NATIONAL WATER RESOURCES BOARD
THE REPUBLIC OF THE PHILIPPINES

THE STUDY
ON
INTEGRATED WATER RESOURCES MANAGEMENT
FOR
POVERTY ALLEVIATION AND ECONOMIC DEVELOPMENT
IN
THE PAMPANGA RIVER BASIN
IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME III: SUPPORTING REPORTS

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Composition of Final Report

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Sector A

Topography and Meteo-Hydrology

Sector A. Topography and Meteo-Hydrology

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Sector A. Topography and Meteo-Hydrology

A.1 Introduction

This Sector Report A describes Topographic conditions, Meteo-hydrological characteristics, Geological conditions, Present situation of land subsidence and Long-term rainfall-runoff simulation. Based on the results of long-term rainfall-runoff simulation, Surface water resources potential and Groundwater resources potential have been evaluated and described in Sector Report H.

Monitoring data for meteorological and hydrological conditions have been collected. Selected data have been arranged and inputted and shown in Data Book. Monitoring data meteorological and hydrological is very important for water resource management. The more reliable, accurate and long-term data are available, the more efficient and solid planning and management for the water resources would be implemented. However, duration of observation is in general very short in many stations the study area. Therefore, appropriate observation of hydrological data would be required in appropriate stations.

In the present study, technical transfers on Hydrological Analysis to personnel of NWRB have been conducted.

A.2 Topographic Conditions

A.2.1 General

Pampanga river basin is located in Central Luzon (see Annex-F A.2.1.1 for the general topographic map). The southern boundary of the basin lies along Manila Bay, while the northwest boundary forms the relatively flat area, which extends toward the adjacent Agno river basin. Other boundaries are surrounded by the mountains such as Sierra Madra Mountains on the east, Caraballo Mountains on the north, and Zambales Mountains, which includes the well-known Pinatubo Mountains on the west. Zambales Ranges is characterized by the volcanic imprint associated with geologically young calderagenic-type volcanic eruption. In contrast, the eastern highlands area comprises more of dissected and eroded terrain. The central part of the basin is relatively flat, which forms Central Luzon Plain. The highest elevation of 1,885 m above mean sea level in the study area can be seen at the northeast boundary of the study area in Sierra Madra Mountains. The lowest elevation which is almost equal to mean sea level extends widely at around the river mouth of Pampanga river basin. There are some small peaks in Luzon Central Plain namely, Mt. Arayat with an elevation of 1,026m.

A.2.2 Topographic Classification

A.2.2.1 Preparation of Digital Elevation Model (DEM)

In the present study, Digital Elevation Model (DEM) with 100m grid has been created for the analysis of topographic condition in the study area by using the digitized counter lines and spot elevations by the following two sources of topographic maps.

- Contour lines with 100m interval and spot elevations of New NAMRIA topographic map (1:50,000) digitized by NAMRIA and JICA in 2008[1)]
- Contour lines with 100m interval of Old NAMRIA topographic map (1:50,000) digitized by DENR Region III and spot elevations in flat area digitized by JICA Study Team

Annex-F A.2.2.1 shows the locations in which the New NAMRIA topographic maps are available. The main portion of the study area is covered by the New NAMRIA topographic maps. However, the eastern and northern parts are not covered. Old NAMRIA topographic maps are employed there, instead.

A.2.2.2 Classification by Elevation

The study area is categorized by elevation zones using the DEM. Annex-F A.2.2.2 shows the distribution of each elevation zones in the study area. Table A.2.2.1 summarizes the share of the each elevation zone.

About 15% of the study area has elevation less than 10m above mean sea level. This low-land area extends widely from the river mouth toward the middle reach of Pampanga River. In more than 50% of the study area, the elevation ranges from 10m to 200m above mean sea level. It consists of Central Luzon plain. The hilly to low mountain area with elevation of 200-800m is surrounding Central Luzon plain. Almost all portions of Sierra Madra Mountains reside in the range. The area with more than 800m above mean sea level in elevation shares about 5% of the study area. It is mainly located in Pinatubo Mountains and the north- eastern boundary of the study area.

Table A. 2.2.1 Elevation Classification in the Study Area

Elevation Zone	Area (km^2)	Percentage of the Total Area
< 5 m	820.4	7.9
5 – 10 m	581.0	5.6
10 – 50 m	2,899.0	27.8
50 – 200 m	2,772.0	26.6
200 – 500 m	1,896.6	18.2
500 – 800 m	969.7	9.3
800 – 1,200 m	392.9	3.8
1,200 – 1,600 m	96.6	0.9
1,600 m <	6.1	0.1
Total	10,434.4	100.0

Source: JICA Study Team

A.2.2.3 Classification by Slope

Slope is one of important factors for water resources planning. It usually related to erosion and consequently sediment and nutrient yields from a river basin. The study area is also categorized by the slope. Annex-F A.2.2.3 shows the distribution of each category of slope in the study area. Table A.2.2 summarizes the share of the each category of slope.

More than 65% of the study area is categorized as “level to nearly level (slope is less than 3%)”. It extends widely from Manila Bay to Central Luzon plain. The share of the remained categories almost evenly distributed to each category. The area with the categories of “steep” and “very steep” covers more than 10% of the study area.

Table A. 2.2.2 Slope Classification in the Study Area

Description	Percent Slope (%)	Area (km^2)	Percentage of the Total Area
Level to nearly level	< 3	7,045.5	67.5
Gently sloping to undulating	3 – 8	600.2	5.8
Undulating to rolling	8 – 18	706.5	6.8
Rolling to moderately steep	18 -30	781.4	7.5
Steep	30 - 50	979.6	9.4
Very steep	50 <	321.3	3.1
Total		10,434.4	100.0

Source: JICA Study Team

A.2.2.4 Summary of Regional Topography

The topographic condition in the study area can be largely categorized as follows, considering the elevation, slope and other factors.

(1) Central Luzon Plain

- Alluvial plain
- River bed

(2) Hilly Region

- Low terrace
- High terrace
- Lahar, talus

(3) Mountainous Region

The detail description on the category of the topography is presented in Table A.2.2.3.

Table A. 2.2.3 Category of Topographic Condition in the Study Area

Quaternary volcanics		Slope condition	Description
Large	Small		
Central Luzon Plain	Alluvial plain	Level to nearly level	Seashore, levee, lagoon, sandbar, hinterland, Candaba widely distributed in Pampanga river basin. It is mainly utilized for paddy field. Elevation: 0－25m.
	River bed	Level to rolling	It is distributed along the river up to upstream reach. Unused land.
Hilly Region	Low terrace	Gently sloping to undulating	It is distributed along the plain and Southern Sierra Madre Mountains. High from the plain 10-15 m & used paddy field getting water from upstream in general.
	High terrace	Undulating to rolling	High 30-40m from plain and some area used for paddy field.
	Lahal, talus	Rolling to moderately steep	It is distributed at the foot of Mt. Pinatubo. Talus topographies are formed here and there at the mountain foot of eastern mountains.
Mountainous Region		Rolling to moderately steep	It forms gentle mountains and distributed the western part of Southern Sierra Madre Mountains.
		Steep to very steep	It is distributed at Mt. Pinatubo, Southern Sierra Madre Mountains, in which old rocks can be observed.

Source: JICA Study Team

A.2.3 Change in Topography by Pinatubo Eruption in 1991

The most significant change in topography in the study area occurred in 1991. It was the eruption of Pinatubo Mountains. As demonstrated in Annex-F A.2.2.4, the top of Mt. Pinatubo was blown out during the eruption, making the height of the mountain about 500m lower than before.

Significant volume of lahar has been produced by the eruption. The lahar is deposited widely around Pinatubo Mountains as shown in Annex-F A.2.2.5. The deposition of the lahar may cause flooding during a heavy rainfall event at surrounding areas. How to deal with the lahar deposit is one of important issues in Pinatubo area in nowadays.

A.3 River Systems and Sub-Basins

A.3.1 Delineation of Sub-Basins in the Study Area

The study area is largely divided into the following three river systems.

- Pampanga Main river system
- Angat river system
- Pasac river system

These river systems are connected each other at low-land area of the river mouth of Pampanga River. However, because those connecting channels are relatively minor, it can be regarded that three river systems are rather independent as a drainage system.

In the study area, there are six major and principle tributaries identified by NWRB[2)], which has code number, as follows.

- Angat (03055)
- Penaranda (03056)
- Coronell (03057)
- Pantabangan (03058)
- Pampanga (03059)
- Rio Chico (03421)

The sub-basins in the study area are delineated considering the three river systems and the major and principle tributaries identified by NWRB. The delineation was conducted on the basis of the following principles.

- To basically follow natural topographic condition.
- To consider artificial drainage network, irrigation canal and levees, if natural topographic condition is very flat.

Totally 13 sub-basins are delineated. The delineated sub-basins are shown in Annex-F A.3.1.1 together with main rivers. Table A.3.1.1 summarizes the main feature of the sub-basins. The elevation and slope classification for each sub-basin is shown in Annex-T A.3.1.

Table A. 3.1.1 Main Features of Sub-Basins

River System	Code	Code by NWRB[2)]	Name by NWRB[2)]	Area (km^2)	Average Elevation (m)	Main Rivers, Tributaries and Main Reservoirs
Pampanga Main	PAM01	03059	Pampanga	159.20	5	Pampanga River
	PAM02	03059	Pampanga	1,517.26	74	Pampanga River Maasim River San Miguel River
	PAM03	03059	Pampanga	39.79	19	Pampanga River
	PAM04	03059	Pampanga	798.67	90	Pampanga River Tabualing River Cabu Creek
	PAM05	03059	Pampanga	436.59	336	Pampanga River Digmala River
	PAN01	03058	Pantabangan	849.42	517	Pantabangan River Pantabangan Dam
	RCH01	03421	Rio Chico	2,895.29	137	Rio Chico River Baliwag River Talavera River Bamban River
	PEN01	03056	Penaranda	569.71	326	Penaranda River Sumacbao River
	COR01	03057	Coronell	712.02	485	Coronell River
Angat	ANG01	03055	Angat	193.50	6	Labangan Floodway
	ANG02	03055	Angat	345.77	213	Angat River Bayabas River
	ANG03	03055	Angat	545.89	524	Angat River Angat Dam
Pasac	PAS01	N/A	N/A	1,371.29	130	Pasac River Manapi Mesapinit River (New diversion channel connected to Abacan River and San Fernando River) Abacan River San Fernando River Guagua River Sapang Labuan River Pasig Potrero River Gumain River Porac River
Total				10,434.39		

Source: JICA Study Team

A.3.2 Characteristics of Main Rivers and Sub-Basins

A.3.2.1 Pampanga Main River System

The main stream of Pampanga River originates from Caraballo Mountains on the north of the study area. The most upstream part of Pampanga River is often called as Pantabangan River. After passing Pantabangan storage dam, the flow merges with the second largest tributaries, Coronell River, which makes significant increase in flow discharge. Pampanga River meets with Penaranda River, which originates from Sierra Madra Mountains, at further downstream. At around the Mt. Arayat, the largest tributaries, Rio Chico River merges into Pampanga River. Pampanga River then flows though low-land area such as Candaba Swamp, and finally reaches to the river mouth.

The schematic river system with nine (9) sub-basins which consists of Pampanga Main river system is shown in Annex-F A.3.2.1. The total length of Pampanga main stream including Pantabanan River is 265km and the total catchment area is 7,977.95km^2. The longitudinal profiles of Pampanga River including Pantabangan River and the main tributaries are demonstrated in Annex-F A.3.3. The topographic features of the sub-basins are as described below:

Table A. 3.2.1 Topographic Features of Sub-basins of Pampanga Main River System

Sub-basin Code	Topographic Features
PAM01	The sub-basin PAM01 is located at the most downstream of Pampanga River. Almost all of the area in the sub-basin is lower than 5m above mean sea level, which is characterized as a wet-land. The river slope of Pampanga River in this sub-basin is less than 1/10,000. The excess surface water is drained mainly directly to Manila Bay through braided river network in the wet-land area. The main land use in this sub-basin is fish pond.
PAM02 and PAM03	The sub-basins PAM02 and PAM03 are the attached catchment of the main stream of Pampanga River between Calumpit and the confluence with Penaranda River. The sub-basin is located at the east side of Pampanga River. Along the river does low land area widely extend, which is called as Candaba Swamp. Massim and San Miguel Rivers are the main tributaries to Candaba Swamp and eventually to Pampanga River. The river slope of Pampanga River around these sub-basins is between 1/10,000 and 1/2,500. These sub-basins have both low-land and hilly areas. There are irrigation areas between the swamp and the hilly area.
PAM04	The sub-basin PAM04 is located at between the confluence with Penaranda River and that with Coronell River. Two main tributaries, Tabuating River and Cabu Creek, merge to Pampanga River in the sub-basin. The river slope of Pampanga River around this sub-basin is between 1/2,500 and 1/1,000. The main part of the sub-basin is relatively flat, which the irrigation area is widely extended. There exists the urban area of Cabanatuan city in the sub-basin.
PAM05	The sub-basin PAM05 is located between the confluence with Coronell River and Pantabangan storage dam. The river slope of Pampanga River around this sub-basin is between 1/1,000 and 1/400. The sub-basin is generally hilly area. It contains the catchment of Digmala River, which is a typical fluvial fan river and originates from the highest peak of Pampanga river basin.
PAN01	The upstream of Pantabangan storage dam is the sub-basin PAN01. It is typical mountainous catchment. The river slope of Pampanga River around this sub-basin is more than 1/400. The main land cover in the sub-basin is forest and brush land.
RCH01	The sub-basin RCH01 is the catchment of Rio Chico River, the largest tributaries of Pampanga River. Rio Chico River consists of Talavera River and Baliwag River. Bamban River, which originates from Pinatubo mountain, also contributes to Rio Chico River. The land is relatively flat, which is largely utilized as irrigation areas. San Antonio Swamp is located at around the confluence with Pampanga River. A part of Tarlac city is in this sub-basin.
PEN01	The sub-basin PEN01 is the catchment of Penaranda River. Penaranda River has the lager tributary, Sumacbao River. The main part of this sub-basin is located in Sierra Madra Mountains. The land cover is mainly forest and brush land.
COR01	The sub-basin COR01 is the catchment of Coronell River, the second largest tributaries Pampanga River. Coronell River flows though the valley bottom of the highest and steepest mountain area in Pampanga river basin.

Source: JICA Study Team

A.3.2.2 Angat River System

Angat River originates from Sierra Madra Mountains. The river flows through meandering narrow valley in Sierra Madra Mountains. After reaching the relatively flat terrain, Angat River flows toward the west. Bayabas River, the main tributary, merges to Angat River at around Angat town. The river continues to flow around the southern boundary of Candaba Swamp, and eventually drains to Manila Bay through Labangan Floodway. There is a small connecting channel with Pampanga River, which is called as Bagbag River.

The schematic river system with three (3) sub-basins which consists of Angat river system is shown in Annex-F A.3.2.3. The total length of the main stream of Angat River is 153km and the total catchment area is 1,085.16km^2. The longitudinal profiles of Angat River and the main tributary are demonstrated in Annex-F A.3.2.4. The topographic features of the sub-basins are as described below:

Table A. 3.2.2 Topographic Features of Sub-basins of Angat River System

Sub-basin Code	Topographic Features
ANG01	The sub-basin ANG01 is located at the most downstream of Angat River. Almost all the area in the southern half of the sub-basin is lower than 5m above mean sea level, which is characterized as a wet-land. Labangan Floodway that is connected to Angat River at around Calumpit is a main drainage in this sub-basin. The river slope of Labangan Floodway is less than1/2,000. The excess surface water in this sub-basin is drained mainly directly to Manila Bay through braided river network in the wet-land area. The main landuse in the wet-land area is fish pond. Northern part of the sub-basin is utilized as irrigation area. Malolos city, the capital of Bulacan Province, is located in the sub-basin.
ANG02	The sub-basin ANG02 is located between the confluence with Bagbag River that is connecting channel to Pampanga River and Angat storage dam. The lower half of the sub-basin is characterized as a narrow corridor in which the catchment area is restricted by dykes and irrigation canals. The rest part is in the hilly to mountainous area. The river slope of Angat River in the sub-basin is between 1/2,000 and 1/300. The land cover of the hilly to mountainous area is mainly brush land.
ANG03	The sub-basin ANG03 is a catchment of Angat storage dam. The typical mountainous topography can be observed in the sub-basin. The river slope of Angat River in the sub-basin is more than 1/300. The land cover is mainly forest. The precipitation amount in the sub-basin exceeds well over the average precipitation amount in the entire study area.

Source: JICA Study Team

A.3.2.3 Pasac River System

Pasac river system is an allied river system of Pampanga River. It is connected with Pampanga River mainly by Bebe-San Esteban Cutoff Channel. The river system covers the south eastern slope of Pinatubo Mountain. It has the most variable sub-basins among the three principal river systems in the study area, because of the variations in both natural conditions such as Pinatubo eruption and social conditions such as rapid urbanization in San-Fernando and Angels areas. To present the characteristics of the sub-basin, the river system is further largely sub-divided into four main catchments as follows (see also Annex-F A.3.1.1).

- Abacan-San Fernando River Catchment
- Guagua River Catchment
- Porac-Gumain River Catchment
- Other low-land Catchments

The schematic river system is shown in Annex-F A.3.2.5 with the main catchments. The total catchment area of Pasac river system is 1,371.29km^2. The longitudinal profiles of the main rivers in Pasac river system are demonstrated in Annex-F A.3.2.6

(1) Abacan-San Fernando River Catchment

Abacan River flows through the most northern part of the sub-basin. It originates from the peak of Pinatubo Mountain. The river goes toward the southeast, and finally reaches to the confluence with San Fernando River at around Mexico town. The catchment includes the drainage area of Pampanga Delta Irrigation System.

San Fernando River originally flows from the confluence with Abacan River to the southwest, and merges to Guagua River. However, after the eruption of Pinatubo Mountain in 1991, its original river course has been obstructed by the sediment deposition and the dyke system to prevent the sediment disaster in Pasig-Potrero River. The excess water from the catchment of San Fernando River is now planned to be drained through Manapi Mesapinit River (a new diversion channel connected to Abacan River and San Fernando River).

The rapidly urbanized areas such as San Fernando and Angels are located in the catchment. The buildup area and irrigation areas are dominant in landuse in this catchment.

(2) Guagua River Catchment

Pasig-Potrero River also originates from Pinatubo Mountain. It is connected to Sapang Labuan River and finally to Guagua River. The eastern part of the catchment area is

restricted by large dyke systems for Pasig-Potrero River to prevent the sediment disaster. The inside of the dyke systems, which is actually the catchment of Pasig-Potrero River, is full of sediment initiated by the Pinatubo Mountains. The remained catchment area is rather used for irrigation area.

(3) Porac-Gumain River Catchment

Porac-Gumain River flows through the most western part of the sub-basin. The upper part of the catchment covers the south-eastern slope of Pinatubo Mountain. The lower part of the catchment is a narrow corridor, which restricted by dyke systems for Porac-Gumain River.

(4) Other Low-land Catchments

The most part of the remained catchment is rather low-land area. The excess surface water in the catchment is drained either by Pasac River or directly to Manila Bay through braided river network in the low-land area. The main landuse in the wet-land area is fish pond.

A.4 Meteorology and Hydrology

A.4.1 Monitoring Data for Meteorology and Hydrology

Monitoring data for meteorological and hydrological conditions are fundamental for better water resources management in a river basin. The more reliable, accurate and long-term data are available, the more efficient and solid planning and management for the water resources would be implemented. The available meteorological and hydrological data for the IWRM for Pampanga river basin are described below.

A.4.1.1 Meteorological Data

Meteorological data including precipitation are observed, collected and stored mainly by Philippine Atmospheric, Geophysical & Astronomical Services Administration (PAGASA). There are two synoptic stations, at which climatic data are fully observed, inside Pampanga river basin. PAGASA also collects some precipitation data by their stations and real time data using flood forecasting system. According to the explanation by PAGASA, the processed data by PAGASA may require the additional cost to obtain, but the raw data could be freely distributed. There are other available historical data shown in the previous report.

In the present study, the available meteorological data have been collected as much as possible, considering the importance, those cost and easiness for inputting and arranging for the study. The data for the following stations have been then selected for the discussion and analysis for the present study.

(1) Precipitation data (totally 36 stations)

- PAGASA synoptic stations (2 stations for the inside of the study area, 7 stations for the surroundings of the study area)
- PAGASA other stations (9 stations)
- PAGASA telemetry stations (12 stations)
- Others (6 stations mainly from previous reports[3), 4), 5)])

(2) Other climatic data (2 stations)

- PAGASA synoptic stations (2 stations for the inside of the study area: CLSU Munoz and Cabanatuan)

The lists of the stations together with the duration when the data are available are presented in Annex-T A.4.1.1 for the precipitation data and Annex-T A.4.1.2 for the other climatic data. The locations of the meteorological stations are shown in Annex-F A.4.1.1.

For the precipitation data, daily data have been basically collected except for some stations outside of the study area. The monthly data have been arranged and inputted for further analysis. The daily data for the synoptic stations have also been arranged and inputted. Except for the data at PAGASA synoptic stations, the duration of observation is generally short or there are many missing data. The gap filling of the missing data are necessary for utilizing the data at those stations. However, those data are still valuable for estimating spatial distribution of the precipitation.

Some collected data are not selected for further analysis in the present study, if they are significantly inconsistent with other data. Typical example is the data observed in the telemetry system in Angat storage dam. They indicate that the long-term annual average precipitation in the catchment of Angat storage dam be around 3,500mm/year considering reasonable range of the correction of precipitation for elevation. However, the long-term averaged inflow volume to Angat dam reservoir is recorded at about 3,400mm/year. Considering the evapotranspiration loss in the catchment, the precipitation should be more than 4,000mm/year. In such case, such precipitation data have been excluded for further analysis.

For the other climatic data, the monthly average data for the following parameters are collected.

- Mean air temperature
- Relative humidity
- Sunshine duration
- Wind speed
- Pan evaporation

The WorldClim[6)] dataset is global dataset which includes 1km mesh data for precipitation and mean air temperature. They are long-term averaged monthly data. The data have been prepared based on observed data with correction for altitude using digital elevation model. The mean temperature data by the Worldclim dataset are utilized for the study for evaluation of spatial distribution of potential evapotraspiration in the study area.

A.4.1.2 Hydrological Data

(1) Surface water

Surface water quantity has been mainly monitored and stored by BRS-DPWH. Before 1980s, there were relatively large numbers of the monitoring stations in and around the study area. However, many of them have been abandoned.

In the present study, the available hydrological data have been collected and inputted as much as possible, considering the importance and easiness for inputting and arranging for the study. The data for totally seventy-two (72) stations in and around the study area have been collected from BRS-DPWH. Nineteen (19) stations have only water level data among them. The monthly average, annual maximum and minimum flow data have been arranged and inputted. The daily data have been inputted only for the selected stations. Besides the data by BRS-DPWH, some data are available from the previous report[3)], and they are also collected and inputted.

The inflow data for Angat dam reservoir and Pantabangan dam reservoir are also available. The inflow data are those calculated based on the water balance in the reservoir, which is relatively reliable as compared with an unstable river gauging station.

The operation data of Angat dam reservoir have been collected from National Power Corporation (NPC). The monthly inflow is estimated as follows:

- The daily water balance data are available after 1996. In addition, the historical monthly inflow data before 1995 have been prepared by NPC.
- The daily water balance data after 1996 have been checked and the monthly inflow after 1996 is calculated considering the loss such as evaporation and seepage.
- The average loss was estimated based on the total inflow and outflow before 1995 shown by NPC.
- The estimated monthly inflow before 1995 by NPC is utilized as they are.

The operation data of Pantabangan dam reservoir have been collected from National Irrigation Administration (NIA)-UPRIIS. The monthly inflow is estimated as follows:

- The daily water balance data are available after 1980.
- In the present study, the estimated inflow by NIA is used as it is. The water balance data are rather complicated, because they have two (2) connected dams; Pantabangan storage dam and Masiway dam. Although the way of estimating the inflow is not clearly shown, it is judged that the estimated inflow includes both the inflow to Pantabangan dam reservoir and local inflow from the catchment of Masiway dam.
- By checking the balance between inflow and outflow, the average loss such as evaporation and seepage has been estimated.

The lists of the stations are presented in Annex-T A.4.1.3 and the duration when the data are available is presented in Annex-T A.4.1.4. The locations of the hydrological stations are shown in Annex-F A.4.1.2.

(2) Groundwater

There are basically no pure monitoring wells in the study area according to the information from NWRB. The monitoring of groundwater is usually conducted using production wells by water districts, instead. The monitoring data are accumulated in each water district and some are stored in the data center of LWUA.

The monitoring division of NWRB sometimes implements the inventory survey for the wells to which the water use permit has been issued. Such data also supplements the monitoring data for groundwater. The locations of the wells, part of which could be utilized as a monitoring station for groundwater, are indicated as location of granted water permits for groundwater in Sector Report D.

A.4.2 Meteorology

A.4.2.1 General

PAGASA classifies climates types for the Philippines based on the Modified Coronas Climate Classification using the data at forty five (45) synoptic stations and sixty six (66) climate stations during 1951 to 2003 as shown in the following table.

Table A. 4.2.1 Climate Classification in the Philippines

Type	Description
Type I	Two pronounced season dry from November to April and wet during the rest of the year. Maximum rain period is from June to September.
Type II	No dry season with a very pronounced maximum rain period from December to February. There is not a single dry month. Minimum monthly rainfall occurs during the period from March to May.
Type III	No very pronounced maximum rain period, with a dry season lasting only from one to three months, either during the period from December to February or from March to May. This type resembles Type I since it has a short dry season.
Type IV	Rainfall is more or less evenly distributed throughout the year. This type resembles Type II since it has no dry season.

Source: PAGASA, Climate Map of the Philippines (1951-2003), 2007[7)]

Annex-F A.4.2.1 shows the classified climate zone in and around the study area. The western part of the study area is covered by Type I. The area around east boundary is mostly classified as Type III.

The spatially averaged annual total precipitation in the study area is estimated at about 2,150mm/year. The spatially averaged annual mean air temperature in the study area is estimated at about 26 degree Celsius.

A.4.2.2 Gap Filling of Precipitation Data

The precipitation data collected have many gaps. As a first step for filling the gaps, the correlations among the observed precipitation data at each station have been investigated. Annex-T A.4.2.1 shows the correlation coefficients among the observed precipitation data. In general, the stations with same climate zone have higher correlation.

Based on the correlation among the stations and the location of the stations, the key stations for the gap filling have been selected from the PAGASA synoptic stations that have longer duration of observation and fewer gaps. The followings are the selected key stations.

- Cabanatuan
- Science Garden
- Infanta

- Iba

Firstly, the gaps at the key stations have been filled using linear regression equations with the stations with higher correlation. Annex-T A.4.2.2 shows the stations used for the gap filling for the key stations together with the regression equation. The regression equation has been prepared considering a double mass curve so that long-term total precipitation volume after the gap filling and one calculated only by the observed data would be almost same.

Secondly, the gaps at other stations have been filled using the precipitation data at the key stations. Annex-T A.4.2.3 shows the key station used for the gap filling and regression equation for each station.

By the gap filling, the monthly precipitation data during 1951 to 2007 have been basically completed. However, at some stations located in Type II climate zones, it was not possible to fill the gaps perfectly for entire periods during 1951 to 2007, due to lack of the observed data.

A.4.2.3 Estimation of Potential Evapotranspiration (PET)

There are several methods to estimate potential evapotranspiration (PET). Some methods require only mean air temperature and others require more climatic parameters. Considering the necessity of the estimation of spatial distribution of PET for evaluating water resources in a river basin scale, the method that requires less parameter is preferable. In the present study, the Harmon method[8)], which requires only mean air temperature, is selected for the estimation of PET. The Harmon method is also employed in the rainfall-runoff model described in the later chapter. PET can be estimated by the following equations in the Harmon method.

$$PET = 13.97 d D^2 W_t$$

$$W_t = \frac{4.95 \exp(0.062T)}{100}$$

where PET = potential evapotranspiration in mm/month, d = number of days in a month, D = mean monthly hours of daylight in units of 12hrs, W_t = a saturated water vapor density term in grams/m^3, T = mean monthly air temperature in degree Celsius.

It should be noted that PET is not actual evapotranspiration. Actual evapotranspiration would vary according to availability of water in a surface soil.

A.4.2.4 Temporal Variation in Meteorological Conditions

(1) Long-term Trend

The changes in the annual total precipitation at the key stations during 1951 to 2007 are presented in Annex-F A.4.2.2. No clear tendency of long-term variation of the precipitation can be observed, although there could be some periodical patterns.

The annual averaged air temperatures at CLSU Munoz and Cabanatuan have a tendency to increase during the observation period. However, the measured pan evaporation in CLSU Munoz seems to be, in contrast, decreasing, although the increase of air temperature may result in increasing evaporation. No clear tendency is observed in other climatic parameters. It is difficult to judge if there is an irreversible change in climatic condition in the study area at this moment with the limited information.

(2) Monthly Variation

(a) Precipitation

The long-term averaged monthly variations of the precipitation at the key stations based on the completed data during 1951 to 2007 are shown in Table A.4.2.2. In Cabanatuan and Science-Garden, the driest month is February and the maximum precipitation occurs in August. In Infanta, the precipitation is almost evenly distributed through a year.

Table A. 4.2.2 Monthly Variation of Precipitation at Key Stations

(unit: mm)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cabanatuan	10	8	16	30	173	253	341	385	315	186	111	41	1,869
Science Garden	16	12	19	37	185	312	450	513	408	251	152	67	2,422
Infanta	322	231	201	205	243	257	261	213	293	584	602	622	4,034
Iba	17	9	17	40	301	501	746	923	604	250	132	35	3,574

Source: JICA Study Team based on PAGASA data

(b) Other Climatic Parameters

The monthly variations of the climatic parameters at CLSU Munoz are shown in Table A.4.2.3. Annex-F A.4.2.3 shows the monthly variations of the climatic parameters at CLSU Munoz.

Table A. 4.2.3 Monthly Variation of Climatic Parameters at CLSU Munoz

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mean Air Temperature (℃)	25.9	26.1	27.0	28.7	29.4	28.6	27.9	27.5	27.5	27.5	27.4	26.3	27.5
Relative Humidity (%)	76.4	77.6	76.3	74.9	76.2	81.3	84.2	87.0	86.0	82.7	77.8	75.5	79.7
Wind Speed (m/s)	3.2	3.1	2.7	2.5	2.1	2.2	1.8	2.0	1.9	2.0	2.7	3.0	2.4
Sunshine Duration (hrs)	7.9	8.7	8.9	9.3	7.6	6.4	5.3	4.7	5.1	6.2	6.8	7.0	7.0
Pan Evaporation (mm/month)	168	169	203	213	192	147	135	119	120	129	135	153	1,879
PET (mm/month)	82	84	111	138	166	163	156	139	114	104	88	81	1,426

Source: JICA Study Team based on PAGASA data

In general, there is not so significant change in air temperature through a year. The hottest month is May with mean air temperature of 29.4degree Celsius. On the other hand, January is the coolest with mean air temperature of 25.9degree Celsius. The difference in the hottest month and the coolest month is just about 3.5degree Celsius.

The relative humidity ranges between 75% and 87%. The highest relative humidity appears in August. The driest month in terms of relative humidity comes in April after the least precipitation month in February.

The average wind speed is high during December to February. During the season with higher wind speed, wind direction is dominant from northeast due to monsoon. The highest wind speed with 3.2 m/s appears in January. The annual averaged wind speed is 2.4m/s.

The annual mean sunshine duration is 7.0hrs. The longer sunshine duration appears in April (9.3hrs) and the shortest appears in August (4.7hrs).

Annual total pan evaporation is 1,879mm/year. It is the highest in April with 213mm/month, and the lowest in August with 119mm/month.

The estimated annual total PET using Harmon method is 1,426mm/year, which is about 76% of total pan evaporation. The maximum PET with 166mm/month appears in May and the minimum with 81mm/month appears in December.

A.4.2.5 Spatial Distribution of Meteorological Conditions

In order to estimate the total precipitation in a basin, it is necessary to consider spatial distribution of precipitation. The volume of precipitation usually increases with elevation. This tendency is

observed also in the present study as shown in Annex-F A.4.2.4, although the data in the figure are scattering. The precipitation at the stations in Type I climatic zone except around the western costal area is generally lower than the others. This is mainly because of regional differences in precipitation volume and not because of the difference of elevation. When only the data at the stations in Type I climatic zone except around the western costal area are used, the following equation may represent the relationship between elevation and precipitation volume.

$$P = P_0 \exp\left[C_e\left(EL - EL_0\right)\right]$$

where P = precipitation volume, P_0 = precipitation volume at reference elevation, C_e = Coefficient for correction for elevation (C_e = 0.0003 would fit best in the present study), EL = elevation, EL_0 = reference elevation.

To estimate the spatial distribution of the precipitation, the following procedure was applied.

- The long-term averaged monthly precipitation (1951-2007) at each station is converted to that at mean sea level using the relationship between the precipitation and elevation.
- The contour map for the long-term averaged monthly precipitation at mean sea level is prepared by triangular linear interpolation method.
- The long-term averaged monthly precipitation at mean sea level with about 1km grid is prepared using the above-mentioned contour map.
- The long-term averaged monthly precipitation at each grid point is corrected considering the elevation using the relationship between the precipitation and elevation.
- The grid data for the long-term averaged monthly precipitation can be used for any analysis and presentation purpose.

Annex-F A.4.2.5 shows spatial distribution of annual total precipitation. The annual total precipitation is higher in mountain areas in general. The annual total precipitation exceeds 4,000mm/year around the south-east boundary of the study area. In the middle part of Central Luzon plain, the annual total precipitation is less than 1,500mm/year. Annex-F A.4.2.6 and A.4.2.7 show the averaged monthly precipitation in dry season (November to April) and that in wet season (May to October), respectively. Even in dry season, the precipitation volume is kept high around the south-east boundary of the study area.

The worldclim dataset can give the mean air temperature data with about 1km grid. Based on the dataset, monthly total PET has been calculated using the Harmon method for each grid. Annex-F A.4.2.8 and A.4.2.9 show the spatial distribution of annual mean air temperature and the estimated annual total PET, respectively.

The annual total PET is the highest at the middle part of the Central Luzon plain with about 1,400mm/year. The lower PET can be observed in the mountain areas, ranging 1,000 to 1,200mm/year.

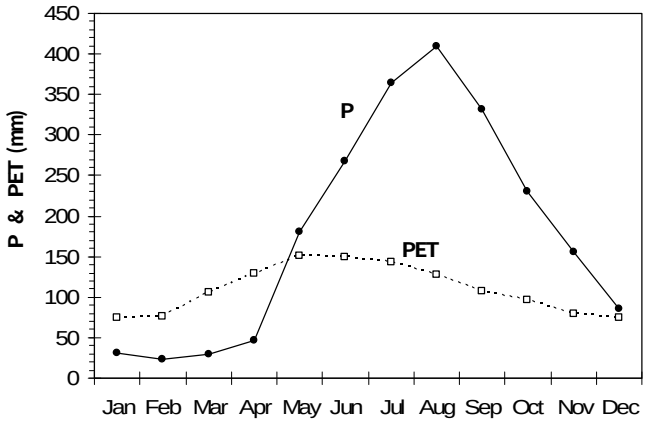
The annual total precipitation and PET for the entire study area is estimated at 2,155mm/year and 1,315mm/year, respectively. Their variations in a year are shown in the following table.

Table A. 4.2.4 Monthly Variation of Precipitation and PET for the Entire Study Area

(unit: mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
P	31.8	24.1	29.0	46.1	180.4	267.5	363.8	409.7	331.6	230.5	155.5	84.9	2,155.0
PET	74.5	76.9	105.8	128.6	151.6	148.9	142.5	127.9	107.9	96.4	79.1	74.2	1,314.7

Source: JICA Study Team



Source: JICA Study Team

Figure A. 4.2.1 Monthly Variation of Precipitation and PET for the Entire Study Area

The monthly precipitation and PET for each sub-basin are calculated and presented in Annex-T A.4.2.4 and A.4.2.5. These are utilized for further discussion on water resources potential.

A.4.2.6 Extreme Event

In order to clarify the extreme events such as drought and flood in term of precipitation volume, frequency analysis of the precipitation have been conducted. Probable precipitation has been estimated assuming a probability density function. Either Log Pearson-III distribution or Gumbel distribution has been employed after confirming their applicability.

Table A.4.2.5 shows the probable annual total precipitation at Cabanatuan and Science Garden based on the completed data during 1951 to 2007. Total annual precipitation at Cabanatuan in 1979 recorded 1,235mm, which is the smallest during 57 years. Its return period is evaluated at more than 20years.

Table A. 4.2.5 Probable Annual Total Precipitation

(unit: mm/y)

Probability of non-exceedance	Cabanatuan	Science Garden
1/2	1,845	2,336
1/5	1,558	1,991
1/10	1,422	1,845
1/20	1,324	1,746
Probability density function	LogP3	Gumbel

Source: JICA Study Team

Table A.4.2.6 shows the probable total dry season precipitation (November to April) at Cabanatuan and Science Garden based on the complete data during 1951 to2007.

Table A. 4.2.6 Probable Total Dry Season Precipitation

(unit: mm/dry season)

Probability of non-exceedance	Cabanatuan	Science Garden
1/2	183	277
1/5	102	172
1/10	74	128
1/20	56	94
Probability density function	LogP3	Gumbel

Source: JICA Study Team

Table A.4.2.7 shows the probable maximum 1day precipitation at Cabanatuan and Science Garden based on the collected daily precipitation data during 1951 to 2007 (Science Garden: 1961 to 2000).

Collected daily precipitation data have some gaps. However, 1day maximum data was selected without filling the gaps.

Table A. 4.2.7 Probable Maximum 1day Precipitation

(unit: mm/day)

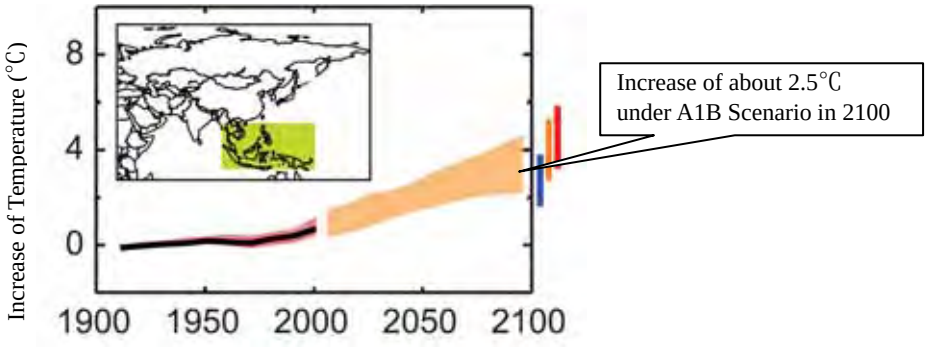
Probability of exceedence	Cabanatuan	Science Garden
1/2	115	152
1/5	157	201
1/10	188	235
1/20	220	270
1/50	266	317
1/100	304	355
Probability density function	LogP3	LogP3

Source: JICA Study Team

Annex-F A.4.12 shows the rainfall intensity-duration curve at Cabanatuan and Science Garden, which have been collected from previous report [9].

A.4.2.7 Expected Regional Climate Change by IPCC 4th Report

The study area is located in the Southeast Asian (SEA) region. According to the chapter for regional climate projection in 4th evaluation report of IPCC [10], the average temperature in the SEA region may increase with about 2.5℃ in 2100 under A1B scenario that assumes higher growing society with balanced energy use (see Figure A.4.2.2).



