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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

FINAL REPORT

VOLUME 3

SUPPORTING REPORT

FEBRUARY 1995

CTI ENGINEERING CO., LTD.
IN ASSOCIATION WITH
PACIFIC CONSULTANTS INTERNATIONAL

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STUDY ON
THE FLOOD CONTROL FOR RIVERS
IN THE SELECTED URBAN CENTERS

FINAL REPORT

VOL. 3

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1. STUDY AREA

1.1 Geography

The Philippines, one of the largest archipelagoes in the world, has 7,107 islands and covers an area of approximately 300,000 km^2. It consists of three major island groups: Luzon with an area of 141,395 km^2; Visayas with 56,606 km^2; and Mindanao with 101,909 km^2.

The study area for the river inventory shall cover the representative medium and small-scale rivers in the thirteen (13) selected urban centers (hereinafter referred to as SUC or SUCs); namely, the cities of Laoag, Ilagan, Olongapo, Batangas, Lucena, Puerto Princesa, Legaspi, Iloilo, Cebu, Tacloban, Ormoc, Zamboanga and Davao.

The area and population of the urban centers and their related river basins are tabulated as follows:

Item No.	Name of SUC	Area (km^2)	Population (1990)	Related Rivers	Catchment Area (km^2)
1.	Laoag	108	83,756	Laoag	1,319.0
2.	Ilagan	1,394	99,120	Ilagan	1,840.0
3.	Olongapo	103	193,327	Sta. Rita	95.0
4.	Batangas	283	184,970	Kalumpang	406.0
5.	Lucena	69	150,624	Tayabas	269.0
6.	Pto. Princesa*	2,107	92,147		
7.	Legaspi	154	121,116	Yawa	70.0
				Macabalo	25.0
8.	Iloilo	56	309,505	Jaro	412.0
				Iloilo	106.0
9.	Cebu	281	610,417	Bulacao	10.7
				Kinalumsan	17.8
				Guadalupe	16.3
				Lahug	6.3
				Subang Daku	12.6
10.	Tacloban	464	136,891	Mangonbangon	4.9
				Abucay	2.4
				Burayan	6.5
11.	Ormoc	101	129,456	Anilao	25.2
				Malbasag	11.1
12.	Zamboanga	1,415	442,345	Tumaga	228.0
13.	Davao	2,211	849,947	Davao	1,623.0
Total		8,746	3,403,621		4,548.1

* Puerto Princesa is not related to or affected by any river.

The study areas for the Master Plan shall cover the river basins in four (4) SUCs, as listed in the river inventory. Project areas for the Feasibility Study will be selected based on the Master Plan Study.

1.2 Hydrology

Hydrology in the study area is described below.

(1) Existing Stations

The required meteorological data of the study area were obtained from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). The locations and details of the related meteorological stations are listed in Table 1.1. Taking the location and recording period into account, the representative rainfall station of each basin is selected as tabulated below.

Item No.	City/Basin	Station	Recording Period	Classification
1.	Laoag	Laoag*	1951-to date	SS
2.	Ilagan	Tuguegarao*	1951-to date	SS
3.	Olongapo	San Marcelino	1975-to date	CS
4.	Batangas	Ambulong	1951-to date	SS
5.	Lucena	Tayabas	1970-to date	SS
6.	P. Princesa	P. Princesa*	1951-to date	SS
7.	Legaspi	Legaspi*	1951-to date	SS
8.	Iloilo	Iloilo*	1951-to date	SS
9.	Cebu	Mactan*	1972-to date	SS
10.	Tacloban	Tacloban*	1951-to date	SS
11.	Ormoc	Merida	1971-to date	CS
12.	Zamboanga	Zamboanga*	1951-to date	SS
13.	Davao	Davao*	1951-to date	SS

SS = Synoptic station, CS = Climate/Rain/VSS/Cooperative station
* Station located in airport.

The required river runoff data were obtained from the Bureau of Research and Standard (DPWH). The locations and details of the streamflow gauging stations are given in Table 1.2.

The required tidal data were obtained from the Department of Environment and Natural Resources. The locations and details of the related tide stations are given in Table 1.3.

(2) Climatic Classification

Several systems of climatic classification have been adopted in the Philippines. The classification presented in this report was taken from PAGASA and is based on seasonal rainfall distribution; that is, considering the two most important rain periods in the country. These rain periods generally fall during the prevalence of the southwest and northeast monsoons. The so-called "Modified Corona's Classification of Climate" is considered a dry month as that with less than 50 mm of rainfall, although a month with more than 100 mm can still be considered as dry if it comes after three or more very dry months. Using the average monthly distribution of rainfall at different stations, Corona defines four types of such rainfall distribution in the Philippines, as follows (refer to Fig. 1.1):

Type I : The first type which has two pronounced seasons, dry from November to April and wet during the rest of the year, is predominant in the cities of Laoag, Olongapo, Batangas and Iloilo.

Type II : The second type which is characterized with no dry season with a very pronounced maximum rainfall from November to January, is predominant in the cities of Legaspi and Tacloban.

Type III : The third type which is characterized with no pronounced season and relatively dry from November to April and wet during the rest of the year, is predominant in the cities of Lucena, Puerto Princesa and Zamboanga.

Type IV : The fourth type which is characterized with evenly distributed rainfall throughout a year, is predominant in the cities of Ilagan, Cebu, Ormoc and Davao.

(3) Temperature

The Philippines generally has high temperatures because of its tropical maritime setting and the warm air currents flowing over its land masses. The mean annual temperature is about 27°C. The hottest months are May with 28.4°C, June with 27.9°C and April with 27.8°C. The coldest months are January with 25.5°C, February with 25.8°C and December with 26.1°C. The seasonal variation of temperature is so small with an average annual range of 2.9°C.

The mean monthly temperatures at the representative stations in the study area are given in Table 1.4.

(4) Rainfall

Rainfall in the Philippines is brought about by different rainfall causing weather patterns such as air streams, tropical cyclones, the Intertropical Convergence Zone (ITCZ) and to a lesser extent, by fronts, easterly wave, local convection, etc. Its intensity of amount is influenced by latitude or geographical setting, topography and exposure and the season. In a recent study, it has been shown that 47% of the average annual rainfall in the country is attributed to the occurrence of tropical cyclones in the vicinity. The northeast and southwest monsoons each contribute seven percent. The remaining 39% is due to the combined effects of the ITCZ, shearline, easterly waves and other rainfall-causing weather patterns.

Generally, the Philippines has abundant water resources, having an average annual rainfall of 2,360 mm. The annual rainfall ranges from less than 1,000 mm in the southern portion of Mindanao to more than 4,000 mm in its eastern portion. The annual rainfall, mean monthly rainfall and maximum daily rainfall of the representative stations in the study area are summarized in Table 1.5.

To evaluate the safety of SUCs and their related rivers against flood, extreme rainfall conditions are analyzed on the basis of daily rainfall, as below:

(a) Maximum Daily Rainfall

The maximum daily rainfall which measure the scale of floods is recorded to be higher in Luzon Region and less in Visayas and Mindanao regions. The recorded first, second and third maximum daily rainfall for each SUC is given in the table below:

(Unit: mm)

Item No.	City	First Max. Rainfall	2nd Max. Rainfall	3rd Max. Rainfall
1.	Laoag	510.3	498.4	437.2
2.	Ilagan	746.0	349.7	345.4
3.	Olongapo	471.8	449.4	422.3
4.	Batangas	765.8	499.2	283.6
5.	Lucena	557.7	359.7	306.0
6.	P. Princesa	269.3	265.9	252.0
7.	Legaspi	484.6	458.6	432.3
8.	Iloilo	303.0	255.6	203.8
9.	Cebu	374.0	129.0	112.8
10.	Tacloban	204.0	167.9	163.6
11.	Ormoc	259.1	257.8	217.1
12.	Zamboanga	193.2	138.7	117.5
13.	Davao	174.3	150.3	149.6

Note: Recording period is 31 years from 1961 to 1991 for Laoag, Ilagan, Batangas, Puerto Princesa, Legaspi, Iloilo, Tacloban and Davao; 18 years from 1975 to 1992 for Olongapo; 20 years from 1970 to 1989 for Lucena; 19 years from 1972 to 1991 except 1990 for Cebu; 22 years from 1971 to 1992 for Ormoc; and 30 years from 1971 to 1990 for Zamboanga.

(b) Probable Daily Rainfall

Probable daily rainfalls are estimated for the representative rainfall stations by means of the Gumbel Method, as follows:

(Unit: mm)

Item No.	City	2-Yr	5-Yr	10-Yr	20-Yr	50-Yr	100-Yr
1.	Laoag	200	300	370	430	510	570
2.	Ilagan	170	260	320	370	450	500
3.	Olongapo	190	280	350	410	490	540
4.	Batangas	160	240	290	330	400	440
5.	Lucena	170	260	330	390	470	530
6.	P. Princesa	110	180	220	260	320	360
7.	Legaspi	190	280	340	400	470	520
8.	Iloilo	110	180	220	260	320	360
9.	Cebu	80	120	150	180	210	240
10.	Tacloban	120	150	170	200	220	240
11.	Ormoc	130	200	240	280	330	370
12.	Zamboanga	80	120	140	160	190	210
13.	Davao	100	130	150	170	190	210

(c) Rainfall-Duration-Frequency

Rainfall-duration-frequency was prepared by the Hydrology and Flood Forecast Center in 1981 at the representative rainfall station for each SUC (refer to Table 1.6). Comparing the probable daily rainfall to this probable 24-hour rainfall, the latter is higher than the former.

(5) Tropical Cyclones

Tropical cyclones contribute largely to the rainfall in the Philippines from June to December. About 47% of rainfall is associated with these cyclones. They affect prevailing winds, humidity, and cloudiness, and are usually responsible for maximum values of rainfall and winds minimal pressure observed in many places. Tropical cyclones are, by international agreement, classified as:

(a) Tropical depression : with maximum wind speeds of up to 63 km/hr.
(b) Tropical storm : with maximum wind speed between 64 and 118 km/hr.
(c) Typhoon : with maximum winds greater than 118 km/hr.

Fig. 1.2 shows the track of tropical cyclones affecting the Philippines and Fig. 1.3 shows the mean percentage frequency of tropical cyclone passage in the different parts of the Philippines. As tabulated below, about 20 typhoons hit or come close to the Philippines every year.

Year	A	B	C	Total
1987	7	6	3	16
1988	9	9	2	20
1989	9	6	4	19
1990	6	7	7	20
1991	10	4	5	19
Total No.	41	32	21	94
Mean	8.2	6.4	4.2	18.8

A : Number of Tropical Cyclones (TC) that affected the Philippines (RP); center crossed RP.
B : Number of TCs that affected RP; center did not cross RP.
C : Number of TCs that did not affecting RP.

(6) River Runoff

There are a few streamflow gauging stations in and around the study area. The maximum discharge and mean monthly discharge of the related rivers are given in Table 1.7. The range of specific discharge in the related river basins is from 1.2 $m^3/s/km^2$ to 15.3 $m^3/s/km^2$.

Range of runoff coefficient of the related rivers is estimated to be from 57% to 99%, and the average runoff coefficient is about 75%. In accordance with the Survey Report on the Ormoc Flood of November 1991, the relation of runoff to size of drainage area for Philippine rivers is as shown in Fig. 1.4.

The river basins in the study area have a few available streamflow gauging stations located within their confines. According to the Framework Plan (NWRC) and the Philippine Water Resources Summary Data (NWRC/BRS), major flood discharges and their specific discharges are as follows:

Item No.	City	River	Drainage Area (km^2)	Peak Discharge (m^3/s)	Specific Discharge ($m^3/s/km^2$)
1.	Laoag	Laoag	1,355	15,575	11.5
		Bonga	535	4,392	8.2
		Gasgas	73	1,041	14.3
2.	Ilagan	Ilagan	1,565	1,840	1.2
3.	Olongapo	Sto. Tomas	177	855	4.8
4.	Batangas	Maragondon	260	3,987	15.3
5.	Lucena	Dumaca	74	574	7.8
6.	P. Princesa				
7.	Legaspi	San. Francisco	36	302	8.4
8.	Iloilo	Suague	186	320	1.7
9.	Cebu	Balamban	49	497	10.1
10.	Tacloban	Mainit	98	583	6.0
11.	Ormoc	Baleon	19	53	2.8
12.	Zamboanga	Mercedes	39	56	1.4
13.	Davao	Matina	48	147	3.1

1.3 Socioeconomy

Socioeconomy in the study areas is described below.

Administration

The country is divided into Regions, the Regions into Provinces, and the Provinces into Cities/Municipalities. These Cities/Municipalities are further divided into Barangays. As of 1988, there were 14 Regions, 73 Provinces, 60 Cities, 1,532 Municipalities and 40,904 Barangays.

The 13 SUCs selected for the medium and small-scale river basin study are distributed in Regions and Provinces ,as follows:

Item No.	Name of SUC	Region No.	Province Related to River Basin and SUC
1.	Laoag	I	Ilocos Norte
2.	Ilagan	II	Isabela, Quirino, Aurora
3.	Olongapo	III	Zambales, Bataan
4.	Batangas	IV	Batangas
5.	Lucena	IV	Quezon
6.	Puerto Princesa	IV	Palawan
7.	Legaspi	V	Albay
8.	Iloilo	VI	Iloilo
9.	Cebu	VII	Cebu
10.	Tacloban	VIII	Leyte
11.	Ormoc	VIII	Leyte
12.	Zamboanga	IX	Zamboanga del Sur
13.	Davao	XI	Davao del Sur, Davao

Incidentally, a City is one of the local government units. The above 13 SUCs are mostly classified as highly urbanized cities which are politically independent of the Provinces. Highly urbanized cities are large centers of population and have generally a high degree of

economic and cultural development. At present, they must have a population of at least 150,000 and an average annual income of ₱30 million.

Population

Population in the study areas is described below.

(1) 1990 Census Population and Growth

According to the 1990 census by the National Statistics Office (NSO), the Philippines had a population of 60,703 thousand. This population increased by 12.6 million compared with the 1980 census population, as shown in Table 1.8. In the 1970's, the average growth rate of population was recorded at 2.7% per annum. In the 1980's, the growth rate afterward slowed down to 2.4%. This rate, however, indicates that the population may double in about 30 years.

