REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

STUDY OF AGNO RIVER BASIN FLOOD CONTROL

FINAL REPORT

VOLUME IV

SUPPORTING REPORT PART I MASTER PLAN

DECEMBER, 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

SUPPORTING REPORT
PART I MASTER PLAN

1. SE

SOCIO-ECONOMY

SE: SOCIO-ECONOMY

SUMMARY

(1) Parts of the Study Area are located in Region I (Ilocos), Region II (Cagayan Valley) and Region III (Central Luzon). Among these regions the following nine provinces are included in the area:

Region		Province
I	:	Benguet, La Union, Pangasinan
II	:	Ifugao, Nueva Viscaya
III	:	Nueva Ecija, Pampanga, Tarlac, Zambales

(2) The population in the Study Area increased from 1.72 million persons in 1970 to 2.05 million persons in 1980 with the average growth rate of 1.75% per year during this 10 year period. This rate is similar to that of Region I (1.70%) but significantly lower than those of Region II (2.73%), Region III (2.88%) and the whole country (2.75%). This lower growth rate in the Study Area (hereinafter called the Area) may indicate that net out-migration was high in the Area during 1970 to 1980. The present population in the Area is estimated at 2.407 million persons.

(3) The population in the Area is projected to increase at an annual average of 1.03% from 2.41 million persons in 1989 to 3.66 million persons in 2030. Also, the population in the inundated area is projected to increase at a similar rate of 1.01% from 1.56 million persons in 1989 to 2.35 million persons in 2030. During this period, the average population density in the Area and inundated area will go up from 290 persons/km^2 and 630 persons/km^2 in 1989 to 440 persons/km^2 and 955 persons/km^2 in 2030, respectively.

(4) In 1987, the Gross Domestic Product (GDP) of the Area amounted to 17,500 million pesos which was 2.5% of the country's GDP. In real terms, the local economy grew at an average of 2.95% per year during the period 1980

to 1987 while the national economy grew at a slower rate of 0.44% per year during the same period. Per capita GDP of the Area in 1987 was estimated at 7,539 pesos, the same as the per capita GDP of Region I, which was lower than the average per capita GDP of the whole country of 12,300 pesos.

(5) The projected per capita GDP of Region I is then used to develop the GDP projections for the Area and its inundated area. The projections are summarized below and presented in detail in Table 2.7 to 2.10 for the Philippines, Region I, Area and inundated area, respectively.

Year	1989	1990	1995	2000	2005	2010
1. GDP at Constant 1989 Prices (million pesos)						
Philippines	936,412	999,826	1,387,438	1,936,703	2,747,303	4,044,515
Region I	39,902	42,257	54,396	70,022	92,092	121,117
Study Area (SA)	22,802	24,121	30,825	39,431	51,547	67,350
Inundated Area (IA)	14,758	15,600	19,896	25,420	33,204	43,350
2. Per Capita GDP at Constant 1989 Prices (pesos)						
Philippines	15,582	16,263	20,277	25,746	33,672	46,379
Region I, SA, IA	9,473	9,846	11,598	13,803	16,985	21,172

SE : SOCIO-ECONOMY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

1. NAME OF PHILIPPINE GOVERNMENT AGENCIES

AFCS	Agno Flood Control System
ARIS	Agno River Irrigation System
DENR	Department of Environment and Natural Resources
DOTC	Department of Transportation and Communications
DPWH	Department of Public Works and Highways
GOP	Government of the Philippines
LATRIS	Lower Agno and Totonogen River Irrigation System
NAPOCOR	National Power Corporation
NAMRIA	National Mapping and Resource Information Authority
NIA	National Irrigation Administration
OCD	Office of Civil Defense
PENRO	Provincial Environment and Natural Resources Office
PM	Project Manager
PMO	Project Management Office
PNR	Philippine National Railways
SMORIS	San Miguel - O'Donnell River Irrigation System

2. NAME OF JAPANESE GOVERNMENT AND OTHER OFFICIAL AGENCIES AND ORGANIZATION

GOJ	Government of Japan
JICA	Japan International Cooperation Agency
MOC	Ministry of Construction, Japan
OECF	Overseas Economic Cooperation Fund, Japan
UN	United Nations

3. MEASUREMENT UNITS

(Length)		(Weight)	
mm	millimeter(s)	gr(grs)	gramme(s)
cm	centimeter(s)	kg(kgs)	kilogramme(s)
m	meter(s)	ton(s)	ton(s),eq'vt to 1,000 kg
km	kilometer(s)		

(Area)

mm^2	square millimeter(s)
cm^2	square centimeter(s)
m^2	square meter(s)
km^2	square kilometer(s)
ha(has)	hectare(s)

(Time)

sec	second(s)
min	minute(s)
hr(hrs)	hour(s)
dy(dys)	day(s)
mth(mths)	month(s)
yr(yrs)	year(s)

(Volume)

cm^3	cubic centimeter(s)
m^3	cubic meter(s)
ltr	liter(s)

1. THE STUDY AREA

1.1 Definition of the Study Area

The area covered in the Study consists of the Agno River basin and the Allied River basins delineated in Fig. 1.1. The total drainage area of the Study Area (hereinafter called the Area) is about 7,640 km^2, broken down into 5,907 km^2 for the Agno River basin and 1,733 km^2 for the Allied river basins.

The Agno River basin is located in the western part of Central Luzon, and is ranked as the fifth largest river basin in the Philippines. The 275 km long river flows down the southern slopes of the Cordillera Central Mountains from its source north of Baguio City, passes through the Pangasinan Plain, and empties itself into Lingayen Gulf. Its five main tributaries include the following rivers: Tarlac, Ambayoan, Viray-Dipalo, Banila and Camiling.

In the northwestern part of the Pangasinan Plain, there is a group of medium size rivers called the Allied Rivers. The Allied Rivers consisting of the Cayanga River, Patalan River, Bued River, Pantal River and Sinocalan River also empties into the Lingayen Gulf.

1.2 Definition of the Inundation Area

The inundation area inside the Area is the maximum area that would be flooded as determined by the flood inundation analysis using available flood records and flood mark survey data. The inundation area is delineated as shown in Fig. 1.2, and is estimated to have an area of 2,465 km^2. It is the reference area used in the flood damage analysis for estimating the probable damage caused by floods of different return periods, and in the benefit cost analysis for optimizing the scale of development of the integrated long term plan.

2. SOCIO-ECONOMY

2.1 Socio-Economic Conditions in the Study Area

2.1.1 Administrative Regions in the Study Area

The regions, provinces and municipalities in the Area are shown in Fig. 2.1. Parts of the Area are located in Region I (Ilocos), Region II (Cagayan Valley) and Region III (Central Luzon). In these regions, the following provinces are included in the Area.

Region	Province
I	Benguet, La Union, Pangasinan
II	Ifugao, Nueva Vizcaya
III	Nueva Ecija, Pampanga, Tarlac, Zambales

There are 83 municipalities in the Area, distributed as follows:

Province	Number of Municipalities in the Province	Number of Municipalities in the Study Area
Benguet	14	9
La Union	20	3
Pangasinan	48	40
Ifugao	7	3
Nueva Vizcaya	15	2
Nueva Ecija	32	5
Pampanga	22	1
Tarlac	17	15
Zambales	14	5
9	189	83

2.1.2 Socio-Economic Profile

The socio-economic profile of the Area is summarized in Table 2.1.

The population in the Area increased from 1.72 million persons in 1970 to 2.05 million persons in 1980 at an average growth rate of 1.75% per year during this 10-year period. This rate is similar to that of Region I (1.70%) but significantly lower than those of Region II (2.73%), Region III (2.88%) and the whole country (2.75%). This lower growth rate in the Area may indicate that net out-migration was high in the Area during 1970 to 1980. The population growth in the Area by municipality is detailed in Table 2.2. The present population in the Area is estimated at 2.41 million persons.

The population density in the Area was 246 persons/km^2 in 1980 which was higher than the average of 160 persons/km^2 for the whole country. As indicated also in Table 2.2, the most densely populated municipalities with cultivated agricultural land are located in the flood plain of the Agno River and the Allied Rivers in Pangasinan and Tarlac.

The average household size and dwelling occupancy in the Area in 1980 is estimated at 5.6 persons/household and 5.7 persons/dwelling unit, respectively. Table 2.3 shows the number of households and dwelling units by municipality in 1980.

The urban population in the Area, as defined by the National Statistics Office, was 529,000 in 1980 which accounted for 26% of the total population. This was lower than the country's urban population share of 37% indicating a shower urbanization rate in the area.

The population of working age belonging to the 15 years old and over group in the Area was 1.24 million persons or 61% of the total population in 1980 which was similar to the country's figure of 60%. Labor force in the Area totaled to 694,000 persons or 56% of the working age population. This was lower than the country's 60% indicating that on a per capita basis there were fewer economically active persons in the Area than the national average.

The number of employed persons in the Area increased from 670,000 in 1980 to 800,000 in 1987. In 1987, the agriculture sector absorbed 405,000 workers

or 51% of total employment compared to 55% in 1980. During the same period, the service sector increased its share of total employment from 30% in 1980 to 34% in 1987. This employment share of the industry sector remained at 15%. Although mainly agriculture based, the structure of the Area's economy is shifting gradually towards a service sector orientation. In 1987, the Area accounted for 4.1% of the country's agricultural workers, 4.0% of the country's industrial workers and 3.5% of the country's service sector workers.

In 1987, the Gross Domestic Product (GDP) of the Area amounted to 17,500 million pesos which was 2.5% of the country's GDP. In real terms, the local economy grew at an average of 2.95% per year during the period 1980 to 1987 while the national economy grew at a slower rate of 0.44% per year during the same period. Per capita GDP of the Area in 1987 was estimated at 7,539 pesos, the same as the per capita GDP of Region I, which was lower than the average per capita GDP of the whole country of 12,300 pesos.

2.2 Projected Population

The population projection prepared by NEDA up to the year 2030 using the medium assumption of moderate fertility decline and moderate mortality decline is reasonable and appropriate for use in the Study.

The population in the Area is projected to increase at an annual average of 1.03% from 2.41 million persons in 1989 to 3.66 million persons in 2030. Also, the population in the inundated area is projected to increase at a similar rate of 1.01% from 1.56 million persons in 1989 to 2.35 million persons in 2030. During this period, the average population density in the Area and inundated area will go up from 290 persons/km^2 and 630 persons/km^2 in 1989 to 440 persons/km^2 and 955 persons/km^2 in 2030, respectively.

The projected population in the Area and inundated area is summarized below and presented in detail by municipality in Tables 2.4 and 2.5, respectively.

	Study Area		Inundated Area	
Year	Population (million persons)	Growth Rate (%/yr)	Population (million persons)	Growth Rate (%/yr)
1989	2.407	-	1.558	-
1990	2.450	1.77	1.584	1.71
1995	2.658	1.64	1.715	1.60
2000	2.857	1.45	1.842	1.43
2005	3.035	1.22	1.955	1.20
2010	3.181	0.95	2.048	0.93
2015	3.310	0.80	2.129	0.79
2020	3.440	0.77	2.211	0.76
2025	3.561	0.69	2.289	0.69
2030	3.661	0.56	2.353	0.56

2.3 Projected Gross Domestic Product

The per capita GDP of the Study Area, specifically its inundated area, can be appropriately represented by the per capita GDP of Region I. The inundated area, which will benefit from the flood control project, covers most of the provinces of Pangasinan (Region I) and Tarlac (Region III), and three municipalities in the province of Nueva Ecija (Region III). Although these provinces belong to two different regions, they have similar agriculture-based economy with the industry sector being limited mainly to cottage industries. This similarity is reflected in the average annual family income in the three provinces obtained from the 1985 Family Income and Expenditure Survey, as shown below:

Region/Province	Annual Family Income in 1985 (pesos)
Region I	31,463
Pangasinan	29,243
Region III	38,819
Tarlac	27,596
Nueva Ecija	28,264

The average family income in Pangasinan, Tarlac and Nueva Ecija is closer to that of Region I than Region III.

Beyond the Medium Term Plan 1987-1992, the country's GDP is expected to grow at an annual average of 6.8% for the period 1992-2000 and 7.6% for the period 2000-2010. These growth rates will enable the Philippines to achieve its goal of attaining the status of a newly industrialized economy by the year 2010. On the basis of the 5.8% annual growth achieved by the country during the period 1972-1982 (See Table 2.6), these target growth rates are considered appropriate for a "high growth" scenario. This period, which includes the oil crises of 1973 and 1979 but excludes the political crises of 1983-1986 and the subsequent period of economic recovery, is considered to be a typical condition for the "high growth" scenario.

Also under the "high growth" scenario, the GDP of Region I is projected to grow at an annual average of 5.2% for the period 1992-2000 and 5.6% for the period 2000-2010. These growth rates can be realized considering that the economy of Region I grew at an annual average of 5.2% during the period 1975-1982 (see Table 2.6).

The projected per capita GDP of Region I is then used to develop the GDP projections for the Area and its inundated area. The projections are summarized below and presented in detail in Table 2.7 to 2.10 for the Philippines, Region I, Area and inundated area, respectively.

Year	1989	1990	1995	2000	2005	2010
1. GDP at Constant 1989 Prices (million pesos)						
Philippines	936,412	999,826	1,387,438	1,936,703	2,747,303	4,044,515
Region I	39,902	42,257	54,396	70,022	92,092	121,117
Study Area (SA)	22,802	24,121	30,825	39,431	51,547	67,350
Inundated Area (IA)	14,758	15,600	19,896	25,420	33,204	43,350
2. Per Capita GDP at Constant 1989 Prices (pesos)						
Philippines	15,582	16,263	20,277	25,746	33,672	46,379
Region I, SA, IA	9,473	9,846	11,598	13,803	16,985	21,172

2.4 Projected Infrastructure Investment

The actual amount spent by the GOP on its infrastructure program during the period 1974-1987 is shown in Table 2.11. At current prices, the share of flood control to the total annual expenditure on infrastructure ranged from a low of 0.5% in 1984 to a high of 11.7% in 1974. Converted to constant prices, as shown in Table 2.12, the peak years of infrastructure spending were 1982 and 1983. This table also indicates that for the period 1975-1983, annual expenditure on infrastructure averaged about 5% of the GDP.

To obtain indicative levels of future investment on infrastructure in the inundated area, 5% of the projected GDP is assumed to be available each year for this purpose. The resulting amounts, annually and cumulatively, are shown in Table 2.13. In total, some 11,000 million pesos, at constant 1989 prices, is estimated to be available for investment on infrastructure in the inundated area during the period 1990-2000.

3. OPTIMIZATION OF THE LONG TERM PLAN

3.1 Objectives

The long term plans are subjected to a benefit cost analysis to achieve the following objectives:

(1) to rank the alternatives in terms of their economic rate of return (EIRR), and

(2) to optimize the scale of development of each alternative.

3.2 Alternative Long Term Plans

The long term plans included in the benefit cost analysis are as follows:

(1) Agno Main Stream, Tarlac and Allied Rivers

(The optimum combination of river improvement, floodway and natural retarding basin)

LAA-10-10	10 year flood for all rivers
LAA-25-25	25 year flood for all rivers
LAA-50-50	50 year flood for all rivers

(2) Agno Main Stream, Tarlac, Tributaries and Allied Rivers

(The optimum combination of river improvement, floodway and natural retarding basin)

LAAT-10-10	10 year flood for all rivers
LAAT-25-25	25 year flood for all rivers
LAAT-50-50	50 year flood for all rivers

(3) Agno Main Stream and Tarlac River

(Combination of river improvement and natural retarding basin)

LAG-A2-10	10 year flood for all rivers
LAG-A2-25	25 year flood for all rivers
LAG-A2-50	50 year flood for all rivers

(4) Agno River Tributaries

(River improvement only)

LAT-AT-10	10 year flood for all rivers
LAT-AT-25	25 year flood for rivers
LAT-AT-50	50 year flood for all rivers

(5) Allied Rivers

(The optimum combination of river improvement and floodway)

LAL-AT-10	10 year flood for all rivers
LAL-AT-25	25 year flood for all rivers
LAL-AT-50	50 year flood for all rivers

3.3 Criteria for the Benefit Cost Analysis

The criteria used in the benefit cost analysis are as follows:

(1)	Base Year for Benefit Cost Analysis	Beginning of 1990
(2)	Project Life	50 year (from 1990-2044)
(3)	Start of Construction	Beginning of 1995
(4)	Construction Period	15 years (from 1995-2009)
(5)	Disbursement Schedule	Uniform distribution of total project cost during the construction period
(6)	Annual Operation and Maintenance Cost	0.5% of main construction cost and physical contingency of completed works
(7)	Price Escalation Rate	No escalation

(8) Timing of Benefits	(a) River improvement and floodway: in proportion to the works already completed (b) Dam: the year the whole dam is completed
(9) Growth Factor (GF) of Future Benefits	(a) Current development level: constant (GF=1.0) (b) Future development level: low growth of GDP (See Table 3.1)

3.4 Results of the Benefit Cost Analysis

The results of the benefit cost analysis are summarized in Table 3.2 and illustrated in Fig. 3.1.

Under the Future development level which is assumed that future benefits will be increased annually at the 5.2% growth rate of the GDP in the inundated area, the optimum development scale of the flood control plan for the Allied Rivers is one corresponding to a design flood with a return period of 10 years or less. At the stated development scale, this alternative is estimated to yield an EIRR of at least 34%. At the low end, the EIRR for the Agno tributaries at the optimum development scale corresponding to a design flood with a return period of about 25 years is about 16%. For the same return period, the EIRR for the Agno main stream including the Tarlac River is estimated at about 17%.

The benefit cost calculations for each optimum long term plan under the Future development level and the Current development level are shown in Tables 3.3 to 3.12.

TABLES

Table 2.1 SOCIO-ECONOMIC PROFILE OF THE STUDY AREA

Parameter	Unit	1980						1987					
		Philippines	Region I Ilocos	Region II Cagayan Valley	Region III Central Luzon	Study Area Amount	Study Area Share (%)	Philippines	Region I Ilocos	Region II Cagayan Valley	Region III Central Luzon	Study Area Amount	Study Area Share (%)
I. Population													
1. Total	Thousands	48,098	3,541	2,216	4,803	2,046	4.3	57,356	4,056	2,648	5,726	2,324	4.1
2. Rural Population	Thousands	30,155	2,699	1,872	2,794	1,517	5.0						
Percent of Total	%	62.7	76.2	84.5	58.2	74.1	-						
3. Population 15 yrs. old & over	Thousands	28,967	2,158	1,316	2,880	1,242	4.3	34,840	2,496	1,576	3,519	1,429	4.1
Percent of Total	%	60.2	60.9	59.4	60.0	60.7	-	60.7	61.5	59.5	61.5	61.5	-
4. Total Labor Force	Thousands	17,308	1,202	867	1,624	694	4.0	22,984	1,558	1,108	2,189	892	3.9
Percent of Pop. 15 yrs. old & over	%	59.8	55.7	65.9	56.4	55.9	-	65.7	62.4	70.3	62.2	62.4	-
5. Employed Persons													
-Agriculture, Fishery & Forestry	Thousands	8,453	706	589	586	369	4.4	9,940	768	689	733	405	4.1
-Industry	Thousands	2,554	156	80	312	101	4.0	3,045	198	77	358	121	4.0
-Service	Thousands	5,427	307	164	631	200	3.7	7,810	445	288	818	274	3.5
Total	Thousands	16,434	1,169	833	1,529	670	4.1	20,795	1,410	1,055	1,909	800	3.8
Agriculture as Percent of Total	%	51.4	60.4	70.7	38.3	55.1	-	47.8	54.5	65.3	38.4	50.6	-
Employment Rate	%	95.0	97.3	96.1	94.2	96.5	-	90.5	90.5	95.2	87.2	89.7	-
II. GDP													
1. Total at Current Prices	Million P	264,652	10,706	7,567	24,456	6,181	2.3	705,467	30,577	16,152	62,638	17,521	2.5
at 1972 Constant Prices	Million P	92,568	3,500	2,606	7,644	2,021	2.2	95,434	4,323	2,301	7,665	2,477	2.6
2. Per Capita at Current Prices	P	5,477	3,021	3,397	5,067	3,021	-	12,300	7,539	6,100	10,939	7,539	-
at 1972 Constant Prices	P	1,916	988	1,170	1,584	988	-	1,664	1,066	869	1,339	1,066	-
3. Contribution to GDP at Current Prices													
-Agriculture	Million P	36,332						95,516	8,224	5,200	7,373		
Palay	Million P	9,080						24,028	2,453	2,854	4,649		
Corn	Million P	3,481						11,551	281	972	28		
Other crops	Million P	23,771						59,937	5,490	1,373	2,696		
-Livestock & Poultry	Million P	7,488						28,028	2,368	1,496	4,219		
-Fishery	Million P	11,198						36,319	598	159	1,569		
-Forestry	Million P	6,743						10,907	125	1,468	13		
Total Agri., Fishery & Forestry	Million P	61,761	3,255	3,244	4,713			170,770	11,315	8,323	13,174		
Percent of GDP	%	23.3	30.4	42.9	19.3			24.2	37.0	51.5	21.0		
-Industry	Million P	96,723	3,515	2,048	10,843			229,683	8,080	1,809	24,917		
Percent of GDP	%	36.6	32.8	27.1	44.3			32.6	26.4	11.2	39.8		
-Service	Million P	106,168	3,936	2,275	8,900			305,014	11,182	6,020	24,547		
Percent of GDP	%	40.1	36.8	30.0	36.4			43.2	36.6	37.3	39.2		
4. Labor Productivity													
-Agriculture	P	7,306	4,610	5,508	8,043			17,180	14,733	12,080	17,973		
-Industry	P	37,871	22,532	25,600	34,753			75,430	40,808	23,494	69,601		
-Service	P	19,563	12,821	13,872	14,105			39,054	25,128	20,903	30,009		
III. Land Use													
1. Total Area	km2	300,000	21,568	36,403	18,231	8,305	2.8						
2. Agricultural Land													
-Temporary crops	km2	43,652	3,086	4,157	4,445	2,029	4.6						
-Permanent crops	km2	34,890	200	380	138	96	0.3						
-Pasture	km2	5,300	504	956	171	159	3.0						
-Others	km2	13,409	499	897	266	198	1.5						
Total	km2	97,251	4,309	6,390	5,020	2,482	2.6						
Percent of Total Area	%	32.4	20.0	17.6	27.5	29.9	-						