Source: Regional Climate Projections in Climate Change, 2007[10].

Figure A. 4.2.2 Projected Change in Average Temperature in SEA region

The report summarizes the results of series of climate models as shown in Table A.4.2.8. The following is noted for SEA region.

- Warming is likely to be similar to the global mean.
- Precipitation in boreal winter is likely to increase in the southern part of Southeast Asia.
- Precipitation in summer is likely to increase in most of Southeast Asia.
- Extreme rainfall and winds associated with tropical cyclones are likely to increase.

Table A. 4.2.8 Regional Averages of Temperature and Precipitation Projections for SEA region

		Temperature Response (^{0}C)						Precipitation Response (%)						Extream Seasons (%)		
SEA	Season	Min	25	50	75	Max	Tyrs	Min	25	50	75	Max	Tyrs	Warm	Wet	Dry
	DJF	1.6	2.1	2.5	2.9	3.6	10	-4	3	6	10	12	80	99	23	2
11S,95E	MAM	1.5	2.2	2.7	3.1	3.9	10	-4	2	7	9	17	75	100	27	1
to	JJA	1.5	2.2	2.4	2.9	3.8	10	-3	3	7	9	17	70	100	24	2
20N,115E	SON	1.6	2.2	2.4	2.9	3.6	10	-2	2	6	10	21	85	99	26	3
	Annual	1.5	2.2	2.5	3.0	3.7	10	-2	3	7	8	15	40	100	244	1

Note: The value shown in the table is the comparison between the values in 1980-1999 and those in 2080-2099.
Source: Regional Climate Projections in Climate Change, 2007[10].

A.4.3 Hydrology

A.4.3.1 Overview in Runoff Condition

The annual average discharge has been calculated for the hydrometric stations whose complete monthly discharge record is available for more than 5 years. In Pampanga river basin, Pantabangan storage dam started its operation in 1974. It is expected that significant change in the flow regime along Pampanga River appears after 1974. The calculation of the annual average discharge was thereby conducted by the following two separated periods; from 1951 to 1973 and from 1974 to 2007.

Annex-T A.4.3.1 summarizes the calculated annual average discharge together with the average precipitation and PET for the catchment of the hydrometric station. It also shows the specific discharge, runoff depth and runoff rate (total runoff / precipitation). Table A.4.3.1 summarizes the annual average discharges observed at the representative hydrological gauging stations in the study area.

Table A. 4.3.1 Annual Average Runoff Discharge in the Study Area

Code No. of Gauging Station*	Name of River Basin	Catchment Area (km^2)	1951-1973			1974-2007		
			Discharge (m^3/s)	Specific Discharge ($m^3/s/ha$)	Runoff Ratio	Discharge (m^3/s)	Specific Discharge ($m^3/s/ha$)	Runoff Ratio
343	Pampanga	6,315	237.0	3.8	0.57	229.3	3.6	0.56
334	Pampanga	2,455	141.8	5.8	0.85	69.1	2.8	0.41
345	Rio Chico	1,604	52.9	3.3	0.54	71.4	4.5	0.73
3998	Angat	546	60.8	11.1	0.80	58.7	10.7	0.77

*: Named by JICA Study Team

As one can see, at some stations, runoff rate exceeds 1.0, which actually never happens. This indicates errors either in estimation of precipitation or in discharge measurement. These data are excluded for further analysis and discussion. There are also the cases that total runoff is less than P-PET (precipitation - potential evapotranspiration). In these cases, not only the errors in precipitation and/or discharge but also effect of abstraction of surface water could be related. These data are also excluded for further analysis when one discusses the natural runoff condition. However, they are shown in tables and figures as a reference.

At some stations which are not located along the main stream of Pampanga River such as the hydrometric station Code 345 (expressed as a way of “HMS345” hereinafter) in Rio Chico River, the annual average runoff volume after 1974 is quite different from that before 1974, although there seems to be no significant change in the runoff condition in the catchment. Some errors are expected in this case. It is also judged that utilization of those data for calibration of a mathematical model used in the present study be avoided.

The specific discharge is plotted against catchment area as shown in Annex-F A.4.3.1. The specific discharge decreases with the catchment area and tends to reach to about $0.04 m^3/s/km^2$ when the catchment area is large, although the data are scattering. It can be observed that the specific discharge after 1974 is somehow lower than that before 1973. This is presumably because of the impact of abstraction for irrigation in the basin which became available by the start of the operation of Pantabangan storage dam.

The specific discharge for Angat storage dam catchment is much higher than that in the other catchments in Pampanga river basin. It is due to much higher precipitation volume in Angat storage dam catchment.

Annex-F A.4.3.2 shows the runoff rate against catchment area. The runoff rate ranges from 0.4 to 0.9. It tends to decrease with the catchment area and reaches to about 0.5 to 0.6 when the catchment area is large. In very rough view, the runoff volume is about 50 - 60 % of the total precipitation volume in the basin, which is equivalent that the runoff volume is about 1,100 - 1,300 mm/year (11,000 – 13,000 MCM/year).

A.4.3.2 Temporal Variation of Water Quantity

Annex-F A.4.3.3 shows the long-term trend of annual average discharge at HMS343 (Arayat in Pampanga River) and HMS334 (Cabanatuan in Pampanga River). Location of these two hydrometric stations is shown in Figure A.4.3.1.

As shown in Annex-F A.4.3.3, the annual averaged discharge at HMS334 remarkably decreases after the start of operation of Pantabangan storage dam in 1974. At HMS343, the decrease of the discharge is not so significant. This may be because of more contribution of the runoff discharge from tributaries at HMS343. It should be noted that at just upstream of HMS343, Cong Dadong diversion dam started its operation in 2002, which may bring about significant change in the observed discharge at HMS343. However, the observation at HMS343 finished in 2002, so that the observed data at HMS343 do not include the effect of the operation of Cong Dadong diversion dam.

Annex-F A.4.3.4 shows the monthly variation of discharge at HMS343 and HMS334. The minimum and maximum flow appears at April and September, respectively. It can be observed that the flow regime changes drastically after 1974 both at HMS343 and HMS334. At HMS343, the discharge at dry season increases and that in wet season decreases slightly. At HMS334, the discharge at both dry and wet seasons decreases. This is presumably related to the abstraction and return flow by irrigation water use. HMS334 is located at downstream of the major intake points for irrigation. On the other hand, HMS343 is located at further downstream in which some return flow from irrigation area is expected.

Further discussion on the flow regime would be made based on the result of the mathematical model introduced in the present study in the later chapter.

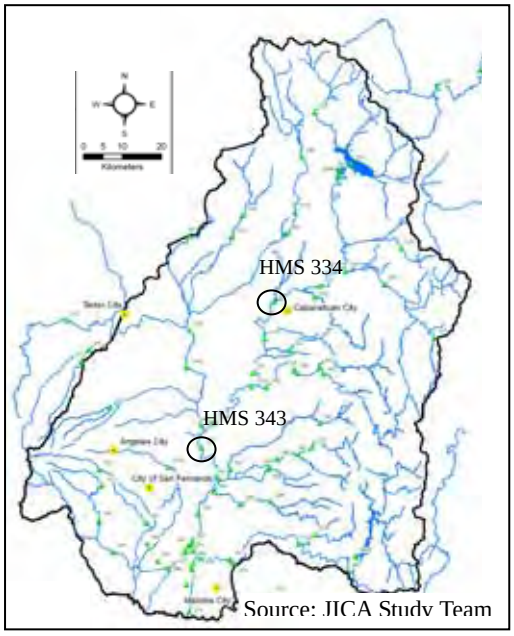


Figure A. 4.3.1 Location of Hydrometric Stations of HMS 334 and HMS343

A.4.3.3 Extreme Event

Annex-T A.4.3.2 shows the probable flood discharge at principal stations in the study area, which was estimated by the previous report of DPWH, NIA, JICA[11]. Annex-T A.4.3.3 and Annex-F A.4.3.5 show the probable specific discharge estimated from the probable discharges listed in Annex-T A.4.3.2.

The probable specific discharge in the study area is relatively small compared to other rivers located not only in Luzon area but also in Visayas and Mindanao areas. This could be attributed to the retarding function of Candaba Swamp and also the topographic characteristic of the widely extended floodplain in Pampanga river basin.

Table A.4.3.2 shows the probable annual average discharge and minimum monthly discharge at HMS343 based on the collected monthly discharge data during 1951 to 1973 and 1974 to 2007 except data missing years. There seems to be slightly decreased in probable annual average discharge after 1974. On the other hand, probable minimum monthly discharge has increased after 1974.

Table A. 4.3.2 Probable Annual Average Discharge and Minimum Monthly Discharge at HMS343

(unit: m^3/s)

Probability of non-exceedance	Annual average discharge		Minimum monthly discharge	
	Before 1973	After 1974	Before 1973	After 1974
1/2	241.1	220.9	21.1	41.2
1/5	181.9	155.7	14.1	24.9
1/10	153.2	125.4	11.2	18.0
1/20	132.2	103.8	9.0	12.5
Probability density function	LogP3	LogP3	Gumbel	Gumbel

Note: The data in 1973 and 1974 are excluded, because it is judged that impact of initial operation of Pantabangan storage dam causes unusual river condition.
Source: JICA Study Team

A.4.3.4 Issues in Hydrological Data

As have been discussed in the above section, there are several issues in utilizing the observed hydrological data for water resources management as follows:

- Duration of observation is in general very short in many stations.
- Some hydrological data are inconsistent with others.
- Characteristics of the hydrological data sometimes changes with time even if there is no significant change in hydrological conditions at upstream reach.
- Many hydrological stations are affected by artificial water movement such as abstraction and discharge and/or regulation by dam.

The followings are necessary to be considered to cope with the issues:

- It is necessary to select appropriate stations with appropriate observation duration for further discussion on water resources.
- To evaluate water resources potential in quasi-natural condition, it is necessary to reproduce run-off condition using a mathematical model.

A.5 Geology and Hydrogeology

A.5.1 Geology

A.5.1.1 General

Philippines is situated in and along the Circum-Pacific Volcanic-Earthquake Belt characterized by earthquakes and volcanic activities, some of which are destructive. General geological structure trends north to north north-west faulted by Philippines Fault System and its splay faults particularly along the Southern Sierra Madre Mountains. Faults in Nueva Ecija named "Dingalan Fault" are supposed to be active fault and faults distributed in Bulacan are supposed to be probable active fault[12)].

The oldest rocks of BC are distributed along the eastern highland of the study area, which is considered to be older than the Cretaceous and to be composed of amphibolite, mica schist and phyllites etc. Sedimentary rocks are widely distributed in the eastern mountain area from the age of Cretaceous period to Tertiary-Miocene epoch. They are composed of marine wackes (sandstone) and flysch (shale) intercalated by basalt, andesite flow, and pyroclastics. Oligocene sedimentary rocks are intruded by quarts diorite. Upper-Miocene sedimentary rocks are overlain by pyroclastics and tuffaceous sedimentary rocks. These rocks are not basically aquiclude, which is not expected to be used for groundwater exploitation excluding caves/cavities of limestone and lava flow. The location and scale of caves/cavities is not clear at this moment.

Alluvium (R) which consists of unconsolidated clay, sand gravel is widely distributed in the Central Luzon Plain with a thickness of about 199m on the basis of existing drilling[13)]. It is considered as a good aquifer. Especially, sand and gravel layers ensure good aquifer, which can be widely utilized for domestic water and others.

Quaternary pyroclastics (QVP) is overlaid by Alluvium. The possibility of groundwater extraction by an ultra-deep well depends on the depth of the pyroclastics.

The geology in the study area is summarized in Annex-T A.5.1.1 and is shown in Annex-F A.5.1.1.

A.5.1.2 Quaternary- Recent (R)

Alluvium is formed in flood plain, lacustrine (lake deposite), levee, sandbar, lagoon and hinterland, which have been deposited and unconsolidated. Most of them consist of bedded clay, silt, sand and gravel. The sand and gravel have high to very high permeability and thus usually form aquifers when they have sufficient thickness and extension.

As shown in Annex-F A.5.1.1, the alluvium is widely extended in the central part of the study area, which indicates existence of widely extended aquifers there. However, it should be noted that the detail condition of the aquifers may vary place by place. Based on the database in LUWA, the sand and gravel layers in Angels varies from very thin to about 200m[13),14)]. Sand and gravel layer with a high permeability and clay with a low permeability alternate in City of San Fernand[15)]. Sand and gravel layer is distributed a little within a clay layer in Guagua City[16)]. Because of the possibility of the spatial variation of the aquifers, it could be required to survey the aquifer condition in detail, prior to the determination of actual production well point.

A.5.1.3 Sedimentary Rocks

The sedimentary rocks are composed of BC, K, KPG, PG1, PG2, N1, and N2.

BC is the oldest rock in the study area, which is composed of amphiobolite, mica schist, phyllites. Other rocks are mainly composed of sandstone and shale and/or mudstone with andsites, basalts, and pyroclastics. They had been folded and faulted. The cracks that have been created by fault are considered to be hardened by hydrothermal materials and/or filled by secondary clay.

PG2 and N1 have minor limestone and they are expected to be solution cavity. These rocks are basically aquiclude and thus have little possibility for the groundwater exploration, although few possibility in the cavity in lava flows and solution cavity in a limestone remains.

A.5.1.4 Igneous Rocks

The distribution of old igneous rocks is limited and most of them are Miocene dyke of quartz diorite (IN). Quaternary volcanics are distributed around Mt. Pinatubo and Arayat, which are composed of andesite (QV) and its piedmont deposits (QVP). Quaternary volcanics have openings and cavities in lava flows. It is there easy for rainfall to infiltrate into the ground.

These rocks are basically aquiclude and thus have less possibility for the groundwater exploration, although little possibility in the cavity in lava flow remains. It is difficult to survey or find them. There are no other ways than utilizing a spring which could be originated from the cavity in lava flow.

A.5.2 Hydrogeology

The possible geological layers to form aquifers in Pampanga river basin are river deposits, fan deposits, and terrace deposit of Quaternary deposits that consists of sand and gravel with clay. Other possible geological features are limestone with hole and cavity. The former is called "Granular aquifer" and the latter is "Karst aquifer". Another possible aquifer is lava flow with hole and cavity. Both limestone and lava have limited potential. According to the existing data, almost all aquifers are "Granular aquifer" in the Quaternary deposits (so hereinafter called as "Quaternary aquifer") in Pampanga river basin. Limestones (PG2, Tertiary period Upper- Paleocene Stage) are distributed here and there in the sub-basin of PAM02, ANG03, PEN01. Unfortunately, the details on the limestones are unknown.

Annex-F A.5.2.1 shows the groundwater availability and general hydrogeology in Pampanga river basin, which have been prepared by JICA Study Team on the basis of available information on some hydrogeological parameters as well as the geological map. The available information on the hydrogeological parameters from the data of existing study and monitoring results are summarized in Annex-T A.5.2.1.

The geology of Central Luzon Plain is mainly composed of old riverbed and shallow sea deposit with an alluvial fan, lake/swamp deposits, volcanic ash/clastics/lahar. Therefore, it is inter-beded sand, gravel, clay layer. The sand and gravel layers ensure good aquifers. Bluish color in Annex-F A.5.2.1, which shows high productive aquifers, largely coincides with the distribution of recent deposit (symbol R in the geological map). The characteristics of aquifers are summarized below.

- **Highly productive aquifers:** The distribution area of alluvial deposit (R: in Geological Map) that is composed of the alternation of sand, gravel and clay. It is located the Central Luzon Plain and large groundwater basin is formed with complex structures consisting of several aquifers and impervious layers. The aquifers have high to very high permeability. It is expected that the transmissivity is often 190-650m^2/day, and 1,200 - 2,400 m^2/day in some special areas.
- **Productive Aquifer:** Flood plains in the valley (R: in Geological Map). The flood plain deposit of narrow valley on the geological map is composed of sand, gravel, and clay. It is expected to be moderate to high permeability, although extension of aquifer is limited. The transmissivity is expected to be about 400m^2/day.
- **Possible Aquifer:** This area occupies only a small portion of the region along narrow belts between the plains and the Sierra Madre Mountains (N3+Q1: in Geological Map). It is composed of sandstone and conglomerate. The transmissivity is expected to be 12-53m^2/day based on the data outside Pampanga river basin.
- **Rock with limited potential:** Non-color area is not investigated sufficiently. However, they are supposed to be impermeable basically. Lave flows of andesite & basalt is generally massive or slightly fractured. These fractures are usually tight with secondary clay and minerals. Only the loosen clacks area may be the possible local aquifer. Limestone of Tertiary could have solution cavities and might be aquifer. There are no enough data to judge if there is aquifer or not, however. Only when a spring which may be originated from the aquifer is found, it can be used.

Table A.5.2.1 shows the ratio of the categorized hydrogeological area in the sub-basins. About 55% of the study area is occupied by highly productive and/or productive aquifers, whereas about 3% by possible aquifer and about 42% by rock with limited potential. The highly productive and/or productive aquifers are widely extended in the sub-basin of PAM01, PAM03, ANG01, PAS01, and RCH01. These sub-basins can be both groundwater use area and recharge area. On the other hand, rocks with limited potential area are distributed in the basin of ANG03, PAN01, COR01, PEN01, ANG02, and PAM05. The rocks with limited potential area are mountainous with relatively steep sloop, which are basically regarded as a recharge area for aquifers at further downstream.

Table A. 5.2.1 Ratio of Categorized Hydrogeological Area in the Sub-Basins

Sub-Basin	Ratio of Categorized Hydrogeological Area (%)				
	Highly Productive Aquifer	Productive Aquifer	Possible Aquifer	Rocks with Limited Potential	Total (sub-Basin)
PAM01	100.0	0.0	0.0	0.0	100.0
PAM02	65.7	0.0	8.2	26.2	100.0
PAM03	100.0	0.0	0.0	0.0	100.0
PAM04	66.6	1.2	9.7	22.5	100.0
PAM05	24.3	11.1	0.0	64.6	100.0
PAN01	0.0	10.0	0.0	90.0	100.0
RCH01	76.7	0.0	0.0	23.3	100.0
PEN01	9.5	0.0	8.9	81.6	100.0
COR01	7.6	9.3	0.0	83.1	100.0
ANG01	100.0	0.0	0.0	0.0	100.0
ANG02	21.9	4.2	10.5	63.5	100.0
ANG03	0.0	0.0	0.0	100.0	100.0
PAS01	76.9	0.0	0.0	23.1	100.0
Total Area (%)	52.6	2.1	2.8	42.5	100.0
Total Area (km^2)	5,485.0	224.3	288.2	4,436.9	10,434.4

Source: JICA Study Team

A.6 Land Subsidence

The low-lying Pampanga Delta in the study area in particular is subject to the chronic flood damage, and one of the major causes of the flood damage would be attributed to the current rapid progress of the land subsidence.

The JICA Study in 2002[17] reported that the evidence of the land subsidence in Pampanga Delta could be seen at Orani Harbor in Bataan Province located in the northwestern part of Manila Bay. The dock and market in the Harbor had never been flooded at the time of its construction. However, they are currently flooded with the maximum inundation depth of about 1m every year during the Spring High Tides. The said JICA Study presumed that the aggravation of flood at the Orani Harbor would be due to the land subsidence but not to other hydrological changes such as rise of river water level inflicted by sediment deposits in the river channels and/or the rise of the tidal level. The Study also gives other evidence such that the ground floor level of several old buildings in Guagua and Sasmuan Municipalities in Pampanga Province had sunk by 2 to 3m over several decades.

The actual degrees of land subsidence were examined in the above JICA Study in 2002 as well as the Study by Rodolf and Siringan, University of Philippine in 2003[18]. With referring these studies, it is preliminarily presumed that the land subsidence is occurring at least over the coastal area in Pampanga Province from the shoreline to about 40 km inland. The coastal area in Bulacan Province could be also affected by the land subsidence judging from the similar geological settings and the excessive abstraction of groundwater to those in Pampanga Province, although no relevant previous study has confirmed it yet.

The annual average rate of the land subsidence in the costal area in Pampanga Province is preliminarily presumed, with referring to the above two studies, to be in a range of 0.5 cm/year at inland to 8cm/year at the coastal side. This preliminary estimation stands on the following results of the studies:

(1) Results of JICA Study in 2002 assumed that the elevations of benchmarks located in the mountainous area are hardly changed by the land subsidence, while those in the low-lying area of Pampanga Delta seriously affected by the current progressive land subsidence. From this point of view, the actual degree of land subsidence was assumed as the long-term difference between the elevations of benchmarks located in the mountainous area and the low-lying delta area. As the results, the annual average rates of land subsidence for a period of 50 years were estimated to be in a range of 0.5 cm/year in and around Mexico Municipality (located about 40 km from the shoreline) to 2.5cm/year in Santo Tomas Municipality (about 20 km from the shore line) as shown in Figure A.6.1.

(2) The Study by Rodolf and Siringan, University of Philippines in 2003 estimated at 2 to 8cm/year as the annual average rate of land subsidence from 1991 to 2001 on the brink of Manila Bay (refer to Figure A.6.1.1).

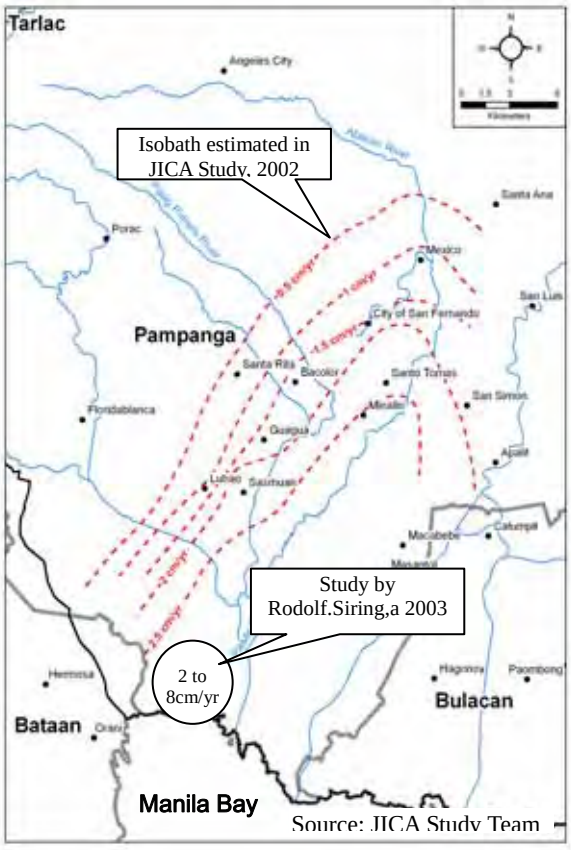


Figure A.6.1.1 Annual Average Rate of Land Subsidence Estimated in the Previous Study

The area of the subject land subsidence in Pampanga Province is a broad tidal-river delta

complex formed by the sediment runoff from Pampanga river basin, and its underlying alluvium is composed of consolidated silt or clay, and poor cemented sand and gravel. This geological setting tends to cause land compaction, once dewatering of aquifer is made by abstraction of the groundwater. At the same time, the present abstraction volume of the groundwater in the subject area far exceeds the estimated groundwater potential in some places as described in Sector Report H. These factors of the geological setting and the excessive abstraction of the groundwater could be the principal causes of the present land subsidence.

It is herein noted that the land subsidence could also occur due to the natural compaction caused by the squeezing out of the pore water by accumulating weight of overlying sediment. Nevertheless, the previous study[19)] estimated through the analysis of sediment core samples that this natural annual compaction rate is in a range of about 0.16 to 0.56cm/year or 0.36cm/year on average only. This natural compaction rate corresponds to 2 to 7% of the foresaid 8cm/year estimated as the artificial compaction by the excessive abstraction of the groundwater in the shoreline. Thus, the natural compaction would be far less influential to the present land subsidence as compared with the abstraction of the groundwater.

The land elevation lowered by land subsidence is hardly recovered once it occurs, and the control of the present excessive abstraction of the groundwater is only the solution to refrain the further land subsidence. However, the present lack of the monitoring system for the land elevation in the coastal area would cause difficulties in identifying the precise progressive rate of the land subsidence, which leads to difficulties in estimating the proper abstraction volume of the groundwater. From this point of view, the periodical leveling survey for the benchmarks together with monitoring of abstraction of the groundwater would be required to estimate the proper abstraction volume of the groundwater.

A.7 Long-term Rainfall-Runoff Simulation

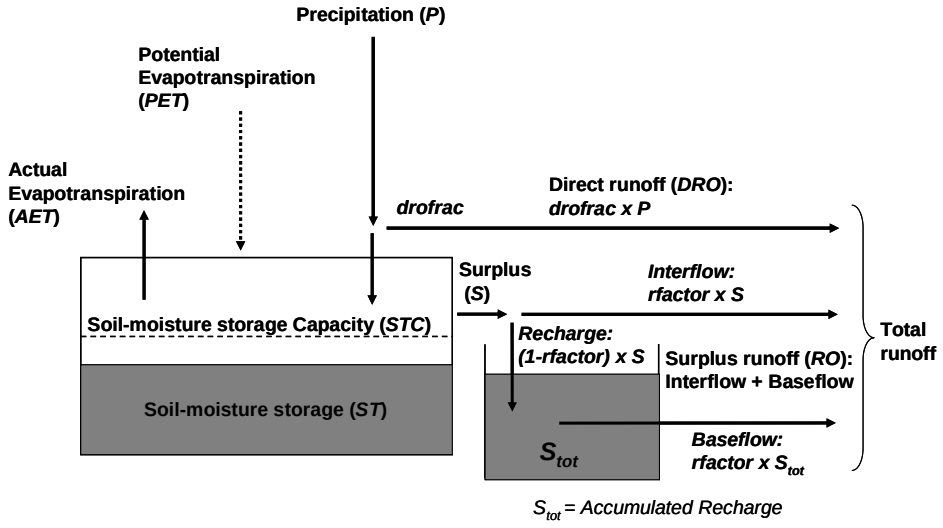
A.7.1 General

To discuss details on the available water resource in the study area, a mathematical model to represent the long-term rainfall-runoff process has been introduced. The model has been calibrated with the selected hydrometric stations which have reasonable observation data. The calibrated model has been used to clarify the long-term runoff generating from the separated catchments on the premises of the condition of natural river network and the existence of important structures such as main reservoirs and major intakes. The generated runoff is assumed to represent the runoff in quasi-natural condition.

A.7.2 Rainfall-Runoff Simulation Model

There exist many rainfall-runoff simulation models to estimate the long-term flow regime. In the present study, a monthly-basis soil-moisture accounted model, which is called as the Thornthwaite water-balance model[20] has been selected as a rainfall-runoff model. It is a rather simple model, which can be implemented in a spread sheet and does not require any complicated software. However, it can usually capture the essential and important hydrological cycle on a land surface.

The original Thornthwaite water-balance model can consider snow accumulation and its melting process. However, the snow process has not been incorporated in the present study, because snow never falls in the study area. The basic concept of the Thornthwaite water-balance model is presented in Figure A.7.2.1.



Source: JICA Study Team

Figure A. 7.2.1 Basic Concept of Thornthwaite Water Balance Model

There are several hydrological components considered in the model as described below. In the model, the calculation is conducted in a dimension of millimeter (mm).

(1) Direct runoff

- Direct runoff (*DRO*) is runoff from impervious surfaces or runoff resulting from infiltration-excess overflow. The fraction (*drofrac*) of precipitation (*P*) is directly runoff without infiltrating into a surface soil. The expression for *DRO* is as follows.

$$DRO = P \cdot drofrac$$

- Direct runoff (*DRO*) is subtracted from *P* to compute the amount of remaining precipitation (P_{remain}).

$$P_{remain} = P - DRO$$

(2) Evapotranspiration and soil moisture storage

- Actual evapotranspiration (*AET*) is derived from potential evapotranspiration (*PET*), P_{remain}, soil-moisture storage (*ST*) and soil-moisture storage withdraw (*STW*).
- Monthly total *PET* is given as input data, which can be calculated by the Harmon equation as shown in section 4.2.3.
- When P_{remain} is more than *PET*, *AET* is equal to be *PET*. The excess water is assumed to infiltrate into the surface soil to increase soil-moisture (*ST*). When *ST* is greater than the soil-moisture storage capacity (*STC*), the excess water becomes surplus (*S*) and eventually available for runoff.
- When P_{remain} is less than *PET*, *AET* is equal to P_{remain} plus the amount of soil moisture that can be withdrawn from storage in the surface soil (*STW*). Accordingly, the soil-moisture in the surface soil decreases with *STW*.
- *STW* decreases with decreasing *ST*, because water in the surface soil becomes difficult to be removed when the soil becomes drier. This nature is modeled as the following equation in the present study.

$$STW = ST_{i-1}\left[1 - \exp\left(\frac{P_{remain} - PET}{\alpha \cdot STC}\right)\right]$$

where ST_{i-1} = the soil moisture storage for the previous month and α = the parameter for soil-moisture withdraw.

(3) Runoff generation

- Runoff is generated from the surplus (*S*) at a specified rate (*rfactor*). The *rfactor* parameter determines the fraction of surplus that becomes runoff in a month. The remaining surplus is carried over to the following month and is accumulated. The accumulated surplus is to be used for computing total *S* for that month.
- Direct runoff (*DRO*) is added directly to the runoff generated from surplus to compute total monthly runoff.

(4) Groundwater recharge

- The surplus runoff could be further sub-divided into interflow and baseflow. The interflow is much more rapid runoff component compared to the baseflow, which is some how similar to the direct runoff. On the other hand, the baseflow is a slow runoff component, which is regarded to be supplied from groundwater aquifer through the recharge of groundwater. In the model, the surplus runoff is expressed as follows.

$$RO_i = Interflow + Baseflow$$

$$Interflow = rfactor \cdot S_i$$

$$Baseflow = rfactor \cdot S_{tot,i-1}$$

where RO_i = surplus runoff at i-th month, *rfactor* = parameter determines the fraction of surplus that becomes runoff in a month, S_i = surplus at i-th month, $S_{tot,i-1}$ = accumulated remained surplus at (i-1)-th month.

The surplus that does not contribute to the interflow component is accumulated and finally becomes baseflow component. It would be regarded as the recharge of groundwater, and thus could be calculated by the following equation.

$$RG_i = (1 - rfactor) \cdot S_i$$

where RG_i = recharge of groundwater at i-th month. The total recharge of groundwater

is calculated by summing-up the above equation for a period considered for total amount.

(5) Model parameters

- In the present study, after some trial calculations, it has been decided to express the model parameter related to direct runoff (*drofrac*) as a function of ST_{i-1}, P and PET as follows (see also Figure A.7.2.2).

$$drofrac = df_s \cdot \frac{ST_{i-1}}{STC}$$

i) for $P - PET \le STC$

$$df_s = df_{sn}$$

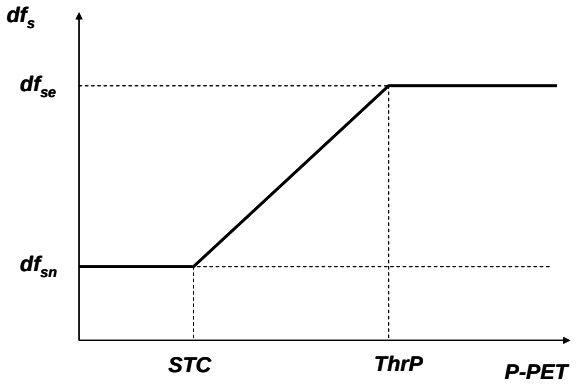
ii) for $STC < P - PET < ThrP$

$$df_s = df_{sn} + (df_{se} - df_{sn}) \frac{[(P - PET) - STC]}{[ThrP - STC]}$$

iii) for $ThrP \le P - PET$

$$df_s = df_{se}$$

where df_s = *drofrac* for saturated soil, $df_{sn} = df_s$ at normal situation, $df_{se} = df_s$ at extreme situation, *ThrP* = threshed *P-PET* for extreme precipitation.



Source: JICA Study Team

Figure A. 7.2.2 Parameter *Drofrac* for Saturated Soil as a Function of P-PET

- In summary, the followings six parameters are the model parameters to be calibrated.
  - *STC*: soil-moisture storage capacity
  - α: parameter for soil-moisture withdraw
  - df_{sn}: fraction of direct runoff (*drofrac*) for saturated soil at normal situation
  - df_{se}: fraction of direct runoff (*drofrac*) for saturated soil at extreme situation
  - *ThrP*: threshed P-PET for extreme precipitation
  - *rfactor*: parameter determines the fraction of surplus that becomes runoff in a month

A.7.3 Input Data

The required input data are time series of (1) monthly total precipitation and (2) monthly total PET. In the present study, these are given as described below.

A.7.3.1 Monthly Total Precipitation

Basic idea to prepare the time series of monthly total precipitation in a target catchment is to get the time series whose long-term averaged values are corresponding to those prepared by the precipitation map (average of about 1km grid data in the target catchment). The following procedure is applied.

- 1st step: Preparation of Thiessen Polygon

  Thiessen polygon for each meteorological station is prepared (see Annex-F A.7.3.1 for the prepared Thiessen polygon)

- 2nd step: Calculation of time series of catchment average precipitation by Thiessen method

  Based on the Thiessen polygon, Thiessen coefficient is calculated for target catchments. The time series of the catchment averaged precipitation is then calculated. The calculated catchment averaged precipitation based on the Thiessen method does not correspond to the long-term averaged precipitation for the catchment given by the precipitation map (average of about 1km grid data). This is because of 1) lack of consideration of elevation difference and 2) limitation of resolution by Thiessen method.

- 3rd step: Correction of precipitation based on elevation

  The time series of the precipitation is corrected by considering the average elevation of the catchment and the average elevation of the meteorological stations used. Even after the correction, the corrected precipitation does not match to the long-term averaged precipitation for the catchment given by the precipitation map.

- 4th step: Correction for limitation of resolution by Thiessen method.

  For each month, the difference in the precipitation is calculated. The differences are considered as bias. The bias is then added or subtracted. To avoid generating negative precipitation by subtracting the bias, the maximum subtraction was limited to the minimum precipitation. The remained error caused by this treatment was finally adjusted by multiplying proportional coefficient.

A.7.3.2 Monthly Total PET

Based on the prepared PET map (about 1km grid data), time series of monthly total PET is given. Because there are no available temperature data before 1977 even at the representative synoptic station, CLSU Munoz in the study area, the same PET values for each year are used for the simulation as a first order approximation.

A.7.4 Model Calibration

The model parameters are calibrated at the selected hydrometric stations. The stations that are expected to be less impacted by significant regime change due to operation of hydraulic structure or are expected to have the duration with little impact by the significant regime change are selected. Annex-F A.7.4.1 shows the location of the selected stations.

The selected hydrometric stations have reasonable observed data in terms of runoff rate. The duration of calibration has also been carefully selected so that the periods when unrealistic runoff rate appears would be avoided for the calibration of the model. Annex-T A.7.4.1 shows the duration of calibration for each selected hydrometric stations. Annex-F A.7.4.2 shows an example of the selected duration of calibration at HMS327 (Coronell).

The following criteria have been considered for the calibration.

(6) 1st priority: Total mass during the calibration period

  The calibration has been conducted so that the total mass error between observed and simulated discharges is less than 3%.

(7) 2nd priority: Overall shape of runoff pattern, especially for runoff pattern in dry season

The best fit parameters are explored so that the accumulated square error for logarithmic values for observed and simulated discharges for each time step becomes to be minimum with keeping the condition that the total mass error is less than 3%.

The calibrated parameters for each selected hydrometric station are summarized in the Annex-T A.7.4.2.

Annex-F A.7.4.3 shows the example of the calibrated result. The accumulated depth of runoff as well as the depth of runoff by both simulation and observation at HMS327(Coronell) are compared in the figure. It can be seen that the estimated total mass of simulated results and the estimated overall shape of runoff pattern, especially for in dry season, are reasonably agree with the observed ones.

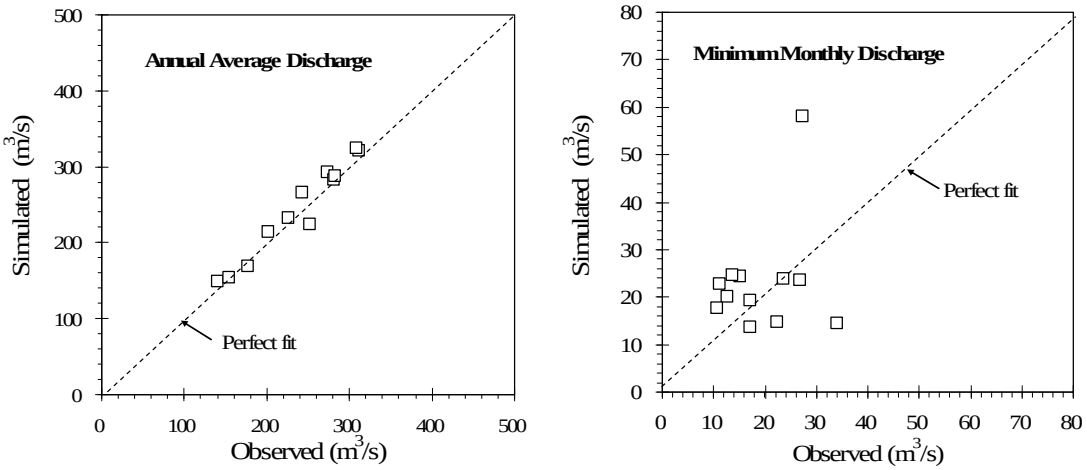
For HMS343(Arayat), one of key stations in Pampanga River, the calibration has been conducted as follows.

- The observed discharge at HMS343 is subtracted by the total calculated discharge by the calibrated model for the upstream catchments (PAN01, PAM0501, PAM0502, PAM0503, COR01, PEN0101, PEN0102, PEN0103, RCH0104, which are described in section A.7.5). The remained discharge is regarded as the runoff from the residual catchment.
- The calibration of the model parameters is conducted for the residual catchment using the remained discharge.
- The observed discharge before 1974 is used for the calibration to avoid including the influence of the regime change by operation of Pantabangan storage dam.

Annex-F A.7.4 demonstrates the calibrated result for the discharge at HMS343(Arayat). The accumulated depth of runoff as well as the depth of runoff by both simulation and observation at HMS343(Arayat) are compared in the figure. It can be seen that the simulated results reasonably agree with the observed ones.

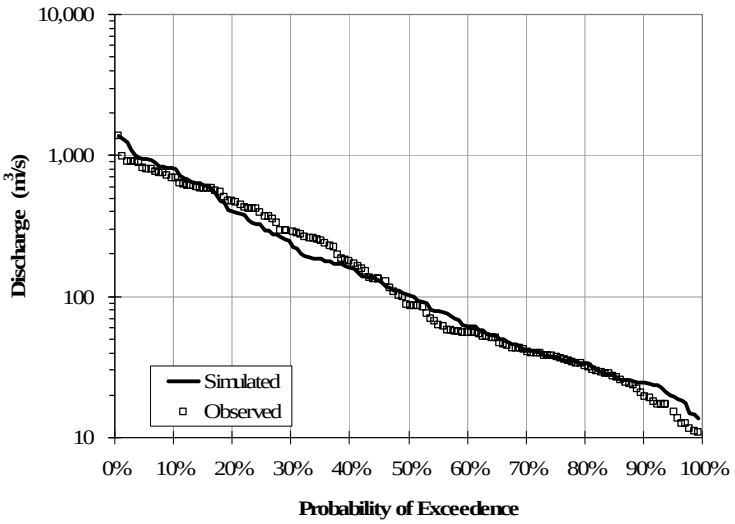
Figure A.7.4.1 shows the comparisons between the observed and simulated discharges for each year in terms of annual average discharge and minimum monthly discharge. It can be understood that the simulated annual average discharge agrees well with the observed one. The simulated minimum monthly discharge is sometimes higher than the observed one, and is sometimes lower. This is because the model calibration has targeted to fit to the overall shape of runoff pattern during the calibration periods, but not targeted to fit to particular extreme events. It is judged that the simulated minimum monthly discharge reasonably agrees with the observed one in an average sense.

