106.4	105.5	269.1	354.0	129.0	280.0	316.6	250.9	143.4	2257.8
1986	110.6	63.0	33.2	245.1	59.3	215.6	283.2	227.8	304.1	377.6	220.4	72.5	2212.4
1987	50.2	25.0	9.7	54.9	16.0	185.2	316.0	247.1	249.0	218.1	340.5	396.0	2107.7
1988	131.1	48.7	29.9	185.4	85.6	217.7	274.7	145.3	308.7	507.0	433.0	168.5	2435.5
1989	278.5	293.8	145.3	159.0	216.2	356.3	269.6	224.7	346.0	213.7	180.5	237.9	2920.4
1990	180.1	18.4	13.0	20.9	175.9	438.8	293.4	253.8	159.9	262.8	319.4	127.3	2262.7
1991	36.6	14.7	116.8	51.2	65.1	376.0	296.1	340.1	236.8	154.6	292.0	164.3	2144.3
1992	100.2	21.7	12.5	35.7	94.1	146.7	356.6	177.1	256.0	391.3	204.1	210.4	1806.4
1993	70.8	55.0	43.4	25.6	40.8	152.7	563.4	531.5	315.2	269.3	450.2	577.3	3100.2
1994	294.9	22.1	69.0	181.1	206.0	242.9	497.6	154.8	354.2	164.8	28.0	392.5	2607.9
1995	72.5	43.4	17.5	54.1	113.0	201.6	373.8	332.1	395.6	238.9			
Average	153.7	75.4	75.5	90.5	137.8	249.1	314.3	257.8	299.3	281.5	273.7	306.8	2517.3

Source : JICA Team's Estimate

Table A.2.21 Estimated Monthly Rainfall in the Study Area

Unit : mm

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1949	71.6	19.0	125.1	133.9	135.2	123.7	228.7	141.7	257.2	290.1	414.1	590.5	2530.9
1950	436.4	162.2	284.9	56.3	91.1	262.8	195.6	159.3	518.0	218.3	333.1	168.2	2886.3
1951	190.3	397.2	58.4	200.4	326.7	314.2	184.8	235.5	216.8	190.5	455.9	441.6	2925.2
1952	375.5	220.8	150.8	147.9	32.8	157.2	291.7	341.8	130.1	264.8	245.5	530.8	2889.6
1953	194.7	155.1	142.6	72.6	48.4	246.1	204.4	188.2	202.9	419.1	397.8	429.6	2701.6
1954	177.6	94.0	473.5	69.9	282.2	164.4	204.8	256.9	141.7	222.1	441.1	750.6	3278.7
1955	353.8	78.9	128.6	182.2	120.1	296.1	222.1	215.1	235.3	280.7	636.5	222.3	3031.7
1956	184.0	193.4	232.6	476.1	219.7	111.9	312.2	240.9	457.4	175.8	435.1	804.2	3843.1
1957	305.2	79.8	123.9	183.6	95.5	212.7	232.1	295.5	247.5	311.2	292.2	172.0	2553.9
1958	252.2	163.9	201.8	48.0	133.3	197.6	240.2	297.4	258.6	825.2	359.6	81.3	3058.8
1959	199.0	194.5	307.9	54.3	283.9	96.3	230.3	227.3	212.3	293.8	492.8	601.2	3196.3
1960	152.0	176.1	68.5	280.4	275.5	333.4	233.1	202.9	288.0	526.2	447.3	220.4	3203.3
1961	57.2	33.2	92.9	81.4	202.3	247.0	271.3	299.8	177.3	311.9	222.9	194.4	2191.2
1962	201.8	136.9	138.4	65.8	372.3	249.3	396.9	296.9	400.0	133.2	369.9	125.3	2886.6
1963	47.9	106.8	28.2	28.7	132.0	328.5	201.1	663.9	184.7	163.4	290.7	271.1	2446.7
1964	225.9	159.5	76.8	297.9	108.4	200.0	187.4	212.7	354.1	215.4	314.8	534.3	2886.9
1965	278.5	137.5	150.0	134.7	181.2	338.4	520.2	247.4	267.3	253.0	347.3	404.4	3259.4
1966	409.5	69.9	111.3	58.4	197.5	159.9	376.4	183.6	228.6	330.6	410.7	691.9	3228.2
1967	455.0	119.8	156.1	105.8	44.7	115.2	220.5	340.8	310.5	195.9	399.7	171.1	2634.9
1968	266.1	76.3	70.6	28.2	9.7	160.3	170.9	237.7	587.7	468.7	334.4	295.0	2705.5
1969	114.5	60.8	41.8	80.1	50.0	185.2	265.7	133.6	379.5	119.9	261.9	441.7	2174.4
1970	197.4	272.6	198.2	119.2	89.1	157.1	432.4	490.7	244.4	554.3	643.4	390.5	3699.1
1971	323.5	239.2	316.9	129.1	434.4	203.6	411.8	138.5	154.4	437.0	251.3	714.8	3754.2
1972	570.0	83.4	204.3	58.7	143.0	378.5	224.9	336.4	236.8	130.5	420.1	323.4	3109.6
1973	143.1	56.3	32.5	59.1	79.5	170.5	230.8	382.2	219.0	528.5	633.0	661.8	3416.0
1974	147.9	244.8	65.7	68.7	169.9	496.3	432.0	129.8	86.5	451.8	461.2	438.8	3193.2
1975	273.4	136.3	65.1	281.2	109.9	187.4	250.1	218.3	303.9	169.3	303.4	1277.6	3565.7
1976	478.7	124.8	183.6	58.3	477.9	256.1	143.7	366.7	269.5	220.6	333.6	719.3	3632.5
1977	172.3	158.0	79.8	85.3	205.8	90.1	398.6	270.6	365.7	114.2	505.0	100.4	2545.7
1978	40.0	51.4	122.5	124.1	181.8	295.1	216.3	348.2	293.8	453.7	161.3	349.1	2637.1
1979	87.0	124.9	49.8	268.9	150.7	275.6	264.2	247.9	483.1	217.4	233.0	223.2	2616.4
1980	184.6	158.2	191.0	60.4	58.1	386.7	380.0	275.5	232.0	405.0	190.0	167.4	2688.6
1981	302.7	118.7	40.2	116.4	165.0	558.7	162.2	189.2	257.7	295.3	530.4	337.9	3074.1
1982	167.7	307.3	184.7	78.4	185.3	142.7	379.9	293.2	626.3	220.7	255.1	252.6	3143.7
1983	72.9	6.2	19.3	30.7	11.0	205.4	427.6	135.6	285.6	258.7	368.2	384.8	2206.1
1984	302.0	135.8	160.7	16.9	91.4	369.6	219.1	340.2	198.3	393.8	503.9	131.8	2863.4
1985	228.8	129.2	128.3	144.1	123.0	266.3	333.6	98.9	260.5	351.6	334.4	202.3	2600.9
1986	168.7	107.6	63.0	305.9	74.8	199.7	236.1	222.1	288.3	431.3	278.9	118.9	2495.3
1987	80.4	45.4	36.3	84.1	29.6	161.8	281.3	246.2	224.6	222.8	497.1	499.3	2398.7
1988	198.7	84.1	57.9	236.3	102.2	202.2	234.4	119.2	177.8	600.2	665.1	231.9	2900.1
1989	414.1	485.2	238.3	205.4	238.4	374.9	216.0	218.3	336.9	217.0	206.4	313.5	3464.6
1990	313.6	61.7	22.5	42.2	221.2	411.9	246.3	265.0	183.6	352.8	357.7	242.8	2721.0
1991	168.7	77.8	159.5	77.9	169.4	448.0	305.5	316.4	203.5	183.3	340.4	317.3	2707.5
1992	166.7	78.1	33.4	41.3	111.1	133.6	342.2	226.4	232.7	187.9	249.3	281.1	2083.6
1993	116.0	83.6	99.5	30.8	80.1	184.8	478.5	453.5	304.5	318.0	576.1	712.4	3437.5
1994	442.7	49.1	119.0	229.4	120.1	219.3	437.4	110.0	304.0	167.7	78.0	428.4	2754.8
1995	173.5	68.0	31.4	83.8	126.6	199.7	360.9	352.0	394.2	250.0			
Average	230.3	128.1	129.1	123.9	156.2	244.1	285.6	260.0	282.4	305.2	375.6	395.0	2937.9

Source : JICA Team's Estimate

Table A.3.1 Monthly Discharge Data at Nasisi Station

RIVER : NASISI R. STA. ID 05SW131233PW026 LOCATION: NASISI, LIGAO
DRAINAGE AREA 39.00 KM2 ALBAY Unit m3/sec

Year	January	February	March	April	May	June	July	August	September	October	November	December	Mean
1951	***	***	***	***	***	***	***	***	***	***	3.48	3.16	***
1952	2.16	2.58	2.06	1.49	1.18	0.93	0.86	0.87	2.37	2.53	1.20	2.35	1.72
1953	1.99	1.76	2.02	1.53	1.22	1.18	1.37	1.64	1.88	1.29	1.80	2.76	1.70
1954	2.06	1.35	1.74	1.31	1.01	0.76	0.91	1.11	1.10	1.34	3.29	2.99	1.58
1955	5.24	4.00	2.31	2.29	1.52	1.35	1.29	1.27	1.40	1.75	2.43	2.24	2.26
1956	1.99	2.06	2.26	2.02	1.26	0.99	1.30	1.49	2.53	2.00	2.72	5.01	2.14
1957	5.05	2.75	2.57	2.45	2.24	1.55	1.07	1.21	1.52	2.11	3.06	2.48	2.34
1958	2.26	1.80	1.64	1.38	1.45	1.62	1.83	1.95	1.65	2.88	1.43	1.32	1.77
1959	1.48	1.70	2.52	2.57	3.20	2.87	1.89	1.57	1.53	2.06	2.47	1.98	2.15
1960	1.01	0.87	0.90	1.65	1.98	5.06	1.92	1.74	2.45	2.89	3.25	2.98	2.23
1961	3.15	1.97	2.27	1.77	2.00	1.64	1.99	1.69	1.53	1.66	2.02	2.48	2.01
1962	2.33	2.12	2.18	1.80	2.51	1.76	1.85	1.90	1.81	1.66	3.78	2.03	2.14
1963	1.49	2.10	1.57	1.41	1.40	2.62	1.37	2.93	1.82	1.76	2.08	1.76	1.86
1964	2.42	1.65	1.44	1.43	1.39	2.04	1.69	1.75	2.63	1.29	1.75	3.85	1.94
1965	4.00	2.62	1.66	1.33	1.39	1.27	1.32	1.28	1.36	1.31	1.28	1.53	1.70
1966	1.46	1.31	1.29	1.25	1.28	1.29	1.32	1.46	1.27	1.18	1.48	2.74	1.44
1967	2.70	3.04	2.51	3.01	2.21	2.14	2.18	1.78	1.02	1.49	1.51	0.86	2.04
1968	1.76	1.76	1.44	1.41	1.19	1.39	1.39	1.51	2.44	1.41	6.61	1.64	2.00
1969	0.92	0.86	1.06	0.78	0.84	0.82	1.07	0.93	1.08	1.11	1.22	3.29	1.17
1970	0.93	0.90	0.81	0.68	0.66	0.61	0.60	***	0.60	2.02	0.71	0.73	***
1971	0.72	0.79	1.04	0.57	0.93	0.79	0.88	***	0.59	1.24	1.74	3.11	***
1972	11.42	1.14	1.18	0.85	0.70	1.11	0.91	1.82	2.00	2.09	2.78	3.67	2.47
1973	2.94	2.24	2.05	1.96	1.73	1.71	1.73	2.01	1.67	3.05	8.43	12.70	3.52
1974	4.60	3.87	2.36	1.68	***	***	3.35	2.02	1.79	2.33	4.59	5.27	***
1975	0.29	0.31	0.32	1.11	1.76	1.34	2.23	2.86	2.35	2.09	1.71	6.16	1.91
1976	1.27	1.29	1.08	1.17	1.03	1.14	1.26	2.09	2.84	***	***	***	***
1977	2.47	3.22	2.65	2.89	2.75	2.36	2.15	1.36	1.42	1.56	1.56	1.40	2.15
1978	3.14	2.74	5.55	5.86	5.34	4.41	***	***	***	5.40	5.36	***	***
Average	2.64	1.96	1.87	1.76	1.70	1.72	1.53	1.68	1.73	1.98	2.73	3.10	2.03

Source : NWRB

Table A.3.2 Monthly Discharge Data at Ugsong Station

RIVER : UGSONG R. STA. ID 05SW131233PW028 LOCATION: BENANUAN, LIGAO
DRAINAGE AREA 11.00 KM2 ALBAY Unit m3/sec

Year	January	February	March	April	May	June	July	August	September	October	November	December	Mean
1955	1.97	1.39	1.28	1.41	1.24	1.26	1.23	1.24	1.28	1.44	1.96	1.27	1.41
1956	1.02	1.16	1.36	1.88	2.04	1.78	2.29	0.82	3.80	8.09	4.67	2.90	2.65
1957	2.47	2.07	1.95	1.89	5.69	1.51	1.49	3.80	2.62	2.58	2.48	1.90	2.54
1958	2.07	1.80	1.99	1.99	1.46	1.80	1.77	1.82	2.21	3.20	2.60	1.42	2.01
1959	1.08	0.98	1.43	1.16	1.19	0.73	1.27	1.44	1.59	2.18	2.02	1.18	1.35
1960	0.45	0.53	0.51	***	***	6.01	1.36	2.01	4.34	5.40	4.25	0.94	***
1961	0.84	0.41	1.22	0.86	0.93	0.73	0.79	0.99	0.75	1.42	1.10	1.20	0.94
1962	1.03	0.87	0.21	0.28	1.04	5.21	1.52	1.08	0.53	0.67	1.24	0.50	1.18
1963	0.13	0.31	0.06	0.04	0.03	1.06	0.55	0.34	0.68	1.03	1.47	0.50	0.52
1964	1.68	0.14	0.57	***	0.62	0.26	0.07	0.20	0.28	1.84	1.43	1.12	***
1965	0.95	0.30	0.26	0.07	0.20	0.35	1.04	0.65	1.02	0.93	1.83	1.73	0.78
1966	2.41	2.85	0.19	0.05	0.37	0.55	0.86	0.57	0.56	0.22	0.68	0.73	0.84
1967	0.56	0.10	***	0.53	0.25	0.02	0.37	0.37	0.53	0.51	1.17	0.51	***
1968	1.01	0.50	0.52	0.57	0.64	0.28	0.05	0.07	1.54	1.75	2.15	1.85	0.91
1969	1.08	0.03	0.02	0.02	0.01	0.38	0.72	0.55	0.48	0.32	0.61	0.66	0.41
1970	0.07	1.00	0.06	0.09	0.08	0.06	0.25	0.69	0.27	0.79	0.75	0.76	0.41
1971	0.33	0.25	0.36	0.02	0.61	0.54	0.50	0.03	0.12	1.37	1.21	2.75	0.67
1972	0.93	0.02	0.14	0.38	0.33	1.00	0.87	1.02	0.89	0.80	0.97	0.68	0.67
1973	0.47	0.28	0.10	0.23	0.36	0.35	0.81	1.60	0.90	0.90	0.95	2.56	0.79
1974	0.63	1.36	0.82	0.33	0.40	1.43	1.33	0.59	1.43	1.93	2.49	***	***
1975	***	***	***	1.25	0.66	0.28	1.71	1.30	1.90	2.26	2.42	3.69	***
1976	0.80	0.50	0.25	0.36	0.34	0.58	0.49	0.82	0.67	0.34	0.59	1.93	0.64
1977	1.16	1.26	1.05	0.93	0.76	1.04	1.16	0.86	0.98	0.76	1.22	0.77	1.00
1978	***	***	***	***	***	***	***	***	***	***	***	***	***
1979	***	***	***	***	***	***	***	***	***	***	***	***	***
1980	***	***	***	***	***	***	***	***	***	***	***	***	***
1981	***	***	***	***	***	***	***	***	***	***	***	***	***
1982	***	1.69	1.40	1.48	1.61	1.73	1.94	1.86	2.06	2.08	2.14	1.84	***
1983	1.37	1.24	1.15	1.20	1.00	***	1.57	1.39	1.39	1.47	1.29	1.55	***
1984	1.52	1.32	1.37	1.16	1.32	1.48	1.44	1.61	1.64	***	***	***	***
1985	1.67	1.39	1.46	1.55	1.48	1.47	***	***	***	***	1.50	1.51	***
1986	1.59	1.47	1.45	1.48	1.42	***	1.54	1.56	***	***	***	***	***
1987	***	***	***	***	***	***	***	***	***	***	***	***	***
1988	***	***	***	***	***	***	***	***	***	***	***	***	***
1989	***	***	***	***	***	***	***	***	***	***	***	***	***
Average	1.13	0.93	0.81	0.82	0.97	1.23	1.07	1.08	1.33	1.77	1.74	1.46	1.19

Source : NWRB

Table A.3.3 Monthly Discharge Data at Cumadcad Station

RIVER : CUMADCAD R. STA. ID 05SW125234PW034 LOCATION: CUMADCAD, CASTILLA
DRAINAGE AREA 13.00 KM2 SORSOGON Unit m3/sec

Year	January	February	March	April	May	June	July	August	September	October	November	December	Mean
1957	***	***	***	***	***	***	***	***	1.07	0.93	1.27	0.35	***
1958	0.50	0.34	0.67	0.18	0.12	0.09	0.21	0.48	1.08	3.43	2.30	0.88	0.86
1959	0.58	1.15	1.37	0.27	0.16	0.11	2.10	0.23	0.31	0.19	1.11	2.38	0.83
1960	1.25	1.05	0.56	0.53	0.57	3.42	0.60	0.51	0.86	2.93	3.12	1.00	1.37
1961	0.46	0.20	0.11	0.07	0.10	0.44	1.02	0.18	0.99	1.06	1.70	0.96	0.61
1962	1.37	0.89	1.00	0.42	0.95	0.74	1.39	1.51	1.83	1.20	1.48	1.18	1.16
1963	0.64	0.65	0.30	0.16	0.13	0.25	0.66	1.68	0.97	0.85	1.51	0.97	0.73
1964	0.69	0.97	0.39	0.50	0.54	0.33	0.64	0.37	0.57	0.44	1.85	3.19	0.87
1965	0.96	0.88	0.69	0.24	0.50	0.62	0.89	0.73	0.47	0.85	1.50	2.18	0.88
1966	1.33	0.19	0.20	0.16	0.14	0.10	0.55	0.53	0.86	1.00	1.97	2.40	0.79
1967	4.83	0.77	0.76	0.10	0.06	0.06	0.14	0.94	1.42	0.55	1.09	0.36	0.92
1968	1.06	0.48	0.15	0.06	0.06	0.06	0.22	0.69	0.39	0.38	0.90	0.36	0.40
1969	0.06	0.08	0.05	0.03	0.01	0.05	0.10	0.36	0.93	0.38	1.08	***	***
1970	***	0.73	0.51	0.41	0.16	0.16	1.06	1.38	1.02	1.88	0.95	1.56	***
1971	1.21	1.73	0.52	0.09	0.43	0.32	0.98	0.10	0.44	0.73	0.59	2.68	0.82
1972	2.40	***	***	***	***	***	***	***	***	***	***	***	***
1973	***	***	***	0.19	0.10	0.08	0.13	0.30	0.72	1.70	1.59	3.89	***
1974	1.31	1.04	0.41	0.26	0.28	0.92	1.08	0.78	0.57	0.98	***	***	***
1975	2.02	0.50	0.40	0.53	0.37	0.40	***	***	***	***	***	***	***
1976	1.81	0.54	0.52	0.29	***	***	***	***	***	***	***	***	***
1977	***	***	***	***	0.36	0.26	***	***	***	***	***	0.76	***
1978	0.88	0.28	0.22	0.17	0.12	0.83	0.62	***	***	***	***	***	***
1979	***	***	***	***	***	***	***	***	***	***	***	***	***
1980	***	***	***	***	***	***	1.28	1.15	1.63	2.39	2.27	1.60	***
1981	1.92	0.68	0.24	0.14	0.16	0.20	1.92	1.47	1.15	2.29	3.92	***	***
1982	2.13	2.72	1.08	1.07	1.14	0.53	1.27	0.81	4.59	0.65	1.09	1.22	1.52
1983	0.31	0.15	0.06	0.02	0.01	0.07	1.20	0.49	0.87	1.23	3.16	4.75	1.03
1984	2.25	1.30	1.20	0.31	0.11	0.50	0.75	0.85	1.87	1.11	1.82	1.62	1.14
1985	***	***	***	***	***	***	***	***	***	***	***	***	***
1986	2.99	2.05	0.56	1.29	0.67	0.71	2.46	1.47	0.52	4.05	2.94	2.16	1.82
1987	***	***	***	***	***	***	***	***	***	***	***	***	***
1988	***	***	***	***	***	***	***	***	***	***	***	***	***
1989	***	5.05	1.81	0.70	1.38	***	0.44	0.45	0.42	1.33	0.79	2.49	***
Average	1.43	1.02	0.57	0.33	0.34	0.47	0.90	0.76	1.07	1.35	1.74	1.77	0.98

Source : NWRB

Table A.3.4 Monthly Discharge Data at Malbog Station

RIVER : MALBOG R. STA. ID 05SW125234PW035 LOCATION: CUMADCAD, CASTILLA
DRAINAGE AREA 8.00 KM2 SORSOGON Unit m3/sec

Year	January	February	March	April	May	June	July	August	September	October	November	December	Mean
1955	***	***	***	0.08	0.05	0.05	0.01	0.02	0.03	0.05	1.67	0.09	***
1956	0.54	0.75	0.70	0.52	0.20	0.19	0.36	0.49	1.21	0.53	1.64	1.66	0.73
1957	1.29	0.31	0.26	0.36	0.16	0.13	0.95	0.54	0.61	0.53	0.81	0.26	0.52
1958	0.31	0.25	0.34	0.08	0.06	0.05	0.26	0.45	0.75	1.64	1.17	0.50	0.49
1959	0.12	0.43	0.52	0.08	0.06	0.05	0.18	0.28	0.35	0.13	0.80	1.74	0.40
1960	0.77	0.55	0.18	0.11	0.13	***	***	***	1.00	1.51	1.85	0.98	***
1961	0.41	0.19	0.14	0.09	0.19	0.50	0.87	0.19	0.72	0.73	1.09	0.65	0.48
1962	0.69	0.36	0.52	0.12	0.34	0.24	0.65	0.82	0.96	0.80	1.11	0.78	0.62
1963	0.29	0.23	0.12	0.06	0.07	0.30	0.36	0.82	0.73	0.33	0.85	0.55	0.39
1964	0.29	0.43	0.09	0.13	0.16	0.18	0.48	0.12	0.26	0.28	1.56	2.77	0.56
1965	0.96	0.69	0.63	0.16	0.24	0.81	0.91	0.46	0.68	1.53	1.81	2.27	0.93
1966	2.06	0.19	0.14	0.10	0.13	0.12	0.92	0.80	0.67	1.95	2.48	2.56	1.01
1967	4.00	0.23	0.25	0.08	0.04	0.04	0.05	0.72	0.71	0.44	2.16	0.42	0.76
1968	1.05	0.34	0.11	0.06	0.07	0.02	0.07	0.27	0.23	0.19	0.20	0.09	0.23
1969	***	***	***	***	***	***	***	***	***	***	***	***	***
1970	***	***	***	***	***	***	***	***	***	***	***	***	***
1971	***	***	***	***	***	***	***	***	***	***	***	***	***
1972	***	***	***	***	***	***	***	***	***	***	***	***	***
Average	0.98	0.38	0.31	0.15	0.14	0.21	0.47	0.46	0.64	0.76	1.37	1.09	0.58

Source : NWRB

Table A.3.5 Monthly Discharge Data at Pilir Station

RIVER : PILI R. STA. ID 05SW125235PW036 LOCATION: SAN ISIDRO, CASTILLA
DRAINAGE AREA 18.00 KM2 SORSOGON Unit m3/sec

Year	January	February	March	April	May	June	July	August	September	October	November	December	Mean
1953	***	***	***	***	***	***	***	***	***	***	***	5.86	***
1954	3.58	1.34	3.06	0.40	0.21	0.10	0.15	0.24	0.78	1.32	3.82	4.75	1.65
1955	5.28	0.94	1.04	0.46	0.23	0.12	0.21	0.27	0.45	0.73	3.27	2.11	1.26
1956	1.07	1.34	1.81	1.04	0.33	0.18	0.36	0.86	1.96	1.00	2.74	4.66	1.45
1957	6.54	1.47	0.80	1.16	0.52	0.19	0.80	0.63	0.88	0.90	1.27	1.13	1.36
1958	1.39	1.35	***	0.45	0.19	0.11	0.19	***	0.36	3.91	2.38	1.57	***
1959	1.55	0.78	1.72	0.46	0.07	0.03	0.03	0.02	0.05	0.01	0.52	5.61	0.90
1960	2.11	1.16	0.52	0.04	0.05	***	***	***	***	***	***	***	***
1961	1.38	0.40	0.12	0.08	0.12	0.28	0.33	0.22	0.33	0.63	1.83	1.60	0.61
1962	1.20	***	2.16	0.30	0.80	0.35	0.23	0.62	0.34	0.33	1.01	1.07	***
1963	0.83	1.17	0.05	0.02	0.04	0.21	0.18	1.62	1.10	0.25	0.67	0.59	0.56
1964	0.42	1.16	0.58	0.24	0.85	0.37	0.36	0.09	0.30	0.80	0.80	2.76	0.73
1965	2.42	1.21	1.16	0.23	0.60	0.50	1.42	0.31	0.70	0.76	1.23	3.09	1.14
1966	4.09	0.45	0.07	0.05	0.05	0.05	0.07	0.14	0.18	0.65	3.95	4.16	1.16
1967	4.26	1.27	1.46	0.16	0.03	0.02	0.01	0.27	0.27	0.27	4.75	0.19	1.08
1968	0.21	***	0.01	0.01	0.01	0.02	0.01	0.17	0.01	0.04	***	***	***
1969	***	0.01	0.01	0.01	0.01	***	0.02	0.08	0.06	0.10	***	***	***
1970	***	1.07	***	***	0.14	0.18	0.40	***	***	***	0.89	***	***
1971	2.22	3.25	***	0.40	***	***	***	***	***	***	***	***	***
1972	***	***	***	***	***	***	***	***	***	***	***	***	***
Average	2.41	1.15	0.97	0.32	0.25	0.18	0.30	0.40	0.52	0.78	2.08	2.80	1.01

Source : NWRB

Table A.3.6 Monthly Discharge Data at Cawayan Station

RIVER : CAWAYAN R. STA. ID 05SW125235PW037 LOCATION: BASUD, SORSOGON
DRAINAGE AREA 15.00 KM2 SORSOGON Unit m3/sec

Year	January	February	March	April	May	June	July	August	September	October	November	December	Mean
1954	1.55	1.16	2.71	0.67	0.50	0.39	0.32	0.31	0.30	0.31	1.03	8.10	1.45
1955	7.11	0.69	0.56	0.45	0.36	0.30	0.36	0.34	0.35	1.98	1.98	2.30	1.40
1956	1.30	3.09	2.69	1.88	1.11	0.89	0.96	1.01	1.46	1.42	1.43	3.94	1.77
1957	5.88	2.27	1.15	1.20	0.64	0.52	0.55	0.57	0.58	0.63	1.22	1.10	1.36
1958	1.92	1.92	2.76	0.98	0.68	0.51	0.53	0.53	0.64	2.48	6.21	3.89	1.92
1959	6.32	5.12	3.36	0.78	0.53	0.39	0.39	0.34	0.29	0.33	***	3.38	***
1960	1.51	1.21	1.04	0.75	0.82	1.62	0.50	0.47	0.47	3.27	3.17	2.92	1.48
1961	2.36	1.76	1.37	1.27	0.94	0.83	0.87	0.69	0.74	0.62	1.41	1.09	1.16
1962	1.49	1.45	1.16	0.72	2.09	2.02	***	2.52	2.51	1.83	2.29	2.40	***
1963	4.32	5.32	3.34	2.05	1.98	2.04	1.97	1.50	0.83	0.81	0.89	1.20	2.19
1964	1.37	1.48	1.36	1.58	1.62	1.10	1.28	0.94	0.87	0.82	1.78	4.32	1.54
1965	5.69	1.59	0.91	0.81	0.74	0.60	0.67	0.58	0.57	0.63	0.88	1.19	1.24
1966	1.57	1.05	0.89	0.89	0.55	0.52	0.58	0.68	0.62	0.60	0.75	0.98	0.81
1967	0.83	0.32	0.33	0.24	0.21	0.20	0.24	0.20	0.24	0.22	0.95	0.64	0.39
1968	0.68	0.65	0.70	0.65	0.61	0.44	0.41	0.46	***	0.18	0.21	0.24	***
1969	0.22	0.18	0.15	0.12	0.07	0.03	0.08	0.15	0.29	0.29	0.28	1.19	0.25
1970	***	***	0.95	0.95	0.82	0.75	0.79	***	0.77	0.86	0.92	0.10	***
1971	1.09	1.62	2.18	0.76	1.01	1.35	1.03	0.90	0.90	***	1.00	2.72	***
1972	2.83	0.51	0.39	0.36	0.33	0.38	0.22	0.22	0.09	0.08	0.15	0.21	0.48
1973	0.11	0.17	***	***	0.10	0.04	***	0.14	0.16	0.25	0.26	0.47	***
1974	0.19	0.78	0.60	0.69	0.32	0.19	0.16	0.17	0.06	0.13	0.75	0.80	0.40
1975	***	***	***	***	0.36	0.20	0.23	0.31	***	***	0.43	3.55	***
1976	6.01	1.95	0.93	0.32	0.54	0.52	0.24	0.40	0.23	***	***	***	***
1977	***	***	***	***	***	***	***	***	***	***	***	***	***
1978	***	***	***	***	***	***	***	***	***	***	***	***	***
1979	***	***	***	***	***	***	***	***	***	***	***	***	***
1980	***	***	***	***	***	***	***	***	***	***	***	***	***
1981	***	***	***	***	***	***	***	1.10	1.50	3.64	7.07	4.81	***
1982	***	5.02	***	***	***	***	9.39	***	1.46	***	15.44	15.70	***
Average	2.59	1.79	1.41	0.86	0.74	0.69	0.99	0.63	0.69	1.02	2.20	2.80	1.37