Table 2.2 (1/2) POPULATION GROWTH IN THE STUDY AREA BY MUNICIPALITY: 1970-1980

Province/ Municipality	Administrative Area: Population 1970	1975	1980	Land Area (km2)	Study Area: % Inside Study Area: Population	Land Area	Population 1970	1975	1980	Average Annual Growth Rate (%): 1970-75	1975-80	1970-80	Land Area (km2)	Density in 1980 (persons/km2)
Benguet														
Baguio city	84538	97449	119009	48.9	20	30	16908	19490	23802	2.88	4.08	3.48	14.7	1622.5
Atok	10215	11589	14466	137.0	2	2	204	232	289	2.56	4.53	3.54	2.7	105.6
Bokod	10161	10404	11859	425.3	95	95	9653	9884	11304	0.47	2.72	1.59	404.0	28.0
Buguias	12402	15142	17509	193.1	80	60	9922	12114	14007	4.07	2.95	3.51	115.9	120.9
Itogon	39034	41081	47605	423.7	98	98	39037	40259	46653	0.62	2.99	1.80	415.2	112.4
Kabayan	7116	8363	9072	177.5	80	80	5693	6690	7258	3.28	1.64	2.46	142.0	51.1
La Trinidad	16551	22732	28713	61.4	4	4	742	909	1149	4.15	4.78	4.47	2.5	467.6
Tuba	17939	25304	30449	314.4	50	50	8970	12652	15225	7.12	3.77	5.43	157.2	96.8
Tublay	7413	8610	9686	84.9	20	20	1483	1722	1937	3.04	2.38	2.71	17.0	114.1
Sub Total	208169	240674	288408	1866.2			92611	103952	121623	2.34	3.19	2.76	1271.2	95.7
La Union														
Fugo	6483	7180	7780	43.2	30	21	1945	2154	2334	2.06	1.62	1.84	9.1	257.3
Rosario	22118	25356	29331	72.8	80	66	17694	20283	23465	2.77	2.96	2.86	48.0	488.4
Sto. Tomas	19482	21341	22610	64.0	1	1	195	213	226	1.84	1.16	1.50	0.6	353.3
Sub Total	48083	53875	59721	180.0			19834	22651	26025	2.69	2.82	2.75	57.8	450.6
Pangasinan														
Dagupan City	83582	90092	98344	37.2	100	100	83582	90092	98344	1.51	1.77	1.64	37.2	2643.7
San Carlos City	84393	90882	101243	166.4	100	100	84393	90882	101243	1.51	2.18	1.84	166.4	608.4
Aguilar	17696	19853	22080	152.9	100	100	17696	19853	22080	2.33	2.15	2.24	152.9	144.4
Alcala	22208	24376	24993	36.5	100	100	22208	24376	24993	1.88	0.50	1.19	36.5	684.7
Asingan	34148	36267	37301	66.6	100	100	34148	36267	37301	1.21	0.56	0.89	66.6	560.1
Balungao	14989	16745	17342	93.8	100	100	14989	16745	17342	2.24	0.70	1.47	93.8	184.9
Basista	14204	15241	17191	15.6	100	100	14204	15241	17191	1.42	2.44	1.93	15.6	1102.0
Bautista	14985	16749	18072	126.3	100	100	14985	16749	18072	2.25	1.53	1.89	126.3	143.1
Bayambang	56415	62808	64037	75.2	100	100	56415	62808	64037	2.17	0.39	1.28	75.2	851.6
Binalonan	32441	34726	35574	77.6	100	100	32441	34726	35574	1.37	0.48	0.93	77.6	458.4
Binmaley	40645	43543	47332	61.2	100	100	40645	43543	47332	1.39	1.68	1.53	61.2	773.4
Bugallon	31637	33981	39072	169.3	99	99	31340	33621	38691	2.39	1.66	2.03	169.6	230.8
Calasiao	38576	43640	48101	53.4	100	100	38576	43640	48101	2.50	1.97	2.23	53.4	900.8
Infanta	10469	11336	12323	247.4	1	12	105	113	123	1.60	1.68	1.64	29.7	4.2
Labrador	10835	11745	12120	87.8	90	34	9752	10571	10908	1.63	0.63	1.13	47.4	230.1
Lingayen	56096	59034	65187	67.7	100	100	56056	59034	65187	1.03	2.00	1.51	67.7	962.9
Mabini	12769	15894	15979	236.3	1	2	128	159	160	4.48	0.11	2.27	4.7	33.8
Malasiqui	61423	67489	70905	127.0	100	100	61423	67489	70905	1.90	0.99	1.45	127.0	558.3
Manaoag	31738	31699	36742	27.2	100	100	31738	31699	36742	-0.02	3.00	1.47	27.2	1350.8
Mangaldan	41867	46230	50434	44.8	100	100	41867	46230	50434	2.00	1.76	1.88	44.8	1125.8
Mangatarem	35080	37604	40582	317.6	100	100	35080	37604	40582	1.40	1.54	1.47	317.6	127.8
Mapandan	16653	18143	20094	30.0	100	100	16653	18143	20094	1.73	2.06	1.90	30.0	669.8
Natividad	13592	14416	15246	76.8	100	100	13592	14416	15246	1.18	1.13	1.15	76.8	198.5
Pozzorubio	33006	35618	38257	134.6	100	100	33006	35618	38257	1.53	1.46	1.49	134.6	284.2
Rosales	29530	34155	36582	68.4	100	100	29530	34355	36582	3.07	1.26	2.16	68.4	534.8
San Fabian	35014	38034	42018	92.4	70	46	24510	27338	29413	2.21	1.47	1.84	42.5	692.0
San Jacinto	16583	18722	20612	39.1	100	100	16583	18722	20612	2.46	1.94	2.20	39.1	527.2
San Manuel	26157	27555	29622	133.7	100	100	26357	27555	29622	0.89	1.46	1.17	133.7	221.6
San Nicolas	21687	23377	23243	210.2	100	100	21687	23377	23243	1.51	-0.11	0.70	210.2	110.6
San Quintin	18842	20381	20835	115.9	100	100	18842	20381	20835	1.58	0.44	1.01	115.9	179.8
Sta. Barbara	30580	34418	37001	77.4	100	100	30580	34418	37001	2.39	1.46	1.92	77.4	478.0
Sta. Maria	16296	18766	19018	69.5	100	100	16296	18766	19018	2.86	0.27	1.56	69.5	273.6
Sto. Tomas	7562	8615	8946	8.3	100	100	7562	8615	8946	2.64	0.76	1.69	8.3	1077.8
Sison	20849	23642	25053	97.7	100	100	20849	23642	25053	2.55	1.17	1.85	97.7	256.4
Tayug	24143	26153	26273	51.3	100	100	24143	26153	26273	1.61	0.09	0.85	51.3	512.1
Umingan	36133	40880	41364	264.6	99	98	35774	40471	40950	2.50	0.24	1.36	259.3	157.9
Urbiztondo	23385	24006	27348	81.6	100	100	23385	24006	27348	0.53	2.64	1.58	81.6	335.1
Urdaneta	58690	65392	71796	121.0	100	100	58690	65392	71796	2.19	1.89	2.04	121.0	593.4
Villasis	31676	36080	39126	75.8	100	100	31676	36080	39126	2.64	1.63	2.13	75.8	516.2
Laoac	16353	16751	19252	40.5	100	100	16353	16751	19252	0.48	2.82	1.65	40.5	475.4
Sub Total	1223089	1338258	1436640	4076.6			1187818	1297641	1393999	1.78	1.44	1.61	3530.0	394.9
Ifugao														
Banaue	20268	20489	22900	326.4	1	2	203	205	229	0.22	2.25	1.23	6.5	35.1
Hungduan	8958	12301	9857	260.3	20	30	1792	2460	1971	6.55	-4.33	0.96	78.1	25.2
Kiangan	15123	15935	17481	443.3	10	15	1512	1594	1748	1.05	1.87	1.46	66.5	26.3
Sub Total	44349	48725	50238	1030.0			3507	4259	3949	3.96	-1.50	1.19	151.1	26.1
Nueva Vizcaya														
Kayapa	14920	20718	20491	482.9	40	30	5968	8287	8196	6.79	-0.22	3.22	144.9	56.6
Sta. Fe	4254	5961	6338	310.0	10	40	425	596	634	6.98	1.23	4.07	124.0	5.1
Sub Total	19174	26679	26829	793			6393	8883	8830	6.80	-0.12	3.28	268.9	32.8

Table 2.2 (2/2) POPULATION GROWTH IN THE STUDY AREA BY MUNICIPALITY: 1970-1980

Province/ Municipality	Administrative Area: Population 1970	1975	1980	Land Area (km2)	% Inside Study Area: Population	Land Area	Study Area: Population 1970	1975	1980	Average Annual Growth Rate (%) 1970-75	1975-80	1970-80	Land Area (km2)	Density in 1980 (persons/km2)
Nueva Ecija														
Carranglan	15536	16875	19891	731.2	10	15	1554	1688	1989	1.67	3.34	2.50	112.7	17.7
Cuyapo	34793	39109	39654	167.5	98	98	34097	38327	38861	2.37	0.28	1.32	164.2	236.7
Gabaldon	50261	55781	58847	94.5	20	40	10052	11156	11769	2.11	1.08	1.59	37.8	311.4
Lupao	20005	22106	23050	151.7	10	30	2001	2211	2305	2.02	0.84	1.43	45.5	50.6
Munoz	6639	7350	7597	52.6	100	100	6639	7350	7597	2.06	0.66	1.36	52.6	144.4
Sub total	127234	141221	149039	1217.5			54342	60731	62521	2.25	0.58	1.41	412.7	151.5
Pampanga														
Mabalacat	55897	69874	80966	152.6	1	20	559	699	810	4.56	2.99	3.77	30.5	26.5
Sub Total	55897	69874	80966	152.6			559	699	810	4.56	2.99	3.77	30.5	26.5
Tarlac														
Anao	6672	6084	6519	23.9	100	100	6672	6084	6519	-1.83	1.39	-0.23	23.9	272.8
Bamban	18474	22723	26072	133.1	10	60	1847	2272	2607	4.23	2.79	3.51	79.9	32.6
Camiling	49156	52411	53860	140.5	100	100	49156	52411	53860	1.29	0.55	0.92	140.5	383.3
Capas	35515	42561	46523	440.0	20	80	7103	8512	9305	3.69	1.80	2.74	352.0	26.4
Gerona	41831	46513	50433	141.4	100	100	41831	46513	50433	2.14	1.63	1.89	141.4	356.7
Mayantoc	13358	16427	17135	356.6	99	98	13422	16263	16964	3.91	0.85	2.37	347.5	48.8
Moncada	29195	31825	34451	85.7	100	100	29195	31825	34451	1.74	1.60	1.67	85.7	402.0
Paniqui	47718	53031	55006	105.2	100	100	47718	53031	55006	2.12	0.73	1.43	105.2	522.9
Pura	12763	14409	14801	31.0	100	100	12763	14409	14801	2.46	0.54	1.49	31.0	477.5
Ramos	9649	10626	11215	24.4	100	100	9649	10626	11215	1.95	1.08	1.52	24.4	459.6
San Clemente	6073	7406	7117	48.6	100	100	6073	7406	7117	4.05	-0.79	1.60	48.6	146.4
San Manuel	10583	12803	13491	42.1	100	100	10583	12803	13491	3.69	1.05	2.36	42.1	320.5
Santa Ignacia	20775	23157	25224	75.4	100	100	20775	23157	25224	2.19	1.72	1.96	75.4	334.5
Tarlac	135128	160595	175691	936.0	70	90	94590	112417	122984	3.51	1.81	2.66	842.4	146.0
Victoria	33141	34889	34942	111.5	10	30	3314	3489	3494	1.03	0.03	0.53	33.5	104.5
Sub Total	470331	535460	572480	2693.4			354792	401218	427470	2.49	1.28	1.88	2373.4	180.1
Zambales														
Botolan	23848	27307	27125	613.7	1	5	238	273	271	2.75	-0.13	1.30	30.7	8.8
Candelaria	12378	14630	15684	437.6	1	20	124	146	157	3.40	1.40	2.40	87.5	1.8
Masinloc	22736	24807	27735	256.0	1	10	227	248	277	1.76	2.26	2.01	25.6	10.8
Palauig	14546	16359	17176	310.0	1	1	145	164	172	2.38	0.98	1.68	3.1	55.4
Sta. Cruz	28282	32307	33665	414.1	1	15	283	323	337	2.70	2.00	2.35	62.1	5.7
Sub Total	101788	115410	123357	2031.4			1018	1154	1234	2.54	1.35	1.98	209.0	5.9
Total	2,298,114	2,570,176	2,787,708	14040.6	73	59	1,720,873	1,901,187	2,046,461	2.01	1.48	1.75	8304.7	246.4

					Average Annual Growth Rate (%) 1970-75	1975-80	1970-80	Density in 1980 (persons/km2)
Region I	2990561	3269391	3540893	21568.4	1.80	1.61	1.70	164.2
Region II	1692127	1933177	2215522	36403.0	2.70	2.76	2.73	60.9
Region III	3615496	4210136	4892793	18230.8	3.09	2.67	2.88	263.4
Philippines	36684486	42070660	48098460	300000.0	2.78	2.71	2.75	160.3

Source of Basic Data: "Special Report No.3 - Philippines 1980 Population, Land Area, and Density : 1970, 1975, and 1980." National Statistics Office

Table 2.3 (1/5) POPULATION, DENSITY, HOUSEHOLD SIZE AND DWELLING OCCUPANCY BY MUNICIPALITY: 1980

Administration	Population (persons)	Land Area (km2)	Households (number)	Dwellings (number)	Density (persons/ km2)	Household Size (persons/ household)	Dwelling Occupancy (persons/ dwelling)
Region I							
Benguet	354,751	2,655.4	67,189	65,769	133.6	5.3	5.4
Atok	14,466	137.0	2,822	2,756	105.6	5.1	5.2
Baguio city	119,009	48.9	21,934	21,532	2433.7	5.4	5.5
Bakun	8,878	237.4	1,701	1,699	37.4	5.2	5.2
Bokod	11,899	425.3	2,100	2,100	28.0	5.7	5.7
Buguias	17,509	193.1	3,127	3,077	90.7	5.6	5.7
Itogon	47,605	423.7	9,813	9,201	112.4	4.9	5.2
Kabayan	9,072	177.5	1,639	1,638	51.1	5.5	5.5
Kapangan	13,381	136.4	2,615	2,604	98.1	5.1	5.1
Kibungan	10,500	192.1	1,986	1,986	54.7	5.3	5.3
La Trinidad	28,713	61.4	5,510	5,432	467.6	5.2	5.3
Mankayan	25,684	131.7	4,921	4,911	195.0	5.2	5.2
Sablan	7,900	91.6	1,381	1,378	86.2	5.7	5.7
Tuba	30,449	314.4	5,875	5,699	96.8	5.2	5.3
Tublay	9,686	84.9	1,765	1,765	114.1	5.5	5.5
La Union	452,578	1,493.1	80,129	78,650	303.1	5.6	5.8
Agoo	34,849	39.1	5,964	5,891	891.3	5.8	5.9
Aringay	27,524	109.5	4,783	4,750	251.4	5.8	5.8
Bacnotan	24,800	76.6	4,585	4,531	323.8	5.4	5.5
Bagulin	7,009	49.5	1,258	1,256	141.6	5.6	5.6
Balaoan	25,197	60.4	4,497	4,472	417.2	5.6	5.6
Bangar	23,715	47.4	4,019	3,942	500.3	5.9	6.0
Bauang	41,859	72.9	7,092	6,958	574.2	5.9	6.0
Burgos	4,149	70.8	711	691	58.6	5.8	6.0
Caba	14,114	66.7	2,465	2,396	211.6	5.7	5.9
Luna	25,081	52.6	4,764	4,764	476.8	5.3	5.3
Naguilian	29,304	78.1	5,165	5,132	375.2	5.7	5.7
Pugo	7,780	43.2	1,442	1,403	180.1	5.4	5.5
Rosario	29,331	72.8	4,988	4,829	402.9	5.9	6.1
San Fernando	68,410	120.8	12,436	12,252	566.3	5.5	5.6
San Gabriel	10,248	178.1	1,881	1,862	57.5	5.4	5.5
San Juan	20,362	55.7	3,614	3,577	365.6	5.6	5.7
Sto. Tomas	22,610	64.0	4,058	3,788	353.3	5.6	6.0
Santol	7,836	93.7	1,481	1,341	83.6	5.3	5.8
Serdipen	10,796	84.4	2,026	2,025	127.9	5.3	5.3
Tubao	17,604	56.8	2,900	2,790	309.9	6.1	6.3

Table 2.3 (2/5) POPULATION, DENSITY, HOUSEHOLD SIZE AND DWELLING OCCUPANCY BY MUNICIPALITY: 1980

Administration	Population (persons)	Land Area (km2)	Households (number)	Dwellings (number)	Density (persons/ km2)	Household Size (persons/ household)	Dwelling Occupancy (persons/ dwelling)
Pangasinan	1,636,057	5,368.2	295,728	286,872	304.8	5.5	5.7
Dagupan City	98,344	37.2	17,323	16,968	2643.7	5.7	5.8
San Carlos City	101,243	166.4	17,144	16,811	608.4	5.9	6.0
Agno	17,241	165.2	3,257	3,248	104.4	5.3	5.3
Aguilar	22,080	152.9	3,691	3,669	144.4	6.0	6.0
Alaminos	47,715	159.2	9,184	9,046	299.7	5.2	5.3
Alcala	24,993	36.5	4,550	4,468	684.7	5.5	5.6
Anda	20,454	82.0	3,886	3,763	249.4	5.3	5.4
Asingan	37,301	66.6	6,964	6,917	560.1	5.4	5.4
Balungao	17,342	93.8	3,316	3,316	184.9	5.2	5.2
Bani	29,102	152.7	5,712	5,652	190.6	5.1	5.1
Basista	17,191	15.6	2,993	2,934	1102.0	5.7	5.9
Bautista	18,072	126.3	3,032	2,940	143.1	6.0	6.1
Bayambang	64,037	75.2	11,100	10,861	851.6	5.8	5.9
Binalonan	35,574	77.6	6,823	6,732	458.4	5.2	5.3
Binmaley	47,332	61.2	8,138	7,934	773.4	5.8	6.0
Bolinao	39,335	232.2	7,274	7,054	169.4	5.4	5.6
Bugallon	39,072	169.3	6,571	6,533	230.8	5.9	6.0
Burgos	12,817	119.0	2,442	2,401	107.7	5.2	5.3
Calasiao	48,101	53.4	8,386	8,163	900.8	5.7	5.9
Dasol	16,957	230.9	3,214	3,149	73.4	5.3	5.4
Infanta	12,323	247.4	2,524	2,473	49.8	4.9	5.0
Labrador	12,120	87.8	2,221	2,194	138.0	5.5	5.5
Lingayen	65,187	67.7	10,939	10,737	962.9	6.0	6.1
Mabini	15,979	236.3	3,089	3,088	67.6	5.2	5.2
Malasiqui	70,905	127.0	12,807	12,191	558.3	5.5	5.8
Manaoag	36,742	27.2	6,151	6,119	1350.8	6.0	6.0
Mangaldan	50,434	44.8	8,724	8,538	1125.8	5.8	5.9
Mangatarem	40,582	317.6	7,292	7,123	127.8	5.6	5.7
Mapandan	20,094	30.0	3,343	3,200	669.8	6.0	6.3
Natividad	15,246	76.8	2,734	2,706	198.5	5.6	5.6
Pozzurubio	38,257	134.6	6,831	6,578	284.2	5.6	5.8
Rosales	36,582	68.4	6,563	6,441	534.8	5.6	5.7
San Fabian	42,018	92.4	7,272	7,104	454.7	5.8	5.9
San Jacinto	20,612	39.1	6,576	3,413	527.2	3.1	6.0
San Manuel	29,622	133.7	5,448	5,349	221.6	5.4	5.5
San Nicolas	23,243	210.2	4,407	4,368	110.6	5.3	5.3
San Quintin	20,835	115.9	3,806	3,599	179.8	5.5	5.8
Sta. Barbara	37,001	77.4	6,324	6,284	478.0	5.9	5.9
Sta. Maria	19,018	69.5	3,437	3,375	273.6	5.5	5.6
Sto. Tomas	8,946	8.3	1,636	1,585	1077.8	5.5	5.6
Sison	25,053	97.7	4,777	4,553	256.4	5.2	5.5
Sual	15,796	150.3	3,022	3,006	105.1	5.2	5.3
Tayug	26,273	51.3	4,977	4,972	512.1	5.3	5.3
Umingan	41,364	264.6	7,380	7,268	156.3	5.6	5.7
Urbiztondo	27,348	81.8	4,615	4,593	334.3	5.9	6.0
Urdaneta	71,796	121.0	13,014	12,823	593.4	5.5	5.6
Villasis	39,126	75.8	7,232	7,091	516.2	5.4	5.5
Laoac *	19,252	40.5	3,587	3,542	475.4	5.4	5.4

* Created municipality March 5, 1979 under Batas Pambansa Blg. 18; taken from Manaoag.

Table 2.3 (3/5) POPULATION, DENSITY, HOUSEHOLD SIZE AND DWELLING OCCUPANCY BY MUNICIPALITY: 1980

Administration	Population (persons)	Land Area (km2)	Households (number)	Dwellings (number)	Density (persons/ km2)	Household Size (persons/ household)	Dwelling Occupancy (persons/ dwelling)
Region II							
Ifugao	111,368	2,517.8	23,016	22,971	44.2	4.8	4.8
Banawe	22,900	326.4	5,221	5,185	70.2	4.4	4.4
Hungduan	9,857	260.3	1,973	1,950	37.9	5.0	5.1
Kiangan	17,481	443.3	3,407	3,598	39.4	5.1	4.9
Lagawe	15,075	432.1	3,438	3,398	34.9	4.4	4.4
Lamut	11,017	104.6	2,077	2,055	105.3	5.3	5.4
Mayuyao	24,022	540.9	4,849	4,763	44.4	5.0	5.0
Potia	11,016	410.2	2,051	2,022	26.9	5.4	5.4
Nueva Vizcaya	241,690	3,903.9	45,029	44,861	61.9	5.4	5.4
Ambaguio	3,856	185.6	785	785	20.8	4.9	4.9
Aritao	22,004	265.6	3,968	3,968	82.8	5.5	5.5
Bagabag	20,855	183.9	3,786	3,786	113.4	5.5	5.5
Bambang	26,204	345.0	4,778	4,778	76.0	5.5	5.5
Bayombong	32,066	136.0	6,204	6,204	235.8	5.2	5.2
Diadi	8,605	181.2	1,675	1,656	47.5	5.1	5.2
Dupax del Norte	16,743	347.3	3,177	3,135	48.2	5.3	5.3
Dupax del Sur	9,632	374.7	1,756	1,755	25.7	5.5	5.5
Kasiba	15,029	318.8	3,020	3,001	47.1	5.0	5.0
Kayapa	20,491	482.9	3,727	3,640	42.4	5.5	5.6
Quezon	9,716	176.2	1,786	1,786	55.1	5.4	5.4
Sta. Fe	6,338	310.0	1,164	1,164	20.4	5.4	5.4
Solana	36,710	139.8	6,759	6,759	262.6	5.4	5.4
Villa Verde (Ibung)	10,644	81.5	1,904	1,904	130.6	5.6	5.6
Alfonso Castaneda *	2,797	375.4	540	540	7.5	5.2	5.2

* Created municipality April 20, 1979 under Batas Pambansa Blg. 27; taken from Dupax del Sur.