Figure A.7.4.2 shows the comparison of flow duration curves for the observed and simulated monthly discharges. It can be seen that the overall shape of flow duration curve for the simulated discharge reasonably agrees with the observed one. It should be noted that the simulated discharge tends to be slightly overestimated for the discharge whose probability of exceedence is more than 90%, however.



Source: JICA Study Team

Figure A. 7.4.1 Comparisons between Observed and Simulated Discharges for Each Year in Terms of Annual Average Discharge and Minimum Monthly Discharge at HMS343(Arayat)



Source: JICA Study Team

Figure A. 7.4.2 Comparison of Flow Duration Curves for Observed and Simulated Monthly Discharges at HMS343(Arayat)

A.7.5 Generated Long-term Runoff Discharge

In order to generate the runoff using the calibrated rainfall-runoff model, the study area is divided into catchments. The delineation is conducted based on the sub-basins described in section A.3.1. The sub-basins are further sub-divided, considering the present and future possible major abstraction and storage sites. In the present study, the study area is divided into thirty three catchments. In addition, eight catchments related to trans-basin water transfer are delineated. The delineated catchments are called as water balance catchments in the present study hereinafter. Annex-F A.7.5.1 demonstrates the distribution of the water balance catchments.

At the downstream end of each water balance catchment, the control points, which are used for checking flow conditions, are set as shown in Annex-F A.7.5.2. The brief explanation of the control points are shown in Annex-T A.7.5.1.

The runoff simulation has been conducted for the last 50 years (1958 to 2007) for each water balance catchment using the calibrated parameters. Annex-T A.7.5.2 shows the parameters to be used for each water balance catchment. After simulating the runoff for each catchment, the simulated results are processed and the total runoff at the control points is calculated.

The simulated runoff can be regard as the runoff in a quasi-natural condition. The simulated mean annual average discharges at the representative control points are shown in the following table. The mean total runoff volume in a quasi-natural condition for the entire study area is estimated at 13,264MCM/year.

Table A. 7.5.1 Estimated Mean Annual Average Discharge at Representative Control Points

Control Point *	Mean Annual Average Discharge (m^3/s)	Mean Annual Average Runoff Volume (MCM/year)
P1 (Pampanga River)	289.8	9,199
A1 (Angat River)	74.7	2,368
S1 (Pasac River)	40.5	1,283

Note: * The control points are as shown in Annex-T A.7.5.1 and Annex-F A.7.5.2.
Source: JICA Study Team

The simulated mean annual average discharge, mean monthly minimum discharge, mean monthly dry season discharge, mean monthly wet season discharge at each control point are summarized in Annex-T A.7.5.3. The mean annual average discharge and mean monthly minimum discharge are shown also in Annex-F A.7.5.2.

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Annex-Tables

Annex-T A.3.1.1 Elevation and Slope Classification for Each Sub-Basin

River System	Sub-Basin	Elevation Area (km^2)									Total
		< 5 m	5 - 10 m	10 - 50 m	50 - 200 m	200 - 500 m	500 - 800 m	800 - 1200 m	1200 - 1600 m	> 1600 m	
Pampanga Main	PAM01	159.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	159.2
	PAM02	118.8	357.6	541.2	352.9	119.0	27.2	0.5	0.0	0.0	1,517.3
	PAM03	0.0	2.9	36.9	0.0	0.0	0.0	0.0	0.0	0.0	39.8
	PAM04	0.0	0.0	338.6	389.6	64.3	6.2	0.0	0.0	0.0	798.7
	PAM05	0.0	0.0	0.0	249.0	105.9	37.2	25.1	17.7	1.7	436.6
	PAN01	0.0	0.0	0.0	63.1	454.9	204.9	109.6	16.8	0.1	849.4
	RCH01	0.0	20.8	1,545.8	861.6	262.0	115.2	72.0	17.8	0.0	2,895.3
	PEN01	0.0	0.0	43.3	207.3	210.3	100.9	8.0	0.0	0.0	569.7
	COR01	0.0	0.0	0.0	229.5	217.1	135.9	83.9	41.3	4.2	712.0
Angat	ANG01	170.3	22.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	193.5
	ANG02	4.0	8.4	74.3	145.3	76.7	31.3	5.9	0.0	0.0	345.8
	ANG03	0.0	0.0	0.0	0.3	254.9	244.2	46.6	0.0	0.0	545.9
Pasac	PAS01	368.2	168.9	318.2	273.6	131.4	66.7	41.4	2.9	0.0	1,371.3
	Grand Total	820.4 (7.9%)	581.0 (5.6%)	2,899.0 (27.8%)	2,772.0 (26.6%)	1,896.6 (18.2%)	969.7 (9.3%)	392.9 (3.8%)	96.6 (0.9%)	6.1 (0.1%)	10,434.4 (100.0%)

River System	Sub-Basin	Slope Area (km^2)						Total
		0% - 3 %	3% - 8%	8% - 18%	18% - 30%	30% - 50%	> 50%	
Pampanga Main	PAM01	159.2	0.0	0.0	0.0	0.0	0.0	159.2
	PAM02	1,272.1	74.5	78.5	54.1	35.9	2.1	1,517.3
	PAM03	39.8	0.0	0.0	0.0	0.0	0.0	39.8
	PAM04	706.6	24.5	32.0	20.0	15.0	0.5	798.7
	PAM05	200.4	68.7	40.8	40.5	41.5	44.7	436.6
	PAN01	250.4	89.3	145.7	176.1	156.5	31.4	849.4
	RCH01	2,424.6	106.5	103.7	105.9	126.4	28.1	2,895.3
	PEN01	225.8	40.0	64.4	85.4	127.6	26.5	569.7
	COR01	179.4	73.1	82.4	93.8	172.5	110.7	712.0
Angat	ANG01	193.5	0.0	0.0	0.0	0.0	0.0	193.5
	ANG02	194.4	32.0	34.3	41.3	41.1	2.8	345.8
	ANG03	96.4	34.1	76.7	108.6	183.6	46.5	545.9
Pasac	PAS01	1,102.9	57.5	48.0	55.5	79.5	27.9	1,371.3
	Grand Total	7,045.5 (67.5%)	600.2 (5.8%)	706.5 (6.8%)	781.4 (7.5%)	979.6 (9.4%)	321.3 (3.1%)	10,434.4 (100.0%)

Source: JICA Study Team

Annex-T A.4.1.1 List of Meteorological Stations

No.	Station Name	Province	Type	Coordinates *1			Monthly Precipitation Data Available Record Years
				Latitude N	Longitude E	Source	1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
01	CLSU Munoz	NUEVA ECIJA	PAGASA-Synoptic	15°43′00″	120°54′00″	1	
02	Cabanatuan	NUEVA ECIJA	PAGASA-Synoptic	15°29′18″	120°57′42″	6	
03	Port Area	NCR	PAGASA-Synoptic	14°35′00″	120°59′00″	1	
04	Science Garden	NCR	PAGASA-Synoptic	14°38′41″	121°02′31″	6	
05	Infanta	QUEZON	PAGASA-Synoptic	14°45′00″	121°38′48″	6	
06	Baler	QUEZON	PAGASA-Synoptic	15°46′00″	121°34′00″	1	
07	Casiguran	AURORA	PAGASA-Synoptic	16°17′00″	122°07′00″	1	
08	Dagupan	PANGASINAN	PAGASA-Synoptic	16°03′00″	120°20′00″	1	
09	Iba	ZAMBALES	PAGASA-Synoptic	15°20′00″	119°58′00″	1	
10	Balungao	PANGASINAN	PAGASA	15°54′00″	120°40′00″	1	
11	Consuelo	NUEVA VIZCAYA	PAGASA	16°10′00″	120°57′00″	3	
12	Bai Magalang	PAMPANGA	PAGASA	15°13′00″	120°42′00″	1	
13	San Fernando	PAMPANGA	PAGASA	15°02′00″	120°42′00″	3	
14	Mayantoc	TARLAC	PAGASA	15°36′00″	120°21′00″	4	
15	Santa Rita	ZAMBALES	PAGASA	15°10′00″	120°03′00″	4	
16	Hacienda Luisita	TARLAC	PAGASA	15°26′00″	120°36′00″	4	
17	Becuran	PAMPANGA	PAGASA	15°00′00″	120°34′00″	4	
18	SantaCruz	PAMPANGA	PAGASA	15°04′00″	120°33′00″	4	
19	Base AFB	PAMPANGA	Air Force Base	15°01′00″	120°30′00″	4	
20	Gabong	NUEVA VIZCAYA	NIA	16°01′40″	121°21′00″	3	
21	Pantabangan Dam	NUEVA ECIJA	NIA-UPRIIS	15°49′06″	121°06′34″	2	
22	Sapang Buho	NUEVA ECIJA	TelemetryNetwork	15°35′39″	121°07′09″	2	
23	Gabaldon	NUEVA ECIJA	TelemetryNetwork	15°29′55″	121°21′20″	2	
24	Zaragoza	PAMPANGA	TelemetryNetwork	15°26′36″	120°45′03″	2	
25	Papaya	PAMPANGA	TelemetryNetwork	15°21′17″	121°03′56″	2	
26	San Isidro	PAMPANGA	TelemetryNetwork	15°18′49″	120°54′09″	2	
27	Arayat	PAMPANGA	TelemetryNetwork	15°10′06″	120°46′56″	2	
28	Candaba	PAMPANGA	TelemetryNetwork	15°06′56″	120°51′01″	2	
29	Sibul Spring	BULACAN	TelemetryNetwork	15°10′04″	121°03′27″	2	
30	Sasmuan	PAMPANGA	TelemetryNetwork	14°56′14″	120°37′37″	2	
31	Sulipan	PAMPANGA	TelemetryNetwork	14°56′22″	120°45′31″	2	
32	Ipo Dam	BULACAN	TelemetryNetwork	14°52′30″	121°08′44″	2	
33	San Rafael	BULACAN	TelemetryNetwork	14°57′31″	120°57′53″	JST	
34	Masanga	QUEZON	others	14°59′36″	121°32′06″	5	
35	Tuno	QUEZON	others	14°45′50″	121°32′30″	5	
36	Lumutan	QUEZON	others	14°45′00″	121°21′00″	5	

Note (*1): 1- identified in Ref(1), 2- identified in Ref(2), 3- identified in Ref(3), 4- identified in Ref(4), 5- identified in Ref(5), 6- identified in PAGASA data, JST- estimated by Jica Study Team ■: data available ▨: include missing data

References:

Ref(1): NWIN, http://www.nwin.nwrb.gov.ph/

Ref(2): PAGASA-JICA, Basic Design Study Report on the Project for Upgrading of Flood Forecasting and Warning System in Pampanga and Agno River and Basins in Republic of Philippines, 2007.

Ref(3): NIA, Defenitive Development Plan, Irrigation Component of the Casecnan Multipurpose Irrigation and Power Project (CMIPP-IC), Appendix-I, 2000.

Ref(4): Pinatubo Hazard Urgent Rehabilitation Project, Mornitoring and Planning of Flood Control Works on the Pasac Delta (including the Porac-Gumain River) and Third River Channel, Final Report, Appendix No.2, Meteorology and Hydrology, 2002

Ref(5): JICA,NWRB, The Study on Water Resources Development for Metro Manila in the Republic of the Philippines, Final Report, Vol.III, Master Plan Study, Supporting Report, 2003.

Annex-T A.4.1.2 Collected Other Climatic Data

No.	Station Name	Type	Available data period
Monthly Mean Temperture (°C)			
1	CABANATUAN	PAGASA-Synoptic	1961 - 1980
			1991 - 2007
2	CLSU MUNOZ	PAGASA-Synoptic	1977 - 2007
Monthly Relative Humidity Data			
1	CABANATUAN	PAGASA-Synoptic	1961 - 1980
			1991 - 2007
2	CLSU MUNOZ	PAGASA-Synoptic	1974 - 2007
Monthly Wind speed Data			
1	CABANATUAN	PAGASA-Synoptic	1961 - 1980
			1991 - 2007
2	CLSU MUNOZ	PAGASA-Synoptic	1974 - 1999
Monthly Sunshine duration Data			
1	CLSU MUNOZ	PAGASA-Synoptic	1974 - 2007
Monthly Evaporation Data			
1	CLSU MUNOZ	PAGASA-Synoptic	1977 - 2007
Maximum Mean Temperture (°C)			
1	CLSU MUNOZ	PAGASA-Synoptic	1974 - 1999
Minimum Mean Temperture (°C)			
1	CLSU MUNOZ	PAGASA-Synoptic	1974 - 1999

Annex-T A.4.1.3 (1/2) List of Hydrometric Stations

No.	ID	RiverName	Location	Original Coordinates *1		This Study Coodinate		Drainage Area (Original)	Drainage Area (This Study)	Status *2	Location Remarks *3
				Latitude N	Longitude E	Latitude N	Longitude E				
01	326	Carranglan	Baluarte, Carranglan, Nueva Ecija	15°58′00″	121°03′14″	15°58′02″	121°03′02″	258	246	a	about 1.5 kms. west from Carrangalan town proper, approximately 15 meters upstream of the temporary steel bridge and about 3/4 km. downstream of the confluence of Siquin Creek and Carrangalan River.
02	327	Santor	San Vicente, Laur, Nueva Ecija	15°36′08″	121°09′57″	15°33′34″	121°13′27″	544	545	a	about 100 meters downstream of the confluence of Makalaw Greek and Santor River near Km Post 152 and about 1.5 kms. east of Barrio San Vicente, Laur Nueva Ecija.
03	328	Santor	Cuyapa, Gabaldon, Nueva Ecija	15°28′30″	121°18′48″	15°26′03″	121°20′48″	89	88	a	about 1 Km. upstream of the bridge along the road to sitio Tablang, Cuyapa, Gabaldon, Nueva Ecija.
04	329	Digmala	Labi, Bongabon, Nueva Ecija	15°38′52″	121°15′50″	15°38′45″	121°15′54″	52	54	a	about 25.00 meters upstream of the suspension bridge on the Bongabon-Baler National Road at Barrio Labi, Bongabon, Nueva Ecija.
05	330	Coronell	Bangkerohan, Bongabon, Nueva Ecija	15°35′35″	121°07′35″	15°35′25″	121°07′45″	709	712	a	near Km. Post No. 139 on the Cabanatuan Baler National road at barrio Bangkerchan, Bongabon, Nueve Ecija.
06	332	Pampanga	Malate, Bongabon, Nueva Ecija	15°30′57″	121°02′40″	15°33′14″	121°04′00″	2015	2038	a	on the left bank, about 1.5 kms. north of Bo. Malate, Bongabon, Nueva Ecija, 15 kms downstream of Santor River.
07	333	Cabu	Cabu, Cabanatuan City	15°31′45″	121°03′30″	15°31′39″	121°03′19″	143	142	a	at barrio Cabu about 20 meters downstream from the steel highway bridge along the Cabanatuan-Bongabon Road, 12 kms. from Cabanatuan City.
08	334	Pampanga	Valdefuente, Cabanatuan City	15°31′45″	120°57′20″	15°30′56″	120°57′17″	2441	2455	o	about 700 meters downstream from the confluence of the Pampanga River and Dalampang Creek at Valdefuente bridge, Cabanatuan City.
09	335	Tabuating	Soledad, Sta.Rosa, Nueva Ecija	15°24′00″	120°59′45″	15°24′01″	120°59′45″	79	81	o	about 6 kms. Southeast of Sta. Rosa at the Pampanga-Bongabon River Irrigation System in barrio Soledad, Sta. Rosa, Nueva
10	337	Pampanga	San Anton, San Leonardo, Nueva Ecija	15°20′45″	120°54′30″	15°20′46″	120°54′22″	2851	2778	a	about 1.5 kms. Upstream from the bridge along the road to the town of Jaen, Nueva Ecija.
11	338	Penaranda	San Vicente, Gapan, Nueva Ecija	15°18′46″	120°56′30″	15°18′43″	120°56′22″	575	566	a	on the bridge of the National Highway in San Vicente, Nueva Ecija.
12	339	Penaranda	San Josef, Penaranda, Nueva Ecija	15°21′10″	121°00′25″	15°21′13″	121°00′27″	512	519	a	on the left bank, at the upstream side of Manila railroad steel bridge in barrio San Josef, Pena5randa, Nueva Ecija.5 km. downsteram from the diversion dam of the Penaranda River Irrigation System.
13	340	Penaranda(Headworks)	San Josef, Penaranda, Nueva Ecija	15°19′10″	120°56′52″	15°20′58″	121°00′34″	511	519	a	about 500 meters upstream from the railroad bridge at San Josef, Penaranda, Nueva Ecija.
14	341	Chico	Ilog na Munti, Gen.Tinio, Nueva Ecija	15°21′48″	121°04′07″	15°21′42″	121°04′07″	160	157	a	about 1.5 kms. from the Pilot Barrio School along the road to Fort Magsaysay.
15	342	Sumacbao	Pias, Gen.Tinio, Nueva Ecija	15°20′28″	121°06′25″	15°20′43″	121°04′39″	287	309	a	about 1.5 kms. Upstream of the confluence of Chico and Sumacbao rivers at barrio-Pias, General Tinio, Nueva Ecija.
16	343	Pampanga	Camba(San Agustin), Arayat, Pampanga	15°10′06″	120°46′48″	15°10′05″	120°46′54″	6487	6315	a	at the Highway Bridge along San Fernando-Arayat Road at Barrio San Agustin, Arayat, Pampanga.
17	344	Talavera	Caboboloonan, Talavera, Nueva Ecija	15°41′26″	120°58′10″	15°40′39″	120°59′04″	431	391	a	at barrio Caboboloonan, Talavera, Nueva ecija, about 2 kms. upstream of the diversion canal at Sitio Bulak and approximately 27 kms. downstream of the gaging station at Lomboy.
18	345	Rio Chico	Sto. Rosario, Zaragoza, Nueva Ecija	15°26′44″	120°45′02″	15°26′44″	120°44′59″	1177	1604	o	at the bridge about 2.5 kms. From Las Pinas,Tarlac and about 5.5 kms. From Zaragosa, Nueva Ecija.
19	346	Rio Chico	Banga, Arayat, Pampanga	15°13′11″	120°46′54″	15°13′10″	120°46′54″	2982	2888	a	at sitio Banga, Arayat, Pampanga, about 12 kms. upstream from the confluence of RioChico and Pampanga River.
20	347	Benituan	Pasong Intsik, Guimba, Nueva Ecija	15°40′08″	120°44′40″	15°40′12″	120°44′47″	208	117	a	on the steel bridge along the National Highway # 15, Km. 156,43, about 500 meters downstream of the confluence of the Benituan and Baloy Rivers, and approximately 2 kms. From the town of guimba.
21	348	Baliwag	Catalanacan, Munoz, Nueva Ecija	15°43′22″	120°53′00″	15°43′12″	120°52′39″	284	248	a	at Barrio Catalanacan, Munoz, Nueva Ecija, about 3 kms. upstream of the railroad bridge across the Baliwag River.
22	349	Talavera	Lomboy, San Jose, Nueva Ecija	15°51′30″	121°00′45″	15°51′38″	121°01′14″	261	281	a	about 200 meters eat of highway No.5 (Cagayan Valley Road) and north of San Jose, Nueva Ecija, about 27 kms upstream of the gaging situation at Kaboboloonan.
23	350	Pampanga	Pialuan, Pantabangan, Nueva Ecija	15°49′39″	121°06′51″	15°49′40″	121°06′50″	838	834	a	about 4 kms. from the town of Pantabangan and about 1 km. downstream of the confluence of the Pantabangan and Pampanga Rivers.
24	351	Pampanga	Pasig, Candaba, Pampanga	15°05′48″	120°49′18″	15°05′44″	120°49′24″	7468	6324	a	on the Candava Suspension bridge along the Sta. Ana-Candava Road at pasig, Candava, Pampanga.
25	352	Pantabangan	Poblacion, Pantabangan, Nueva Ecija	15°51′31″	121°08′04″	15°50′42″	121°08′24″	253	268	a	near the Poblacion of Pantabangan, about 3 kms. upstream of the confluence of the Pantabangan and Pampanga Rivers.
26	353	Pampanga	Sta. Cruz, San Luis, Pampanga	15°00′26″	120°46′35″	15°00′31″	120°46′30″	7756		a	at San Luis, Pampanga.
27	354	Pampanga	San Juan, San Simon, Pampanga	15°00′51″	120°46′37″	15°03′49″	120°48′51″	7776		a	on the right bank at Barrio San Juan, San Simon, Pampanga
28	355	Maasim	Bahay-Pare, Candaba, Pampanga	15°01′58″	120°53′00″	15°01′58″	120°52′48″	174	187	a	at Bahay Pare, Candaba, Pampanga, on the highway bridge along the Baliwag-Bahay Pare road and about 800 kms. from the town of Baliwag, Bulacan.
29	356	Maasim	Diliman, San Rafael, Bulacan	15°02′15″	120°57′25″	15°02′24″	120°57′12″	150	146	a	about 800 meters upstream of the railroad steel bridge at Diliman-San Rafael, Bulacan and 900 meters downstream from the old station at barrio Maasim-San Rafael, Bulacan.
30	357	Candaba Swamps	Ducma, Candaba, Pampanga	15°06′37″	120°51′00″	15°06′59″	120°51′10″	7458		a	east of the trail going to Barrio Mandili, about 700 meters from the Paralaya Barrio Cementery at Ducma, Candava,
31	358	Garlang Creek	Garlang, San Ildefonso, Bulacan	15°06′48″	120°57′00″	15°07′02″	120°56′46″	5	6	a	
32	359	Garlang	Garalang, San Ildefonso, Bulacan	15°07′18″	120°57′08″	15°07′11″	120°56′46″	85	80	a	on the downstream wingwall of the abutment of the highway bridge near Km. Post 71 of the Manila-Cabanatuan road and about 7 kms. north of San Ildefonso,Bulacan.
33	360	San Miguel	San Vicente, San Miguel, Bulacan	15°08′48″	120°58′20″	15°08′30″	120°58′01″	256	234	a	at the Natinal Highway Bridge along the San Miguel-Cabanatuan diversion road, San Vicente San Miguel, Bulacan about 12 kms. from the Pampanga River.
34	361	Balaong-Madlum	Sta. Ines, San Miguel, Bulacan	15°09′15″	121°00′18″	15°09′12″	121°01′05″	204	206	a	about 200 meters downstream from the confluence of Madlum and Balaong-Madlum Rivers, 3 kms. southeast of Barrio Sta. Ines, San Miguel, Bulacan.
35	362	Bulo	Malibay, San Miguel, Bulacan	15°13′45″	121°04′12″	15°13′40″	121°04′13″	57	58	a	at Barrio Malibay, San Miguel, Bulacan, about 4 kms. from the Araneta Grassland Compound.
36	363	Pampanga	Sulipan, Apalit, Pampanga	14°56′24″	120°45′43″	14°56′29″	120°45′42″	7849		o	about 800 meters upstream from the combined Sulipan highway and railroad bridge at barrio Sulipan, Apalit Pamonga.
37	364	Sulipan Cut-off Channel	Sulipan, Apalit, Pampanga	14°56′13″	120°45′26″	14°56′12″	120°45′27″	7874		a	at the Sulipan highway bridge on the Manila north road, between the towns of Calumpit and Apalit, near the provincial boundary of Bulacan and Pampanga.
38	365	Francis	San Miguel Calumpit, Bulacan	14°56′22″	120°45′06″	14°55′54″	120°45′06″			a	about 4 kms. downstream from the highway Bridge along the Manila North Road in Calumpit and about 30 meters downstream from the Flood Control Checkgate.
39	366	Bebe Cut-off Channel No.1	Bebe, Masantol, Pampanga	14°52′40″	14°52′40″	14°52′46″	120°42′19″			a	about 150 meters downstream of the mouth of the cut-off channel at Barrio, Bebe, Masantol, Pampanga.
40	367	Bebe Cut-off Channel No.2	Bebe, Masantol, Pampanga	14°53′30″	120°40′30″	14°53′49″	120°40′41″			a	approximately 7 kms. downstream of the gaging station at Bebe Cut-off channel No. 1, at Sitio Pakapat, Bebe, Masantol, Pampanga.
41	368	Pampanga	Budbud, Masantol, Pampanga	14°46′16″	120°39′11″	14°56′17″	120°39′07″			a	approximately 15 kms. from the town of Masantol and about 20 meters upstream from the mouth at the Manila Bay in Barrio Budbud, Masantol, Pampanga.

Annex-T A.4.1.3 (2/2) List of Hydrometric Stations

No.	ID	RiverName	Location	Original Coordinates *1		This Study Coodinate		Drainage Area (Original)	Drainage Area (This Study)	Status *2	Location Remarks *3
				Latitude N	Longitude E	Latitude N	Longitude E				
42	369	Pampanga	Poblacion, Calumpit, Bulacan	14°55′20″	120°45′52″	14°55′17″	120°45′54″	7910		a	at the town proper of Calumpit, Bulacan, between the railroad and highway bridges.
43	370	Pampanga	San Miguel, Calumpit, Bulacan	14°55′11″	120°44′42″	14°55′11″	120°44′42″	7914		a	at the junction of Sulipan Cut-Off Channel and the Pampanga River at San Miguel, Calumpit, Bulacan.
44	371	Labangan	Halang, Hagonoy, Bulacan	14°50′28″	120°44′56″	14°50′28″	120°44′58″			a	about 7.00 meters upstream of the Halang Steel Bridge along the Hagonoy-Paombong road and about 2 kms. From Hagonoy, Bulacan.
45	372	Sta.Maria	Bagbagin, Sta.Maria, Bulacan	14°48′50″	120°57′38″	14°49′02″	120°57′32″	187		a	at Bo. Bagbagin, Sta Maria, Bulacan approximately 250 meters upstream from Bagbagin bridge.
46	373	Labangan	Tibagin, Hagonoy, Bulacan	14°46′08″	120°45′00″	14°46′36″	120°45′20″			a	about 13 kms. West of the town of Hagonoy and about 1.20 kms. Upstream from the mouth of Manila Bay at Tibagin-Hagonoy, Bulacan.
47	374	Labangan	San Antonio, Hangonoy, Bulacan	14°52′45″	120°45′38″	14°52′46″	120°45′40″			a	about 3 kms. Downstream of the Labangan River Baging Station at Bagbag, Calumpit, Bulacan and approximately 300 meters from the barrio chapel at San Antonio, Hagonoy, Bulacan.
48	375	Labangan	Bagbag, Calumpit, Bulacan	14°53′02″	120°46′13″	14°53′29″	120°45′52″	1016		a	at the Labangan Highway Bridge, on the Manila North Road, 48 kms. From Manila or 2.5 kms.from Calumpit, Bulacan.
49	376	Angat	Pungo, Calumpit, Bulacan	14°54′07″	120°47′00″	14°54′12″	120°47′00″	1014		a	at Pungo, Calumpit, Bulacan, about 1 km. upstream from the confluence of Angat and Bagbag rivers and approximately 1 1/3 kms. upstream of the Labangan River gaging station at Bagbag, Calumpit, Bulacan.
50	377	Angat	Poblacion, Pulilan, Bulacan	14°53′55″	120°50′36″	14°54′07″	120°51′20″	963		a	at Poblacion, Pulilan, Bulacan, about 3 kms. downstream of the Angat River Gaging Station at Plaridel bridge and approximately 6 kms. Upstream of the Angat River Gaging Station at Pungo, Calumpit, Bulacan.
51	378	Angat	Longos, Pulilan, Bulacan	14°53′30″	120°51′50″	14°53′35″	120°51′53″	959	882	a	at the downstream side of the Plaridel Bridge on Highway No.5, Barrio Longos, Pulilan, Bulacan.
52	379	Bayabas	Pulong Sampaloc, Angat, Bulacan	14°57′20″	121°03′45″	14°57′47″	121°03′39″	74	70	a	at Bo.Pulong Sampaloc, Angat, Bulacan, about 50 meters from the Bo. School and approximately 6 kms. upstream of the confluence with Angat River.
53	380	Angat	Below Ipo Dam, Norzagaray, Bulacan	14°52′36″	121°08′30″	14°52′54″	121°08′23″	629	619	a	about 1 km. downstream from the dam of the National Waterworks and Sewerage Authority, at barrio Ipo Norsagaray,
54	381	Pasig-Potrero	Cabetican, Bacolor, Pampanga	14°59′24″	120°38′50″	14°59′16″	120°38′57″	242		a	at the highway bridge, Barrio Cabetican, Bacolor, Pampanga.
55	382	Pasig-Potrero	HDA. Dolores, Porac, Pampanga	15°06′37″	120°31′58″	15°06′44″	120°32′03″	28		a	about 3 kms. upstream from the Porac-Angeles Highway bridge at Hacienda Dolores, Porac, pampanga.
56	3100	Pampanga	San Vicente, Cabiao, Nueva Ecija	15°13′18″	120°48′31″	15°13′29″	120°48′37″	3467	3404	a	
57	3101	Parua	San Nicolas, Bamban, Tarlac	15°15′38″	120°33′26″	15°15′42″	120°33′29″	148		a	at the bridge boundary of Pampanga and Tarlac Province, Barrio San Nicolas, Bamban, Tarlac.
58	3103	Madlum	Sibul Spring, San Miguel, Bulacan	15°10′04″	121°03′30″	15°10′15″	121°03′04″	102	118	a	about 13.5 kms. upstream of the Balaong -Madlum River approximately 4 kms. northeast of Sibul Spring, San Miguel,
59	3104	Rio Chico	Sta. Monica, Concepcion, Tarlac	15°21′00″	120°44′10″	15°21′23″	120°44′37″	2090	1818	a	
60	233	Casecnan	Dakgan, Madella, Nueva Vizcaya	16°04′10″	121°27′12″	16°04′15″	121°27′12″	872	859	a	
61	236	Casecnan	Gabong, Nueva Vizcaya	16°01′40″	121°21′00″	16°01′40″	121°21′03″	532	584	a	
62	3110	Talavera	San Andres Llanera, San Jose City	15°42′50″	121°00′35″	15°43′44″	121°00′14″	380	375	o	
63	3116	Pampanga	San Isidro Bridge, San Isidro, Nueva Ecija	15°18′55″	120°54′13″	15°18′53″	120°54′08″	3387	3368	o	
64	3119	Abacan	San Juan, Mexico, Pampanga	15°07′10″	120°42′09″	15°07′12″	120°42′05″	86		o	
65	384	Porac	Del Carmen, Floridablanca, Pampanga	14°59′34″	120°32′05″	14°59′33″	120°32′04″	111	116	o	on the left bank, about 3kms upstream of the Porac Irrigation Dam and approximately 2.5kms upstream of the Del Carmen bridge at Del Carmen, Floridablanca, Pampanga.
66	3121	Porac	Poblaciaon, Porac, Pampanga	15°04′20″	120°32′30″	15°04′26″	120°32′26″	37	38	o	
67	3122	Angat	Sabang, Angat, Bulacan	14°56′23″	121°01′20″	14°56′28″	121°01′17″	794	781	o	
68	385	Gumain Floodway	Sta Cruz, Lubao, Pampanga	14°55′00″	120°34′08″	14°55′02″	120°34′11″	370	259	a	at Sta. Cruz Bridge along the Lubao-Dinalupihan Road, at Barrio Sta. Cruz, Lubao Pampanga.
69	3115	Pampanga	Poblacion, Sta. Rosa, Nueva Ecija	15°25′40″	120°56′04″	15°25′36″	120°55′58″	2681	2607	o	
70	3111	Baliuag	Catalanacan, Sto.Domingo, Munoz, Nueva Ecija	15°40′01″	120°51′13″	15°40′06″	120°51′09″	313	303	o	
71	3999	Pantabangan	Pantabangan Dam	15°37′12″	121°07′00″	15°49′00″	121°06′29″	853	938	o	
72	3114	Coronell	Sapang Buho, Bongabon, Nueva Ecija	15°35′26″	121°07′42″	15°35′25″	121°07′45″	718	712	o	
73	311	O'donnel	Palublub, Capas, Tarlac	15°23′47″	120°30′05″	15°23′47″	120°30′19″	240	259	a	About 1.50 kms. from the confluence of Bangot and O'donnel rivers at Palublub, Capas, Tarlac.
74	312	Bangot	Sta.Lucia, Capas, Tarlac	15°22′05″	120°29′19″	15°22′12″	120°29′14″	91	92	o	
75	310	Bulsa	Villa Aglipay, Tarlac, Tarlac	15°28′06″	120°26′56″	15°27′59″	120°26′57″	405	447	a	About 1km BR. INTO BO.SCH ELDG.
76	3998	Angat	Angat Dam			14°54′42″	121°09′32″		546		

Note:

*1: 1- identified in Philippine Water Resources Summary Data Volume1 , 2- information of BRS, 3- identified in Ref(3)

*2: o- Operational, a- Abandoned , based on information of BRS

*3: specified in Philippine Water Resources Summary Data Volume1

References:

Ref(1): NWRC, Pampanga River Basins Frameworkplan, 1983.

Ref(2): DPWH-JICA, The Study on Flood Control Project Implementation System for Princple Rivers in the Republic of Philippines, Annex 3, 2004.

Ref(3): NIA, Defenitive Development Plan, Irrigation Component of the Casecnan Multipurpose Irrigation and Power Project (CMIPP-IC), Appendix-I, 2000.

Annex-T A.4.1.4 Available Hydrological Data Period

No.	ID	RiverName	Location	Drainage Area (Original)	Drainage Area (This Study)	Monthly Discharge Data Available Record Years
01	326	Carranglan	Baluarte, Carranglan, Nueva Ecija	258	246	
02	327	Santor	San Vicente, Laur, Nueva Ecija	544	545	
03	328	Santor	Cuyapa, Gabaldon, Nueva Ecija	89	88	
04	329	Digmala	Labi, Bongabon, Nueva Ecija	52	54	
05	330	Coronel	Bangkerohan, Bongabon, Nueva Ecija	709	712	
06	332	Pampanga	Malate, Bongabon, Nueva Ecija	2015	2038	
07	333	Cabu	Cabu, Cabanatuan City	143	142	
08	334	Pampanga	Valdefuente, Cabanatuan City	2441	2455	
09	335	Tabuating	Soledad, Sta.Rosa, Nueva Ecija	79	81	
10	337	Pampanga	San Anton, San Leonardo, Nueva Ecija	2851	2778	
11	338	Penaranda	San Vicente, Gapan, Nueva Ecija	575	566	
12	339	Penaranda	San Josef, Penaranda, Nueva Ecija	512	519	
13	340	Penaranda(Headworks)	San Josef, Penaranda, Nueva Ecija	511	519	
14	341	Chico	Ilog na Munti, Gen.Tinio, Nueva Ecija	160	157	
15	342	Sumacbao	Pias, Gen.Tinio, Nueva Ecija	287	309	
16	343	Pampanga	Camba(San Agustin), Arayat, Pampanga	6487	6315	
17	344	Talavera	Caboboloonan, Talavera, Nueva Ecija	431	391	
18	345	Rio Chico	Sto. Rosario, Zaragoza, Nueva Ecija	1177	1604	
19	346	Rio Chico	Banga, Arayat, Pampanga	2982	2888	
20	347	Benituan	Pasong Intsik, Guimba, Nueva Ecija	208	117	
21	348	Baliwag	Catalanacan, Munoz, Nueva Ecija	284	248	
22	349	Talavera	Lomboy, San Jose, Nueva Ecija	261	281	
23	350	Pampanga	Pialuan, Pantabangan, Nueva Ecija	838	834	
24	351	Pampanga	Pasig, Candaba, Pampanga	7468	6324	
25	352	Pantabangan	Poblacion, Pantabangan, Nueva Ecija	253	268	
26	353	Pampanga	Sta. Cruz, San Luis, Pampanga	7756		
27	354	Pampanga	San Juan, San Simon, Pampanga	7776		
28	355	Maasim	Bahay-Pare, Candaba, Pampanga	174	187	
29	356	Maasim	Diliman, San Rafael, Bulacan	150	146	
30	357	Candaba Swamps	Ducma, Candaba, Pampanga	7458		
31	358	Garlang Creek	Garlang, San Ildefonso, Bulacan	5	6	
32	359	Garlang	Garalang, San Ildefonso, Bulacan	85	80	
33	360	San Miguel	San Vicente, San Miguel, Bulacan	256	234	
34	361	Balaong-Madlum	Sta. Ines, San Miguel, Bulacan	204	206	
35	362	Bulo	Malibay, San Miguel, Bulacan	57	58	
36	363	Pampanga	Sulipan, Apalit, Pampanga	7849		
37	364	Sulipan Cut-off Channel	Sulipan, Apalit, Pampanga	7874		
38	365	Francis	San Miguel Calumpit, Bulacan	0		
39	366	Bebe Cut-off Channel No.1	Bebe, Masantol, Pampanga	0		
40	367	Bebe Cut-off Channel No.2	Bebe, Masantol, Pampanga	0		
41	368	Pampanga	Budbud, Masantol, Pampanga	0		
42	369	Pampanga	Poblacion, Calumpit, Bulacan	7910		
43	370	Pampanga	San Miguel, Calumpit, Bulacan	7914		
44	371	Labangan	Halang, Hagonoy, Bulacan	0		
45	372	Sta.Maria	Bagbagin, Sta.Maria, Bulacan	187		
46	373	Labangan	Tibagin, Hagonoy, Bulacan	0		
47	374	Labangan	San Antonio, Hangonoy, Bulacan	0		
48	375	Labangan	Bagbag, Calumpit, Bulacan	1016		
49	376	Angat	Pungo, Calumpit, Bulacan	1014		
50	377	Angat	Poblacion, Pulilan, Bulacan	963		
51	378	Angat	Longos, Pulilan, Bulacan	959	882	
52	379	Bayabas	Pulong Sampaloc, Angat, Bulacan	74	70	
53	380	Angat	Below Ipo Dam, Norzagaray, Bulacan	629	619	
54	381	Pasig-Potrero	Cabetican, Bacolor, Pampanga	242		
55	382	Pasig-Potrero	HDA, Dolores, Porac, Pampanga	28		
56	3100	Pampanga	San Vicente, Cabiao, Nueva Ecija	3467	3404	
57	3101	Parua	San Nicolas, Bamban, Tarlac	148		
58	3103	Madlum	Sibul Spring, San Miguel, Bulacan	102	118	
59	3104	Rio Chico	Sta. Monica, Concepcion, Tarlac	2090	1818	
60	233	Casecnan	Dakgan, Madella, Nueva Vizcaya	872	859	
61	236	Casecnan	Gabong, Nueva Vizcaya	532	584	
62	3110	Talavera	San Andres Llanera, San Jose City	380	375	
63	3116	Pampanga	San Isidro Bridge, San Isidro, Nueva Ecija	3387	3368	
64	3119	Abacan	San Juan, Mexico, Pampanga	86		
65	384	Porac	Del Carmen, Floridablanca, Pampanga	111	116	
66	3121	Porac	Poblaciaon, Porac, Pampanga	37	38	
67	3122	Angat	Sabang, Angat, Bulacan	794	781	
68	385	Gumain Floodway	Sta Cruz, Lubao, Pampanga	370	259	
69	3115	Pampanga	Poblacion, Sta. Rosa, Nueva Ecija	2681	2607	
70	3111	Baliuag	Catalanacan, Sto.Domingo, Munoz, Nueva Ecija	313	303	
71	3999	Pantabangan	Pantabangan Dam	853	938	
72	3114	Coronel	Sapang Buho, Bongabon, Nueva Ecija	718	712	
73	311	O'donnel	Palublub, Capas, Tarlac	240	259	
74	312	Bangot	Sta.Lucia, Capas, Tarlac	91	92	
75	310	Bulsa	Villa Aglipay, Tarlac, Tarlac	405	447	
76	3998	AngatDam	AngatDam		546	