Source : NWRB

Table A.3.7 Estimated Monthly Runoff at Camalig Diversion Dam Site

Unit : 1000 m3

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1949	370	98	647	693	699	640	1,183	733	1,330	1,500	2,341	3,053	13,086
1950	2,155	801	1,407	278	450	1,298	966	787	2,558	1,078	1,645	830	14,252
1951	936	527	287	985	1,606	1,544	909	1,157	1,066	937	2,241	2,185	14,380
1952	1,853	1,090	744	730	162	776	1,440	1,687	642	1,307	1,212	2,620	14,263
1953	984	784	721	367	244	1,243	1,032	951	1,025	2,117	2,010	2,170	13,646
1954	842	445	2,244	331	1,338	779	971	1,218	671	1,052	2,091	3,558	15,539
1955	1,719	383	625	885	583	1,439	1,079	1,337	1,143	1,364	3,092	1,080	14,729
1956	833	875	1,053	2,154	994	506	1,413	1,090	2,070	795	1,969	3,639	17,390
1957	1,573	411	638	946	492	1,096	1,196	1,538	1,276	1,604	1,506	886	13,162
1958	1,222	794	978	233	646	957	1,163	1,441	1,253	3,997	1,742	394	14,818
1959	950	929	1,471	259	1,356	460	1,100	1,086	1,014	1,404	2,354	2,886	15,269
1960	725	840	327	1,338	1,315	1,591	1,113	968	1,375	2,512	2,135	1,052	15,292
1961	312	181	508	445	1,105	1,349	1,482	1,638	969	1,704	1,218	1,062	11,972
1962	996	676	683	325	1,838	1,231	1,960	1,466	1,975	658	1,826	618	14,253
1963	251	559	147	150	691	1,720	1,053	3,476	967	855	1,522	1,419	12,810
1964	1,115	788	379	1,471	535	987	925	1,650	1,748	1,063	1,554	2,638	14,254
1965	1,322	653	712	640	860	1,607	2,470	1,174	1,269	1,201	1,619	1,920	15,476
1966	1,950	333	530	278	941	761	1,792	874	1,089	1,574	1,956	3,295	15,373
1967	2,318	611	795	539	228	587	1,124	1,737	1,582	998	2,037	872	13,427
1968	1,343	385	356	143	49	810	863	1,200	2,967	2,366	1,688	1,489	13,659
1969	628	333	229	439	274	1,015	1,456	951	2,080	657	1,435	2,421	11,917
1970	903	1,247	906	545	407	718	1,978	1,833	1,118	2,535	2,942	1,786	16,918
1971	1,473	1,089	1,443	588	1,978	927	1,875	631	703	1,990	1,145	3,256	17,099
1972	2,746	402	984	283	689	1,824	1,084	1,621	1,141	629	2,024	1,558	14,984
1973	670	263	246	277	372	798	1,080	1,789	1,025	2,474	2,963	4,034	15,989
1974	707	1,170	314	328	812	2,371	2,064	620	413	2,159	2,204	2,097	15,259
1975	1,263	584	301	1,299	508	866	1,156	1,009	1,405	763	1,402	5,905	16,480
1976	2,201	574	844	268	2,197	1,177	660	1,686	1,239	1,014	1,534	3,307	16,699
1977	889	815	412	440	1,062	465	2,057	1,396	1,887	589	2,606	518	13,135
1978	204	262	624	632	926	1,503	1,102	1,774	1,497	2,311	822	1,778	13,434
1979	444	638	208	1,374	770	1,408	1,350	1,266	2,468	1,110	1,190	1,140	13,367
1980	934	800	966	305	294	1,957	1,923	1,394	1,174	2,049	961	847	13,604
1981	1,464	574	194	563	798	2,702	784	915	1,246	1,428	2,565	1,634	14,868
1982	805	1,476	687	376	890	685	1,824	1,408	3,248	1,060	1,225	1,213	15,096
1983	397	34	105	167	60	1,119	2,330	739	1,556	1,410	2,006	2,097	12,021
1984	1,495	672	796	83	452	1,830	1,085	1,684	982	1,950	2,495	653	14,177
1985	1,171	661	657	738	630	1,363	1,708	507	1,334	1,800	1,712	1,036	13,316
1986	877	559	328	1,590	389	1,038	1,227	1,154	1,498	2,242	1,450	618	12,970
1987	424	239	139	443	156	853	1,484	1,298	1,185	1,175	2,622	2,634	12,653
1988	980	415	285	1,165	504	997	1,106	588	877	2,959	3,279	1,143	14,297
1989	1,930	2,262	1,111	958	1,111	1,748	1,007	1,017	1,570	1,012	962	1,461	16,149
1990	1,550	311	113	212	1,114	2,035	1,241	1,335	925	1,777	1,802	1,223	13,710
1991	549	392	805	393	855	2,261	1,542	1,597	1,027	925	1,718	1,602	13,665
1992	930	436	165	230	619	745	1,908	1,263	1,297	1,048	1,390	1,568	11,619
1993	542	391	465	144	374	863	2,235	2,119	1,422	1,456	2,692	3,329	16,060
1994	2,221	246	597	1,151	853	1,100	2,194	552	1,525	841	391	2,149	13,821
1995	976	393	176	471	712	1,123	2,030	1,980	2,218	1,406			
Average	1,131	625	629	610	765	1,211	1,420	1,292	1,405	1,509	1,851	1,928	14,356

Source : JICA Team's Estimate

Table A.3.8 Estimated Monthly Runoff at No.1 Dam Site

Unit : 1000 m3

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1949	118	31	205	220	222	203	375	233	422	476	680	969	4,154
1950	724	269	473	94	151	436	325	264	860	362	553	279	4,790
1951	316	178	97	333	543	522	307	391	360	317	758	739	4,861
1952	633	367	250	246	54	261	484	567	716	410	408	881	4,797
1953	321	256	235	120	80	406	337	311	335	692	657	709	4,459
1954	298	158	794	117	473	276	343	431	237	372	739	1,258	5,496
1955	590	131	214	304	200	493	370	459	392	468	1,061	370	5,052
1956	312	328	394	806	372	189	529	408	775	298	737	1,362	6,510
1957	501	131	203	302	157	349	381	490	407	511	480	282	4,194
1958	421	273	337	80	222	330	400	496	431	1,376	600	335	5,101
1959	333	325	515	91	475	161	385	380	355	492	824	1,011	5,347
1960	254	295	115	469	461	558	390	339	482	881	748	369	5,361
1961	92	54	150	132	327	399	439	455	287	501	360	314	3,543
1962	335	227	230	109	618	414	659	493	664	221	614	208	4,792
1963	78	175	46	47	216	537	329	1,056	302	267	476	443	4,002
1964	375	265	127	494	180	332	311	353	588	358	523	887	4,793
1965	467	230	251	226	304	567	871	414	448	424	582	677	5,461
1966	686	117	186	98	331	268	630	307	383	554	688	1,158	5,406
1967	749	197	257	174	74	190	363	561	512	323	658	282	4,340
1968	439	126	117	47	16	265	282	393	970	774	552	487	4,468
1969	185	98	67	129	81	299	429	281	613	194	423	714	3,513
1970	333	461	335	201	150	265	731	677	413	937	1,087	660	6,250
1971	547	404	536	218	735	344	696	234	261	739	425	1,209	6,348
1972	952	139	341	98	239	632	376	562	395	218	701	549	5,193
1973	240	95	88	99	134	287	388	642	368	888	1,064	1,449	5,742
1974	247	410	110	115	284	830	723	217	145	756	772	734	5,343
1975	461	213	110	474	185	316	421	368	512	265	511	2,154	6,010
1976	808	211	310	98	807	432	242	619	455	372	563	1,214	6,131
1977	283	259	131	140	338	148	655	444	601	187	829	165	4,180
1978	66	85	202	204	299	456	356	574	484	747	266	575	4,344
1979	143	206	67	443	248	454	435	408	795	358	384	367	4,308
1980	305	261	315	100	96	638	627	455	383	668	313	276	4,437
1981	505	198	67	194	275	932	271	316	430	493	885	564	5,130
1982	260	514	309	131	310	238	635	490	1,130	369	436	422	5,254
1983	118	10	31	50	18	332	692	220	462	419	596	623	3,571
1984	501	225	267	28	152	613	364	564	329	653	836	219	4,751
1985	376	213	211	237	202	438	549	163	429	578	550	333	4,279
1986	277	176	103	501	123	327	387	364	473	707	457	195	4,090
1987	131	74	43	137	48	264	459	402	367	364	812	815	3,916
1988	330	140	96	392	170	336	373	198	295	997	1,105	385	4,817
1989	697	816	401	346	401	631	363	367	567	365	347	527	5,828
1990	518	102	37	70	365	680	407	438	303	583	591	401	4,495
1991	179	128	263	129	280	740	504	522	336	303	562	524	4,470
1992	268	126	54	66	179	215	550	364	374	302	401	452	3,351
1993	195	141	167	52	135	311	805	763	512	535	969	1,198	5,783
1994	732	81	197	379	261	363	723	182	503	272	129	708	4,555
1995	278	109	50	134	203	320	579	565	633	401			
Average	383	213	215	206	260	405	473	431	468	506	624	657	4,848

Source : JICA Team's Estimate

Table A.3.9 Estimated Monthly Runoff at No.2 Dam Site

Unit : 1000 m3

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1949	92	24	161	172	174	159	294	182	330	373	532	758	3,251
1950	567	211	370	73	118	341	254	207	673	284	433	218	3,749
1951	248	139	76	261	425	409	240	306	282	248	593	578	3,805
1952	458	287	196	192	43	204	379	444	169	344	319	690	3,755
1953	252	200	184	94	62	318	264	243	262	542	514	555	3,490
1954	233	123	621	92	370	216	269	337	156	291	579	985	4,302
1955	461	103	168	238	157	386	290	359	307	366	830	290	3,955
1956	244	256	308	631	291	148	414	319	606	233	577	1,066	5,093
1957	392	103	159	236	123	273	298	384	318	400	376	221	3,283
1958	329	214	263	63	174	258	313	388	337	1,077	469	106	3,991
1959	261	255	403	71	372	126	301	298	278	385	645	791	4,186
1960	193	231	90	367	361	437	305	266	377	689	586	289	4,197
1961	72	42	118	103	256	313	343	379	224	395	282	246	2,773
1962	262	178	180	85	484	324	516	386	520	173	481	163	3,752
1963	61	137	36	37	169	421	257	850	236	209	372	347	3,132
1964	294	207	100	387	141	260	243	276	460	280	409	694	3,751
1965	365	180	197	177	238	444	682	324	350	332	455	530	4,274
1966	537	92	146	76	259	209	493	241	300	433	538	907	4,231
1967	587	154	201	136	58	148	284	439	400	253	515	221	3,396
1968	344	99	91	36	33	207	221	307	759	606	432	381	3,496
1969	145	77	53	101	63	234	336	220	430	152	331	559	2,751
1970	261	360	262	158	118	208	572	530	323	733	851	516	4,892
1971	428	317	419	171	575	269	545	183	204	578	333	946	4,968
1972	745	109	267	77	187	495	294	440	309	170	549	423	4,065
1973	188	74	69	78	105	224	304	503	268	695	833	1,134	4,495
1974	194	321	86	90	222	650	566	170	113	592	604	574	4,182
1975	361	167	86	371	145	247	330	288	401	223	400	1,685	4,704
1976	632	165	242	77	631	338	190	484	356	291	441	950	4,797
1977	221	203	103	110	264	116	512	348	470	147	649	129	3,272
1978	52	66	158	160	234	380	279	449	379	585	208	450	3,400
1979	112	161	53	346	194	355	340	319	622	280	300	288	3,370
1980	238	204	247	78	75	499	491	356	300	523	245	216	3,472
1981	395	155	52	152	215	729	212	247	336	385	692	441	4,011
1982	219	402	242	102	242	187	497	383	834	289	334	330	4,111
1983	92	8	24	39	14	260	542	172	362	328	467	488	2,796
1984	392	176	209	22	119	480	285	442	257	511	654	171	3,718
1985	295	166	165	186	158	343	430	127	335	453	431	260	3,349
1986	216	138	81	392	96	256	303	285	370	553	358	153	3,201
1987	103	58	34	107	38	207	360	315	287	285	635	638	3,067
1988	258	109	75	307	133	263	292	155	231	780	864	301	3,768
1989	545	639	314	270	314	494	284	287	444	286	272	413	4,562
1990	405	80	29	54	286	532	318	343	237	456	462	314	3,516
1991	140	100	206	101	219	579	395	409	263	237	440	410	3,499
1992	210	98	42	52	140	168	431	285	293	237	314	354	2,624
1993	153	110	131	40	105	243	639	597	401	418	758	938	4,524
1994	573	63	154	297	220	284	566	142	393	217	101	554	3,564
1995	218	85	39	105	159	251	453	442	495	314			
Average	300	167	168	161	203	317	371	337	366	396	488	515	3,794

Source : JICA Team's Estimate

Table A.3.10 Estimated Monthly Runoff at No.3 Dam Site

Unit : 1000 m3

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1949	56	15	98	105	106	97	180	111	202	228	325	464	1,987
1950	346	129	226	45	72	209	155	126	411	173	264	134	2,290
1951	151	85	46	159	260	250	147	187	172	151	362	353	2,323
1952	298	175	120	117	26	125	232	271	103	210	195	421	2,293
1953	154	122	113	57	38	194	161	149	160	331	314	339	2,132
1954	142	75	380	56	226	132	164	206	114	178	354	602	2,629
1955	282	63	103	145	96	236	177	219	168	224	507	177	2,417
1956	149	157	188	386	178	91	253	195	370	142	352	651	3,112
1957	240	63	97	144	75	167	182	234	194	244	230	135	2,065
1958	201	131	161	38	106	158	192	237	206	656	287	65	2,440
1959	159	156	246	43	227	77	184	182	170	235	394	483	2,556
1960	122	141	55	224	220	267	187	162	230	421	358	176	2,563
1961	44	26	72	63	156	191	210	232	137	241	172	150	1,694
1962	160	109	110	52	296	198	315	236	318	106	294	99	2,293
1963	37	84	22	22	103	257	157	519	144	128	227	212	1,912
1964	179	127	61	236	86	159	149	169	261	171	250	424	2,292
1965	223	110	120	108	145	271	417	198	214	203	278	324	2,611
1966	328	56	89	47	158	128	301	147	183	265	329	554	2,585
1967	358	94	123	83	35	91	174	269	245	154	315	135	2,076
1968	210	60	56	22	8	127	135	188	464	370	264	233	2,137
1969	89	47	32	62	39	143	205	134	293	93	202	341	1,680
1970	159	220	160	96	72	127	349	324	197	418	520	316	2,958
1971	262	193	256	104	351	165	333	112	125	353	203	578	3,035
1972	455	67	163	47	114	302	180	269	189	104	335	258	2,483
1973	115	45	42	48	64	137	186	307	176	425	509	693	2,747
1974	118	196	53	55	136	397	346	104	69	361	369	351	2,555
1975	220	102	52	227	89	151	202	176	245	136	245	1,030	2,875
1976	386	101	148	47	386	207	116	296	217	178	269	581	2,932
1977	135	124	63	67	162	71	313	213	287	90	397	79	2,001
1978	32	40	96	98	143	233	170	274	231	357	127	275	2,076
1979	68	98	32	212	119	217	208	195	380	171	183	176	2,059
1980	146	125	151	48	46	305	300	217	183	320	150	132	2,123
1981	241	95	32	93	132	446	129	151	206	236	423	270	2,454
1982	134	246	148	63	148	114	304	234	541	176	204	202	2,514
1983	56	5	15	24	9	159	331	105	221	200	285	298	1,708
1984	240	108	128	13	73	293	174	270	157	312	400	205	2,273
1985	180	102	101	113	97	210	263	78	205	277	263	159	2,048
1986	132	84	49	240	59	157	185	174	226	338	219	93	1,956
1987	63	35	21	66	23	126	220	192	175	174	388	390	1,873
1988	158	67	46	188	81	161	178	95	141	477	528	184	2,304
1989	333	390	192	165	192	302	174	176	271	175	166	252	2,788
1990	248	49	18	33	175	325	195	209	145	279	283	192	2,151
1991	86	61	126	62	134	354	241	250	161	145	269	251	2,140
1992	128	60	26	32	85	103	263	174	179	145	192	216	1,603
1993	93	67	80	25	64	149	385	365	245	256	463	573	2,765
1994	350	39	94	181	135	173	346	87	240	133	62	339	2,179
1995	133	52	24	64	97	153	277	270	303	192			
Average	183	102	103	98	124	194	226	206	224	242	298	314	2,319

Source : JICA Team's Estimate

Table A.3.11 Estimated Monthly Runoff at No.4 Dam Site

Unit : 1000 m3

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1949	194	52	339	363	361	335	620	384	698	787	1,123	1,601	6,863
1950	1,197	445	781	154	250	721	536	437	1,421	599	914	451	7,916
1951	523	294	100	550	897	863	508	647	595	523	1,252	1,221	8,033
1952	1,030	606	414	406	90	431	800	937	357	726	674	1,456	7,927
1953	531	423	389	198	132	671	558	513	554	1,143	1,065	1,172	7,369
1954	492	260	1,311	194	782	455	567	711	392	615	1,222	2,079	9,080
1955	974	217	354	502	331	815	612	758	648	773	1,753	612	8,349
1956	515	541	651	1,332	615	313	873	674	1,280	492	1,217	2,250	10,753
1957	828	217	336	498	259	577	630	810	672	844	793	467	6,931
1958	695	452	556	132	367	541	662	819	712	2,274	991	224	8,428
1959	550	538	851	150	785	266	636	626	587	812	1,362	1,670	8,835
1960	420	487	189	775	762	922	644	561	796	1,455	1,237	609	8,857
1961	153	89	248	218	541	660	725	801	474	833	596	520	5,858
1962	553	375	380	180	1,021	684	1,089	814	1,097	365	1,015	341	7,917
1963	129	289	76	77	357	888	544	1,795	499	442	786	733	6,615
1964	620	437	211	817	297	548	514	583	971	591	863	1,456	7,918
1965	771	380	415	373	501	937	1,430	685	740	700	961	1,119	9,022
1966	1,133	193	308	161	546	442	1,041	508	632	915	1,136	1,914	8,929
1967	1,238	326	425	288	122	313	600	928	845	533	1,088	466	7,172
1968	726	208	193	77	26	437	466	649	1,603	1,278	912	805	7,380
1969	306	162	111	214	133	494	709	464	1,013	320	699	1,180	5,805
1970	551	761	553	333	249	438	1,207	1,119	682	1,547	1,796	1,090	10,326
1971	904	668	865	361	1,214	569	1,150	387	431	1,221	702	1,997	10,489
1972	1,572	230	563	162	394	1,044	620	928	653	360	1,159	892	8,577
1973	397	156	146	164	221	473	641	1,061	608	1,468	1,758	2,393	9,486
1974	409	677	181	190	470	1,372	1,194	359	239	1,249	1,275	1,213	8,828
1975	761	352	181	783	306	522	696	608	846	471	845	3,558	9,929
1976	1,335	348	512	162	1,333	714	401	1,022	751	615	930	2,006	10,129
1977	467	429	217	232	558	244	1,081	734	992	310	1,370	272	6,905
1978	109	140	333	338	495	803	589	948	800	1,235	439	950	7,179
1979	237	340	111	731	410	750	718	674	1,314	591	634	607	7,117
1980	503	431	521	165	158	1,054	1,036	751	632	1,104	518	456	7,329
1981	834	327	111	322	455	1,540	447	521	710	814	1,462	931	8,473
1982	463	848	510	216	511	394	1,049	810	1,867	609	704	697	8,678
1983	195	17	52	82	29	549	1,144	363	764	692	985	1,029	5,901
1984	828	372	441	46	250	1,013	601	932	543	1,079	1,381	361	7,847
1985	622	351	349	392	334	724	907	269	708	956	909	550	7,071
1986	457	291	171	828	202	541	639	601	781	1,168	755	322	6,756
1987	217	122	71	227	80	436	759	664	606	601	1,341	1,347	6,471
1988	545	231	159	648	280	555	616	327	438	1,647	1,825	636	7,957
1989	1,151	1,349	663	571	663	1,042	600	607	936	603	574	871	9,630
1990	856	168	61	115	604	1,124	672	723	501	963	976	663	7,426
1991	297	212	435	213	462	1,222	833	863	555	500	929	856	7,387
1992	443	208	89	110	295	355	909	602	618	499	662	747	5,537
1993	322	232	276	85	223	513	1,329	1,260	846	883	1,601	1,979	9,549
1994	1,209	134	325	627	465	599	1,195	300	831	458	213	1,170	7,526
1995	460	180	83	222	336	529	957	933	1,045	663			
Average	632	352	355	340	427	669	782	712	773	837	1,031	1,086	8,019

Source : JICA Team's Estimate

Table A.3.12 Estimated Monthly Runoff at No.5 Dam Site

Unit : 1000 m3

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1949	409	109	714	765	772	706	1,306	809	1,468	1,656	2,364	3,371	14,449
1950	2,520	937	1,645	325	526	1,518	1,129	920	2,991	1,261	1,923	971	16,666
1951	1,106	619	338	1,158	1,888	1,816	1,069	1,361	1,253	1,101	2,635	2,570	16,908
1952	2,168	1,275	871	854	190	908	1,684	1,974	751	1,529	1,418	3,065	16,687
1953	1,118	891	819	417	278	1,413	1,174	1,081	1,165	2,407	2,285	2,467	15,515
1954	1,035	548	2,760	407	1,645	959	1,194	1,498	826	1,295	2,572	4,376	19,115
1955	2,051	457	745	1,056	696	1,716	1,288	1,595	1,364	1,627	3,690	1,289	17,574
1956	1,084	1,139	1,370	2,804	1,294	659	1,839	1,419	2,694	1,035	2,563	4,737	22,637
1957	1,744	456	768	1,049	545	1,215	1,326	1,705	1,414	1,778	1,670	982	14,592
1958	1,463	951	1,171	278	773	1,146	1,393	1,725	1,500	4,786	2,086	471	17,743
1959	1,158	1,132	1,792	316	1,652	560	1,340	1,322	1,235	1,710	2,868	3,516	18,601
1960	884	1,025	398	1,632	1,603	1,940	1,356	1,181	1,676	3,063	2,603	1,283	18,644
1961	322	167	523	458	1,138	1,389	1,526	1,687	998	1,755	1,254	1,094	12,331
1962	1,165	791	799	380	2,150	1,439	2,292	1,714	2,310	769	2,136	723	16,668
1963	273	607	160	163	751	1,859	1,144	3,778	1,051	930	1,654	1,542	13,922
1964	1,304	921	443	1,720	626	1,155	1,082	1,228	2,044	1,244	1,818	3,085	16,670
1965	1,623	801	874	785	1,056	1,972	3,031	1,441	1,557	1,474	2,024	2,356	18,924
1966	2,385	407	648	340	1,150	931	2,192	1,069	1,331	1,925	2,392	4,029	18,799
1967	2,607	686	894	606	256	660	1,263	1,953	1,779	1,122	2,290	980	15,096
1968	1,528	438	405	162	56	921	981	1,365	3,375	2,692	1,920	1,694	15,537
1969	644	342	235	450	281	1,041	1,493	976	2,133	634	1,472	2,483	12,224
1970	1,160	1,602	1,165	700	523	923	2,541	2,355	1,436	3,257	3,781	2,295	21,738
1971	1,903	1,407	1,854	759	2,555	1,198	2,422	814	908	2,570	1,478	4,204	22,082
1972	3,310	454	1,166	341	830	2,198	1,306	1,954	1,375	758	2,410	1,878	18,060
1973	836	329	307	345	465	997	1,349	2,235	1,280	3,090	3,701	5,038	19,973
1974	861	1,425	382	399	989	2,888	2,514	755	503	2,629	2,684	2,553	18,582
1975	1,603	741	382	1,648	644	1,098	1,466	1,280	1,782	993	1,779	7,491	20,907
1976	2,810	732	1,077	342	2,805	1,503	843	2,152	1,582	1,295	1,958	4,222	21,321
1977	984	903	456	437	1,176	514	2,277	1,546	2,089	652	2,885	573	14,542
1978	229	294	702	714	1,041	1,691	1,239	1,995	1,683	2,600	924	2,000	15,109
1979	498	715	233	1,540	863	1,578	1,513	1,420	2,766	1,245	1,334	1,278	14,983
1980	1,060	908	1,096	346	334	2,220	2,181	1,581	1,331	2,325	1,090	961	15,433
1981	1,756	689	233	676	957	3,242	941	1,098	1,495	1,713	3,078	1,960	17,838
1982	975	1,786	1,074	455	1,077	829	2,208	1,704	3,931	1,283	1,483	1,468	18,273
1983	410	35	109	173	62	1,156	2,408	764	1,608	1,457	2,073	2,167	12,422
1984	1,743	784	927	97	527	2,133	1,265	1,963	1,144	2,272	2,908	761	16,524
1985	1,309	739	734	825	704	1,524	1,909	566	1,491	2,012	1,914	1,158	14,885
1986	962	613	359	1,744	426	1,138	1,345	1,266	1,644	2,459	1,590	678	14,225
1987	457	258	149	477	168	919	1,598	1,398	1,275	1,265	2,823	2,836	13,623
1988	1,148	456	334	1,365	590	1,168	1,296	689	1,027	3,467	3,842	1,339	16,751
1989	2,424	2,840	1,395	1,202	1,395	2,194	1,264	1,277	1,971	1,270	1,208	1,834	20,274
1990	1,802	354	129	242	1,271	2,367	1,415	1,523	1,055	2,027	2,055	1,395	15,635
1991	624	447	916	447	973	2,573	1,755	1,817	1,169	1,063	1,955	1,822	15,551
1992	933	437	187	231	621	747	1,914	1,267	1,302	1,051	1,395	1,573	11,658
1993	678	489	582	180	469	1,061	2,798	2,652	1,781	1,850	3,370	4,567	20,107
1994	2,545	282	684	1,320	978	1,261	2,516	632	1,749	964	418	2,454	15,844
1995	968	380	175	457	707	1,115	2,014	1,955	2,200	1,395			
Average	1,331	742	748	716	904	1,408	1,647	1,499	1,627	1,762	2,170	2,287	15,863

Source : JICA Team's Estimate

Table A.3.13 Water Quality Criteria for Class GA Water

Quantity Parameter	Specification
1 Total Solids	500 mg/l
2 pH	6.5 - 8.5
3 Bacteria	Bacteria of the coliform group shall not exceed a monthly geometric average Most Probable Number (MPN) of 50 per 100 ml.
4 Phenolic Substances	0.001 mg/l
5 Radioactive Substances	
Ra-226	
Sr-90	
Beta Emitter	
6 Trace Elements	Not to exceed the following
Arsenic	0.05 mg/l
Barium	1 mg/l
Cadmium	0.01 mg/l
Chromium	0.05 mg/l
Copper	1 mg/l
Cyanide	0.05 mg/l
Fluoride	0.06 mg/l
Iron	1 mg/l
Lead	0.05 mg/l
Manganese	0.5 mg/l
Mercury	0.002 mg/l
Selenium	0.05 mg/l
Silver	0.05 mg/l
Zinc	5 mg/l
7 Organic Chemicals	
Synthetic Detergents (MBAS)	Nil
Oil and Grease	Nil
8 Persistent Pesticides	
Aldrin	0.001 mg/l
DDT	0.05 mg/l
Dieldrin	0.001 mg/l
Chlordane	0.003 mg/l
Endrin	0.0002 mg/l
Heptachlor	0.0001 mg/l
Lindane	0.004 mg/l
Toxaphane	0.005 mg/l
Methoxychlor	0.1 mg/l
2, 4-D	0.1 mg/l
2, 4, 5-TP	0.01 mg/l
PCB	Nil
9 Other Chemicals	
Calcium	75 mg/l
Chloride	200 mg/l
Magnesium	50 mg/l
Nitrate	30 mg/l
Sulfate	200 mg/l

Source : Rules & Regulations of the National Pollution COmmissions (1978), Section 69
Remark : Values in bold follows the Philippine Standards for Drinking Water (1978)

Table A.3.14 Water Quality Criteria for Class D Water

Quantity Parameter	Specification
1 Temperature	The maximum rise above natural temperature shall not exceed 3 C outside the mixing zones as determined by the Commission.
2 Dissolved Oxgen	Not less than 3 mg/l
3 Transperaancy	1 m
4 Total Dissolved Soilds	Not more than 1000 mg/l
5 pH	6.0 - 8.5
6 Trace Elements	Not to exceed the following
Alminium	5 mg/l
Arsenic	0.01 mg/l
Beryllium	0.01 mg/l
Boron	0.75 mg/l
Cadmium	0.01 mg/l
Chromium	0.1 mg/l
Cobalt	0.05 mg/l
Copper	0.2 mg/l
Cyanide	1 mg/l
Fluoride	5 mg/l
Iron	5 mg/l
Lead	2.5 mg/l
Lithium	0.2 mg/l
Manganese	0.01 mg/l
Molybdenum	0.2 mg/l
Nickel	0.02 mg/l
Vanadium	0.1 mg/l
Zinc	2 mg/l
7 Sodium Absorption Ratio (SAR)	8.0 - 13.0
8 Organic Chemicals	
Oil and Grease	5 ml/l
9 Nutrients	Shall not be present in amounts to cause delerious or abnormal biotic growth

Source : Rules & Regulations of the National Pollution COmmissions (1978), Section 69

Table A.3.15 Results of Water Quality Test for Surface Waters

No.	Barangay	Municipality	pH	Temperature C	Electric Conductivity (ms/cm)	Total Dissolved Solids (g/L)	Chloride (mg/L)	Fluoride (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Dissolved Oxigen (mg/L)	NO3 as N (ug/L)	PO4 as P (ug/L)
1	Centro	Camalig	7.6	34.8	0.31	0.16	8	0.50	29.7	15.0	8.9	0.31	0.81
2	Tinago	Camalig	7.4	31.1	0.31	0.15	9	0.10	31.3	10.7	7.9	0.30	0.72
3	Centro	Camalig	7.4	36.2	0.34	0.17	12	0.07	32.9	13.1	9.1	0.30	0.84
4	Ligban	Camalig	7.5	32.6	0.34	0.14	11	0.05	35.3	12.6	8.4	0.30	0.76
5	Tagaytay	Camalig	7.6	32.3	0.34	0.18	11	0.40	36.9	13.6	8.1	0.31	0.75
6	Taladong	Camalig	7.4	30.2	0.41	0.21	6	0.10	59.3	17.0	7.6	0.30	0.70
7	Taladong	Camalig	7.4	32.9	0.10	0.05	8	0.20	53.7	12.6	8.4	0.30	0.76
8	Inarado	Daraga	7.0	29.9	0.41	0.20	9	0.30	45.7	19.9	7.6	0.28	0.70
9	Comun	Daraga	7.3	29.4	0.25	0.12	9	0.30	27.2	11.1	7.8	0.30	0.68
10	Gabawan	Daraga	7.2	29.3	0.11	0.05	7	0.10	10.4	4.9	7.8	0.29	0.68
11	Gabawan	Daraga	7.0	28.6	0.11	0.05	6	0.05	10.4	3.9	7.8	0.28	0.66
12	Bascaran	Daraga	7.3	29.2	0.11	0.05	8	0.10	10.4	8.3	7.8	0.30	0.68
13	San Ramon	Daraga	6.2	28.7	0.21	0.10	6	0.03	31.3	6.8	7.8	0.25	0.66
14	Gapo	Daraga	7.4	29.3	0.12	0.06	7	0.40	15.2	2.9	7.8	0.30	0.68
15	Panoypoy	Camalig	7.9	28.7	0.34	0.17	8	0.20	11.2	29.2	7.8	0.32	0.67
Standard Limit as per Class D			6.00-8.50			1.00		1			more than 3	Shall not be present	Shall not be present
Standard Limit as per ClassGA							250		75	50			
FAO Standards					0.7								

Source : JICA Team's Analysis

Remarks : Since Class D does not cover all test items, Class GA and FAO Standards are refered.