Table 2.3 (4/5) POPULATION, DENSITY, HOUSEHOLD SIZE AND DWELLING OCCUPANCY BY MUNICIPALITY: 1980

Administration	Population (persons)	Land Area (km2)	Households (number)	Dwellings (number)	Density (persons/ km2)	Household Size (persons/ household)	Dwelling Occupancy (persons/ dwelling)
Region III							
Nueva Ecija	1,069,409	5,284.3	186,489	185,444	202.4	5.7	5.8
Cabanatuan City	138,298	192.7	24,057	23,935	717.7	5.7	5.8
Palayan City	14,959	35.6	2,422	2,422	420.2	6.2	6.2
San Jose City	64,254	180.5	11,818	11,660	356.0	5.4	5.5
Aliaga	32,349	115.6	5,672	5,571	279.8	5.7	5.8
Bongabon	32,451	260.2	5,516	5,496	124.7	5.9	5.9
Cabiao	37,922	112.5	6,009	6,009	337.1	6.3	6.3
Carranglaan	19,891	751.2	3,652	3,645	26.5	5.4	5.5
Cuyapo	39,654	167.5	7,662	7,584	236.7	5.2	5.2
Gabaldon	17,169	228.2	3,001	2,998	75.2	5.7	5.7
Gapan	60,014	134.2	10,026	9,927	447.2	6.0	6.0
Gen.M. Natividad	17,388	95.1	2,979	2,969	182.8	5.8	5.9
Gen. Tinio	23,406	682.3	3,845	3,821	34.3	6.1	6.1
Guimba	58,847	94.5	10,749	10,612	622.7	5.5	5.5
Jaen	39,064	95.6	6,607	6,604	408.6	5.9	5.9
Laur	17,729	57.5	3,140	3,132	308.3	5.6	5.7
Licab	14,543	56.3	2,566	2,561	258.3	5.7	5.7
Llanera	18,652	118.0	3,335	3,297	158.1	5.6	5.7
Lupao	23,050	151.7	4,154	4,133	151.9	5.5	5.6
Munoz	43,211	231.3	7,416	7,346	186.8	5.8	5.9
Nampicuan	7,597	52.6	1,361	1,337	144.4	5.6	5.7
Pantabangan	13,916	376.6	2,534	2,534	37.0	5.5	5.5
Penaranda	16,753	94.2	2,910	2,910	177.8	5.8	5.8
Quezon	20,846	75.1	3,621	3,616	277.6	5.8	5.8
Rizal	31,407	158.8	5,546	5,544	197.8	5.7	5.7
San Antonio	42,969	171.7	7,490	7,483	250.3	5.7	5.7
San Isidro	28,550	56.4	4,941	4,871	506.2	5.8	5.9
San Leonardo	34,706	60.1	5,727	5,742	577.5	6.1	6.0
Sta. Rosa	32,424	144.2	5,587	5,587	224.9	5.8	5.8
Sto. Domingo	29,013	74.9	5,069	5,066	387.4	5.7	5.7
Talavera	62,225	111.8	10,464	10,425	556.6	5.9	6.0
Talugtog	11,734	51.8	2,291	2,291	226.5	5.1	5.1
Zaragoza	24,418	95.6	4,322	4,316	255.4	5.6	5.7
Pampanga							
Mabalacat	80,966	152.6	13,236	13,164	530.6	6.1	6.2

Table 2.3 (5/5) POPULATION, DENSITY, HOUSEHOLD SIZE AND DWELLING OCCUPANCY BY MUNICIPALITY: 1980

Administration	Population (persons)	Land Area (km2)	Households (number)	Dwellings (number)	Density (persons/ km2)	Household Size (persons/ household)	Dwelling Occupancy (persons/ dwelling)
Tarlac	688,457	3,053.4	122,474	119,483	225.5	5.6	5.8
Anao	6,519	23.9	1,192	1,184	272.8	5.5	5.5
Bamban	26,072	133.1	4,114	4,114	195.9	6.3	6.3
Camiling	53,860	140.5	10,497	10,364	383.3	5.1	5.2
Capas	46,523	440.0	7,513	7,442	105.7	6.2	6.3
Concepcion	80,647	245.7	12,936	12,627	328.2	6.2	6.4
Gerona	50,433	141.4	9,249	9,189	356.7	5.5	5.5
La Paz	35,330	114.3	5,997	5,902	309.1	5.9	6.0
Mayantoc	17,135	354.6	3,257	3,248	48.3	5.3	5.3
Moncada	34,451	85.7	6,058	5,971	402.0	5.7	5.8
Paniqui	55,006	105.2	9,990	9,910	522.9	5.5	5.6
Pura	14,801	31.0	2,598	2,590	477.5	5.7	5.7
Ramos	11,215	24.4	2,020	2,006	459.6	5.6	5.6
San Clemente	7,117	48.6	1,386	1,381	146.4	5.1	5.2
San Manuel	13,491	42.1	2,364	2,354	320.5	5.7	5.7
Santa Ignacia	25,224	75.4	4,726	4,696	334.5	5.3	5.4
Tarlac	175,691	936.0	29,931	29,873	187.7	5.9	5.9
Victoria	34,942	111.5	8,646	6,632	313.4	4.0	5.3
Zambales	444,037	3,714.4	87,034	85,323	119.5	5.1	5.2
Olongapo City	156,430	103.3	32,641	32,350	1514.3	4.8	4.8
Botolan	27,125	613.7	5,026	4,992	44.2	5.4	5.4
Cabangan	11,636	239.4	2,914	2,307	48.6	4.0	5.0
Candelaria	15,686	437.6	2,786	2,520	35.8	5.6	6.2
Castillejos	19,154	86.5	3,622	3,620	221.4	5.3	5.3
Iba	22,791	153.4	4,028	3,902	148.6	5.7	5.8
Masinloc	27,735	256.0	4,915	4,801	108.3	5.6	5.8
Palaing	17,176	310.0	2,933	2,903	55.4	5.9	5.9
San Antonio	22,382	205.0	4,516	4,461	109.2	5.0	5.0
San Felipe	13,834	103.7	2,706	2,610	133.4	5.1	5.3
San Marcelino	24,964	440.9	4,980	4,952	56.6	5.0	5.0
San Narciso	19,119	71.6	3,784	3,749	267.0	5.1	5.1
Sta. Cruz	35,665	414.1	6,482	6,454	86.1	5.5	5.5
Subic	30,340	279.2	5,701	5,702	108.7	5.3	5.3

Sources of Basic Data:

1. "Special Report No. 2 - 1980 Census of Population by Municipality and Barangay." National Statistics Office
2. "Special Report No. 3 - Philippines 1980 : Population,Land Area and Density 1970,1975 and 1980." National Statistics Office
3. "Special Report No. 5 - 1980 Census of Population and Housing : Housing Characteristics of Occupied Dwelling Units by Region, Province, City and Municipality." National Statistics Office

Table 2.4 (1/2) PROJECTED POPULATION IN THE STUDY AREA BY MUNICIPALITY: 1985-2030

Province/ Municipality	Projected Population										Land Area (km2)	Density (persons/km2)		
	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030		2010	2020	2030
Benguet														
Baguio City	27,652	31,673	35,688	39,447	42,856	45,851	48,634	51,379	53,872	55,900	14.7	3119	3495	3803
Atok	344	403	463	521	576	625	672	718	760	795	2.7	232	266	294
Bokod	12,733	14,173	15,555	16,786	17,846	18,726	19,527	20,327	21,050	21,622	404.0	46	50	54
Buguias	16,184	18,444	20,685	22,766	24,639	26,270	27,781	29,272	30,625	31,721	115.9	227	253	274
Itogon	53,216	59,932	66,484	72,430	77,709	82,191	86,303	90,381	94,070	97,026	415.2	198	218	234
Kabayan	8,386	9,557	10,718	11,796	12,766	13,668	14,394	15,167	15,868	16,435	142.0	96	107	116
La Trinidad	1,353	1,570	1,790	1,999	2,193	2,367	2,530	2,691	2,837	2,957	2.5	947	1076	1183
Tuba	18,004	20,964	23,980	26,874	29,562	31,982	34,258	36,499	38,546	40,230	157.2	203	232	256
Tublay	2,238	2,551	2,861	3,149	3,408	3,633	3,842	4,048	4,235	4,387	17.0	214	238	258
Sub Total	140,109	159,266	178,223	195,788	211,556	225,314	237,941	250,482	261,863	271,073	1271.2	177	197	213
La Union														
Pugo	2,608	2,904	3,207	3,498	3,767	4,004	4,228	4,458	4,679	4,869	9.1	440	490	535
Rosario	27,094	31,105	35,318	39,521	43,552	47,260	50,820	54,436	57,886	60,899	48.0	985	1134	1269
Sto. Tomas	250	276	302	326	349	368	387	406	424	440	0.6	614	676	733
Sub Total	29,952	34,285	38,826	43,345	47,668	51,633	55,435	59,300	62,989	66,208	57.7	895	1028	1147
Pangasinan														
Dagupan City	107,087	116,211	125,465	134,369	142,317	148,752	154,392	160,099	165,484	169,983	37.2	3999	4304	4569
San Carlos City	110,244	119,636	129,163	138,330	146,513	153,137	158,943	164,819	170,362	174,994	166.4	920	990	1052
Aguilar	24,226	26,476	28,770	30,994	33,003	34,659	36,125	37,596	38,980	40,140	152.9	227	246	263
Alcala	27,215	29,534	31,885	34,148	36,168	37,804	39,237	40,687	42,056	43,199	36.5	1036	1115	1184
Asingan	39,387	41,543	43,694	45,692	47,362	48,559	49,553	50,636	51,696	52,569	66.6	729	760	789
Balungao	18,884	20,493	22,124	23,695	25,096	26,231	27,226	28,232	29,182	29,975	93.8	280	301	320
Basista	18,719	20,314	21,932	23,488	24,878	26,003	26,986	27,986	28,927	29,714	15.6	1667	1794	1905
Bautista	19,726	21,454	23,210	24,903	26,420	27,656	28,743	29,840	30,873	31,737	126.3	219	236	251
Bayambang	69,730	75,671	81,697	87,495	92,670	96,860	100,533	104,249	107,736	110,685	73.2	1288	1386	1472
Binalonan	37,849	40,201	42,555	44,762	46,545	48,051	49,299	50,498	51,711	52,715	77.6	619	651	679
Binmaley	51,540	55,931	60,385	64,671	68,496	71,593	74,307	77,054	79,646	81,811	61.2	1170	1259	1337
Bugallon	42,480	46,464	50,528	54,472	58,040	60,988	63,599	66,218	68,680	70,744	167.6	364	395	422
Calasiao	53,582	59,383	65,365	71,250	76,679	81,297	85,467	89,574	93,440	96,700	53.4	1522	1677	1811
Infanta	134	146	157	168	178	186	193	201	207	213	29.7	6	7	7
Labrador	11,747	12,617	13,494	14,327	15,057	15,629	16,122	16,629	17,112	17,513	47.4	330	351	369
Lingayen	70,982	77,030	83,164	89,066	94,335	98,600	102,338	106,121	109,691	112,673	67.7	1456	1568	1664
Mabini	174	189	204	218	231	242	252	260	269	276	4.7	51	55	59
Malasiqui	77,209	83,787	90,459	96,879	102,609	107,249	111,315	115,430	119,312	122,556	127.0	844	909	965
Mangaldan	41,448	46,475	51,708	56,919	61,801	66,044	69,902	73,722	77,297	80,327	27.2	2428	2710	2953
Mangaldan	55,281	60,358	65,531	70,541	75,060	78,779	82,064	85,366	88,472	91,074	44.8	1758	1905	2033
Mangatarem	44,247	48,074	51,959	55,702	59,050	61,770	64,158	66,570	68,854	70,747	317.6	194	210	223
Mapandan	21,580	23,745	25,635	27,455	29,079	30,394	31,546	32,712	33,812	34,732	30.0	1013	1090	1158
Natividad	16,324	17,442	18,563	19,623	20,540	21,244	21,845	22,472	23,071	23,568	76.8	277	293	307
Pozzorubio	41,577	45,037	48,542	51,909	54,903	57,315	59,424	61,563	63,584	65,270	134.6	426	457	485
Rosales	39,834	43,228	46,670	49,983	52,939	55,333	57,431	59,554	61,557	63,230	68.4	809	871	924
San Fabian	32,028	34,756	37,524	40,187	42,564	44,489	46,176	47,882	49,493	50,838	42.5	1047	1127	1196
San Jacinto	22,496	24,465	26,465	28,394	30,122	31,530	32,767	34,015	35,192	36,176	39.1	806	870	925
San Manuel	32,219	34,927	37,672	40,310	42,660	44,557	46,217	47,900	49,488	50,815	133.7	333	358	380
San Nicolas	26,895	26,607	28,326	29,951	31,350	32,439	33,363	34,325	35,245	36,008	210.2	154	163	171
San Quintin	22,391	24,004	25,628	27,168	28,510	29,555	30,454	31,382	32,266	33,000	115.9	255	271	285
Sta. Barbara	40,268	43,677	47,132	50,456	53,419	55,815	57,914	60,039	62,044	63,720	77.4	721	776	823
Sta. Maria	20,709	22,473	24,263	25,985	27,522	28,766	29,857	30,960	32,002	32,872	69.5	414	445	473
Sto. Tomas	9,575	10,227	10,882	11,500	12,034	12,444	12,794	13,159	13,507	13,797	8.3	1499	1585	1662
Sison	27,078	29,183	31,308	33,337	35,124	36,542	37,771	39,029	40,220	41,213	97.7	374	399	422
Tayug	28,274	30,351	32,442	34,429	36,166	37,524	38,694	39,900	41,047	42,001	51.3	731	778	819
Umingan	44,591	48,390	52,243	55,951	59,260	61,940	64,289	66,666	68,907	70,781	259.3	239	257	273
Urbiztondo	30,598	34,049	37,618	41,146	44,417	47,222	49,753	52,265	54,618	56,606	81.6	579	641	694
Urdaneta	79,375	87,357	95,540	103,534	110,833	116,953	122,410	127,860	132,972	137,271	121.0	967	1057	1134
Villasis	42,912	46,879	50,924	54,843	58,381	61,297	63,875	66,464	68,899	70,940	75.8	809	877	936
Laoac	21,630	24,163	26,792	29,400	31,831	33,931	35,833	37,718	39,483	40,976	40.5	838	931	1012
Sub Total	1,520,544	1,652,947	1,787,618	1,917,650	2,034,263	2,129,378	2,213,148	2,297,652	2,377,414	2,444,160	3530.0	603	651	692
Ifugao														
Banaue	257	287	318	349	377	401	422	445	466	484	6.5	62	68	74
Hungduan	2,158	2,358	2,563	2,758	2,932	3,073	3,197	3,327	3,452	3,560	78.1	39	43	46
Kiangan	1,942	2,152	2,367	2,578	2,769	2,928	3,072	3,220	3,361	3,482	66.5	44	48	52
Sub Total	4,356	4,797	5,248	5,684	6,078	6,402	6,692	6,991	7,278	7,526	151.1	42	46	50
Nueva Vizcaya														
Kayapa	8,776	9,328	9,838	10,270	10,609	10,851	11,072	11,344	11,636	11,911	144.9	75	78	82
Sta. Fe	725	819	913	1,003	1,085	1,157	1,224	1,294	1,363	1,453	124.0	9	10	12
Sub Total	9,501	10,147	10,751	11,274	11,695	12,008	12,296	12,638	12,999	13,364	268.9	45	47	50

Table 2.4 (2/2) PROJECTED POPULATION IN THE STUDY AREA BY MUNICIPALITY: 1985-2030

Province/ Municipality	Projected Population										Land Area	Density (persons/km2)		
	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	(km2)	2010	2020	2030
Nueva Ecija														
Carranglan	2,216	2,451	2,690	2,918	3,125	3,298	3,454	3,607	3,750	3,872	112.7	29	32	34
Cuyapo	43,292	47,888	52,549	57,016	61,045	64,433	67,473	70,475	73,269	75,640	164.2	392	429	461
Guimba	13,069	14,413	15,772	17,070	18,235	19,208	20,078	20,939	21,740	22,420	37.8	508	554	593
Lupao	2,549	2,800	3,054	3,294	3,509	3,686	3,844	4,001	4,148	4,271	45.5	81	88	94
Nampicuan	8,416	9,261	10,114	10,926	11,653	12,256	12,795	13,318	13,826	14,247	52.6	233	253	271
Sub Total	69,541	76,813	84,178	91,225	97,566	102,881	107,644	112,350	116,733	120,451	412.8	249	272	292
Pampanga														
Mabalacat	944	1,091	1,248	1,406	1,557	1,693	1,819	1,943	2,059	2,158	30.5	55	64	71
Sub Total	944	1,091	1,248	1,406	1,557	1,693	1,819	1,943	2,039	2,158	31	55	64	71
Tarlac														
Anao	7,145	7,782	8,411	9,002	9,520	9,935	10,292	10,638	10,953	11,211	23.9	416	445	469
Bamban	2,921	3,245	3,572	3,888	4,175	4,416	4,630	4,835	5,022	5,177	79.9	55	61	65
Camiling	56,990	60,060	62,991	65,599	67,677	69,081	70,179	71,328	72,403	73,252	140.5	492	508	521
Capas	10,308	11,334	12,360	13,338	14,210	14,928	15,554	16,158	16,708	17,159	352.0	42	46	49
Gerona	55,667	61,003	66,321	71,366	75,840	79,488	82,655	85,717	88,501	90,786	141.4	562	606	642
Mayantoc	18,566	19,999	21,402	22,702	23,813	24,670	25,391	26,100	26,747	27,271	347.5	71	75	78
Moncada	37,617	41,193	44,754	48,130	51,119	53,552	55,662	57,702	59,557	61,080	85.7	625	673	713
Paniqui	58,735	62,420	65,975	69,192	71,840	73,748	75,296	76,851	78,305	79,459	105.2	701	731	755
Pura	16,045	17,292	18,514	19,643	20,614	21,363	21,994	22,614	23,179	23,638	31.0	689	729	763
Ramos	12,185	13,159	14,116	15,005	15,770	16,365	16,870	17,363	17,814	18,179	26.4	671	712	745
San Clemente	7,821	8,535	9,244	9,913	10,501	10,975	11,385	11,781	12,142	12,437	48.6	226	242	256
San Manuel	14,825	16,179	17,523	18,790	19,906	20,805	21,581	22,332	23,016	23,576	42.1	494	530	560
Santa Ignacia	27,718	30,250	32,762	35,132	37,218	38,899	40,349	41,755	43,033	44,080	75.4	516	554	585
Tarlac	137,521	152,525	167,663	182,247	195,444	206,520	216,295	225,705	234,259	241,537	842.4	245	268	286
Victoria	3,749	4,002	4,247	4,470	4,657	4,795	4,908	5,021	5,126	5,209	33.5	143	150	155
Sub Total	467,813	508,977	549,855	588,419	622,303	649,540	673,040	695,910	716,765	733,851	2373.5	274	293	309
Zambales														
Botolan	296	320	343	363	378	390	400	409	417	422	30.7	13	13	14
Candelaria	180	204	229	251	272	289	305	320	332	342	87.5	3	4	4
Masinloc	325	376	427	477	523	564	601	636	667	691	25.6	22	25	27
Palauig	194	216	238	258	276	291	303	315	326	333	3.1	94	101	107
Sta. Cruz	415	477	540	600	656	704	748	789	825	853	62.1	11	13	14
Sub Total	1,410	1,594	1,777	1,950	2,105	2,238	2,357	2,469	2,567	2,641	209.0	11	12	13
STUDY Area														
Total	2244171	2449917	2637723	2858741	3034790	3181086	3310373	3439736	3560666	3661431	8304.7	383	414	441
Average Annual Growth Rate (%)	1.86	1.77	1.64	1.45	1.22	0.95	0.80	0.77	0.69	0.56				
Region I														
Population	3901587	4291931	4689960	5072984	5421838	5720643	5995381	6275399	6541712	6770355				
AAGR (%)	1.96	1.92	1.79	1.58	1.34	1.08	0.94	0.92	0.83	0.69				
Region II														
Population	2520974	2846695	3182116	3517946	3834664	4116473	4382957	4657053	4923946	5163957				
AAGR (%)	2.62	2.45	2.27	2.03	1.74	1.43	1.26	1.22	1.12	0.96				
Region III														
Population	5456140	6141618	6844231	7528875	8162034	8713196	9214615	9700778	10143410	10509601				
AAGR (%)	2.58	2.40	2.19	1.93	1.63	1.32	1.13	1.03	0.90	0.71				
Philippines														
Population	54668332	61480180	68424077	75223853	81590921	87206449	92429710	97681831	102686370	107123873				
AAGR (%)	2.59	2.38	2.16	1.91	1.64	1.34	1.17	1.11	1.00	0.85				

Source of Basic Data: "Philippine Population Projections 1980-2030"
Medium Assumptions: Moderate Fertility Decline and Moderate Mortality Decline
National Economic and Development Authority