Annex-T A.4.2.1 Correlation Coefficients for Precipitation at Each Station

	01_CLSU Munoz	02_Cabanatuan	03_Port Area	04_Science Garden	05_Infanta	06_Baler	07_Casiguran	08_Dagupan	09_Iba	10_Balungao	11_Consuelo	12_Bai Magalang	13_San Fernando	14_Mayantoc	15_Santa Rita	16_Hacienda Luisita	17_Becuran	18_SantaCruz	19_Base AFB	20_Gabong	21_Pantabangan Dam	22_Sapang Buho	23_Gabaldon	24_Zaragoza	25_Papaya	26_San Isidro	27_Arayat	28_Candaba	29_Sibul Spring	30_Sasmuan	31_Sulipan	32_Ipo Dam	33_San Rafael	34_Masanga	35_Tuno	36_Lumutan
01_CLSU Munoz	1.000	0.962	0.844	0.851	0.000	0.202	0.114	0.825	0.840	0.826	0.835	0.697	0.790	0.784	0.857	0.876	0.810	0.799	0.778	0.665	0.876	0.856	0.653	0.834	0.781	0.868	0.793	0.813	0.809	0.822	0.766	0.826	0.791	0.205	0.032	0.720
02_Cabanatuan	0.962	1.000	0.838	0.853	0.000	0.221	0.138	0.832	0.844	0.826	0.862	0.680	0.799	0.803	0.837	0.875	0.788	0.832	0.771	0.675	0.862	0.885	0.695	0.872	0.814	0.901	0.830	0.846	0.841	0.823	0.784	0.846	0.813	0.155	0.032	0.703
03_Port Area	0.844	0.838	1.000	0.960	0.084	0.263	0.152	0.847	0.842	0.792	0.867	0.655	0.881	0.834	0.866	0.864	0.853	0.899	0.861	0.594	0.822	0.837	0.663	0.824	0.731	0.834	0.822	0.784	0.825	0.897	0.822	0.846	0.876	0.167	0.348	0.743
04_Science Garden	0.851	0.853	0.960	1.000	0.084	0.257	0.167	0.847	0.840	0.805	0.853	0.704	0.886	0.835	0.856	0.873	0.855	0.882	0.868	0.624	0.819	0.828	0.624	0.818	0.701	0.852	0.771	0.822	0.845	0.873	0.806	0.854	0.844	0.263	0.084	0.763
05_Infanta	0.000	0.000	0.084	0.084	1.000	0.660	0.764	0.118	0.152	0.000	0.176	0.000	0.077	0.000	0.126	0.000	0.000	0.000	0.000	0.253	0.032	0.032	0.382	0.045	0.089	0.077	0.055	0.055	0.167	0.045	0.045	0.077	0.118	0.605	0.681	0.489
06_Baler	0.202	0.221	0.263	0.257	0.660	1.000	0.767	0.071	0.063	0.158	0.418	0.114	0.200	0.071	0.045	0.167	0.145	0.173	0.205	0.588	0.249	0.286	0.618	0.200	0.396	0.293	0.307	0.257	0.373	0.232	0.224	0.329	0.315	0.230	0.414	0.438
07_Casiguran	0.114	0.138	0.152	0.167	0.764	0.767	1.000	0.000	0.000	0.071	0.257	0.134	0.122	0.000	0.000	0.063	0.063	0.105	0.095	0.522	0.179	0.164	0.414	0.071	0.239	0.184	0.219	0.176	0.272	0.063	0.122	0.173	0.200	0.405	0.591	0.549
08_Dagupan	0.825	0.832	0.847	0.847	0.118	0.071	0.000	1.000	0.842	0.840	0.814	0.576	0.869	0.887	0.905	0.901	0.841	0.899	0.866	0.526	0.811	0.829	0.529	0.843	0.750	0.801	0.799	0.782	0.762	0.865	0.780	0.792	0.755	0.385	0.114	0.683
09_Iba	0.840	0.844	0.842	0.840	0.152	0.063	0.000	0.842	1.000	0.762	0.686	0.615	0.796	0.766	0.972	0.835	0.819	0.799	0.785	0.507	0.802	0.798	0.548	0.828	0.746	0.792	0.773	0.792	0.735	0.854	0.788	0.804	0.731	0.391	0.148	0.609
10_Balungao	0.826	0.826	0.792	0.805	0.000	0.158	0.071	0.840	0.762	1.000	0.903	0.571	0.792	0.810	0.748	0.914	0.697	0.815	0.829	0.587	0.787	0.669	0.662	0.736	0.661	0.731	0.706	0.722	0.688	0.869	0.689	0.707	0.686	0.321	0.141	0.404
11_Consuelo	0.835	0.862	0.867	0.853	0.176	0.418	0.257	0.814	0.686	0.903	1.000	0.749	0.881	0.891	0.733	0.913	0.808	0.846	0.775	0.749	0.927	0.754	0.000	0.804	0.801	0.849	0.846	0.865	0.892	0.000	0.794	0.839	0.846	0.274	0.212	0.589
12_Bai Magalang	0.697	0.680	0.655	0.704	0.000	0.114	0.134	0.576	0.615	0.571	0.749	1.000	0.746	0.675	0.574	0.677	0.677	0.887	0.692	0.631	0.663	0.748	0.477	0.688	0.597	0.699	0.700	0.659	0.668	0.635	0.634	0.699	0.656	0.345	0.095	0.513
13_San Fernando	0.790	0.799	0.881	0.886	0.077	0.200	0.122	0.869	0.796	0.792	0.881	0.746	1.000	0.877	0.842	0.896	0.847	0.932	0.916	0.595	0.804	0.716	0.628	0.846	0.712	0.831	0.884	0.843	0.797	0.869	0.877	0.828	0.828	0.366	0.055	0.707
14_Mayantoc	0.784	0.803	0.834	0.835	0.000	0.071	0.000	0.887	0.766	0.810	0.891	0.675	0.877	1.000	0.777	0.944	0.720	0.901	0.913	0.538	0.767	0.619	0.422	0.793	0.629	0.762	0.760	0.736	0.722	0.675	0.746	0.789	0.802	0.342	0.071	0.533
15_Santa Rita	0.857	0.837	0.866	0.856	0.126	0.045	0.000	0.905	0.972	0.748	0.733	0.574	0.842	0.777	1.000	0.856	0.834	0.879	0.859	0.555	0.861	0.786	0.616	0.836	0.714	0.810	0.787	0.803	0.731	0.879	0.831	0.780	0.720	0.429	0.158	0.612
16_Hacienda Luisita	0.876	0.875	0.864	0.873	0.000	0.167	0.063	0.901	0.835	0.914	0.913	0.677	0.896	0.944	0.856	1.000	0.854	0.956	0.875	0.496	0.850	0.811	0.659	0.912	0.760	0.883	0.863	0.835	0.844	0.860	0.875	0.889	0.855	0.381	0.176	0.672
17_Becuran	0.810	0.788	0.853	0.855	0.000	0.145	0.063	0.841	0.819	0.697	0.808	0.677	0.847	0.720	0.834	0.854	1.000	0.823	0.880	0.640	0.762	0.761	0.630	0.822	0.688	0.818	0.814	0.826	0.801	0.931	0.880	0.789	0.775	0.344	0.055	0.557
18_SantaCruz	0.799	0.832	0.899	0.882	0.000	0.173	0.105	0.899	0.799	0.815	0.846	0.887	0.932	0.901	0.879	0.956	0.823	1.000	0.898	0.552	0.869	0.781	0.170	0.828	0.737	0.832	0.875	0.822	0.762	0.943	0.848	0.736	0.802	0.367	0.045	0.664
19_Base AFB	0.778	0.771	0.861	0.868	0.000	0.205	0.095	0.866	0.785	0.829	0.775	0.692	0.916	0.913	0.859	0.875	0.880	0.898	1.000	0.518	0.704	0.751	0.644	0.721	0.701	0.778	0.752	0.767	0.725	0.778	0.783	0.803	0.713	0.295	0.110	0.453
20_Gabong	0.665	0.675	0.594	0.624	0.253	0.588	0.522	0.526	0.507	0.587	0.749	0.631	0.595	0.538	0.555	0.496	0.640	0.552	0.518	1.000	0.813	0.575	0.000	0.562	0.713	0.612	0.696	0.621	0.636	0.000	0.660	0.605	0.662	0.114	0.187	0.694
21_Pantabangan Dam	0.876	0.862	0.822	0.819	0.032	0.249	0.179	0.811	0.802	0.787	0.927	0.663	0.804	0.767	0.861	0.850	0.762	0.869	0.704	0.813	1.000	0.812	0.709	0.796	0.722	0.807	0.749	0.733	0.763	0.784	0.742	0.768	0.741	0.239	0.000	0.732
22_Sapang Buho	0.856	0.885	0.837	0.828	0.032	0.286	0.164	0.829	0.798	0.669	0.754	0.748	0.716	0.619	0.786	0.811	0.761	0.781	0.751	0.575	0.812	1.000	0.750	0.820	0.812	0.853	0.777	0.804	0.812	0.828	0.762	0.843	0.766	0.243	0.110	0.487
23_Gabaldon	0.653	0.695	0.663	0.624	0.382	0.618	0.414	0.529	0.548	0.662	0.000	0.477	0.628	0.422	0.616	0.659	0.630	0.170	0.644	0.000	0.709	0.750	1.000	0.677	0.694	0.695	0.575	0.657	0.720	0.620	0.616	0.700	0.675	0.000	0.000	0.000
24_Zaragoza	0.834	0.872	0.824	0.818	0.045	0.200	0.071	0.843	0.828	0.736	0.804	0.688	0.846	0.793	0.836	0.912	0.822	0.828	0.721	0.562	0.796	0.820	0.677	1.000	0.762	0.880	0.829	0.866	0.835	0.841	0.827	0.846	0.831	0.109	0.138	0.517
25_Papaya	0.781	0.814	0.731	0.701	0.089	0.396	0.239	0.750	0.746	0.661	0.801	0.597	0.712	0.629	0.714	0.760	0.688	0.737	0.701	0.713	0.722	0.812	0.694	0.762	1.000	0.792	0.804	0.737	0.775	0.631	0.709	0.782	0.687	0.303	0.161	0.709
26_San Isidro	0.868	0.901	0.834	0.852	0.077	0.293	0.184	0.801	0.792	0.731	0.849	0.699	0.831	0.762	0.810	0.883	0.818	0.832	0.778	0.612	0.807	0.853	0.695	0.880	0.792	1.000	0.847	0.837	0.858	0.832	0.803	0.844	0.846	0.335	0.071	0.650
27_Arayat	0.793	0.830	0.822	0.771	0.055	0.307	0.219	0.799	0.773	0.706	0.846	0.700	0.884	0.760	0.787	0.863	0.814	0.875	0.752	0.696	0.749	0.777	0.575	0.829	0.804	0.847	1.000	0.839	0.806	0.713	0.815	0.843	0.789	0.421	0.302	0.823
28_Candaba	0.813	0.846	0.784	0.822	0.055	0.257	0.176	0.782	0.792	0.722	0.865	0.659	0.843	0.736	0.803	0.835	0.826	0.822	0.767	0.621	0.733	0.804	0.657	0.866	0.737	0.837	0.839	1.000	0.856	0.767	0.820	0.849	0.831	0.332	0.071	0.586
29_Sibul Spring	0.809	0.841	0.825	0.845	0.167	0.373	0.272	0.762	0.735	0.688	0.892	0.668	0.797	0.722	0.731	0.844	0.801	0.762	0.725	0.636	0.763	0.812	0.720	0.835	0.775	0.858	0.806	0.856	1.000	0.827	0.835	0.849	0.854	0.130	0.235	0.743
30_Sasmuan	0.822	0.823	0.897	0.873	0.045	0.232	0.063	0.865	0.854	0.869	0.000	0.635	0.869	0.675	0.879	0.860	0.931	0.943	0.778	0.000	0.784	0.828	0.620	0.841	0.631	0.832	0.713	0.767	0.827	1.000	0.838	0.851	0.841	0.000	0.000	0.000
31_Sulipan	0.766	0.784	0.822	0.806	0.045	0.224	0.122	0.780	0.788	0.689	0.794	0.634	0.877	0.746	0.831	0.875	0.880	0.848	0.783	0.660	0.742	0.762	0.616	0.827	0.709	0.803	0.815	0.820	0.835	0.838	1.000	0.810	0.805	0.303	0.077	0.502
32_Ipo Dam	0.826	0.846	0.846	0.854	0.077	0.329	0.173	0.792	0.804	0.707	0.839	0.699	0.828	0.789	0.780	0.889	0.789	0.736	0.803	0.605	0.768	0.843	0.700	0.846	0.782	0.844	0.843	0.849	0.849	0.851	0.810	1.000	0.857	0.414	0.063	0.523
33_San Rafael	0.791	0.813	0.876	0.844	0.118	0.315	0.200	0.755	0.731	0.686	0.846	0.656	0.828	0.802	0.720	0.855	0.775	0.802	0.713	0.662	0.741	0.766	0.675	0.831	0.687	0.846	0.789	0.831	0.854	0.841	0.805	0.857	1.000	0.187	0.130	0.560
34_Masanga	0.205	0.155	0.167	0.263	0.605	0.230	0.405	0.385	0.391	0.321	0.274	0.345	0.366	0.342	0.429	0.381	0.344	0.367	0.295	0.114	0.239	0.243	0.000	0.109	0.303	0.335	0.421	0.332	0.130	0.000	0.303	0.414	0.187	1.000	0.680	0.210
35_Tuno	0.032	0.032	0.348	0.084	0.681	0.414	0.591	0.114	0.148	0.141	0.212	0.095	0.055	0.071	0.158	0.176	0.055	0.045	0.110	0.187	0.000	0.110	0.000	0.138	0.161	0.071	0.302	0.071	0.235	0.000	0.077	0.063	0.130	0.680	1.000	0.440
36_Lumutan	0.720	0.703	0.743	0.763	0.489	0.438	0.549	0.683	0.609	0.404	0.589	0.513	0.707	0.533	0.612	0.672	0.557	0.664	0.453	0.694	0.732	0.487	0.000	0.517	0.709	0.650	0.823	0.586	0.743	0.000	0.502	0.523	0.560	0.210	0.440	1.000

Source: JICA Study Team

Annex-T A.4.2.2 Reference Stations used for Gap Filling

Key station	Reference station		Regression equation
	Priority	Station used for gap filling	
Cabanatuan	1	CLSU Munoz	$P=P_{ref}/1.0455$
	2	Pantabangan Dam	$P=P_{ref}/0.9559$
Science Garden	1	Port Area	$P=P_{ref}/0.8565$
	2	Cabanatuan	$P=P_{ref}/0.7853$
Infanta	1	Casiguran	$P=P_{ref}/0.8670$
	2	Baler	$P=P_{ref}/0.8126$
Iba	1	SantaRita	$P=P_{ref}/1.1009$
	2	Cabanatuan	$P=P_{ref}/0.4983$

Remarks: P-Precipitation at key station, P_{ref} - Precipitation at reference station

Source: JICA Study Team

Annex-T A.4.2.3 Key Stations used for Gap Filling

Target station	Key station used for gap filling	Regression equation
01_CLSU Munoz	Cabanatuan	$P=1.0455P_{key}$
02_Cabanatuan	(Key station)	N/A
03_Port Area	Science Garden	$P=0.8565P_{key}$
04_Science Garden	(Key station)	N/A
05_Infanta	(Key station)	N/A
06_Baler	Infanta	$P=0.8126P_{key}$
07_Casiguran	Infanta	$P=0.8670P_{key}$
08_Dagupan	Iba	$P=0.6415P_{key}$
09_Iba	(Key station)	N/A
10_Balungao	Cabanatuan	$P=1.0270P_{key}$
11_Consuelo	Cabanatuan	$P=1.3752P_{key}$
12_Bai Magalang	Cabanatuan	$P=1.0735P_{key}$
13_San Fernando	Science Garden	$P=0.7445P_{key}$
14_Mayantoc	Cabanatuan	$P=1.1372P_{key}$
15_Santa Rita	Science Garden	$P=1.1009P_{key}$
16_Hacienda Luisita	Science Garden	$P=1.0425P_{key}$
17_Becuran	Science Garden	$P=0.7382P_{key}$
18_SantaCruz	Science Garden	$P=0.9077P_{key}$
19_Base AFB	Science Garden	$P=1.0015P_{key}$
20_Gabong	Cabanatuan	$P=0.9325P_{key}$
21_Pantabangan Dam	Cabanatuan	$P=0.9559P_{key}$
22_Sapang Buho	Cabanatuan	$P=0.7946P_{key}$
23_Gabaldon	Cabanatuan	$P=1.3166P_{key}$
24_Zaragoza	Cabanatuan	$P=0.7642P_{key}$
25_Papaya	Cabanatuan	$P=0.9306P_{key}$
26_San Isidro	Cabanatuan	$P=0.8102P_{key}$
27_Arayat	Cabanatuan	$P=0.7622P_{key}$
28_Candaba	Cabanatuan	$P=0.7060P_{key}$
29_Sibul Spring	Science Garden	$P=0.8171P_{key}$
30_Sasmuan	Science Garden	$P=0.6786P_{key}$
31_Sulipan	Science Garden	$P=0.7764P_{key}$
32_Ipo Dam	Science Garden	$P=1.0510P_{key}$
33_San Rafael	Science Garden	$P=0.7172P_{key}$
34_Masanga	Infanta	$P=1.9233P_{key}$
35_Tuno	Infanta	$P=1.7058P_{key}$
36_Lumutan	Science Garden	$P=1.9301P_{key}$

Remarks: P-Precipitation at target station, P_{key} - Precipitation at key station

Source: JICA Study Team

Annex-T A.4.2.4 Monthly Precipitation for Each Sub-Basin

Code	Code_NWRB	Name_NWRB	Area (km^2)	Precipitation (mm)												
				Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PAM01	03059	Pampanga	159	1,731	10	8	13	27	135	226	319	380	288	179	103	42
PAM02	03059	Pampanga	1,517	1,811	18	14	20	34	148	233	319	358	284	197	124	61
PAM03	03059	Pampanga	40	1,509	9	7	12	27	140	197	278	311	250	158	83	36
PAM04	03059	Pampanga	799	1,724	10	8	14	30	151	234	307	356	289	176	107	41
PAM05	03059	Pampanga	437	2,016	20	15	24	40	184	255	342	392	314	223	143	66
PAN01	03058	Pantabangan	849	2,183	26	20	30	49	201	269	368	404	340	244	157	74
RCH01	03421	Rio Chico	2,895	1,926	12	10	17	38	179	257	355	400	319	189	110	41
PEN01	03056	Penaranda	570	2,638	77	56	56	66	198	298	377	416	361	311	247	175
COR01	03057	Coronell	712	2,460	45	32	41	56	209	301	384	437	360	272	209	115
ANG01	03055	Angat	194	1,806	10	9	14	28	139	235	334	397	297	188	109	46
ANG02	03055	Angat	346	2,425	28	21	27	51	188	297	418	479	387	261	174	91
ANG03	03055	Angat	546	4,391	229	168	145	146	281	389	495	504	491	557	521	464
PAS01	N/A	N/A	1,371	2,096	11	10	16	37	170	277	400	464	346	202	115	47

Source: JICA Study Team

Annex-T A.4.2.5 Monthly PET for Each Sub-Basin

Code	Code_NWRB	Name_NWRB	Area (km^2)	PET (mm)												
				Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PAM01	03059	Pampanga	159	1,415	81	84	115	140	164	158	151	135	114	104	86	80
PAM02	03059	Pampanga	1,517	1,367	77	80	110	134	158	155	148	133	112	100	82	77
PAM03	03059	Pampanga	40	1,393	79	82	113	138	161	157	150	135	114	102	84	78
PAM04	03059	Pampanga	799	1,365	77	79	109	133	158	156	149	134	113	100	82	76
PAM05	03059	Pampanga	437	1,262	70	73	100	121	145	144	139	125	105	93	75	71
PAN01	03058	Pantabangan	849	1,186	66	69	94	114	136	136	131	117	99	87	71	67
RCH01	03421	Rio Chico	2,895	1,354	77	79	109	133	156	153	147	131	111	99	81	76
PEN01	03056	Penaranda	570	1,256	71	73	100	122	144	143	137	123	104	92	75	71
COR01	03057	Coronell	712	1,197	67	69	95	115	137	137	132	118	100	88	72	68
ANG01	03055	Angat	194	1,411	81	83	115	140	164	158	151	136	115	103	85	80
ANG02	03055	Angat	346	1,308	74	77	105	128	151	148	141	127	107	96	79	74
ANG03	03055	Angat	546	1,173	67	69	94	114	134	133	127	114	97	86	71	67
PAS01	N/A	N/A	1,371	1,358	78	81	111	135	157	151	145	129	110	100	83	78

Source: JICA Study Team

Annex-T A.4.3.1 Calculated Annual Average Discharge before and after 1974

Code	Name	DA (km^2)	P (mm)	PET (mm)	P-PET (mm)	1951 - 1973						1974 - 2007					
						Number of year	Discharge (m^3/s)	Specific Discharge ($m^3/s/km^2$)	Runoff Depth (mm)	Runoff Rate (-)	Category	Number of year	Discharge (m^3/s)	Specific Discharge ($m^3/s/km^2$)	Runoff Depth (mm)	Runoff Rate (-)	Category
326	Carranglan	246	2,265	1,146	1,119	14	8.96	0.036	1148	0.507	0						
327	SANTOR	545	2,672	1,155	1,517	12	31.94	0.059	1848	0.692	0						
328	Santor	88	3,261	1,200	2,061	14	5.44	0.062	1951	0.598	1						
329	DIGMALA	54	2,879	997	1,882	12	4.94	0.091	2884	1.002	2						
330	CORONELL	712	2,462	1,196	1,266	14	49.04	0.069	2172	0.882	0						
332	PAMPANGA	2,038	2,233	1,210	1,023	17	69.29	0.034	1072	0.480	0						
334	PAMAPNGA	2,455	2,149	1,234	915	5	141.84	0.058	1822	0.848	0	14	69.13	0.028	888	0.413	1
335	TABUATING	81	1,748	1,348	400	12	3.89	0.048	1516	0.867	0	14	4.08	0.050	1588	0.909	0
337	PAMPANGA	2,778	2,101	1,251	850	11	118.92	0.043	1350	0.643	0						
338	PENARANDA	566	2,646	1,255	1,391	6	35.65	0.063	1986	0.751	0						
339	PENARANDA (RRBR.)	519	2,739	1,243	1,496	22	17.50	0.034	1063	0.388	1						
340	PENARANDA (HW)	519	2,741	1,243	1,498	6	19.19	0.037	1166	0.425	1						
341	CHICO	157	2,365	1,235	1,130	6	7.14	0.045	1433	0.606	0	5	4.98	0.032	1001	0.423	1
342	SUMACBAO	309	3,108	1,226	1,882	11	24.83	0.080	2534	0.815	0						
343	PAMPANGA	6,315	2,063	1,300	763	22	237.00	0.038	1184	0.574	0	16	229.34	0.036	1145	0.555	0
344	TALAVERA	391	2,291	1,184	1,107	8	12.65	0.032	1020	0.445	1						
345	RIO CHICO	1,604	1,914	1,337	577	5	52.85	0.033	1039	0.543	0	16	71.44	0.045	1405	0.734	0
347	BENITUAN	117	1,862	1,391	471	13	10.49	0.090	2828	1.519	2						
348	BALIWAG	248	2,017	1,343	674	13	7.29	0.029	927	0.460	0						
349	TALAVERA	281	2,434	1,133	1,301	16	15.20	0.054	1706	0.701	0						
350	PAMPANGA	834	2,187	1,185	1,002	12	42.96	0.052	1624	0.743	0						
351	PAMPANGA	6,324	2,062	1,300	762	13	233.76	0.037	1166	0.565	0						
352	PANTABANGAN	268	2,310	1,199	1,111	9	15.12	0.056	1779	0.770	0						
355	MAASIM	187	2,012	1,344	668	12	13.18	0.070	2223	1.105	2						
356	MAASIM	146	2,133	1,330	803	20	9.27	0.064	2003	0.939	0						
359	GARLANG RIVER	80	1,908	1,367	541	7	3.71	0.046	1464	0.767	0						
360	SAN MIGUEL	234	2,482	1,300	1,182	14	13.52	0.058	1823	0.734	0						
361	BALAONG-MADLUM	206	2,568	1,290	1,278	17	7.10	0.034	1086	0.423	1						
362	BULO	58	2,159	1,315	844	8	2.56	0.044	1393	0.645	0						
372	STA. MARIA	187	2,313	1,176	1,137	5	5.80	0.031	978	0.423	1						
3100	PAMPANGA	3,404	2,182	1,254	928	8	127.32	0.037	1180	0.541	0						
3103	Madlum	118	2,711	1,277	1,434	9	4.27	0.036	1141	0.421	1						
233	Casecnan	859	2,467	1,019	1,448							6	41.20	0.048	1513	0.613	0
236	Casecnan	584	2,468	992	1,476							6	21.98	0.038	1187	0.481	1
3110	TALAVERA RIVER	375	2,313	1,176	1,137							10	17.34	0.046	1459	0.631	0
3101	PARUA	87	2,711	1,261	1,450	8	7.33	0.084	2657	0.980	0						
3116	PAMPANGA	3,368	2,189	1,252	937							7	133.27	0.040	1248	0.570	0
384	PORAC RIVER	116	2,562	1,305	1,257	20	4.86	0.042	1322	0.516	0	7	12.51	0.108	3402	1.328	2
3121	PORAC RIVER	38	2,680	1,257	1,423							6	2.66	0.070	2209	0.824	0
385	GUMAIN FLOODWAY	259	2,732	1,280	1,452	15	32.65	0.126	3975	1.455	2	8	20.55	0.079	2502	0.916	0
3115	Pampanga	2,607	2,127	1,243	884							7	97.39	0.037	1178	0.554	0
3111	BALIUAG RIVER	303	1,996	1,350	646							5	9.86	0.033	1026	0.514	0
3999	Pantabangan	938	2,227	1,184	1,043							28	37.81	0.040	1271	0.571	0
3114	CORONELL	712	2,462	1,196	1,266							15	62.07	0.087	2749	1.117	2
311	O'DONNEL	259	2,915	1,258	1,657	5	6.68	0.026	813	0.279	1						
312	BANGAT	92	2,787	1,273	1,514	5	6.19	0.067	2122	0.761	0	13	4.65	0.051	1593	0.572	0
310	BULSA RIVER	447	3,017	1,221	1,796	11	31.11	0.070	2195	0.727	0						
3998	ANGAT	546	4,391	1,173	3,218	6	60.84	0.111	3514	0.800	0	34	58.66	0.107	3388	0.772	0

Remarks:
Category 0: P-PET < TRO < P, 1: TRO < P-PET, 2: P < TRO
(TRO: Total Runoff, P: Precipitation, PET: Potential evapotranspiration)

Source: JICA Study Team

Annex-T A.4.3.2 Probable Flood Discharge

River	Station	Drainage Area (km^2)*1	Probable Flood Discharge (m^3/s)				
			5-yr	10-yr	20-yr	50-yr	100-yr
Pampanga Main Stream	Cabanatuan	2,482	1,977	2,365	2,725	3,205	3,572
	San Isidro	3,472	2,408	3,051	3,641	4,315	4,857
	Cabiao	3,512	2,424	3,071	3,668	4,349	4,895
	Arayat	6,532	2,349	2,731	3,068	3,451	3,734
	Sulipan	8,907	2,654	3,517	4,779	6,111	7,039
Rio Chico	Zaragoza	1,675	1,061	1,497	1,883	2,422	2,840
	Inflow to San Antonio Swamp	3,020	1,508	2,212	2,853	3,721	4,368
Penaranda	Confluence to Main Stream	601	529	732	864	1,046	1,192
Angat	Longos	895	737	1,015	1,367	2,050	2,429
Pasac *2	River Mouth	945	326	470	573	774	1,004

Source: DPWH, NIA, JICA: Feasibility Report on The Pampanga Delta Development Project, 1982

Note: *1: Drainage area specified in source report,

*2: Original river name, Gua-Gua river, has been modified by Jica Study Team because Gua-Gua river belong to Pasac river system in the present study. The data of the San Fernando station in the Gua-Gua river has been deleted by Jica Study Team because flow regime was changed by eruption of the Pinatubo Mountain.

Annex-T A.4.3.3 Probable Specific Discharge

River	Station	Drainage Area (km^2)*1	Specific Discharge ($m^3/s/km^2$)				
			5-yr	10-yr	20-yr	50-yr	100-yr
Pampanga Main Stream	Cabanatuan	2,482	0.80	0.95	1.10	1.29	1.44
	San Isidro	3,472	0.69	0.88	1.05	1.24	1.40
	Cabiao	3,512	0.69	0.87	1.04	1.24	1.39
	Arayat	6,532	0.36	0.42	0.47	0.53	0.57
	Sulipan	8,907	0.30	0.39	0.54	0.69	0.79
Rio Chico	Zaragoza	1,675	0.63	0.89	1.12	1.45	1.70
	Inflow to San Antonio Swamp	3,020	0.50	0.73	0.94	1.23	1.45
Penaranda	Confluence to Main Stream	601	0.88	1.22	1.44	1.74	1.98
Angat	Longos	895	0.82	1.13	1.53	2.29	2.71
Pasac	River Mouth	945	0.34	0.50	0.61	0.82	1.06

Source: JICA Study Team based on DPWH, NIA, JICA: Feasibility Report on The Pampanga Delta Development Project, 1982

Note: *1: Drainage area specified in source report

Annex-T A.5.1.1 Geology in the Study Area

Era, Period	Stage-Epoch	Symbol	Description - lithology	Topography
Cenozoic, Quaternary	Holocene (Recent)	R	Alluvium (flood plain, lacustrine, levee, sandbar, lagoon, hinterland deposits)	Plain. Level to nearly level
	Pleistocene to Pliocene	N3+Q1	Sandstone (ss), conglomerate (cg). (Guadalupe Formation)	Undulated
Tertiary	Upper-Miocene	N2	Ss, cg, mudstone (md) overlain by pyroclastics (mainly tuff) & tuffaceous sedimentary rocks. (Tartaro Formation)	Hilly. Gently sloping
	Middle-Miocene to Late-Oligocene	N1	Thick, extensive shale (flysch) with minor cg, ss. Upper part is limestone. Folded and intruded by quartz diorite.	Mountainous. Moderately sloping
	Upper-Paleocene	PG2	ss, cg and shales with minor limestone and andesite flows.	Mountainous. Strongly sloping
	Lower-Paleocene	PG1	Thick, extensive ss, cg & shales with minor basal conglomerate. Generally moderately folded and intruded by quartz diorite.	Mountainous.
Mesozoic, Cretaceous	Paleocene to Cretaceous	KPG	Ss, cg & metamorphosed shales with basalt to andesite, pyroclastics.	Mountainous.
	Cretaceous	K	Ss, cg & shales with spilites.	Mountainous.
Unknown	Basement Complex	BC	Amphiolite, mica schist, phyllites. Folded by upthrusts.	Mountainous.
Igneous rocks				
Cenozoic, Quaternary	Quaternary pyroclastics	QVP	Volcanic piedmont deposits. Chiefly pyroclastics and/or volcanic debris at foot of volcanos.	Hilly
	Quaternary volcanics	QV	Non-active cones. Generally pyroxene andesite.	Mountainous. Strongly sloping
Tertiary	Miocene	IN	Quartz diorite dyke	
	Before Miocene	IPG1	Quartz diorite, dacite & andesite flows & dikes.	
Paleogene-Creataceous	Undifferentiated volcanics	UV	Metamorphosed submarine flows: largely spilites and basalts	

P, K: Ophiolite. N: marine sedimentary rocks and diorite intrusive rocks. Q: volcanic rocks-Mt. Pinatubo
Source: MGB, Geological Map of Philippines 1/1,000,000

Annex-T A.5.2.1 Available Hydrogeological Parameters

Tested values are average

Sub- basin	Area (km^2)	Outline of geology	location	Test well	Well depth	Water level (GL-m)	S*1 (m^2/d)	T*2 (m^2/day)	Q*3 (m^3/day)
PAM01	159	Recent deposit. Depth: > 200m.	Calumpit					1192-2423	1382-6134
PAM02	1,517	Recent deposit. 66% Depth: >200m to 0m N3+Q1 sediments: 8%, Tertiary rocks: 26%	San Miguel Pulilan St. Ildefonso		90 252 125-150 S=26 D=71	6 - S=5.2 D=5.9	(N3+Q1) 563 47 S=41 D=105	24 648 60-81	 3829 2160
PAM03	40	Recent deposit. Depth:>200m							
PAM04	798	Recent deposit. 67% Depth: >200m to 0m N3+Q1 sediments: 11%, Tertiary rocks: 22%			S=11 D=89	S=4.1 D=4.1	S=70 D=34	(85) (41)	
PAM05	437	Recent deposit. 24% Depth: 60m to 0m N3+Q1 sediments: 11%, Tertiary & Cretaceous rocks: 65%			S=13 D=56	S=4.1 D=2.6	S=87 D=84	(106) (102)	
ANG01	194	Recent deposit. Depth: > 200m.							
ANG02	346	Recent deposit. 22% Depth. >200m to 0m N3+Q1 sediments: 15%, Tertiary rocks: 63%							
ANG03	546	Tertiary & Cretaceous rocks	Limited potential						
PAS01 *4 *5 *6 *7	1,371	Recent deposit. 77% Depth: >200m to 0m Recent volcanics and lahar: 23	Tarlac, Concepcion, Angeles - -	9 6 11 357 -	131-155 144-223 54 S=22 D=120	4.0 4.0-10.1 4.0 S=6.7 D=9.9	110 86-346 70 S=114 D=105	307 185 279 (139) (128)	- 2,152 2,772 (6,005)
PEN01	570	Recent deposit. 10% Depth. >200m to 0m N3+Q1 sediments: 9%, Tertiary rocks: 81%	Limited potential						
PAN01	849	N3+Q1 sediments: 10%, Tertiary & Cretaceous rocks: 90	Limited potential		34	4.7	158	(198)	
RCH01	2,895	Recent deposit. 77% Depth: >200m to 0m Lahar etc: 23%,		6	100	4-10			2,151
COR01	712	Recent deposit. 8% Depth. >200m to 0m N3+Q1 sediments: 9%, Tertiary rocks: 83%	Limited potential						
Total	10,434	Notes: well means test well							

Source: MGB and others. Partly analyzed by JICA Study Team.

S=shallow well, D=Deep well

S*1: Specific capacity,

T*2: Transmissivity. Parenthesis number is roughly estimated as the following formula; S=1.22T.