Table A.3.16 Results of Water Quality Test for Groundwater

No.	Barangay	Municipality	pH	Temperature	Electric Conductivity	Total Dissolved Solids	Chloride	Fluoride	Calcium	Magnesium	Dissolved Oxigen	BOD	Total Coliform Bacteria	Fecal Coliform Bacteria
				C	(ms/cm)	(g/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(MPN/100mL)	(MPN/100mL)
1	Ligban	Camalig	6.9	29.1	0.66	0.33	11	0.30	99.4	20.4	6.6	4.8	more than 16	more than 16
2	Tagaytay	Camalig	7.0	28.5	0.45	0.22	12	0.09	58.5	9.2	5.4	0.4	9.2	5.1
3	Baligang	Camalig	7.5	29.2	0.54	0.27	13	0.03	69.7	22.3	5.6	0.8	2.2	less than 2.2
4	Comun	Camalig	7.5	29.5	0.62	0.31	11	0.07	78.6	27.1	5.8	1.5	more than 16	16
5	Cotmon	Camalig	7.6	28.2	0.69	0.35	47	0.05	68.1	32.5	6.2	1.4	more than 16	more than 16
6	Del Rosario	Camalig	7.4	28.3	0.61	0.30	11	0.20	44.9	46.1	5.3	0.1	more than 16	more than 16
7	Inarado	Camalig	7.2	30.8	0.44	0.22	7	0.20	26.5	33.5	5.4	0.7	more than 16	5.1
8	Tabon Tabon	Daraga	6.9	30.2	0.44	0.23	25	0.09	22.4	18.0	8.5	1.2	more than 16	more than 16
9	Namantao	Daraga	6.9	29.6	0.62	0.32	20	0.01	97.8	24.7	8.4	0.2	more than 16	16
10	Anislag	Daraga	6.8	31.1	0.59	0.30	21	0.03	41.7	50.5	5.6	0.9	more than 16	more than 16
11	Mayon	Daraga	7.0	30.1	0.57	0.30	20	0.03	41.7	50.5	7.9	0.3	more than 16	more than 16
12	San Ramon	Daraga	7.1	29.5	0.60	0.31	18	0.01	23.2	180.2	5.1	0.6	more than 16	2.2
13	San Ramon	Daraga	6.2	29.2	0.22	0.11	9	0.03	26.4	4.9	4.1	0.4	more than 16	more than 16
14	Anislag	Daraga	6.6	31.1	0.80	0.41	68	0.01	66.5	52.4	5.3	0.3	more than 16	more than 16
15	Del Rosario	Camalig	7.7	28.6	0.78	0.39	29	0.03	26.4	76.8	11.9	4.6	more than 16	more than 16
Standard Limit as per Class AA			6.00-8.50			0.50	200	0.06	75	50		1	less than 2.2	less than 2.2
Standard Limit as per Class D							250		75	50	more than 3			
FAO Standards					0.7									

Source : JICA Team's Analysis

Remarks : Since Class AA does not cover all test items, Class D and FAO Standards are refered.

Values in shade indicate that they exceed the standard value.

Table A.4.1 Simulation of Camalig Diversion Dam (1/10)

RS Paddy	130	ha
DS Paddy	130	ha

Year	Month	Inflow (1000 m3)	Requirement for Irigation (1000 m3)	Balance (1000 m3)
1949	May	699.31	121.87	577.44
1949	Jun	639.55	407.72	231.83
1949	Jul	1,182.65	198.47	984.18
1949	Aug	732.64	194.99	537.65
1949	Sep	1,329.96	0.00	1,329.96
1949	Oct	1,499.95	0.00	1,499.95
1949	Nov	2,141.23	0.00	2,141.23
1949	Dec	3,053.10	139.28	2,913.82
1950	Jan	2,154.92	240.25	1,914.67
1950	Feb	801.15	327.08	474.07
1950	Mar	1,406.61	170.61	1,236.00
1950	Apr	278.13	0.00	278.13
1950	May	449.77	121.87	327.90
1950	Jun	1,297.66	407.72	889.94
1950	Jul	965.83	198.47	767.36
1950	Aug	786.65	194.99	591.66
1950	Sep	2,558.02	0.00	2,558.02
1950	Oct	1,078.05	0.00	1,078.05
1950	Nov	1,644.84	0.00	1,644.84
1950	Dec	830.42	139.28	691.14
1951	Jan	935.59	240.25	695.34
1951	Feb	526.81	327.08	199.73
1951	Mar	287.14	170.61	116.53
1951	Apr	984.89	0.00	984.89
1951	May	1,605.84	121.87	1,483.97
1951	Jun	1,544.31	407.72	1,136.59
1951	Jul	908.65	198.47	710.18
1951	Aug	1,157.49	194.99	962.50
1951	Sep	1,065.86	0.00	1,065.86
1951	Oct	936.66	0.00	936.66
1951	Nov	2,240.91	0.00	2,240.91
1951	Dec	2,185.43	139.28	2,046.15
1952	Jan	1,853.23	240.25	1,612.98
1952	Feb	1,089.76	327.08	762.68
1952	Mar	744.34	170.61	573.73
1952	Apr	730.22	0.00	730.22
1952	May	161.97	121.87	40.10
1952	Jun	775.79	407.72	368.07
1952	Jul	1,439.72	198.47	1,241.25
1952	Aug	1,686.89	194.99	1,491.90
1952	Sep	641.94	0.00	641.94
1952	Oct	1,307.12	0.00	1,307.12
1952	Nov	1,212.01	0.00	1,212.01
1952	Dec	2,619.94	139.28	2,480.66
1953	Jan	983.61	240.25	743.36
1953	Feb	783.53	327.08	456.45
1953	Mar	720.50	170.61	549.89
1953	Apr	366.72	0.00	366.72
1953	May	244.31	121.87	122.44
1953	Jun	1,243.09	407.72	835.37
1953	Jul	1,032.41	198.47	833.94
1953	Aug	950.64	194.99	755.65
1953	Sep	1,024.98	0.00	1,024.98
1953	Oct	2,117.05	0.00	2,117.05
1953	Nov	2,009.50	0.00	2,009.50
1953	Dec	2,170.02	139.28	2,030.74
1954	Jan	841.50	240.25	601.25
1954	Feb	445.46	327.08	118.38
1954	Mar	2,243.94	170.61	2,073.33
1954	Apr	331.24	0.00	331.24

Table A.4.1 Simulation of Camalig Diversion Dam (2/10)

RS Paddy 130 ha
DS Paddy 130 ha

Year Month	Inflow (1000 m3)	Requirement for Irigation (1000 m3)	Balance (1000 m3)
1954 May	1,337.57	121.87	1,215.70
1954 Jun	779.33	407.72	371.61
1954 Jul	970.55	198.47	772.08
1954 Aug	1,217.66	194.99	1,022.67
1954 Sep	671.44	0.00	671.44
1954 Oct	1,052.39	0.00	1,052.39
1954 Nov	2,090.52	0.00	2,090.52
1954 Dec	3,557.58	139.28	3,418.30
1955 Jan	1,718.87	240.25	1,478.62
1955 Feb	383.18	327.08	56.10
1955 Mar	624.80	170.61	454.19
1955 Apr	884.96	0.00	884.96
1955 May	583.38	121.87	461.51
1955 Jun	1,438.63	407.72	1,030.91
1955 Jul	1,079.19	198.47	880.72
1955 Aug	1,336.65	194.99	1,141.66
1955 Sep	1,143.18	0.00	1,143.18
1955 Oct	1,363.71	0.00	1,363.71
1955 Nov	3,092.34	0.00	3,092.34
1955 Dec	1,079.95	139.28	940.67
1956 Jan	832.62	240.25	592.37
1956 Feb	875.15	327.08	548.07
1956 Mar	1,052.54	170.61	881.93
1956 Apr	2,154.17	0.00	2,154.17
1956 May	993.94	121.87	872.07
1956 Jun	506.36	407.72	98.64
1956 Jul	1,412.73	198.47	1,214.26
1956 Aug	1,089.87	194.99	894.88
1956 Sep	2,069.55	0.00	2,069.55
1956 Oct	795.29	0.00	795.29
1956 Nov	1,968.87	0.00	1,968.87
1956 Dec	3,639.08	139.28	3,499.80
1957 Jan	1,572.63	240.25	1,332.38
1957 Feb	411.26	327.08	84.18
1957 Mar	638.28	170.61	467.67
1957 Apr	946.21	0.00	946.21
1957 May	491.91	121.87	370.04
1957 Jun	1,096.18	407.72	688.46
1957 Jul	1,195.90	198.47	997.43
1957 Aug	1,538.10	194.99	1,343.11
1957 Sep	1,275.52	0.00	1,275.52
1957 Oct	1,603.55	0.00	1,603.55
1957 Nov	1,505.89	0.00	1,505.89
1957 Dec	886.17	139.28	746.89
1958 Jan	1,221.50	240.25	981.25
1958 Feb	793.99	327.08	466.91
1958 Mar	977.58	170.61	806.97
1958 Apr	232.53	0.00	232.53
1958 May	645.51	121.87	523.64
1958 Jun	957.24	407.72	549.52
1958 Jul	1,163.36	198.47	964.89
1958 Aug	1,440.70	194.99	1,245.71
1958 Sep	1,252.50	0.00	1,252.50
1958 Oct	3,997.30	0.00	3,997.30
1958 Nov	1,742.02	0.00	1,742.02
1958 Dec	393.60	139.28	254.32
1959 Jan	950.39	240.25	710.14
1959 Feb	928.90	327.08	601.82
1959 Mar	1,470.62	170.61	1,300.01
1959 Apr	259.16	0.00	259.16

Table A.4.1 Simulation of Camalig Diversion Dam (3/10)

RS Paddy	130	ha
DS Paddy	130	ha

Year	Month	Inflow (1000 m3)	Requirement for Irigation (1000 m3)	Balance (1000 m3)
1959	May	1,356.21	121.87	1,234.34
1959	Jun	460.03	407.72	52.31
1959	Jul	1,099.92	198.47	901.45
1959	Aug	1,085.59	194.99	890.60
1959	Sep	1,014.17	0.00	1,014.17
1959	Oct	1,403.50	0.00	1,403.50
1959	Nov	2,353.89	0.00	2,353.89
1959	Dec	2,886.30	139.28	2,747.02
1960	Jan	725.37	240.25	485.12
1960	Feb	840.42	327.08	513.34
1960	Mar	326.76	170.61	156.15
1960	Apr	1,338.32	0.00	1,338.32
1960	May	1,314.93	121.87	1,193.06
1960	Jun	1,591.33	407.72	1,183.61
1960	Jul	1,112.52	198.47	914.05
1960	Aug	968.36	194.99	773.37
1960	Sep	1,374.60	0.00	1,374.60
1960	Oct	2,511.95	0.00	2,511.95
1960	Nov	2,135.06	0.00	2,135.06
1960	Dec	1,052.14	139.28	912.86
1961	Jan	312.25	240.25	72.00
1961	Feb	181.13	327.08	-145.95
1961	Mar	507.58	170.61	336.97
1961	Apr	444.75	0.00	444.75
1961	May	1,105.04	121.87	983.17
1961	Jun	1,349.26	407.72	941.54
1961	Jul	1,482.03	198.47	1,283.56
1961	Aug	1,637.75	194.99	1,442.76
1961	Sep	968.72	0.00	968.72
1961	Oct	1,703.86	0.00	1,703.86
1961	Nov	1,217.59	0.00	1,217.59
1961	Dec	1,062.15	139.28	922.87
1962	Jan	996.18	240.25	755.93
1962	Feb	675.97	327.08	348.89
1962	Mar	683.37	170.61	512.76
1962	Apr	324.90	0.00	324.90
1962	May	1,838.30	121.87	1,716.43
1962	Jun	1,230.72	407.72	823.00
1962	Jul	1,959.76	198.47	1,761.29
1962	Aug	1,466.00	194.99	1,271.01
1962	Sep	1,975.07	0.00	1,975.07
1962	Oct	657.70	0.00	657.70
1962	Nov	1,826.45	0.00	1,826.45
1962	Dec	618.44	139.28	479.16
1963	Jan	250.79	240.25	10.54
1963	Feb	558.91	327.08	231.83
1963	Mar	147.39	170.61	-23.22
1963	Apr	150.00	0.00	150.00
1963	May	691.11	121.87	569.24
1963	Jun	1,719.67	407.72	1,311.95
1963	Jul	1,052.90	198.47	854.43
1963	Aug	3,475.99	194.99	3,281.00
1963	Sep	966.78	0.00	966.78
1963	Oct	855.25	0.00	855.25
1963	Nov	1,522.02	0.00	1,522.02
1963	Dec	1,419.14	139.28	1,279.86
1964	Jan	1,115.38	240.25	875.13
1964	Feb	787.53	327.08	460.45
1964	Mar	378.95	170.61	208.34
1964	Apr	1,470.63	0.00	1,470.63

Table A.4.1 Simulation of Camalig Diversion Dam (4/10)

RS Paddy 130 ha
DS Paddy 130 ha

Year	Month	Inflow (1000 m3)	Requirement for Irrigation (1000 m3)	Balance (1000 m3)
1964	May	535.22	121.87	413.35
1964	Jun	987.25	407.72	579.53
1964	Jul	925.28	198.47	726.81
1964	Aug	1,049.95	194.99	854.96
1964	Sep	1,748.11	0.00	1,748.11
1964	Oct	1,063.28	0.00	1,063.28
1964	Nov	1,554.32	0.00	1,554.32
1964	Dec	2,638.09	139.28	2,498.81
1965	Jan	1,322.09	240.25	1,081.84
1965	Feb	652.62	327.08	325.54
1965	Mar	711.97	170.61	541.36
1965	Apr	639.56	0.00	639.56
1965	May	860.11	121.87	738.24
1965	Jun	1,606.74	407.72	1,199.02
1965	Jul	2,469.70	198.47	2,271.23
1965	Aug	1,174.43	194.99	979.44
1965	Sep	1,268.92	0.00	1,268.92
1965	Oct	1,201.02	0.00	1,201.02
1965	Nov	1,648.76	0.00	1,648.76
1965	Dec	1,919.87	139.28	1,780.59
1966	Jan	1,950.15	240.25	1,709.90
1966	Feb	332.88	327.08	5.80
1966	Mar	530.04	170.61	359.43
1966	Apr	277.88	0.00	277.88
1966	May	940.55	121.87	818.68
1966	Jun	761.25	407.72	353.53
1966	Jul	1,792.28	198.47	1,593.81
1966	Aug	874.35	194.99	679.36
1966	Sep	1,088.65	0.00	1,088.65
1966	Oct	1,574.40	0.00	1,574.40
1966	Nov	1,955.86	0.00	1,955.86
1966	Dec	3,295.01	139.28	3,155.73
1967	Jan	2,318.42	240.25	2,078.17
1967	Feb	610.50	327.08	283.42
1967	Mar	795.23	170.61	624.62
1967	Apr	539.16	0.00	539.16
1967	May	227.54	121.87	105.67
1967	Jun	586.80	407.72	179.08
1967	Jul	1,123.67	198.47	925.20
1967	Aug	1,736.71	194.99	1,541.72
1967	Sep	1,582.31	0.00	1,582.31
1967	Oct	998.31	0.00	998.31
1967	Nov	2,036.87	0.00	2,036.87
1967	Dec	871.92	139.28	732.64
1968	Jan	1,343.44	240.25	1,103.19
1968	Feb	385.21	327.08	58.13
1968	Mar	356.43	170.61	185.82
1968	Apr	142.57	0.00	142.57
1968	May	48.97	121.87	-72.90
1968	Jun	809.53	407.72	401.81
1968	Jul	862.67	198.47	664.20
1968	Aug	1,200.15	194.99	1,005.16
1968	Sep	2,966.82	0.00	2,966.82
1968	Oct	2,366.01	0.00	2,366.04
1968	Nov	1,688.01	0.00	1,688.01
1968	Dec	1,489.09	139.28	1,349.81
1969	Jan	627.53	240.25	387.28
1969	Feb	333.22	327.08	6.14
1969	Mar	228.81	170.61	58.20
1969	Apr	438.72	0.00	438.72

Table A.4.1 Simulation of Camalig Diversion Dam (5/10)

RS Paddy 130 ha
DS Paddy 130 ha

Year	Month	Inflow (1000 m3)	Requirement for Irigation (1000 m3)	Balance (1000 m3)
1969	May	273.76	121.87	151.89
1969	Jun	1,014.73	407.72	607.01
1969	Jul	1,455.92	198.47	1,257.45
1969	Aug	951.43	194.99	756.44
1969	Sep	2,079.61	0.00	2,079.61
1969	Oct	657.12	0.00	657.12
1969	Nov	1,435.37	0.00	1,435.37
1969	Dec	2,420.78	139.28	2,281.50
1970	Jan	902.59	240.25	662.34
1970	Feb	1,246.75	327.08	919.67
1970	Mar	906.48	170.61	735.87
1970	Apr	545.17	0.00	545.17
1970	May	407.28	121.87	285.41
1970	Jun	718.28	407.72	310.56
1970	Jul	1,977.61	198.47	1,779.14
1970	Aug	1,832.63	194.99	1,637.64
1970	Sep	1,117.55	0.00	1,117.55
1970	Oct	2,535.13	0.00	2,535.13
1970	Nov	2,942.40	0.00	2,942.40
1970	Dec	1,785.98	139.28	1,646.70
1971	Jan	1,473.18	240.25	1,232.93
1971	Feb	1,089.23	327.08	762.15
1971	Mar	1,443.12	170.61	1,272.51
1971	Apr	587.77	0.00	587.77
1971	May	1,978.28	121.87	1,856.41
1971	Jun	927.31	407.72	519.59
1971	Jul	1,875.35	198.47	1,676.88
1971	Aug	630.58	194.99	435.59
1971	Sep	703.23	0.00	703.23
1971	Oct	1,990.35	0.00	1,990.35
1971	Nov	1,144.57	0.00	1,144.57
1971	Dec	3,255.61	139.28	3,116.33
1972	Jan	2,746.46	240.25	2,506.21
1972	Feb	401.64	327.08	74.56
1972	Mar	984.23	170.61	813.62
1972	Apr	282.62	0.00	282.62
1972	May	688.84	121.87	566.97
1972	Jun	1,823.90	407.72	1,416.18
1972	Jul	1,083.74	198.47	885.27
1972	Aug	1,621.03	194.99	1,426.04
1972	Sep	1,140.84	0.00	1,140.84
1972	Oct	628.61	0.00	628.61
1972	Nov	2,024.12	0.00	2,024.12
1972	Dec	1,558.39	139.28	1,419.11
1973	Jan	669.58	240.25	429.33
1973	Feb	263.29	327.08	-63.79
1973	Mar	245.51	170.61	74.90
1973	Apr	276.63	0.00	276.63
1973	May	371.89	121.87	250.02
1973	Jun	798.07	407.72	390.35
1973	Jul	1,080.32	198.47	881.85
1973	Aug	1,788.98	194.99	1,593.99
1973	Sep	1,025.08	0.00	1,025.08
1973	Oct	2,473.54	0.00	2,473.54
1973	Nov	2,962.91	0.00	2,962.91
1973	Dec	4,033.64	139.28	3,894.36
1974	Jan	706.74	240.25	466.49
1974	Feb	1,169.78	327.08	842.70
1974	Mar	313.71	170.61	143.10
1974	Apr	328.04	0.00	328.04

Table A.4.1 Simulation of Camalig Diversion Dam (6/10)

RS Paddy 130 ha
DS Paddy 130 ha

Year	Month	Inflow (1000 m3)	Requirement for Irigation (1000 m3)	Balance (1000 m3)
1974	May	811.87	121.87	690.00
1974	Jun	2,371.33	407.72	1,963.61
1974	Jul	2,064.13	198.47	1,865.66
1974	Aug	620.25	194.99	425.26
1974	Sep	413.34	0.00	413.34
1974	Oct	2,158.93	0.00	2,158.93
1974	Nov	2,203.85	0.00	2,203.85
1974	Dec	2,096.57	139.28	1,957.29
1975	Jan	1,263.41	240.25	1,023.16
1975	Feb	583.75	327.08	256.67
1975	Mar	300.89	170.61	130.28
1975	Apr	1,299.46	0.00	1,299.46
1975	May	507.95	121.87	386.08
1975	Jun	865.92	407.72	458.20
1975	Jul	1,155.72	198.47	957.25
1975	Aug	1,008.97	194.99	813.98
1975	Sep	1,404.61	0.00	1,404.61
1975	Oct	782.50	0.00	782.50
1975	Nov	1,402.17	0.00	1,402.17
1975	Dec	5,905.01	139.28	5,765.73
1976	Jan	2,200.72	240.25	1,960.47
1976	Feb	573.51	327.08	246.43
1976	Mar	843.83	170.61	673.22
1976	Apr	267.79	0.00	267.79
1976	May	2,197.04	121.87	2,075.17
1976	Jun	1,177.13	407.72	769.41
1976	Jul	660.40	198.47	461.93
1976	Aug	1,685.59	194.99	1,490.60
1976	Sep	1,238.74	0.00	1,238.74
1976	Oct	1,014.16	0.00	1,014.16
1976	Nov	1,533.65	0.00	1,533.65
1976	Dec	3,306.82	139.28	3,167.54
1977	Jan	889.00	240.25	648.75
1977	Feb	815.22	327.08	488.14
1977	Mar	411.74	170.61	241.13
1977	Apr	440.12	0.00	440.12
1977	May	1,061.85	121.87	939.98
1977	Jun	464.62	407.72	56.90
1977	Jul	2,056.63	198.47	1,858.16
1977	Aug	1,396.19	194.99	1,201.20
1977	Sep	1,886.87	0.00	1,886.87
1977	Oct	588.97	0.00	588.97
1977	Nov	2,605.61	0.00	2,605.61
1977	Dec	518.03	139.28	378.75
1978	Jan	203.78	240.25	-36.47
1978	Feb	261.60	327.08	-65.48
1978	Mar	623.82	170.61	453.21
1978	Apr	632.23	0.00	632.23
1978	May	925.93	121.87	804.06
1978	Jun	1,503.39	407.72	1,095.67
1978	Jul	1,101.69	198.47	903.22
1978	Aug	1,773.91	194.99	1,578.92
1978	Sep	1,496.51	0.00	1,496.51
1978	Oct	2,311.38	0.00	2,311.38
1978	Nov	821.74	0.00	821.74
1978	Dec	1,778.49	139.28	1,639.21
1979	Jan	444.21	240.25	203.96
1979	Feb	638.09	327.08	311.01
1979	Mar	208.18	170.61	37.57
1979	Apr	1,373.51	0.00	1,373.51

Table A.4.1 Simulation of Camalig Diversion Dam (7/10)

RS Paddy	130	ha
DS Paddy	130	ha

Year	Month	Inflow (1000 m3)	Requirement for Irigation (1000 m3)	Balance (1000 m3)
1979	May	769.90	121.87	648.03
1979	Jun	1,407.99	407.72	1,000.27
1979	Jul	1,349.50	198.47	1,151.03
1979	Aug	1,266.48	194.99	1,071.49
1979	Sep	2,467.82	0.00	2,467.82
1979	Oct	1,110.40	0.00	1,110.40
1979	Nov	1,190.36	0.00	1,190.36
1979	Dec	1,140.29	139.28	1,001.01
1980	Jan	934.02	240.25	693.77
1980	Feb	800.45	327.08	473.37
1980	Mar	966.15	170.61	795.54
1980	Apr	305.37	0.00	305.37
1980	May	293.97	121.87	172.10
1980	Jun	1,956.59	407.72	1,548.87
1980	Jul	1,922.69	198.47	1,724.22
1980	Aug	1,393.70	194.99	1,198.71
1980	Sep	1,173.60	0.00	1,173.60
1980	Oct	2,049.19	0.00	2,049.19
1980	Nov	961.09	0.00	961.09
1980	Dec	846.74	139.28	707.46
1981	Jan	1,463.78	240.25	1,223.53
1981	Feb	574.10	327.08	247.02
1981	Mar	194.35	170.61	23.74
1981	Apr	563.17	0.00	563.17
1981	May	797.79	121.87	675.92
1981	Jun	2,701.94	407.72	2,294.22
1981	Jul	784.49	198.47	586.02
1981	Aug	914.83	194.99	719.84
1981	Sep	1,246.38	0.00	1,246.38
1981	Oct	1,427.99	0.00	1,427.99
1981	Nov	2,565.07	0.00	2,565.07
1981	Dec	1,634.03	139.28	1,494.75
1982	Jan	805.31	240.25	565.06
1982	Feb	1,475.69	327.08	1,148.61
1982	Mar	886.95	170.61	716.34
1982	Apr	376.24	0.00	376.24
1982	May	889.59	121.87	767.72
1982	Jun	685.02	407.72	277.30
1982	Jul	1,824.08	198.47	1,625.61
1982	Aug	1,407.98	194.99	1,212.99
1982	Sep	3,247.66	0.00	3,247.66
1982	Oct	1,059.82	0.00	1,059.82
1982	Nov	1,225.02	0.00	1,225.02
1982	Dec	1,212.77	139.28	1,073.49
1983	Jan	397.23	240.25	156.98
1983	Feb	33.91	327.08	-293.17
1983	Mar	105.21	170.61	-65.40
1983	Apr	167.23	0.00	167.23
1983	May	59.94	121.87	-61.93
1983	Jun	1,118.95	407.72	711.23
1983	Jul	2,329.98	198.47	2,131.51
1983	Aug	738.87	194.99	543.88
1983	Sep	1,556.45	0.00	1,556.45
1983	Oct	1,409.89	0.00	1,409.89
1983	Nov	2,006.48	0.00	2,006.48
1983	Dec	2,096.79	139.28	1,957.51
1984	Jan	1,495.07	240.25	1,254.82
1984	Feb	672.47	327.08	345.39
1984	Mar	795.75	170.61	625.14
1984	Apr	83.43	0.00	83.43

Table A.4.1 Simulation of Camalig Diversion Dam (8/10)

RS Paddy 130 ha
DS Paddy 130 ha

Year	Month	Inflow (1000 m3)	Requirement for Irigation (1000 m3)	Balance (1000 m3)
1984	May	452.41	121.87	330.54
1984	Jun	1,829.91	407.72	1,422.19
1984	Jul	1,085.03	198.47	886.56
1984	Aug	1,684.23	194.99	1,489.24
1984	Sep	981.58	0.00	981.58
1984	Oct	1,949.60	0.00	1,949.60
1984	Nov	2,494.78	0.00	2,494.78
1984	Dec	652.60	139.28	513.32
1985	Jan	1,171.28	240.25	931.03
1985	Feb	661.46	327.08	334.38
1985	Mar	656.91	170.61	486.30
1985	Apr	737.70	0.00	737.70
1985	May	629.51	121.87	507.64
1985	Jun	1,363.42	407.72	955.70
1985	Jul	1,707.95	198.47	1,509.48
1985	Aug	506.55	194.99	311.56
1985	Sep	1,333.54	0.00	1,333.54
1985	Oct	1,799.94	0.00	1,799.94
1985	Nov	1,712.14	0.00	1,712.14
1985	Dec	1,035.61	139.28	896.33
1986	Jan	877.03	240.25	636.78
1986	Feb	559.25	327.08	232.17
1986	Mar	327.66	170.61	157.05
1986	Apr	1,589.82	0.00	1,589.82
1986	May	388.61	121.87	266.74
1986	Jun	1,037.82	407.72	630.10
1986	Jul	1,227.17	198.47	1,028.70
1986	Aug	1,154.40	194.99	959.41
1986	Sep	1,498.35	0.00	1,498.35
1986	Oct	2,241.57	0.00	2,241.57
1986	Nov	1,449.83	0.00	1,449.83
1986	Dec	618.16	139.28	478.88
1987	Jan	424.24	240.25	183.99
1987	Feb	239.43	327.08	-87.65
1987	Mar	138.68	170.61	-31.93
1987	Apr	443.43	0.00	443.43
1987	May	155.88	121.87	34.01
1987	Jun	853.29	407.72	445.57
1987	Jul	1,483.92	198.47	1,285.45
1987	Aug	1,298.41	194.99	1,103.42
1987	Sep	1,184.56	0.00	1,184.56
1987	Oct	1,175.13	0.00	1,175.13
1987	Nov	2,621.88	0.00	2,621.88
1987	Dec	2,633.71	139.28	2,494.43
1988	Jan	979.50	240.25	739.25
1988	Feb	414.74	327.08	87.66
1988	Mar	285.43	170.61	114.82
1988	Apr	1,165.02	0.00	1,165.02
1988	May	503.95	121.87	382.08
1988	Jun	996.73	407.72	589.01
1988	Jul	1,106.32	198.47	907.85
1988	Aug	587.81	194.99	392.82
1988	Sep	876.74	0.00	876.74
1988	Oct	2,959.15	0.00	2,959.15
1988	Nov	3,278.75	0.00	3,278.75
1988	Dec	1,143.05	139.28	1,003.77
1989	Jan	1,930.36	240.25	1,690.11
1989	Feb	2,261.75	327.08	1,934.67
1989	Mar	1,110.92	170.61	940.31
1989	Apr	957.52	0.00	957.52