Table 2.5 PROJECTED POPULATION IN THE INUNDATED AREA BY MUNICIPARITY 1989-2030

Province/ Municipality	Projected Population										Land Area (km2)	Population Density (persons/km2)	
	1989	1990	1995	2000	2005	2010	2015	2020	2025	2030		1989	2030
La Union													
Rosario	30,258	31,105	35,318	39,521	43,552	47,260	50,820	54,436	57,886	60,899	10	3,026	6,090
Pangasinan													
Aguilar	13,979	14,218	15,449	16,644	17,723	18,612	19,399	20,189	20,932	21,553	24	582	898
Alcala	29,053	29,534	31,885	34,148	36,168	37,808	39,237	40,687	42,056	43,199	36	807	1,200
Asingan	41,103	41,543	43,694	45,692	47,362	48,589	49,533	50,636	51,698	52,569	67	613	785
Balungao	10,189	10,349	11,173	11,966	12,673	13,247	13,749	14,257	14,737	15,137	38	268	398
Bautista	19,984	20,314	21,932	23,488	24,878	26,003	26,988	27,986	28,927	29,714	16	1,249	1,857
Bayambang	21,097	21,454	23,210	24,903	26,420	27,656	28,743	29,840	30,873	31,737	87	242	365
Binalonan	68,743	69,844	75,406	80,758	85,534	89,402	92,792	96,222	99,459	102,162	70	982	1,459
Binmaley	34,643	35,055	37,108	39,032	40,674	41,900	42,989	44,034	45,092	45,967	61	568	754
Bugallon	54,312	55,204	59,600	63,850	67,606	70,662	73,341	76,052	78,611	80,747	62	876	1,302
Calasiao	15,400	15,658	17,028	18,357	19,559	20,553	21,433	22,315	23,145	23,841	29	531	822
Labrador	131	139	148	158	166	172	177	183	188	193	2	66	97
Laoac	23,634	24,163	26,792	29,400	31,831	33,931	35,833	37,718	39,483	40,976	41	576	999
Lingayen	75,264	76,491	82,582	88,443	93,675	97,910	101,622	105,378	108,923	111,884	58	1,298	1,929
Malasiqui	57,714	58,651	63,321	67,815	71,826	75,074	77,921	80,801	83,518	85,789	92	627	932
Manaoag	39,831	40,759	45,348	49,918	54,199	57,921	61,304	64,654	67,789	70,447	19	2,096	3,708
Mangaldan	56,114	57,099	61,992	66,732	71,007	74,525	77,633	80,756	83,695	86,136	45	1,247	1,915
Mangatarem	11,310	11,682	12,626	13,536	14,349	15,010	15,590	16,177	16,732	17,192	58	198	296
Mapandan	23,360	23,745	25,635	27,455	29,079	30,394	31,546	32,712	33,812	34,732	30	779	1,158
Natividad	10,531	10,675	11,361	12,009	12,570	13,001	13,369	13,753	14,119	14,424	15	702	962
Pozzorubio	19,826	20,132	21,698	23,203	24,542	25,620	26,563	27,519	28,422	29,176	32	620	912
Rosales	32,666	33,199	35,843	38,387	40,657	42,496	44,107	45,737	47,276	48,561	48	681	1,012
San Fabian	1,366	1,390	1,501	1,607	1,703	1,780	1,847	1,915	1,980	2,034	12	114	170
San Jacinto	19,362	19,694	21,304	22,857	24,248	25,382	26,377	27,382	28,330	29,122	28	692	1,040
San Manuel	22,082	22,458	24,223	25,919	27,430	28,650	29,718	30,800	31,821	32,674	52	425	628
San Nicolas	8,496	8,621	9,178	9,704	10,157	10,510	10,810	11,121	11,419	11,687	20	425	583
San Quintin	13,103	13,298	14,198	15,051	15,795	16,373	16,872	17,386	17,875	18,282	24	546	762
Sta. Barbara	39,151	39,790	42,937	45,965	48,665	50,847	52,760	54,696	56,522	58,049	69	567	841
Sta. Maria	22,109	22,473	24,263	25,985	27,522	28,766	29,857	30,960	32,002	32,872	69	320	476
Sto. Tomas	10,093	10,227	10,882	11,500	12,034	12,444	12,794	13,159	13,507	13,797	8	1,262	1,725
Sison	6,909	7,004	7,514	8,001	8,430	8,770	9,065	9,367	9,653	9,891	12	576	824
Tayug	29,924	30,351	32,442	34,429	36,166	37,524	38,694	39,900	41,047	42,001	51	587	824
Umingan	19,670	19,983	21,576	23,108	24,474	25,581	26,551	27,533	28,459	29,233	37	532	790
Urbiztondo	33,329	34,049	37,618	41,146	44,417	47,222	49,753	52,265	54,618	56,606	82	406	690
Urdaneta	79,200	80,718	88,279	95,665	102,410	108,065	113,107	118,143	122,866	126,838	111	714	1,143
Villasis	38,111	38,769	42,114	45,335	48,281	50,693	52,823	54,966	56,979	58,667	60	635	978
Dagupan City	111,196	113,073	122,077	130,741	138,474	144,736	150,223	155,776	161,016	165,393	38	2,926	4,352
San Carlos City	117,696	119,636	129,163	138,330	146,513	153,137	158,943	164,819	170,362	174,994	167	705	1,048
Tarlac													
Anao	7,650	7,782	8,411	9,002	9,520	9,935	10,292	10,638	10,953	11,211	24	319	467
Camiling	37,381	37,778	39,621	41,262	42,569	43,452	44,143	44,865	45,541	46,076	90	415	512
Gerona	42,641	43,434	47,221	50,813	53,998	56,595	58,850	61,031	63,013	64,640	76	561	851
Moncada	40,452	41,193	44,754	48,130	51,119	53,552	55,662	57,702	59,557	61,080	86	470	710
Paniqui	14,187	14,357	15,174	15,914	16,523	16,962	17,318	17,678	18,010	18,276	87	163	210
Pura	14,456	14,664	15,700	16,659	17,481	18,116	18,651	19,177	19,656	20,045	23	628	872
Ramos	12,958	13,159	14,116	15,005	15,770	16,365	16,870	17,363	17,814	18,179	25	518	727
San Clemente	3,509	3,568	3,864	4,144	4,389	4,588	4,759	4,924	5,075	5,199	13	270	400
San Manuel	15,899	16,179	17,523	18,790	19,906	20,805	21,581	22,332	23,016	23,576	42	379	561
Sta. Ignacia	1,486	1,512	1,638	1,757	1,861	1,945	2,017	2,088	2,152	2,204	4	372	551
Tarlac	23,134	23,641	25,988	28,248	30,294	32,011	33,526	34,984	36,310	37,407	35	661	1,069
Victoria	119	120	127	134	140	144	147	151	154	156	1	119	156
Nueva Ecija													
Cuyapo	14,559	14,843	16,290	17,675	18,924	19,974	20,917	21,847	22,713	23,448	51	285	460
Guimba	989	1,009	1,104	1,195	1,276	1,343	1,405	1,466	1,522	1,569	21	47	75
Nampicuan	9,085	9,261	10,114	10,926	11,653	12,256	12,795	13,328	13,826	14,247	53	171	269
Total for the Inundated Area	1,537,821	1,586,434	1,715,428	1,841,662	1,954,871	2,047,534	2,129,285	2,211,378	2,288,579	2,353,190	2,465	632	955
Average Annual Growth Rate (%/yr)			1990-95 1.60	1995-2000 1.43	2000-05 1.20	2005-10 0.93	2010-15 0.79	2015-20 0.76	2020-25 0.69	2025-30 0.56			

Table 2.6 GROWTH RATES OF GROSS DOMESTIC PRODUCT, PHILIPPINES AND REGION I: 1972-1982

Year	Philippines		Region 1 : Ilocos	
	GDP at Constant 1972 Prices (million pesos)	Annual Growth Rate (%)	GDP at Constant 1972 Prices (million pesos)	Annual Growth Rate (%)
1972	56,464		na	
1973	60,931	7.91	na	
1974	64,139	5.26	na	
1975	68,437	6.70	2795	
1976	73,922	8.01	2821	0.93
1977	78,467	6.15	3009	6.66
1978	82,784	5.50	3076	2.23
1979	87,962	6.25	3371	9.59
1980	92,568	5.24	3500	3.83
1981	96,208	3.93	3769	7.69
1982	98,999	2.90	3983	5.68
Total		57.87		36.60
Average of Total		5.79		5.23
1972-1982 Compound Rate		5.78		
1975-1982 Compound Rate		5.42		5.19

na - data not available

Source of Basic Data: National Statistical Coordination Board

Table 2.7 PROJECTED GROSS DOMESTIC PRODUCT, PHILIPPINES:1989-2010

Year	Average Growth Rate (%/yr)	GDP at Constant 1972 Prices (million pesos)	Implicit Price Index (1972=100)	GDP at Current Prices (million pesos)	GDP at Constant 1989 Prices (million pesos)	Population (thousand persons)	Per Capita GDP (pesos/person) at Current Prices	at Constant 1972 Prices	at Constant 1989 Prices
1987	4.7	95,434	739.22	705,467	832,424	57,356	12,300	1,664	14,513
1988	6.6	101,759	807.64	821,840	887,587	58,721	13,996	1,733	15,115
1989	5.5	107,356	872.25	936,412	936,412	60,097	15,582	1,786	15,582
1990	6.8	114,626	928.95	1,064,815	999,826	61,480	17,320	1,864	16,263
1991	6.8	122,389	980.04	1,199,456	1,067,536	62,868	19,079	1,947	16,981
1992	6.8	130,677	1033.94	1,351,122	1,139,830	64,259	21,026	2,034	17,738
1993	6.8	139,526	1116.66	1,558,031	1,217,021	65,649	23,733	2,125	18,538
1994	6.8	148,975	1205.99	1,796,626	1,299,438	67,038	26,800	2,222	19,384
1995	6.8	159,064	1302.47	2,071,759	1,387,438	68,424	30,278	2,325	20,277
1996	6.9	170,036	1406.67	2,391,844	1,483,144	69,804	34,265	2,436	21,247
1997	6.9	181,766	1519.20	2,761,383	1,585,453	71,175	38,797	2,554	22,275
1998	6.9	194,304	1640.74	3,188,014	1,694,819	72,536	43,951	2,679	23,365
1999	6.9	207,707	1771.99	3,680,560	1,811,728	73,886	49,814	2,811	24,521
2000	6.9	222,033	1913.75	4,249,204	1,936,703	75,224	56,487	2,952	25,746
2001	7.2	238,117	2066.85	4,921,529	2,076,977	76,456	64,371	3,114	27,166
2002	7.2	255,364	2232.20	5,700,232	2,227,412	77,709	73,354	3,286	28,663
2003	7.2	273,859	2410.78	6,602,144	2,388,742	78,892	83,686	3,471	30,279
2004	7.2	293,695	2603.64	7,646,761	2,561,757	80,276	95,256	3,659	31,912
2005	7.2	314,967	2811.93	8,856,660	2,747,303	81,591	108,550	3,860	33,672
2006	8.0	340,296	3036.89	10,334,410	2,968,237	82,684	124,987	4,116	35,899
2007	8.0	367,862	3279.84	12,058,726	3,206,938	83,792	143,913	4,388	38,273
2008	8.0	397,229	3542.23	14,070,747	3,464,835	84,915	165,704	4,678	40,804
2009	8.0	429,174	3825.60	16,418,478	3,743,471	86,053	190,795	4,987	43,502
2010	8.0	463,687	4131.65	19,157,932	4,044,515	87,206	219,685	5,317	46,379

Note : GDP projections are for the "high growth" scenario.

Table 2.8 PROJECTED GROSS DOMESTIC PRODUCT, REGION I (ILOCOS):1989-2010

Year	Average Growth Rate (%/yr)	GDP at Constant 1972 Prices (million pesos)	Implicit Price Index (1972=100)	GDP at Current Prices (million pesos)	GDP at Constant 1989 Prices (million pesos)	Population (thousand persons)	Per Capita GDP (pesos/person) at Current Prices	at Constant 1972 Prices	at Constant 1989 Prices
1987	1.4	4,323	707.25	30,577	36,143	4,056	7,539	1,066	8,911
1988	4.3	4,507	774.06	34,888	37,679	4,133	8,441	1,090	9,117
1989	5.9	4,773	835.98	39,902	39,902	4,212	9,473	1,133	9,473
1990	5.9	5,055	890.32	45,003	42,257	4,292	10,486	1,178	9,846
1991	5.2	5,317	939.29	49,938	44,446	4,371	11,425	1,216	10,168
1992	5.2	5,592	990.95	55,414	46,748	4,452	12,447	1,256	10,500
1993	5.2	5,882	1070.23	62,947	49,170	4,531	13,893	1,298	10,852
1994	5.2	6,186	1155.85	71,504	51,717	4,611	15,507	1,342	11,216
1995	5.2	6,507	1248.31	81,225	54,396	4,690	17,319	1,387	11,598
1996	5.2	6,844	1348.18	92,267	57,214	4,768	19,351	1,435	11,999
1997	5.2	7,198	1456.03	104,811	60,177	4,846	21,628	1,485	12,418
1998	5.2	7,571	1572.52	119,060	63,295	4,923	24,184	1,538	12,857
1999	5.2	7,963	1698.32	135,245	66,573	4,998	27,060	1,593	13,320
2000	5.2	8,376	1834.18	153,631	70,022	5,073	30,284	1,651	13,803
2001	5.6	8,848	1980.92	175,267	73,966	5,141	34,092	1,721	14,387
2002	5.6	9,346	2139.39	199,950	78,132	5,210	38,378	1,794	14,997
2003	5.6	9,873	2310.54	228,109	82,533	5,280	43,202	1,870	15,631
2004	5.6	10,429	2495.39	260,234	87,181	5,350	48,642	1,949	16,296
2005	5.6	11,016	2695.02	296,882	92,092	5,422	54,757	2,032	16,985
2006	5.6	11,636	2910.62	338,692	97,279	5,481	61,794	2,123	17,748
2007	5.6	12,292	3143.47	386,390	102,758	5,540	69,746	2,219	18,548
2008	5.6	12,984	3394.95	440,806	108,546	5,599	78,729	2,319	19,387
2009	5.6	13,715	3666.54	502,884	114,659	5,660	88,849	2,423	20,258
2010	5.6	14,488	3959.87	573,705	121,117	5,721	100,287	2,533	21,172

Note : GDP projections are for the "high growth" scenario.

Table 2.9 PROJECTED GROSS DOMESTIC PRODUCT, STUDY AREA:1989-2010

Year	Average Growth Rate (%/yr)	GDP at Constant 1972 Prices (million pesos)	Implicit Price Index (1972=100)	GDP at Current Prices (million pesos)	GDP at Constant 1989 Prices (million pesos)	Population (thousand persons)	Per Capita GDP (pesos/person) at Current Prices	at Constant 1972 Prices	at Constant 1989 Prices
1987	1.4	2,477	707.25	17,521	20,709	2,324	7,539	1,066	8,911
1988	4.3	2,579	774.06	19,963	21,561	2,365	8,441	1,090	9,117
1989	5.9	2,728	835.98	22,802	22,802	2,407	9,473	1,133	9,473
1990	5.9	2,885	890.32	25,690	24,121	2,450	10,486	1,178	9,846
1991	5.2	3,029	939.29	28,449	25,320	2,490	11,425	1,216	10,168
1992	5.2	3,179	990.95	31,503	26,576	2,531	12,447	1,256	10,500
1993	5.2	3,339	1070.23	35,739	27,916	2,572	13,893	1,298	10,852
1994	5.2	3,508	1155.85	40,545	29,326	2,615	15,507	1,342	11,216
1995	5.2	3,687	1248.31	46,029	30,825	2,658	17,319	1,387	11,598
1996	5.2	3,870	1348.18	52,175	32,354	2,696	19,351	1,435	11,999
1997	5.2	4,063	1456.03	59,160	33,967	2,735	21,628	1,485	12,418
1998	5.2	4,268	1572.52	67,111	35,678	2,775	24,184	1,538	12,857
1999	5.2	4,486	1698.32	76,181	37,499	2,815	27,060	1,593	13,320
2000	5.2	4,717	1834.18	86,514	39,431	2,857	30,284	1,651	13,803
2001	5.6	4,976	1980.92	98,580	41,603	2,892	34,092	1,721	14,387
2002	5.6	5,250	2139.39	112,327	43,893	2,927	38,378	1,794	14,997
2003	5.6	5,539	2310.54	127,989	46,309	2,963	43,202	1,870	15,631
2004	5.6	5,845	2495.39	145,864	48,866	2,999	48,642	1,949	16,296
2005	5.6	6,166	2695.02	166,176	51,547	3,035	54,757	2,032	16,985
2006	5.6	6,504	2910.62	189,313	54,374	3,064	61,794	2,123	17,748
2007	5.6	6,862	3143.47	215,705	57,365	3,093	69,746	2,219	18,548
2008	5.6	7,240	3394.95	245,800	60,527	3,122	78,729	2,319	19,387
2009	5.6	7,637	3666.54	280,031	63,848	3,152	88,849	2,423	20,258
2010	5.6	8,056	3959.87	319,022	67,350	3,181	100,287	2,533	21,172

Note : GDP projections are for the "high growth" scenario. Per capita GDP of the Study Area is assumed to be the same as the per capita GDP of Region I.

Table 2.10 PROJECTED GROSS DOMESTIC PRODUCT, INUNDATION AREA:1989-2010

Year	Average Growth Rate (%/yr)	GDP at Constant 1972 Prices (million pesos)	Implicit Price Index (1972=100)	GDP at Current Prices (million pesos)	GDP at Constant 1989 Prices (million pesos)	Population (thousand persons)	Per Capita GDP (pesos/person) at Current Prices	at Constant 1972 Prices	at Constant 1989 Prices
1987	1.4	1,603	707.25	11,339	13,403	1,504	7,539	1,066	8,911
1988	4.3	1,669	774.06	12,921	13,955	1,531	8,441	1,090	9,117
1989	5.9	1,765	835.98	14,758	14,758	1,558	9,473	1,133	9,473
1990	5.9	1,866	890.32	16,614	15,600	1,584	10,486	1,178	9,846
1991	5.2	1,958	939.29	18,392	16,369	1,610	11,425	1,216	10,168
1992	5.2	2,054	990.95	20,358	17,174	1,636	12,447	1,256	10,500
1993	5.2	2,157	1070.23	23,086	18,033	1,662	13,893	1,298	10,852
1994	5.2	2,265	1155.85	26,182	18,937	1,688	15,507	1,342	11,216
1995	5.2	2,380	1248.31	29,709	19,896	1,715	17,319	1,387	11,598
1996	5.2	2,497	1348.18	33,671	20,879	1,740	19,351	1,435	11,999
1997	5.2	2,622	1456.03	38,171	21,916	1,765	21,628	1,485	12,418
1998	5.2	2,753	1572.52	43,292	23,015	1,790	24,184	1,538	12,857
1999	5.2	2,893	1698.32	49,132	24,185	1,816	27,060	1,593	13,320
2000	5.2	3,041	1834.18	55,773	25,420	1,842	30,284	1,651	13,803
2001	5.6	3,208	1980.92	63,540	26,815	1,864	34,092	1,721	14,387
2002	5.6	3,384	2139.39	72,386	28,286	1,886	38,378	1,794	14,997
2003	5.6	3,569	2310.54	82,464	29,836	1,909	43,202	1,870	15,631
2004	5.6	3,765	2495.39	93,961	31,478	1,932	48,642	1,949	16,296
2005	5.6	3,972	2695.02	107,042	33,204	1,955	54,757	2,032	16,985
2006	5.6	4,189	2910.62	121,923	35,019	1,973	61,794	2,123	17,748
2007	5.6	4,418	3143.47	138,893	36,938	1,991	69,746	2,219	18,548
2008	5.6	4,661	3394.95	158,242	38,966	2,010	78,729	2,319	19,387
2009	5.6	4,916	3666.54	180,244	41,096	2,029	88,849	2,423	20,258
2010	5.6	5,186	3959.87	205,341	43,350	2,048	100,287	2,533	21,172

Note : GDP projections are for the "high growth" scenario. Per capita GDP of the Inundated Area is assumed to be the same as the per capita GDP of Region I.

Table 2.11 EXPENDITURE ON GOVERNMENT INFRASTRUCTURE PROGRAM BY SECTOR, PHILIPPINES: 1974-1987

(In million pesos at current prices)

Sector\Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Power	250	1,038	2,064	3,681	3,389	5,702	6,332	7,111	7,977	11,946	7,271	7,811	5,126	4,313
Water Resources														
Water supply	61	83	219	281	311	319	578	1,033	1,349	999	1,337	1,632	1,844	774
Irrigation	118	801	583	846	935	1,659	1,701	1,834	1,892	1,581	1,440	1,143	535	1,865
Flood control	254	319	677	296	327	290	235	318	164	288	74	163	224	769
Transportation	1,333	1,896	2,177	2,260	1,721	2,268	2,232	3,016	4,457	3,176	2,876	2,137	3,794	3,507
Social Infrastructure	62	184	389	283	385	214	504	513	509	552	582	462	655	1,651
Communications	1	12	27	33	21	26	11	26	105	159	50	44	16	70
Others	100	353	443	347	246	377	175	95	82	84	22	0	3	906
Total	2,179	4,686	6,579	8,027	7,335	10,855	11,768	13,946	16,535	18,785	13,652	13,392	12,197	13,855

Source of Basic Data : annual Philippine Development Report, NEDA

Table 2.12 SHARE OF INFRASTRUCTURE IN GROSS DOMESTIC PRODUCT, PHILIPPINES: 1974-1987

Year	Infrastructure Expenditure at Current Prices (million pesos)	GDP at Current Prices (million pesos)	Implicit Price Index of Gross Value of Gov't Construction (1972=100)	Implicit Price Index of GDP (1972=100)	Infrastructure Expenditure at Constant 1989 Prices (million pesos)	GDP at Constant 1989 Prices (million pesos)	Infrastructure Expenditure Share of GDP (%)
1974	2,179	99,638	189.3	155.3	12,294	559,654	2.20
1975	4,686	114,697	190.4	167.6	26,285	596,958	4.40
1976	6,579	135,272	205.5	183.0	34,192	644,797	5.30
1977	8,027	154,226	221.7	196.5	38,669	684,638	5.65
1978	7,335	177,669	241.3	214.6	32,465	722,184	4.50
1979	10,855	217,543	288.8	247.3	40,142	767,338	5.23
1980	11,768	264,650	335.9	285.9	37,417	807,465	4.63
1981	13,946	305,258	381.8	317.3	39,011	839,195	4.65
1982	16,535	340,597	410.4	344.0	43,030	863,671	4.98
1983	18,785	384,096	451.5	384.4	44,435	871,610	5.10
1984	13,652	540,466	673.6	575.4	21,645	819,340	2.64
1985	13,392	612,665	798.3	681.6	17,916	784,078	2.29
1986	12,197	624,430	839.8	684.9	15,511	795,284	1.95
1987	13,855	705,467	896.1	739.2	16,513	832,493	1.98
1988		821,840	988.9	807.6		887,681	
1989			1068.0	872.3			

Sources of Basic Data:

1. Infrastructure expenditure data, annual Philippine Development Report, NEDA.
2. 1974-1988 GDP data, annual Philippine Statistical Yearbook, National Statistical Coordination Board.