Among the 13 SUCs, the largest SUCs in terms of population are the cities of Davao, Cebu, Zamboanga and Iloilo in order of the number of population, which have more than 300 thousand in the 1990 census. Regarding population growth rate between 1980 and 1990, Puerto Princesa City had attained the highest annual rate of 4.2% on average. Succeedingly, Lucena, Davao, Tacloban, Batangas and Zamboanga have grown at a higher rate than the national average rate of 2.4% per annum. Laoag City showed the lowest rate of 1.9% per annum.

(2) Population Density

Among the 13 SUCs, the following four (4) cities have more than 1,000 km^2 of city land area: Davao, Puerto Princesa, Zamboanga and Ilagan. As shown in Table 1.8, their density are quite low, i.e., 384, 44, 313 and 71 persons/km^2, respectively. On the other hand, the following five (5) cities showed more than 1,000 persons/km^2 of population density: Iloilo (5,527), Lucena (2,199), Cebu (2,173), Olongapo (1,872) and Ormoc (1,283).

(3) Urban Population

Even in the SUCs, most of them have rural activities in the city areas. In general, a city consists of a number of Barangays within its territorial boundary. Some barangays are densely inhabited and are called city proper or "poblacion". Most of the areas outside the "poblacion" are identified as rural barangays.

Hence, according to NSO, urbanized areas are defined to consist of:

(a) In their entirety, all cities and municipalities having a population density 1,000 persons/km^2.

(b) Poblacions or central districts of municipalities and cities which have a population density of at least 500 persons/km^2.

(c) Poblacions or central districts not included in (a) and (b) regardless of the population size, which have the following:

- Street pattern, i.e., network of streets in either parallel or right-angle orientation;
- At least six establishments (commercial, manufacturing, recreational and/or personal services); and
- At least three of the following:

(i) A town hall, church or chapel with religious services at least once a month.

(ii) A public plaza, park or cemetery.

(iii) A market place or building where trading activities are carried on at least once a week.

(iv) A public building like school, hospital, puericulture and health center or library.

(d) Barangay having at least 1,000 inhabitants which meet the conditions set forth in (iii) above, and where the occupation of the inhabitants is predominantly non-farming or non-fishing.

All areas not falling under any of the above classifications are considered rural.

Referring to the above definition, the city population in the 1990 census was classified into urban and rural populations. Table 1.9 shows the urban and rural populations and their density in the 13 SUCs. The urban population is further classified into two categories: (1) urban population in Poblacion, and (2) urban population in Barangays outside of Poblacion, which are located on the outskirts of Poblacion or not identified as part of Poblacion at the census time. The urban areas are measured through the census maps which were provided by NSO for the implementation of the 1990 census.

As shown in Table 1.9, the following five (5) SUCs have been identified as the most densely inhabited Poblacions among 13 SUCs: Ormoc, Batangas, Davao, Laoag and Iloilo in order of population density. In the case of Ormoc City, the density of 221 persons/ha seems to be too big for urban people to live with comfort. On the other hand, the Poblacions of Zamboanga, Tacloban and Olongapo recorded the lower population density; less than 20 persons/ha. In particular, that of Zamboanga City was only 9.7 persons/ha.

Gross Domestic Product

Gross domestic product in the study areas is described below.

(1) Gross Domestic Product

Gross Domestic Product (GDP) in 1990 was about ₱1,066 billion, as shown in Table 1.10(1). Per capita GDP was ₱17,565 which is equivalent to approximately US$750. Real growth rates of GDP was 2.1% in 1990, as shown in Table 1.10(2). This rate was the lowest since 1986 when the Aquino administration started. The average growth rate of GDP between 1985 and 1990 was 4.5% per annum. On the other hand, the growth rate of per capita GDP was 2.3% per annum on average during the same period. Thus, the private life of Philippine people is said to improve at this rate.

(2) Gross Regional Domestic Product

Gross Regional Domestic Product (GRDP) of the respective Regions are shown in Tables 1.10(1) and 1.10(2). Among all Regions in the country, the National Capital Region (NCR, Metro Manila) attained the largest share in GDP, accounting for ₱346 billion in 1990 or almost one-third of the GDP. GRDP per capita of NCR was ₱43,524, which was approximately 2.5 times that of the country.

Among Regions related to the 13 SUCs, GRDP of Region IV (Southern Tagalog) was the largest, ₱148 billion in 1990. It shares approximately 14% of the GDP. Its GRDP per capita was ₱17,863, almost the same as the national one. Per capita

GRDPs of other Regions were lower than the national average. Only Region XI (Southern Mindanao) attained close to the national average. The lowest value of GRDP per capita was shown in Region V (Bicol), accounting for ₱7,896 or less than half of the national one.

The Region which showed the highest growth of GRDP in 1990 is Region III (Central Luzon). It grew at 7.1%. The second highest growth was attained by Region VII at 3.9% as shown in Table 1.9. Regarding the growth of GRDP per capita, the following three Regions could slightly exceed the national growth rate of 2.3% per annum during 1985 to 1990: Region VII, Region III and Region V. Resultingly, the disparity between the regional per capita GRDPs and the national one has gradually been increasing as understood in Table 1.9. The extensive economic development for less developed regions may be imperative to promote equity and social justice, one of the national development goals of the Philippines.

Present Land Use

Present land use in the study areas is described below.

(1) Global Land Classification

Land is basically classified into two patterns, i.e., (1) alienable and disposable land, and (2) forest land. The former is released for non-forest purposes such as agriculture, industrial and residential. This land is allocated to areas with 18% slope and below. The latter is designated to be the public domain areas used for forest purpose. This land with slopes of more than 18% is to be retained for permanent forest purposes. Forest land is identified to achieve the two objectives of maintaining ecological balance and sustained yield.

Table 1.11(1) shows the land area of Provinces including the 13 SUCs, classified by the above categories. In the national composition in 1991, the alienable and disposable land accounted for 47% and the forest land 53%. Among Provinces, the following two Provinces recorded the largest share of alienable and disposable land of more than 80%: Batangas and Albay. On the contrary, Zambales and Palawan Provinces recorded the largest share of forest land of approximately 70%.

(2) Land Use by Broad Category

Existing land use refers to the actual land cover as distinguished from the legal classification system mentioned above. In general, land use is broadly classified into the following seven (7) dominant patterns: agricultural, forestry, pasture, settlements, mining and quarrying, inland fishery, and open land.

Agricultural area is used for agricultural production such as paddy, corn, coconut, banana, sugarcane, coffee, tobacco, fruit, vegetable, etc. Although this area includes some farmhouses and may have to be encroached by urbanization, the area not having a densely inhabited area is delineated as agricultural area. Forest land includes forest, bamboo and bushlands. Pasture comprises not only grassland but also shrubs suitable for livestock grazing.

Settlements is a densely inhabited zone. Finally, open land is considered as residual land with low potentials for development but may still be devoted to any of the broad land uses.

Table 1.11(2) shows the existing land use by region concerned in the 13 SUCs on the basis of the above broad categories. In the country, the settlement area accounted for 7,197 km^2 or 2.4% of the total area. In the same manner, the agricultural area occupied 88,443 km^2 or 29.5% and inland fishery, 6,758 km^2 or 2.2%. In particular,

the NCR area is classified into these three categories only, i.e., 93% of settlements, 6% of agriculture, and 1% of inland fishery. The region, having the largest share of settlements, is Region VII. Of the total regional land area, 921 km^2 or 6.2% is used for settlement. On the other hand, Region II recorded the smallest share for settlements, which accounted for 29.4 km^2 or 0.8%. It also had the smallest share for agricultural land accounting for 5,134 km^2 or 14.1%. On the contrary, Region V had the largest share for agricultural purposes, which accounted for 8,273 km^2 or 46.9%.

2. FLOOD AND FLOOD CONTROL WORKS

2.1 Flood Problems

Floods in the SUCs, in general, occur as a result of overbank flow of rivers and stagnant water due to inadequate drainage systems during periods of intense storm runoff. As shown in Table 2.1, the total flood area in the city proper of the 13 SUCs is 2,385 ha or 2.2% of the whole urbanized area.

Among the 13 SUCs, the five (5) largest cities in terms of flood area are Iloilo, Legaspi, Laoag, Ormoc and Cebu, which have more than 190 ha of the flood area in each city proper. Regarding the ratio of flood area to the total urbanized area of the city proper, Ormoc City has the largest flood area ratio, followed by Batangas, Laoag and Iloilo, which have more than 9% of flood area's ratio.

As to flood depth and duration, Laoag, Ilagan, Legaspi, Iloilo and Ormoc have more severe conditions than other SUCs because the major cause of floods in those five SUCs is the overbank flow of rivers.

In the recent years, floods in the SUCs have become more serious problems, because the low-lying areas, which are defined as flood-prone areas, have been rapidly and disorderly urbanized without any countermeasures against flooding problems. Though revetments and spurdikes have been constructed for river sections which had severe flood and erosion problems, these piecemeal countermeasures without a comprehensive river improvement plan could not rationally solve all flooding problems.

Moreover, drainage problems in the SUCs have escalated due to lack or poor functioning of drainage system. Although some drainage channels and pipes have been constructed in some parts of the city proper, these existing systems do not function efficiently because of non-completion of the system and insufficient drainage capacity due to clogging with garbage and sediment. Moreover, some drainage systems constructed in newly urbanized areas do not satisfy the future requirements of drainage, because the future expansion of these urbanized areas were not considered in planning the system.

Therefore, a comprehensive master plan of flood control and drainage for the SUCs is desirable, taking the following major causes of existing flood problems into account:

(1) Urbanization in flood-prone areas;
(2) Reduction of water detention forests;
(3) Inadequate capacity of river channels and drainage system;
(4) Encroachment of river channels by squatters;
(5) Extensive sediment and garbage dumping in river channels; and
(6) Lack of operation and maintenance works.

2.2 Flood and Damage

The Office of Civil Defense (OCD), Department of National Defense has compiled damage records of major typhoons that occurred at the 13 SUCs, as enumerated in Table 2.2. Although the OCD damage records cannot be directly substituted as flood damages, they indicate the tendency of flood damage conditions, because most of the major floods occurred during the typhoons.

The OCD damage reports describe various damage items such as casualties, population affected, homeless, houses destroyed, infrastructure, crops, livestock, fisheries and private properties. During the last 11 years from 1982 to 1992, the total damage for the 13 SUCs

have reached 4,700 casualties and 1,667,000 affected population, and the total direct damage amounted to 1,852 million pesos.

Among the SUCs, Ormoc City has the largest casualty of 4,561 dead with total direct damages amounting to 560 million pesos. The damage in Ormoc City was mostly caused by Typhoon Uring on November 5, 1991.

In terms of population affected by the typhoon, the largest are Cebu, Legaspi, Ormoc, Tacloban and Iloilo in order of population scale, which have more than 100 thousand in the records. The largest affected population of 638 thousand in Cebu City for the last 11 years was brought by the inadequate capacity of rivers and drainage systems with intense rainfall in the busy city areas. Therefore, the direct damage amount of 278 million pesos in Cebu City for the last 11 years, which ranked only 4th highest among the 13 SUCs, would definitely increase taking the indirect damage in the busy city areas into account.

The Municipality of Ilagan, compared with other cities, had only minor damages, therefore, OCD had not compiled any flood damage records in the past 11 years.

2.3 Existing Flood Control Works

Existing flood control works in the study area are described below.

(1) River

The conditions of existing flood control works for medium and small-scale rivers in the Philippines are summarized as follows, and their inventory is presented in Table 2.3.

(a) Main river flood control works are bank protection works with boulder concrete revetments or concrete walls without embankment.

(b) These structures were designed based on the records of past floods.

(c) There is no comprehensive master plan of flood control for the medium and small-scale rivers except Laoag and Yawa rivers which have rather old plans.

(d) Maintenance works of flood control structures are usually inadequate due to budgetary constraints.

(e) Riparian areas behind river walls have suffered from floods due to lack or insufficiency of drainage facilities.

(f) Expansion of SUC urban areas to low-lying areas has increased the flood damage potential.

(g) Most small-scale rivers in urban areas are clogged with heavy siltation and dumping of solid waste/garbage.

As mentioned above, the existing flood control works have been partially provided only to prevent bank failure, not overflow. Therefore, every river requires river improvement works under a comprehensive master plan of the river basin.

For reference, the project scale of Laoag River and Yawa River is tabulated below.

Particulars	Laoag River	Yawa River
Master Plan	50-year	50-year
Urgent Plan	25-year	-

(2) Drainage

The results of inventory of the existing drainage systems are presented in Table 2.4, and summarized as follows:

(a) The planning and designing of drainage systems in the SUCs are conducted by the Planning Division of each City Government, and construction is executed by the City Engineer's Office.

(b) For the SUCs, drainage networks are constructed for densely populated areas; the surrounding areas have no drainage works.

(c) Overall plans have not been formulated and only drainage pipes were installed at many places. Therefore, inundation has been chronic due to the insufficient capacity of pipes.

(d) Maintenance of drainage systems are rarely executed by local government organizations concerned.

(e) Siltation in the pipes and deterioration of pipe capacity are remarkable.

The project scale for a master plan is stipulated in the Design Guidelines, Criteria and Standard for DPWH, Philippines. A 50-year return period is determined as the project scale for a drainage master plan and 10 to 25-year for urgent works. For reference, project scales applied in the existing drainage plans are given as follows:

(Unit: Year Return Period)

Particulars	Main	Lateral	Source
P. Princesa	5-50	2-10	PREMIUMED
Iloilo	2	1	RCDP
Cebu	2	2	CVUP
Tacloban	10	10	Overall M/P
Davao	2	1	RCDP

RCDP : Regional Cities Development Project
CVUP : Central Visayas Urban Project

2.4 Possible Flood Control Measures

Through the inventory survey on geography, socioeconomy and hydrology of SUCs and their related rivers, and the investigation of flooding conditions and damage as well as the existing flood control works and their performance, some possible flood control measures are enumerated below for further study.

River Flood Control

The flood control facilities are mainly revetments to prevent bank erosion at the river sections nearby the populated areas in the SUCs. Others are a few spurdikes and embankments. River training works are also limited to dredging and excavation for heavily silted portions of rivers. Since there has been no comprehensive master plan, project scales and design criteria have not been given to any of the SUC related rivers.

Based on the condition of flood control works for rivers in the study area, the possible flood control measures are proposed as follows by dividing them into structural and non-structural measures.