Q*3: discharge at pumping test

*4: Report on the Groundwater Resources Survey of Brgy. San Jose de Orquico and Vicinity in Tarlac City, May 2004, MGB Region III

*5: Groundwater Resources Evaluation and Well inventory of Concepcion, Tarlac, MGB

*6: Mapping & Agricultural Potential Study for the Integral Rural Development Program in Pampanga" Nov. 1992, Annex I

*7: Basic Survey for Integrated Water Resources Management, Pampanga River Basin, 1998, NWRB

Annex-T A.7.4.1 Duration of Calibration

HMS_ID	River Name	Calibration period
310	Bulsa	1961,1962,1964-1972
327	Coronell	1958,1960-1969,1975
341	Chico	1961,1962,1965,1967-1969
342	Sumacbao	1961-1963, 1965-1969
349	Talavera	1957-1971
3121	Porac	2000-2003
3998	Angat Dam	1968-1970, 1972-2007
3999	Pantabangan Dam	1980-2007
343 Residual	Pampanga	1956-1969

Source: JICA Study Team

Annex-T A.7.4.2 Calibrated Parameters

Parameters		3121	310	349	3999	327	341	342	3998	343 Residual	Average
		Porac	Bulsa	Talavera	Pantabangan Dam	Coronell	Chico	Sumacbao	AngatDam	Arayat	
Dircet Runoff Rate for extream condition (0-1)	drofrac_ext	1	1	1	1	1	1	1	1	1	1
Dircet Runoff Rate for normal condition (0-1)	drofrac_nor	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Threshold Net Precipitatioin (mm)	Thr_NetP	1000	1000	750	1000	1000	800	320	500	300	721
Soil Moisture Storage Capacity (mm)	STC	300	500	50	500	200	40	150	150	100	201
Parameter for Soil Moisture	alfa	1	1	20	3	3	3	30	5	20	9
Runoff Factor (0-1)	rfactor	0.1	0.5	0.2	0.45	0.3	0.6	0.1	0.7	0.4	0.4
Drainage Area (km^2)	A	38	447	281	938	545	157	309	546	3446	410

Source: JICA Study Team

Annex-T A.7.5.1 Explanation of the Control Points

Most Downstream Catchment	River System	Description
PAM01	Pampanga Main	Residual catchment which is directly drained to Manila Bay
PAM0201	Pampanga Main	Calumpit
PAM0203	Pampanga Main	Cong Dadong diversion dam
PAM03	Pampanga Main	Pampanga river before confluence with Rio Chico river
PAM0401	Pampanga Main	Pampanga river before confluence with Peneranda river
PAM0402	Pampanga Main	Bongabong diversion dam
PAM0501	Pampanga Main	Pampanga river before confluence with Coronell river
PAM0502	Pampanga Main	Rizal diversion dam
PAM0503	Pampanga Main	Masiway dam
PAN01	Pampanga Main	Pantabangan storage dam
PAM0202	Pampanga Main	Proposed site for Massim storage dam
RCH0101	Pampanga Main	Rio Chico river before confluence with Pampanga river
RCH0103	Pampanga Main	Talavera river before confluence with Baliwag river
RCH0104	Pampanga Main	Talavera diversion dam
RCH0102	Pampanga Main	Baliwag river before confluence with Talavera river
PEN0101	Pampanga Main	Penaranda river before confluence with Pampanga river
PEN0102	Pampanga Main	Penaranda diversion dam
PEN0103	Pampanga Main	Proposed diversion dam at downstream of proposed Balintingon storage dam
COR01	Pampanga Main	Coronell river before confluence with Pampanga river
ANG01	Angat	Residual catchment which is directly drained to Manila Bay
ANG0201	Angat	Downstream end of the Angat River,
ANG0202	Angat	Bustos diversion dam
ANG0204	Angat	Ipo dam
ANG03	Angat	Angat Storage dam
ANG0203	Angat	Proposed site for Bayabas storage dam
PAS0101	Pasac	Residual catchment which is directly drained to Manila Bay
PAS0102 & PAS0104	Pasac	Pasac river after confluence with Gumain river
PAS0103	Pasac	Pasac river after confluence of Abacan river and San Fernando river
PAS0104	Pasac	Guagua river after confluence with Gumain river
PAS0105	Pasac	Gumain river after confluence with Porac river
PAS0106	Pasac	Porac diversion dam
PAS0107	Pasac	Gumain diversion dam
PAS0108	Pasac	Proposed site for Gumain storgae dam
T_AUR	Trans-basin	Diversion point of Aurola trans-basin
T_CAS	Trans-basin	Diversion point of Casecnan trans-basin
T_TAL01	Trans-basin	Smoris diverion dam
T_TAL02	Trans-basin	Bulsa diverison dam
T_TAL03	Trans-basin	Proposed site for Balog-Balog storage dam
T_UMI01	Trans-basin	Diversion point for Umiray-Angat Trans-basin
T_UMI02	Trans-basin	Diversion point for Umiray-Angat Trans-basin (not yet completed)
T_UMI03	Trans-basin	Diversion point for Umiray-Angat Trans-basin (not yet completed)

Source: JICA Study Team

Annex-T A.7.5.2 Parameters used for Each Water Balance Catchment

River System	Code	Area (km^2)	HMS of parameters used for calculation
Pampanga Main	PAM01	159.2	343Residual
	PAM0201	1,458.1	343Residual
	PAM0202	52.6	343Residual
	PAM0203	6.6	343Residual
	PAM03	39.8	343Residual
	PAM0401	771.1	343Residual
	PAM0402	27.6	343Residual
	PAM0501	384.7	3999
	PAM0502	31.6	3999
	PAM0503	20.3	3999
	PAN01	917.3	3999
	RCH0101	1,489.5	343Residual
	RCH0102	696.4	343Residual
	RCH0103	408.3	343Residual
	RCH0104	301.1	349
	PEN0101	51.2	341
	PEN0102	269.7	341
	PEN0103	248.8	342
	COR01	712.0	327
Angat	ANG01	193.5	3998
	ANG0201	46.0	3998
	ANG0202	176.0	3998
	ANG0203	52.1	3998
	ANG0204	71.7	3998
	ANG03	545.9	3998
Pasac	PAS0101	137.7	3121
	PAS0102	198.3	3121
	PAS0103	398.4	3121
	PAS0104	341.9	3121
	PAS0105	47.2	3121
	PAS0106	115.6	3121
	PAS0107	14.4	3121
	PAS0108	117.9	3121
TransBasin	T_TAL01	287.6	310
	T_TAL02	235.6	310
	T_TAL03	288.7	310

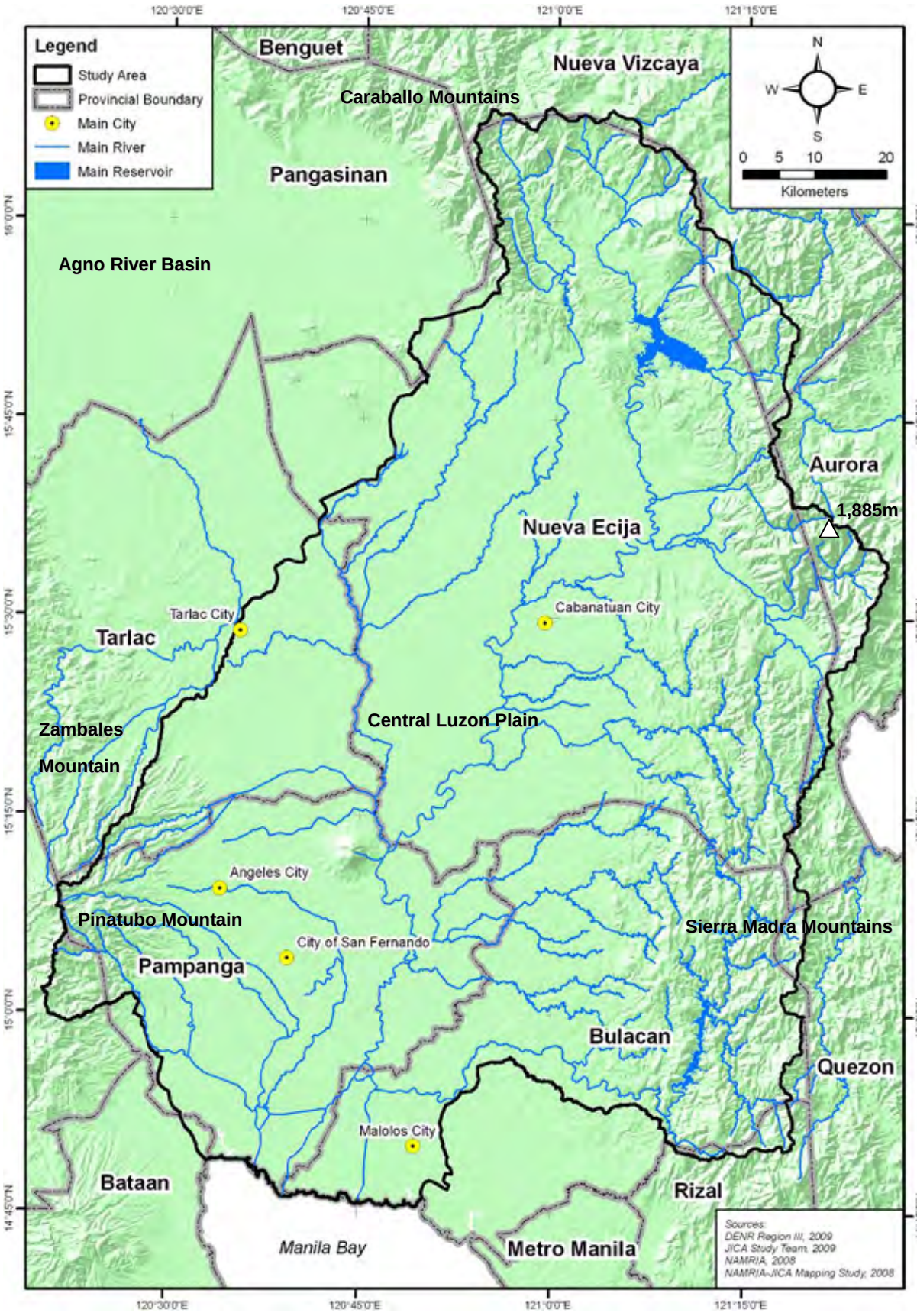
Source: JICA Study Team

Annex-T A.7.5.3 Results of Runoff Simulation

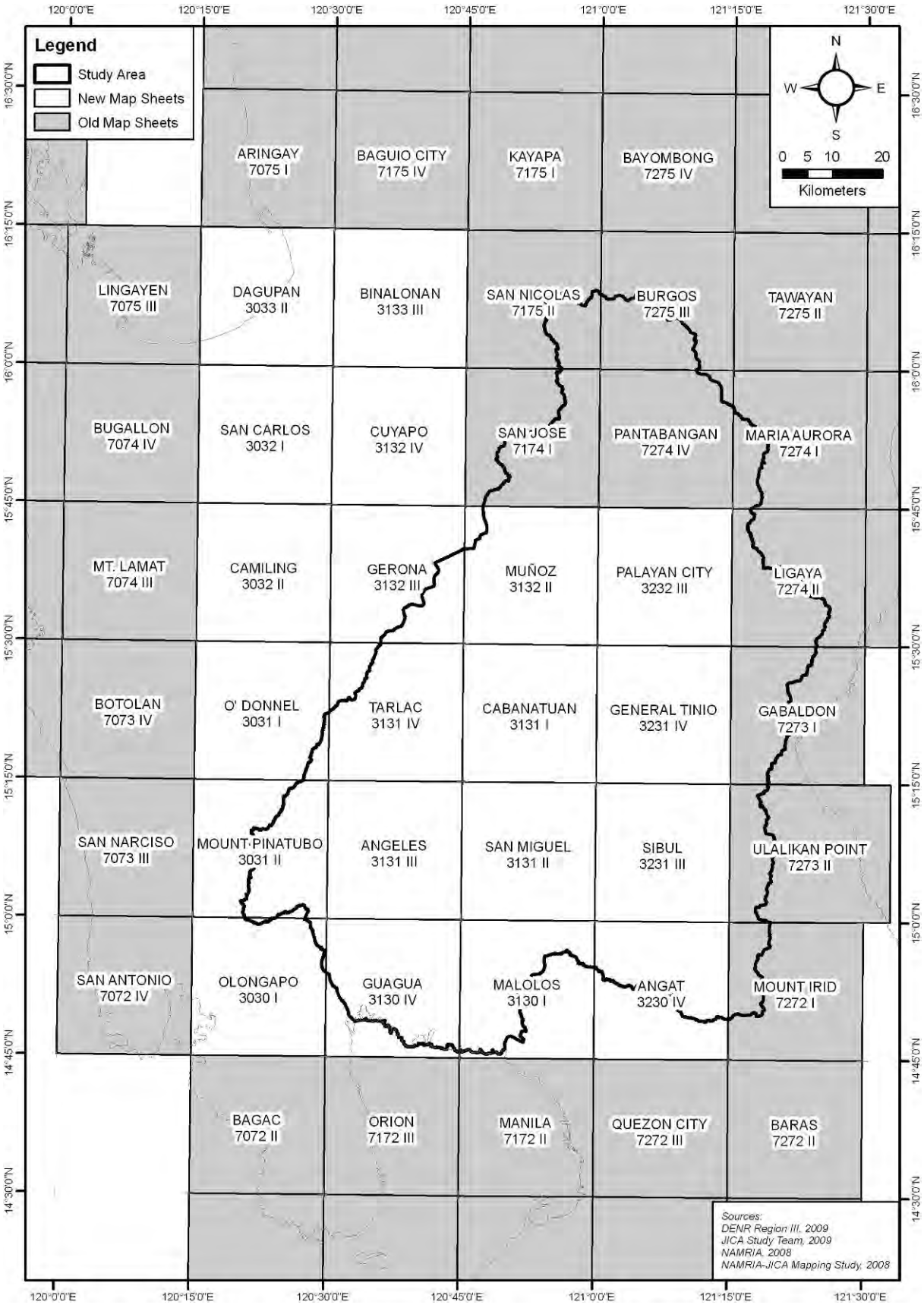
Code	Control Point	Drainage Area	Mean annual average discharge			Mean minimum monthly discharge			Mean monthly dry season discharge			Mean monthly wet season discharge		
		km^2	mm	MCM	m^3/s	mm	MCM	m^3/s	mm	MCM	m^3/s	mm	MCM	m^3/s
PAM01	P0	159.2	955.3	152.1	4.79	3.7	0.6	0.23	12.8	2.0	0.78	146.4	23.3	8.79
PAM0201	P1	7818.7	1176.5	9198.7	289.81	9.9	77.8	30.00	32.0	250.3	95.71	164.1	1282.8	483.92
PAM0202	P10	52.6	1504.0	79.1	2.49	5.9	0.3	0.12	22.6	1.2	0.45	228.0	12.0	4.53
PAM0203	P2	6308.1	1220.5	7699.2	242.61	11.1	70.1	27.03	35.3	222.8	85.18	168.1	1060.4	400.03
PAM03	P3	3406.2	1277.4	4350.9	137.23	14.4	49.0	18.92	49.9	170.0	64.98	163.0	555.2	209.48
PAM0401	P4	2796.7	1190.4	3329.1	105.00	13.4	37.4	14.45	46.8	130.8	50.01	151.6	424.0	159.99
PAM0402	P5	2025.6	1279.6	2591.9	81.79	16.8	34.1	13.14	58.7	118.9	45.45	154.6	313.1	118.13
PAM0501	P6	1286.0	1178.6	1515.7	47.82	11.0	14.2	5.48	50.5	64.9	24.80	146.0	187.7	70.83
PAM0502	P7	901.3	1227.2	1106.2	34.90	11.7	10.5	4.06	52.4	47.2	18.04	152.2	137.2	51.76
PAM0503	P8	869.8	1240.9	1079.3	34.05	11.8	10.3	3.97	53.0	46.1	17.61	153.8	133.8	50.48
PAN01	P9	849.4	1247.4	1059.5	33.43	11.9	10.1	3.91	53.3	45.3	17.30	154.6	131.3	49.55
RCH0101	P11	2895.3	1154.7	3343.3	105.22	7.2	21.0	8.01	18.2	52.7	20.17	174.3	504.5	190.27
RCH0102	P14	696.4	1060.3	738.4	23.24	4.7	3.3	1.22	14.6	10.2	3.90	162.1	112.9	42.58
RCH0103	P12	709.4	1277.9	906.5	28.56	13.7	9.7	3.76	29.7	21.0	8.06	183.3	130.0	49.06
RCH0104	P13	301.1	1634.2	492.1	15.52	26.2	7.9	3.05	49.6	14.9	5.72	222.8	67.1	25.32
PEN0101	P15	569.7	1743.1	993.1	31.32	20.1	11.4	4.41	67.9	38.7	14.78	222.6	126.8	47.87
PEN0102	P16	518.5	1840.9	954.6	30.11	22.0	11.4	4.39	73.2	37.9	14.49	233.7	121.2	45.73
PEN0103	P17	248.8	2547.3	633.7	20.00	43.2	10.7	4.14	120.5	30.0	11.45	304.0	75.6	28.55
COR01	P18	712.0	1481.5	1054.9	33.30	27.7	19.7	7.62	75.3	53.6	20.51	171.6	122.2	46.09
ANG01	A0	193.5	905.0	175.1	5.51	1.5	0.3	0.11	12.3	2.4	0.91	138.5	26.8	10.11
ANG0201	A1	891.7	2655.6	2367.9	74.71	37.0	33.0	12.74	130.9	116.8	44.57	311.7	277.9	104.84
ANG0202	A2	845.7	2754.7	2329.6	73.50	39.0	32.9	12.71	137.3	116.1	44.33	321.8	272.1	102.67
ANG0203	A5	52.1	1887.3	98.3	3.10	7.1	0.4	0.14	51.1	2.7	1.01	263.5	13.7	5.18
ANG0204	A3	617.6	3265.6	2016.9	63.66	50.8	31.3	12.09	177.9	109.9	41.95	366.3	226.3	85.36
ANG03	A4	545.9	3382.7	1846.5	58.29	55.2	30.1	11.62	194.7	106.3	40.57	369.1	201.5	76.01
PAS0101	S0	137.7	632.7	87.1	2.75	28.9	4.0	1.54	39.6	5.5	2.09	65.8	9.1	3.42
PAS_Out	S1	1233.6	1039.9	1282.9	40.53	42.8	52.8	20.37	57.3	70.7	27.09	116.0	143.1	53.96
PAS0103	S2	398.4	806.8	321.4	10.16	38.6	15.4	5.93	52.2	20.8	7.97	82.2	32.8	12.35
PAS0104	S3	637.0	1329.6	847.0	26.74	50.5	32.1	12.40	67.0	42.7	16.35	154.6	98.5	37.14
PAS0105	S4	295.1	1695.8	500.5	15.79	58.2	17.2	6.63	75.9	22.4	8.58	206.7	61.0	23.00
PAS0106	S5	115.6	1497.0	173.1	5.46	55.6	6.4	2.48	74.7	8.6	3.31	174.8	20.2	7.62
PAS0107	S6	132.3	2063.5	273.0	8.61	65.5	8.7	3.27	83.1	11.0	4.21	260.8	34.5	13.01
PAS0108	S7	117.9	2166.3	255.4	8.06	67.8	8.0	3.01	85.8	10.1	3.88	275.2	32.4	12.24
T_AUR	R1	67.9	1795.9	121.9	3.85	42.2	2.9	1.10	117.7	8.0	3.05	181.6	12.3	4.65
T_TAL01	T1	287.6	1735.9	499.3	15.72	6.6	1.9	0.73	46.0	13.2	5.06	243.3	70.0	26.39
T_TAL02	T2	524.3	1838.4	964.0	30.35	6.9	3.6	1.39	45.7	24.0	9.16	260.7	136.7	51.54
T_TAL03	T3	288.7	2193.0	633.1	19.93	7.5	2.2	0.84	50.1	14.5	5.53	315.4	91.0	34.32

Source: JICA Study Team

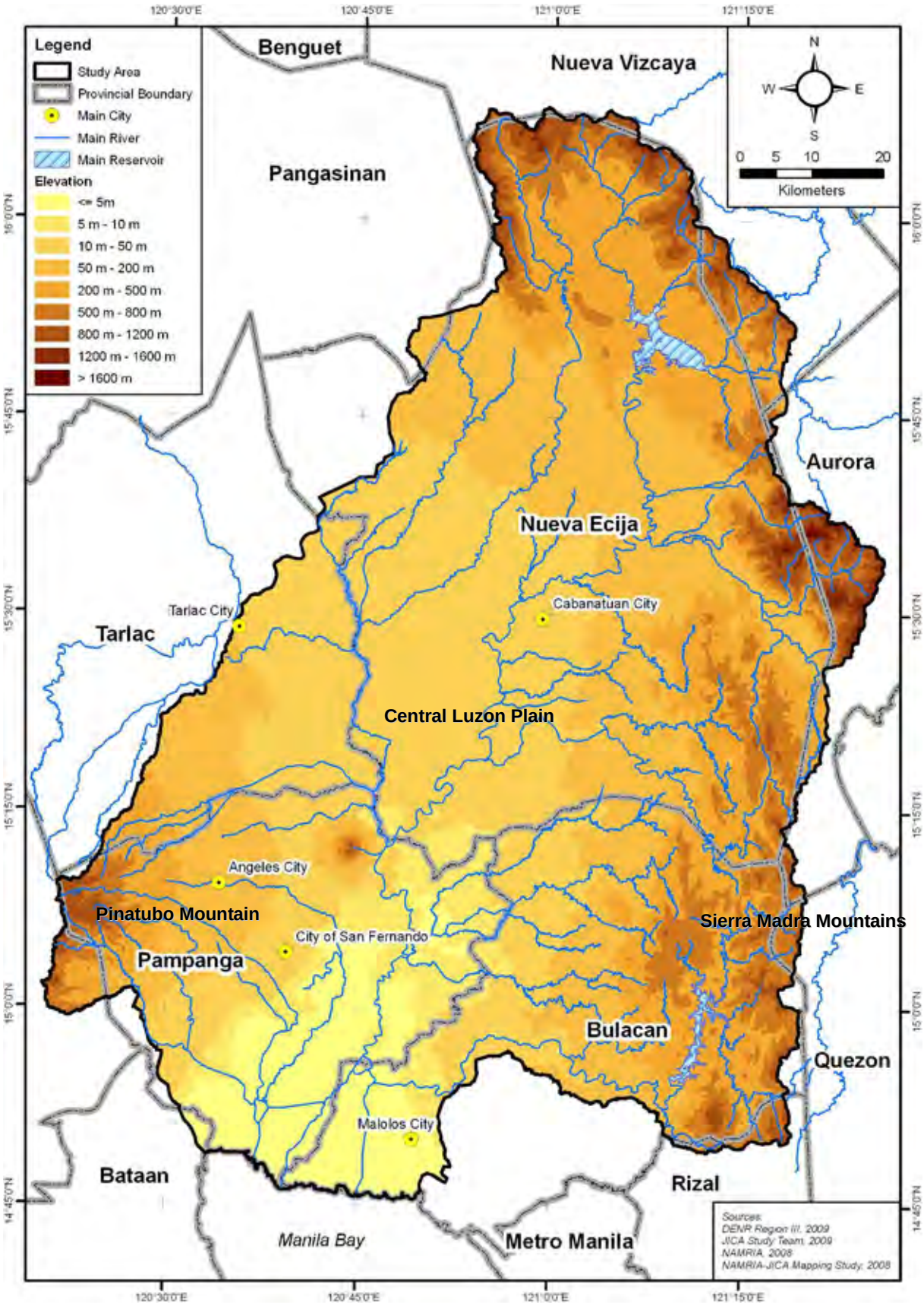
Annex-Figures



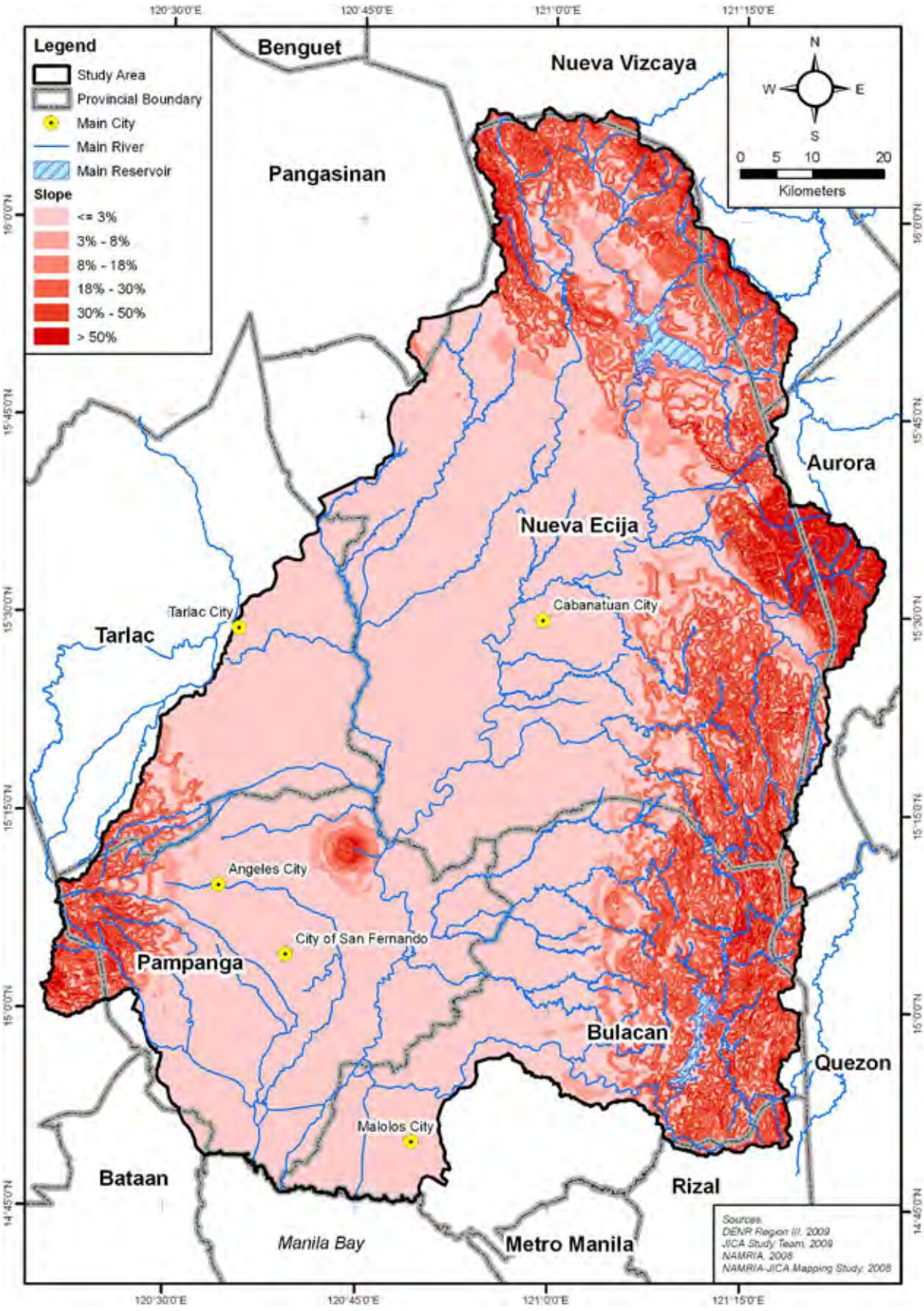
Annex-F A.2.1.1 General Topographic Map in the Pampanga River Basin and the Surrounding Areas



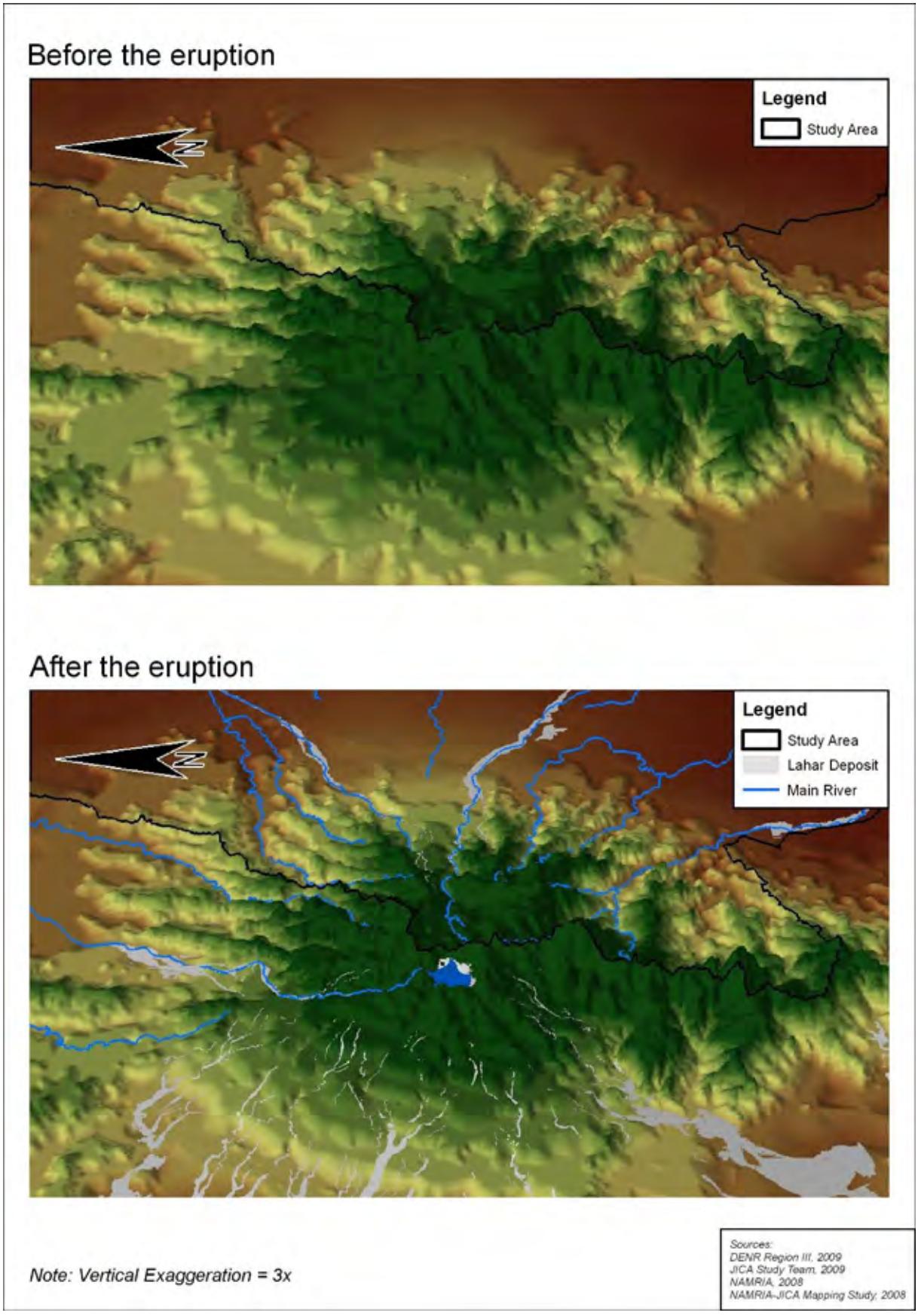
Annex-F A.2.2.1 Location in which New NAMRIA Topographic Maps are Available



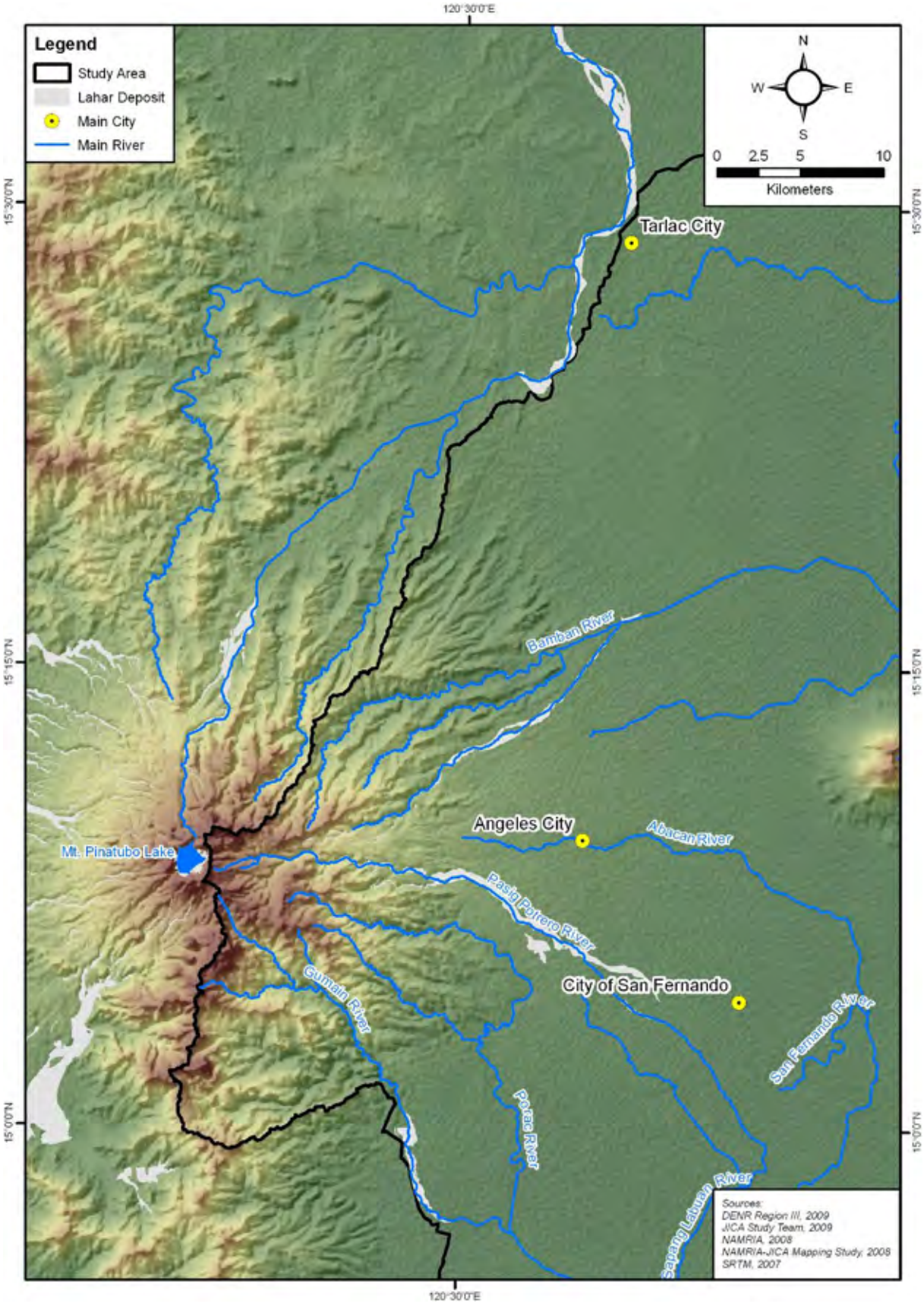
Annex-F A.2.2.2 Distribution of Elevation Zones in the Study Area



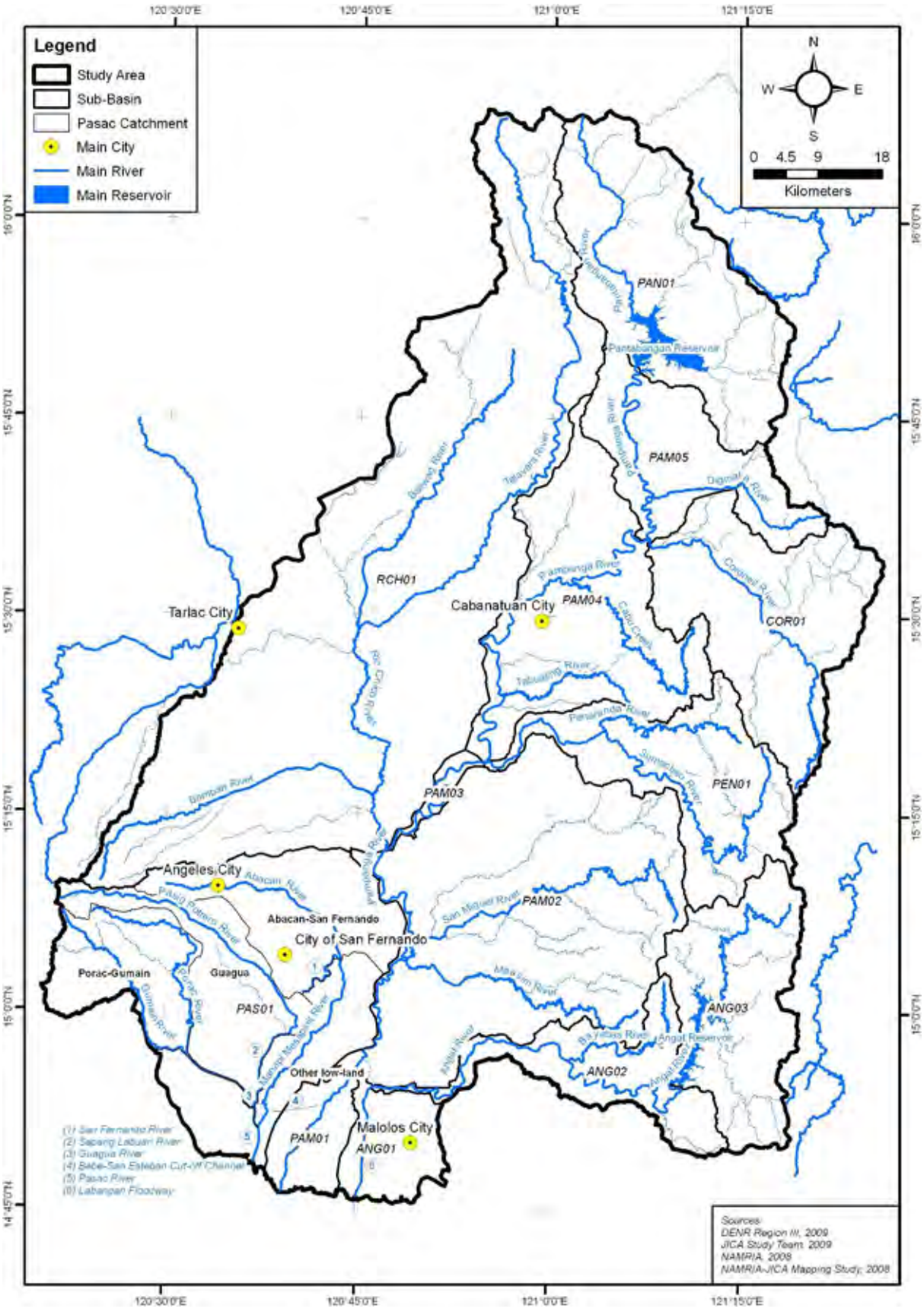
Annex-F A.2.2.3 Distribution of Slope Category in the Study Area



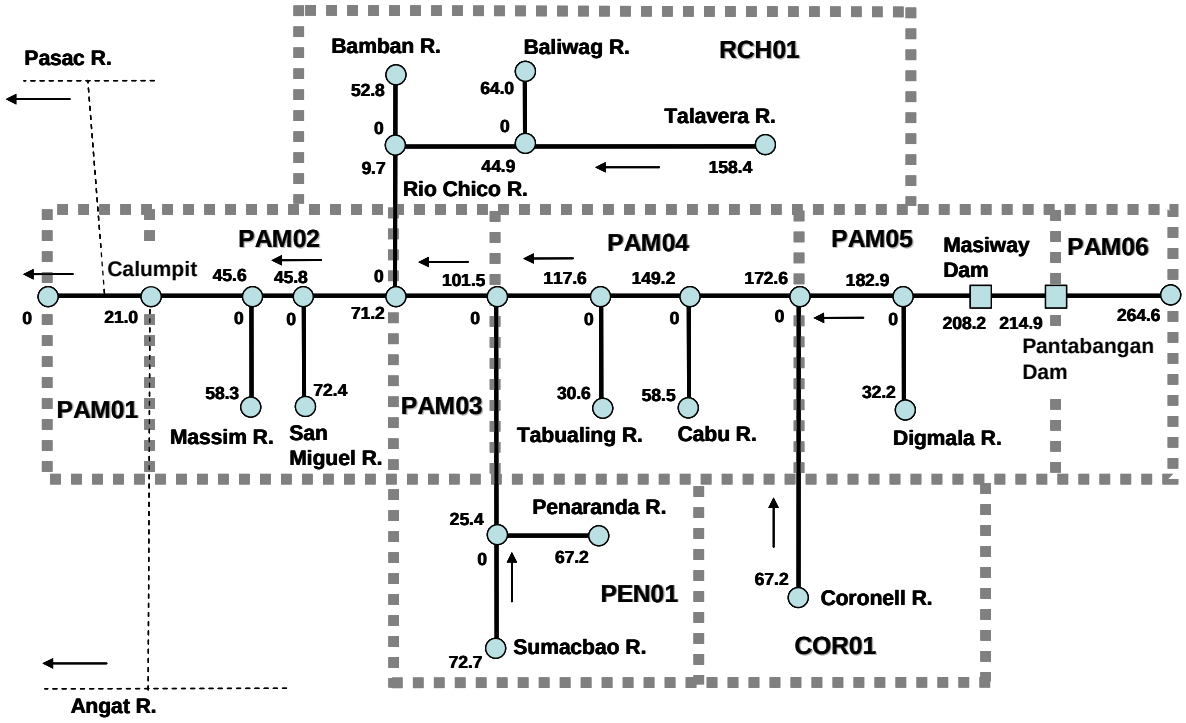
Annex-F A.2.2.4 Change in Topography in Pinatubo Area



Annex-F A.2.2.5 Lahar Deposition around the Pinatubo Mountain



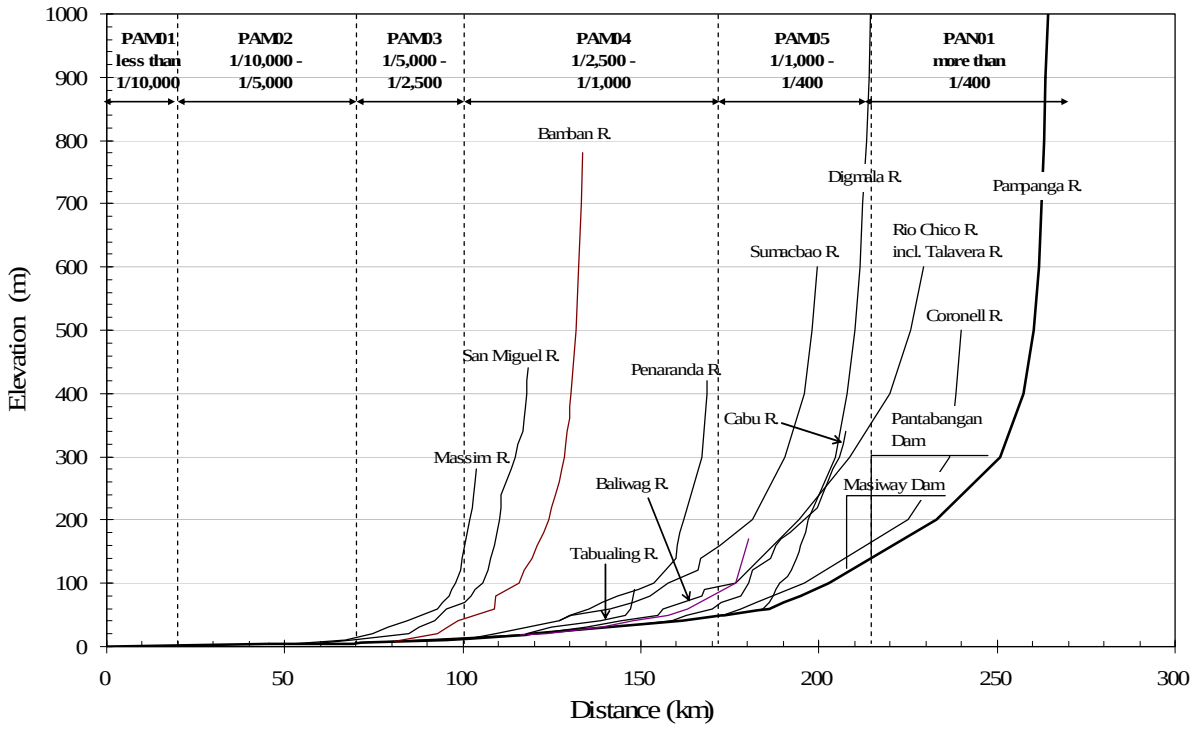
Annex-F A.3.1.1 Sub-Basins



Note: Number shows distance in km from downstream end of a river.