Tabke 2.13 PROJECTED INVESTMENT REQUIREMENT OF THE GOVERNMENT INFRASTRUCTURE PROGRAM, INUNDATED AREA: 1990-2010

Year	Per Capita GDP at Constant 1989 Prices (Pesos)	Per Capita Infra Investment Req'ment at Constant 1989 Prices 1/ (Pesos)	Population (thousands)	Annual Infra Investment Requirement at Constant 1989 Prices (million pesos)	Cumulative Infra Investment Req'ment at Constant 1989 Prices (million pesos)
1990	9,846	492	1,584	780	780
1991	10,168	508	1,610	818	1,598
1992	10,500	525	1,636	859	2,457
1993	10,852	543	1,662	902	3,359
1994	11,216	561	1,688	947	4,306
1995	11,598	580	1,715	995	5,300
1996	11,999	600	1,740	1,044	6,344
1997	12,418	621	1,765	1,096	7,440
1998	12,857	643	1,790	1,151	8,591
1999	13,320	666	1,816	1,209	9,800
2000	13,803	690	1,842	1,271	11,071
2001	14,387	719	1,864	1,341	12,412
2002	14,997	750	1,886	1,414	13,826
2003	15,631	782	1,909	1,492	15,318
2004	16,296	815	1,932	1,574	16,892
2005	16,985	849	1,955	1,660	18,552
2006	17,748	887	1,973	1,751	20,303
2007	18,548	927	1,991	1,847	22,150
2008	19,387	969	2,010	1,948	24,098
2009	20,258	1,013	2,029	2,055	26,153
2010	21,172	1,059	2,048	2,168	28,321

1/ Estimated at 5% of per capita GDP.

Table 3.1 GROWTH RATES USED IN THE PROJECTION OF THE DAMAGEABLE VALUE OF TOTAL ASSETS IN THE INUNDATED AREA: 1989-2044

Scenario/Year		1989	1990	1991	2000	2001	2010	2044
1. High Growth	GDP Growth Rate (%/yr)	5.9	5.9	5.2	5.2	5.6	5.6	5.6
1.1 The region's damageable assets will increase at the same rate as the region's TARGETTED GDP growth rate.	Growth Factor	1.000	1.059	1.114	1.850	1.953	3.368	22.678
1.2 Agricultural products whose price is no longer acceptable to the producers will be replaced with crops having higher price.								
1.3 Increased diversification of crops will come about as a result of the irrigation of the remaining potential irrigable land.								
2. Low Growth	GDP Growth Rate (%/yr)	5.2	5.2	5.2	5.2	5.2	5.2	5.2
2.1 The region's damageable assets will increase at the same rate as the region's LIKELY GDP growth rate. This rate is taken from the actual performance of the region's economy during the period 1975-1982.	Growth Factor	1.000	1.052	1.107	1.837	1.933	3.209	18.920

Table 3.2 ECONOMIC COST, BENEFIT AND INTERNAL RATE OF RETURN OF THE ALTERNATIVE LONG TERM PLANS

	100 Year Flood (Million Pesos)	50 Year Flood (Million Pesos)	25 Year Flood (Million Pesos)	10 Year Flood (Million Pesos)
AGNO RIVER MAINSTREAM				
(1) Main Construction Cost	6,952	6,254	5,528	4,811
(2) Total Project Cost	10,340	9,400	8,394	7,413
(3) Benefit (Annual)	532	503	456	346
TARLAC RIVER				
(1) Main Construction Cost	897	792	713	612
(2) Total Project Cost	1,288	1,170	1,061	923
(3) Benefit (Annual)	45	42	37	26
AGNO TRIBUTARIES				
(1) Main Construction Cost		1,293	1,012	893
(2) Total Project Cost		1,925	1,506	1,330
(3) Benefit (Annual)		76	70	58
(4) EIRR		(2.1%) 14.0%	(3.1%) 15.5%	(2.7%) 14.9%
AGNO MAIN AND TARLAC RIVERS				
(1) Main Construction Cost	7,831	7,056	6,241	5,423
(2) Total Project Cost	11,628	10,570	9,455	8,336
(3) Benefit (Annual)	577	545	493	372
(4) EIRR		(3.8%) 16.5%	(3.9%) 16.6%	(2.8%) 15.1%
AGNO MAIN, TRIBUTARIES AND TARLAC RIVERS				
(1) Main Construction Cost		8,349	7,253	6,316
(2) Total Project Cost		12,495	10,961	9,666
(3) Benefit (Annual)		621	563	430
CAYANGA-PATALAN RIVER		with floodway	with floodway	with floodway
(1) Main Construction Cost		837	777	715
(2) Total Project Cost		1,246	1,159	1,066
(3) Benefit (Annual)		100	97	90
PANTOR-SINOCALAN RIVER		with floodway	with floodway	with floodway
(1) Main Construction Cost		1,715	1,546	1,319
(2) Total Project Cost		2,553	2,303	1,965
(3) Benefit (Annual)		406	400	381
ALLIED RIVERS		with floodway	with floodway	with floodway
(1) Main Construction Cost		2,552	2,323	2,027
(2) Total Project Cost		3,799	3,462	3,020
(3) Benefit (Annual)		506	497	471
(4) EIRR		(12.9%) 30.2%	(13.9%) 31.8%	(15.2%) 33.8%
AGNO MAIN, TARLAC, AND ALLIED RIVERS				
(1) Main Construction Cost		9,608	8,564	7,450
(2) Total Project Cost		14,369	12,917	11,356
(3) Benefit (Annual)		1,051	990	843
(4) EIRR		(6.4%) 20.4%	(6.9%) 21.0%	(6.6%) 20.6%
AGNO MAIN, TARLAC, TRIBUTARIES AND ALLIED RIVERS				
(1) Main Construction Cost		10,901	9,576	8,343
(2) Total Project Cost		16,294	14,423	12,686
(3) Benefit (Annual)		1,127	1,060	901
(4) EIIR		(6.0%) 19.7%	(6.5%) 20.5%	(6.2%) 20.0%

Remarks
a) Cost and benefit at constant 1989 prices.
b) Economic Internal Rate of Return (EIRR) in parentheses are for the case of current development level, i.e. constant benefit.
c) EIRR values without parentheses are for the case of future development level, i.e. increasing at the growth rate of the GDP of the inundated area under the "low growth" scenario.

Table 3.3 BENEFIT COST ANALYSIS:AGNO MAIN, TARLAC AND ALLIED RIVERS, 25 YEAR FLOOD, BENEFITS AT FUTURE DEVELOPMENT LEVEL

		MAIN CONST.	PHYSICAL CONT.	TOTAL COST	UNIT :mil.Pesos
CASE NO. LAA-25-25 Low Grouth					
RIVER IMPROVEMENT WORK		8564	1284.6	12917	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		990	mil. Pesos		
GROWTH FACTORS	2000	1.837			
	2010	3.209			
	2044	18.920			
CALCULATED EIRR		21.00%			

No.	Year	Cost Stream River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.076
2	1991					0.00	0.00	0.00	1.152
3	1992					0.00	0.00	0.00	1.228
4	1993					0.00	0.00	0.00	1.304
5	1994					0.00	0.00	0.00	1.380
6	1995	861.13	0.00	0.00		861.13	0.00	-861.13	1.457
7	1996	861.13	0.00	3.28		864.42	101.15	-763.26	1.533
8	1997	861.13	0.00	6.57		867.70	212.35	-655.35	1.609
9	1998	861.13	0.00	9.85		870.98	333.59	-537.39	1.685
10	1999	861.13	0.00	13.13		874.26	464.88	-409.38	1.761
11	2000	861.13		16.41	0.00	877.55	606.21	-271.34	1.837
12	2001	861.13		19.70	0.00	880.83	781.78	-99.05	1.974
13	2002	861.13		22.98	0.00	884.11	975.47	91.35	2.111
14	2003	861.13		26.26	0.00	887.40	1187.26	299.86	2.249
15	2004	861.13		29.55	0.00	890.68	1417.17	526.49	2.386
16	2005	861.13		32.83	0.00	893.96	1665.18	771.22	2.523
17	2006	861.13		36.11	0.00	897.24	1931.31	1034.06	2.660
18	2007	861.13		39.39	0.00	900.53	2215.54	1315.01	2.797
19	2008	861.13		42.68	0.00	903.81	2517.89	1614.08	2.935
20	2009	861.13		45.96	0.00	907.09	2838.34	1931.25	3.072
21	2010			49.24	0.00	49.24	3176.91	3127.67	3.209
22	2011			49.24	0.00	49.24	3634.38	3585.13	3.671
23	2012			49.24	0.00	49.24	4091.84	4042.60	4.133
24	2013			49.24	0.00	49.24	4549.31	4500.07	4.595
25	2014			49.24	0.00	49.24	5006.78	4957.54	5.057
26	2015			49.24	0.00	49.24	5464.25	5415.00	5.519
27	2016			49.24	0.00	49.24	5921.71	5872.47	5.982
28	2017			49.24	0.00	49.24	6379.18	6329.94	6.444
29	2018			49.24	0.00	49.24	6836.65	6787.41	6.906
30	2019			49.24	0.00	49.24	7294.12	7244.87	7.368
31	2020			49.24	0.00	49.24	7751.58	7702.34	7.830
32	2021			49.24	0.00	49.24	8209.05	8159.81	8.292
33	2022			49.24	0.00	49.24	8666.52	8617.28	8.754
34	2023			49.24	0.00	49.24	9123.99	9074.74	9.216
35	2024			49.24	0.00	49.24	9581.45	9532.21	9.678
36	2025			49.24	0.00	49.24	10038.92	9989.68	10.140
37	2026			49.24	0.00	49.24	10496.39	10447.14	10.602
38	2027			49.24	0.00	49.24	10953.86	10904.61	11.065
39	2028			49.24	0.00	49.24	11411.32	11362.08	11.527
40	2029			49.24	0.00	49.24	11868.79	11819.55	11.989
41	2030			49.24	0.00	49.24	12326.26	12277.01	12.451
42	2031			49.24	0.00	49.24	12783.72	12734.48	12.913
43	2032			49.24	0.00	49.24	13241.19	13191.95	13.375
44	2033			49.24	0.00	49.24	13698.66	13649.42	13.837
45	2034			49.24	0.00	49.24	14156.13	14106.88	14.299
46	2035			49.24	0.00	49.24	14613.59	14564.35	14.761
47	2036			49.24	0.00	49.24	15071.06	15021.82	15.223
48	2037			49.24	0.00	49.24	15528.53	15479.29	15.685
49	2038			49.24	0.00	49.24	15986.00	15936.75	16.147
50	2039			49.24	0.00	49.24	16443.46	16394.22	16.610
51	2040			49.24	0.00	49.24	16900.93	16851.69	17.072
52	2041			49.24	0.00	49.24	17358.40	17309.15	17.534
53	2042			49.24	0.00	49.24	17815.87	17766.62	17.996
54	2043			49.24	0.00	49.24	18273.33	18224.09	18.458
55	2044			49.24	0.00	49.24	18730.80	18681.56	18.920

Table 3.4 BENEFIT COST ANALYSIS:AGNO MAIN, TARLAC AND ALLIED RIVERS, 25 YEAR FLOOD, BENEFITS AT CURRENT DEVELOPMENT LEVEL

		MAIN	PHYSICAL TOTAL		
CASE NO. LAA-25-25 Constant Benefit		CONST.	CONT.	COST	UNIT :mil.Pesos
RIVER IMPROVEMENT WORK		8564	1284.6	12917	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		990	mil. Pesos		
GROWTH FACTORS	2000	1.000			
	2010	1.000			
	2044	1.000			
CALCULATED EIRR		6.85%			

No.	Year	Cost Stream River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.000
2	1991					0.00	0.00	0.00	1.000
3	1992					0.00	0.00	0.00	1.000
4	1993					0.00	0.00	0.00	1.000
5	1994					0.00	0.00	0.00	1.000
6	1995	861.13	0.00	0.00		861.13	0.00	-861.13	1.000
7	1996	861.13	0.00	3.28		864.42	66.00	-798.42	1.000
8	1997	861.13	0.00	6.57		867.70	132.00	-735.70	1.000
9	1998	861.13	0.00	9.85		870.98	198.00	-672.98	1.000
10	1999	861.13	0.00	13.13		874.26	264.00	-610.26	1.000
11	2000	861.13		16.41	0.00	877.55	330.00	-547.55	1.000
12	2001	861.13		19.70	0.00	880.83	396.00	-484.83	1.000
13	2002	861.13		22.98	0.00	884.11	462.00	-422.11	1.000
14	2003	861.13		26.26	0.00	887.40	528.00	-359.40	1.000
15	2004	861.13		29.55	0.00	890.68	594.00	-296.68	1.000
16	2005	861.13		32.83	0.00	893.96	660.00	-233.96	1.000
17	2006	861.13		36.11	0.00	897.24	726.00	-171.24	1.000
18	2007	861.13		39.39	0.00	900.53	792.00	-108.53	1.000
19	2008	861.13		42.68	0.00	903.81	858.00	-45.81	1.000
20	2009	861.13		45.96	0.00	907.09	924.00	16.91	1.000
21	2010			49.24	0.00	49.24	990.00	940.76	1.000
22	2011			49.24	0.00	49.24	990.00	940.76	1.000
23	2012			49.24	0.00	49.24	990.00	940.76	1.000
24	2013			49.24	0.00	49.24	990.00	940.76	1.000
25	2014			49.24	0.00	49.24	990.00	940.76	1.000
26	2015			49.24	0.00	49.24	990.00	940.76	1.000
27	2016			49.24	0.00	49.24	990.00	940.76	1.000
28	2017			49.24	0.00	49.24	990.00	940.76	1.000
29	2018			49.24	0.00	49.24	990.00	940.76	1.000
30	2019			49.24	0.00	49.24	990.00	940.76	1.000
31	2020			49.24	0.00	49.24	990.00	940.76	1.000
32	2021			49.24	0.00	49.24	990.00	940.76	1.000
33	2022			49.24	0.00	49.24	990.00	940.76	1.000
34	2023			49.24	0.00	49.24	990.00	940.76	1.000
35	2024			49.24	0.00	49.24	990.00	940.76	1.000
36	2025			49.24	0.00	49.24	990.00	940.76	1.000
37	2026			49.24	0.00	49.24	990.00	940.76	1.000
38	2027			49.24	0.00	49.24	990.00	940.76	1.000
39	2028			49.24	0.00	49.24	990.00	940.76	1.000
40	2029			49.24	0.00	49.24	990.00	940.76	1.000
41	2030			49.24	0.00	49.24	990.00	940.76	1.000
42	2031			49.24	0.00	49.24	990.00	940.76	1.000
43	2032			49.24	0.00	49.24	990.00	940.76	1.000
44	2033			49.24	0.00	49.24	990.00	940.76	1.000
45	2034			49.24	0.00	49.24	990.00	940.76	1.000
46	2035			49.24	0.00	49.24	990.00	940.76	1.000
47	2036			49.24	0.00	49.24	990.00	940.76	1.000
48	2037			49.24	0.00	49.24	990.00	940.76	1.000
49	2038			49.24	0.00	49.24	990.00	940.76	1.000
50	2039			49.24	0.00	49.24	990.00	940.76	1.000
51	2040			49.24	0.00	49.24	990.00	940.76	1.000
52	2041			49.24	0.00	49.24	990.00	940.76	1.000
53	2042			49.24	0.00	49.24	990.00	940.76	1.000
54	2043			49.24	0.00	49.24	990.00	940.76	1.000
55	2044			49.24	0.00	49.24	990.00	940.76	1.000

Table 3.5 BENEFIT COST ANALYSIS:AGNO MAIN, TARLAC, TRIBUTARIES AND ALLIED RIVERS, 25 YEAR FLOOD, BENEFITS AT FUTURE DEVELOPMENT LEVEL

		MAIN CONST.	PHYSICAL CONT.	TOTAL COST	UNIT :mil.Pesos
CASE NO. LAAT-25-25 Low Grouth					
RIVER IMPROVEMENT WORK		9576	1436.4	14423	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		1060	mil. Pesos		
GROWTH FACTORS	2000	1.837			
	2010	3.209			
	2044	18.920			
CALCULATED EIRR		20.46%			

No.	Year	Cost Stream River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.076
2	1991					0.00	0.00	0.00	1.152
3	1992					0.00	0.00	0.00	1.228
4	1993					0.00	0.00	0.00	1.304
5	1994					0.00	0.00	0.00	1.380
6	1995	961.53	0.00	0.00		961.53	0.00	-961.53	1.457
7	1996	961.53	0.00	3.67		965.20	108.31	-856.90	1.533
8	1997	961.53	0.00	7.34		968.87	227.37	-741.51	1.609
9	1998	961.53	0.00	11.01		972.55	357.18	-615.36	1.685
10	1999	961.53	0.00	14.68		976.22	497.75	-478.47	1.761
11	2000	961.53		18.35	0.00	979.89	649.07	-330.81	1.837
12	2001	961.53		22.02	0.00	983.56	837.06	-146.50	1.974
13	2002	961.53		25.70	0.00	987.23	1044.44	57.21	2.111
14	2003	961.53		29.37	0.00	990.90	1271.21	280.31	2.249
15	2004	961.53		33.04	0.00	994.57	1517.37	522.80	2.386
16	2005	961.53		36.71	0.00	998.24	1782.92	784.68	2.523
17	2006	961.53		40.38	0.00	1001.91	2067.86	1065.95	2.660
18	2007	961.53		44.05	0.00	1005.58	2372.20	1366.61	2.797
19	2008	961.53		47.72	0.00	1009.25	2695.92	1686.67	2.935
20	2009	961.53		51.39	0.00	1012.92	3039.03	2026.11	3.072
21	2010			55.06	0.00	55.06	3401.54	3346.48	3.209
22	2011			55.06	0.00	55.06	3891.35	3836.29	3.671
23	2012			55.06	0.00	55.06	4381.17	4326.11	4.133
24	2013			55.06	0.00	55.06	4870.98	4815.92	4.595
25	2014			55.06	0.00	55.06	5360.79	5305.73	5.057
26	2015			55.06	0.00	55.06	5850.61	5795.55	5.519
27	2016			55.06	0.00	55.06	6340.42	6285.36	5.982
28	2017			55.06	0.00	55.06	6830.23	6775.17	6.444
29	2018			55.06	0.00	55.06	7320.05	7264.99	6.906
30	2019			55.06	0.00	55.06	7809.86	7754.80	7.368
31	2020			55.06	0.00	55.06	8299.68	8244.61	7.830
32	2021			55.06	0.00	55.06	8789.49	8734.43	8.292
33	2022			55.06	0.00	55.06	9279.30	9224.24	8.754
34	2023			55.06	0.00	55.06	9769.12	9714.05	9.216
35	2024			55.06	0.00	55.06	10258.93	10203.87	9.678
36	2025			55.06	0.00	55.06	10748.74	10693.68	10.140
37	2026			55.06	0.00	55.06	11238.56	11183.49	10.602
38	2027			55.06	0.00	55.06	11728.37	11673.31	11.065
39	2028			55.06	0.00	55.06	12218.18	12163.12	11.527
40	2029			55.06	0.00	55.06	12708.00	12652.94	11.989
41	2030			55.06	0.00	55.06	13197.81	13142.75	12.451
42	2031			55.06	0.00	55.06	13687.62	13632.56	12.913
43	2032			55.06	0.00	55.06	14177.44	14122.38	13.375
44	2033			55.06	0.00	55.06	14667.25	14612.19	13.837
45	2034			55.06	0.00	55.06	15157.06	15102.00	14.299
46	2035			55.06	0.00	55.06	15646.88	15591.82	14.761
47	2036			55.06	0.00	55.06	16136.69	16081.63	15.223
48	2037			55.06	0.00	55.06	16626.51	16571.44	15.685
49	2038			55.06	0.00	55.06	17116.32	17061.26	16.147
50	2039			55.06	0.00	55.06	17606.13	17551.07	16.610
51	2040			55.06	0.00	55.06	18095.95	18040.88	17.072
52	2041			55.06	0.00	55.06	18585.76	18530.70	17.534
53	2042			55.06	0.00	55.06	19075.57	19020.51	17.996
54	2043			55.06	0.00	55.06	19565.39	19510.32	18.458
55	2044			55.06	0.00	55.06	20055.20	20000.14	18.920

Table 3.6 BENEFIT COST ANALYSIS:AGNO MAIN, TARLAC, TRIBUTARIES AND ALLIED RIVERS, 25 YEAR FLOOD, BENEFITS AT CURRENT DEVELOPMENT LEVEL

		MAIN CONST.	PHYSICAL CONT.	TOTAL COST	UNIT :mil.Pesos
CASE NO. LAAT-25-25 Constant Benefit					
RIVER IMPROVEMENT WORK		9576	1436.4	14423	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		1060	mil. Pesos		
GROWTH FACTORS	2000	1.000			
	2010	1.000			
	2044	1.000			
CALCULATED EIRR		6.49%			