Table A.4.1 Simulation of Camalig Diversion Dam (9/10)

RS Paddy 130 ha
DS Paddy 130 ha

Year	Month	Inflow (1000 m3)	Requirement for Irigation (1000 m3)	Balance (1000 m3)
1989	May	1,111.43	121.87	989.56
1989	Jun	1,747.64	407.72	1,339.92
1989	Jul	1,006.84	198.47	808.37
1989	Aug	1,017.35	194.99	822.36
1989	Sep	1,570.12	0.00	1,570.12
1989	Oct	1,011.60	0.00	1,011.60
1989	Nov	962.17	0.00	962.17
1989	Dec	1,461.09	139.28	1,321.81
1990	Jan	1,580.09	240.25	1,339.84
1990	Feb	310.63	327.08	-16.45
1990	Mar	113.12	170.61	-57.49
1990	Apr	212.38	0.00	212.38
1990	May	1,114.28	121.87	992.41
1990	Jun	2,075.13	407.72	1,667.41
1990	Jul	1,241.00	198.47	1,042.53
1990	Aug	1,335.22	194.99	1,140.23
1990	Sep	924.83	0.00	924.83
1990	Oct	1,777.35	0.00	1,777.35
1990	Nov	1,802.29	0.00	1,802.29
1990	Dec	1,223.36	139.28	1,084.08
1991	Jan	548.64	240.25	308.39
1991	Feb	392.43	327.08	65.35
1991	Mar	804.80	170.61	634.19
1991	Apr	393.19	0.00	393.19
1991	May	854.77	121.87	732.90
1991	Jun	2,260.95	407.72	1,853.23
1991	Jul	1,541.96	198.47	1,343.49
1991	Aug	1,596.72	194.99	1,401.73
1991	Sep	1,027.13	0.00	1,027.13
1991	Oct	925.18	0.00	925.18
1991	Nov	1,718.11	0.00	1,718.11
1991	Dec	1,601.52	139.28	1,462.24
1992	Jan	929.61	240.25	689.36
1992	Feb	435.53	327.08	108.45
1992	Mar	185.98	170.61	15.37
1992	Apr	230.31	0.00	230.31
1992	May	619.30	121.87	497.43
1992	Jun	745.02	407.72	337.30
1992	Jul	1,908.01	198.47	1,709.54
1992	Aug	1,262.53	194.99	1,067.54
1992	Sep	1,297.46	0.00	1,297.46
1992	Oct	1,047.66	0.00	1,047.66
1992	Nov	1,390.09	0.00	1,390.09
1992	Dec	1,567.57	139.28	1,428.29
1993	Jan	541.71	240.25	301.46
1993	Feb	390.58	327.08	63.50
1993	Mar	464.63	170.61	294.02
1993	Apr	143.66	0.00	143.66
1993	May	374.22	121.87	252.35
1993	Jun	863.38	407.72	455.66
1993	Jul	2,235.30	198.47	2,036.83
1993	Aug	2,118.50	194.99	1,923.51
1993	Sep	1,422.38	0.00	1,422.38
1993	Oct	1,485.69	0.00	1,485.69
1993	Nov	2,691.52	0.00	2,691.52
1993	Dec	3,328.53	139.28	3,189.25
1994	Jan	2,220.76	240.25	1,980.51
1994	Feb	246.08	327.08	-81.00
1994	Mar	596.89	170.61	426.28
1994	Apr	1,150.89	0.00	1,150.89

Table A.4.1 Simulation of Camalig Diversion Dam (10/10)

RS Paddy	130	ha
DS Paddy	130	ha

Year	Month	Inflow (1000 m3)	Requirement for Irigation (1000 m3)	Balance (1000 m3)
1994	May	853.39	121.87	731.52
1994	Jun	1,100.22	407.72	692.50
1994	Jul	2,194.42	198.47	1,995.95
1994	Aug	551.62	194.99	356.63
1994	Sep	1,525.16	0.00	1,525.16
1994	Oct	841.09	0.00	841.09
1994	Nov	391.07	0.00	391.07
1994	Dec	2,149.02	139.28	2,009.74
1995	Jan	976.02	240.25	735.77
1995	Feb	382.53	327.08	55.45
1995	Mar	176.36	170.61	5.75
1995	Apr	471.13	0.00	471.13

THE FEASIBILITY STUDY ON
THE WESTERN LEGAZPI IRRIGATION AND
RURAL DEVELOPMENT PROJECT IN THE PHILIPPINES

FIGURES

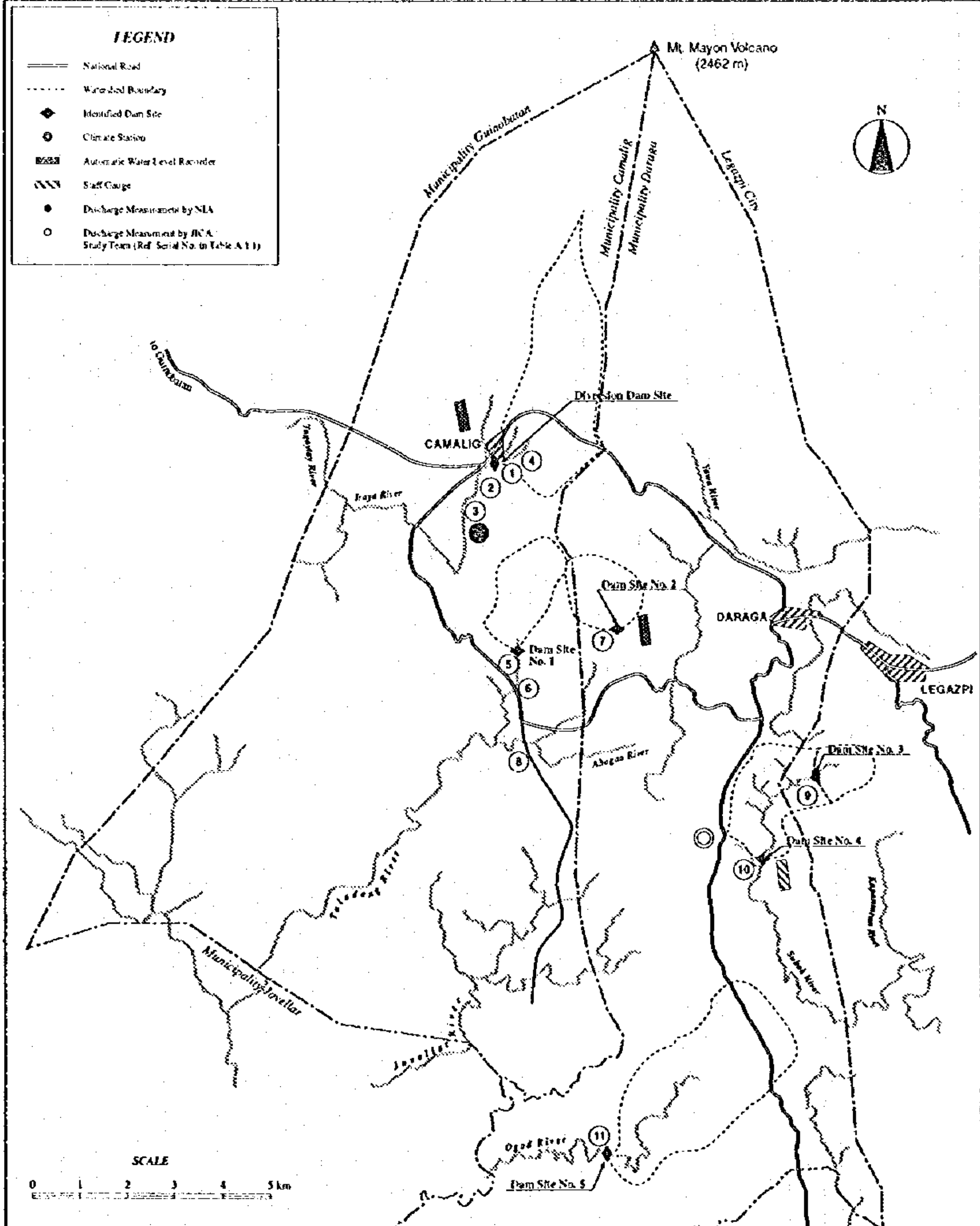


Figure A.1.1 Location of Water Resources

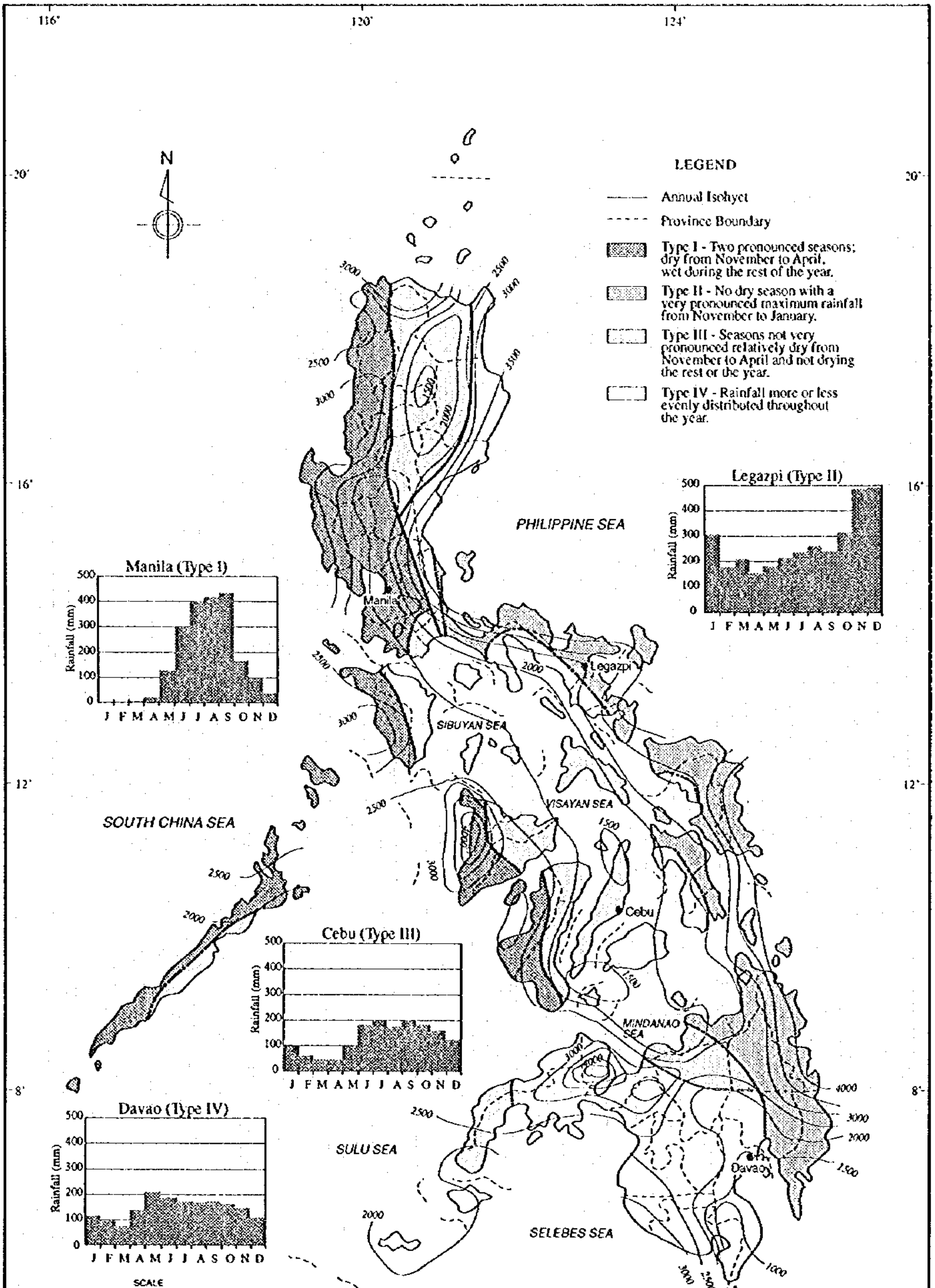


Figure A.2.1 Climate Type of the Philippines

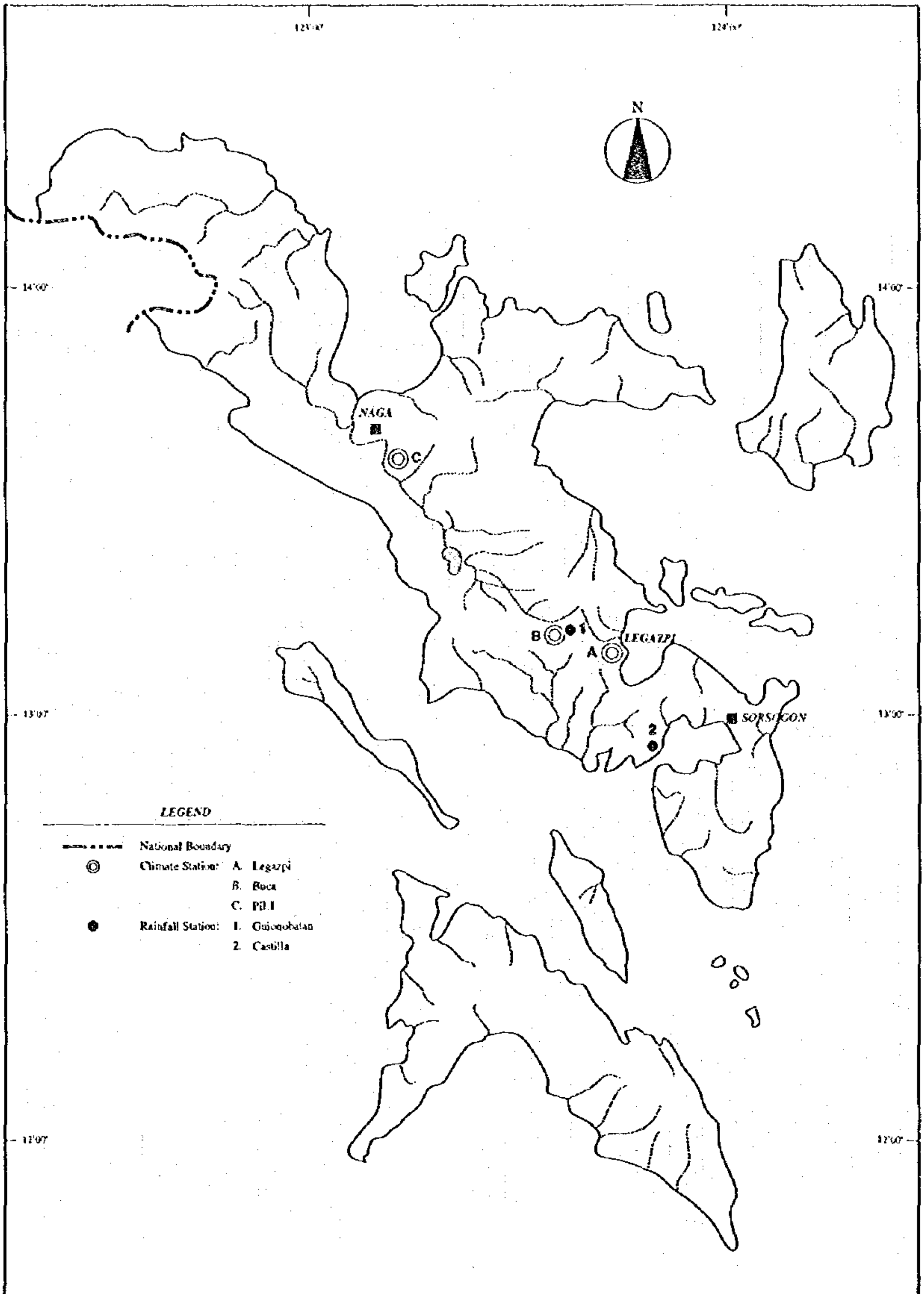


Figure A.2.2 Location of Meteorological Stations

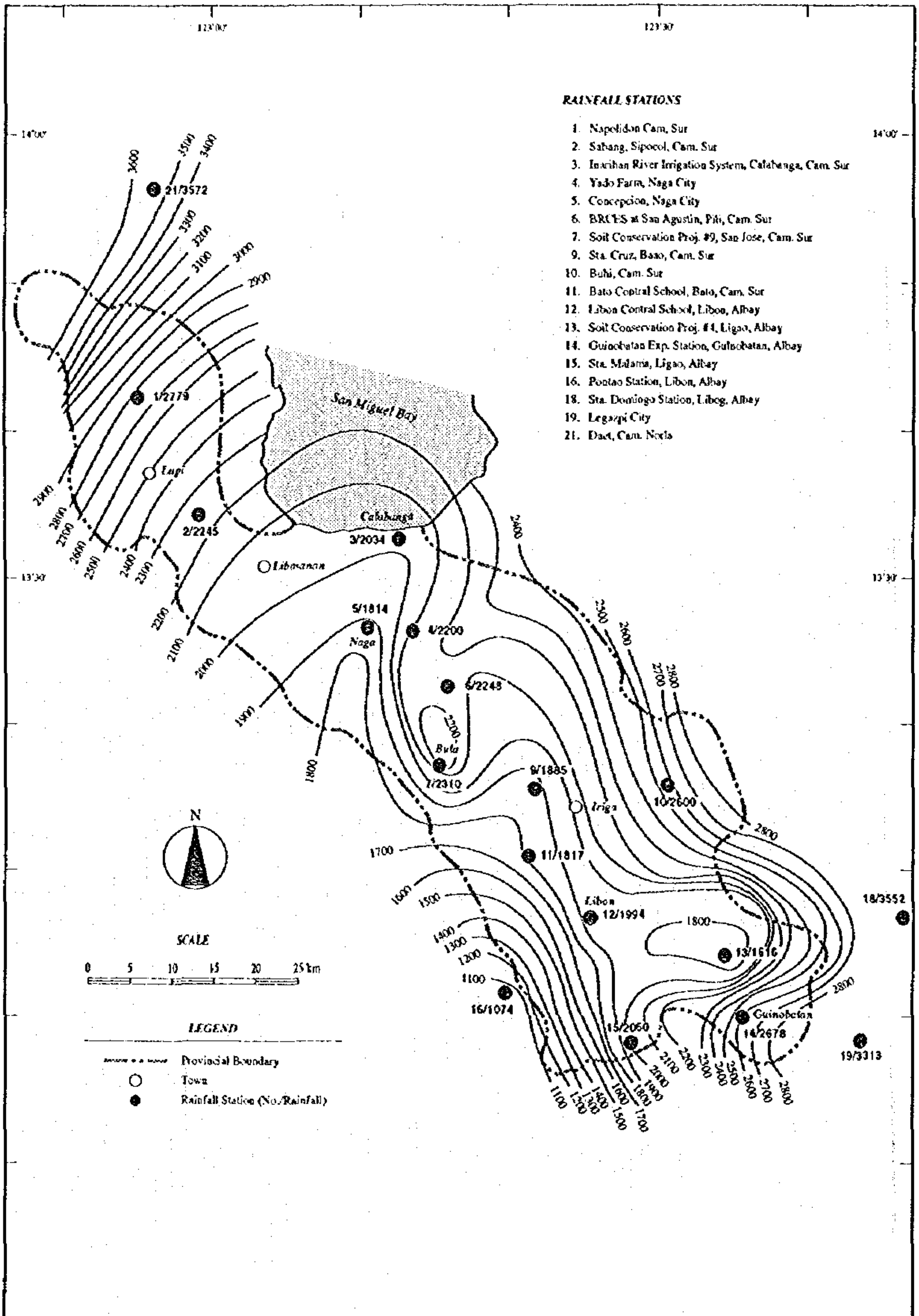


Figure A.2.3 Isohyets for Mean Annual Rainfall, Bicol River Basin

Data Source: F/S Report on Bicol River Basin Irrigation & Flood Control Project.

Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (1/12)
January

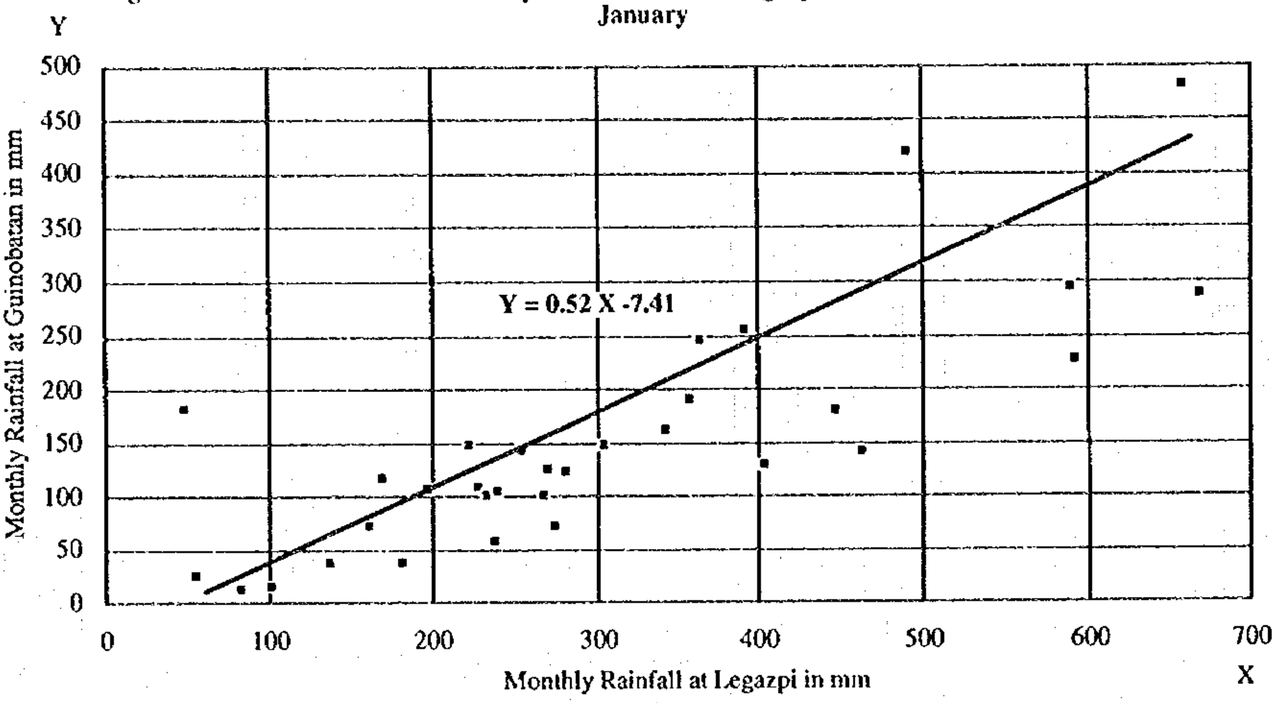


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (2/12)
February

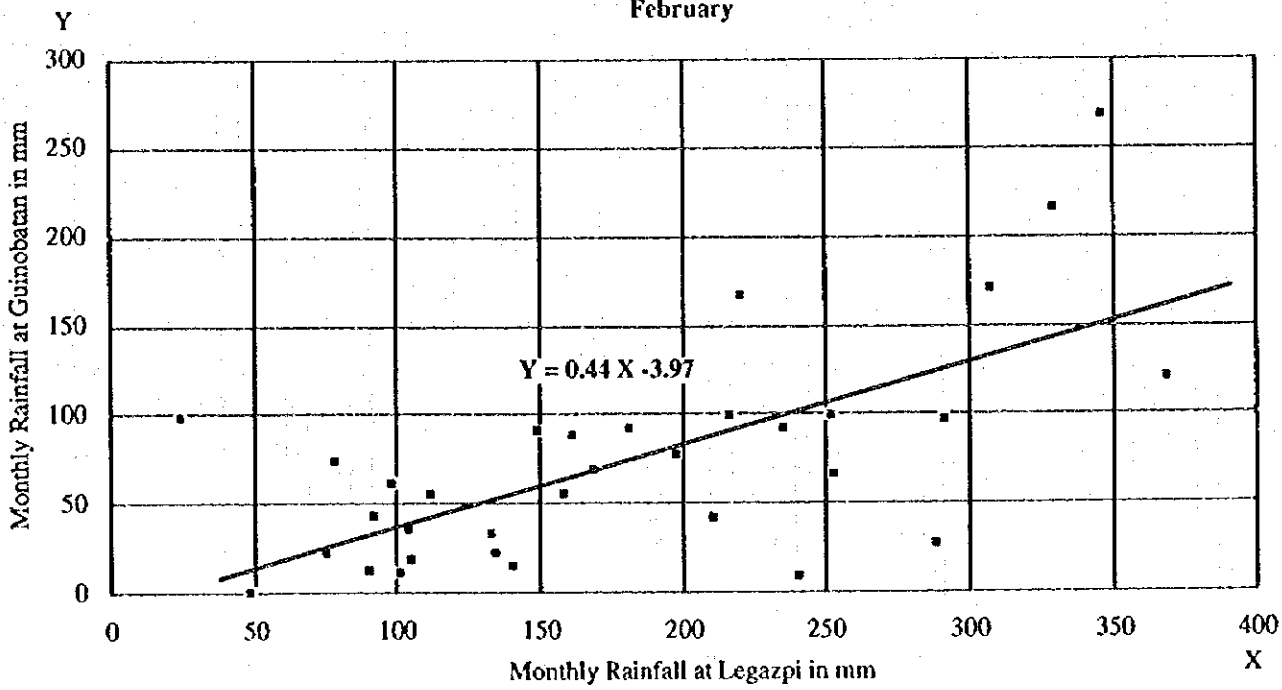


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (3/12)
March

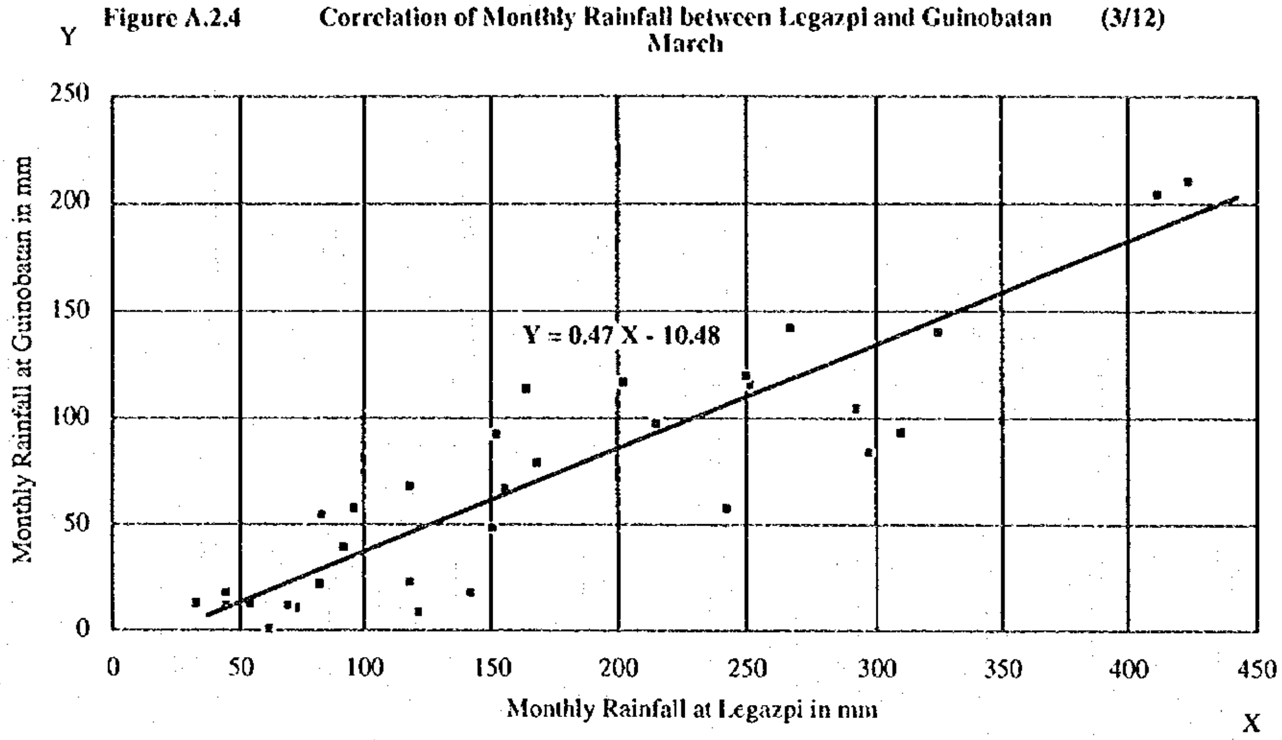


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (4/12)
April

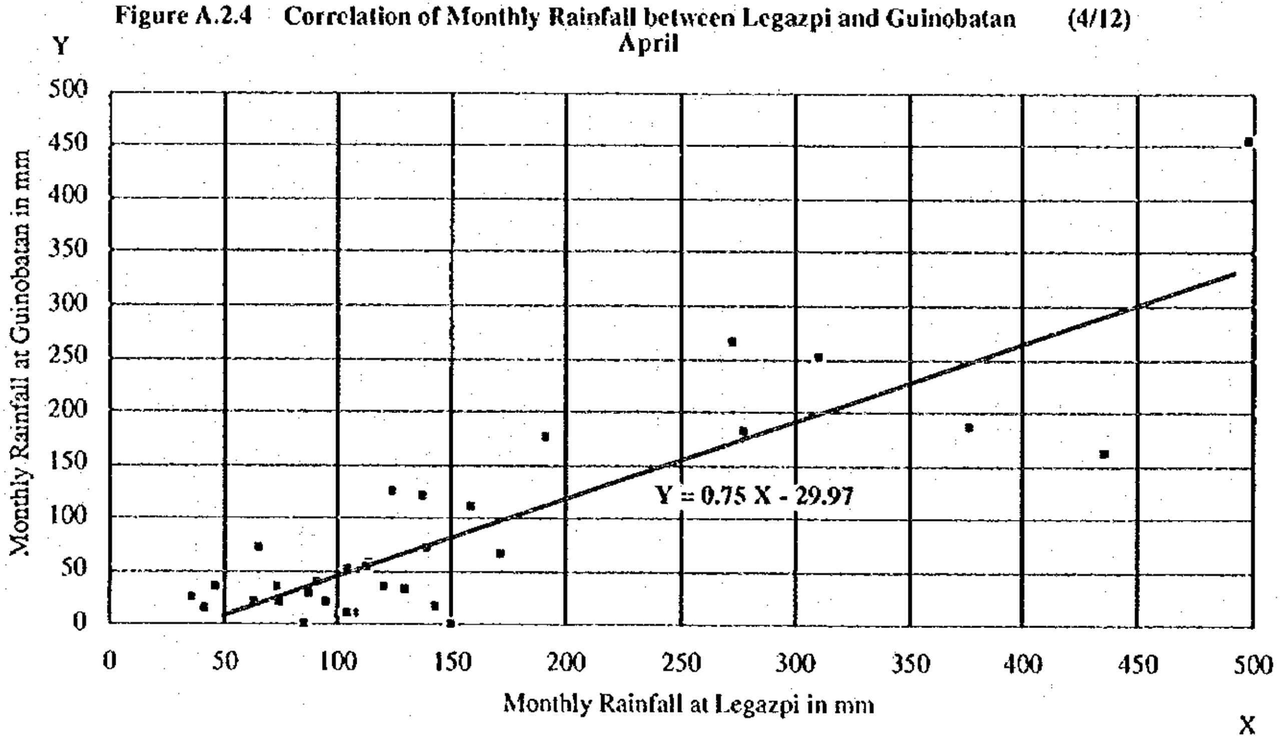


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (5/12)
May

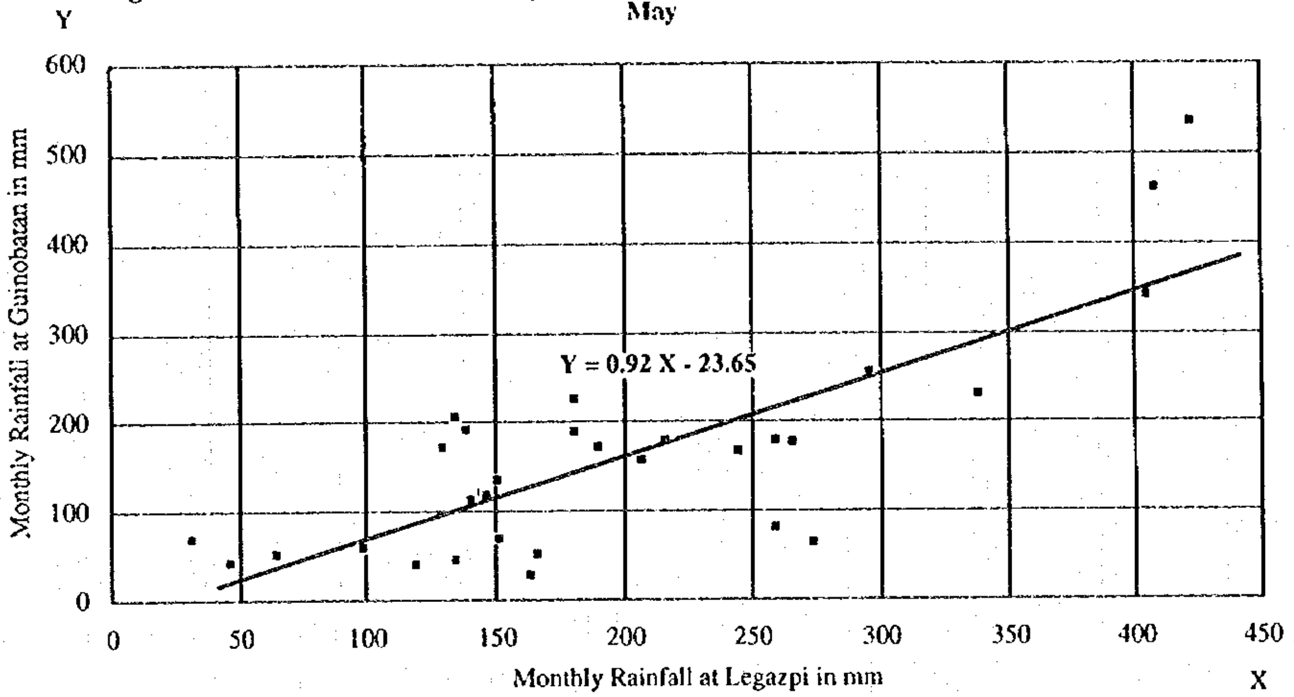


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (6/12)
June

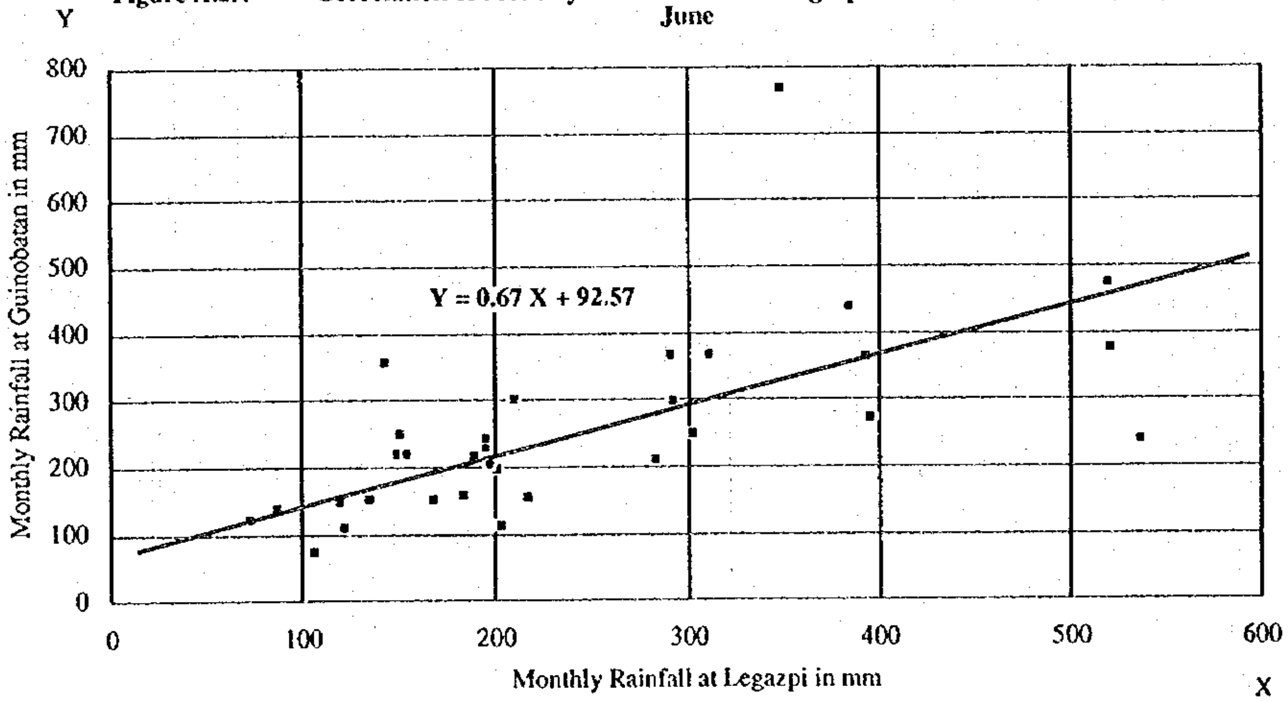


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (7/12)
July

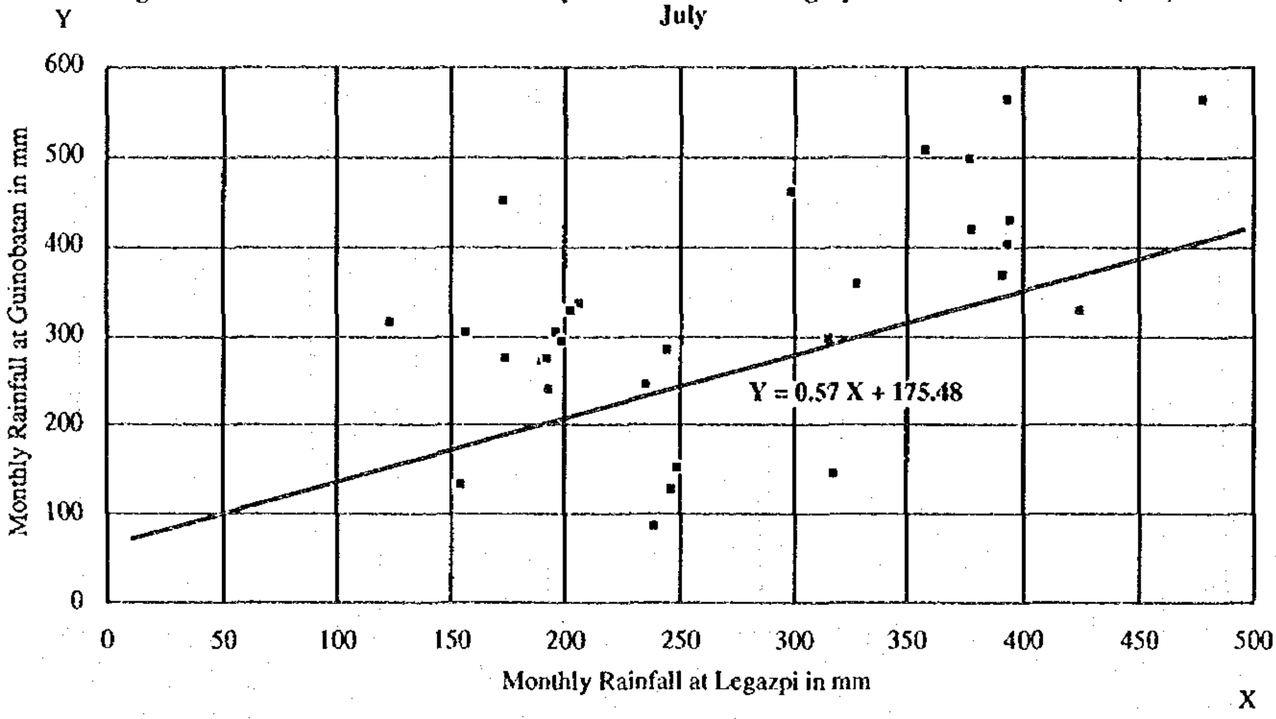


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (8/12)
August

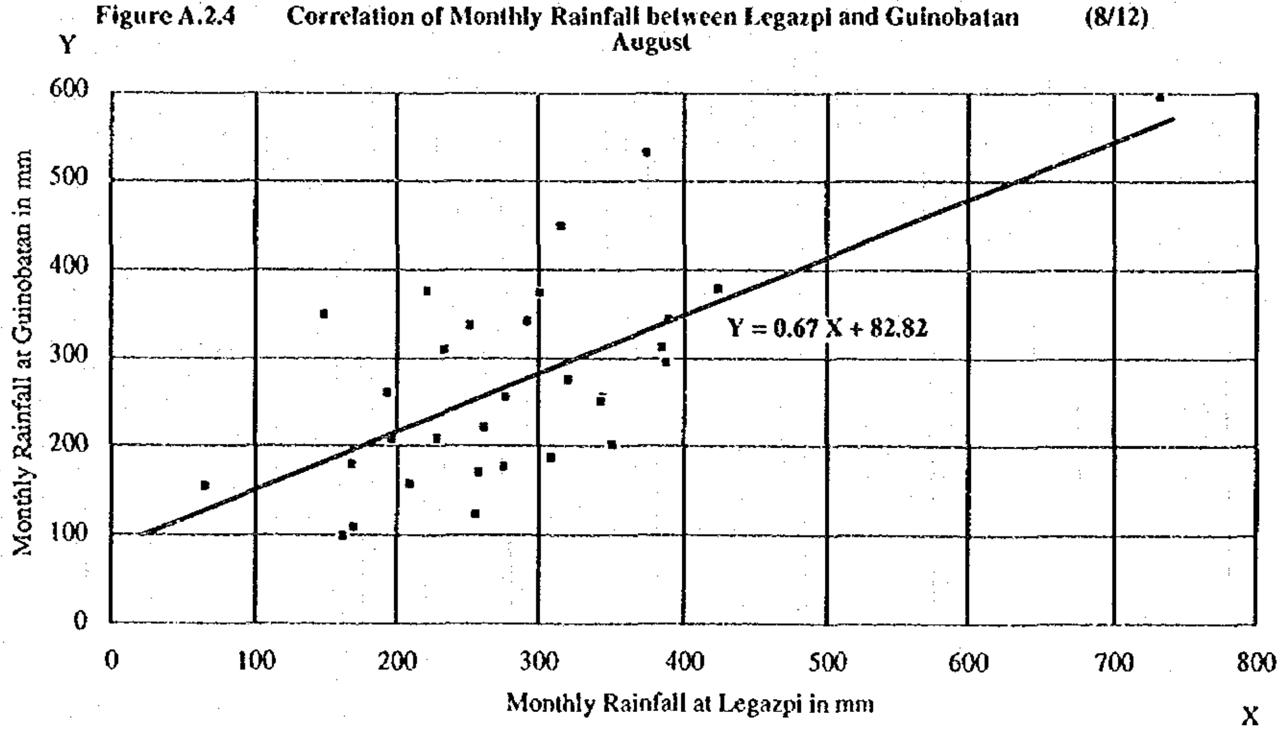


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (9/12)
September

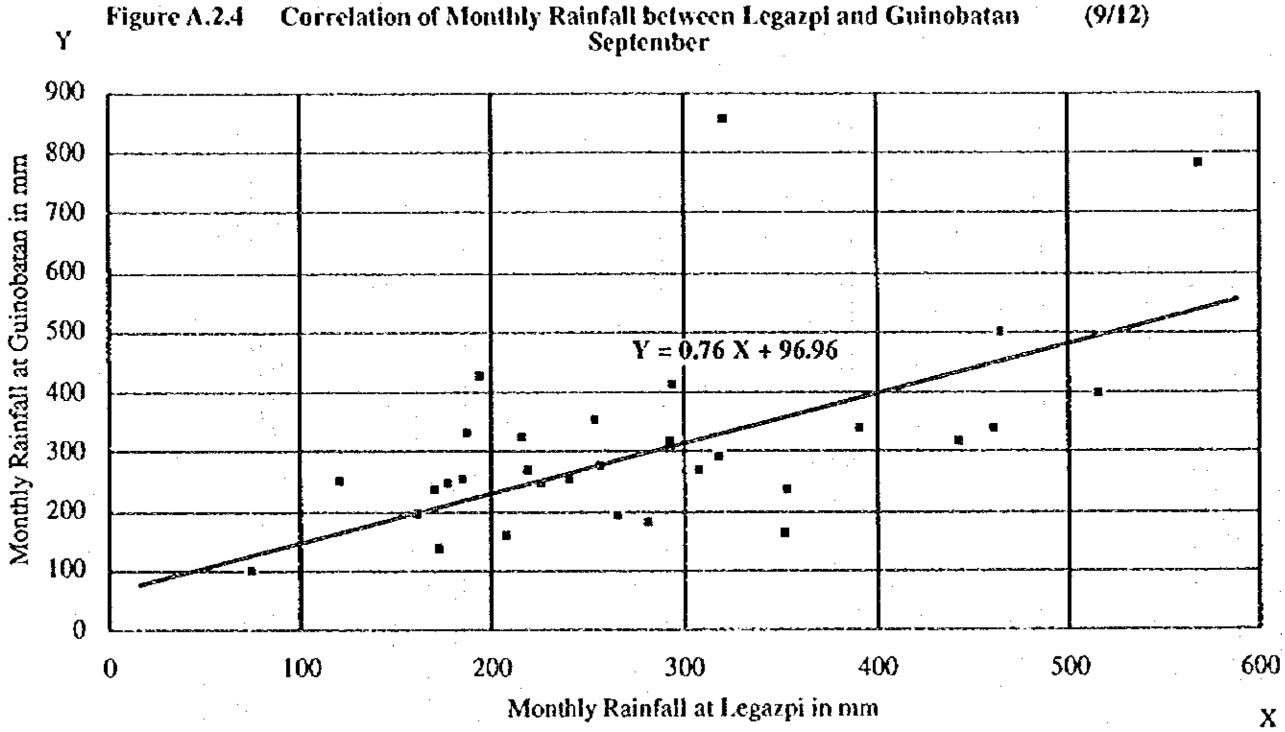


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (10/12)
October

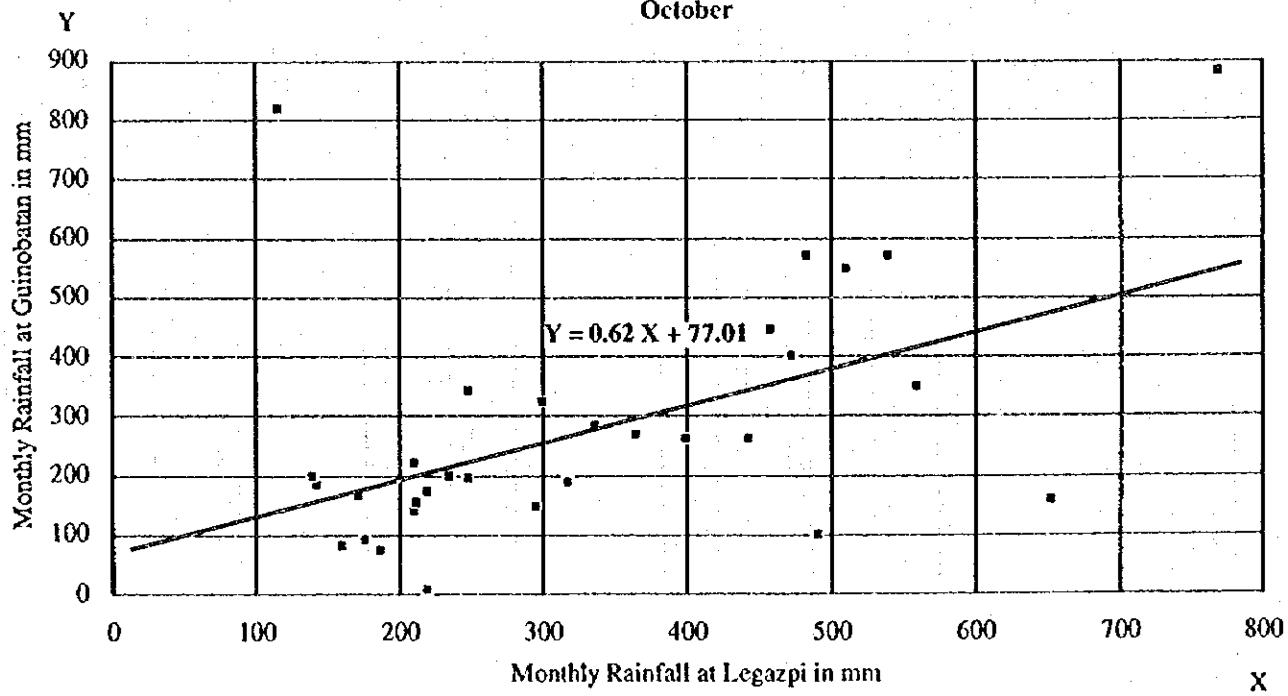


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (11/12)
November

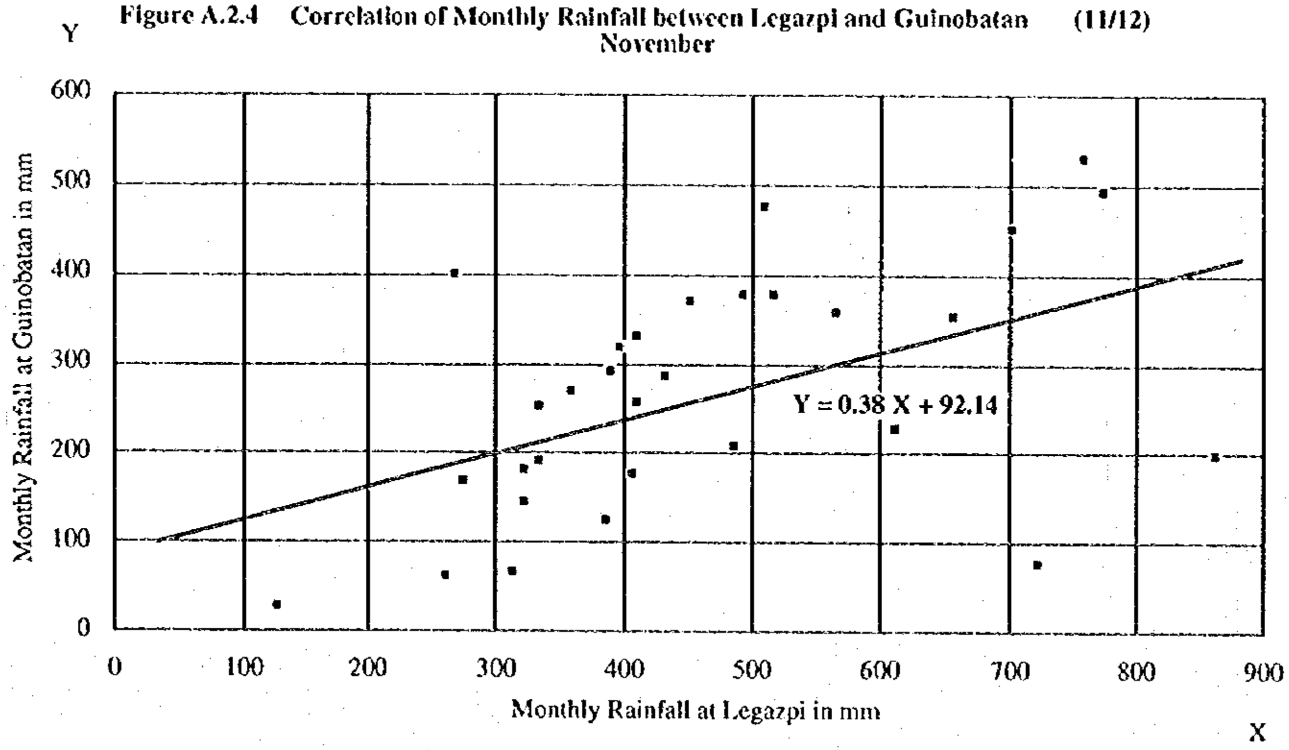
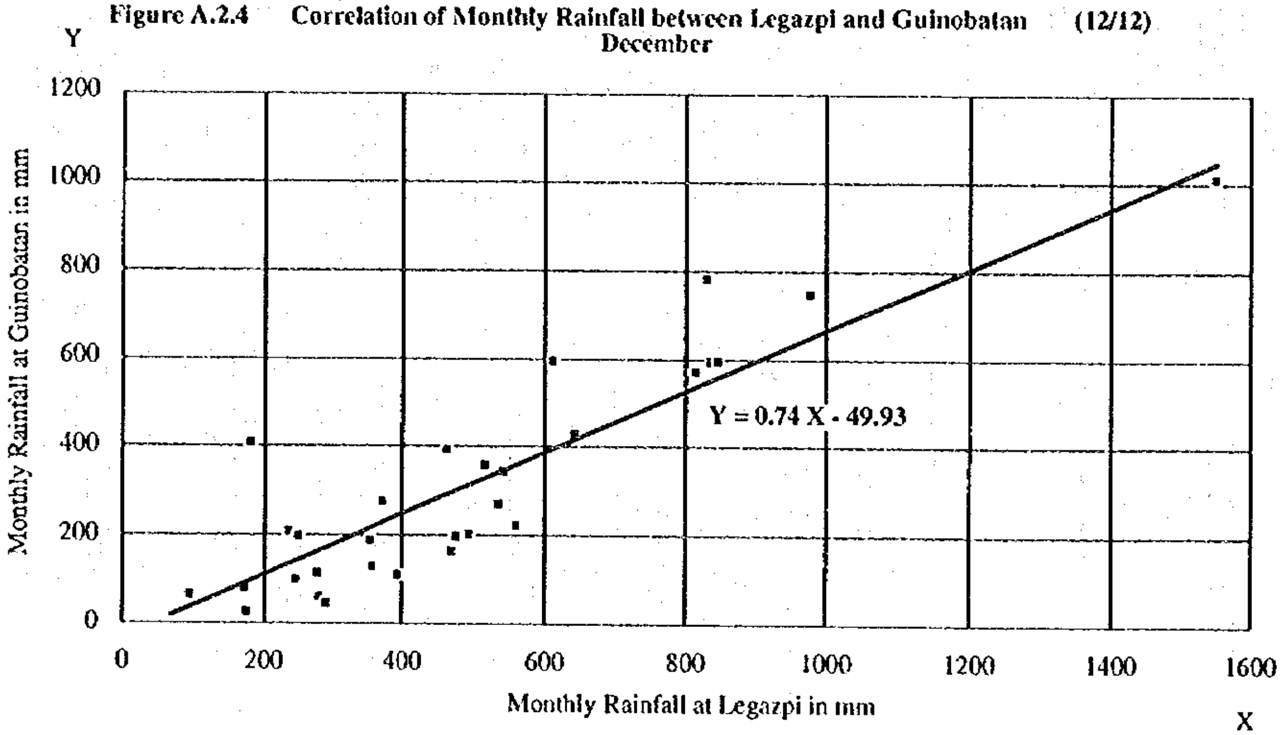


Figure A.2.4 Correlation of Monthly Rainfall between Legazpi and Guinobatan (12/12)
December