(1) Structural Measures

(a) Channel Improvement

The river channel improvement works shall firstly be undertaken for all related rivers (19 rivers) of the 13 SUCs, while the design discharge shall be set up beforehand and the plan of alignment, longitudinal profile and cross-section have to be studied.

River structures such as revetments, spurdikes and groins shall also be employed to prevent bank erosions in Laoag, Kalumpang, Tayabas, Jaro Anilao/Malbasag and Davao rivers.

Dredging and excavation are required for heavy silted rivers such as Laoag, Sta. Rita, and Yawa rivers.

(b) Sediment Control Works

Sediment control works are necessary to prevent heavy sedimentation and siltation due to denudation on mountainous areas or eruption of volcanoes. Sediment control works in the upstreams of Yawa and Sta. Rita rivers are required to control pyroclastic flows, and Laoag and Anilao/Malbasag rivers shall also have sediment control works in their upstream areas.

(c) Dam

On account of topographic conditions of each river basin, some of the rivers may have a flood control dam in the upstream area. They are the Sta. Rita, Kalumpang, Tayabas, Jaro, Tumaga and Davao rivers.

(d) Retarding Basin and Diversion/Bypass Channel

In consideration of topographic conditions and land use along river channels upstream of urban centers, there are some rivers where a retarding basin can be applied. They are the Laoag and Tumaga rivers, and sediment control works shall be simultaneously undertaken for Laoag River. Diversion/bypass channel only is applicable to Tayabas River.

(2) Non-Structural Measures

(a) Zoning

Zoning of flood prone area is effective to mitigate flood damage by means of reducing assets. Land use control is effective for various scales of floods, while it may raise social problems. Zoning program may be applicable to rivers having populated flood-prone areas in the downstream such as Sta. Rita, Tayabas, Jaro, Anilao/Malbasag and five rivers in Cebu City.

(b) Flood Forecasting and Warning System

The flood forecasting and warning system has been employed for large-scale river basins such as Cagayan, Agno, Bicol and Pampanga, where flood runoff time is expected to be long enough for warning and evacuation. Therefore, the system may be applicable only for the Laoag and Davao rivers.

Urban Drainage

All SUCs have urban drainage systems, but they cover only the city proper areas by 1% to 66%. The drainage facilities are mostly open channels, either lined or unlined, underground pipes and small sluices. No pumping station is installed.

Master plans of urban drainage have been formulated for five SUCs. They are Puerto Princesa, Iloilo, Cebu, Tacloban, and Davao.

Flood inundation in the urban areas is usually caused by intense rainfall, and rarely by high river stage and tide around the coastal areas, due to lack and inadequacy of drainage systems. Possible measures are, therefore, considered to be the construction of drainage networks and pumping stations with gates and sluices.

(1) Structural Measures

(a) Drainage Channels/Pipes

All SUCs need more drainage channel/pipe networks to collect and drain stormwater. Before the construction of facilities, update and review on the existing plans for the said five SUCs shall be carried out to cope with the change in land use and road networks. A master plan study on the urban drainage system is necessary for the other eight SUCs.

(b) Improvement of Channels and Pipes

Excavation and desiltation works are required for the heavily silted drainage channels/pipes in Olongapo and Legaspi.

(c) Pumping Station and Gate/Sluice

Flood inundation caused by high tide in and around the coastal area will require pumping station and sluice/gate to pump out the stormwater into the sea. This measure may be required for Batangas, Lucena, Legaspi, Cebu and Tacloban.

(2) Non-Structural Measures

(a) Retention Pond and Bypass Channel

A retention pond is applied to the urban areas which have some underdeveloped land nearby urban centers. This measure is applicable to Batangas, Legaspi and Tacloban.

(b) Zoning

Zoning is also effective for controlling the land use in urban areas. Encroachment of houses and buildings on drainage channels shall be avoided from the planning stage. Iloilo, Cebu, Ormoc and Tacloban have severely suffered from encroachment, and other SUCs will be in the same situation without the zoning program.

3. SELECTION OF MASTER PLAN STUDY AREA

In this section, the four (4) master plan study SUCs are selected on the basis of the findings described in the previous section.

3.1 Prioritization

To select the master plan study areas, the priority of each SUC has been determined on the aspects of necessity, urgency, benefit, and regional equality. These four aspects are evaluated by the following factors with data and information collected in the Inventory Study.

Item No.	Aspect	Evaluation Factor
1.	Necessity	Extent of floods
2.	Urgency	Flood control capacity
3.	Benefit	Extent of flood damage
4.	Regional Equality	Improvement program

Values of the evaluation factors are still broad. Therefore, quantification of the factors should have some limitation in accuracy which are considered allowable in such prioritization procedure. Outline of the criteria for prioritization of each SUC in respect of the above four aspects adopted is given below.

(1) Necessity

To evaluate the priority of necessity of flood control and drainage projects in each SUC, the flooding condition factors expressed by affected areas, depth, duration and people are employed.

Higher priority is given to the SUC with more severe flooding conditions. Priority index ranging from 1 to 3 is given to each SUC based on Table 3.1 as follows:

Factor	1 Point	2 Points	3 Points
Area (ha)	< 100	100 to 200	> 200
Depth (cm)	< 50	50 to 100	> 100
Duration (hr)	< 1	1 to 12	> 12
No. of People	< 20,000	20,000 to 100,000	> 100,000

(2) Urgency

The priority of urgency for project implementation is evaluated using the factors of present flood control capacity of rivers and drainage systems as well as risk of loss of human life by floods. As for the capacity of rivers, occurrence of river flood in each SUC is employed as the substituted factor for flood control capacity, because there is no sufficient data and information available to evaluate river flow capacity.

Higher point is given to the SUC with occurrence of overflow. Priority index ranging from 1 to 3 is given to each SUC based on Table 3.2 as follows:

Factor	1 Point	2 Points	3 Points
Overflow from River	None	Seldom Occurred	Often Occurred

For the capacity of drainage systems, higher point is given to smaller covering ratio of drainage service area. Priority index ranging from 1 to 3 is given to each urban center based on Table 3.3 as follows:

Factor	1 Point	2 Points	3 Points
Progress of Drainage Improvement	> 66%	66 to 33%	< 33%

Casualties of the SUCs brought by the floods in the last 11 years from 1982 to 1992 are substituted for the risk of human life. Higher point is given to the SUC with a bigger number of casualties. Priority index ranging from 1 to 3 is given to each SUC based on Table 3.4 as follows:

Factor	1 Point	2 Points	3 Points
Casualty	< 50	50 to 200	> 200

(3) Benefit

As for the aspect of project benefit, the priority is evaluated using the flood damage amount for the last 11 years from 1982 to 1992.

Since the flood damage is not available, typhoon damage compiled by OCD is substituted for the flood damage in each SUC for this priority study.

Higher point is assigned to the larger flood damage. Priority index of 1 to 3 is employed for each urban center based on Table 3.5 such as point 1 for 0 to 200 million pesos, point 2 for 200 to 400 million pesos, and point 3 for more than 400 million pesos.

(4) Regional Equality

Taking the information of ongoing program into consideration, the priority of regional equality in investment is evaluated for both river and drainage improvement programs.

Higher point is given to the SUC which has no comprehensive improvement program. Priority index ranging from 1 to 3 is assigned to each SUC based on Table 3.6 as follows:

Factor	1 Point	2 Points	3 Points
River Improvement	Not necessary	Prepared	Not Prepared
Drainage Improvement	Not necessary	Prepared	Not Prepared

3.2 Selection of Master Plan Study Area

The cumulative point of priority ranking for each SUC is summarized in Table 3.7. It indicates that the SUC ranked at the highest is Ormoc, followed by Tacloban, Iloilo, Cebu, Legaspi and Laoag, which have more than 10 points in the evaluation.

Evaluation Point	Urban Center
10 to 12 points	Ormoc, Tacloban, Iloilo, Cebu, Legaspi and Laoag
8 to 9 points	Olongapo, Batangas, Lucena, Zamboanga, Davao and Ilagan
6 to 7 points	P. Princesa

The four (4) SUCs of Tacloban, Ormoc, Cebu and Iloilo are evaluated to have higher priority among the 13 SUCs, and Legaspi and Laoag are also ranked at the same priority. As discussed and agreed between DPWH and the JICA Preparatory Survey Team, the first four (4) SUCs are selected as the master plan study areas.

4. FORMULATION OF DATABASE MODEL

4.1 Existing Condition of Data Arrangement

The existing condition of data arrangement is described below.

(1) Flood Control Inventory

Prior to the Study, no systematic arrangement of inventory data of flood control for medium and small-scale rivers had been undertaken by DPWH, although it is responsible for compiling these data in a central file.

Flood control inventory forms were used to update and collect data from the existing river and surrounding conditions during the field survey. All inventory data for the related rivers are arranged under the data system established under this Study.

(2) Meteo-Hydrological Data

For understanding the hydrological environment, meteo-hydrological data at required stations shall be stored and updated periodically in PAGASA and the Bureau of Research and Standard (DPWH). Systematic data collection and processing by a database software has already been introduced in PAGASA. However, it has never been introduced in the Bureau of Research and Standard, DPWH.

4.2 Model Structure

The structure of the model is described below.

(1) Relational Database Management System (RDBMS)

A database management system (DBMS) is a collection of related programs for loading, accessing and controlling a database. The database is independent of the programs that process the information, and a system may have several databases within one database management system. The most fundamental property of a relational database management system is that data are presented to the user as tables. Thus, the data consist of rows and columns, with the rows corresponding to traditional database records or segments and the columns representing fields within the records.

"Join" is a RDBMS operation capable of combining relational tables. Another relational operation is "Selection," creating a subset of all the records in a table. A relational operation always produces new tables. This makes it possible to provide very powerful and concise languages for the manipulation of relational data structures.

For the database development in the Study, RDBMS (dBASE V) is adaptable because of some advantages over the other systems concerning access control, operation of implementation, tubular representation, etc.

(2) Hardware and Software

One set of personal computer and some application programs were provided for this system during the First Field Study, as follows:

(a) Personal computer: AcerMate 386SX133

(b) Printer: HP LASERJET III Plus

(c) Lotus 123 (Multipurpose tabulation software)

(d) dBASE IV (Database software)

(3) Model Structure

An outline of the database management system is shown in Fig. 4.1 and the structure of the database model is shown in Fig. 4.2. This system can be composed of the following functions:

(a) Data Input Function

To enter the following information and records:

- Area data (population, household, area, etc.)
- Industrial data (GRDP, production, land use, etc.)
- Meteo-hydrological data (rainfall, discharge, etc.)
- River information (dimensions, embankment, etc.)
- Flood control structures (sluice, river gate, pump station, etc.)
- Water use (municipal water, irrigation, etc.)
- Urban drainage channel/creek
- Flood damage (inundation area, damage, etc.)

(b) Search Function

To search information and records by specified range.

(c) Display and Print Function

To display the searched information and records on screen and print out.

(d) Assist Function

To arrange records graphically on screen and print out.

(4) Input/Output Method

The input/output form for this database is attached as Annex. The output form is arranged and programmed to access project and its necessity, urgency, benefit and regional equality.

TABLES

Table 1.1 Rainfall Gaging Stations in the Study Area

No.	City	Station Name	No.	Class	Latitude	Longitude	Record Period
1	Laoag	Laoag City **	223	SS	18º 11' N	120º 32' E	1951 to date
		MMSU Batac	006	AS	18º 03' N	120º 34' E	1975 to date
2	Ilagan	Ilagan	209	CS	17º 08' N	121º 45' E	1966 to date
		Tuguegarao **	233	SS	17º 39' N	121º 09' E	1951 to date
3	Olongapo	San Malcelino	322	CS	14º 58' N	120º 09' E	1975 to date
		Morong	301	CS	14º 40' N	120º 15' E	1987 to date
4	Batangas	Gulod Laurel	401	CS	13º 45' N	121º 04' E	1973 to date
		Lipa City	402	CS	13º 57' N	121º 12' E	1981 to date
		Lobo	403	CS	13º 38' N	121º 12' E	1969 to date
		Mabini	404	CS	13º 45' N	120º 56' E	1969 to date
		Ambulong **	432	SS	14º 05' N	121º 03' E	1951to date
5	Lucena	Lucena City	433	SS	13º 56' N	121º 37' E	1951-1970
		Tayabas **	427	SS	14º 02' N	121º 35' E	1970 to date
6	P. Princesa	P. Princesa **	618	SS	09º 45' N	118º 44' E	1951 to date
7	Legaspi	Legaspi City **	444	SS	13º 08' N	123º 44' E	1951 to date
		Sto. Domingo	513	CS	13º 14' N	123º 47' E	1966 to date
		Guinobatan	504	CS	13º 12' N	123º 26' E	1967-1983
8	Iloilo	Iloilo City **	637	SS	10º 42' N	122º 34' E	1951 to date
		Cabatuan	608	CS	10º 53' N	122º 29' E	1971 to date
		Donsol, Potoman	609	CS	10º 57' N	122º 37' E	1983 to date
		Miagao	610	CS	10º 38' N	122º 14' E	1971 to date
9	Cebu	Cebu City	645	SS	10º 20' N	123º 54' E	1951-1983
		Mactan Airport **	646	SS	10º 19' N	123º 59' E	1972 to date
10	Tacloban	Tacloban City **	550	SS	11º 14' N	125º 02' E	1951 to date
		Olot, Tolosa	802	CS	11º 04' N	124º 54' E	1971to date
		Dagami	809	CS	11º 04' N	124º 53' E	1977 to date
		Pastrana	810	CS	11º 08' N	124º 53' E	1977 to date
		Santa Fe	811	CS	11º 10' N	124º 55' E	1977 to date
11	Ormoc	Merida **	806	CS	10º 55' N	123º 33' E	1971 to date
		Jaro	808	CS	11º 11' N	124º 53' E	1973 to date
		Bayboy	803	CS	10º 42' N	124º 48' E	1970 to date
		Bayboy	804	CS	10º 40' N	124º 48' E	1971 to date
12	Zamboanga	Zamboanga City **	836	SS	06º 54' N	122º 04' E	1951 to date
13	Davao	Davao City **	753	SS	07º 07' N	125º 39' E	1951 to date
		PCA, Bago, Oshiro	082	AS	07º 02' N	125º 31' E	1976 to date
		Maramag	1012	CS	07º 47' N	125º 01' E	1968-1977
		Miaray, Dancagan	1013	CS	07º 45' N	125º 03' E	1973-1980
		Quezon	1015	CS	07º 48' N	125º 05' E	1973-1980
		Twin River, Tagum	191	AS	07º 24' N	125º 51' E	1976 to date