No.	Year	Cost Stream River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.000
2	1991					0.00	0.00	0.00	1.000
3	1992					0.00	0.00	0.00	1.000
4	1993					0.00	0.00	0.00	1.000
5	1994					0.00	0.00	0.00	1.000
6	1995	961.53	0.00	0.00		961.53	0.00	-961.53	1.000
7	1996	961.53	0.00	3.67		965.20	70.67	-894.54	1.000
8	1997	961.53	0.00	7.34		968.87	141.33	-827.54	1.000
9	1998	961.53	0.00	11.01		972.55	212.00	-760.55	1.000
10	1999	961.53	0.00	14.68		976.22	282.67	-693.55	1.000
11	2000	961.53		18.35	0.00	979.89	353.33	-626.55	1.000
12	2001	961.53		22.02	0.00	983.56	424.00	-559.56	1.000
13	2002	961.53		25.70	0.00	987.23	494.67	-492.56	1.000
14	2003	961.53		29.37	0.00	990.90	565.33	-425.57	1.000
15	2004	961.53		33.04	0.00	994.57	636.00	-358.57	1.000
16	2005	961.53		36.71	0.00	998.24	706.67	-291.57	1.000
17	2006	961.53		40.38	0.00	1001.91	777.33	-224.58	1.000
18	2007	961.53		44.05	0.00	1005.58	848.00	-157.58	1.000
19	2008	961.53		47.72	0.00	1009.25	918.67	-90.59	1.000
20	2009	961.53		51.39	0.00	1012.92	989.33	-23.59	1.000
21	2010			55.06	0.00	55.06	1060.00	1004.94	1.000
22	2011			55.06	0.00	55.06	1060.00	1004.94	1.000
23	2012			55.06	0.00	55.06	1060.00	1004.94	1.000
24	2013			55.06	0.00	55.06	1060.00	1004.94	1.000
25	2014			55.06	0.00	55.06	1060.00	1004.94	1.000
26	2015			55.06	0.00	55.06	1060.00	1004.94	1.000
27	2016			55.06	0.00	55.06	1060.00	1004.94	1.000
28	2017			55.06	0.00	55.06	1060.00	1004.94	1.000
29	2018			55.06	0.00	55.06	1060.00	1004.94	1.000
30	2019			55.06	0.00	55.06	1060.00	1004.94	1.000
31	2020			55.06	0.00	55.06	1060.00	1004.94	1.000
32	2021			55.06	0.00	55.06	1060.00	1004.94	1.000
33	2022			55.06	0.00	55.06	1060.00	1004.94	1.000
34	2023			55.06	0.00	55.06	1060.00	1004.94	1.000
35	2024			55.06	0.00	55.06	1060.00	1004.94	1.000
36	2025			55.06	0.00	55.06	1060.00	1004.94	1.000
37	2026			55.06	0.00	55.06	1060.00	1004.94	1.000
38	2027			55.06	0.00	55.06	1060.00	1004.94	1.000
39	2028			55.06	0.00	55.06	1060.00	1004.94	1.000
40	2029			55.06	0.00	55.06	1060.00	1004.94	1.000
41	2030			55.06	0.00	55.06	1060.00	1004.94	1.000
42	2031			55.06	0.00	55.06	1060.00	1004.94	1.000
43	2032			55.06	0.00	55.06	1060.00	1004.94	1.000
44	2033			55.06	0.00	55.06	1060.00	1004.94	1.000
45	2034			55.06	0.00	55.06	1060.00	1004.94	1.000
46	2035			55.06	0.00	55.06	1060.00	1004.94	1.000
47	2036			55.06	0.00	55.06	1060.00	1004.94	1.000
48	2037			55.06	0.00	55.06	1060.00	1004.94	1.000
49	2038			55.06	0.00	55.06	1060.00	1004.94	1.000
50	2039			55.06	0.00	55.06	1060.00	1004.94	1.000
51	2040			55.06	0.00	55.06	1060.00	1004.94	1.000
52	2041			55.06	0.00	55.06	1060.00	1004.94	1.000
53	2042			55.06	0.00	55.06	1060.00	1004.94	1.000
54	2043			55.06	0.00	55.06	1060.00	1004.94	1.000
55	2044			55.06	0.00	55.06	1060.00	1004.94	1.000

Table 3.7 BENEFIT COST ANALYSIS:AGNO MAIN AND TARLAC RIVERS, 25 YEAR FLOOD, BENEFITS AT FUTURE DEVELOPMENT LEVEL

		MAIN CONST.	PHYSICAL CONT.	TOTAL COST	UNIT
CASE NO. LAG-A2-25 Low Grouth					mil.Pesos
RIVER IMPROVEMENT WORK		6241	936.15	9455	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		493	mil. Pesos		
GROWTH FACTORS	2000	1.837			
	2010	3.209			
	2044	18.920			
CALCULATED EIRR		16.57%			

No.	Year	Cost Stream River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.076
2	1991					0.00	0.00	0.00	1.152
3	1992					0.00	0.00	0.00	1.228
4	1993					0.00	0.00	0.00	1.304
5	1994					0.00	0.00	0.00	1.380
6	1995	630.33	0.00	0.00		630.33	0.00	-630.33	1.457
7	1996	630.33	0.00	2.39		632.73	50.37	-582.35	1.533
8	1997	630.33	0.00	4.78		635.12	105.75	-529.37	1.609
9	1998	630.33	0.00	7.18		637.51	166.12	-471.39	1.685
10	1999	630.33	0.00	9.57		639.90	231.50	-408.40	1.761
11	2000	630.33		11.96	0.00	642.30	301.88	-340.41	1.837
12	2001	630.33		14.35	0.00	644.69	389.31	-255.38	1.974
13	2002	630.33		16.75	0.00	647.08	485.76	-161.32	2.111
14	2003	630.33		19.14	0.00	649.47	591.23	-58.24	2.249
15	2004	630.33		21.53	0.00	651.86	705.72	53.85	2.386
16	2005	630.33		23.92	0.00	654.26	829.23	174.97	2.523
17	2006	630.33		26.32	0.00	656.65	961.75	305.10	2.660
18	2007	630.33		28.71	0.00	659.04	1103.29	444.25	2.797
19	2008	630.33		31.10	0.00	661.43	1253.86	592.42	2.935
20	2009	630.33		33.49	0.00	663.83	1413.44	749.61	3.072
21	2010			35.89	0.00	35.89	1582.04	1546.15	3.209
22	2011			35.89	0.00	35.89	1809.85	1773.96	3.671
23	2012			35.89	0.00	35.89	2037.66	2001.77	4.133
24	2013			35.89	0.00	35.89	2265.47	2229.58	4.595
25	2014			35.89	0.00	35.89	2493.28	2457.39	5.057
26	2015			35.89	0.00	35.89	2721.08	2685.20	5.519
27	2016			35.89	0.00	35.89	2948.89	2913.01	5.982
28	2017			35.89	0.00	35.89	3176.70	3140.82	6.444
29	2018			35.89	0.00	35.89	3404.51	3368.63	6.906
30	2019			35.89	0.00	35.89	3632.32	3596.44	7.368
31	2020			35.89	0.00	35.89	3860.13	3824.25	7.830
32	2021			35.89	0.00	35.89	4087.94	4052.06	8.292
33	2022			35.89	0.00	35.89	4315.75	4279.87	8.754
34	2023			35.89	0.00	35.89	4543.56	4507.67	9.216
35	2024			35.89	0.00	35.89	4771.37	4735.48	9.678
36	2025			35.89	0.00	35.89	4999.18	4963.29	10.140
37	2026			35.89	0.00	35.89	5226.99	5191.10	10.602
38	2027			35.89	0.00	35.89	5454.80	5418.91	11.065
39	2028			35.89	0.00	35.89	5682.61	5646.72	11.527
40	2029			35.89	0.00	35.89	5910.42	5874.53	11.989
41	2030			35.89	0.00	35.89	6138.23	6102.34	12.451
42	2031			35.89	0.00	35.89	6366.04	6330.15	12.913
43	2032			35.89	0.00	35.89	6593.85	6557.96	13.375
44	2033			35.89	0.00	35.89	6821.66	6785.77	13.837
45	2034			35.89	0.00	35.89	7049.47	7013.58	14.299
46	2035			35.89	0.00	35.89	7277.27	7241.39	14.761
47	2036			35.89	0.00	35.89	7505.08	7469.20	15.223
48	2037			35.89	0.00	35.89	7732.89	7697.01	15.685
49	2038			35.89	0.00	35.89	7960.70	7924.82	16.147
50	2039			35.89	0.00	35.89	8188.51	8152.63	16.610
51	2040			35.89	0.00	35.89	8416.32	8380.44	17.072
52	2041			35.89	0.00	35.89	8644.13	8608.25	17.534
53	2042			35.89	0.00	35.89	8871.94	8836.06	17.996
54	2043			35.89	0.00	35.89	9099.75	9063.86	18.458
55	2044			35.89	0.00	35.89	9327.56	9291.67	18.920

Table 3.8 BENEFIT COST ANALYSIS:AGNO MAIN AND TARLAC RIVERS, 25 YEAR FLOOD, BENEFITS AT CURRENT DEVELOPMENT LEVEL

		MAIN CONST.	PHYSICAL CONT.	TOTAL COST	UNIT :mil.Pesos
CASE NO. LAG-A2-25 Constant Benefit					
RIVER IMPROVEMENT WORK		6241	936.15	9455	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		493	mil. Pesos		
GROWTH FACTORS	2000	1.000			
	2010	1.000			
	2044	1.000			
CALCULATED EIRR		3.86%			

No.	Year	Cost Stream: River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.000
2	1991					0.00	0.00	0.00	1.000
3	1992					0.00	0.00	0.00	1.000
4	1993					0.00	0.00	0.00	1.000
5	1994					0.00	0.00	0.00	1.000
6	1995	630.33	0.00	0.00		630.33	0.00	-630.33	1.000
7	1996	630.33	0.00	2.39		632.73	32.87	-599.86	1.000
8	1997	630.33	0.00	4.78		635.12	65.73	-569.38	1.000
9	1998	630.33	0.00	7.18		637.51	98.60	-538.91	1.000
10	1999	630.33	0.00	9.57		639.90	131.47	-508.44	1.000
11	2000	630.33		11.96	0.00	642.30	164.33	-477.96	1.000
12	2001	630.33		14.35	0.00	644.69	197.20	-447.49	1.000
13	2002	630.33		16.75	0.00	647.08	230.07	-417.01	1.000
14	2003	630.33		19.14	0.00	649.47	262.93	-386.54	1.000
15	2004	630.33		21.53	0.00	651.86	295.80	-356.06	1.000
16	2005	630.33		23.92	0.00	654.26	328.67	-325.59	1.000
17	2006	630.33		26.32	0.00	656.65	361.53	-295.12	1.000
18	2007	630.33		28.71	0.00	659.04	394.40	-264.64	1.000
19	2008	630.33		31.10	0.00	661.43	427.27	-234.17	1.000
20	2009	630.33		33.49	0.00	663.83	460.13	-203.69	1.000
21	2010			35.89	0.00	35.89	493.00	457.11	1.000
22	2011			35.89	0.00	35.89	493.00	457.11	1.000
23	2012			35.89	0.00	35.89	493.00	457.11	1.000
24	2013			35.89	0.00	35.89	493.00	457.11	1.000
25	2014			35.89	0.00	35.89	493.00	457.11	1.000
26	2015			35.89	0.00	35.89	493.00	457.11	1.000
27	2016			35.89	0.00	35.89	493.00	457.11	1.000
28	2017			35.89	0.00	35.89	493.00	457.11	1.000
29	2018			35.89	0.00	35.89	493.00	457.11	1.000
30	2019			35.89	0.00	35.89	493.00	457.11	1.000
31	2020			35.89	0.00	35.89	493.00	457.11	1.000
32	2021			35.89	0.00	35.89	493.00	457.11	1.000
33	2022			35.89	0.00	35.89	493.00	457.11	1.000
34	2023			35.89	0.00	35.89	493.00	457.11	1.000
35	2024			35.89	0.00	35.89	493.00	457.11	1.000
36	2025			35.89	0.00	35.89	493.00	457.11	1.000
37	2026			35.89	0.00	35.89	493.00	457.11	1.000
38	2027			35.89	0.00	35.89	493.00	457.11	1.000
39	2028			35.89	0.00	35.89	493.00	457.11	1.000
40	2029			35.89	0.00	35.89	493.00	457.11	1.000
41	2030			35.89	0.00	35.89	493.00	457.11	1.000
42	2031			35.89	0.00	35.89	493.00	457.11	1.000
43	2032			35.89	0.00	35.89	493.00	457.11	1.000
44	2033			35.89	0.00	35.89	493.00	457.11	1.000
45	2034			35.89	0.00	35.89	493.00	457.11	1.000
46	2035			35.89	0.00	35.89	493.00	457.11	1.000
47	2036			35.89	0.00	35.89	493.00	457.11	1.000
48	2037			35.89	0.00	35.89	493.00	457.11	1.000
49	2038			35.89	0.00	35.89	493.00	457.11	1.000
50	2039			35.89	0.00	35.89	493.00	457.11	1.000
51	2040			35.89	0.00	35.89	493.00	457.11	1.000
52	2041			35.89	0.00	35.89	493.00	457.11	1.000
53	2042			35.89	0.00	35.89	493.00	457.11	1.000
54	2043			35.89	0.00	35.89	493.00	457.11	1.000
55	2044			35.89	0.00	35.89	493.00	457.11	1.000

Table 3.9 BENEFIT COST ANALYSIS: AGNO RIVER TRIBUTARIES, 25 YEAR FLOOD, BENEFITS AT FUTURE DEVELOPMENT LEVEL

		MAIN CONST.	PHYSICAL CONT.	TOTAL COST	UNIT :mil.Pesos
CASE NO. LAT-AT-25 Low Growth					
RIVER IMPROVEMENT WORK		1012	151.8	1506	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		70	mil. Pesos		
GROWTH FACTORS	2000	1.837			
	2010	3.209			
	2044	18.920			
CALCULATED EIRR		15.46%			

No.	Year	Cost Stream River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.076
2	1991					0.00	0.00	0.00	1.152
3	1992					0.00	0.00	0.00	1.228
4	1993					0.00	0.00	0.00	1.304
5	1994					0.00	0.00	0.00	1.380
6	1995	100.40	0.00	0.00		100.40	0.00	-100.40	1.457
7	1996	100.40	0.00	0.39		100.79	7.15	-93.64	1.533
8	1997	100.40	0.00	0.78		101.18	15.01	-86.16	1.609
9	1998	100.40	0.00	1.16		101.56	23.59	-77.98	1.685
10	1999	100.40	0.00	1.55		101.95	32.87	-69.08	1.761
11	2000	100.40		1.94	0.00	102.34	42.86	-59.48	1.837
12	2001	100.40		2.33	0.00	102.73	55.28	-47.45	1.974
13	2002	100.40		2.72	0.00	103.12	68.97	-34.14	2.111
14	2003	100.40		3.10	0.00	103.50	83.95	-19.56	2.249
15	2004	100.40		3.49	0.00	103.89	100.20	-3.69	2.386
16	2005	100.40		3.88	0.00	104.28	117.74	13.46	2.523
17	2006	100.40		4.27	0.00	104.67	136.56	31.89	2.660
18	2007	100.40		4.66	0.00	105.06	156.65	51.60	2.797
19	2008	100.40		5.04	0.00	105.44	178.03	72.59	2.935
20	2009	100.40		5.43	0.00	105.83	200.69	94.86	3.072
21	2010			5.82	0.00	5.82	224.63	218.81	3.209
22	2011			5.82	0.00	5.82	256.98	251.16	3.671
23	2012			5.82	0.00	5.82	289.32	283.50	4.133
24	2013			5.82	0.00	5.82	321.67	315.85	4.595
25	2014			5.82	0.00	5.82	354.01	348.20	5.057
26	2015			5.82	0.00	5.82	386.36	380.54	5.519
27	2016			5.82	0.00	5.82	418.71	412.89	5.982
28	2017			5.82	0.00	5.82	451.05	445.23	6.444
29	2018			5.82	0.00	5.82	483.40	477.58	6.906
30	2019			5.82	0.00	5.82	515.75	509.93	7.368
31	2020			5.82	0.00	5.82	548.09	542.27	7.830
32	2021			5.82	0.00	5.82	580.44	574.62	8.292
33	2022			5.82	0.00	5.82	612.78	606.97	8.754
34	2023			5.82	0.00	5.82	645.13	639.31	9.216
35	2024			5.82	0.00	5.82	677.48	671.66	9.678
36	2025			5.82	0.00	5.82	709.82	704.00	10.140
37	2026			5.82	0.00	5.82	742.17	736.35	10.602
38	2027			5.82	0.00	5.82	774.52	768.70	11.065
39	2028			5.82	0.00	5.82	806.86	801.04	11.527
40	2029			5.82	0.00	5.82	839.21	833.39	11.989
41	2030			5.82	0.00	5.82	871.55	865.73	12.451
42	2031			5.82	0.00	5.82	903.90	898.08	12.913
43	2032			5.82	0.00	5.82	936.25	930.43	13.375
44	2033			5.82	0.00	5.82	968.59	962.77	13.837
45	2034			5.82	0.00	5.82	1000.94	995.12	14.299
46	2035			5.82	0.00	5.82	1033.28	1027.47	14.761
47	2036			5.82	0.00	5.82	1065.63	1059.81	15.223
48	2037			5.82	0.00	5.82	1097.98	1092.16	15.685
49	2038			5.82	0.00	5.82	1130.32	1124.50	16.147
50	2039			5.82	0.00	5.82	1162.67	1156.85	16.610
51	2040			5.82	0.00	5.82	1195.02	1189.20	17.072
52	2041			5.82	0.00	5.82	1227.36	1221.54	17.534
53	2042			5.82	0.00	5.82	1259.71	1253.89	17.996
54	2043			5.82	0.00	5.82	1292.05	1286.23	18.458
55	2044			5.82	0.00	5.82	1324.40	1318.58	18.920

Table 3.10 BENEFIT COST ANALYSIS: AGNO RIVER TRIBUTARIES, 25 YEAR FLOOD, BENEFITS AT CURRENT DEVELOPMENT LEVEL

		MAIN CONST.	PHYSICAL CONT.	TOTAL COST	UNIT :mil.Pesos
CASE NO. LAT-AT-25 Constant Benefit					
RIVER IMPROVEMENT WORK		1012	151.8	1506	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		70	mil. Pesos		
GROWTH FACTORS	2000	1.000			
	2010	1.000			
	2044	1.000			
CALCULATED EIRR		3.08%			

No.	Year	Cost Stream River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.000
2	1991					0.00	0.00	0.00	1.000
3	1992					0.00	0.00	0.00	1.000
4	1993					0.00	0.00	0.00	1.000
5	1994					0.00	0.00	0.00	1.000
6	1995	100.40	0.00	0.00		100.40	0.00	-100.40	1.000
7	1996	100.40	0.00	0.39		100.79	4.67	-96.12	1.000
8	1997	100.40	0.00	0.78		101.18	9.33	-91.84	1.000
9	1998	100.40	0.00	1.16		101.56	14.00	-87.56	1.000
10	1999	100.40	0.00	1.55		101.95	18.67	-83.29	1.000
11	2000	100.40		1.94	0.00	102.34	23.33	-79.01	1.000
12	2001	100.40		2.33	0.00	102.73	28.00	-74.73	1.000
13	2002	100.40		2.72	0.00	103.12	32.67	-70.45	1.000
14	2003	100.40		3.10	0.00	103.50	37.33	-66.17	1.000
15	2004	100.40		3.49	0.00	103.89	42.00	-61.89	1.000
16	2005	100.40		3.88	0.00	104.28	46.67	-57.61	1.000
17	2006	100.40		4.27	0.00	104.67	51.33	-53.33	1.000
18	2007	100.40		4.66	0.00	105.06	56.00	-49.06	1.000
19	2008	100.40		5.04	0.00	105.44	60.67	-44.78	1.000
20	2009	100.40		5.43	0.00	105.83	65.33	-40.50	1.000
21	2010			5.82	0.00	5.82	70.00	64.18	1.000
22	2011			5.82	0.00	5.82	70.00	64.18	1.000
23	2012			5.82	0.00	5.82	70.00	64.18	1.000
24	2013			5.82	0.00	5.82	70.00	64.18	1.000
25	2014			5.82	0.00	5.82	70.00	64.18	1.000
26	2015			5.82	0.00	5.82	70.00	64.18	1.000
27	2016			5.82	0.00	5.82	70.00	64.18	1.000
28	2017			5.82	0.00	5.82	70.00	64.18	1.000
29	2018			5.82	0.00	5.82	70.00	64.18	1.000
30	2019			5.82	0.00	5.82	70.00	64.18	1.000
31	2020			5.82	0.00	5.82	70.00	64.18	1.000
32	2021			5.82	0.00	5.82	70.00	64.18	1.000
33	2022			5.82	0.00	5.82	70.00	64.18	1.000
34	2023			5.82	0.00	5.82	70.00	64.18	1.000
35	2024			5.82	0.00	5.82	70.00	64.18	1.000
36	2025			5.82	0.00	5.82	70.00	64.18	1.000
37	2026			5.82	0.00	5.82	70.00	64.18	1.000
38	2027			5.82	0.00	5.82	70.00	64.18	1.000
39	2028			5.82	0.00	5.82	70.00	64.18	1.000
40	2029			5.82	0.00	5.82	70.00	64.18	1.000
41	2030			5.82	0.00	5.82	70.00	64.18	1.000
42	2031			5.82	0.00	5.82	70.00	64.18	1.000
43	2032			5.82	0.00	5.82	70.00	64.18	1.000
44	2033			5.82	0.00	5.82	70.00	64.18	1.000
45	2034			5.82	0.00	5.82	70.00	64.18	1.000
46	2035			5.82	0.00	5.82	70.00	64.18	1.000
47	2036			5.82	0.00	5.82	70.00	64.18	1.000
48	2037			5.82	0.00	5.82	70.00	64.18	1.000
49	2038			5.82	0.00	5.82	70.00	64.18	1.000
50	2039			5.82	0.00	5.82	70.00	64.18	1.000
51	2040			5.82	0.00	5.82	70.00	64.18	1.000
52	2041			5.82	0.00	5.82	70.00	64.18	1.000
53	2042			5.82	0.00	5.82	70.00	64.18	1.000
54	2043			5.82	0.00	5.82	70.00	64.18	1.000
55	2044			5.82	0.00	5.82	70.00	64.18	1.000

Table 3.11 BENEFIT COST ANALYSIS: ALLIED RIVERS,
10 YEAR FLOOD, BENEFITS AT FUTURE DEVELOPMENT LEVEL

		MAIN CONST.	PHYSICAL CONT.	TOTAL COST	UNIT
CASE NO. LAL-AT-10 Low Grouth					mil.Pesos
RIVER IMPROVEMENT WORK		2027	304.05	3020	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		471	mil. Pesos		
GROWTH FACTORS	2000	1.837			
	2010	3.209			
	2044	18.920			
CALCULATED EIRR		33.77%			