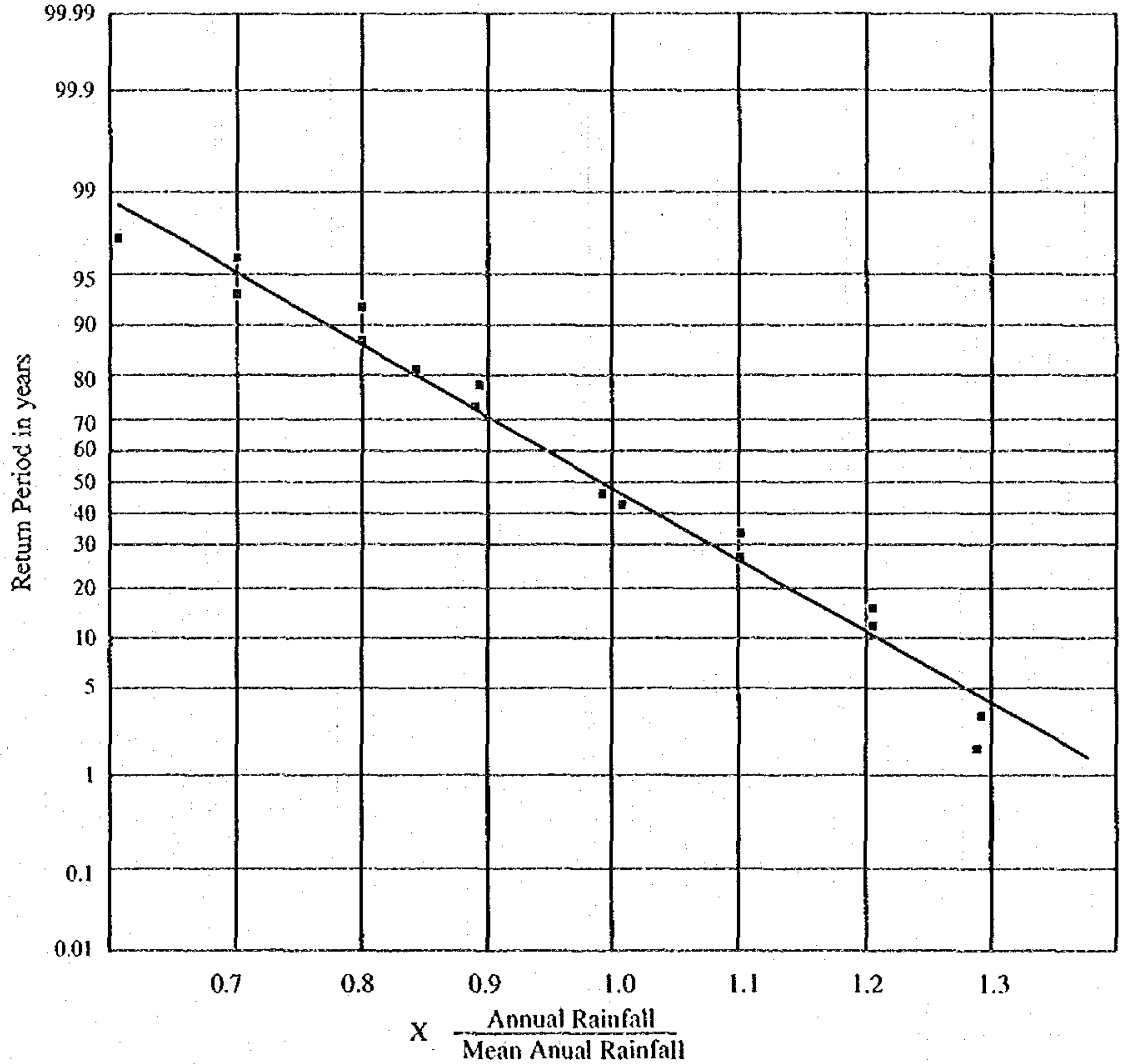


Figure A.2.5 Frequency for Annual Rainfall at Legazpi

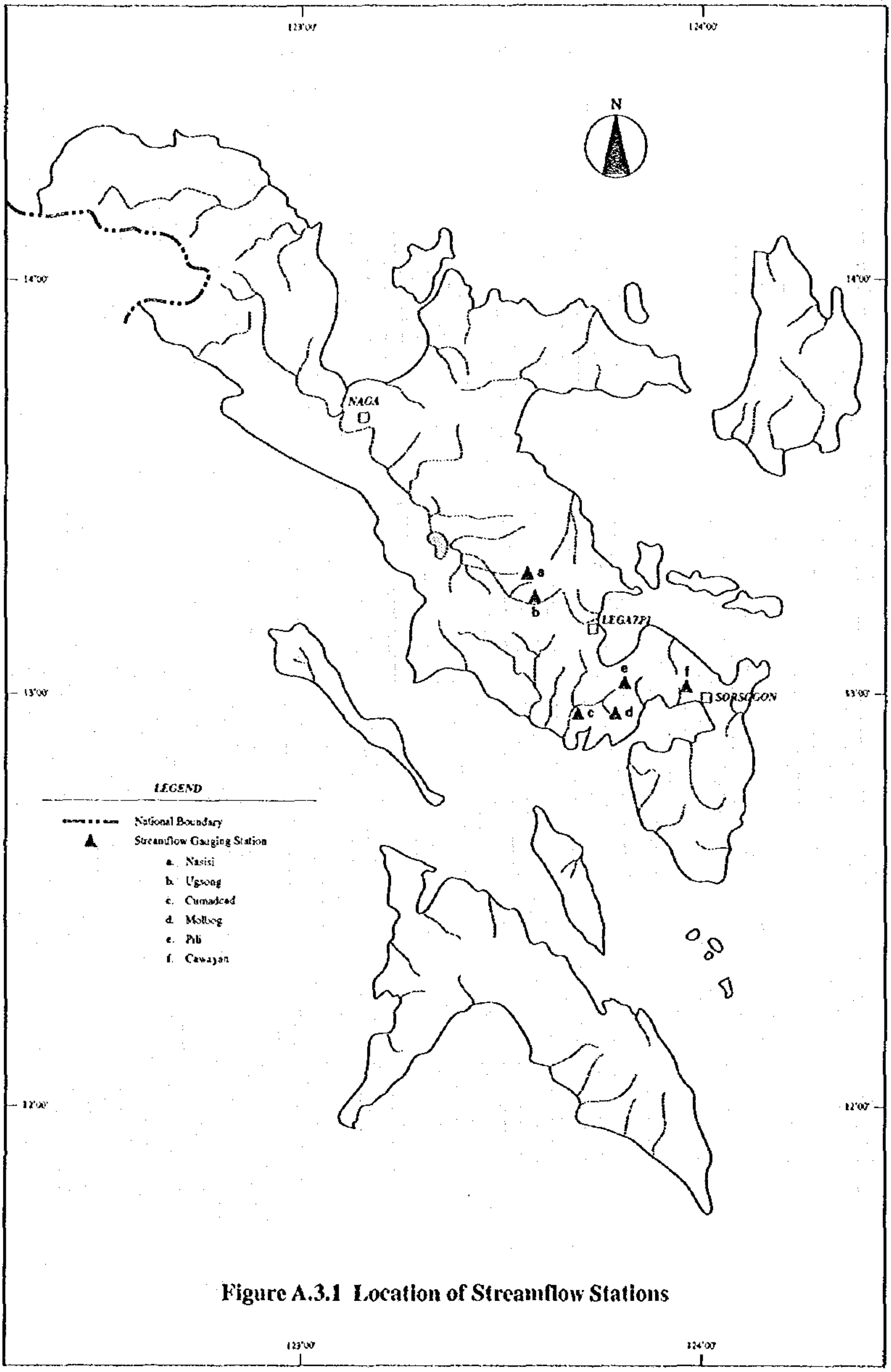


Figure A.3.1 Location of Streamflow Stations

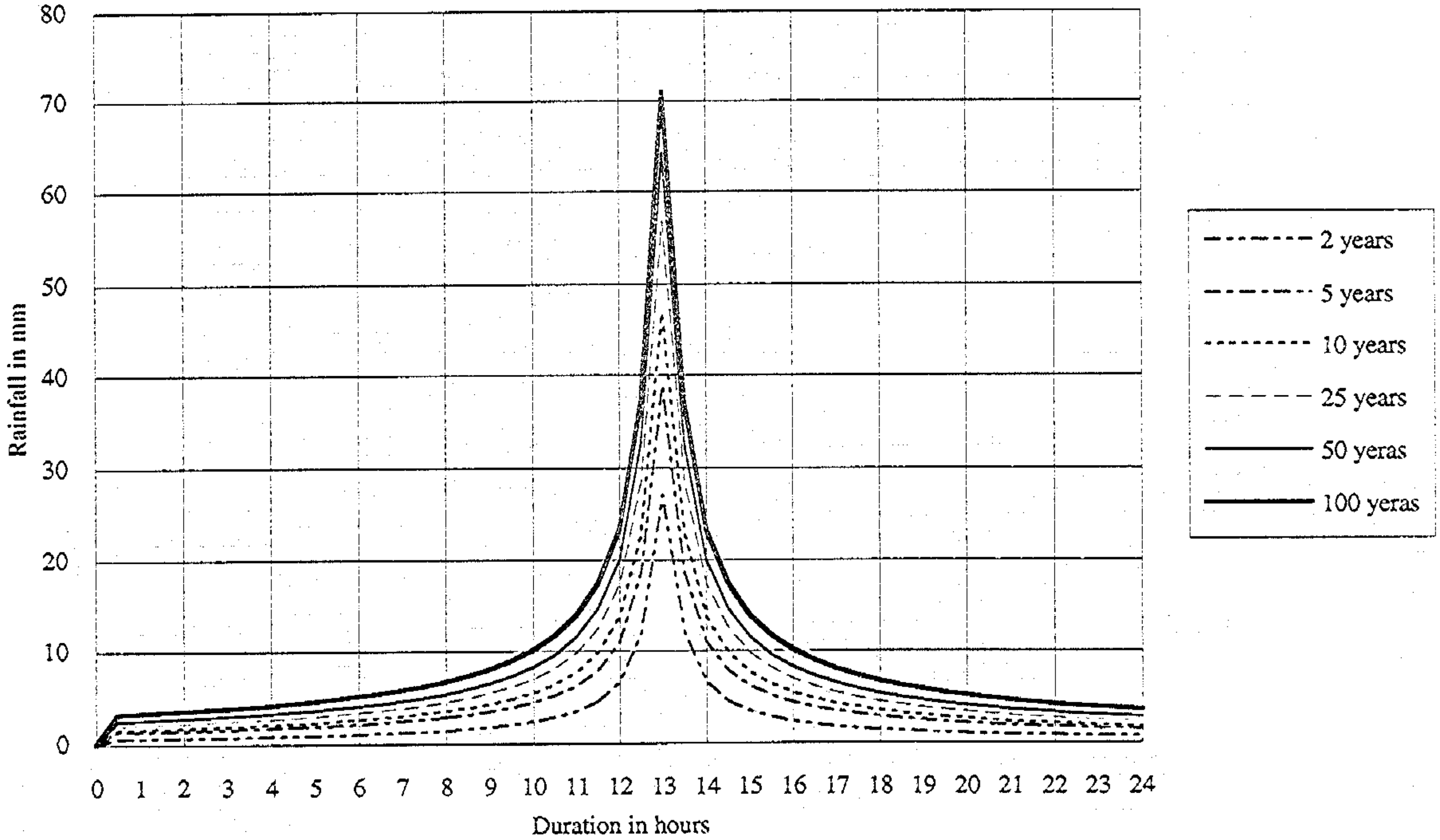
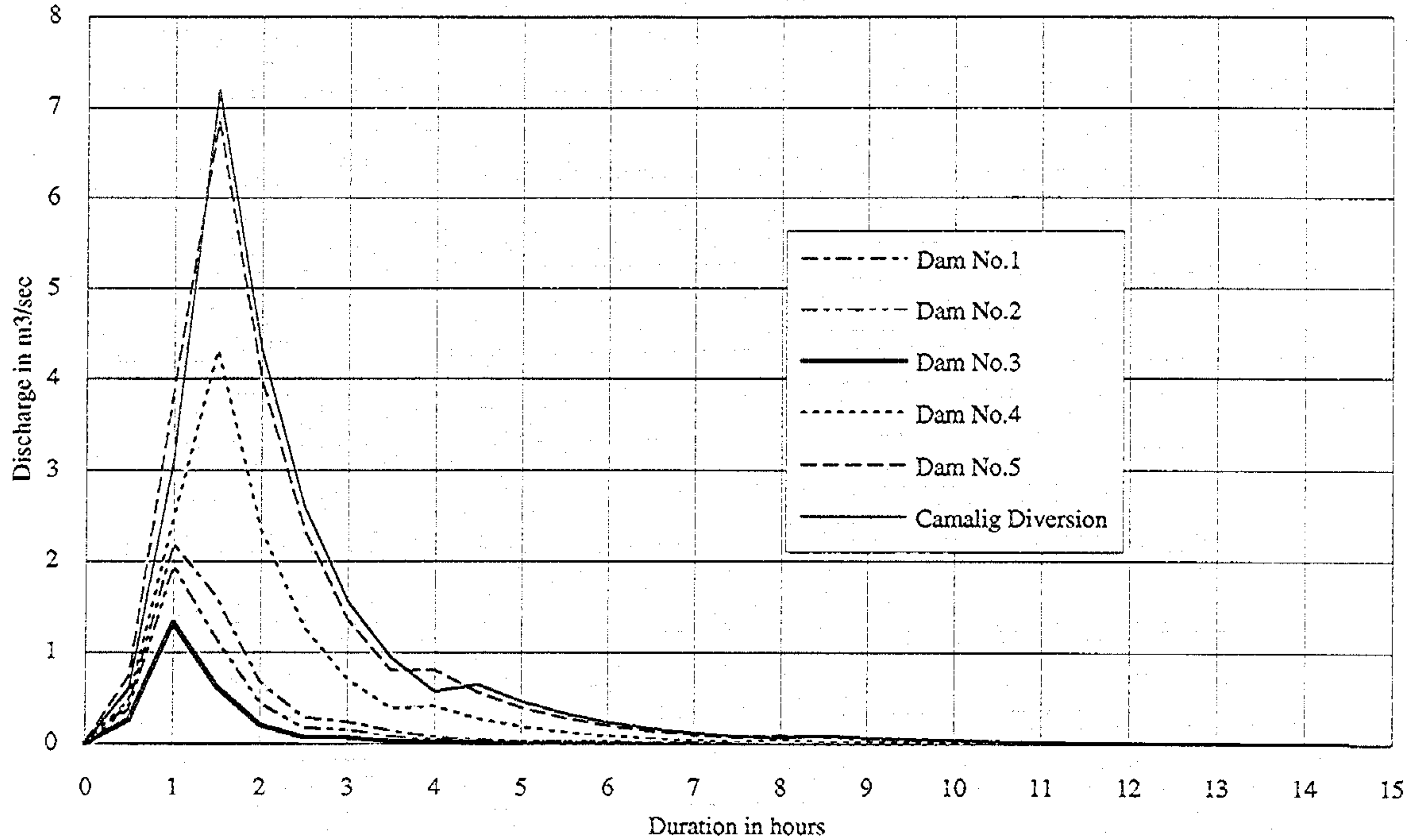