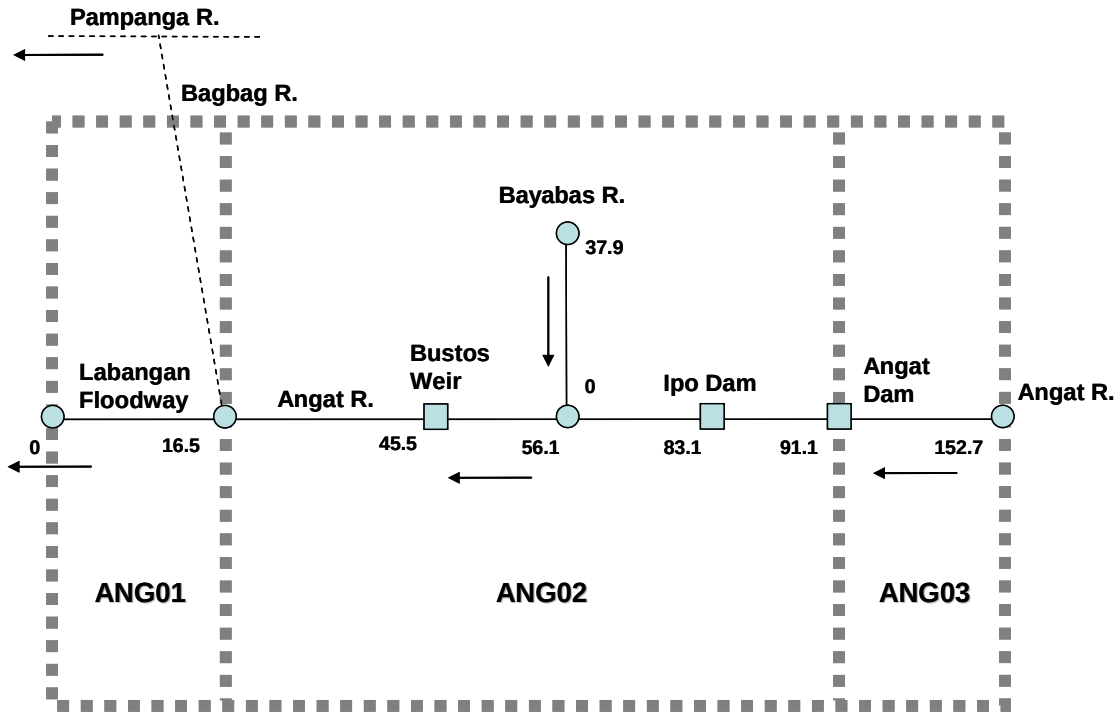
Source: JICA Study Team

Annex-F A.3.2.1 Schematic River System in Pampanga Main River System



Source: JICA Study Team

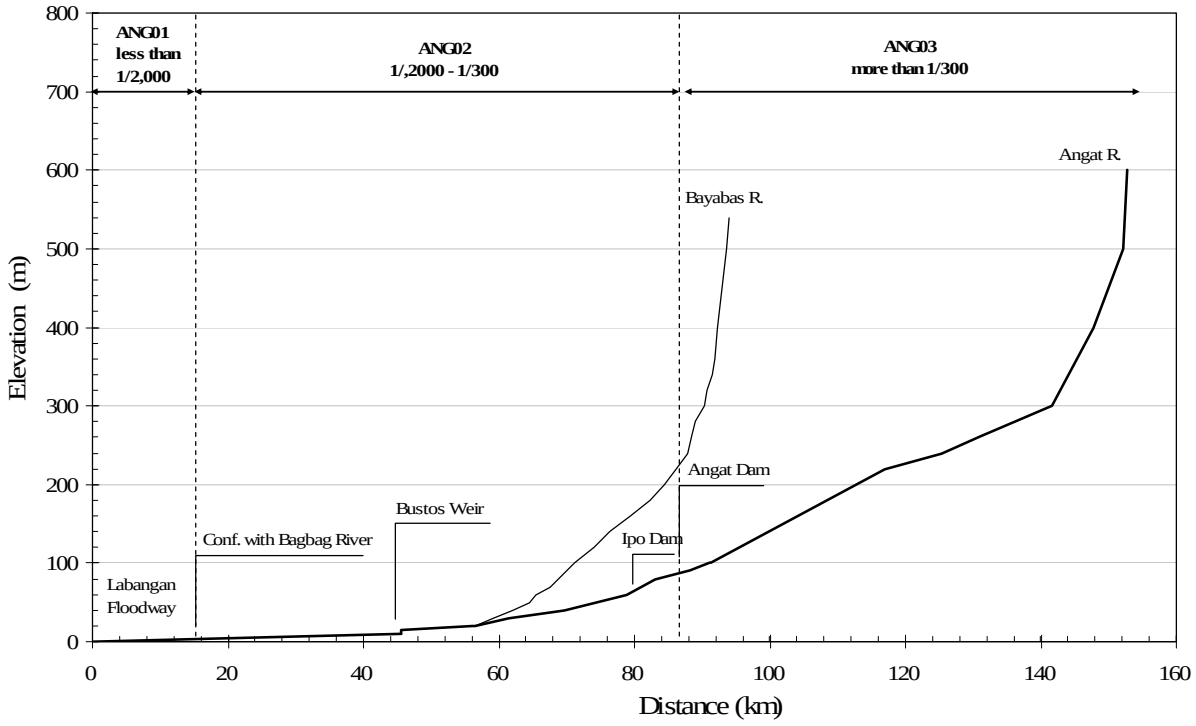
Annex-F A.3.2.2 Longitudinal Profile of the Main Rivers in Pampanga Main River System



Note: Number shows distance in km from downstream end of a river.

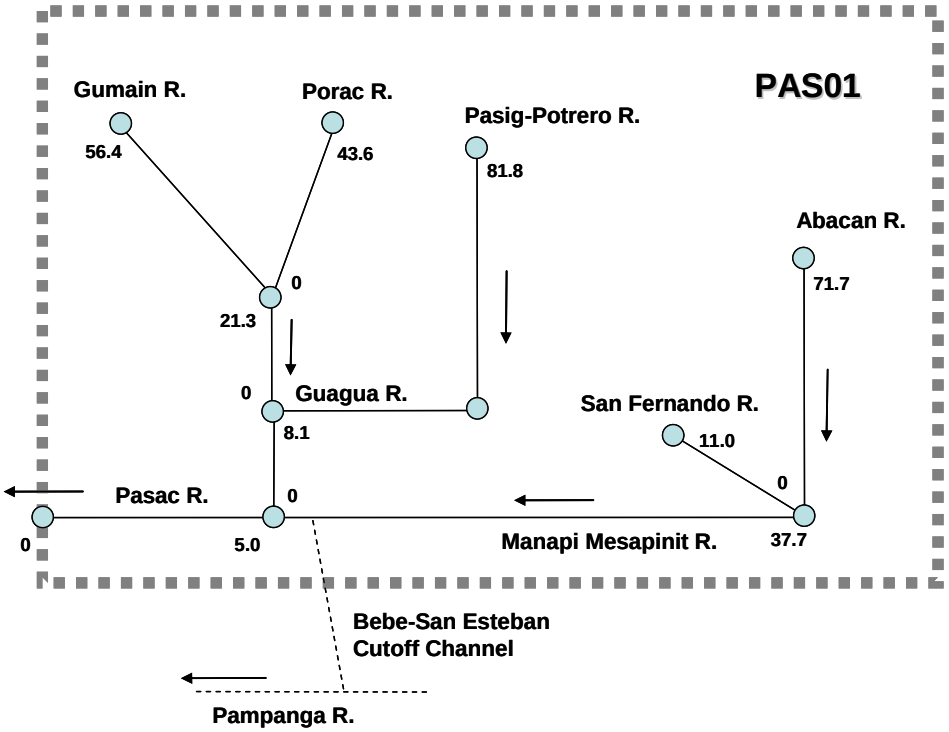
Source: JICA Study Team

Annex-F A.3.2.3 Schematic River System in Angat River System



Source: JICA Study Team

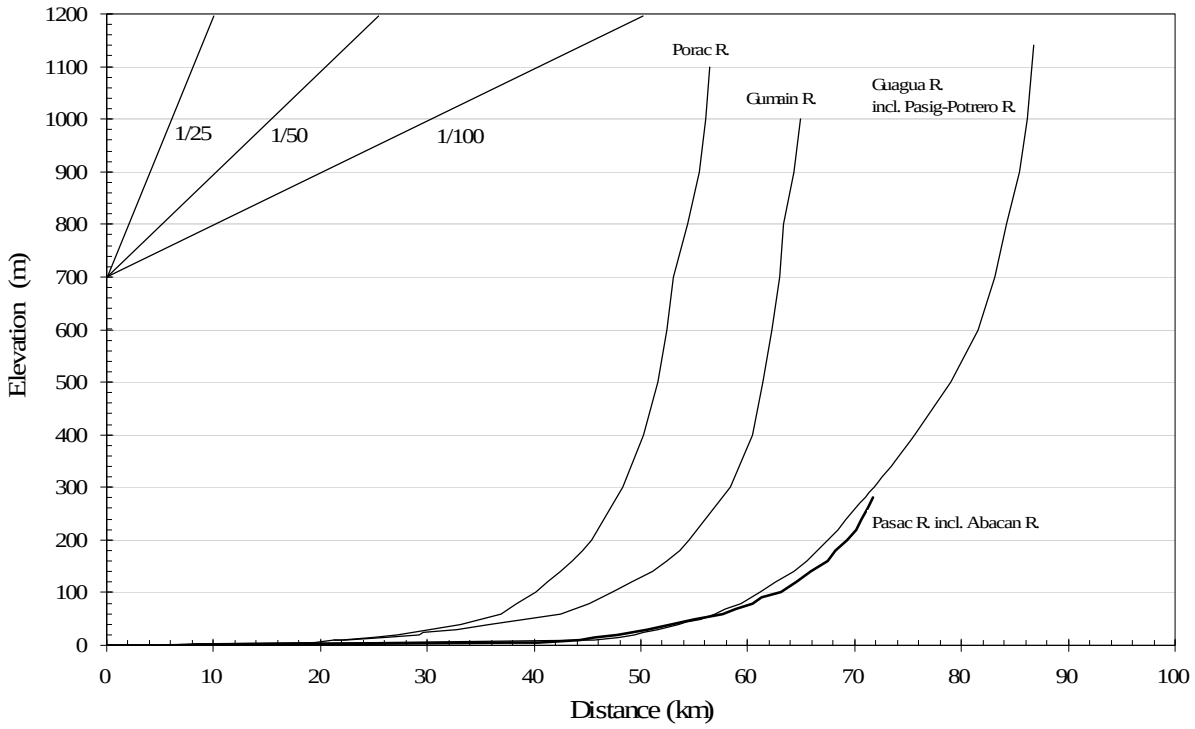
Annex-F A.3.2.4 Longitudinal Profile of the Main Rivers in Angat River System



Note: Number shows distance in km from downstream end of a river.

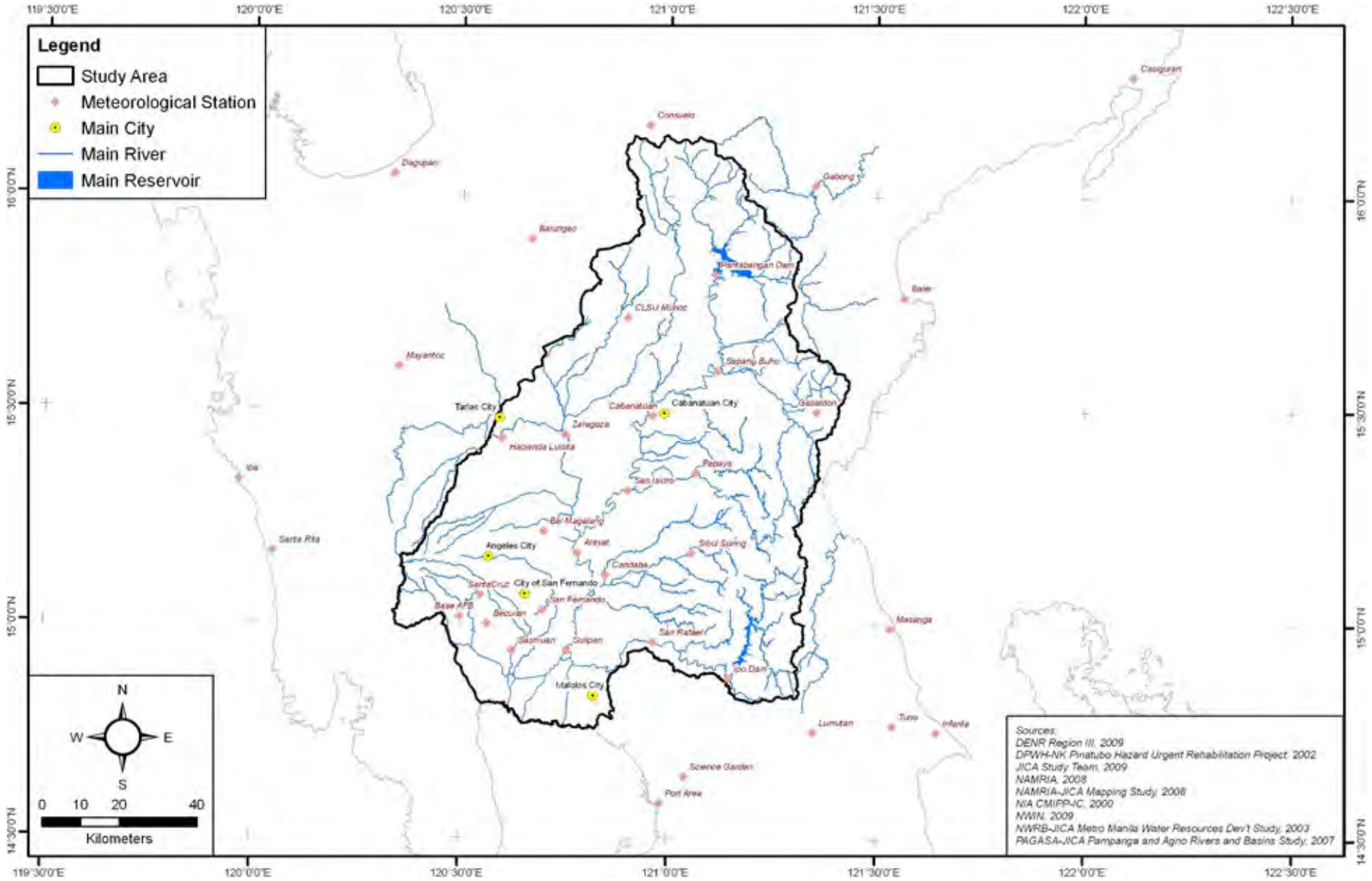
Source: JICA Study Team

Annex-F A.3.2.5 Schematic River System in Pasac River System

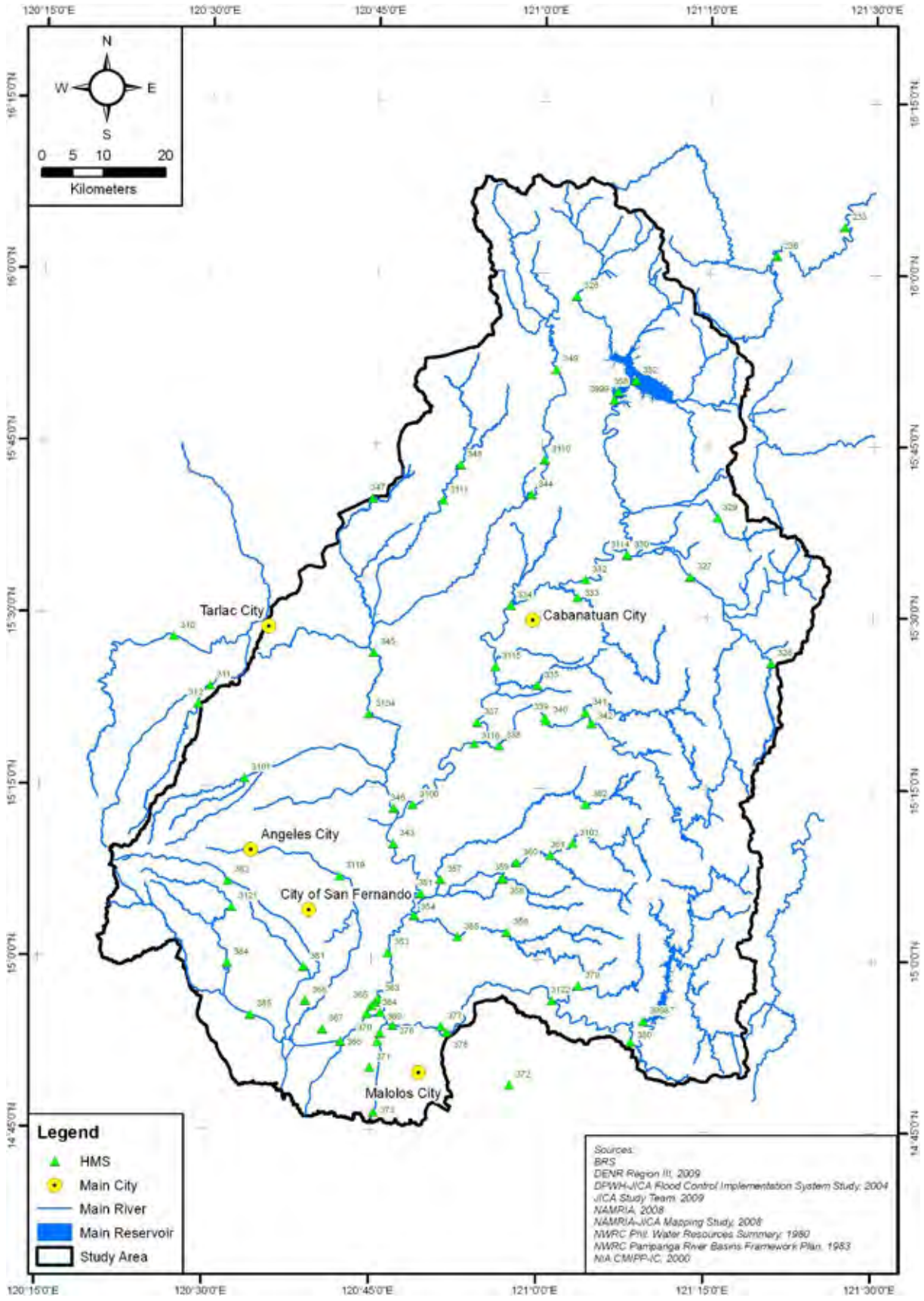


Source: JICA Study Team

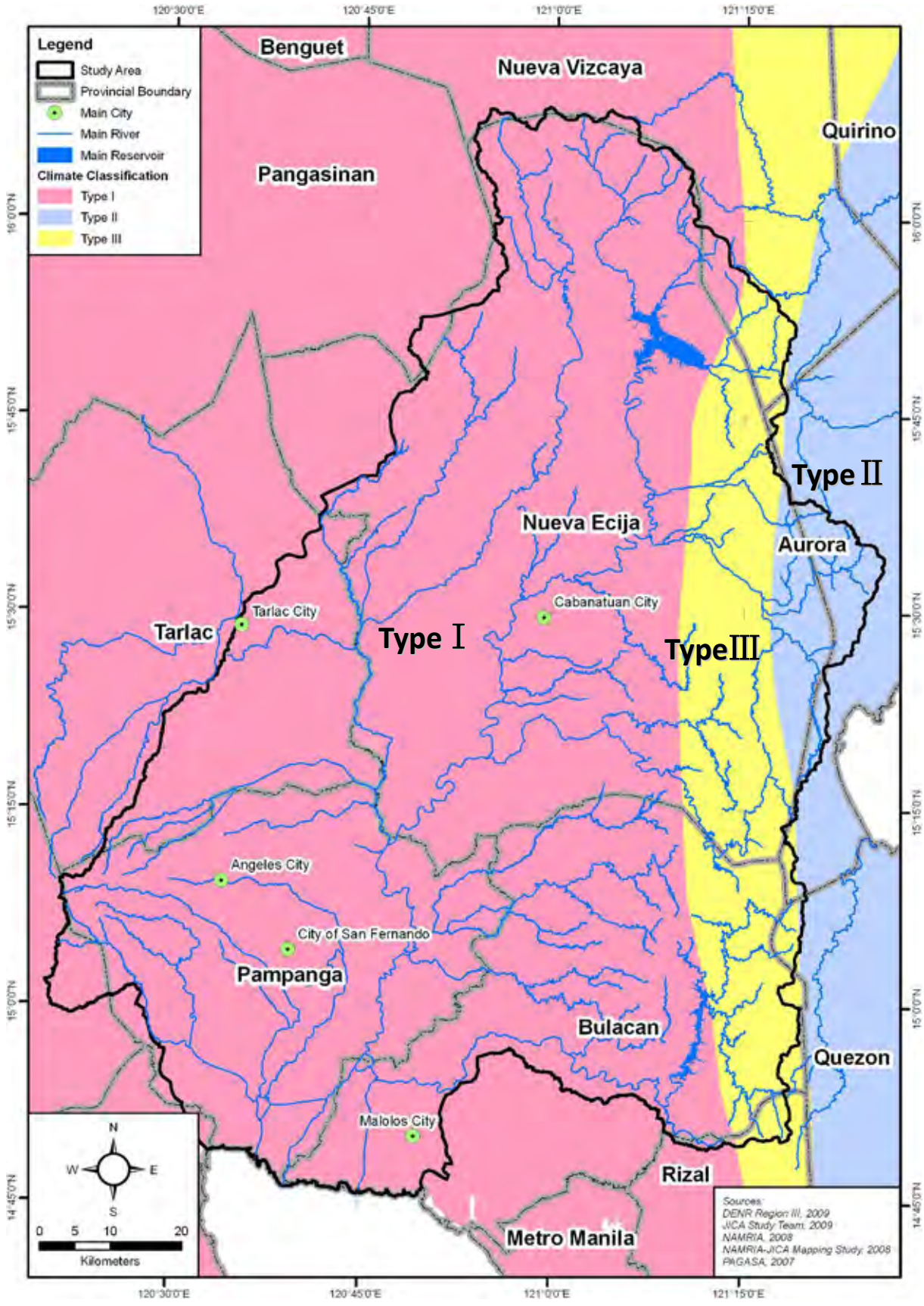
Annex-F A.3.2.6 Longitudinal Profile of the Main Rivers in Pasac River System



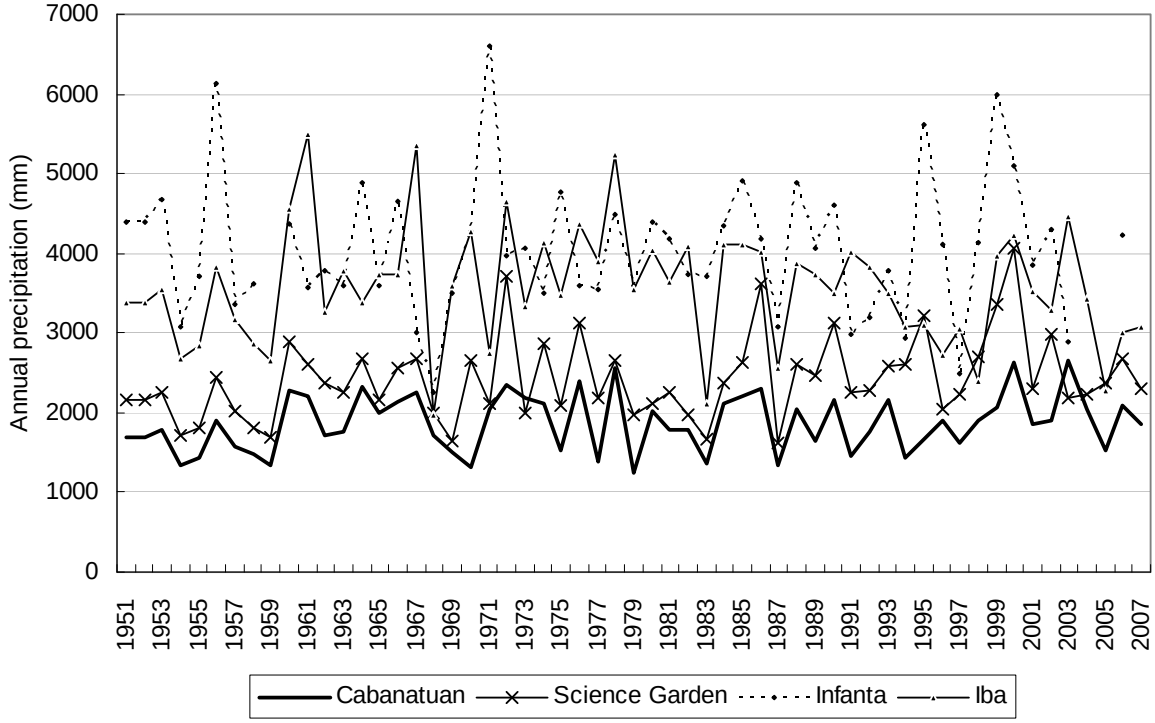
Annex-F A.4.1.1 Location of Meteorological Stations



Annex-F A.4.1.2 Location of Hydrometric Stations

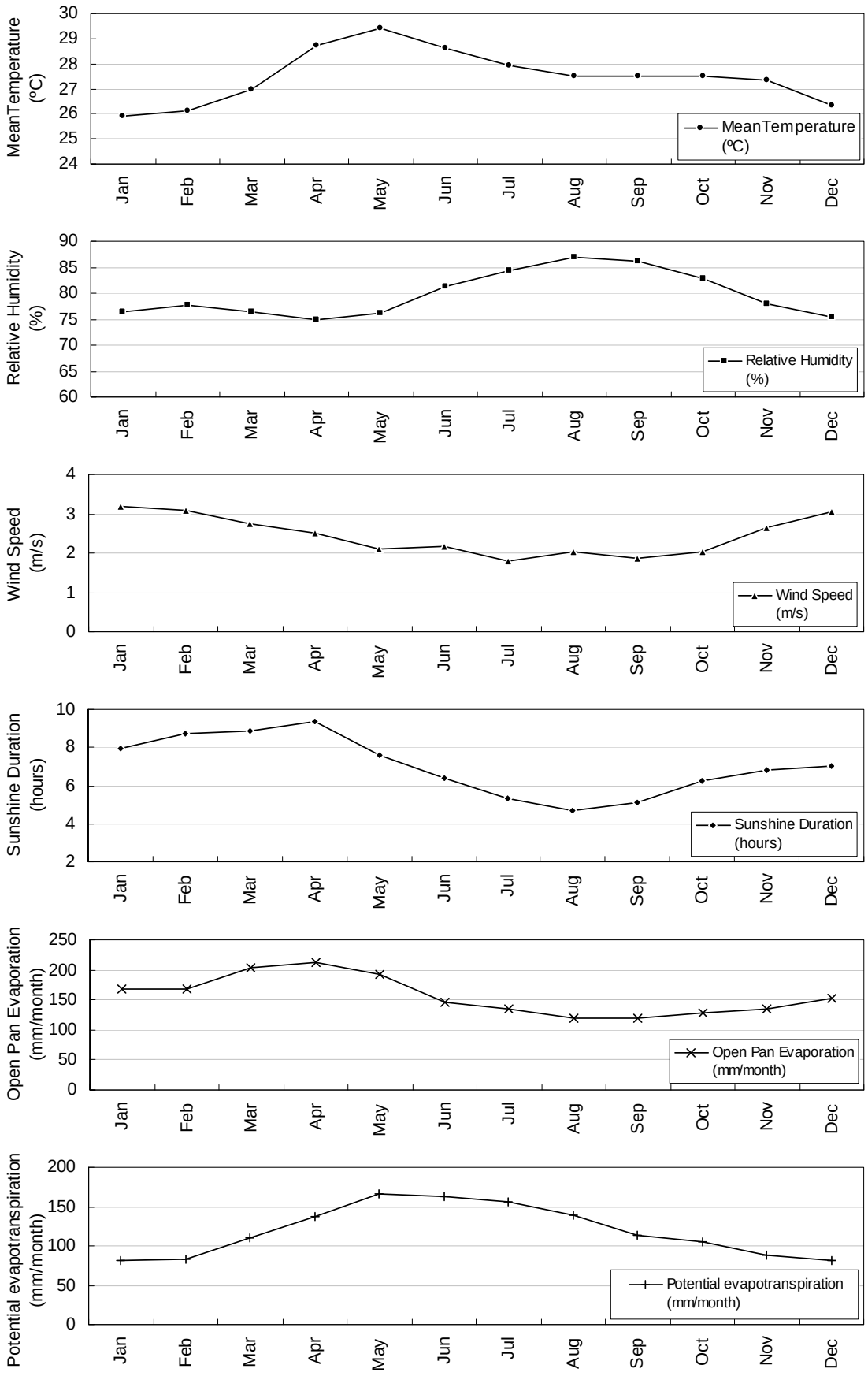


Annex-F A.4.2.1 Climate Zones



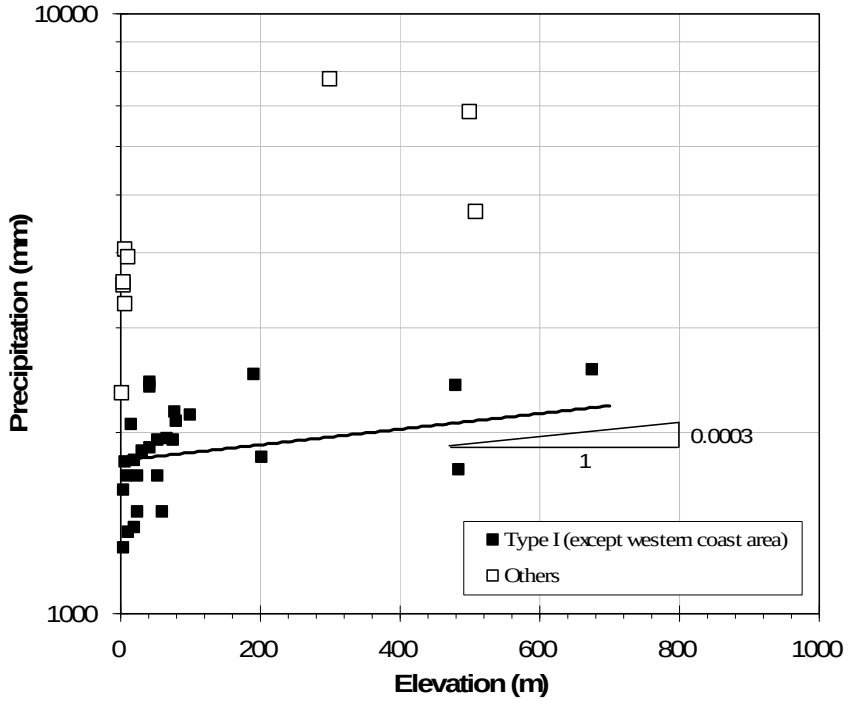
Source: JICA Study Team based on PAGASA data

Annex-F A.4.2.2 Change in Annual Total Precipitation at Key Stations



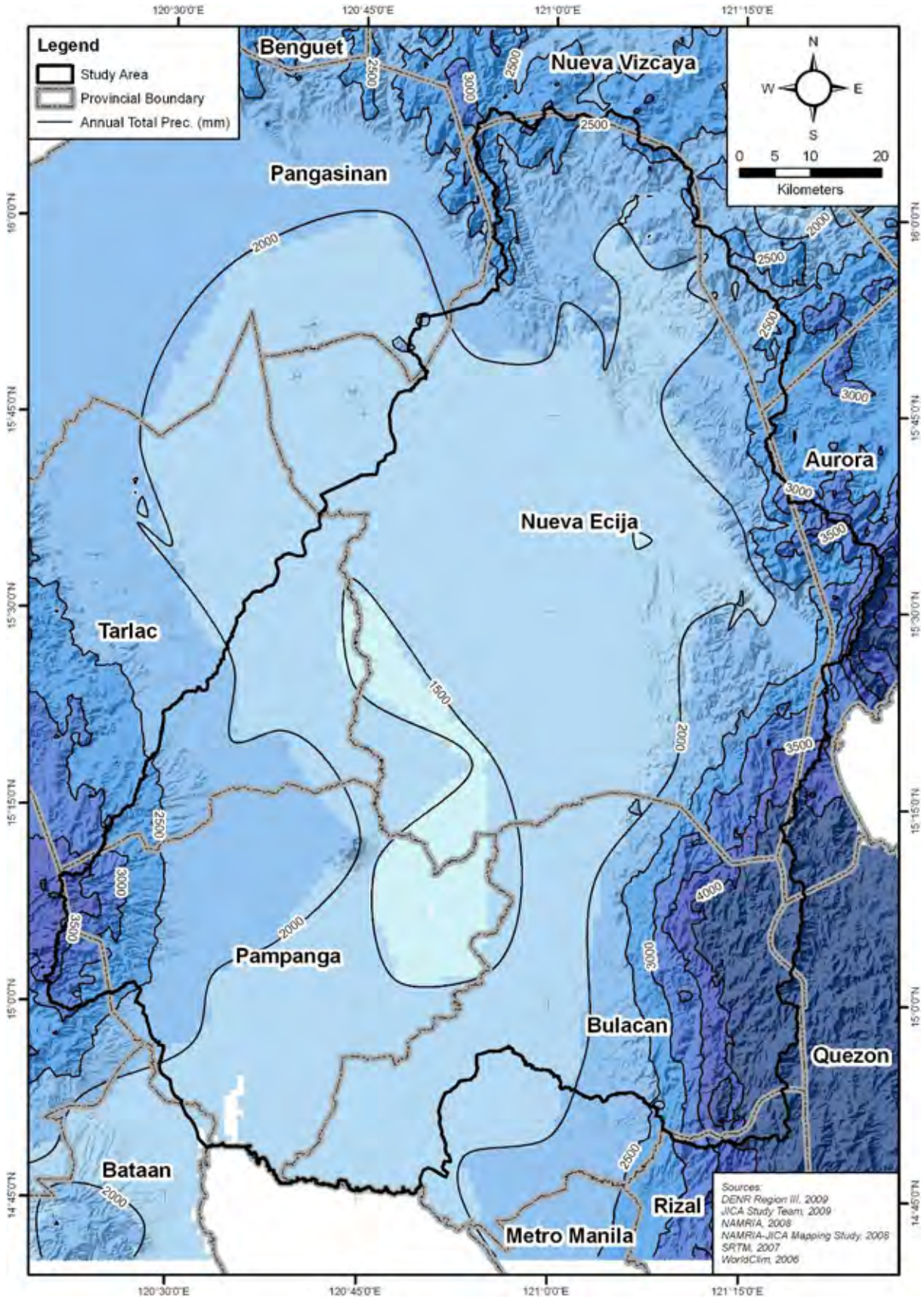
Source: JICA Study Team based on PAGASA data

Annex-F A.4.2.3 Monthly Variations of the Climatic Parameters at CLSU Munoz

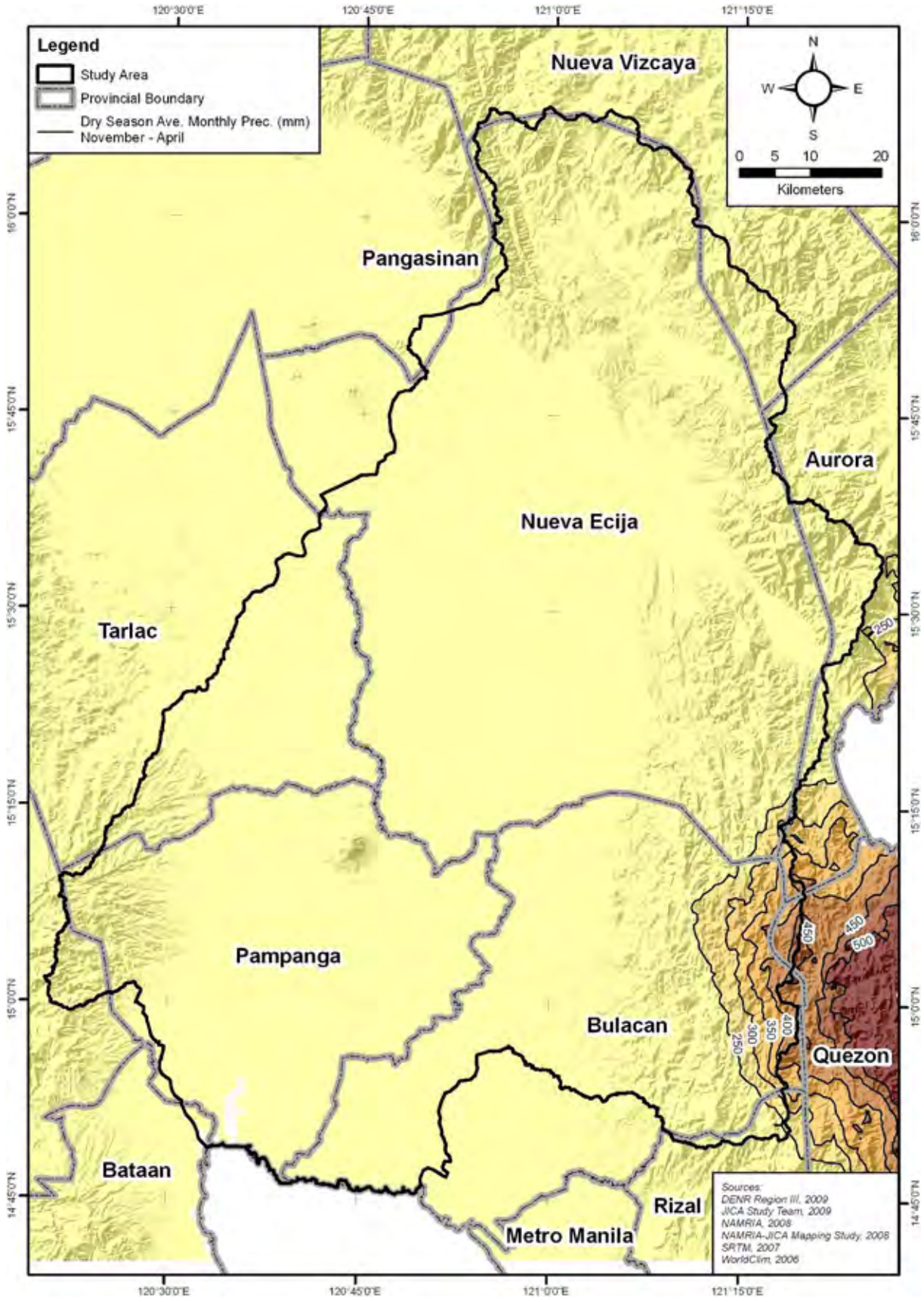


Source: JICA Study Team

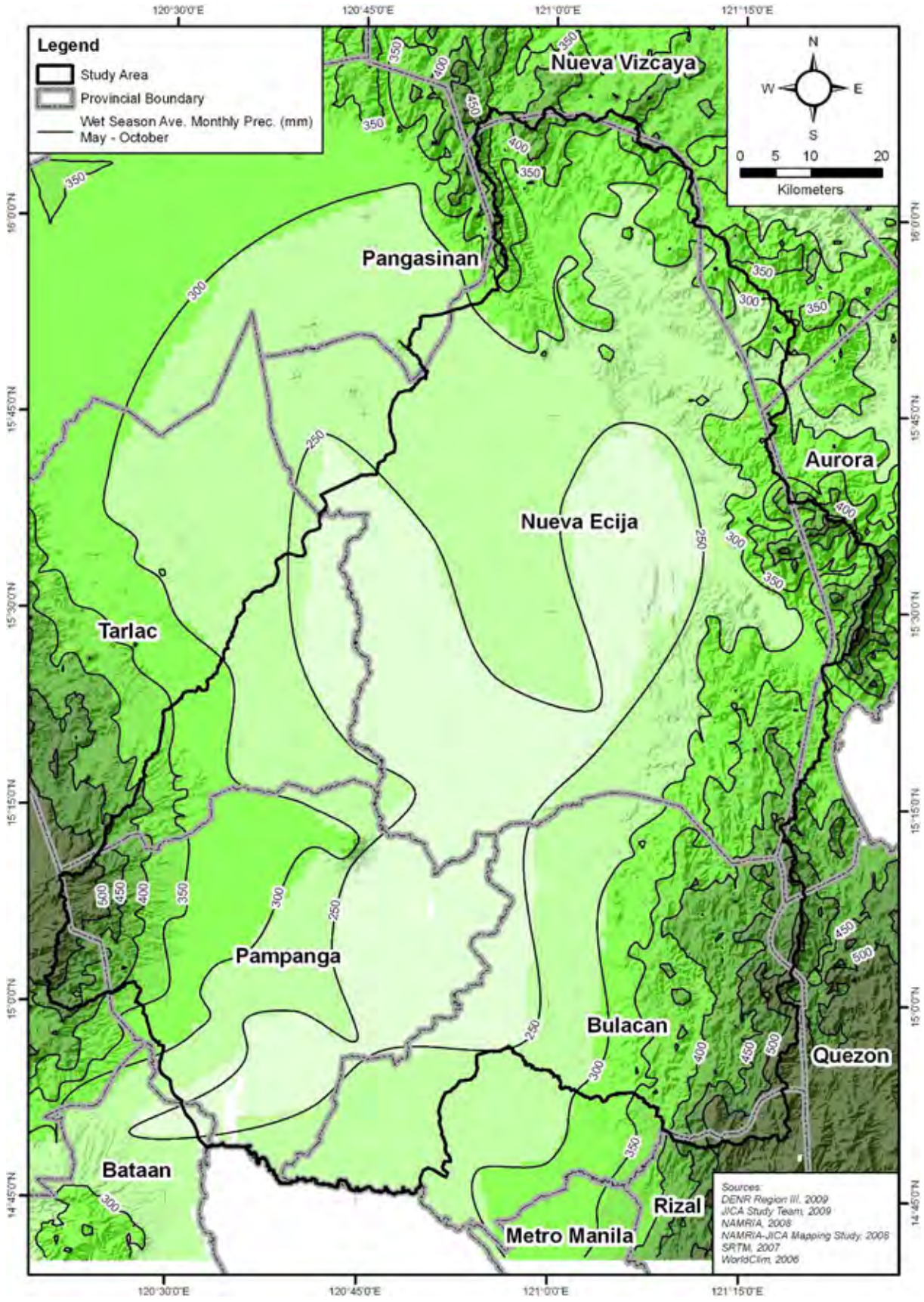
Annex-F A.4.2.4 Relationship between Precipitation and Elevation