Note : SS = Synoptic Station
CS = Climat/Rain/VSS/Cooperative Station
AS = Agromet Station
** = Representative Station for the Study Area

Table 1.2 Streamflow Gaging Stations in the Study Area

No.	City	Station ID	River Name	Latitude	Longitude	Drainage Area (km2)	Year of Record	Maximum Discharge (m3/sec)	Date	Specific Discharge (m3/s/
1	Laoag	01SW181203PW001	Laoag River	18 12' 12" N	120 35' 18" E	1,355	1958-1977	9,140.0	11/04/1977	6.75
		01SW180204PW002	Bonga River	18 05' 00" N	120 42' 00" E	534	1946-1980	1,683.3	09/10/1973	3.15
		01SW181204PW003	Gasgas River	18 04' 47" N	120 50' 06" E	73	1946-1980	161.0	09/10/1973	2.21
2	Ilagan	02SW165220PW031	Ilagan River	16 59' 36" N	122 01' 00" E	1,565	1964-1976	464.0	01/06/1976	0.30
		02SW170214PW034	Cagayan River	17 00' 45" N	121 49' 00" E	6,266	1961-1979	9,692.0	01/06/1976	1.55
3	Olongapo	03SW145201PW094	Sto. Tomas River	14 59' 54" N	120 15' 44" E	177	1947-1972	5.0	29/07/1971	0.03
4	Batangas	04SW135205PW029	Pansipit River	13 56' 20" N	120 56' 54" E	644	1958-1979	112.6	20/09/1979	0.17
5	Lucena	04SW135212PW038	Lagnas River	13 57' 15" N	121 21' 00" E	54	1952-1974	35.4	04/10/1971	0.66
		04SW140212PW039	Bulakin River	14 02' 30" N	121 21' 15" E	11	1958-1974	12.8	17/10/1974	1.16
6	P. Princesa									
7	Legaspi	05SW131232PW026	Nasisi River	13 15' 30" N	123 35' 30" E	39	1951-1978	54.1	18/12/1973	1.39
		05SW131232PW027	San Francisco River	13 14' 00" N	123 31' 34" E	131	1956-1978	111.7	27/12/1975	0.85
		05SW131232PW028	Upsong River	13 14' 05" N	123 35' 40" E	11	1954-1977	10.0	02/01/1972	0.91
8	Iloilo	06SW104222PW010	Sibalom River	10 44' 24" N	122 24' 10" E	117	1910-1979	230.0	19/06/1976	1.97
		06SW105222PW011	Inabasan River	10 50' 23" N	122 26' 55" E	97	1950-to date	121.9	05/10/1971	1.26
		06SW104223PW012	Jalaur River	10 47' 33" N	122 33' 45" E	1,549	1956-to date		19/06/1976	
		06SW104223PW013	Jalaur River	10 49' 30" N	122 39' 30" E	1,065	1956-to date	1,504.0	24/05/1976	1.41
		06SW105224PW014	Jalaur River	10 55' 50" N	122 40' 10" E	1,499	1956-1978	1,625.0	22/11/1973	1.08
9	Cebu	07SW102235PW006	Pitogo River	10 22' 42" N	123 57' 38" E	40	1955-1977	14.4	05/11/1972	0.36
10	Tacloban	08SW111244PW011	Calingcaguing River	11 18' 45" N	124 45' 10" E	128	1948-1978	131.6	20/04/1978	1.03
		08SW111244PW012	Mainit River	11 13' 21" N	124 49' 30" E	98	1949-1980	583.2	20/04/1978	5.95
		08SW111245PW013	Lingayon River	11 11' 10" N	124 51' 45" E	10	1948-1980	48.5	18/01/1972	4.85
		08SW111245PW014	Dap Dap River	11 13' 00" N	124 51' 00" E	30	1952-1980	18.5	27/12/1973	0.62
11	Ormoc	08SW110243PW008	Mas-in River	11 03' 52" N	124 30' 40" E	22	1956-1980	36.8	28/09/1975	1.67
		08SW110243PW009	Balcon River	11 06' 41" N	124 34' 20" E	19	1956-1980	42.3	13/07/1971	2.23
		08SW110243PW010	Bao River	11 08' 12" N	124 35' 52" E	65	1951-1980	133.7	26/12/1973	2.06
12	Zamboanga									
13	Davao	11SW072254PW007	Hijo River	07 27' 00" N	125 49' 40" E	617	1951-1972	158.0	20/01/1971	0.26
		11SW070253PW009	Matina River	07 07' 16" N	125 32' 21" E	48	1959-1978	21.2	29/06/1974	0.44

Note : Max. discharge from 1971 to 1980

Table 1.3 Tide Stations and Datum Planes in the Study Area

No.	City	Reference Station	Locality	Bench Mark	Mean High Water Level (MHW)	Mean Sea Level (MSL)	Mean Low Water (MLW)	Mean Higher High Water (MHHW)	Existing Higher High Water (EHHW)
1	Laoag	Currimao	Currimao, Gaang Bay	3.017	-	0.280	-	0.570	
2	Ilagan	- no -		-	-	-	-	-	
3	Olongapo	- no -		-	-	-	-	-	
4	Butangas	Batangas	Sta. Clara Pier, Batangas Bay	2.721	-	0.630	-	1.280	
5	Lucena	- no -		-	-	-	-	-	
6	P. Princesa	Penascosa	Penascosa Pier, Palawan	2.448	-	0.520	-	1.060	
7	Legaspi	Legaspi	Legaspi Port, Legaspi City	2.884	1.322	0.741	0.166	1.392	
8	Iloilo	Iloilo	Iloilo Harbour, Iloilo City	4.154	1.300	0.750	0.210	1.570	
9	Cebu	Cebu	Pier 2, Cebu City	2.783	1.193	0.688	0.175	1.465	
10	Tacloban	Tacloban	Tacloban Port, Tacloban City	1.720	0.506	0.289	0.036	0.686	
11	Ormoc	Ormoc	Ormoc Pier, Ormoc City	29.440	1.390	0.800	0.200	1.660	
12	Zamboanga	Basilan	Isabela, Basilan City	14.828	-	0.270	-	0.660	
13	Davao	Davao	Sta. Ana Port, Davao City	2.587	1.407	0.755	0.102	1.536	

Source: 1991 PREDICATED TIDE AND CURRENT TABLES
Department of Envirionment and Natural Resources
National Mapping and Resources Information Authority

Table 1.4 Mean Monthly Temperature in the Study Area

No.	City	Station	Mean monthly temperature distribution												Annual
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1	Laoag	Laoag City	24.5	25.0	26.5	28.2	29.1	28.5	28.0	27.6	27.6	27.5	26.8	25.3	27.1
2	Ilagan	Tuguegarao	24.1	25.2	27.3	29.3	30.2	29.7	29.1	28.9	28.4	27.3	25.8	24.3	27.5
3	Olongapo	Iba	25.7	25.9	27.0	28.4	28.5	27.5	27.0	26.6	27.0	27.4	27.2	26.4	27.1
4	Batangas	Ambulong	26.0	26.7	27.9	29.2	29.2	28.3	27.6	27.4	27.5	27.4	27.1	26.3	27.6
5	Lucena	Lucena City	25.4	25.8	26.8	28.2	29.9	29.5	27.9	27.8	27.6	27.3	26.7	25.9	27.4
6	P.Princesa	P.Princesa	26.6	26.8	27.5	28.4	28.6	27.6	27.3	27.2	27.2	27.4	27.2	27.0	27.4
7	Legaspi	Legaspi City	25.3	25.6	26.3	27.3	28.1	28.1	27.7	27.6	27.5	27.2	26.6	25.9	26.9
8	Iloilo	Iloilo City	26.2	26.5	27.6	28.9	29.1	28.1	27.6	27.5	27.6	27.7	27.5	26.8	27.6
9	Cebu	Cebu City	26.8	27.0	27.8	28.8	29.4	28.7	28.3	28.4	28.3	28.1	27.9	27.3	28.1
10	Tacloban	Tacloban City	25.7	25.9	26.5	27.5	28.1	28.0	27.8	28.0	27.9	27.6	27.0	26.3	27.2
11	Ormoc	Tacloban City	25.7	25.9	26.5	27.5	28.1	28.0	27.8	28.0	27.9	27.6	27.0	26.3	27.2
12	Zamboanga	Zamboanga	27.2	27.3	27.7	28.0	28.1	27.7	27.4	27.5	27.6	27.5	27.5	27.4	27.6
13	Davao	Davao City	26.6	26.6	27.4	28.1	28.1	27.5	27.3	27.4	27.5	27.6	27.6	27.1	27.4

Source: PAGASA

Table 1.5 Mean Monthly Rainfall and Maximum Daily Rainfall in the Study Area

No.	City	Station	Mean monthly rainfall distribution												Annual	Max. Daily
			Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Rainfall	Rainfall
1	Laoag	Laoag	4.4	2.2	2.0	19.6	137.9	355.4	392.3	516.3	357.0	115.2	37.9	9.3	1,949.5	510.3
2	Ilagan	Tuguegarao	26.5	14.2	26.3	47.2	132.6	177.4	218.4	281.1	194.2	286.3	321.7	98.0	1,823.9	746.0
3	Olongapo	Iba	2.3	4.0	13.0	26.2	330.9	636.1	848.8	1,089.8	556.6	258.4	92.7	33.9	3,892.7	471.8
4	Batangas	Ambulong	20.5	7.3	20.9	40.2	152.4	299.3	339.8	344.9	314.5	263.5	221.0	93.3	2,117.6	765.8
5	Lucena	Tayabas	155.1	72.3	72.3	103.2	227.5	257.9	260.6	172.6	316.1	512.7	519.9	413.7	3,083.9	557.7
6	P.Princesa	P.Princesa	29.1	15.4	28.6	42.8	153.4	203.7	191.6	189.9	221.5	215.2	221.5	132.2	1,644.9	269.3
7	Legaspi	Legaspi	293.2	188.6	157.9	153.4	167.9	255.0	266.0	280.9	271.2	340.5	479.9	475.0	3,329.5	484.6
8	Iloilo	Iloilo	39.9	19.1	27.1	47.7	117.9	255.2	313.2	363.7	266.8	264.1	174.8	64.2	1,953.7	303.0
9	Cebu	Mactan	78.1	62.3	41.5	29.1	54.8	149.9	157.0	136.5	167.3	148.3	131.4	103.8	1,260.0	374.0
10	Tacloban	Tacloban	281.7	204.1	139.6	118.9	142.4	160.8	167.0	135.5	161.5	197.2	279.0	305.3	2,293.0	204.0
11	Ormoc	Merida	143.0	81.9	84.0	75.9	133.7	155.9	253.2	235.2	241.5	303.0	233.3	173.2	2,113.8	259.1
12	Zamboanga	Zamboanga	43.9	44.2	37.7	51.0	94.8	142.3	135.1	128.5	145.1	192.4	108.7	88.1	1,211.8	193.2
13	Davao	Davao City	104.5	97.1	86.7	146.7	183.7	189.6	148.3	174.7	170.5	170.1	129.1	86.3	1,687.3	174.3

Source: PAGASA

Table 1.6 Rainfall Intensity-Duration-Frequency

(unit: mm)

No.	City	Return Period (yr)	5 min	10 min	30 min	60 min	3 hrs	6 hrs	12 hrs	24 hrs
1	Laoag	2	11	19	39	57	93	124	166	215
		5	14	24	54	78	144	200	263	352
		10	16	28	63	92	177	250	263	443
2	Ilagan	2	13	20	39	50	72	93	122	143
		5	18	27	50	64	102	144	202	235
		10	21	31	57	74	121	178	255	295
3	Olongapo	2	15	23	43	61	98	138	187	238
		5	19	29	52	77	131	190	298	385
		10	23	33	58	87	152	224	372	482
4	Batangas	2	13	19	38	49	73	93	117	134
		5	22	28	51	66	95	143	218	271
		10	28	34	59	77	109	176	285	361
5	Lucena	2	13	19	33	49	78	99	126	138
		5	15	21	40	60	101	136	196	243
		10	17	22	45	67	116	160	243	313
6	Legaspi	2	13	21	39	53	85	119	149	178
		5	16	27	53	74	128	201	246	277
		10	18	31	62	88	156	255	310	342
7	Iloilo	2	11	18	36	46	65	79	92	108
		5	14	24	46	59	81	108	141	173
		10	16	27	53	68	92	127	173	217
8	Cebu	2	12	19	39	50	66	73	80	89
		5	15	24	50	67	103	120	134	147
		10	18	28	58	78	127	150	170	185
9	Tacloban	2	13	17	34	43	61	68	87	110
	& Ormoc	5	15	20	39	52	79	91	123	165
		10	16	22	43	57	91	107	147	201
10	Zamboanga	2	12	19	33	41	55	64	70	85
		5	14	23	41	55	80	93	102	129
		10	16	26	47	65	97	112	124	159
11	Davao	2	12	22	47	67	79	83	84	95
		5	15	27	59	83	96	111	114	129
		10	17	30	67	93	108	130	134	151

Source : PAGASA

Table 1.7 Maximum Discharge and Mean Monthly Discharge in the Study Area

(unit : m^3/s)