Figure A.3.2 Probable Hyetgraph



FigureA.3.3 Unit Hydrograph

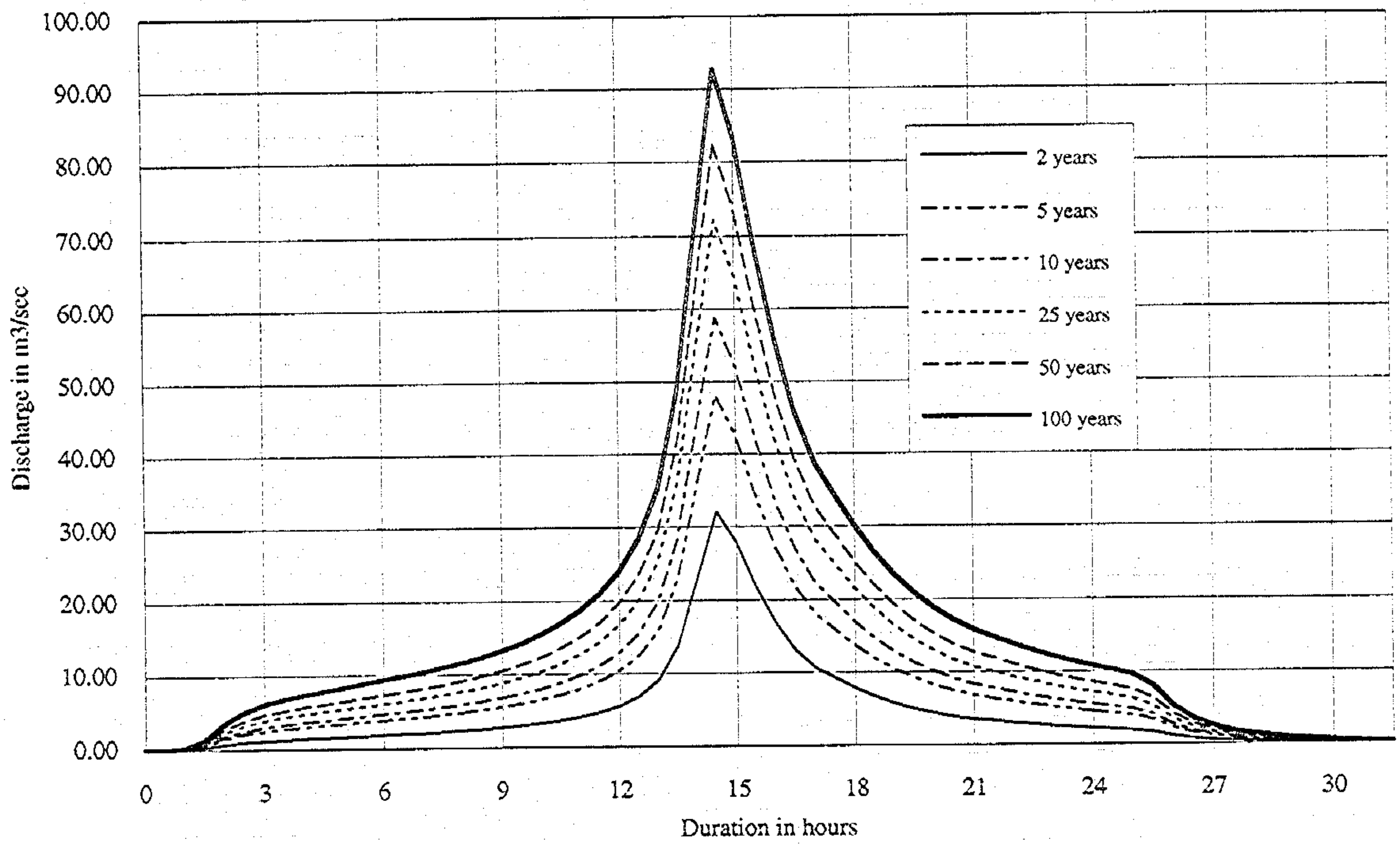


Figure A.3.4 Probable Flood at Camalig Diversion Dam

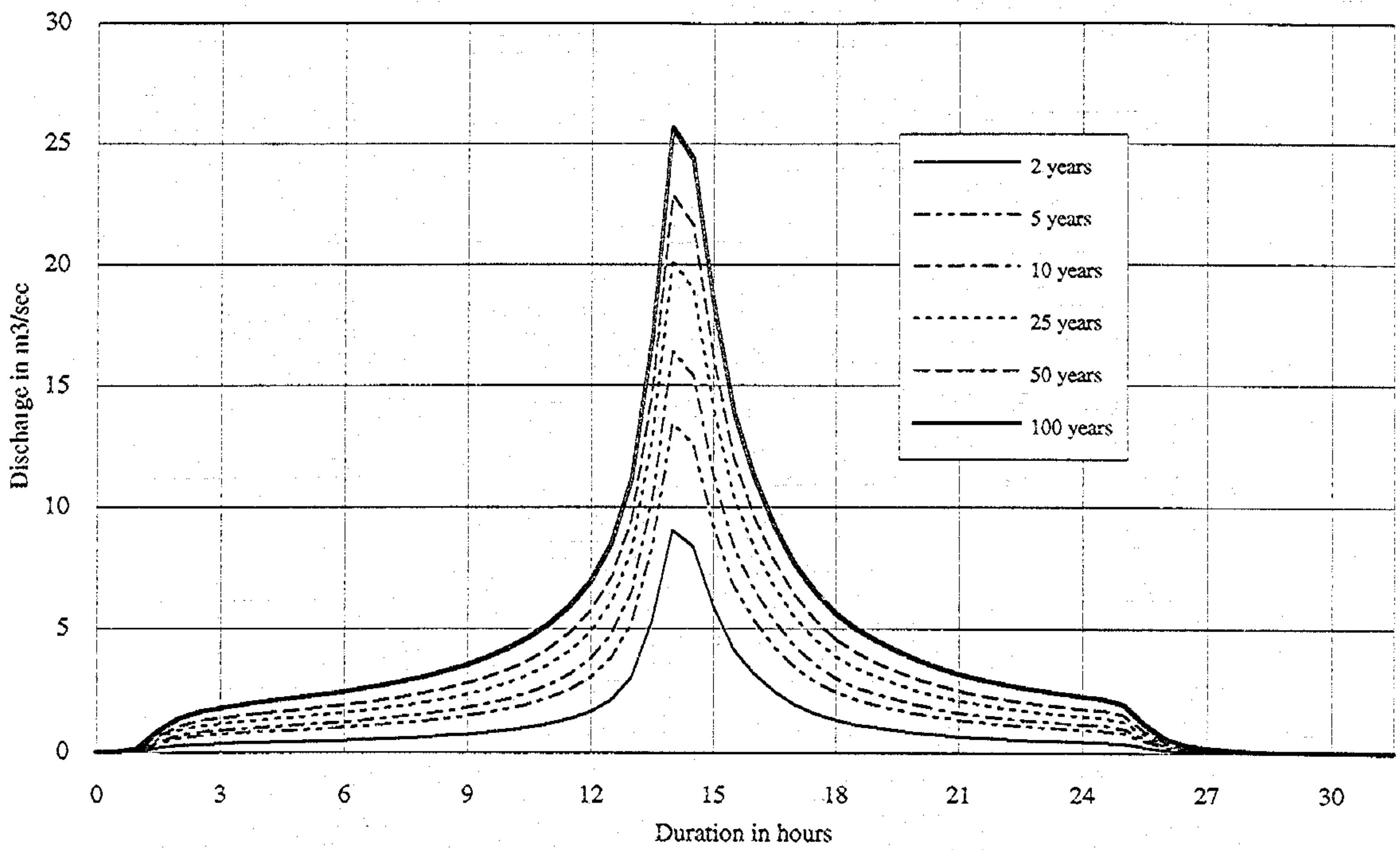


Figure A.3.5 Probable Flood at Dam No.1

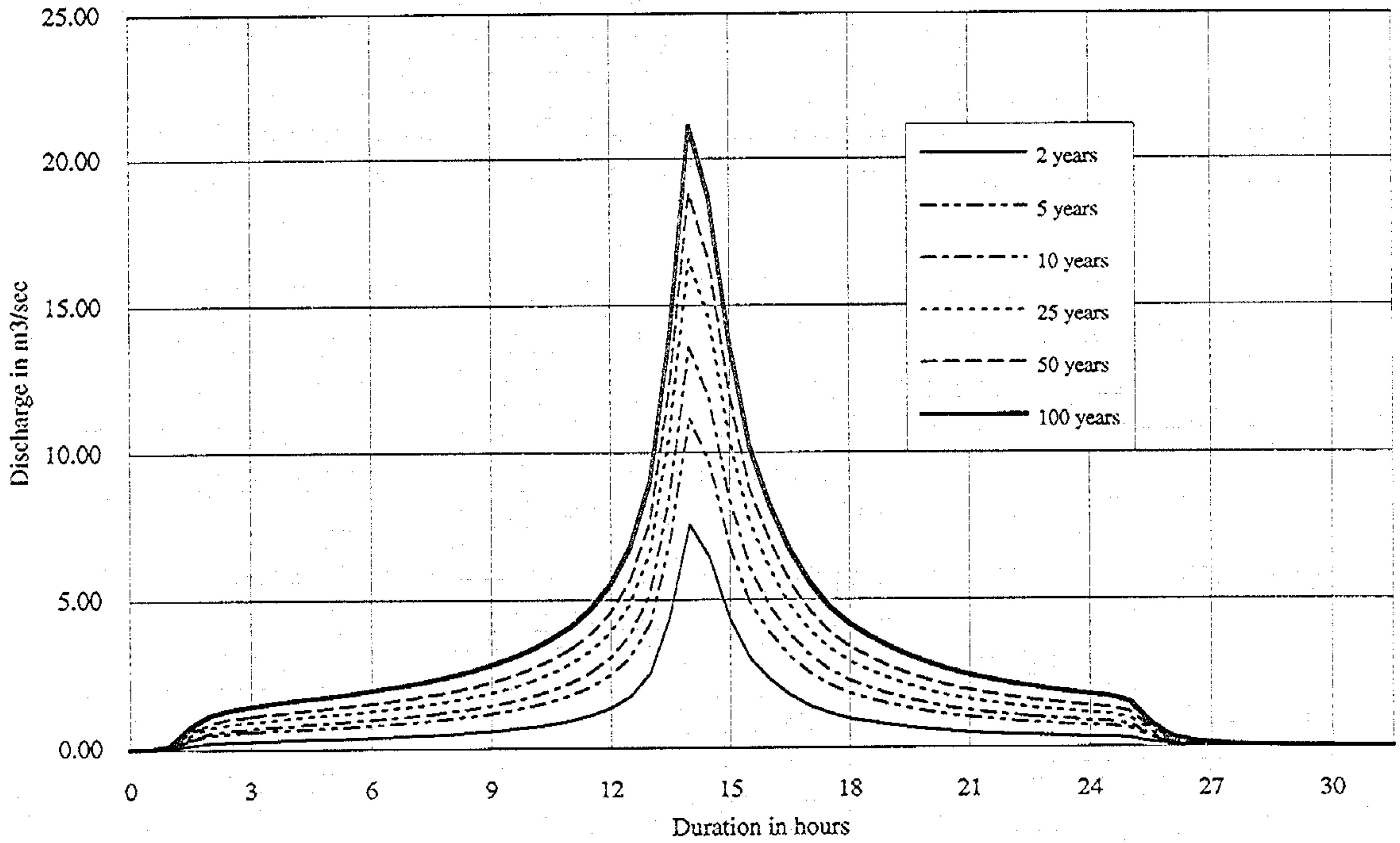


Figure A.3.6 Probable Flood at Dam No.2

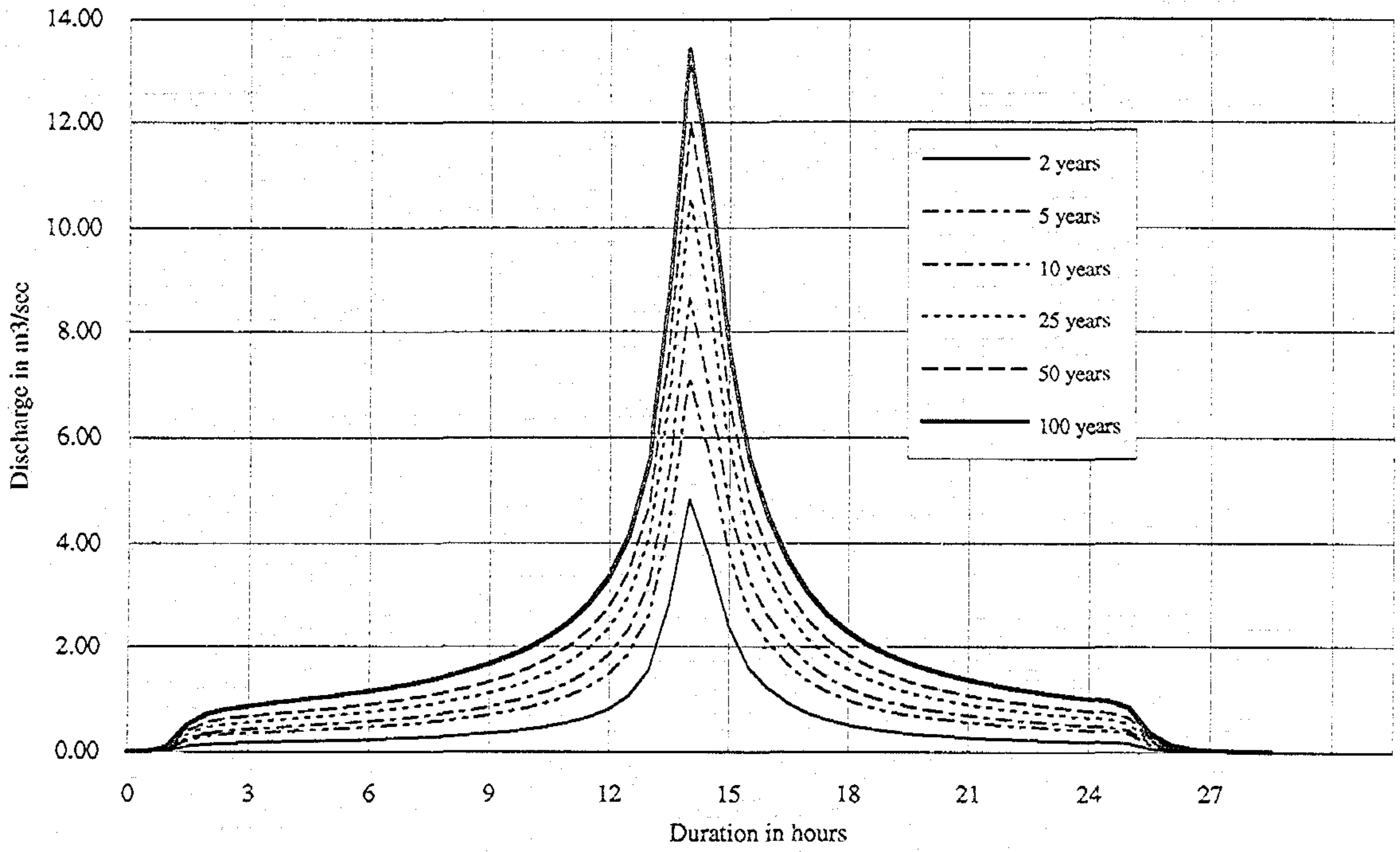


Figure A.3.7 Probable Flood at Dam No.3

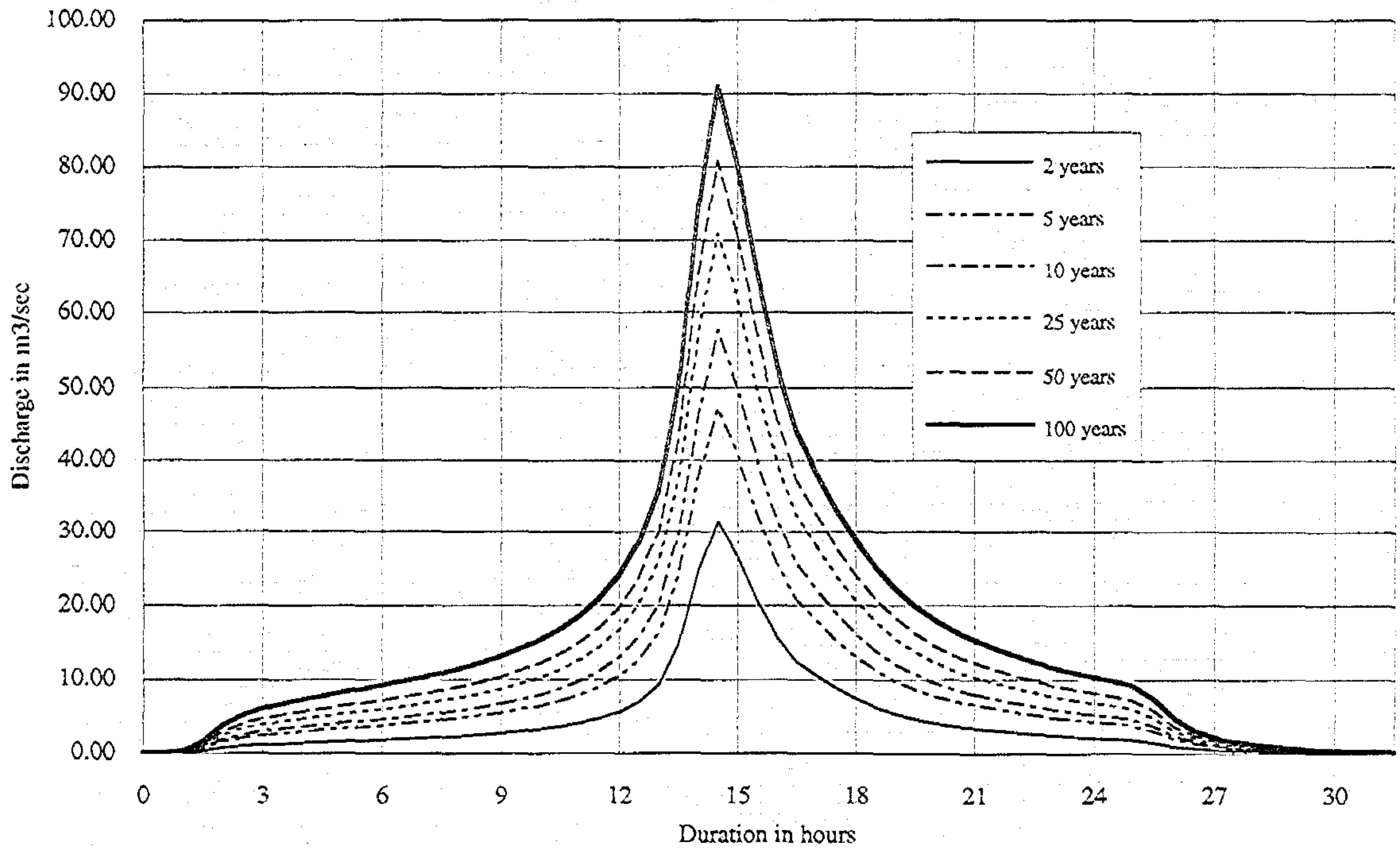


Figure A.3.8 Probable Flood at Dam No.4

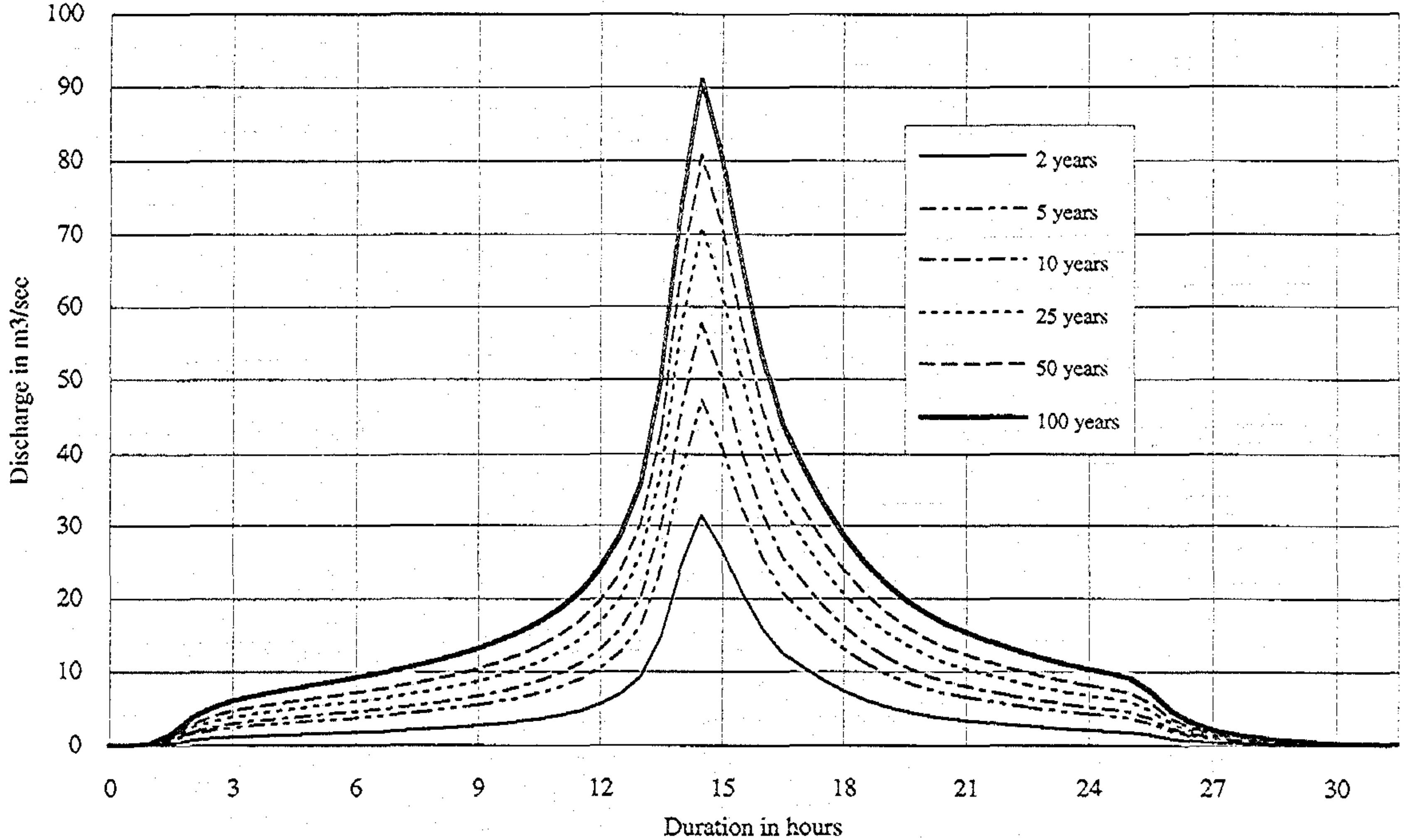


Figure A.3.9 Probable Flood at Dam No.5

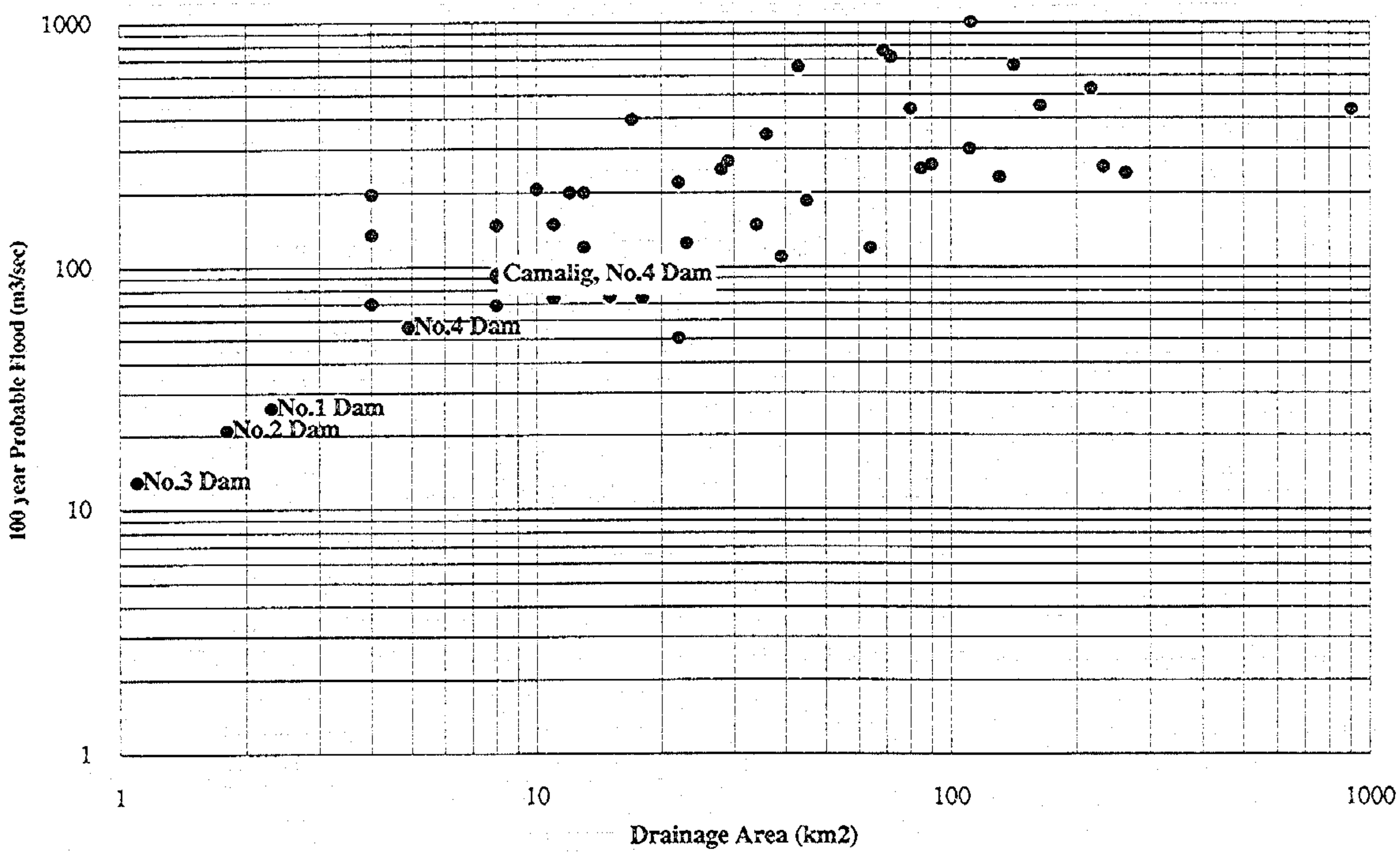


Figure A.3.10 100 Years Flood Discarge in Region V

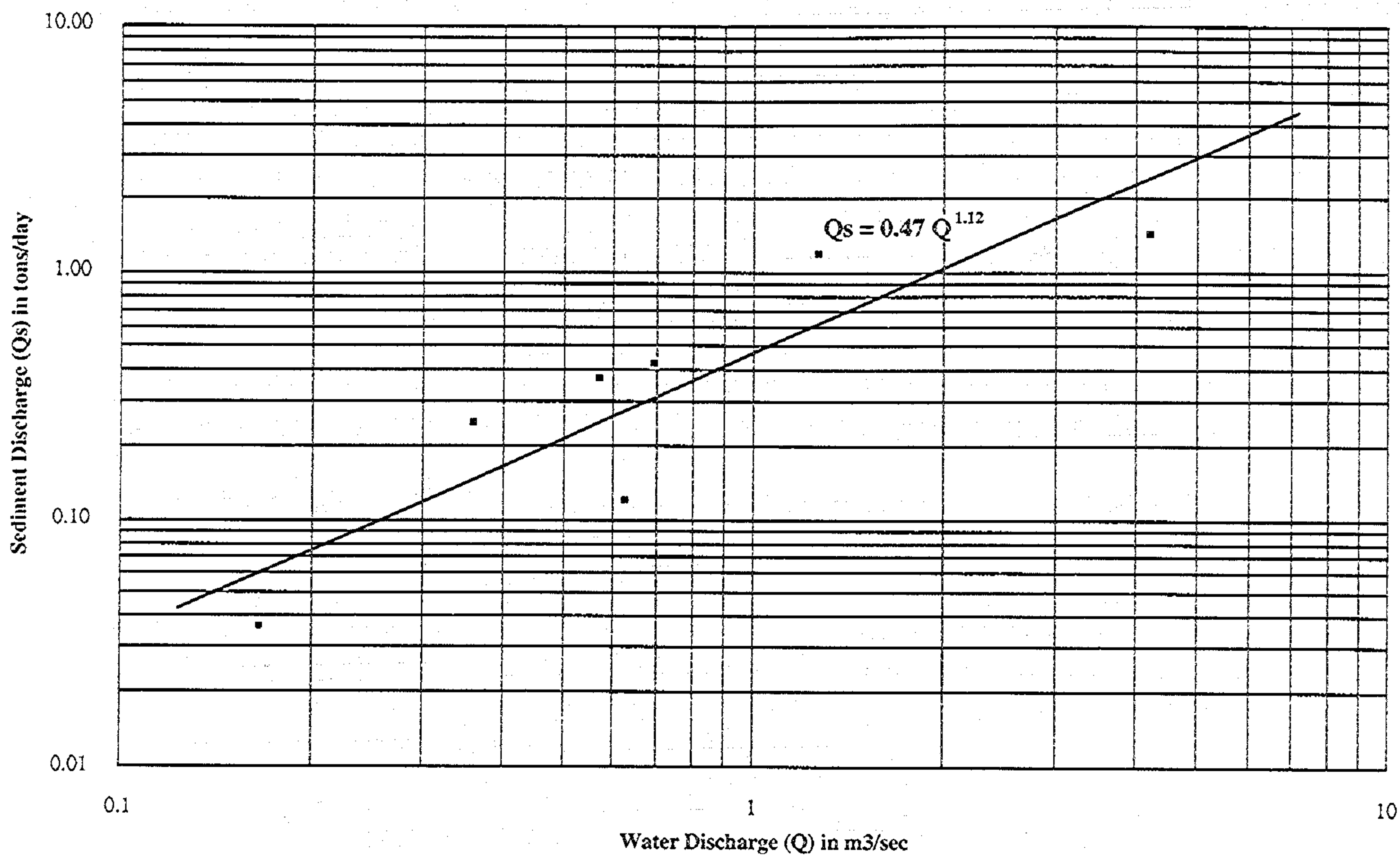


Figure A.3.11 Suspended Load Rating Curve for the Cumadcad River at Castilla

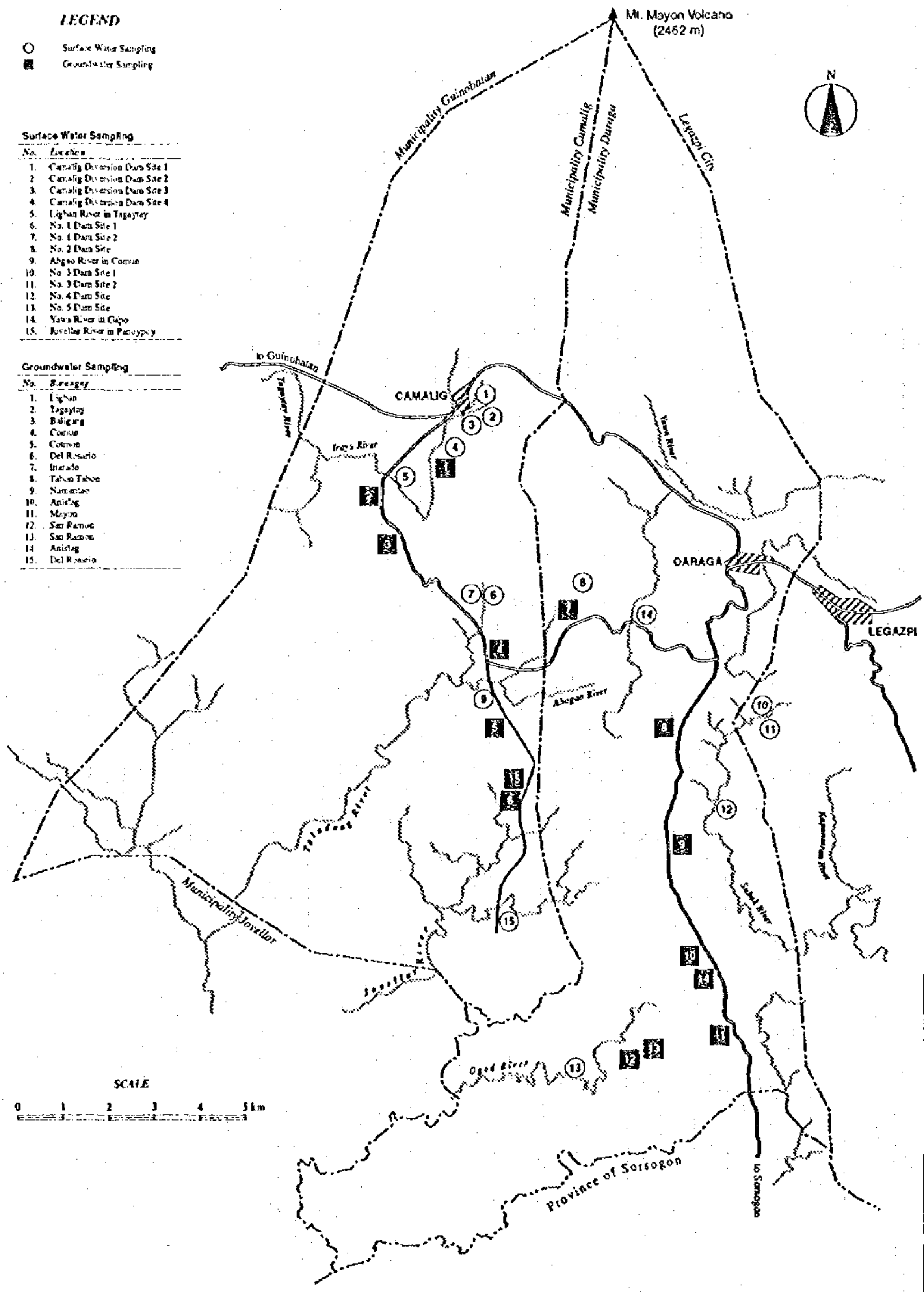
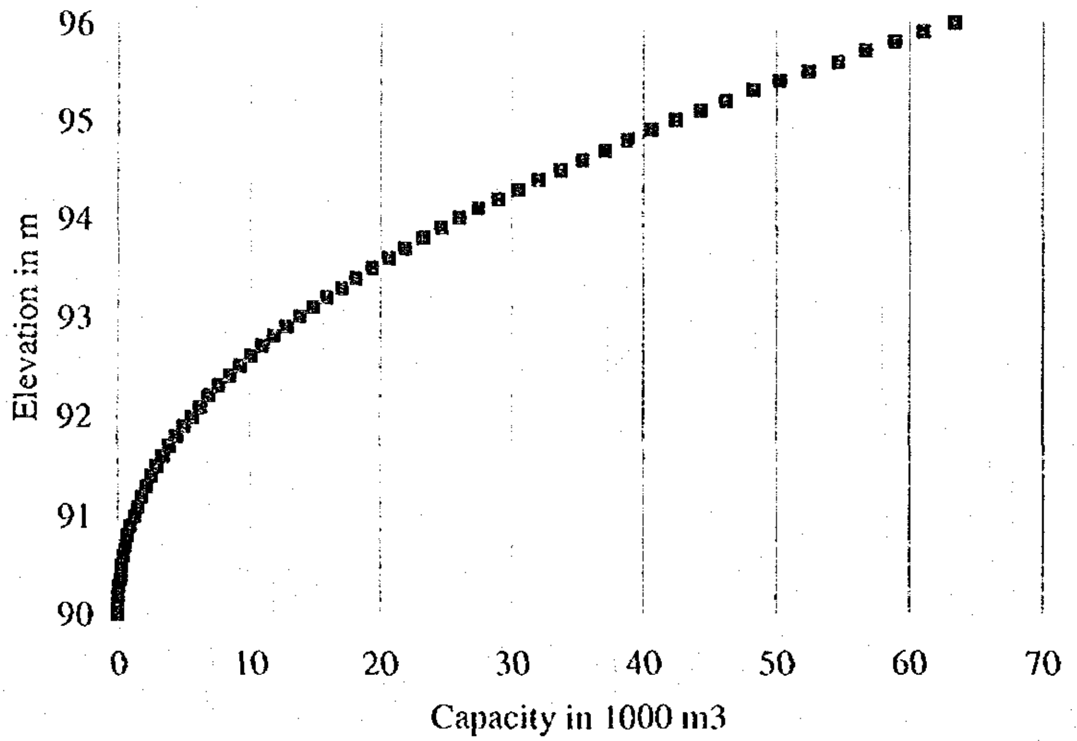


Figure A.3.12 Location of Water Sampling



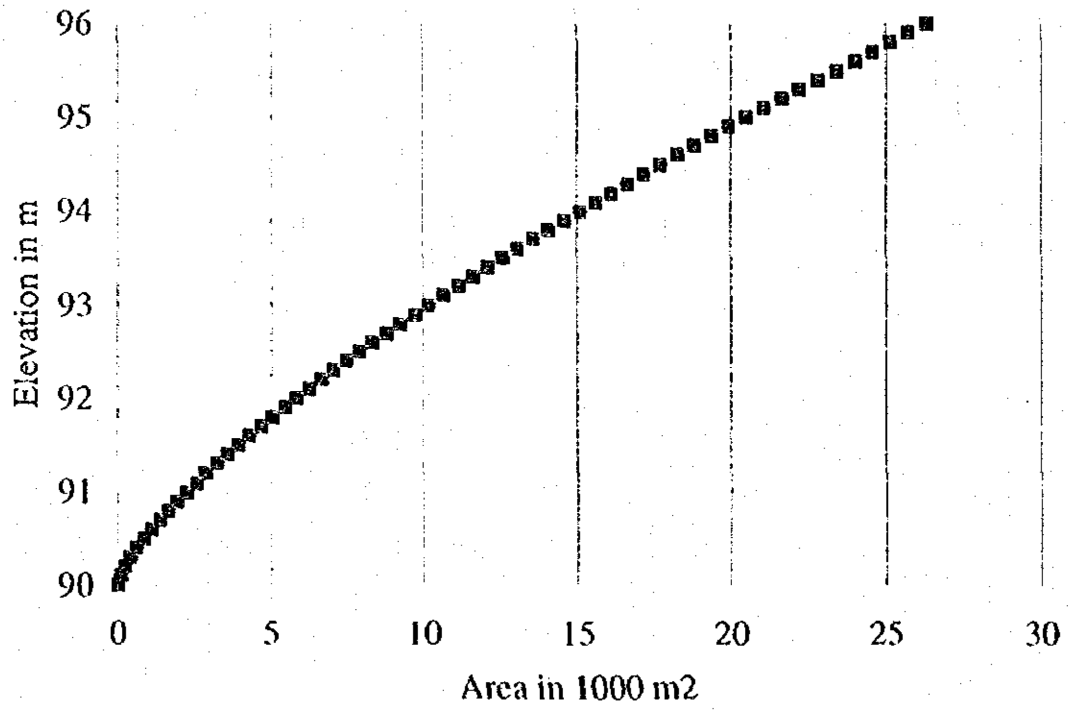
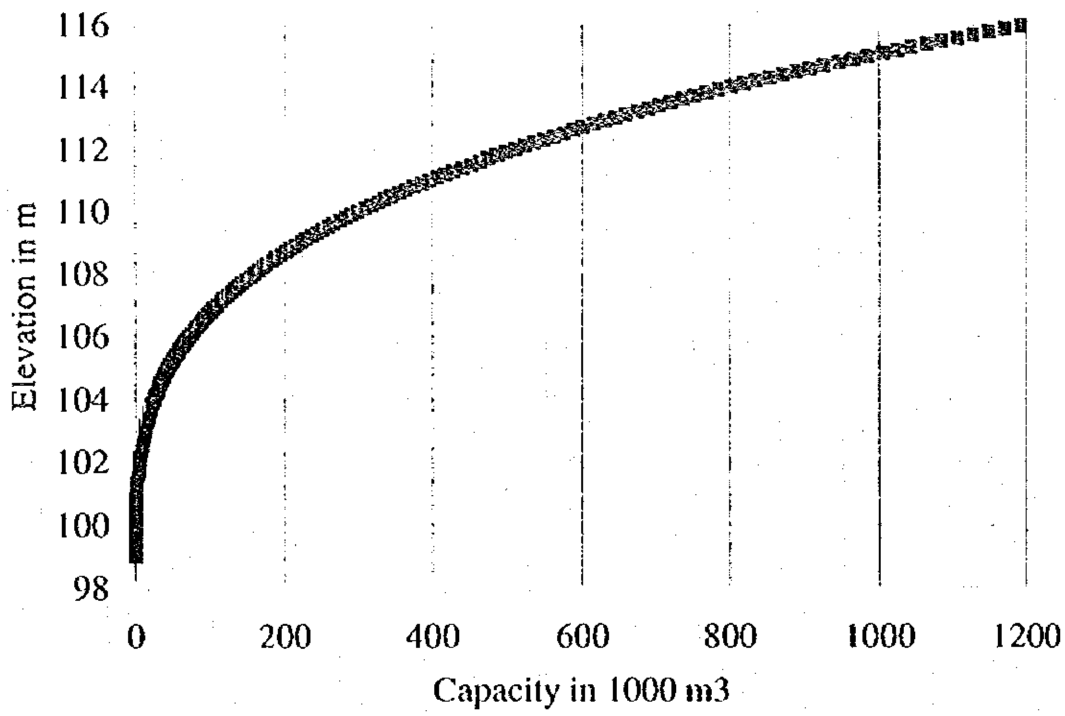


Figure A.5.1 Elevation - Capacity - Area Curve of No.1 Dam



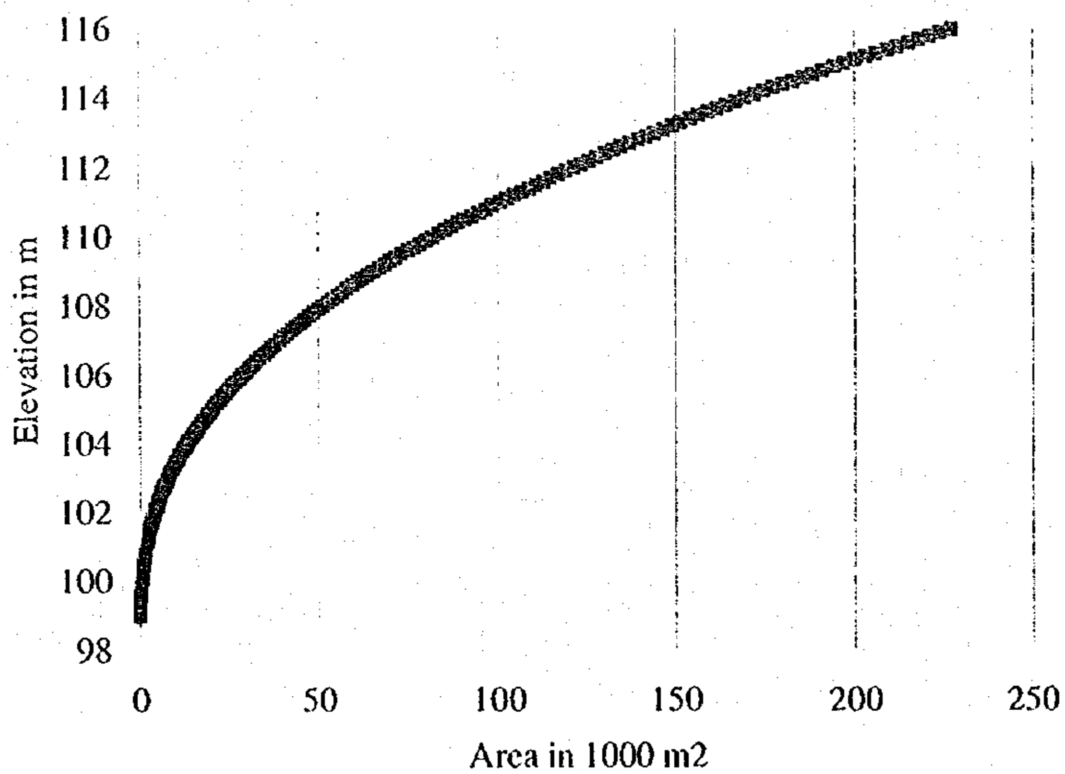
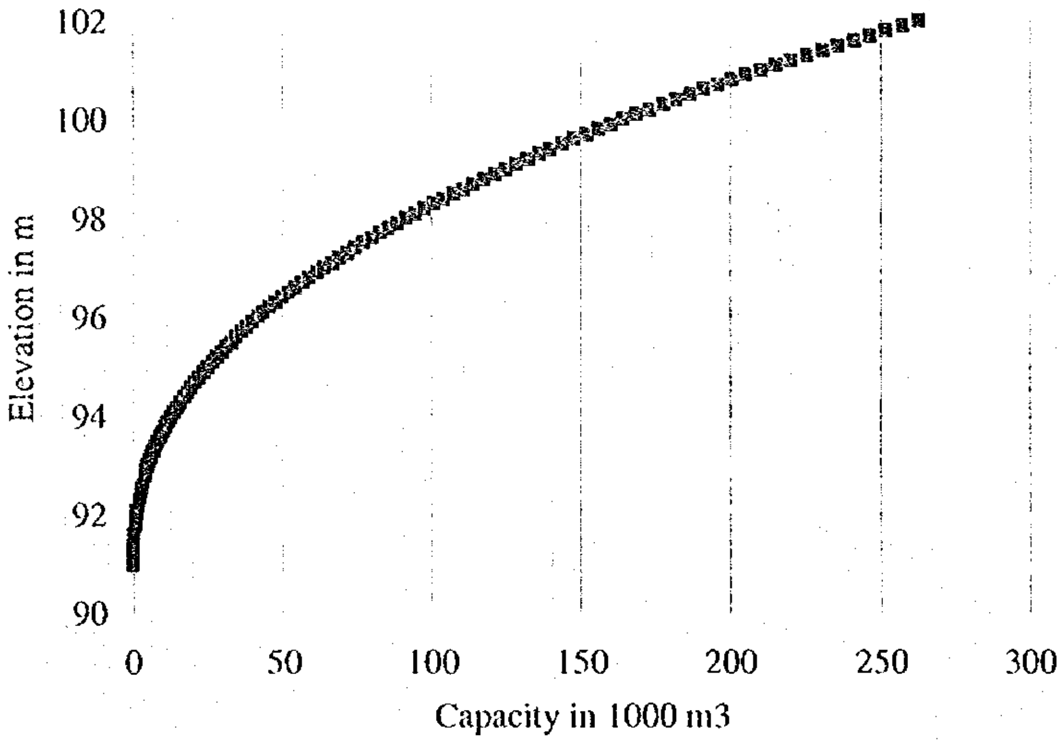