No.	Year	Cost Stream: River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.076
2	1991					0.00	0.00	0.00	1.152
3	1992					0.00	0.00	0.00	1.228
4	1993					0.00	0.00	0.00	1.304
5	1994					0.00	0.00	0.00	1.380
6	1995	201.33	0.00	0.00		201.33	0.00	-201.33	1.457
7	1996	201.33	0.00	0.78		202.11	48.12	-153.99	1.533
8	1997	201.33	0.00	1.55		202.89	101.03	-101.86	1.609
9	1998	201.33	0.00	2.33		203.66	158.71	-44.95	1.685
10	1999	201.33	0.00	3.11		204.44	221.17	16.73	1.761
11	2000	201.33		3.89	0.00	205.22	288.41	83.19	1.837
12	2001	201.33		4.66	0.00	206.00	371.94	165.94	1.974
13	2002	201.33		5.44	0.00	206.77	464.09	257.31	2.111
14	2003	201.33		6.22	0.00	207.55	564.85	357.30	2.249
15	2004	201.33		6.99	0.00	208.33	674.23	465.90	2.386
16	2005	201.33		7.77	0.00	209.10	792.22	583.12	2.523
17	2006	201.33		8.55	0.00	209.88	918.83	708.95	2.660
18	2007	201.33		9.32	0.00	210.66	1054.06	843.40	2.797
19	2008	201.33		10.10	0.00	211.43	1197.90	986.47	2.935
20	2009	201.33		10.88	0.00	212.21	1350.36	1138.15	3.072
21	2010			11.66	0.00	11.66	1511.44	1499.78	3.209
22	2011			11.66	0.00	11.66	1729.08	1717.43	3.671
23	2012			11.66	0.00	11.66	1946.73	1935.07	4.133
24	2013			11.66	0.00	11.66	2164.37	2152.71	4.595
25	2014			11.66	0.00	11.66	2382.01	2370.36	5.057
26	2015			11.66	0.00	11.66	2599.66	2588.00	5.519
27	2016			11.66	0.00	11.66	2817.30	2805.65	5.982
28	2017			11.66	0.00	11.66	3034.94	3023.29	6.444
29	2018			11.66	0.00	11.66	3252.59	3240.93	6.906
30	2019			11.66	0.00	11.66	3470.23	3458.58	7.368
31	2020			11.66	0.00	11.66	3687.87	3676.22	7.830
32	2021			11.66	0.00	11.66	3905.52	3893.86	8.292
33	2022			11.66	0.00	11.66	4123.16	4111.51	8.754
34	2023			11.66	0.00	11.66	4340.81	4329.15	9.216
35	2024			11.66	0.00	11.66	4558.45	4546.79	9.678
36	2025			11.66	0.00	11.66	4776.09	4764.44	10.140
37	2026			11.66	0.00	11.66	4993.74	4982.08	10.602
38	2027			11.66	0.00	11.66	5211.38	5199.72	11.065
39	2028			11.66	0.00	11.66	5429.02	5417.37	11.527
40	2029			11.66	0.00	11.66	5646.67	5635.01	11.989
41	2030			11.66	0.00	11.66	5864.31	5852.65	12.451
42	2031			11.66	0.00	11.66	6081.95	6070.30	12.913
43	2032			11.66	0.00	11.66	6299.60	6287.94	13.375
44	2033			11.66	0.00	11.66	6517.24	6505.59	13.837
45	2034			11.66	0.00	11.66	6734.88	6723.23	14.299
46	2035			11.66	0.00	11.66	6952.53	6940.87	14.761
47	2036			11.66	0.00	11.66	7170.17	7158.52	15.223
48	2037			11.66	0.00	11.66	7387.82	7376.16	15.685
49	2038			11.66	0.00	11.66	7605.46	7593.80	16.147
50	2039			11.66	0.00	11.66	7823.10	7811.45	16.610
51	2040			11.66	0.00	11.66	8040.75	8029.09	17.072
52	2041			11.66	0.00	11.66	8258.39	8246.73	17.534
53	2042			11.66	0.00	11.66	8476.03	8464.38	17.996
54	2043			11.66	0.00	11.66	8693.68	8682.02	18.458
55	2044			11.66	0.00	11.66	8911.32	8899.66	18.920

Table 3.12 BENEFIT COST ANALYSIS: ALLIED RIVERS,
10 YEAR FLOOD, BENEFITS AT CURRENT DEVELOPMENT LEVEL

		MAIN	PHYSICAL	TOTAL	
CASE NO. LAL-AT-10 Constant Benefit		CONST.	CONT.	COST	UNIT :mil.Pesos
RIVER IMPROVEMENT WORK		2027	304.05	3020	
DAM CONSTRUCTION WORK		0	0	0	
ANNUAL BENEFIT		471	mil. Pesos		
GROWTH FACTORS	2000	1.000			
	2010	1.000			
	2044	1.000			
CALCULATED EIRR		15.18%			

No.	Year	Cost Stream River	Dam	OM River	OM Dam	Total	Benefit	B-C	GROWTH FACTOR
0	1989					0.00	0.00	0.00	1.000
1	1990					0.00	0.00	0.00	1.000
2	1991					0.00	0.00	0.00	1.000
3	1992					0.00	0.00	0.00	1.000
4	1993					0.00	0.00	0.00	1.000
5	1994					0.00	0.00	0.00	1.000
6	1995	201.33	0.00	0.00		201.33	0.00	-201.33	1.000
7	1996	201.33	0.00	0.78		202.11	31.40	-170.71	1.000
8	1997	201.33	0.00	1.55		202.89	62.80	-140.09	1.000
9	1998	201.33	0.00	2.33		203.66	94.20	-109.46	1.000
10	1999	201.33	0.00	3.11		204.44	125.60	-78.84	1.000
11	2000	201.33		3.89	0.00	205.22	157.00	-48.22	1.000
12	2001	201.33		4.66	0.00	206.00	188.40	-17.60	1.000
13	2002	201.33		5.44	0.00	206.77	219.80	13.03	1.000
14	2003	201.33		6.22	0.00	207.55	251.20	43.65	1.000
15	2004	201.33		6.99	0.00	208.33	282.60	74.27	1.000
16	2005	201.33		7.77	0.00	209.10	314.00	104.90	1.000
17	2006	201.33		8.55	0.00	209.88	345.40	135.52	1.000
18	2007	201.33		9.32	0.00	210.66	376.80	166.14	1.000
19	2008	201.33		10.10	0.00	211.43	408.20	196.77	1.000
20	2009	201.33		10.88	0.00	212.21	439.60	227.39	1.000
21	2010			11.66	0.00	11.66	471.00	459.34	1.000
22	2011			11.66	0.00	11.66	471.00	459.34	1.000
23	2012			11.66	0.00	11.66	471.00	459.34	1.000
24	2013			11.66	0.00	11.66	471.00	459.34	1.000
25	2014			11.66	0.00	11.66	471.00	459.34	1.000
26	2015			11.66	0.00	11.66	471.00	459.34	1.000
27	2016			11.66	0.00	11.66	471.00	459.34	1.000
28	2017			11.66	0.00	11.66	471.00	459.34	1.000
29	2018			11.66	0.00	11.66	471.00	459.34	1.000
30	2019			11.66	0.00	11.66	471.00	459.34	1.000
31	2020			11.66	0.00	11.66	471.00	459.34	1.000
32	2021			11.66	0.00	11.66	471.00	459.34	1.000
33	2022			11.66	0.00	11.66	471.00	459.34	1.000
34	2023			11.66	0.00	11.66	471.00	459.34	1.000
35	2024			11.66	0.00	11.66	471.00	459.34	1.000
36	2025			11.66	0.00	11.66	471.00	459.34	1.000
37	2026			11.66	0.00	11.66	471.00	459.34	1.000
38	2027			11.66	0.00	11.66	471.00	459.34	1.000
39	2028			11.66	0.00	11.66	471.00	459.34	1.000
40	2029			11.66	0.00	11.66	471.00	459.34	1.000
41	2030			11.66	0.00	11.66	471.00	459.34	1.000
42	2031			11.66	0.00	11.66	471.00	459.34	1.000
43	2032			11.66	0.00	11.66	471.00	459.34	1.000
44	2033			11.66	0.00	11.66	471.00	459.34	1.000
45	2034			11.66	0.00	11.66	471.00	459.34	1.000
46	2035			11.66	0.00	11.66	471.00	459.34	1.000
47	2036			11.66	0.00	11.66	471.00	459.34	1.000
48	2037			11.66	0.00	11.66	471.00	459.34	1.000
49	2038			11.66	0.00	11.66	471.00	459.34	1.000
50	2039			11.66	0.00	11.66	471.00	459.34	1.000
51	2040			11.66	0.00	11.66	471.00	459.34	1.000
52	2041			11.66	0.00	11.66	471.00	459.34	1.000
53	2042			11.66	0.00	11.66	471.00	459.34	1.000
54	2043			11.66	0.00	11.66	471.00	459.34	1.000
55	2044			11.66	0.00	11.66	471.00	459.34	1.000

FIGURES

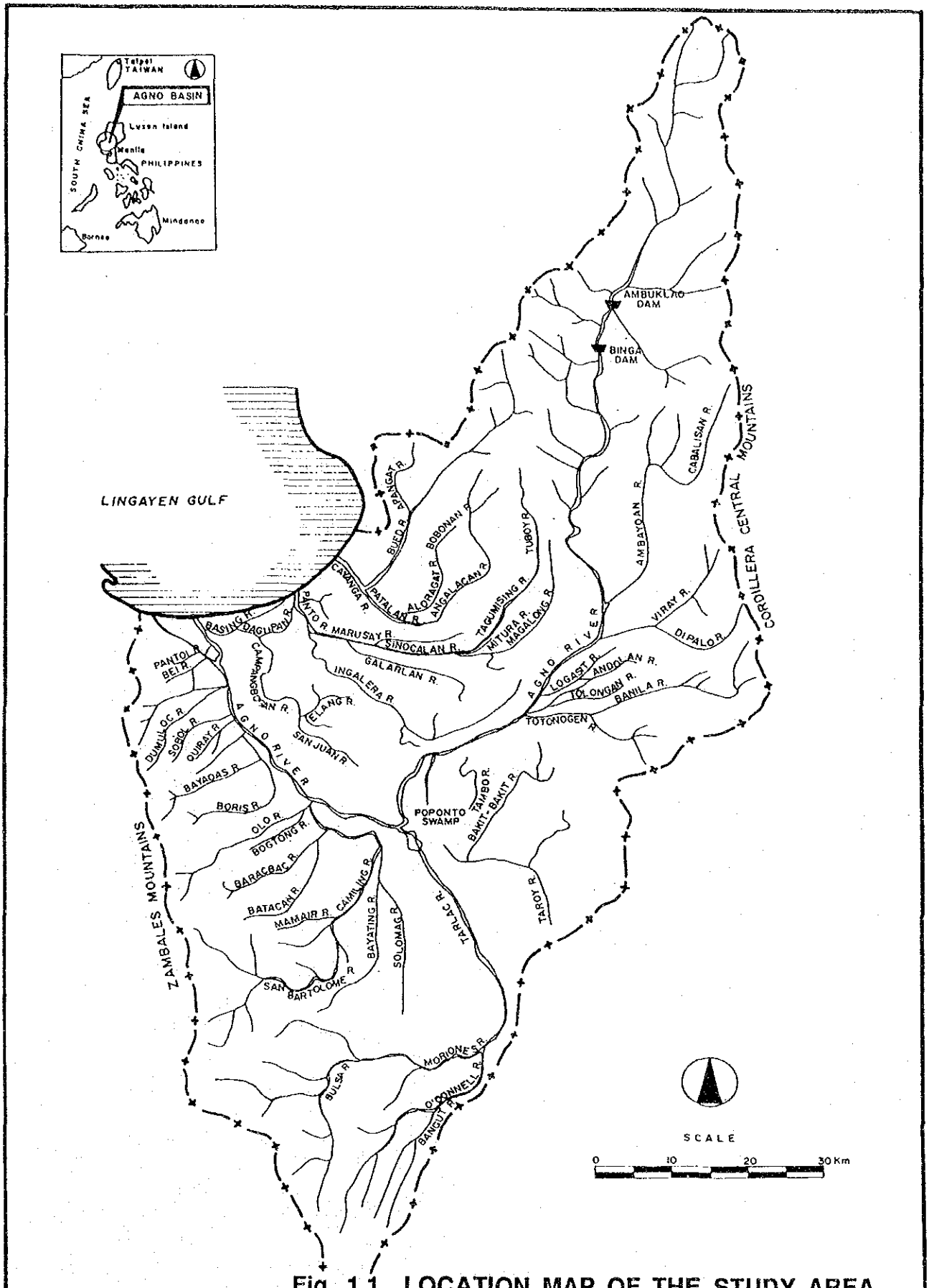

Fig. 1.1 LOCATION MAP OF THE STUDY AREA

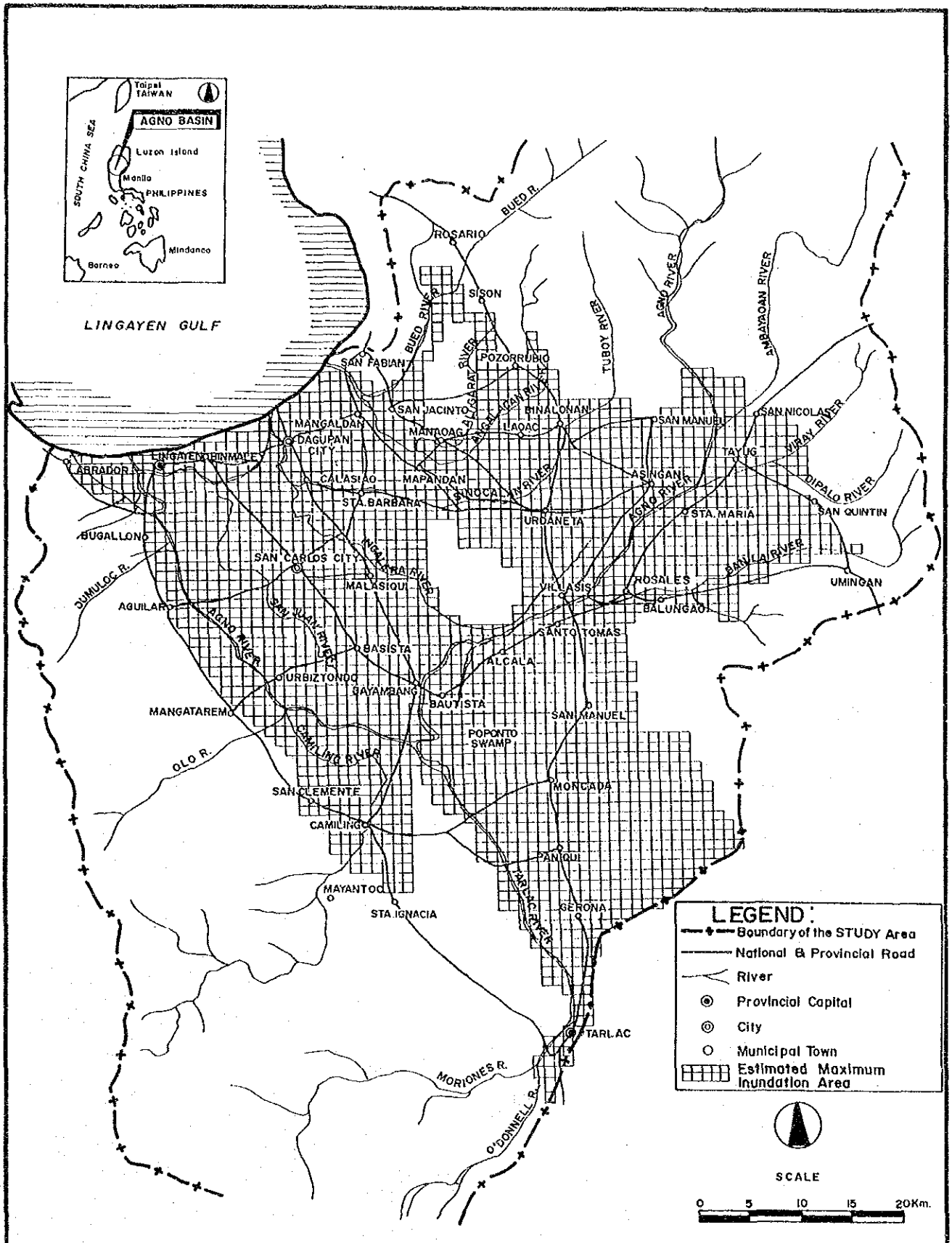

Fig. 1.2 ESTIMATED MAXIMUM INUNDATION AREA

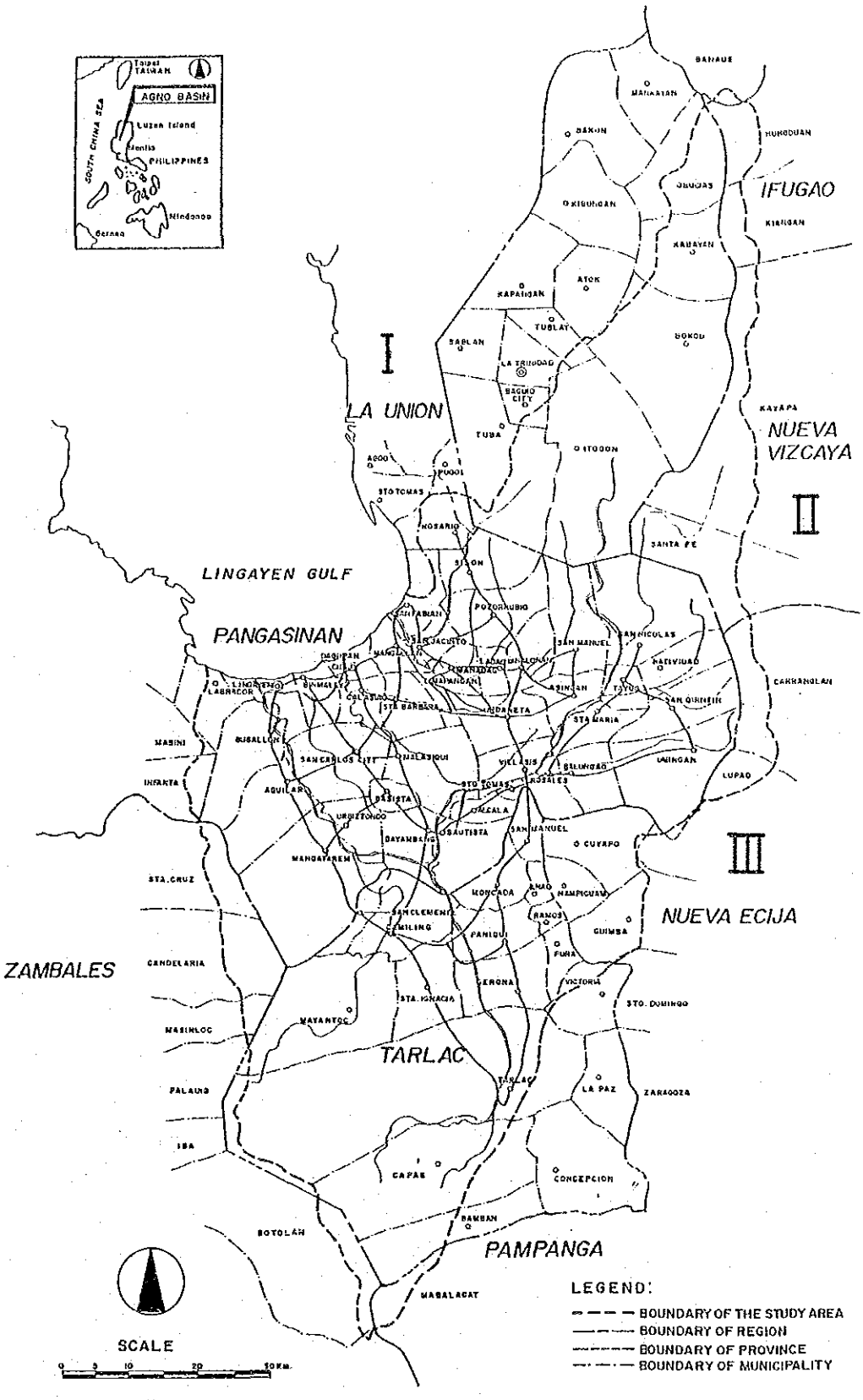

Fig. 2.1 ADMINISTRATIVE DIVISION IN THE STUDY AREA

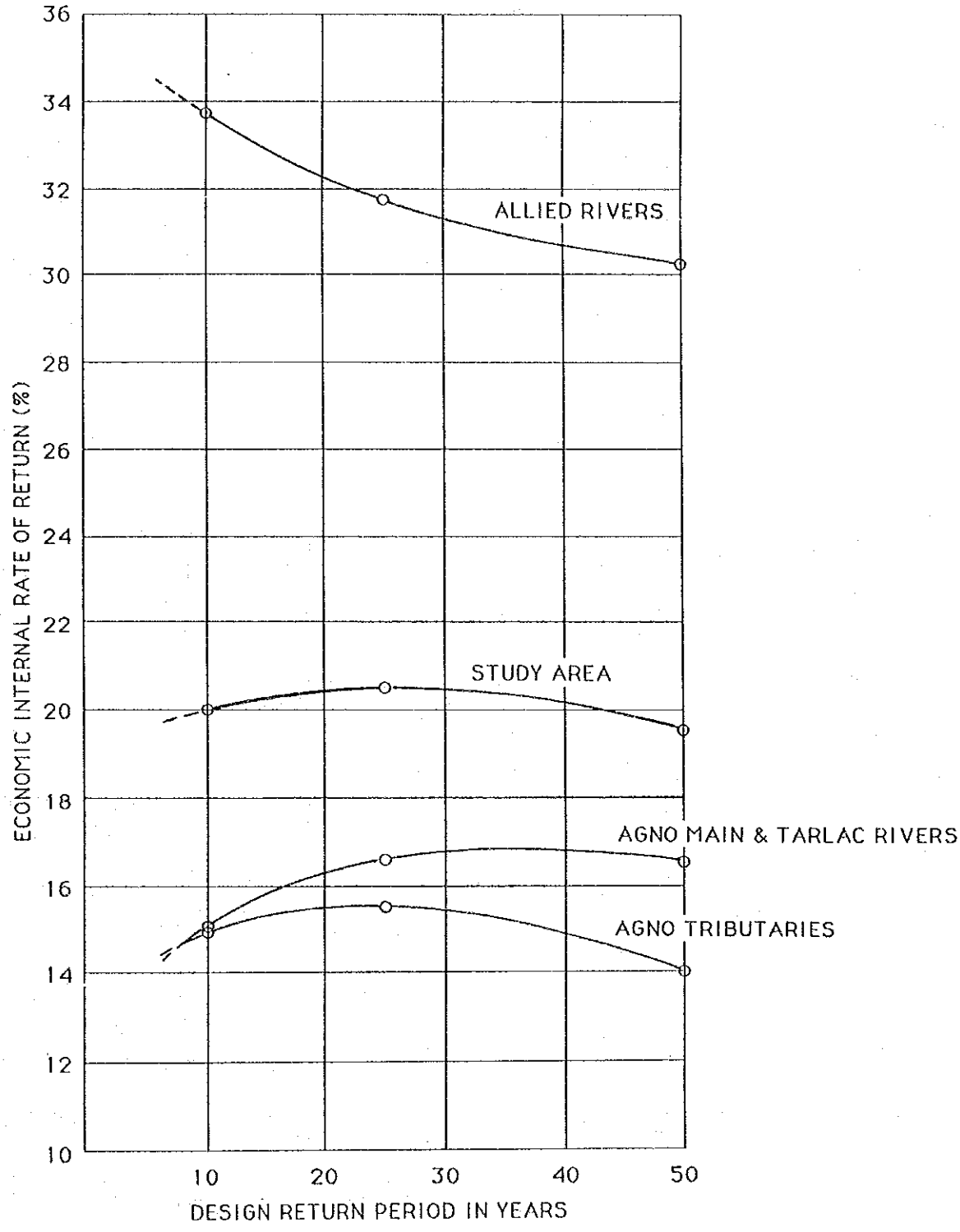

Fig. 3.1 OPTIMIZATION OF DEVELOPMENT SCALE FOR INTEGRATED LONG TERM PLAN

2. HY

HYDROLOGY

HY : HYDROLOGY

SUMMARY

(1) The Agno River basin is surrounded by the Cordillera Central mountains on the north and the Zambales Mountains on the southwest and adjoining the Pampanga River basin on the southeast, which forms the northern part of the Central Plains of Luzon.