No.	City	River (D.A)	Mean monthly discharge distribution												Annual Rainfall	Max. Daily Rainfall
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.		
1	Laoag	Laoag (1,355km²)	22.02	10.90	7.98	8.03	25.48	146.99	333.51	247.13	290.61	185.54	78.16	45.70	116.84	11,345.0
2	Ilagan	Pinacanauan (1,565km²)	95.29	81.94	68.73	47.21	66.32	60.04	57.76	93.24	81.71	153.74	175.77	163.59	95.45	1,840.0
3	Olongapo	Sto.Tomas (177km²)	3.88	4.04	4.41	4.59	7.17	16.29	28.76	44.01	39.50	18.10	9.44	6.36	15.55	855.0
4	Batangas	Pansipit (644km²)	16.72	12.95	10.50	8.80	8.84	11.24	14.47	21.15	28.07	27.94	26.21	23.03	17.49	112.6
5	Lucena	Dumaca (74km²)	7.63	5.11	4.41	3.63	3.41	7.18	4.87	4.78	5.37	9.16	11.62	12.52	6.64	574.0
6	P.Princesa															
7	Legaspi	Yawa (60km²)	10.01	5.77	5.47	4.72	4.24	3.99	2.81	2.79	3.55	5.53	6.05	5.33	5.02	
8	Iloilo	Suague (186km²)	4.18	2.72	1.41	1.41	3.45	4.08	7.23	7.12	6.84	10.36	6.02	5.58	5.03	319.5
9	Cebu	Balamban (49km²)	2.17	1.51	1.45	0.91	2.05	1.94	2.15	1.81	1.88	2.03	5.91	1.65	2.12	497.0
10	Tacloban	Mainit (98km²)	12.58	9.44	7.78	7.28	5.64	5.20	4.38	3.96	4.25	5.83	10.38	14.74	7.62	583.2
11	Ormoc	Baleon (18km²)	1.13	0.91	0.55	0.50	0.79	0.84	1.07	0.93	1.03	1.77	1.27	1.12	0.99	53.2
12	Zabmoanga	Mercedes (39km²)	0.87	0.95	0.75	0.59	1.22	1.50	1.79	1.83	1.66	2.29	1.77	1.21	1.37	18.4
13	Davao	Matina (48km²)	0.56	0.62	0.55	0.60	0.63	1.07	0.68	0.56	0.65	0.58	0.73	0.63	0.66	146.9

Source : Inventory Survey 1993

Table 1.8 Population Growth and Density: 1970, 1975, 1980 and 1990 Census

Region / Province / City/Municipality	Census Population (1000) 1970	1975	1980	1990	Ave. Pop. Growth (%/annum) 1975/70	1980/75	1990/80	Land Area (sq.km.)	1990 Pop. Density (p./km2)
Philippines	36,684.5	42,070.7	48,098.5	60,703.2	2.8	2.7	2.4	300,000	202
I. Ilocos	2,488.4	2,726.2	2,922.9	3,550.6	1.8	1.4	2.0	12,840	277
Ilocos Norte	343.4	371.7	390.7	461.7	1.6	1.0	1.7	3,399	136
Laoag City	61.7	66.3	69.6	83.8	1.4	1.0	1.9	108	779
II. Cagayan Valley	1,463.4	1,665.2	1,919.1	2,340.5	2.6	2.9	2.0	26,838	87
Isabela	648.8	730.4	870.6	1,080.3	2.4	3.6	2.2	10,665	101
Ilagan	62.1	70.1	79.3	99.1	2.4	2.5	2.3	1,394	71
III. Central Luzon	3,615.5	4,210.1	4,802.8	6,199.0	3.1	2.7	2.6	18,231	340
Zambales	343.0	416.3	444.0	563.0	3.9	1.3	2.4	3,714	152
Olongapo City	107.8	147.1	156.4	193.3	6.4	1.2	2.1	103	1,872
IV. Southern Tagalog	4,456.3	5,213.8	6,118.6	8,263.1	3.2	3.3	3.1	46,924	176
Batangas	926.3	1,032.0	1,174.2	1,476.8	2.2	2.6	2.3	3,166	466
Batangas City	108.9	125.4	143.6	185.0	2.9	2.7	2.6	283	654
Quezon	902.9	1,025.9	1,129.3	1,372.4	2.6	1.9	2.0	8,707	158
Lucena City	77.0	92.3	107.9	150.6	3.7	3.2	3.4	69	2,199
Palawan	236.6	300.1	371.8	528.3	4.9	4.4	3.6	14,896	35
Puerto Princesa	37.8	45.7	60.2	92.1	3.9	5.7	4.3	2,107	44
V. Bicol	2,966.9	3,193.7	3,477.0	3,910.0	1.5	1.7	1.2	17,633	222
Albay	674.0	728.8	809.2	903.8	1.6	2.1	1.1	2,553	354
Legaspi City	84.1	88.4	99.8	121.1	1.0	2.5	2.0	154	788
VI. Western Visayas	3,618.3	4,146.4	4,525.6	5,393.3	2.8	1.8	1.8	20,223	267
Iloilo	1,168.0	1,313.0	1,433.6	1,765.5	2.4	1.8	2.1	5,324	332
Iloilo City	209.7	227.0	244.8	309.5	1.6	1.5	2.4	56	5,527
VII. Central Visayas	3,032.7	3,387.3	3,787.4	4,594.1	2.2	2.3	1.9	14,951	307
Cebu	1,634.2	1,818.4	2,091.6	2,646.5	2.2	2.8	2.4	5,088	520
Cebu City	347.1	413.0	490.3	610.4	3.5	3.5	2.2	281	2,173
VIII. Eastern Visayas	2,381.4	2,599.7	2,799.5	3,054.5	1.8	1.5	0.9	21,432	143
Leyte	1,110.6	1,203.1	1,320.6	1,485.8	1.6	1.9	1.2	6,268	237
Tacloban City	84.6	89.5	105.0	136.9	1.1	3.2	2.7	464	295
Ormoc City	76.5	80.7	102.5	129.5	1.1	4.9	2.4	101	1,283
IX. Western Mindanao	1,869.0	2,047.9	2,528.5	3,158.5	1.8	4.3	2.2	18,685	169
Zamboanga del Sur	890.2	1,002.9	1,183.8	1,544.5	2.4	3.4	2.7	8,052	192
Zamboanga City	199.9	265.0	343.7	442.3	5.8	5.3	2.6	1,415	313
XI. Southern Mindanao	2,200.7	2,714.6	3,346.8	4,458.8	4.3	4.3	2.9	31,693	141
Davao del Sur	785.4	936.3	1,133.6	1,482.7	3.6	3.9	2.7	6,378	232
Davao City	392.5	484.7	641.4	849.9	4.3	5.8	2.9	2,211	384

Source: 1) Philippines 1980, Population, Land Area and Density: 1970, 1975 and 1980, NCSO
2) 1990 Census of Population and Housing, Report No.2: Population by Province, City and Municipality, National Summary, Philippines, December 1990, NSO

Table 1.9 Population and Its Density by Urban/Rural Area in 13 Selected Cities: 1990 Census

City / Urban/Rural Area	Land Area (ha)	1990 Census Population: Urban (persons)	Rural (persons)	Total (persons)	Density (p./ha)	Number of Households (Families)
1. Laoag City	10,750	38,875	44,881	83,756	7.8	16,866
1 Poblacion (City Proper)	520	37,624	-	37,624	72.4	7,610
2 Other Urban Area	148	1,251	-	1,251	8.5	246
3 Rural Area	10,083	-	44,881	44,881	4.5	9,010
2. Ilagan	139,360	22,261	76,859	99,120	0.7	18,891
1 Poblacion (City Proper)	518	12,419	-	12,419	24.0	2,269
2 Other Urban Area	1,512	9,842	-	9,842	6.5	1,822
3 Rural Area	137,330	-	76,859	76,859	0.6	14,800
3. Olongapo City	10,330	193,327	-	193,327	18.7	42,623
1 Poblacion (City Proper)	10,330	193,327	-	193,327	18.7	42,623
2 Other Urban Area	0	-	-	-	-	-
3 Rural Area	0	-	-	-	-	-
4. Batangas City	28,300	90,748	94,222	184,970	6.5	35,048
1 Poblacion (City Proper)	195	19,401	-	19,401	99.5	3,836
2 Other Urban Area	2,871	71,347	-	71,347	24.9	13,423
3 Rural Area	25,234	-	94,222	94,222	3.7	17,789
5. Lucena City	6,850	150,624	-	150,624	22.0	29,240
1 Poblacion (City Proper)	6,850	150,624	-	150,624	22.0	29,240
2 Other Urban Area	-	-	-	-	-	-
3 Rural Area	-	-	-	-	-	-
6. Puerto Princesa City	210,670	47,917	44,230	92,147	0.4	17,616
1 Poblacion (City Proper)	1,470	32,040	-	32,040	21.8	5,903
2 Other Urban Area	1,098	15,877	-	15,877	14.5	3,132
3 Rural Area	208,102	-	44,230	44,230	0.2	8,581
7. Legaspi City	15,370	83,226	37,890	121,116	7.9	22,222
1 Poblacion (City Proper)	3,627	83,226	-	83,226	22.9	15,340
2 Other Urban Area	-	-	-	-	-	-
3 Rural Area	11,743	-	37,890	37,890	3.2	6,882
8. Iloilo City	5,600	309,505	-	309,505	55.3	56,617
1 Poblacion (City Proper)	5,600	309,505	-	309,505	55.3	56,617
2 Other Urban Area	-	-	-	-	-	-
3 Rural Area	-	-	-	-	-	-
9. Cebu City	28,090	610,417	-	610,417	21.7	114,708
1 Poblacion (City Proper)	28,090	610,417	-	610,417	21.7	114,708
2 Other Urban Area	-	-	-	-	-	-
3 Rural Area	-	-	-	-	-	-
10. Tacloban City	10,090	136,891	-	136,891	13.6	24,897
1 Poblacion (City Proper)	10,090	136,891	-	136,891	13.6	24,897
2 Other Urban Area	-	-	-	-	-	-
3 Rural Area	-	-	-	-	-	-
11. Ormoc City	46,430	58,393	71,063	129,456	2.8	24,895
1 Poblacion (City Proper)	67	14,833	-	14,833	221.4	2,850
2 Other Urban Area	6,842	43,560	-	43,560	6.4	8,235
3 Rural Area	39,521	-	71,063	71,063	1.8	13,810
12. Zamboanga City	141,470	354,814	87,531	442,345	3.1	81,321
1 Poblacion (City Proper)	36,414	354,814	-	354,814	9.7	64,834
2 Other Urban Area	-	-	-	-	-	-
3 Rural Area	105,056	-	87,531	87,531	0.8	16,487
13. Davao City	221,130	624,757	225,190	849,947	3.8	159,976
1 Poblacion (City Proper)	3,690	254,536	-	254,536	69.0	48,358
2 Other Urban Area	12,941	370,221	-	370,221	28.6	69,536
3 Rural Area	204,499	-	225,190	225,190	1.1	42,082

Source : 1) 1990 Census of Population and Housing, Report 2-39A, Ilocos Norte, NSO
2) 1990 Census of Population and Housing, Report 2-43B, Isabela, NSO
3) 1990 Census of Population and Housing, Report 2-99C, Zambales, NSO
4) 1990 Census of Population and Housing, Report 2-73C, Olongapo City, NSO
5) 1990 Census of Population and Housing, Report 2-13D, Batangas, NSO
6) 1990 Census of Population and Housing, Report 2-73D, Palawan, NSO
7) 1990 Census of Population and Housing, Report 2-80D, Quezon, NSO
8) 1990 Census of Population and Housing, Report 2-5E, Albay, NSO
9) 1990 Census of Population and Housing, Report 2-41F, Iloilo, NSO
10) 1990 Census of Population and Housing, Report 2-47F, Iloilo City, NSO
11) 1990 Census of Population and Housing, Report 2-28G, Cebu, NSO
12) 1990 Census of Population and Housing, Report 2-29G, Cebu City, NSO
13) 1990 Census of Population and Housing, Report 2-51H, Leyte, NSO
14) 1990 Census of Population and Housing, Report 2-102I, Zamboanga del Sur, NSO
15) 1990 Census of Population and Housing, Report 2-100I, Zamboanga City, NSO
16) 1990 Census of Population and Housing, Report 2-52K, Davao del Sur, NSO
17) 1990 Census of Population and Housing, Report 2-53K, Davao City, NSO
18) 1990 Census Maps, NSO

Table 1.10(1/2) Gross Regional Domestic Product at Current Prices by Region Concerned: 1985 to 1990

No.	Region	Gross Regional Domestic Product (in Billion Pesos) 1985	1986	1987	1988	1989	1990	GRDP per Capita(Pesos) 1985	1990*1
	Philippines	571.9	608.9	685.1	802.5	922.6	1,066.2	10,461	17,565
NCR.	Metro Manila	169.2	185.4	213.9	256.1	302.6	345.9	24,372	43,524
I.	Ilocos	25.3	29.5	31.7	34.7	39.3	43.8	6,478	10,094
II.	Cagayan Valley	14.8	15.0	16.9	19.2	22.2	25.5	5,864	9,437
III.	Central Luzon	53.2	54.6	59.8	70.1	77.2	94.2	9,743	15,192
IV.	Southern Tagalog	79.6	83.8	93.4	109.9	125.3	147.6	11,222	17,863
V.	Bicol	18.3	18.7	19.8	22.8	26.7	30.9	4,663	7,896
VI.	Western Visayas	42.6	44.5	49.2	57.6	65.0	75.4	8,375	13,978
VII.	Central Visayas	35.7	38.3	43.4	51.8	60.5	70.3	8,500	15,309
VIII.	Eastern Visayas	16.2	16.3	18.2	21.7	25.3	28.5	5,280	9,323
IX.	Western Mindanao	18.7	19.7	21.1	23.9	27.2	31.6	6,539	10,013
XI.	Southern Midanao	44.1	45.9	54.4	62.5	68.6	78.3	11,497	17,550
		Percentage Distribution by Region (%)						Ratio of Region to Country of GRDP/capit	
	Philippines	100.0	100.0	100.0	100.0	100.0	100.0	1.00	1.00
NCR.	Metro Manila	29.6	30.4	31.2	31.9	32.8	32.4	2.33	2.48
I.	Ilocos	4.4	4.9	4.6	4.3	4.3	4.1	0.62	0.57
II.	Cagayan Valley	2.6	2.5	2.5	2.4	2.4	2.4	0.56	0.54
III.	Central Luzon	9.3	9.0	8.7	8.7	8.4	8.8	0.93	0.86
IV.	Southern Tagalog	13.9	13.8	13.6	13.7	13.6	13.8	1.07	1.02
V.	Bicol	3.2	3.1	2.9	2.8	2.9	2.9	0.45	0.45
VI.	Western Visayas	7.5	7.3	7.2	7.2	7.0	7.1	0.80	0.80
VII.	Central Visayas	6.2	6.3	6.3	6.5	6.6	6.6	0.81	0.87
VIII.	Eastern Visayas	2.8	2.7	2.7	2.7	2.7	2.7	0.50	0.53
IX.	Western Mindanao	3.3	3.2	3.1	3.0	2.9	3.0	0.63	0.57
XI.	Southern Midanao	7.7	7.5	7.9	7.8	7.4	7.3	1.10	1.00