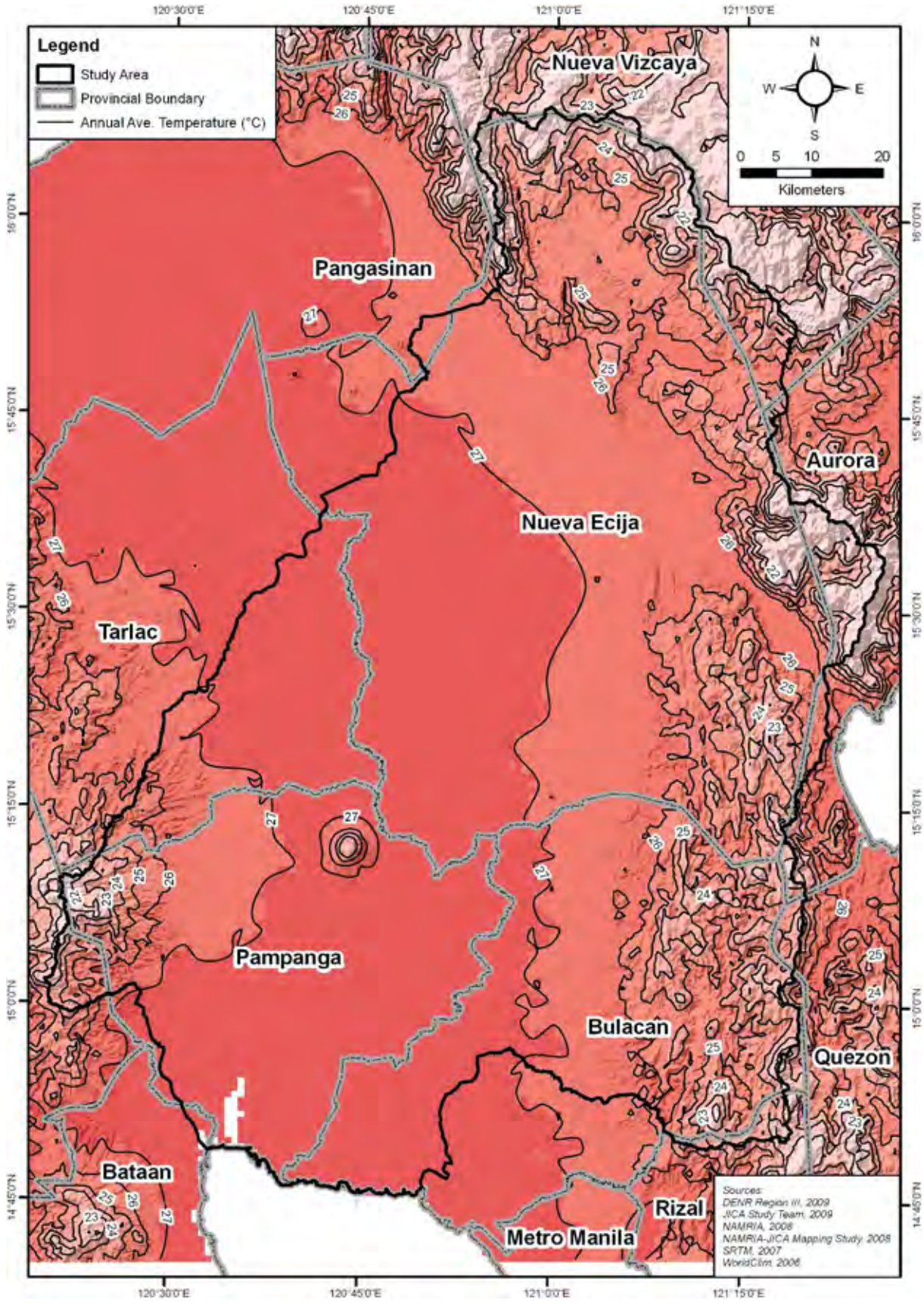
Annex-F A.4.2.5 Spatial Distribution of Annual Total Precipitation



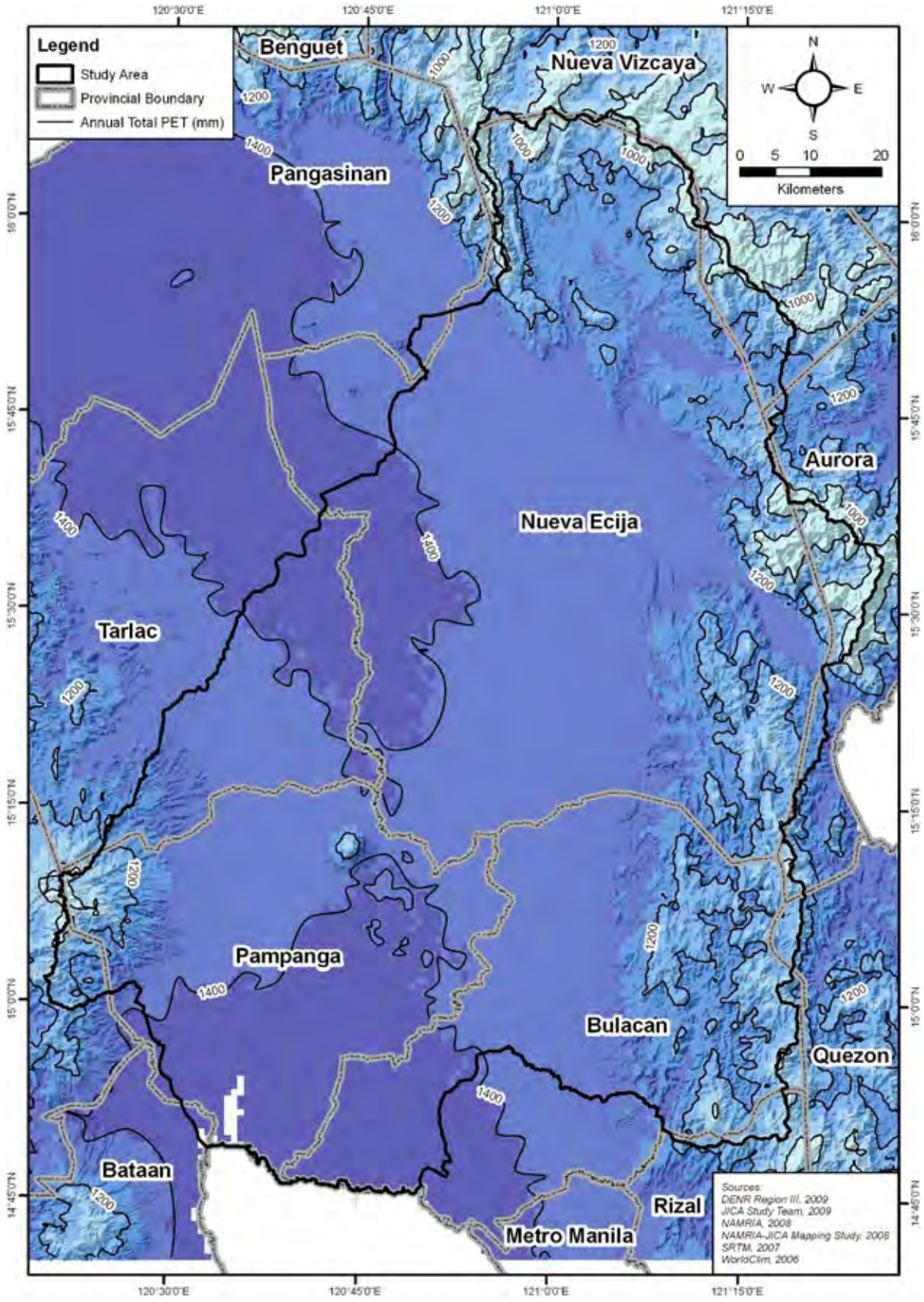
Annex-F A.4.2.6 Spatial Distribution of Precipitation in Dry Season



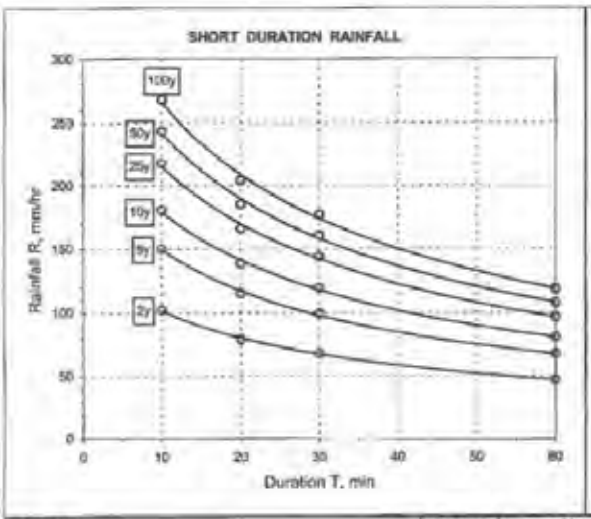
Annex-F A.4.2.7 Spatial Distribution of Precipitation in Wet Season

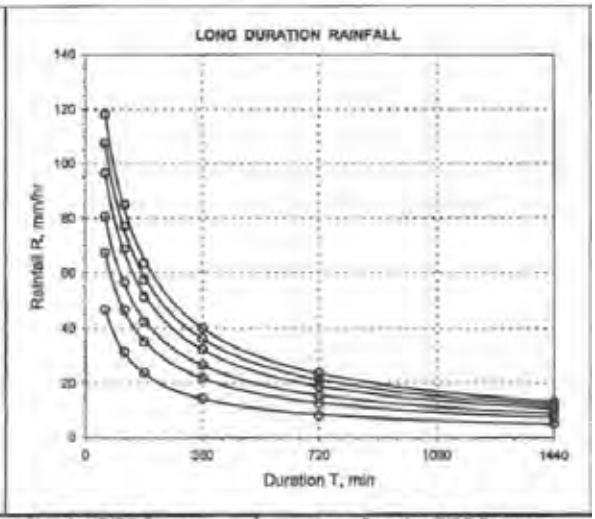


Annex-F A.4.2.8 Spatial Distribution of Annual Mean Temperature



Annex-F A.4.2.9 Spatial Distribution of Annual Total Potential Evapotranspiration (PET)



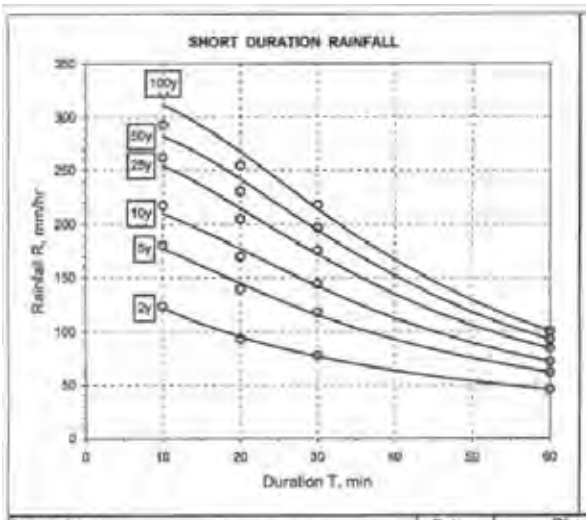


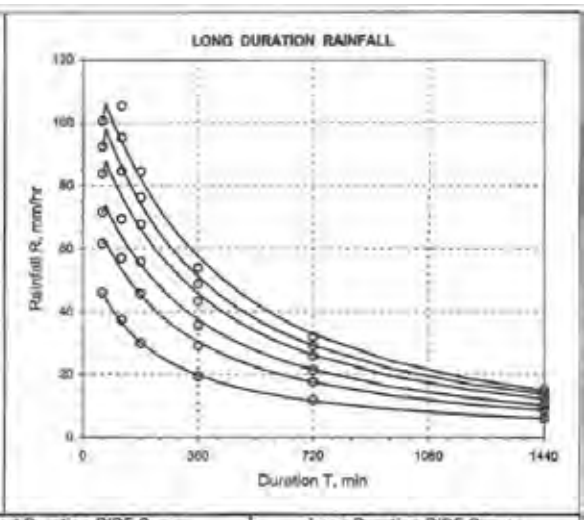
Legends:
- Probable Rainfall
- Fitted RIDF Curve

Type Equation
1 $R = A/(C+T^b)$
2 $R = A/(C+T)^b$

Return Period, Yr	Short Duration RIDF Curves				Long Duration RIDF Curves			
	Type	A	C	b	Type	A	C	b
2	1	2010.70	13.03	0.83	2	1387.07	19.95	0.77
5	1	2919.34	12.74	0.83	2	3038.78	41.38	0.82
10	1	3649.19	14.27	0.86	2	4056.44	47.20	0.84
25	1	5294.14	16.87	0.89	2	5434.72	53.29	0.85
50	1	5241.20	14.38	0.86	2	6455.89	56.71	0.86
100	1	5856.30	14.64	0.87	2	7588.03	60.44	0.87

Cabanatuan Synoptic Station





Legends:
- Probable Rainfall
- Fitted RIDF Curve

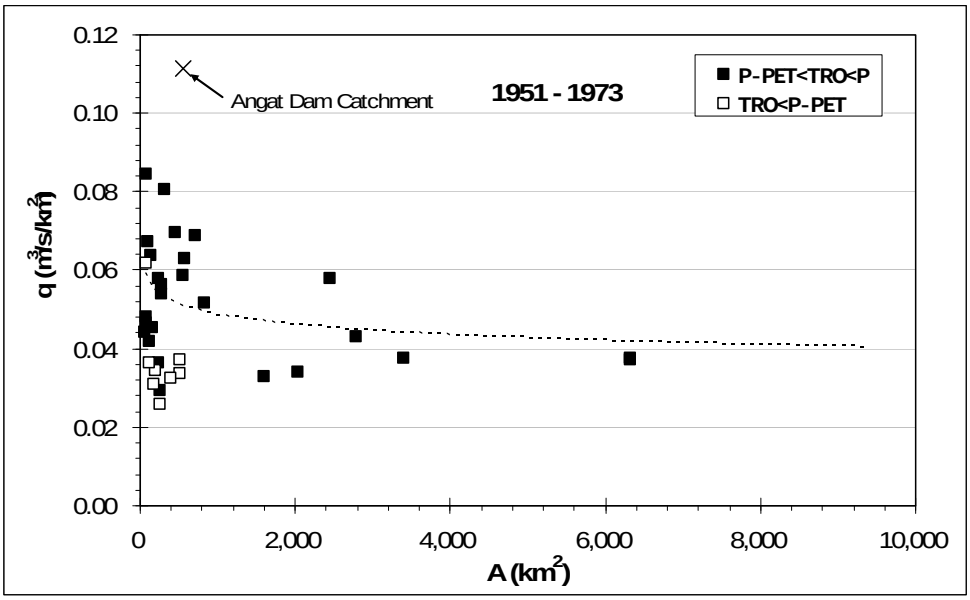
Type Equation
1 $R = A/(C+T^b)$
2 $R = A/(C+T)^b$

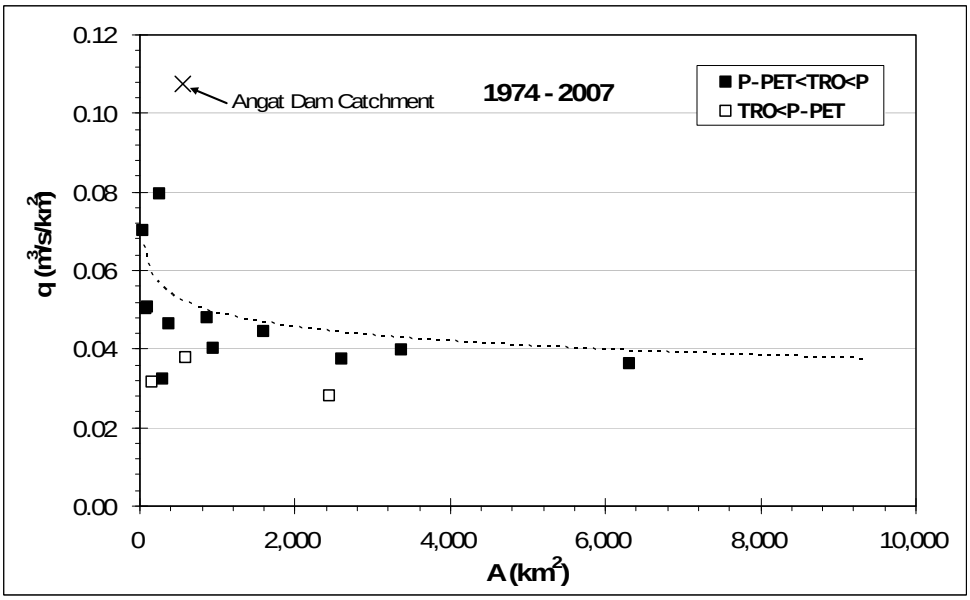
Return Period, Yr	Short Duration RIDF Curves				Long Duration RIDF Curves			
	Type	A	C	b	Type	A	C	b
2	1	9057.83	58.07	1.21	2	15444.66	182.72	1.06
5	1	69252.57	348.52	1.63	2	178319.68	333.88	1.33
10	1	212085.18	936.36	1.86	2	929574.58	445.12	1.51
25	1	337348.73	1238.89	1.94	2	3538628.44	534.04	1.66
50	1	609803.43	2045.04	2.06	2	3312681.27	520.65	1.63
100	1	730032.25	2219.93	2.08	2	43503903.63	713.29	1.94

Science Garden Synoptic Station

Source: DPWH,JICA: Specific Discharge Curve Rainfall Intensity Duration Curve Isohyet of Probable 1-day Rainfall, 2003

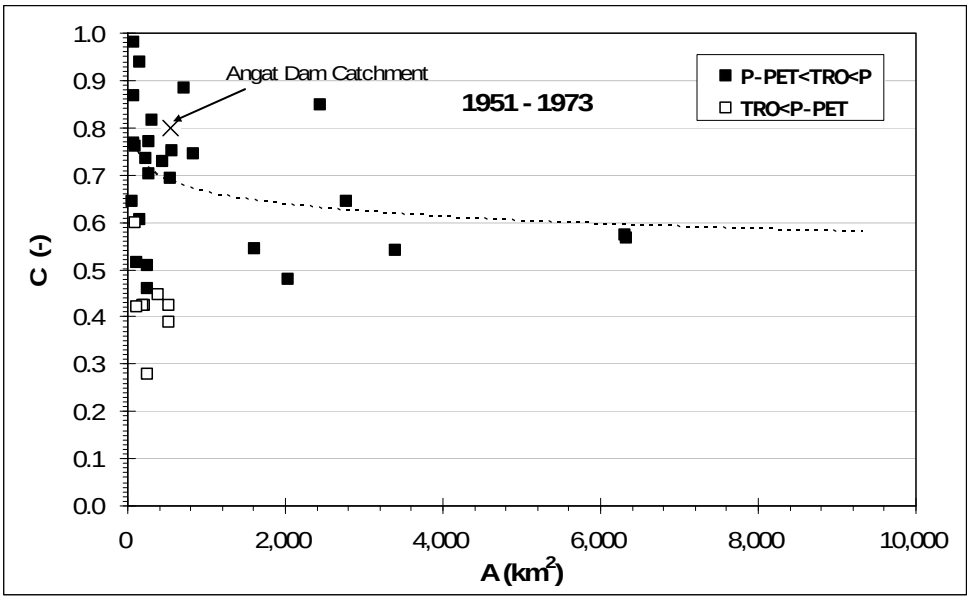
Annex-F A.4.2.10 Rainfall Intensity-Duration Curve at Cabanatuan and Science Garden

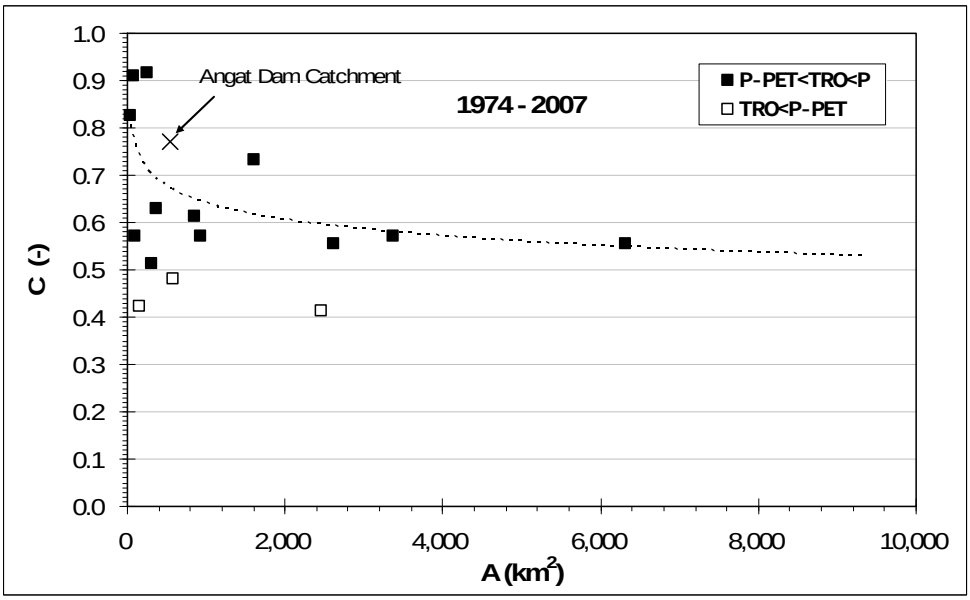




Source: JICA Study Team

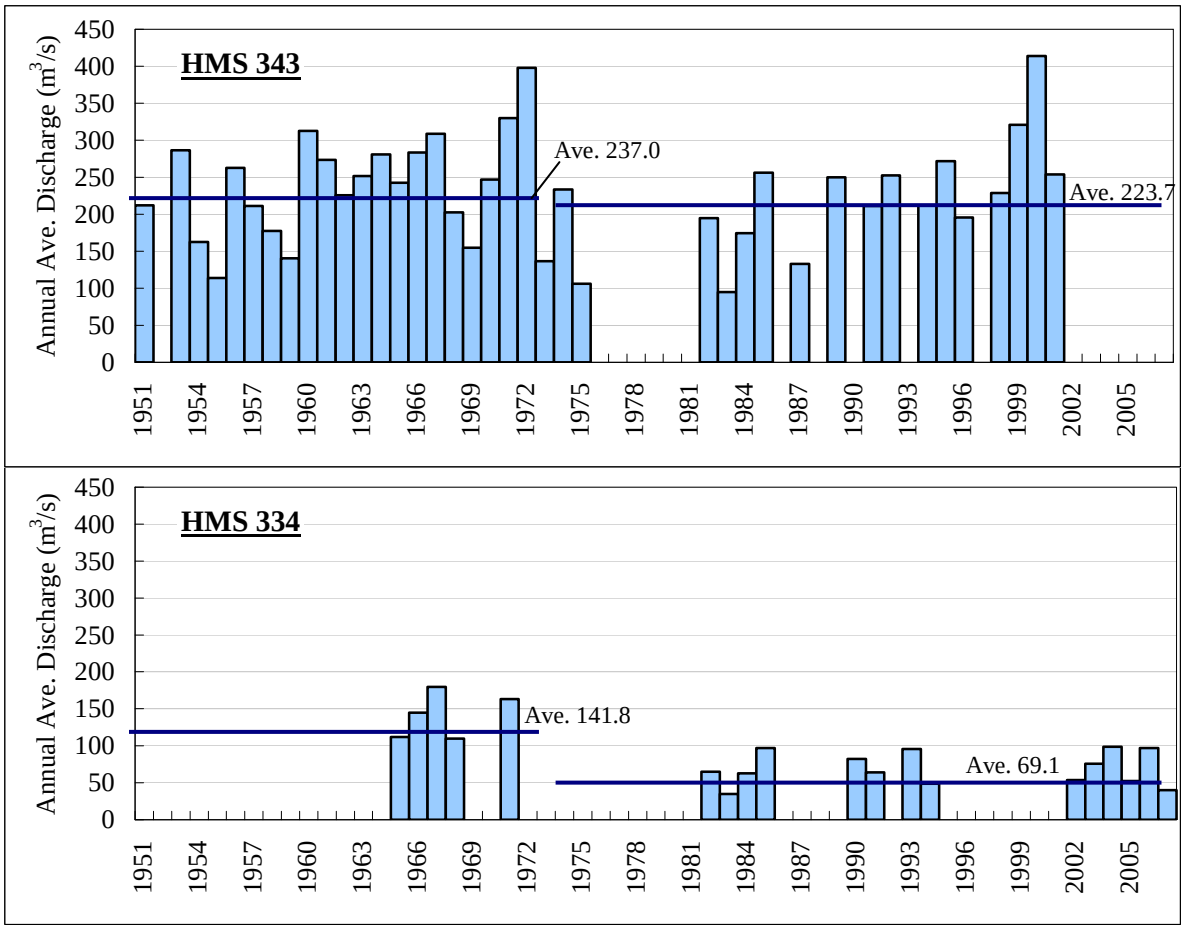
Annex-F A.4.3.1 Specific Discharge





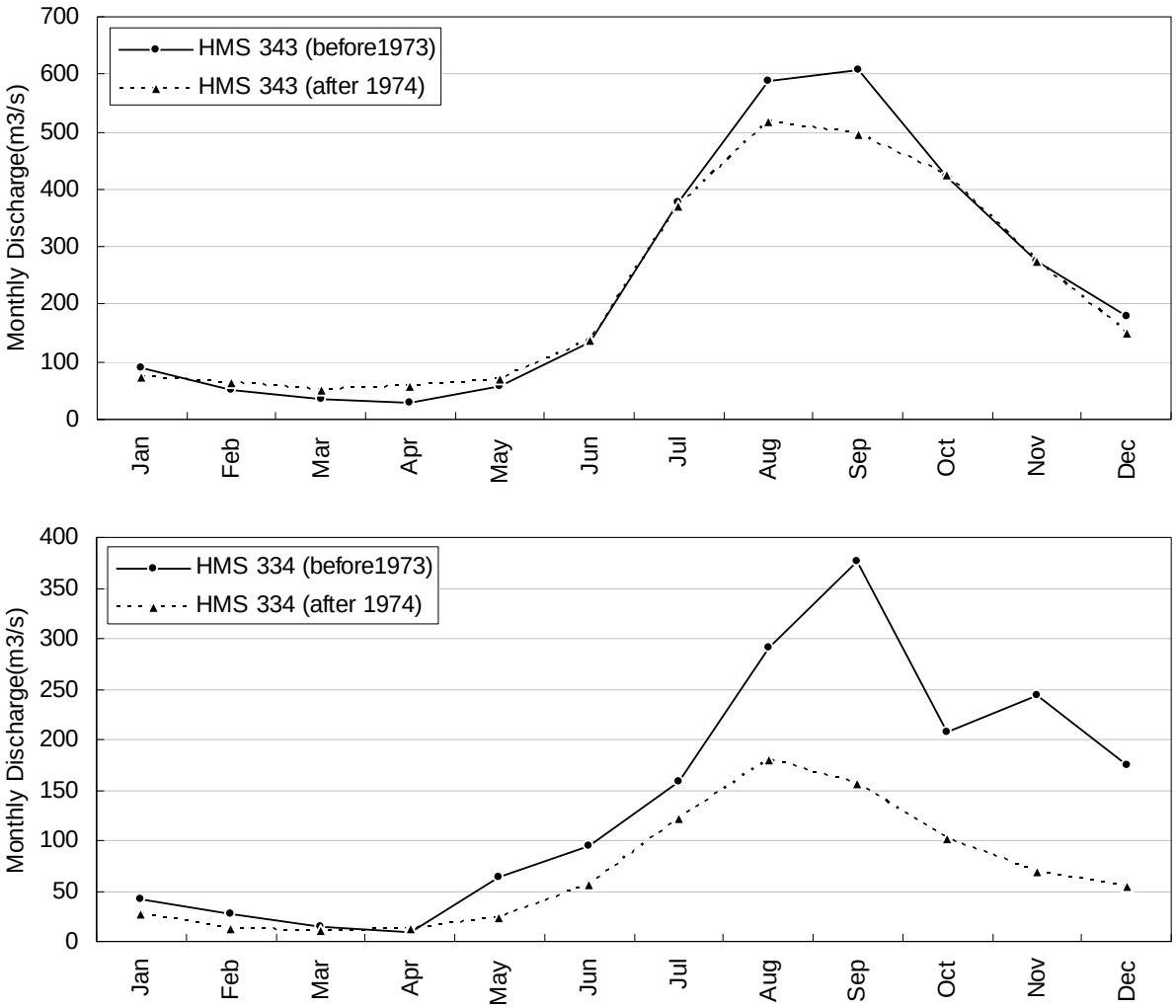
Source: JICA Study Team

Annex-F A.4.3.2 Runoff Rate



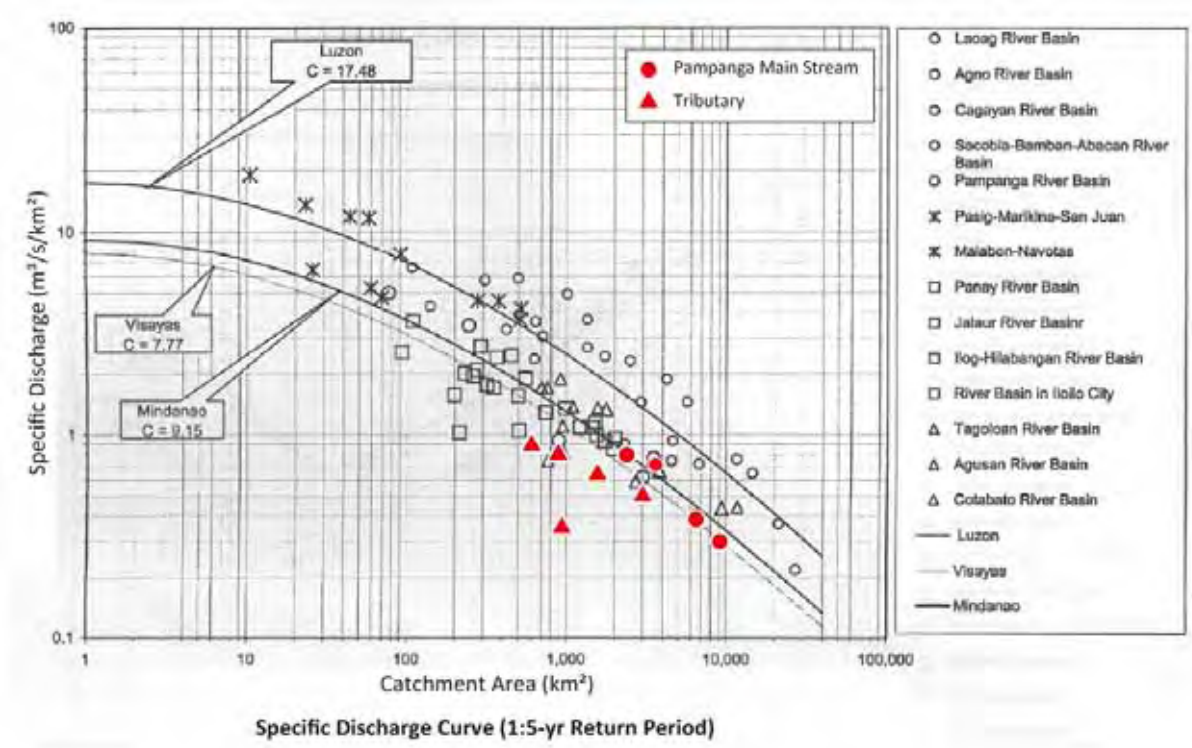
Source: JICA Study Team

Annex-F A.4.3.3 Long-term Trend of Annual Average Discharge at HMS343 and HMS334

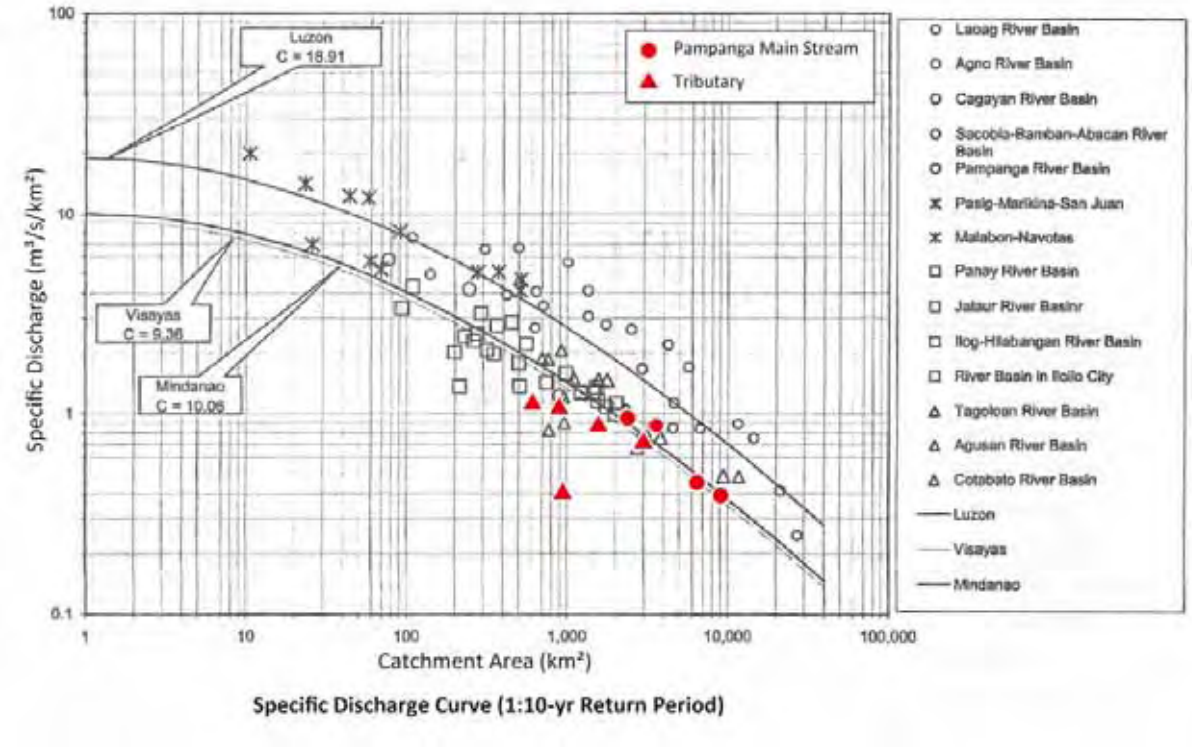


Source: JICA Study Team

Annex-F A.4.3.4 Monthly Variation of Discharge at HMS343 and HMS334



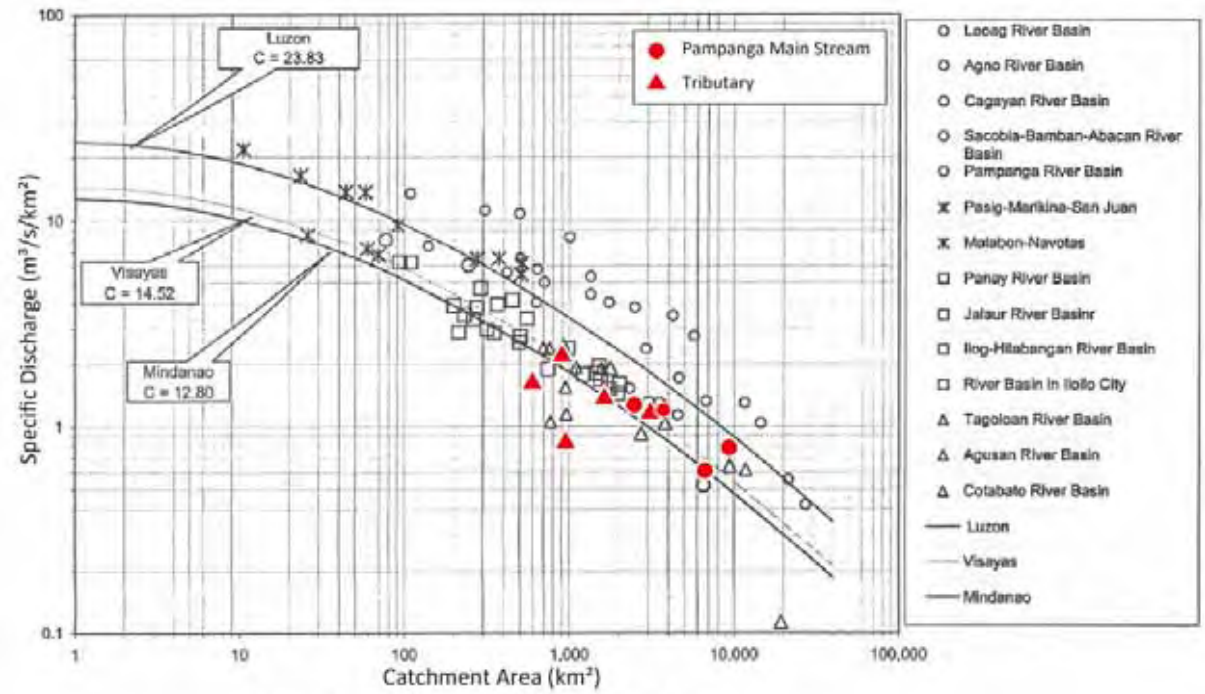
Specific Discharge Curve (1:5-yr Return Period)