Figure A.5.2 Elevation - Capacity - Area Curve of No.2 Dam



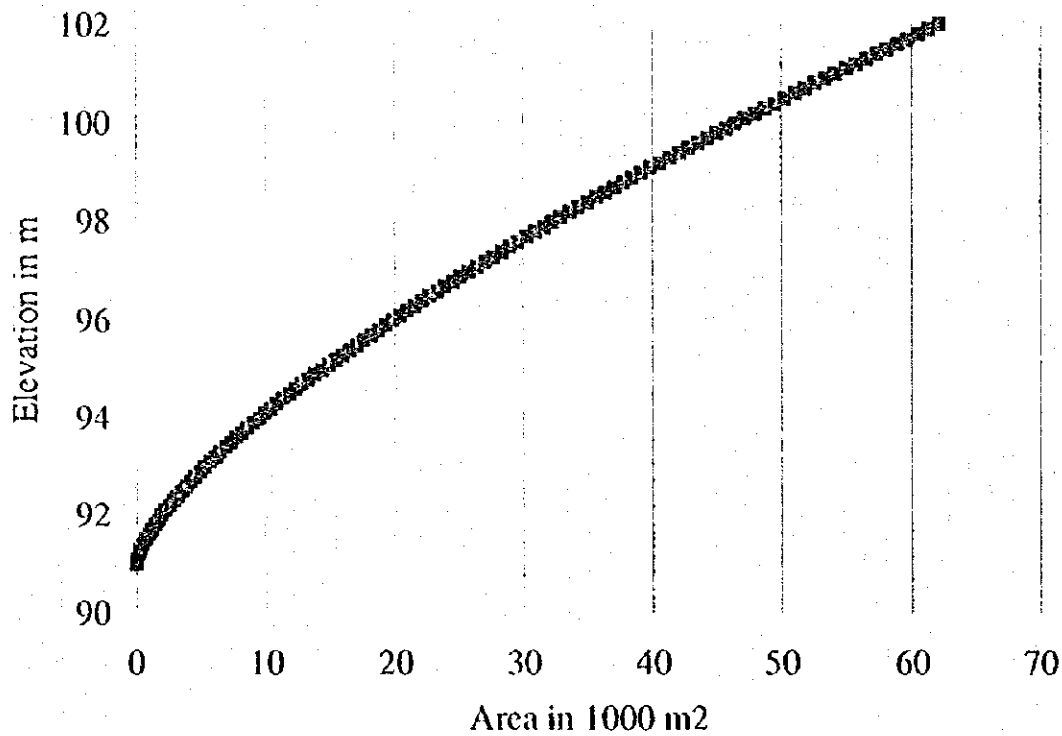
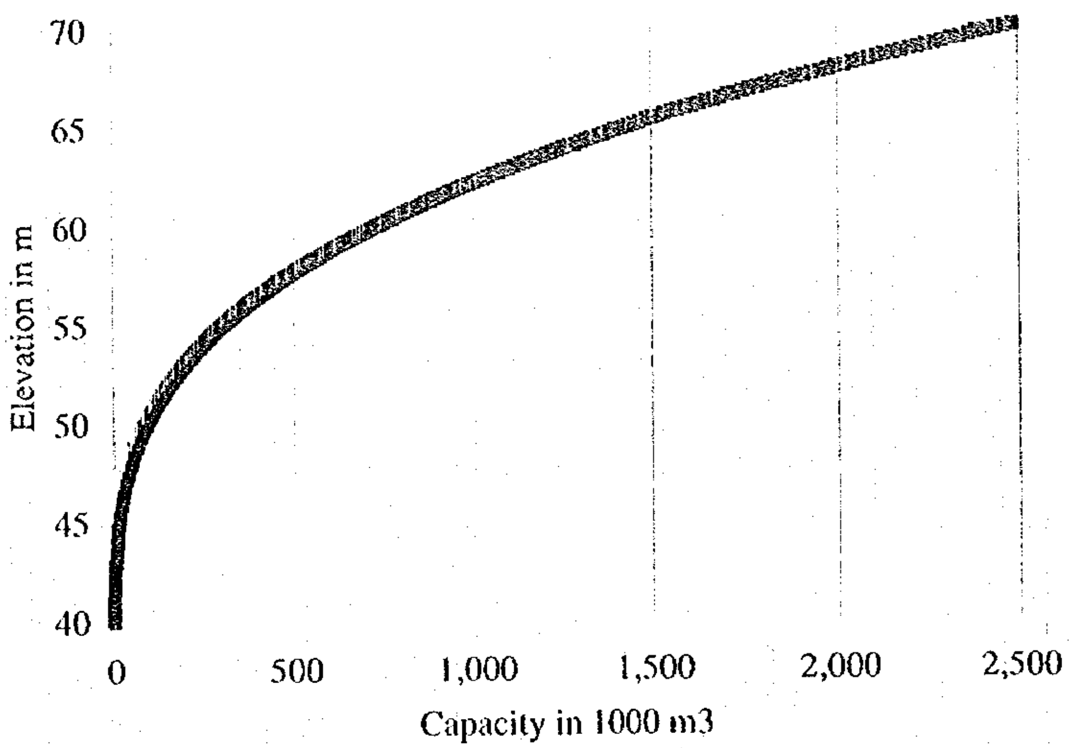


Figure A.5.3 Elevation - Capacity - Area Curve of No.3 Dam



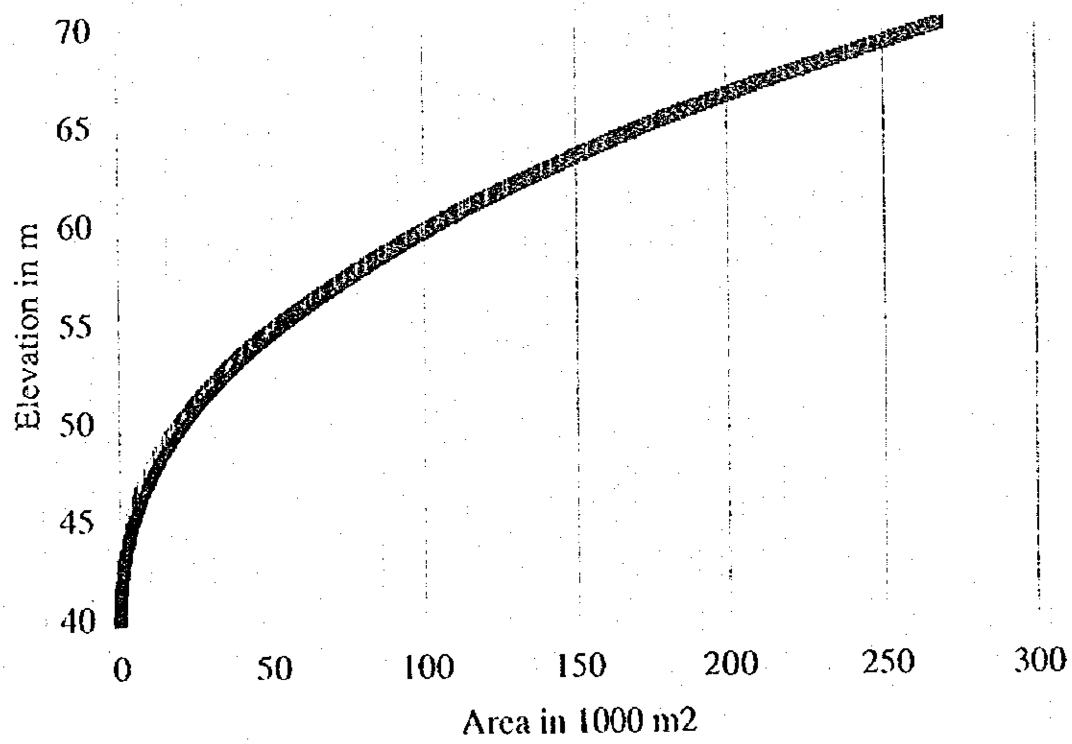


Figure A.5.4 Elevation - Capacity - Area Curve of No.4 Dam

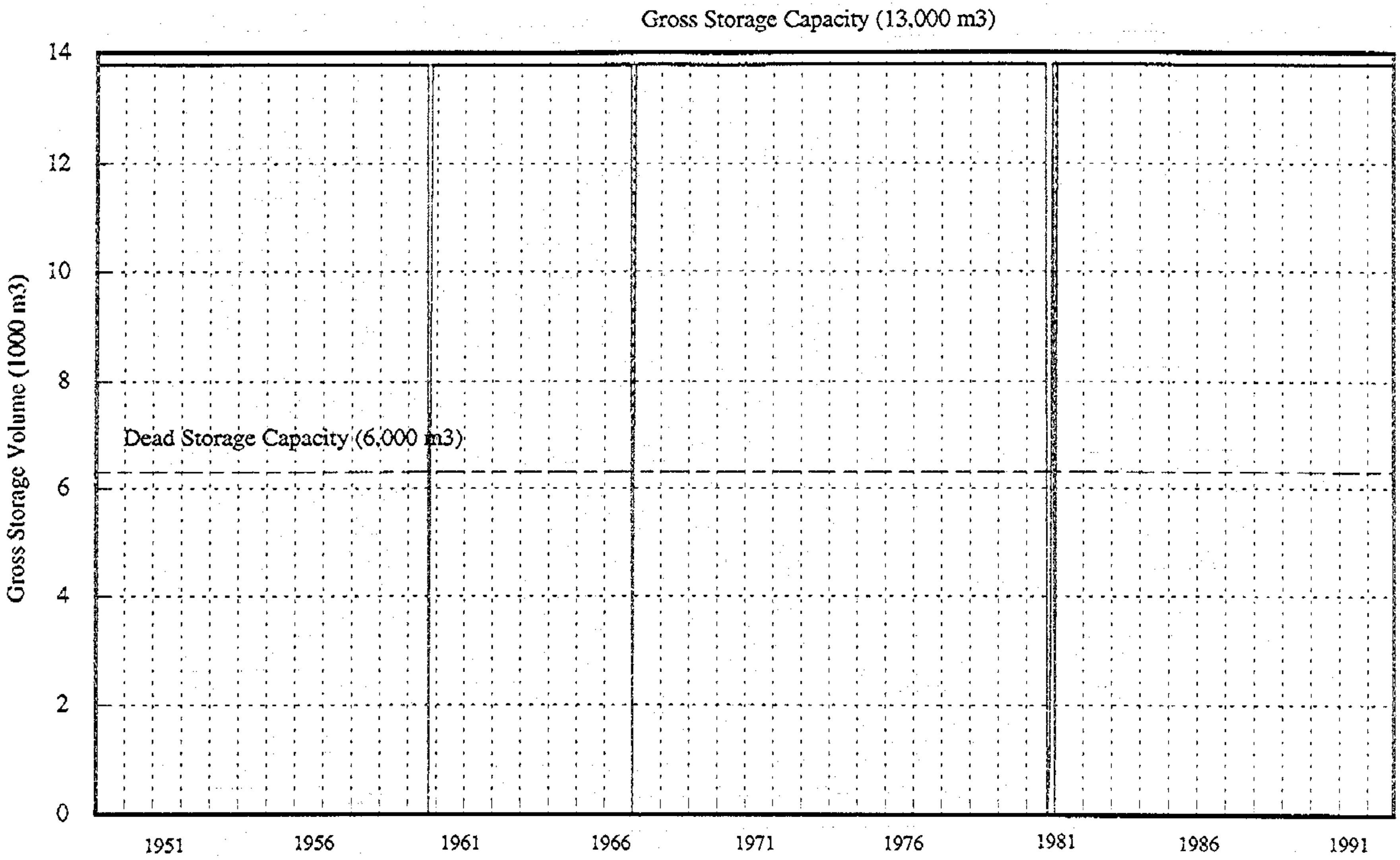


Figure A.5.5 Result of Reservoir Operation of No.1 Reservoir

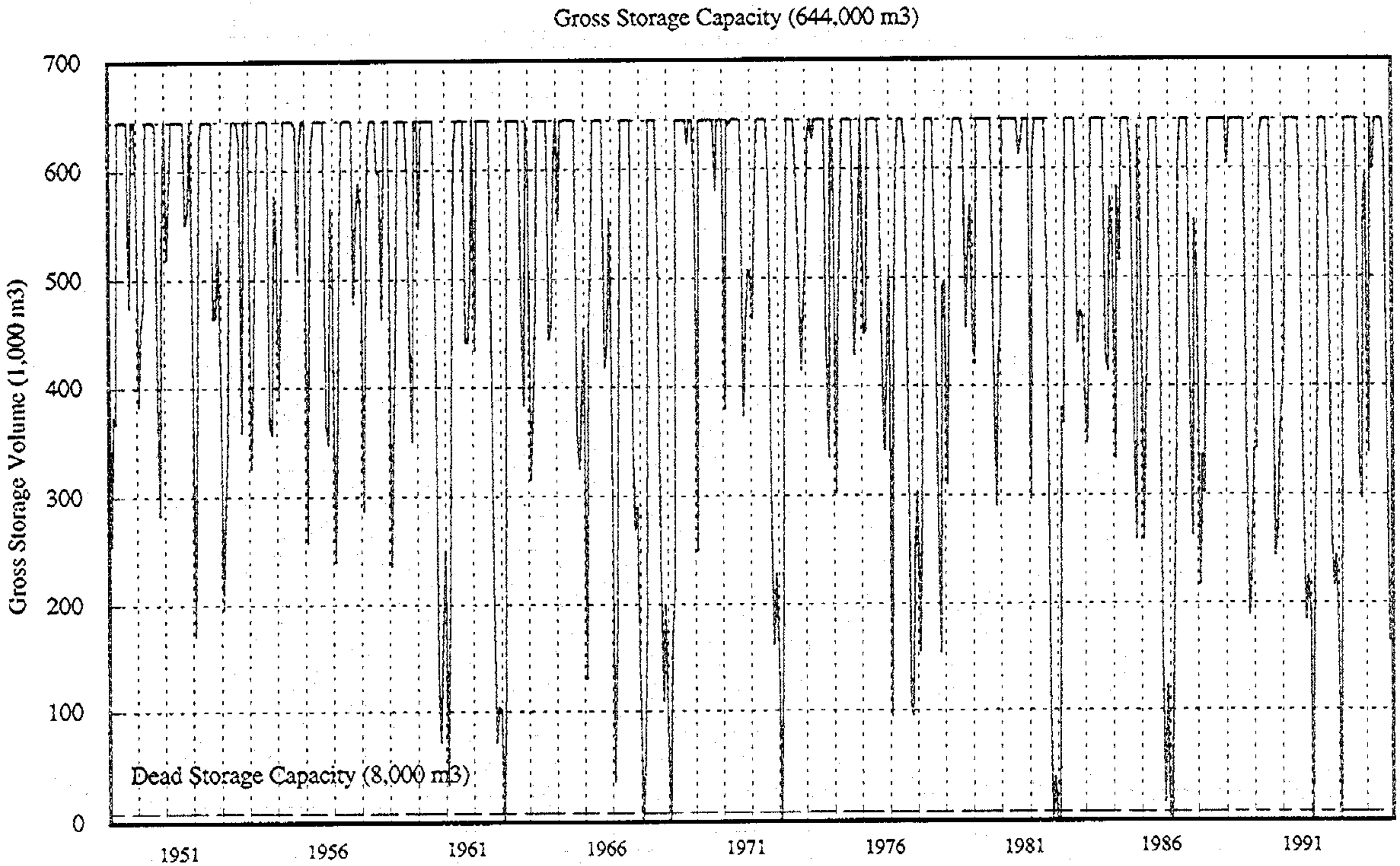
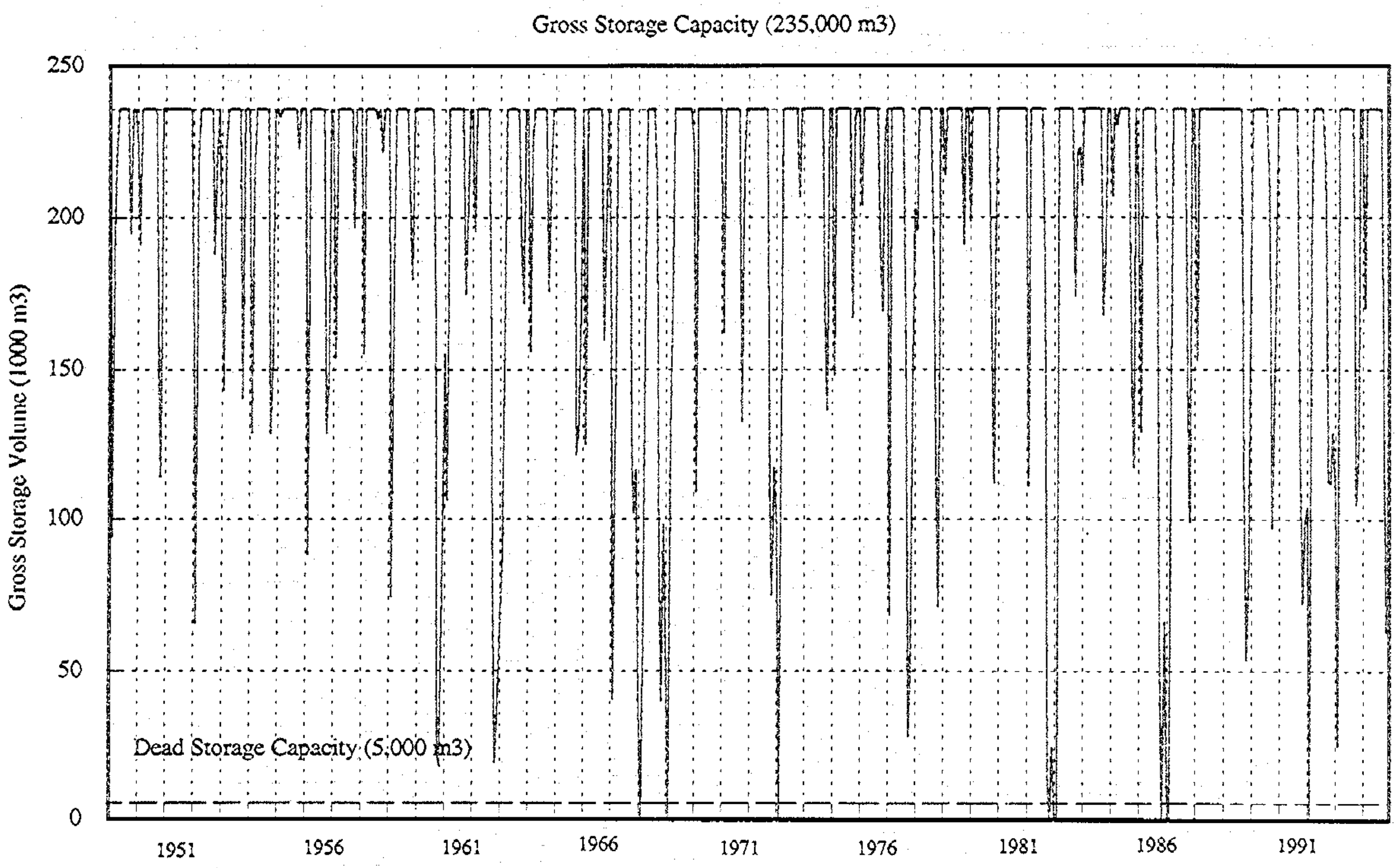


Figure A.5.6 Result of Reservoir Operation in No.2 Dam



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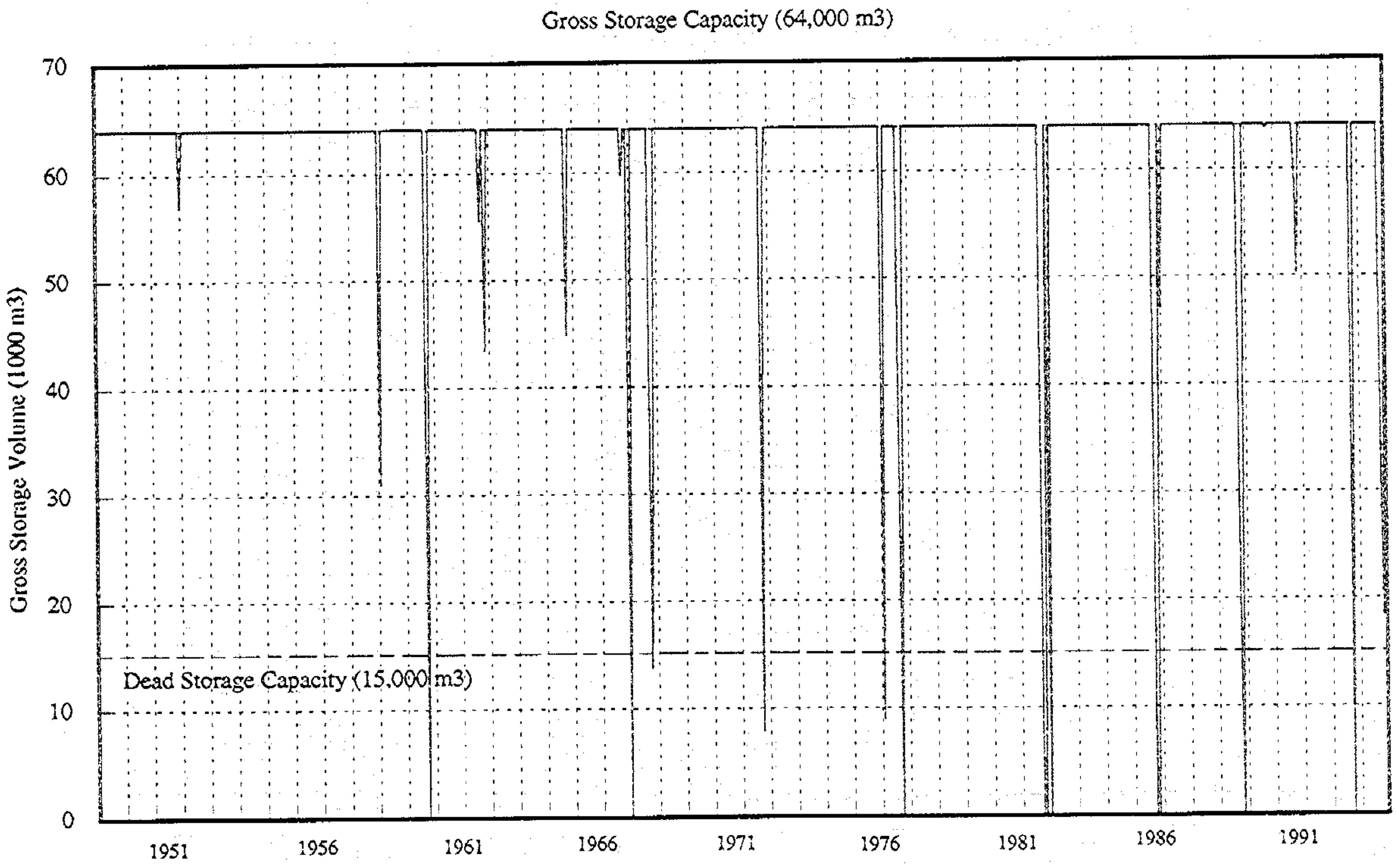

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THE FEASIBILITY STUDY ON
THE WESTERN LEGAZPI IRRIGATION AND
RURAL DEVELOPMENT PROJECT IN THE PHILIPPINES

ANNEX B

GEOLOGY AND HYDROGEOLOGY

ANNEX B
GEOLOGY AND HYDROGEOLOGY

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1. GENERAL

This Annex B was prepared based on the results of geological, soil-mechanics and hydrogeological investigations which were carried out. The geological investigation is carried out through geological reconnaissance, core drilling associated with standard penetration tests and permeability tests, test pitting, aquifer tests and laboratory tests to prepare basic geotechnical data for the plan of water resource development.

1.1 Data Collection

The following reports and data were gathered to review the geology and hydrogeology in and around the Study Area.

Name of Study	Year	Agency Concerned
Mayon Volcano Sabo and Flood Control Project	1981/1993	JICA,DPWH
Legazpi City Water Supply Feasibility Study	1987	Local Water Utilities Administration
Proceedings of Geologic Hazards Seminar Cum Exposure Tour for Media People	1988	PHIVOLCS
Mineral Resources of the Bicol Region	1990	DENR
Geology and Dam Construction Materials of the Gabawan SWIP	1991	DPWH
Bicol River Basin Flood Control and Irrigation Development Project	1991	ADB/UNDP,RDC
Inventory of Artesian Well and Springs Development	1987-1992	DPWH

1.2 Survey and Investigation

In order to clarify the sub-surface geological conditions and characteristics, the following works were carried out.

(1) Geology

1) Field reconnaissance

Field reconnaissance survey carried out at the proposed dam sites from view of geological aspect.

2) Core drilling

Core drilling of 180 m in total was carried out. Furthermore, standard penetration tests and in-situ permeability tests were conducted at three dam sites by using bore hole as shown in Table B.1.1.1 and Figure B.1.1.1.

(2) Soil mechanics

Soil mechanical test of materials, such as rock materials, soil materials and filter materials were carried out through laboratory test.

1) Test pitting

Six (6) test pits were provided to observe the subsurface geological conditions and collect samples for laboratory tests.(Ref.Table B.1.1.2 and Figure B.1.1.1)

2) Laboratory test

Test items and quantities conducted in laboratory are listed in Table B.1.1.3. Figure B.1.1.1 shows the location of those samplings.

(3) Hydrogeology

1) Data collection and field survey

In order to estimate the aquifer potential in the Study Area, existing data and maps on the geological and hydrogeological conditions were collected and reviewed through geological reconnaissance survey.

2) Aquifer test

Taking into account geological and hydrogeological conditions in the Study area, three (3) test well locations were selected. Depth of test well drillings is 30 m were. Aquifer test were conducted to determine the characteristics of the aquifers and to get information on the yield and drawdown of the well. The location of test wells and yield are shown in Figure B.1.1.1 and Table B.1.1.4, respectively.

1.3 Method of Investigation

(1) Equipment

1) Drilling rig

Rotary drilling machine with a capacity of 250 m in depth, with 89 mm and 73 mm diameter of metal crown and diamond bit.

2) Drilling pump

Reciprocating piston type with discharge capacity of 90 lit/min and capable pressure of 15 kg/cm^2.

3) Packer

Pneumatically expanding type rubber packer.

4) Penetration test equipment

Raymond sampler and 63.5 kg drive hummer.

(2) Core drilling

Diameter of the drilling is 73 mm. All core samples taken at every depth of bore hole are kept in wooden cases. According to the recovery of core barrel, rock quality designation (RQD) is calculated.

(3) Standard penetration test

The tests were made in bore holes by counting the number of blows of a drop hummer with 63.5 kg of weight falling from 75 cm of height that was neccessary to make a standard Raymond sampler penetrate 30 cm into the layer.

(4) Field permeability test

The tests were performed in bore holes by every 2 to 5 m stage as a rule, by means of Lugeon test (pumping water injection method) and open end test (gravity pressure injection method) in case of unconsolidated deposits.

(5) Test pit

The test pits were excavated to observe sub-surface geological conditions and taking samples for laboratory tests.

(6) Aquifer test

Well design is shown in Fig B.5.3.1. Pump is a 5 Hp submersible pump with a diameter of 101.6 mm. Pump is set at the depth of 27 m in each three wells. Diameter of the discharge orifice is 56.25 mm. The rate of discharge of the submersible pump is controled by using a gate valve placed near the end of the discharge orifice. The proposed observation wells were not provided because the well is being used as a domestic water supply or clogged up by debris.

Although two type of tests, namely a) constant-discharge b) step drawdown were conducted. During conducting the step drawdown test, a well becomes dry within 25 minutes after starting pumping with the discharge of the minimum allowable discharge rate. In another test well, intrusion of sand-sized particles into the pump had the discharge capacity of the pump reduce, and the step drawdown test is not able to conduct.

(7) Laboratory test

1) Compacting test

Compacting tests were carried out to follow the ASTM standard. The compaction energy (Ec)=100 % is applied to the density of specimen for the mechanical tests as follows :

$$Ec = \frac{W \cdot H \cdot n \cdot L}{V}$$

where, Ec : Compaction energy (Ec of 100 % = 5.625 kg•cm/cm^3)
W : Weight of rammer
H : Fall height of rammer
n : Number of compaction per layer
L : Number of layer
V : Volume of mould

2) Triaxial compression test

(i) The lateral pressures (σ^3) of the test are adopted 0.5, 1.0 and 2.0 kg/cm^2
(ii) The pore water pressure is measured during the compression test (CU test)

3) Test condition

Triaxial compression test and permeability test are carried out for the respective specimen to be prepared for the following conditions

(i) At the optimum density and optimum water content (γ dmax and Wopt)
(ii) At 95 % of the optimum density and wet of the optimum water content (γ dmax x 0.95 and WD 95)

(ii) The pore water pressure is mesured during the compression test (CU test)

3) Test condition

Soil mechanical tests such as triaxial compression test and permeability test are carried out for the respective specimen to be prepared for the following conditions

(i) At the optimum density and optimum water content (γdmax and Wopt)

(ii) At 95 % of the optimum density and wet of the optimum water content (γdmax x 0.95 and WD 95)

2. GENERAL GEOLOGY

(1) Topography

Topography in the Study area is broadly divided into 3 categories such as: a) flood plain of Ligban rivers; b) flat terrace expanded southward from hills of Camalig - Daraga towns; and c) rolling hills.

Flood plain of Ligban river extends in the south eastern area of Camalig town, and has a gentle slope ranging 1/100 to 1/400 from north to southwest with an elevation ranging from 110 m to 99 m above mean sea level. The Ligban river flows down from the hillside of the northern mountain area to the central areas of the flood plain in Barangay Tagaytay.

Flat terrace expands at about 2 km south from the hills of Camalig - Daraga towns and is mainly covered by rainfed paddy field. The elevation of the terrace area ranges from 96 m to 86 m above mean sea level. A few streams that originate from the hills surrounding the terrace area flow down in the area.

The rolling hills extends from the edge of flat terrace to southern part of the Study area. The hills are relatively low, and the altitude ranges from about 40 m to 90 m above mean sea level. The main river is Jovellar river flowing out from the rolling hills to south westward.

(2) Geology

Regional geology in and around the Study Area is mainly classified into Daraga, Bicol, Albay and Ligao formations of Miocene to Plio - Pleistocene epoch and volcanic clastics of Quaternary period as shown in Fig B.2.2.1 and Fig B.2.2.2. An active fault, namely, San Vicent - Ligao fault is located in northern areas from national highway, Camalig-Daraga extending WNW - ESE direction.

Daraga formation (Dpy) consists of mainly lava flow, agglomerate, volcanic breccia, tuff with interbedded clastic sedimentary rocks of Miocene epoch. These rocks are moderately consolidated and are cropped out as soft to hard rocks. The formation expands on the hills located in northern part of the Study Area.

Bicol and Albay formations (Cℓ1Cℓ2) are composed of sandstone, shale and conglomerate alternation of Miocene to Pliocene epoch. They are moderately consolidated soft to moderately hard rocks. These formations are developed on the rolling hill in the north and southeast of the Study Area. Albay formation uncomformably overlies Bicol formation in eastern part of national road, Daraga - Sorsogon.

Ligao formation (Ls) consists of limestone of Plio - Pleistocene epoch, and located in the isolated hilly areas of the central and western parts of the Study Area.

Pyroclastic rocks (Py) appears as a lenticular body in the east part of the Study Area consisting of tuff and tuffaceous clastic rocks intercalated basaltic to andesitic lava of Pleistocene epoch. The formation is moderately consolidated and outcropped as soft to semi-hard rocks without thin lava.

Mt. Mayon area comprises volcanics (Mmf, Maf) such as lava flows, scoria and volcanic ash in higher slope area of the volcano, and predominantly mud flows in lower slope of the vast mountain skirt. Alluvial plain has formations consisting of volcanic ejecta.

Alluvium (Aℓ) develops in northern part of the Study Area, where sand, gravel and clayey silt are predominant.