Source: 1992 Philippine Statistical Yearbook, October 1992, NSCB
Revised esimates as of October 1991
Note: *1 Applied the 1990 census population

Table 1.10(2/2) Gross Regional Domestic Product at Current Prices by Region Concerned: 1985 to 1990

No. Region	Gross Regional Domestic Product (in Billion Pesos)						GRDP per Capita(Pesos)	
	1985	1986	1987	1988	1989	1990	1985	1990*1
Philippines	571.9	591.4	619.7	658.5	697.8	712.7	10,461	11,740
NCR. Metro Manila	169.2	175.2	187.2	204.3	222.9	225.4	24,372	28,364
I. Ilocos	25.3	27.2	27.1	28.1	30.0	30.2	6,478	6,956
II. Cagayan Valley	14.8	15.1	15.5	16.1	16.5	16.7	5,864	6,175
III. Central Luzon	53.2	54.2	57.2	61.5	63.9	68.4	9,743	11,033
IV. Southern Tagalog	79.6	82.9	87.9	92.6	99.2	101.3	11,222	12,265
V. Bicol	18.3	18.4	18.1	19.1	20.3	20.5	4,663	5,247
VI. Western Visayas	42.6	43.8	45.3	47.1	49.2	50.1	8,375	9,284
VII. Central Visayas	35.7	37.5	39.7	43.0	44.9	46.6	8,500	10,149
VIII. Eastern Visayas	16.2	16.0	16.2	17.3	17.8	18.1	5,280	5,910
IX. Western Mindanao	18.7	19.4	19.4	19.8	20.5	21.2	6,539	6,711
XI. Southern Midanao	44.1	45.7	48.7	49.6	50.8	50.8	11,497	11,401

	Annual Growth Rate (%)						Average Growth Rate of GRDP per Capita: 1990/1985 (%/annum)
Philippines	-7.3	3.4	4.8	6.3	6.0	2.1	2.3
NCR. Metro Manila	-9.1	3.5	6.9	9.1	9.1	1.2	3.1
I. Ilocos	0.3	7.7	-0.4	3.8	6.5	0.7	1.4
II. Cagayan Valley	-10.4	2.1	2.8	3.9	2.6	0.8	1.0
III. Central Luzon	-5.7	2.0	5.6	7.4	3.8	7.1	2.5
IV. Southern Tagalog	-8.4	4.2	6.0	5.3	7.1	2.2	1.8
V. Bicol	-5.1	0.4	-1.6	6.0	6.0	1.1	2.4
VI. Western Visayas	-8.2	2.8	3.3	4.0	4.3	1.9	2.1
VII. Central Visayas	-10.3	5.2	5.9	8.3	4.3	3.9	3.6
VIII. Eastern Visayas	-7.4	-1.1	1.1	6.6	2.9	1.5	2.3
IX. Western Mindanao	-7.1	3.4	0.0	2.1	3.9	3.2	0.5
XI. Southern Midanao	-4.5	3.6	6.6	1.9	2.4	0.1	-0.2

Source: 1992 Philippine Statistical Yearbook, October 1992, NSCB
Revised esimates as of October 1991
Note: *1 Applied the 1990 census population

Table 1.11(1/2) Status of Land Classification by Province including Target City: 1991

(Unit: sq.km.)

Province	Total Land Area	Alienable and Dispos-able Land	Forest Land							
			Total	Unclas-sified Public Forest	Classified Public Forest					
					Forest Reserved	Timber Land	Nation-al Parks	Military Reser-vation	Civil Reser-vation	Fishpond Develop-ment
Philippines*1	300,000	141,081	158,919	8,813	14,948	118,020	13,429	1,303	1,659	746
Ilocos Norte	3,399	1,449	1,950	-	1,933	14	3	-	-	-
Isabela	10,665	4,597	6,068	0	313	5,460	202	4	89	-
Zambales	3,714	1,164	2,551	-	518	1,932	0	86	-	14
Batangas	3,166	2,654	512	91	-	332	85	1	-	3
Quezon	8,707	4,724	3,983	497	726	2,650	95	-	0	14
Palawan	14,896	4,478	10,419	-	743	1,749	7,673	-	254	-
Albay	2,553	2,062	491	-	50	385	55	-	-	1
Iloilo	5,324	3,961	1,362	-	418	855	9	-	-	81
Cebu	5,088	3,677	1,411	-	214	1,056	131	0	1	8
Leyte	6,268	4,102	2,166	194	198	1,732	33	0	9	1
Zamboanga del Sur	8,052	4,143	3,909	161	1,762	1,881	-	-	26	80
Davao del Sur	6,378	2,390	3,987	-	557	2,905	523	-	-	3

Source: 1992 Philippine Statistical Yearbook, October 1992, NSCB
Note: *1 Data in 1987, quoted from "Philippine Yearbook 1989, December 1989, NSO

Table 1.11(2/2) Status of Land Classification by Province including Target City: 1991

(unit: sq.km.)

Region	Total Land Area	Agriculture	Forestry	Pasture	Settlements	Minning and Quarruing	Inland Fishery	Open Land*
Philippines	300,000	88,443	114,753	7,082	7,197	882	6,758	74,885
NCR Metro Manila	636	40	-	-	590	-	6	-
I. Ilocos	21,568	3,755	6,660	293	690	642	489	9,039
II. Cagayan Valley	36,403	5,314	18,664	813	294	-	784	10,714
III. Central Luzon	18,231	7,309	3,405	485	563	-	842	5,627
IV. Southern Tagalog	46,924	14,614	20,813	1,006	724	14	1,431	8,322
V. Bicol	17,633	8,273	3,791	1,830	422	-	68	3,249
VI. Western Visayas	20,223	7,846	4,080	213	903	106	447	6,628
VII. Central Visayas	14,951	5,737	2,416	185	921	12	33	5,647
VIII. Eastern Visayas	21,432	5,787	8,495	97	339	-	84	6,630
IX. Western Mindanao	18,685	8,472	5,217	171	346	-	332	4,147
X. Southern Mindanao	31,693	6,021	17,054	1,006	581	-	245	6,786

Source: Handbook on Land and Other Physical Resources, 1984, National Land Use Committee, NEDA
Note: * Open Land refers to residual land with low potentials for development but may still be devoted to any of the broad land uses.

Table 2.1 Summary of Flood Condition

(1982 - 1992)

	Urban Center	Major Causes of Flood	Max. Daily Rainfall		Flood Condition		
			Date	Depth (mm.)	Area (ha.)	Depth (cm.)	Duration (hr.)
1.	Laoag	- overbank flow of river - inadequate drainage system	09/09/89	437	210	200	12
2.	Ilagan	- overbank flow of river	01/08/86	345	46	60-250	5-48
3.	Olongapo	- overbank flow of river due to volcanic ash siltation - inadequate drainage system	20/06/85	422	26	30-125	2-8
4.	Batangas	- overbank flow of river - inadequate drainage system	24/08/90	284	118	100-120	12
5.	Lucena	- overbank flow of river - inadequate drainage system	14/07/83	254	11	30-120	0.3-24
6.	Puerto Princesa	- inadequate drainage system	30/09/83	226	19	15-30	1-3
7.	Legaspi	- overbank flow of river due to volcanic ash siltation - inadequate drainage system	14/02/89	254	316	30-100	8-24
8.	Iloilo	- overbank flow of river - inadequate drainage system	05/11/84	256	1,004	30-200	1-24
9.	Cebu	- overbank flow of river inadequate drainage system	19/12/91	374	187	30-50	1-3
10.	Tacloban	- overbank flow of river - inadequate drainage system	12/03/91	204	79	10-100	6-48
11.	Ormoc	- overbank flow of river - inadequate drainage system	Not Avail.		200	50-300	0.5-1
12.	Zamboanga	- overbank flow of river - inadequate drainage system	29/09/90	193	112	10-210	0.3-24
13.	Davao	- overbank flow of river - inadequate drainage system	08/10/85	150	57	20-150	1-24

Note:

(1) Source: DPWH District Office/City Engineer's Office (by interview)

(2) Flood Conditions indicated only within the city proper

Table 2.2 Summary of Flood Damage

(1982 - 1992)

	Chartered City	Casualty			Population Affected		Homeless		Houses Destroyed		Infra-Structure (Mill. Pesos)	Crops Livestocks Fisheries (Mill. Pesos)	Private Properties (Mill. Pesos)
		Dead	Injured	Missing	Families	Persons	Families	Persons	Totally	Partially			
1	Laoag City	4	5	-	22,080	98,497	230	1,380	230	4,009	83.282	13.166	7.407
2	Ilagan, Isabela												
3	Olongapo City	12	6	-	10,468	55,508	188	1,128	188	564	11.384	-	-
4	Batangas City	18	1	3	3,549	19,126	1,387	8,322	1,387	562	42.830	3.700	2.200
5	Lucena City	2	-	-	2,429	11,432	1	6	1	-	12.280	-	-
6	P. Princesa City	4	4	6	2,877	13,938	1,117	6,702	1,117	1,508	-	-	-
7	Legaspi City	37	51	5	44,647	251,442	15,623	93.738	15,623	13,461	15.081	17.106	1.861
8	Iloilo City	2	10	-	22,011	130,321	4,022	24,132	4,022	17,857	151.198	129.175	16.218
9	Cebu City	49	66	7	123,026	638,209	30,091	180,546	30,091	81,078	104.224	0.728	172.881
10	Tacloban City	23	35	-	32,318	188,557	7,951	47,706	7,951	32,318	29.589	309.500	64.300
11	Ormoc City	4,561	84	1,205	39,691	238,309	3,193	19,158	3,193	12,470	411.959	40.100	108.010
12	Zamboanga City	3	50	-	1,488	8,083	160	960	160	377	57.710	7.656	27.300
13	Davao City	10	4	-	5,257	13,875	139	834	139	1,551	6.524	-	5.244

Source: Office of Civil Defence (OCD), DND

Table 2.3 Existing Flood Control Structures/Works

Name of City	Name of River	Flood Control Facilities						
		Dike		Revetment/Wall		Dredging	Super Dike	Others
		Type	Length (m)	Type	Length (m)	Length (m)	(units)	
Laoag	Laoag	--	--	Rb. Conc.	2,754	381	4	closing dike 1,370m cut-off 3,340m
Ilagan	Ilagan	--	--	Rb. Conc.	100	--	1	
Olongapo	Sta. Rita	--	--	Rb. Conc.	1,284	--	--	
Batangas	Kalumpang	--	--	Rb. Conc.	765	--	--	
Lucena	Tayabas-Iyam	--	--	Rb. Conc.	145	--	--	
	Tayabas-Dumaga			Rb. Conc.	868			
Puerto Princesa		--	--	--	--	--	--	
Legaspi	Yawa	--	--	Rb. Conc.	2,925	--	--	
	Macabalo	--	--	Rb. Conc.	N/A	--	--	
Iloilo	Jaro	--	--	Rb. Conc.	2,585	--	--	
Cebu	Subangdaku	--	--	Rb. Conc.	N/A	1,900	--	
	Lahug	Earth	935	Rb. Conc.	N/A	3,250	--	
	Guadalupe	Boulder	50	Rb. Conc.	N/A	1,500	--	
	Kinalanisan	--	--	Rb. Conc.	N/A	--	--	
	Blacao	--	--	Rb. Conc.	N/A	--	--	
Tacloban	Mangonbangon	--	--	Rb. Conc.	2,170	1,482	--	
	Abucay	--	--	Rb. Conc.	N/A	--	--	
Ormoc	Anilao	Earth	350	Rb. Conc.	1,073	500	--	
				Gabion	350			
	Malbazag	--	--	Rb. Conc.	767	--	--	
Zanboanga	Tumaga	--	--	Rb. Conc.	460	--	--	
Davao	Davao	--	--	Rb. Conc.	2,316	--	--	

Table 2.4 Existing Drainage Facilities

Name of City	City Proper Area (ha)	Drainage Area (ha)	Covering Ratio (%)	Drainage Facilities (Pipe/channel) Channel (m)	Main (m)	Secondary (m)	Tertiary (m)	Total (m)	Others
Laoag	520	165	31.7	2,030	2,778	10,340	7,590	22,738	
Ilagan	518	51	9.8		920	100	13,090	14,110	
Olongapo	10,330	30	0.3	3,352	674	3,196		7,222	
Batangas	195	64	32.8		2,270	3,169		5,439	
Lucena	6,850	37	0.5		5,560	1,600		7,160	
Puerto Princesa	1,470	165	11.2		1,930	1,950		3,880	
Legaspi	3,627	73	2.0		4,080	2,925		7,005	
Iloilo	5,600	454	8.1		3,800	24,150		27,950	
Cebu	28,090	319	1.1	2,200	11,200	3,260	39,190	55,850	Diversion L=900m
Tacloban	10,090	164	1.6	2,600	5,400	3,900	1,700	13,600	
Ormoc	67	44	65.7	580	1,100	1,810		3,490	
Zanboanga	36,414	119	0.3	7,250	1,700	9,540		18,490	
Davao	3,690	876	23.7	15,019	2,790	1,080		18,889	

Covering Ratio = Drainage Survice area / City Proper Area x 100 (%)

Table 3.1 Priority Point of Flood Condition and Population Affected

EVALUATION ITEM / URBAN CENTER	FLOOD AREA		FLOOD DEPTH		FLOOD DURATION		POPULATION AFFECTED BY FLOOD (1982 to 1992)		POINT OF PRIORITY
	AREA (ha.)	POINT OF PRIORITY	DEPTH (cm.)	POINT OF PRIORITY	DURATION (hr.)	POINT OF PRIORITY	POPULATION AFFECTED	POINT OF PRIORITY	
1. Laoag	210	3	200	3	12	2	98,497	2	3
2. Ilagan	46	1	60-250	3	5-48	3	Negative	1	2
3. Olongapo	26	1	30-125	2	2-8	2	55,508	2	2
4. Batangas	118	2	100-120	3	12	2	19,126	1	2
5. Lucena	11	1	30-120	2	0.3-24	3	11,432	1	2
6. Puerto Princesa	19	1	15-30	1	1-3	2	13,938	1	1
7. Legaspi	316	3	30-100	2	8-24	3	251,442	3	3
8. Iloilo	1004	3	30-200	3	1-24	3	130,321	3	3
9. Cebu	187	2	30-50	1	1-3	2	638,209	3	2
10. Tacloban	79	1	10-100	2	6-48	3	188,557	3	2
11. Ormoc	200	3	50-300	3	0.5-1	1	238,309	3	3
12. Zamboanga	112	2	10-210	3	0.3-24	3	8,083	1	2
13. Davao	57	1	20-150	2	1-24	3	13,875	1	2