(2) The Agno River is ranked as the 5th largest scale river in the Philippines with a drainage area of about 5,910 km^2 and its river length of 221 km. The Agno River originates in the Cordillera Central Mountains and flows southward in mountainous areas. Then it debauches into a vast alluvial plain and collects runoff from the left bank tributaries including the Tarlac River which is a major tributary of the Agno River. After the confluence with the Tarlac River, the Agno River takes northwestwards direction, flowing on the eastern side the Zambales Mountains and discharges into the Lingayen Gulf. The Allied Rivers consisting of the two main systems of the Cayanga-Patalan and Pantol-Sinocalan river systems, are located on the northwestern part of the Pangasinan plain and also discharges into the Lingayan Gulf.

(3) The climate of the Agno River basin is characterized by distinct dry and wet seasons. The dry season lasts usually from November to April and the wet season from May to October. The annual rainfall varies from 2,000 mm in the southeastern portion adjoining the Pampanga River basin to over 4,000 mm in northern mountainous part. More than 90% of the annual rainfall occurs in the 6 months of the wet season. The river basin is often hit by typhoons during the wet season. Baguio City located at the mountainous area was recorded the annual rainfall of 9,038 mm in 1911, and the heaviest daily rainfall was 979 mm at the maximum record when a typhoon hit the area in October 17, 1967. the average annual temperature of the basin is 28°C with a slight monthly fluctuation. The average relative humidity in the Pangasinan plain is about 80%.

(4) From the hydrological viewpoint, the existing condition of the Agno River and Allied River basins during flood period is characterized as follows:

(a) A continuous diking system has been provided for almost the whole stretch of the right bank of the main Agno River. For this reason, the Allied River basins are protected from the flood of the Agno River.

(b) However, some breached river sections of the said diking system still remain in the downstream of San Roque caused by past floods and also gaps remain in the diking system. This implies that the flood runoff from the upstream basin will be partly diverted and/or overtopped into the Allied Rivers basin.

(c) Due to the absence of left dike in the main Agno River at the downstream from the confluence with the Tarlac River, there still remains an inundation area.

(d) In order to dissolve a hydraulic bottle-neck point at Bayambang in the Agno River, about 10 km upstream of the junction of the Tarlac River, the by-pass floodway channel to the Poponto swamp was constructed. The Poponto swamp serves as a natural retarding basin at present.

(e) The lowland areas of the Allied Rivers receive the habitual flooding in the rainy season due to inadequate low flow capacity of river channels. Moreover, in case of a flood associated with the one from the Agno River, a wide-spread flooding with a long time duration is readily expected.

(5) The following flood studies are carried out:

(a) Estimation of probable flood runoff distribution under the existing river condition in order to clarify present flood phenomenon,

(b) Estimation of probable flood runoff distribution under the condition with conceivable alternative flood control schemes, and

(c) Estimation of flood water level and duration time due to the probable flood flow in possible inundation area which is required to estimate the flood damage in the flood prove area.

(6) Simulation models are developed to simulate the flood runoff mechanism and to assess the hydrological characteristics in the Agno and Allied Rivers. Then, the said model are calibrated based on the flood record of typhoon Maring in 1984.

(7) The available rainfall data is analyzed for design of the rainfall duration, the probable basin mean rainfall and its hourly distribution. The design rainfall duration is determined to be 4 days and the basin mean rainfall is estimated by Thiessen method taking into account the adjustment for basin mean elevation. The probable 100-year basin mean rainfall with 4-day duration is estimated at 1,008 mm at the rivermouth of the Agno River.

(8) The probable flood runoff at strategic base points are estimated under the confining dike condition together with the existing dams of the Binga and the Ambuklao, the San Roque dam in which the detail design has been completed, and the Balog-Balog dam under construction. The estimated probable 100-year flood peak runoff at the San Roque damsite and the rivermouth of the Agno River are 6,270 m^3/sec and 17,310 m^3/sec respectively. The probable flood peak distribution with recurrence intervals of 1.05, 2, 5, 10, 25, 50 and 100 years are presented for the Agno and the Allied Rivers.

(9) The low flow study is carried out to obtain runoff data on a daily basis at selected locations for the sediment balance calculation in the Agno River. By this study, the runoff record at San Roque is examined and its long-term runoff for the period of 1960-1986 is estimated.

STUDY OF AGNO RIVER BASIN FLOOD CONTROL

HY: HYDROLOGY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

1. NAME OF PHILIPPINE GOVERNMENT AGENCIES

AFCS	Agno River Flood Control
AFFWS	Agno River Flood Forecasting and Warning System
ARIS	Agno River Irrigation System
DPWH	Department of Public Works and Highways
GOP	Government of the Philippines
NAMRIA	National Mapping and Resource Information Authority
NAPOCOR	National Power Corporation
NIA	National Irrigation Administration
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration

2. NAME OF JAPANESE GOVERNMENT AND OTHER OFFICIAL AGENCIES AND ORGANIZATION

GOJ	Government of Japan
JICA	Japan International Cooperation Agency
MOC	Ministry of Construction, Japan

3. MEASUREMENT UNITS

(Length)

mm	millimeter(s)
cm	centimeter(s)
m	meters(s)
km	kilometer(s)

(Time)

sec	second(s)
min	minute(s)
hr(hrs)	hour(s)
dy(dys)	day(s)
mth(mths)	month(s)
yr(yrs)	year(s)

(Area)

m^2	square meter(s)
km^2	square kilometer(s)

(Volume)

m^3	cubic meter(s)

1. INTRODUCTION

This Supporting Report presents the results of meteorological and hydrological study carried out during the Study.

The objectives of the study are:

Flood Studies

(1) To estimate the probable flood runoff distribution under the present river condition to clarify the hydrological characteristic during flood;

(2) To estimate the flood water level and duration time in possible inundation area for the assessment of its flood damage;

(3) To estimate the probable flood runoff distribution under conceivable alternative schemes for the evaluation of their appropriate scales; and

Low Flow Study

(4) To estimate the long-term runoff at an arbitrary location in the basin for the sediment balance study.

In addition, 4 automatic rainfall gauges and 9 automatic water level gauges provided by JICA were newly installed at selected sites during the Study. The observed data thereby are to be analysed and taken into consideration in the meteohydrological study in the Feasibility Study stage.

2. METEOHYDROLOGICAL DATA

2.1 Meteorological Data

Meteorological observation data in and around the Agno River basin such as temperature, relative humidity, evaporation, wind velocity is available at meteorological observatories at Dagupan City, Baguio, Ambuklao dam and San Miguel.

2.2 Rainfall

There exist 25 rainfall gauging stations in and around the Agno River basin as shown in the location map of Fig. 2.1. Fig. 2.2 shows the observation period of rainfall record at these stations. The observation work is managed and executed by PAGASA.

As shown in Fig. 2.1, rainfall stations are densely distributed in upstream basin of the Agno River and middle reaches of the Agno River from the junction of the Ambayoan River. The number of stations is limited, however, in the upstream basins of the Camiling River, the Tarlac River and the Allied Rivers, hourly rainfall record is available at 5 stations of San Roque, Carmen, Wawa, Tibag and Santa. Barbara. Those stations were installed as a part of flood forecasting and warning system in the Agno River in 1982.

2.3 Water Level and Discharge

There are 23 water level gauging stations in the Agno River basin. Water level observation and discharge measurement are carried out by DPWH. Fig. 2.3 shows the location map of water level gauging stations.

The available period of water level record since 1960 is shown in Fig. 2.4. The record is available only up to the beginning of 1970's due to damage of water level gauge equipment and inadequate maintenance works, while some stations remain in operation but observed data thereof are still under compilation.

Hourly water level records in major flood period are available since 1982

at San Roque, Carmen, Wawa, Tibag and Santa. Barbara, where automatic water level gauges are installed for the purpose of flood forecasting and warning in the Agno River basin.

The details of flood record is discussed in Chapter 4.

2.4 Tidal Water Level

There is no tidal stations in the Lingayen Gulf. The tidal water level record is available at San Fernando which is located at about 80 km in the north of Dagupan City. According to the tide table published by NAMRIA, the tide levels at San Fernando are as follows:

Elevation in Meter above Mean Lower Low Water (MLLW)	
Mean Higher High Water (MHHW)	Mean Sea Level (MSL)
0.706	0.329

Remarks: Primary Bench Mark is placed at 4.727 m above MLLW.

3. METEOHYDROLOGICAL CONDITION

3.1 Rivers

The Agno River basin subject to the Study is surrounded by the Cordillera Central Mountains on the north and the Zambales Mountains on the southwest and adjoining the Pampanga River basin on the southeast, which forms the northern part of the Central Plains of Luzon.

The Study Area is mainly divided into two river systems; the Agno River system and its neighboring medium-scale river groups named Allied Rivers system as shown in Fig. 3.1.

The Agno River is ranked as the 5th largest scale river in the Philippines with a drainage area of about 5,910 km^2 and river length of 221 km. The Agno River originates in the Cordillera Central Mountains and flows southward in the mountainous area. Then it debouches into a vast alluvial plain and flows down toward Bayambang collecting runoff from the left bank tributaries such as the Ambayoan and Viray-Dipalo Rivers and joins the Tarlac River, a major tributary of the Agno River.

At the confluence of these two rivers, the Poponto swamp exists and functions as a natural retarding basin to reduce flood peak to downstream. Its inundation area is about 30 km^2 in the rainy season.

After the confluence with the Tarlac River, the Agno Rivers turns in a northwestward direction gathering runoff from the northeastern slope of the Zambales Mountains and finally empties into the Lingayen Gulf.

The Allied Rivers, independent rivers on the Agno River, consist the Cayanga-Patalan and the Panto-Sinocalan river systems. The drainage area of these river systems is 618 km^2 and 1,162 km^2 respectively.

Both rivers originate in the Cordillera Central Mountains and take the same flow direction as the Agno River does, and finally discharge into the Lingayen Gulf.

A vast alluvial plain formed by the Agno River and the Allied Rivers is called as the Pangasinan plain, which has been developed agriculturally for a long time.

3.2 Climate

The climate in the Agno River basin is characterized by distinct dry and wet seasons. The dry season lasts usually from November to April and the wet season from May to October.

Fig. 3.2 shows the isohyetal map of annual rainfall in the Agno River basin. The annual rainfall varies from 2,000 mm in the southeastern portion of the basin adjoining the Pampanga River basin to over 4,000 mm in the northern mountainous area. This variation is mainly due to the topographical condition of the basin.

The monthly mean rainfall distribution at Bobok and Dagupan City is shown in Fig. 3.3. Bobok is located in the northern mountainous area with an elevation of 1,367 m and Dagupan City is in the Pangasinan plain. More than 90% of the annual rainfall occurs in the six months of the wet season. July or August is usually the month of the heaviest rainfall.

The Agno River basin is often attacked by tropical typhoons and storms which brought about heavy rainfall causing harmful flooding in the low land of the plain. During the last two decades the most destructive flood occurred in 1972. It rained almost continuously for thirty days due to successive occurrence of four tropical typhoons/storms from July 6 to August 1, 1972. Baguio City which is located in the vicinity of the northeastern watershed of the Agno River has recorded the heavy daily rainfall of 480 mm in July 17 and the monthly rainfall of 4,775 mm in July, 1972. The flood water from the Agno River basin and the Pampanga River basin almost merged into one big lake.

The mean annual temperature is 28°c at Dagupan City located in the Pangasinan plain and the mean monthly temperature varies from 23°c to 32°c. Relative humidity at Dagupan City is recorded at 77% on annual average. The month of April is the lowest at 70%, while the highest at 85% occurs in August. Meteorological features are summarized in Table 3.1.

4. FLOOD STUDIES

4.1 General

As described in Section 1, the major subjects of the flood studies are itemized below:

(1) Estimation of probable flood runoff distribution under the existing river condition in order to clarify present flood phenomenon,

(2) Estimation of probable flood runoff distribution under the condition with conceivable alternative flood control schemes, and

(3) Estimation of flood water level and duration time due to the probable flood flow in possible inundation area which is required to estimate the flood damage in the flood prove area.

In the light of the above objectives of each subject, flood studies are to be performed as discussed below.

4.2 Presentation of River Basin Model

4.2.1 Hyrological characteristics during flood

From the hydrological viewpoint, the existing condition of the Agno River and Allied River basins during flood period is characterized as follows:

(1) A continuous diking system has been provided for almost the whole stretch of the right bank of the main Agno River. For this reason, the Allied River basins are protected from the flood of the Agno River.

(2) However, some breached river sections of the said diking system, still remain in the downstream of San Roque caused by past floods and also gaps remain in the diking system. This implies that the flood runoff from the upstream basin will be partly diverted and/or overtopped into the Allied River basins.

(3) Due to the absence of left dike in the main Agno River at the downstream from the confluence with the Tarlac River, there still remains an inundation area.

(4) In order to dissolve a hydraulic bottle-neck point at Bayambang in the Agno River, about 10 km upstream of the junction of the Tarlac River, the by-pass floodway channel to the Poponto swamp was constructed. The Poponto swamp serves as a natural retarding basin at present.

(5) The lowland areas of the Allied Rivers receive the habitual flooding in the rainy season due to inadequate low flow capacity of river channels. Moreover, in case of flood associated with the one from the Agno River, a wide-spread flooding with long time duration is readily expected.

4.2.2 River basin model

The following four simulation models are adopted to simulate the said flood runoff mechanism and to assess the hydrological behaviour in the Agno River and the Allied Rivers:

- Basin runoff model
- River channel model
- Retarding basin model
- Flood inundation model

These models are schematically illustrated as shown in Fig. 4.1

4.2.3 Configuration of model

The river basin model is developed by combination of the foregoing simulation models. The river basin model for the Agno River comprises of basin runoff model, river channel model and retarding basin model. The model for the Allied Rivers is constructed by basin runoff model and river channel model.

However, the flood inundation model is applied to the Allied Rivers for the estimation of flood water level and duration time in its inundation area.

(1) Base Points

A base point is defined as a location along the river course to evaluate the magnitude of probable flood and to assess the effect of flood mitigation by conceivable flood control alternative schemes.

The nine base points are selected at confluences and rivermouth of main river streams and major tributaries. The selected base points are given below.

Base Point	Location	Basin Area (km^2)
BP - 1	Rivermouth of Agno River	5,907
BP - 2	Agno River upstream of conf. of Camiling River	4,388
BP - 3	Agno River upstream of conf. of Camiling River	2,441
BP - 4	Agno River at conf. of Ambayoan River	1,345
BP - 5	Camiling River at conf. of Agno River	604
BP - 6	Tarlac River at conf. of Agno River	1,896
BP - 7	Ambayoan River at conf. of Agno River	370
BP - 8	Rivermouth of Cayanga-Patalan River	618
BP - 9	Rivermouth of Pantol-Sinocalan River	1,115

In addition, sub-base points are necessary to estimate the probable flood runoff. These points are set up at locations where significant changes in flood runoff are expected, such as:

- confluence of main river and major tributaries
- proposed/existing damsites
- proposed/existing flood diversion sites
- beginning/end points of river stretches divided from viewpoint of flood control planning, and
- existing water level gauging stations

(2) River basin model diagram

The Agno River and Allied River basins and their river course are divided into sub-basins and river channels taking into account the base points and sub-base points. Divided sub-basins are shown in Figs. 4.2 and 4.3 for the Agno River and the Allied Rivers basins respectively.

The river basin model diagram is thus configurated as illustrated in Fig. 4.4. The model diagram comprises of the following components:

Component	Agno River	Allied Rivers
sub-basin	58	39
river channel	31	22
retarding basin	1	0
dams (existing/identified)	15	2

As shown in Fig. 4.4, these components are linked together by base points and sub-base points.

4.2.4 Basic concept of simulation model

(1) Basin runoff model

Flood runoff from sub-basin is estimated by means of storage function method. The storage function is expressed by the following equations:

$$S = KQ^P$$

$$dS/dt = (1/3.6).f.r.A - Q$$

Where, S : basin storage (m^3)
Q : runoff from sub-basin (m^3/sec)
K,P : constant
t : time (sec)
f : runoff coefficient
r : basin mean rainfall (mm/hr)
A : catchment area (km^2)

Constants of K and P in storage function are initially estimated by means

of the following empirical formula:

$$K = 118.84 \cdot i^{0.3}$$

$$P = 0.175 \cdot i^{-0.235}$$

Where, i : average river bed slope

Finally, flood runoff from sub-basin is adjusted taking lag time into consideration. The lag time is roughly estimated by empirical formula expressed below.

$$Tl = L/V$$

Where, Tl : lag time in sub-basin (hr)

L : river length (km)

V : flow velocity (m/sec)

V = 3.5 m/sec i > 1/100

V = 3.0 m/sec 1/200 < i < 1/100

V = 2.1 m/sec i < 1/200

i : average river bed slope

(2) River channel model

In case that the river bed slope is rather gentle or the water level is affected by the backwater due to the relatively higher water level in the main stream, the flood runoff generally retards through river channel.

The storage function of river channel is estimated by the river cross section, river bed gradient and river length through the non-uniform/uniform flow calculation.

The flood runoff through a river channel is estimated by the following equations:

$$S = K O^P$$

$$dS/dt = I - O$$

Where, S : storage volume in river channel (m^3)

K,P : constants

O : outflow from river channel (m^3/sec)

I : inflow to river channel (m^3/sec)

The lag time in river channel is estimated by the preceding empirical formula.

(3) Retarding basin model

As mentioned before, the Poponto swamp has a function to retard the flood peak runoff. The retardation effect of the swamp is assessed by solving hydraulic equations for continuity and movement derived from the relation among inflow, outflow, water level and storaged volume of the swamp. The basic concept of the model is briefly discussed in Fig. 4.5.

(4) Flood inundation model

Flood inundation model simulates a wide-spread flooding in lowland areas of the Allied Rivers. In order to express two dimensional movement flood flow in inundation area, the sequential pond method is adopted as schemetically illustrated in Fig. 4.6. As shown in Fig. 4.7, the possible inundation area in the Allied Rivers, which is identified through the flood mark survey conducted by the Study Team, is divided into 250 mesh blocks with each area of 2 km x 2 km. This model simulates the flood flow propagation through divided mesh blocks by solving the kinematic and continuity equations as given below;

$$L/g.dv/dt = (h_1 + Z_1) - (h_2 + Z_2) - L.n^2.\ v\ .v/h^{4/3}$$

$$F.dH/dt = Q_i - Q_o$$

Where,
- L : interval between mesh blocks (m)
- g : acceleration of gravity (m/sec^2)
- v : flow velocity (m/sec)
- t : time (sec)
- h : water depth of mesh (m)
- Z : ground elevation (m)
- n : coefficient of roughness
- F : area of mesh block (m^2)
- H : water level of mesh (m)
- Qi : inflow of mesh (m^3/sec)
- Qo : outflow of mesh (m^3/sec)

This inundation model is also incorporated with basin runoff model to estimate a inflow to designated mesh blocks from upstream basins of the Allied Rivers and overflowed flood inflow from the Agno River.

4.3 Calibration of Model

The parameters incorporated in the proposed river basin model are calibrated by use of selected flood record. Because of the availability and quality of the selected flood record, the river basin model for the Agno river is mainly calibrated. The basic concept obtained through the simulation is applied to determine parameters of the model for the Allied Rivers. The calibration is carried out in accordance with the general procedure as shown in Fig. 4.8.

4.3.1 Selection of flood record for calibration

Table 4.1 shows recorded annual maximum peak discharge for the period of 1950-1971 at San Roque and Carmen which are located in middle reaches of the Agno River. However, the flood records of rainfall and discharge on hourly basis are not available, though historically big flood is recorded.

The 3-hour rainfall and discharge records of major past flood since 1982 are available at 5 telemetering gauging stations of AFFWS. Recorded floods caused by big typhoon are enumerated below:

Typhoon	Occurrence date
Maring	Aug. 27-31, 1984
Kuring	June 20-24, 1985
Daring	June 25-29, 1985
Gading	July 7-11, 1986
Miding	Aug.29 - Sept.3, 1986

The observed 4-day rainfall and maximum peak discharge at these gauging stations are summarized in Table 4.2 Water level records at San Roque and Carmen are essential from the viewpoint of calibration of the simulation model. Water level gauge equipments thereof, however, were damaged by typhoon Maring

in 1984 and are still be unrepaired at present.

In view of the above conditions, the flood record of typhoon Maring in 1984 is selected for calibration of the river basin model.

4.3.2 Flood record of typhoon Maring

(1) Discharge

3-hour discharge at 5 stations of AFFWS are estimated from observed water level by use of discharge rating curves as shown in Fig. 4.9.

Table 4.3 shows estimated 3-hour discharge during typhoon Maring.

(2) Basin mean rainfall

Duration of rainfall during typhoon Maring is 4 days as given in Fig. 4.10. Together with 5 rainfall gauging stations of AFFWS, 9 stations are adopted for the estimation of basin mean rainfall by means of Thiessen polygon method. Fig. 4.11 shows Thiessen's polygon laid out in the basin.

Due to differences in station elevations, the estimated basin mean rainfall is adjusted based on rainfall-elevation relationship as introduced in Fig. 4.12.

Accordingly, the basin mean rainfall is estimated by area weight of Thiessen's polygon and adjustment factor for basin mean elevation as expressed by the following equation:

$$Rm = \sum_{i} fi.FLi.Ri$$

Where, Rm : basin mean rainfall (mm)
fi : Thiessen weight
FLi : adjustment factor for basin mean elevation
Ri : point rainfall (mm)

Table 4.4 shows Thiessen weighta and adjustment factors of selected rainfall stations at respective points in the Agno River basin. As given in