Table 3.2 Priority Point of River Capacity

URBAN CENTER	EVALUATION ITEM RELATED RIVER	MAXIMUM DAILY RAINFALL WHEN TYPHOON PASSING (1982-1992) DATE	HEIGHT (mm.)	PROBABILTY	RIVER FLOOD OCCURENCE	AREA (ha.)	POINT OF PRIORITY	POINT OF PRIORITY
1. Laoag	Laoag	9/9/89	437.20	1/22	Occured	210	3	3
2. Ilagan	-	Not Available	Not Available		-do-	46	3	3
3. Olongapo	Sta. Rita	27/6/85	285.00	1/5	-do-	18	3	3
4. Batangas	Kalumpang	9/9/82	204.00	1/3	-do-	66	3	3
5. Lucena	Tayabas	10/10/89	243.30	1/4	-do-	8	3	3
6. Puerto Princesa	-	13/11/90	73.20	1/2	None	-	1	1
7. Legaspi	Yawa	14/7/83	239.40	1/3	Occured	189	3	3
	Macabalo	-do-	-do-	-do-	-do-	127	3	
8. Iloilo	Jaro	5/11/84	255.60	1/17	-do-	924	3	2
	Iloilo	-do-	-do-	-do-	None	0	1	
9. Cebu	Subang Daku	12/11/90	276.10	1/20		0	1	2
	Lahug	-do-	-do-	-do-	Occured	15	3	
	Guadalupe	-do-	-do-	-do-	None	0	1	
	Kinalumsan	-do-	-do-	-do-	Occured	9	3	
	Bulacao	-do-	-do-	-do-	None	0	1	
10. Tacloban	Mangonbangon	24/10/88	167.90	1/9	Occured	23	3	3
	Abucay	-do-	-do-	-do-	-do-	39	3	
11. Ormoc	Anilao	5/11/91	Not Avail.	Not Avail.	-do-	178	3	3
	Malbasag	-do-	-do-	-do-	-do-	22	3	
12. Zamboanga	Tumaga	23/10/88	53.60	Negligible	-do-	83	3	3
13. Davao	Davao	20/8/87	56.20		-do-	51	3	3

Table 3.3 Priority Point of Drainage System Improvement

EVALUATION ITEM / URBAN CENTER	CITY PROPER		DRAINAGE SYSTEM		POINT OF PRIORITY
	AREA (ha.)	POPULATION	AREA (ha.)	AREA RATIO (%)	
1. Laoag	520	37,624	165	32	3
2. Ilagan	518	12,419	51	10	3
3. Olongapo	10,330	193,327	30	1	3
4. Batangas	195	19,401	64	33	2
5. Lucena	6,850	150,624	37	1	3
6. Puerto Princesa	1,470	32,040	165	11	3
7. Legaspi	3,627	83,226	73	2	3
8. Iloilo	5,600	309,505	454	8	3
9. Cebu	28,090	610,417	319	1	3
10. Tacloban	10,090	136,891	164	2	3
11. Ormoc	67	14,833	44	66	1
12. Zamboanga	36,414	354,814	119	1	3
13. Davao	3,690	254,536	876	24	3

Table 3.4 Priority Point of Casualities

EVALUATION ITEM / URBAN CENTER	CASUALTIES BY FLOOD (1982 to 1992)			POINT OF PRIORITY
	DEAD	INJURED	MISSING	
1. Laoag	4	5	-	1
2. Ilagan	Not Avilable	Not Avilable		1
3. Olongapo	12	6	-	1
4. Batangas	18	1	3	1
5. Lucena	2	-	-	1
6. Puerto Princesa	4	4	6	1
7. Legaspi	37	51	5	2
8. Iloilo	2	10	-	1
9. Cebu	49	66	7	2
10. Tacloban	23	35	-	2
11. Ormoc	4,561	84	1,205	3
12. Zamboanga	3	50	-	2
13. Davao	10	4	-	1

Table 3.5 Priority Point of Benefit

EVALUATION ITEM / URBAN CENTER	CITY PROPER AREA (ha.)	CITY PROPER POPULATION	BENEFIT (DAMAGES) DAMAGE AMOUNT (P Million)	POINT OF PRIORITY
1. Laoag	520	37,624	104	2
2. Ilagan	518	12,419	Negative	1
3. Olongapo	10,330	193,327	11	1
4. Batangas	195	19,401	49	1
5. Lucena	6,850	150,624	12	1
6. Puerto Princesa	1,470	32,040	-	1
7. Legaspi	3,627	83,226	34	1
8. Iloilo	5,600	309,505	297	2
9. Cebu	28,090	610,417	278	2
10. Tacloban	10,090	136,891	403	3
11. Ormoc	67	14,833	560	3
12. Zamboanga	36,414	354,814	93	1
13. Davao	3,690	254,536	12	1

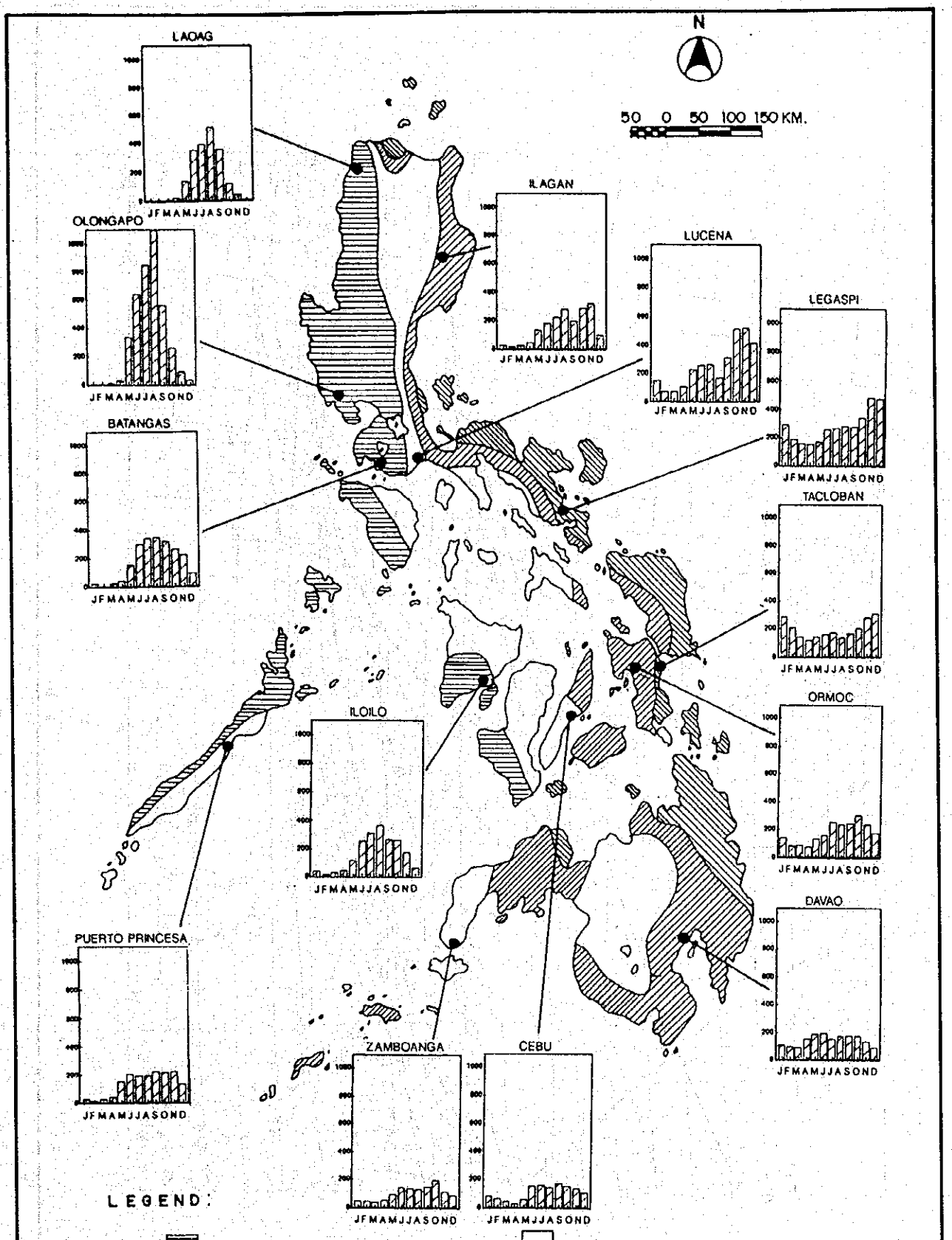
Table 3.6 Priority Point of Regional Equality

EVALUATION ITEM / URBAN CENTER	DRAINAGE DEVELOPMENT PROGRAM			RIVER IMPROVEMENT PROJECT			POINT OF PRIORITY
	IMPLEMENTI	PROPOSED	POINT PRIORITY (1)	IMPLEMENTED	PROPOSED	POINT OF PRIORITY (2)	
1. Laoag	None	None	3	None	None	3	3
2. Ilagan	(No Drainage Problem)		1	"	"	3	2
3. Olongapo	None	None	3	"	"	3	3
4. Batangas	-do-	-do-	3	"	"	3	3
5. Lucena	-do-	-do-	3	"	"	3	3
6. Puerto Princesa	PARTIAL (BY PREMIUMED)		2	No River Problem)		1	1
7. Legaspi	None	None	3	None	None	3	3
8. Iloilo	PARTIAL (BY RCDP)		2	"	"	3	2
9. Cebu	PARTIAL (BY CVUP)		2	"	"	3	2
10. Tacloban	PARTIAL (BY PREMIUMED)		2	"	"	3	2
11. Ormoc	None	None	3	"	"	3	3
12. Zamboanga	-do-	-do-	3	"	"	3	3
13. Davao	PARTIAL (BY RCDP)		2	"	"	3	2

Table 3.7 Prioritization of Flood Control and Drainage Project

Priority Factor	Urban Center	(1) Laoag	(2) Ilagan	(3) Olongapo	(4) Batangas	(5) Lucena	(6) Puerto Princesa	(7) Legaspi	(8) Iloilo	(9) Cebu	(10) Tacloban	(11) Ormoc	(12) Zamboanga	(13) Davao
1. NECESSITY		3	2	2	2	2	1	3	3	2	2	3	2	2
(1) Flood Area		3	1	1	2	1	1	3	3	2	1	3	2	1
(2) Flood Depth		3	3	2	3	2	1	2	3	1	2	3	3	2
(3) Flood Duration		2	3	2	2	3	2	3	3	2	3	1	3	3
(4) Population Affection		2	1	2	1	1	1	3	3	3	3	3	1	1
2. URGENCY		3	3	3	2	3	2	3	2	3	3	3	3	3
(1) River Capacity		3	3	3	3	3	1	3	2	2	3	3	3	3
(2) Drainage Development		3	3	3	2	3	3	3	3	3	3	1	3	3
(3) Casualties		1	1	1	1	1	1	2	1	2	2	3	2	1
3. BENEFIT		1	1	1	1	1	1	1	2	2	3	3	1	1
(1) Total Amount		2	1	1	1	1	1	1	3	3	3	3	2	1
(2) Amount per Capita		1	1	1	1	1	1	1	1	1	1	3	1	1
4. REGIONAL EQUALITY		3	2	3	3	3	2	3	3	3	3	3	3	3
(1) River Project		3	3	3	3	3	1	3	3	3	3	3	3	3
(2) Drainage Project		3	1	3	3	3	2	3	2	2	2	3	3	2
Integrated Evaluation		10	8	9	8	9	6	10	10	10	11	12	9	9

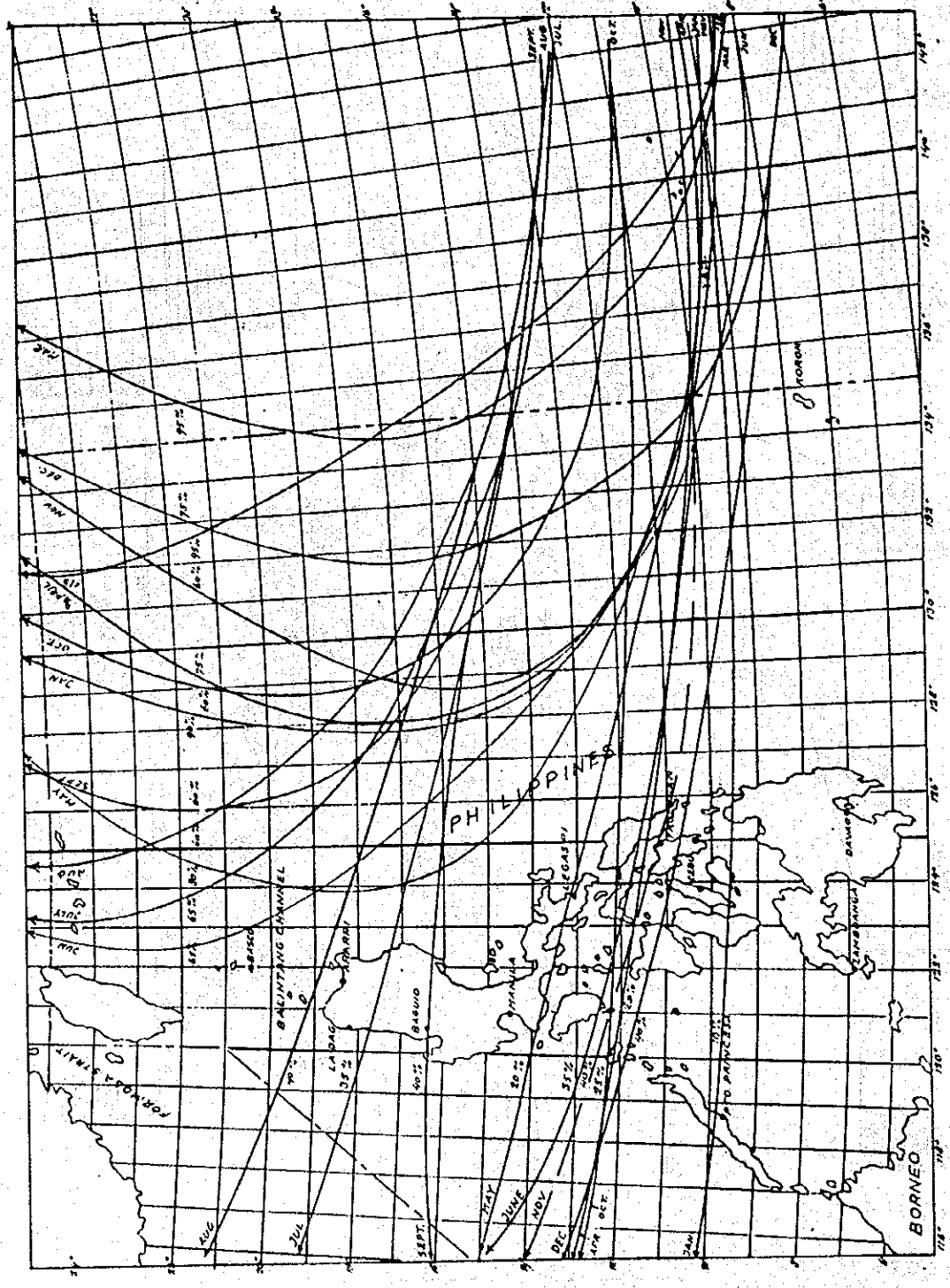
FIGURES



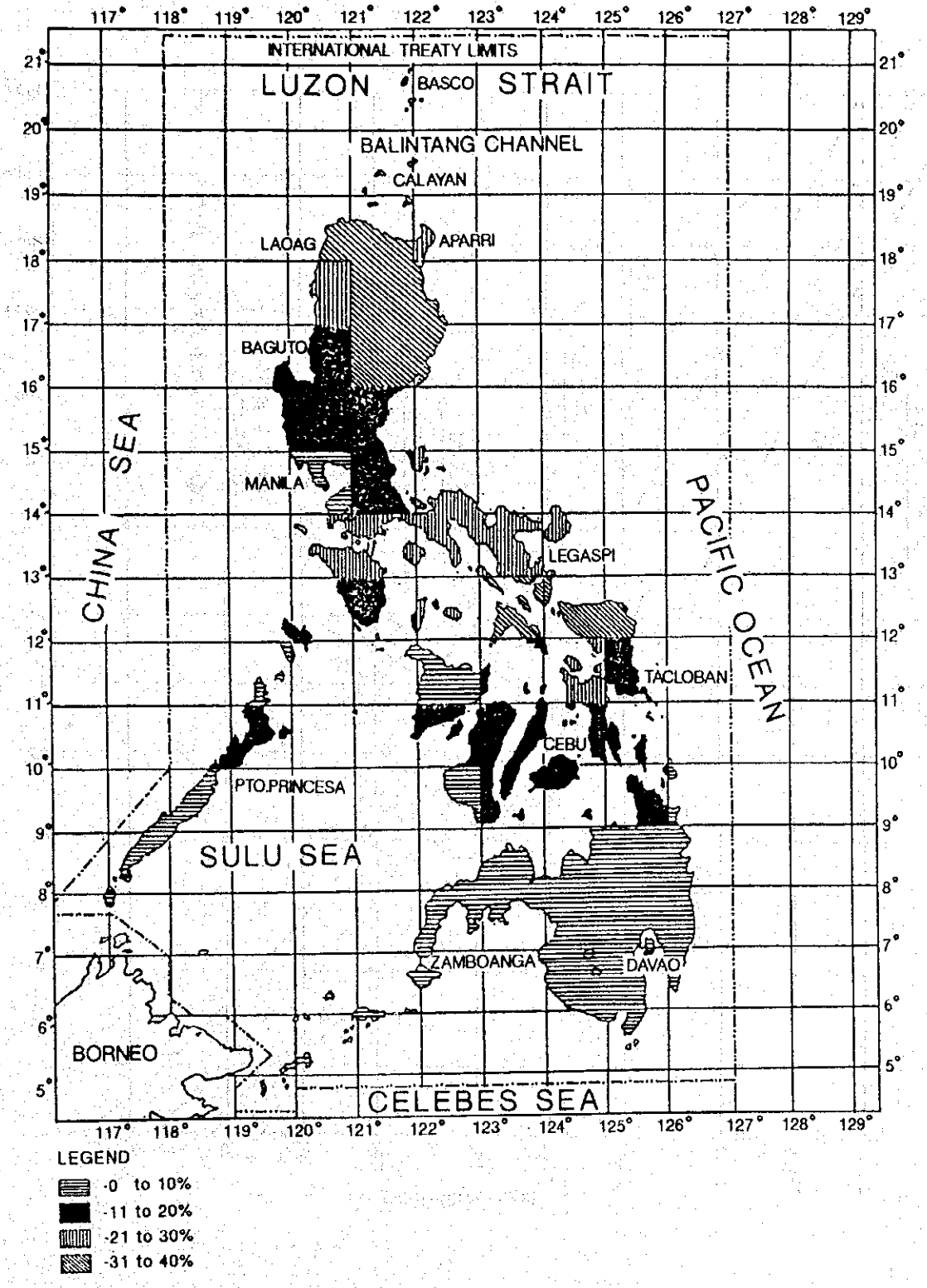
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

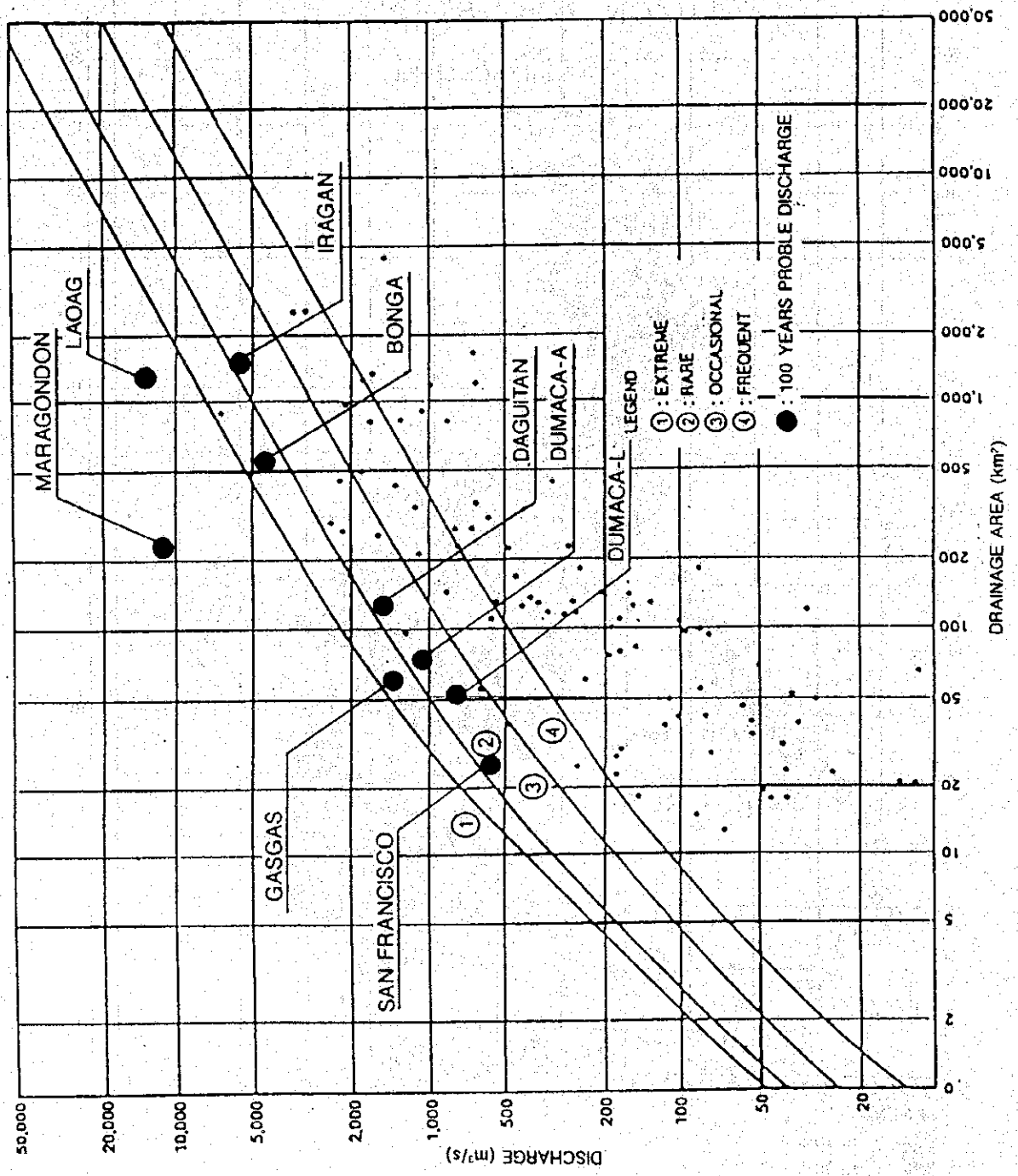
Fig. 1.1
Climate Classification



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 1.2 Mean Monthly Tracks of Tropical Cyclones in the Vicinity of the Philippines
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 1.3 Mean Percentage Frequencies of Tropical Cyclone Passage in Different Parts of the Philippines
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 1.4 Relation of Runoff to Size of Drainage Area in the Philippines
JAPAN INTERNATIONAL COOPERATION AGENCY	

- Data Base for Urban Centers
  - Basic Data
    - Name of Urban Center & Location
    - City Area
    - Name of Allied River
  - Socio-Economy
    - 1980 Census
      - Population in City Proper
      - Population in Urban Area
      - Population in Rural Area
    - 1980 Census
      - Population in City Proper
      - Population in Urban Area
      - Population in Rural Area
    - 1980 GRDP (Industrial Data)
    - 1990 GRDP (Industrial Data)
    - Land Use in Urban Center
      - Present Condition
      - Land Use Plan
  - River
    - Watershed/River Channel
      - Catchment Area
      - River Features
      - River Survey Data
      - Land Use in Watershed
    - Meteorology/Hydrology
      - Rainfall Gauging Station
      - Temperature
      - Rainfall
      - Discharge
      - Tidal Level
      - Water Quality
    - Flood Damage
      - Major Floods
      - Recorded Major Flood
      - Inundation Record
    - River Structures
      - Flood Control Facilities
      - Water Use Facilities
  - Drainage
    - Present Condition
      - Rainfall/Discharge
      - Drainage Network
    - Drainage Problem
  - Proposed/On-going Projects

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

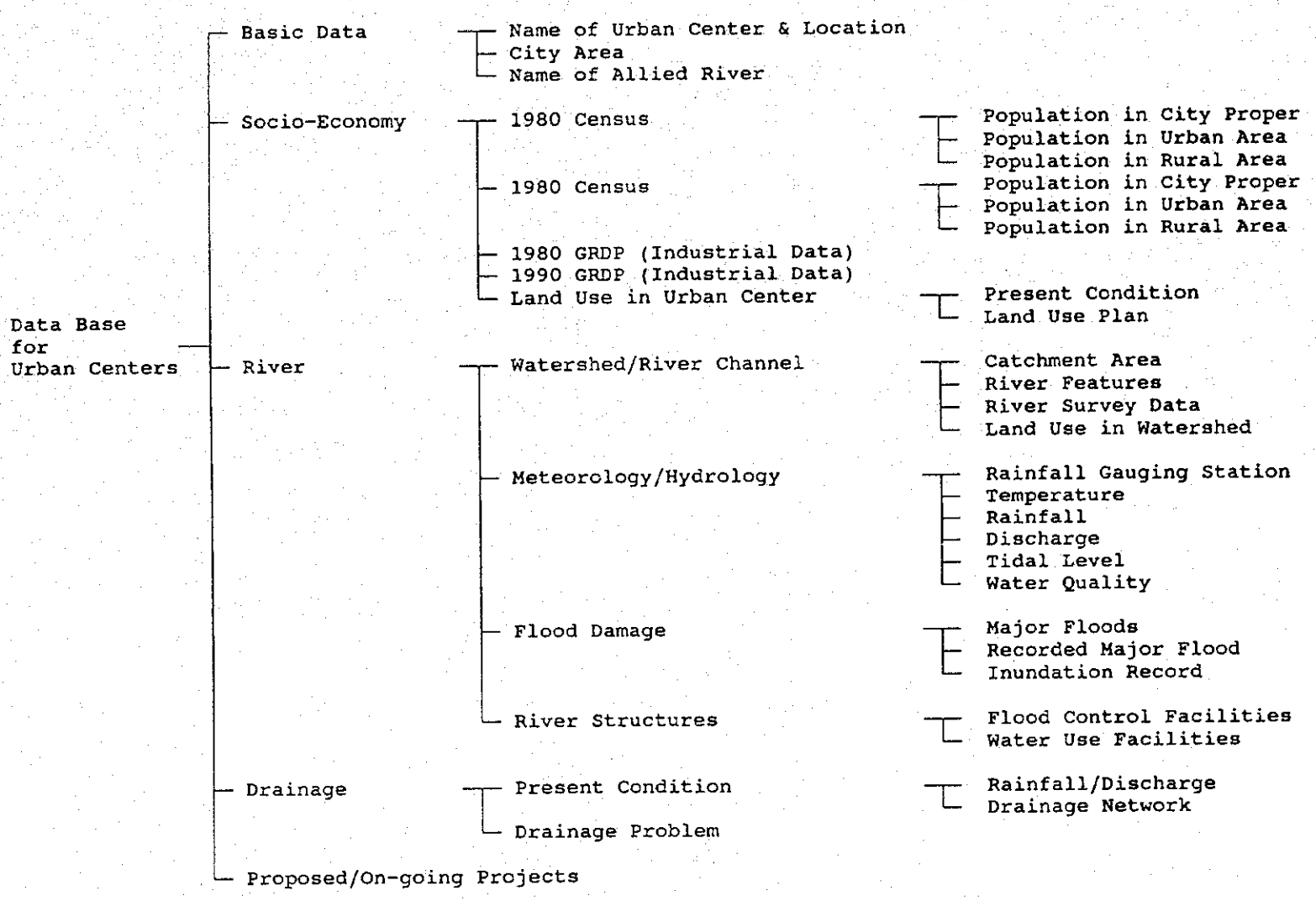


Fig. 4.2
Structure of Database for Flood Control Plan Urban Centers