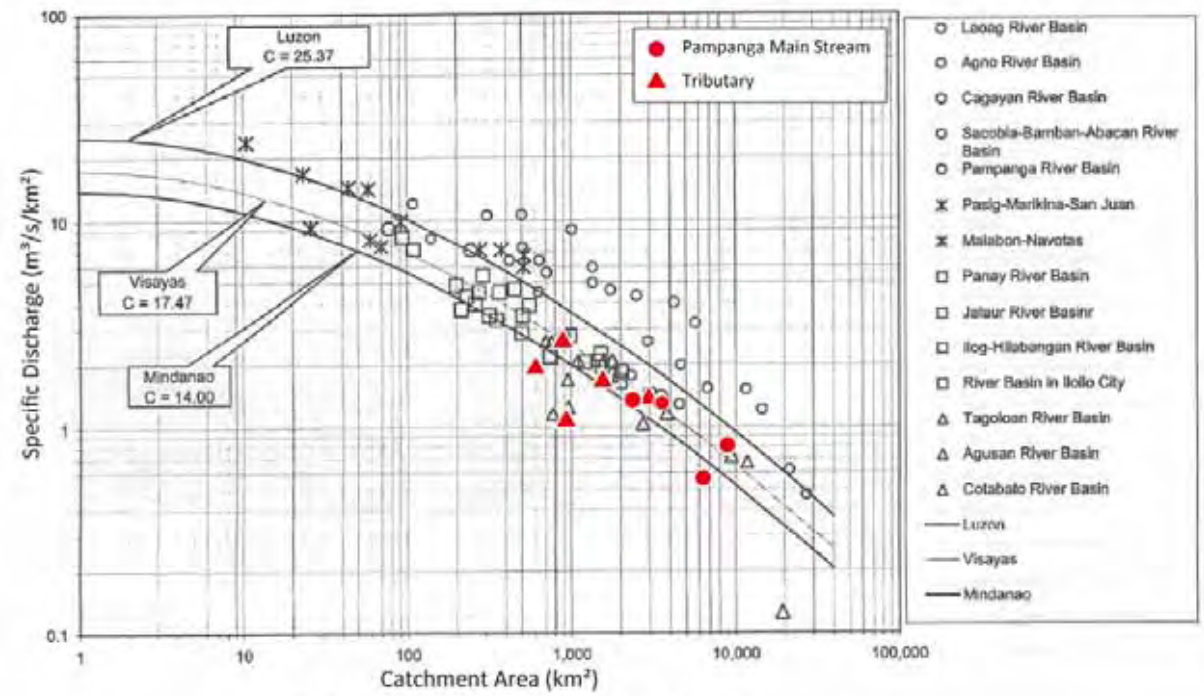
Specific Discharge Curve (1:10-yr Return Period)

Source: MPWH, NIA, JICA: Feasibility Report on The Pampanga Delta Development Project, 1982
JICA Study Team

Annex-F A.4.3.5 (1/2) Probable Specific Discharge



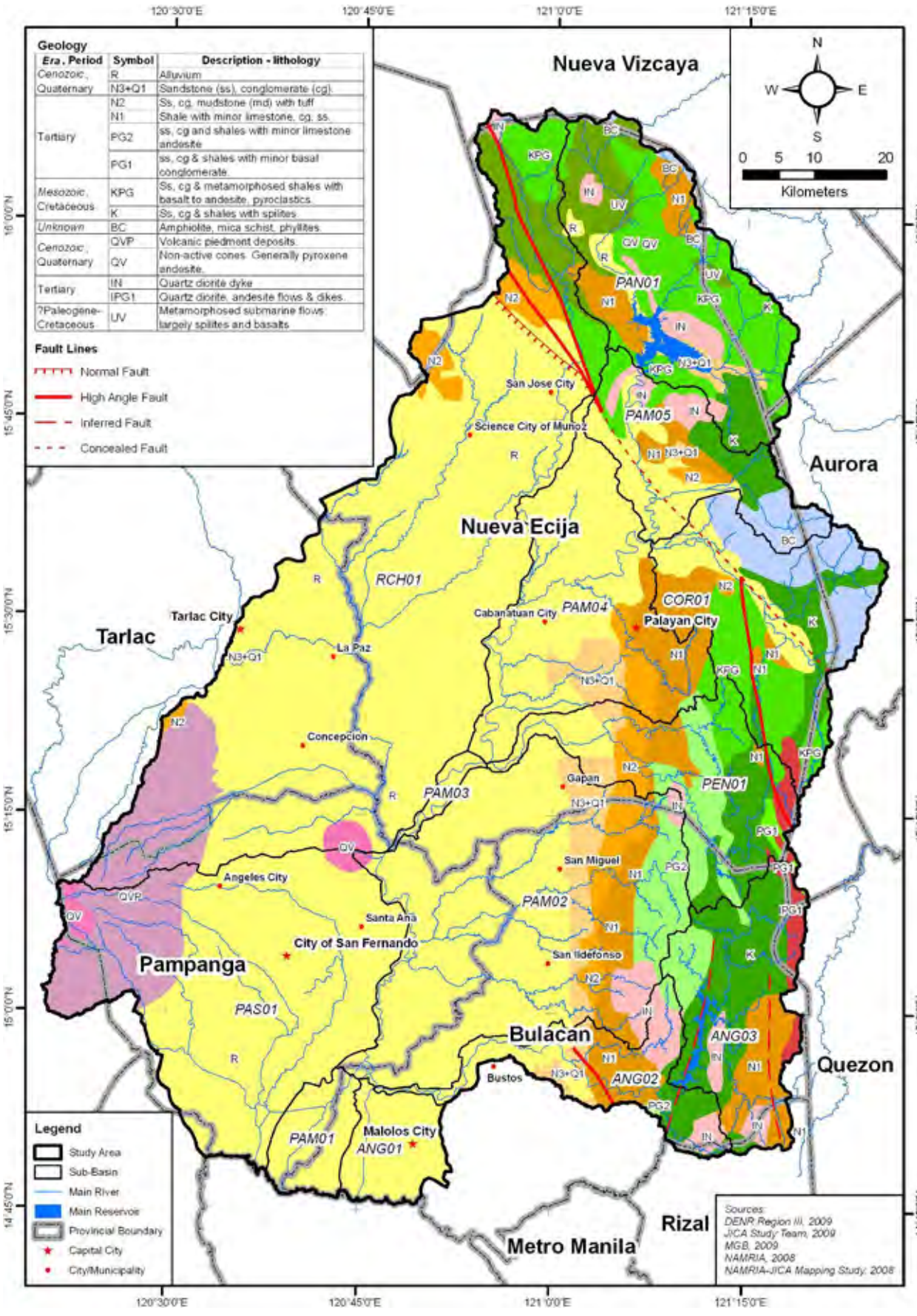
Specific Discharge Curve (1:50-yr Return Period)



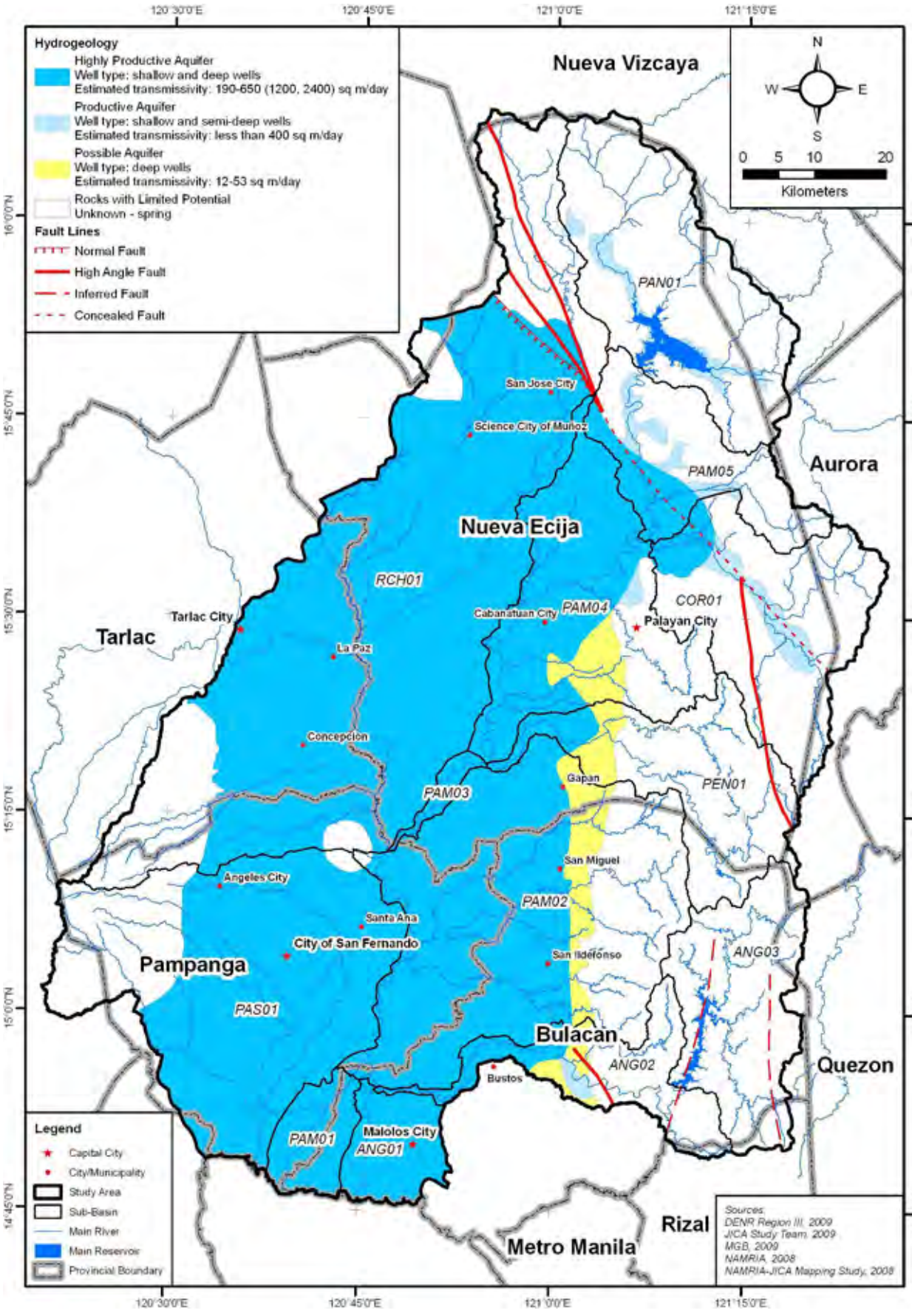
Specific Discharge Curve (1:100-yr Return Period)

Source: MPWH, NIA, JICA: Feasibility Report on The Pampanga Delta Development Project, 1982
JICA Study Team

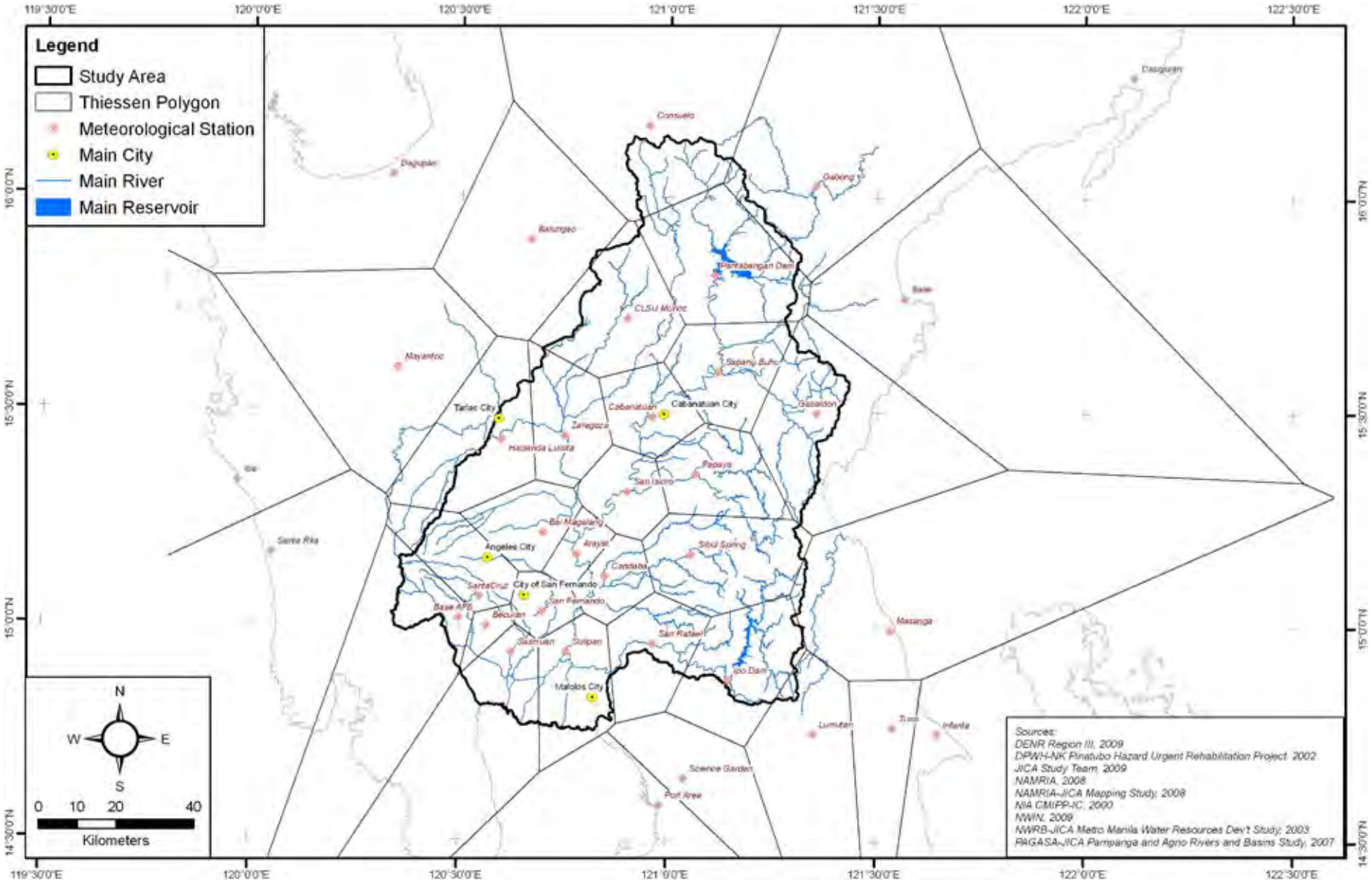
Annex-F A.4.3.5 (2/2) Probable Specific Discharge



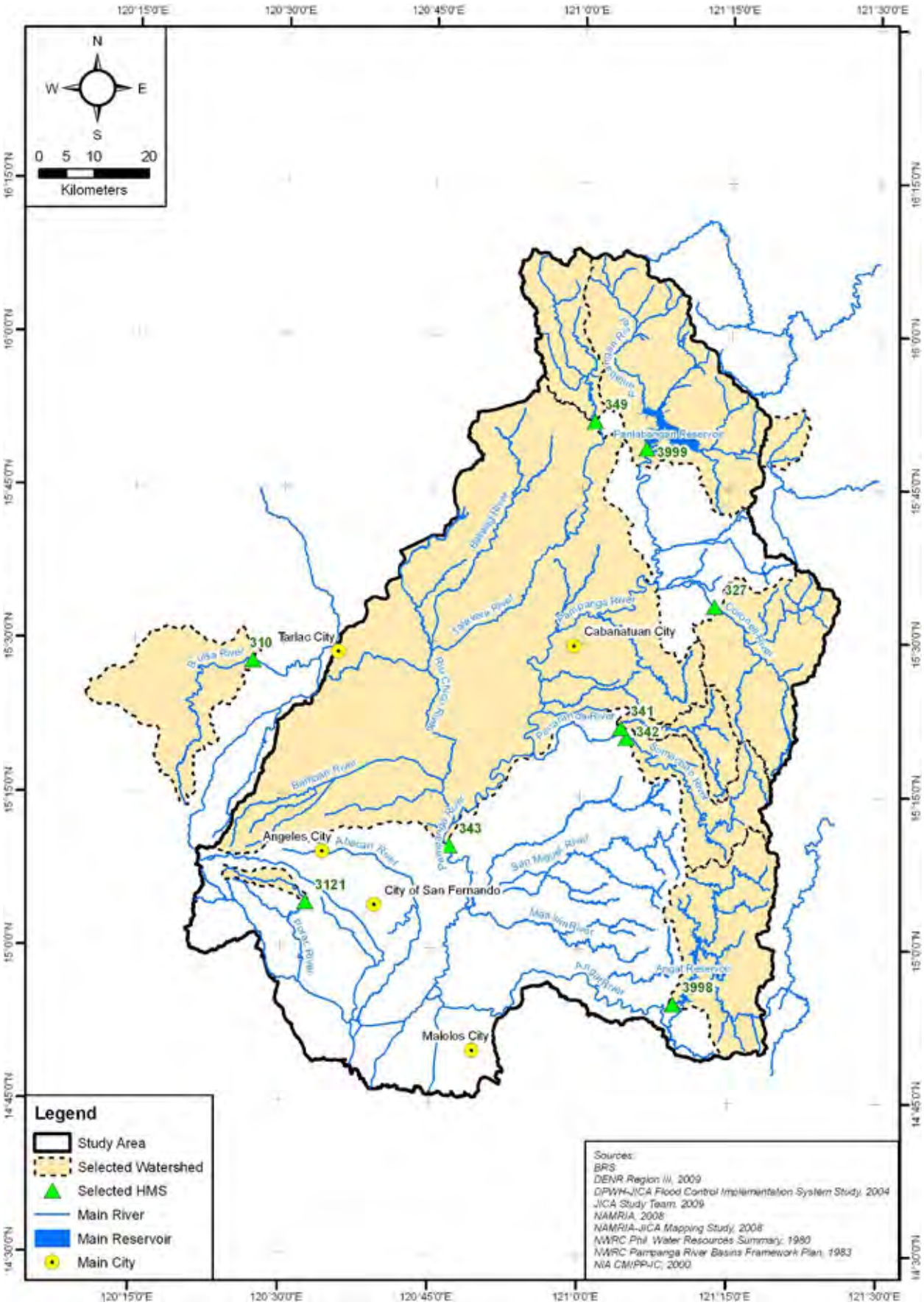
Annex-F A.5.1.1 Geological Map



Annex-F A.5.2.1 Hydrogeology Map

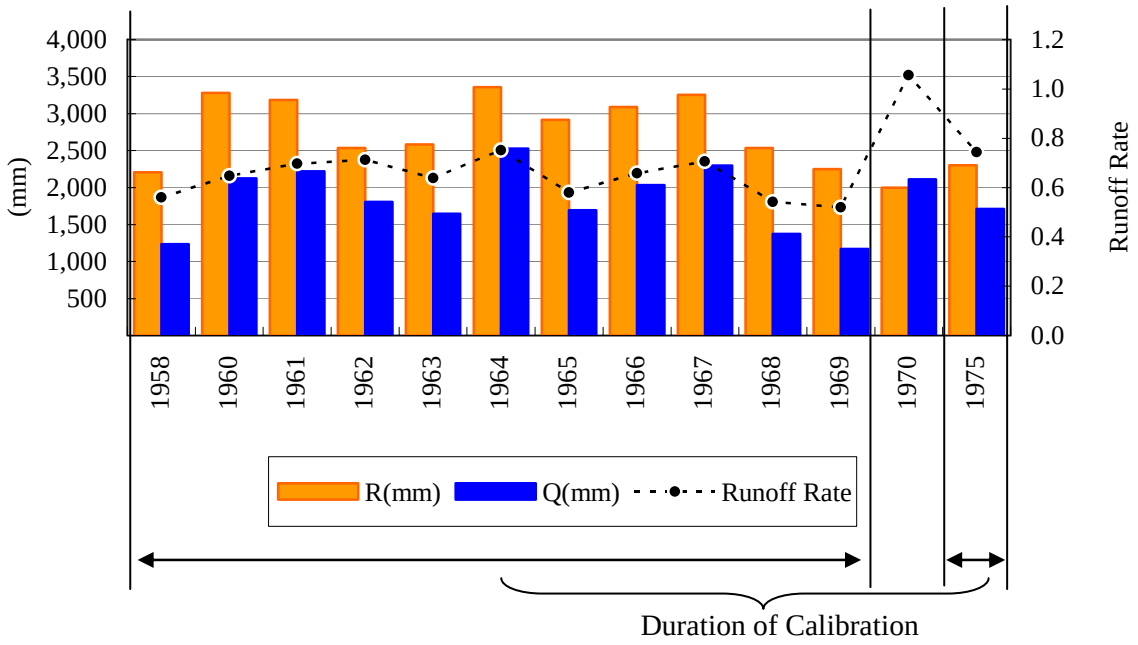


Annex-F A.7.3.1 Thiessen Polygons for Meteorological Stations



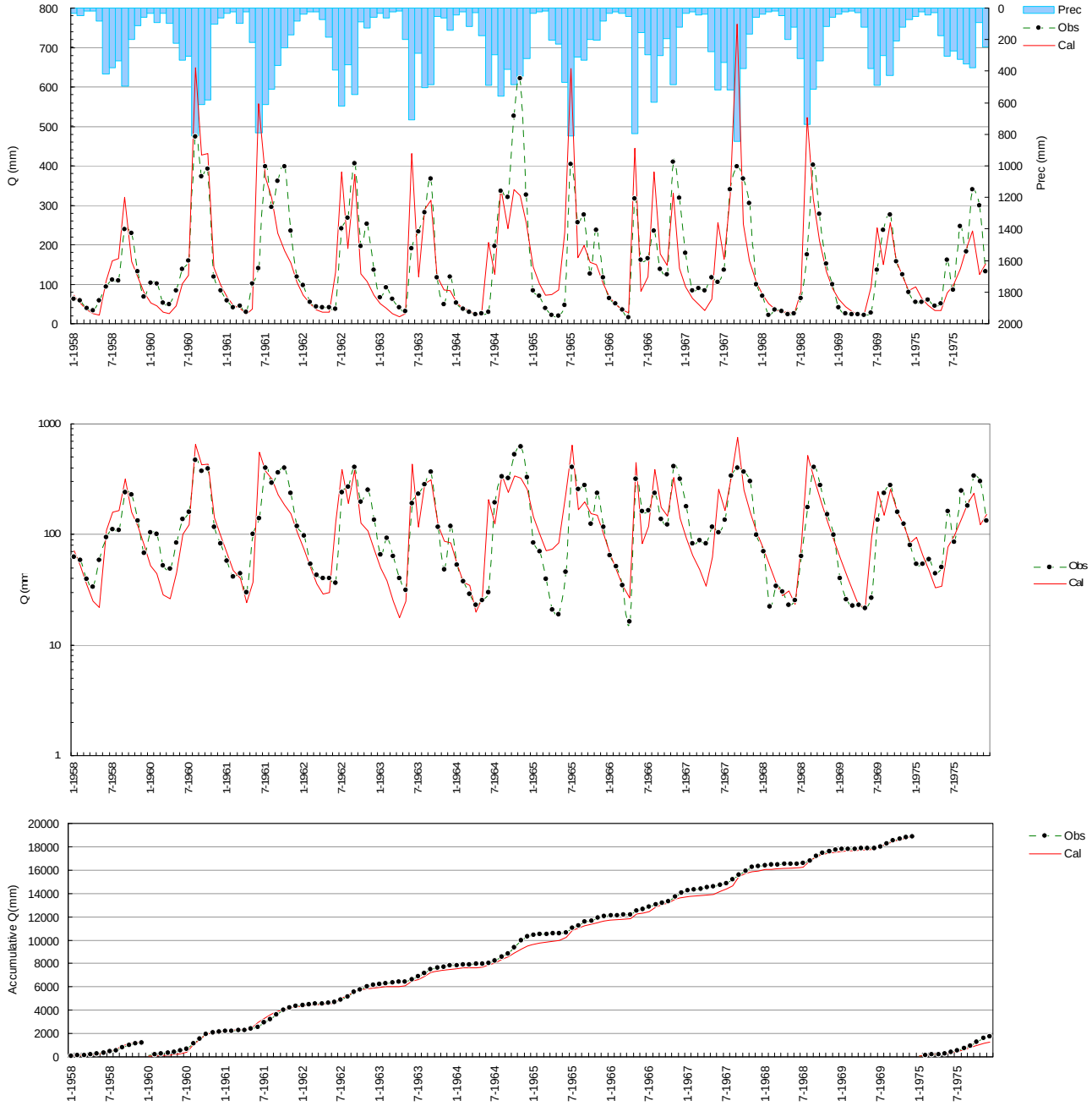
Note: 3999 - Calibration at Pantabangan Dam have been conducted for inflow discharge includes both the inflow to the Pantabangan dam and local inflow to the Masiway dam.

Annex-F A.7.4.1 Location of the Selected Hydrometric Stations



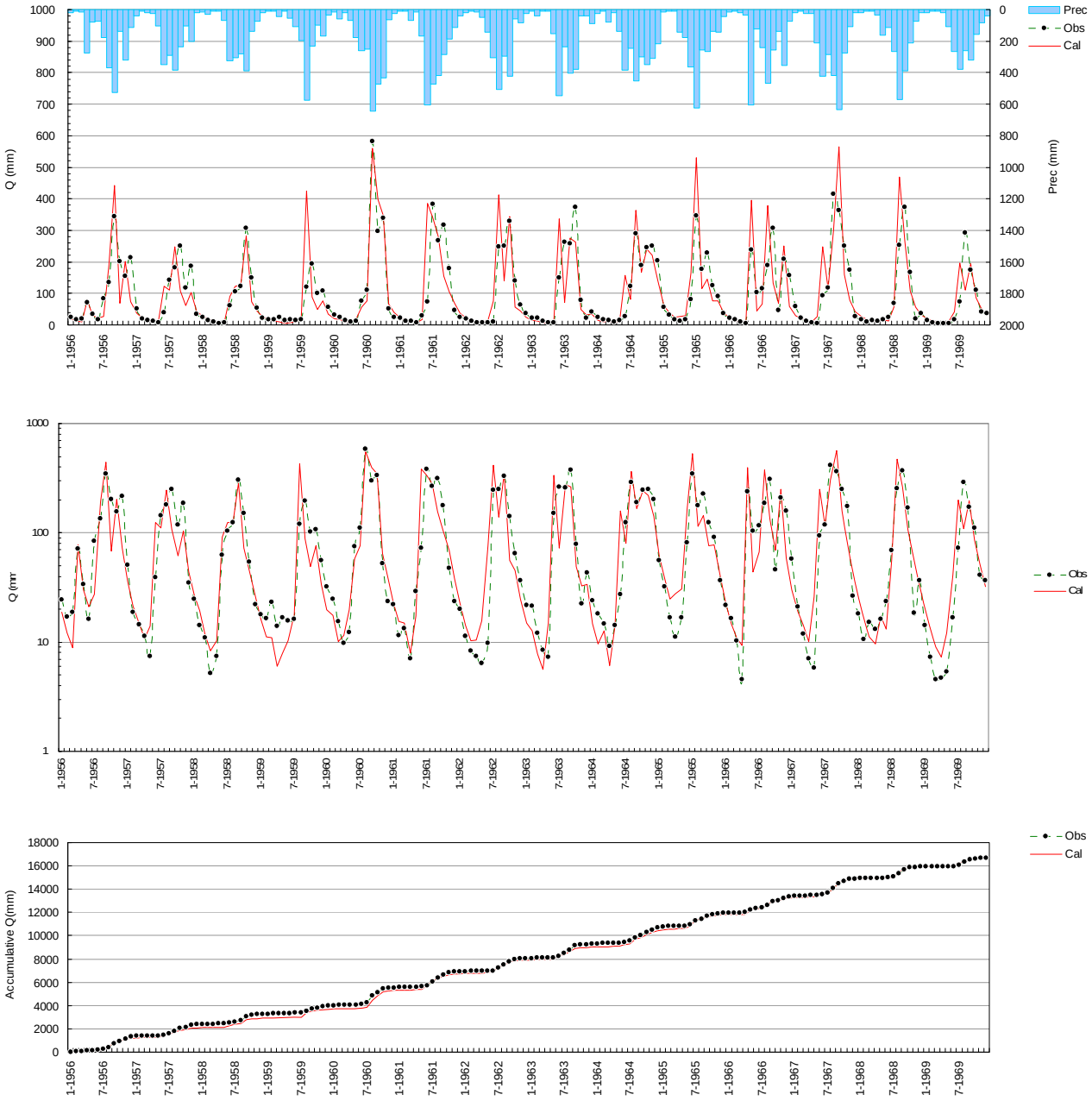
Source: JICA Study Team

Annex-F A.7.4.2 Example of the Selected Duration of Calibration at HMS327



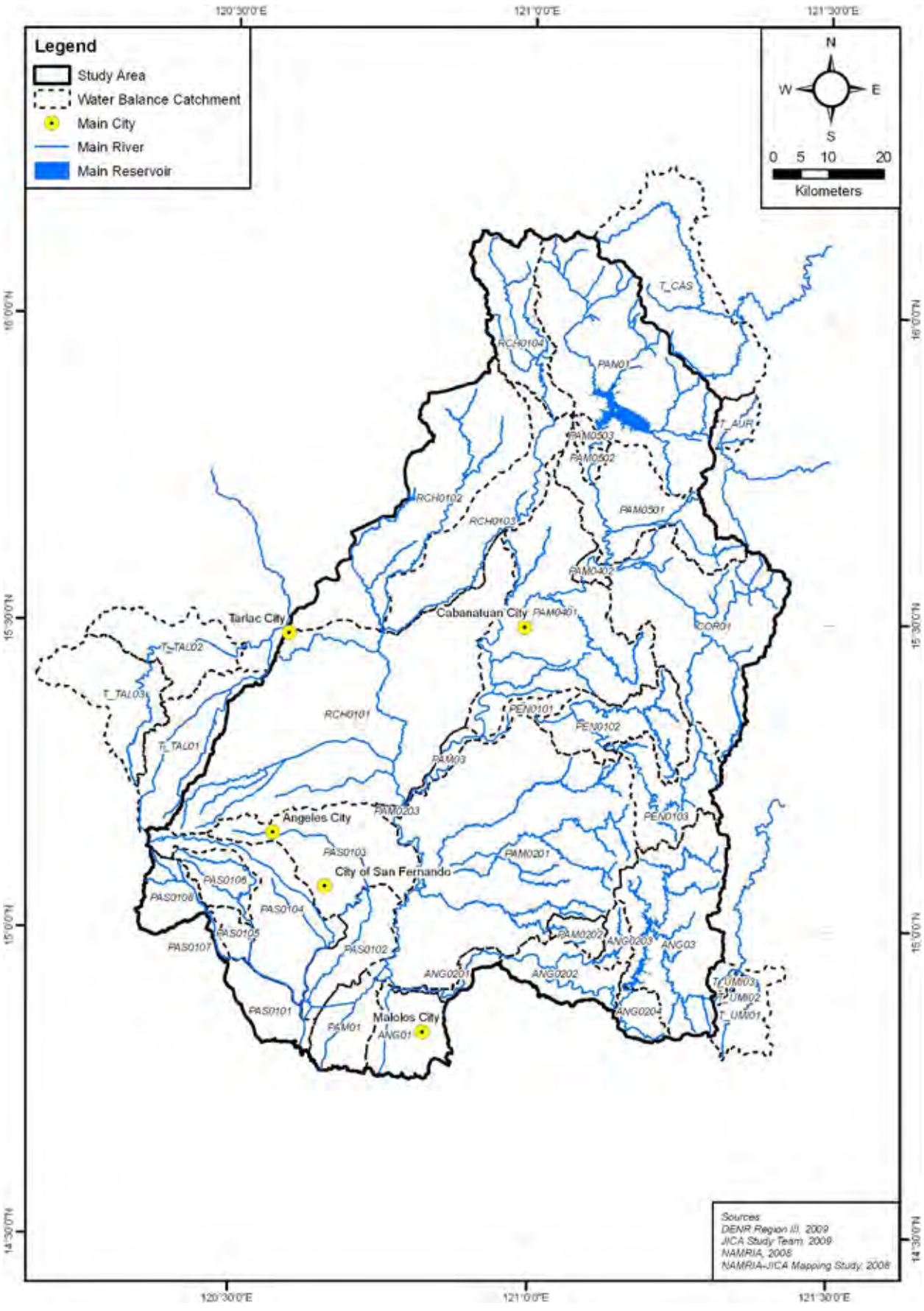
Source: JICA Study Team

Annex-F A.7.4.3 Example of Calibrated Result at HMS327

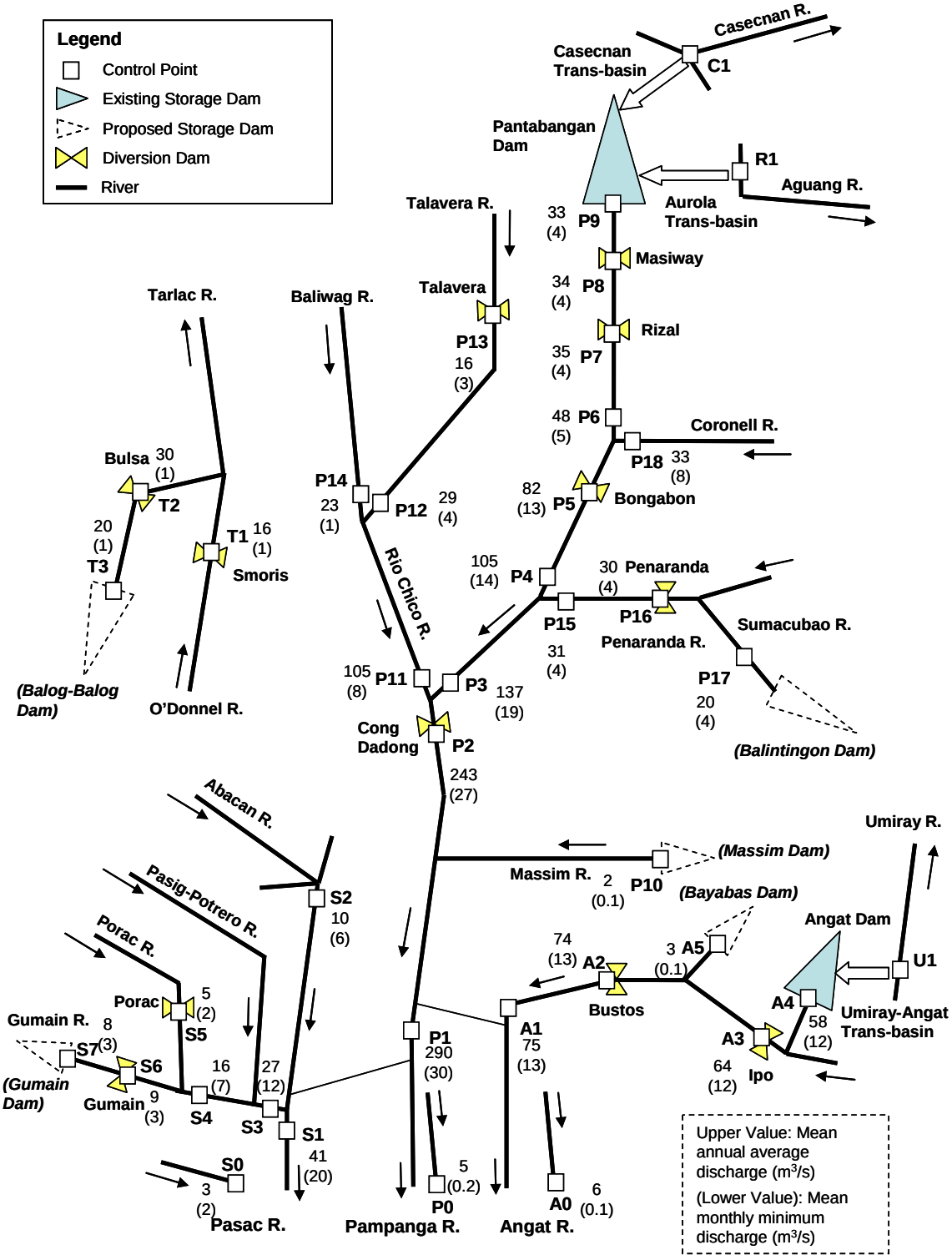


Source: JICA Study Team

Annex-F A.7.4.4 Calibrated Result for Discharge at HMS343



Annex-F A.7.5.1 Water Balance Catchments



Source: JICA Study Team

Annex-F A.7.5.2 Control Points and Discharge in Quasi-Natural Flow Condition

Sector B

Socio-Economy

Sector B. Socio-Economy

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Sector B. Socio-Economy

B.1 Present Socio-Economic Conditions of the Study Area

B.1.1 Demographic Characteristics

B.1.1.1 Extent of the Study Area

The study area spreads over the administrative area of eleven (11) provinces and 90 cities/municipalities. The substantial part of the study area (about 95%) is, however, within the boundary of four provinces, namely, Nueva Ecija, Tarlac, Pampanga and Bulacan. The remaining fringe area (about 5%) is a part of other seven provinces, Aurora, Zambales, Rizal, Quezon, Pangasinan, Bataan and Nueva Viscaya. The extent of the study area divided by the provincial boundaries and the number of cities/municipalities overlapped with the study area is as listed below (refer to Annex-T B.1.1.1):

Table B. 1.1.1 Extent of and Number of Cities/Municipalities Overlapped with the Study Area

(unit: km^2)

Province	Extent		Number of Cities/Municipalities
	Extent (km^2)	Share	
Nueva Ecija	5013	48.0%	30
Pampanga	2022	19.4%	22
Bulacan	2021	19.4%	18
Tarlac	834	8.0%	6
Aurora	195	1.9%	3
Zambales	74	0.7%	2
Rizal	42	0.4%	1
Qezon	30	0.3%	1
Pangasinan	26	0.2%	1
Bataan	14	0.1%	2
Nueva Viscaya	163	1.6%	4
Total	10,434	100.0%	90

Source: JICA Study Team

B.1.1.2 Population

The population in the study area was estimated based on the censuses of NSCB at the city/municipal level in 1980, 1990, 1995, 2000 and 2007. The population within the study area was assumed as the population of each city/municipality multiplied with the percentage of the administrative area covered by the study area. On this assumption, the population in the study area in 2007 is estimated at about 5.8 million, which corresponds to about 59.2% of the total in Region III and/or 6.5% of the national total (refer to Table B.1.1.2 and Annex-T B.1.1.2). Pampanga Province takes the largest population of 2.2 million (about 38% of the total) in the study area. After Pampanga Province, Nueva Ecija has the second largest population of 1.7 million (30% of the total), Bulacan 1.3 million (23%) and Tarlac 0.5 million (8%).

Table B. 1.1.2 Estimated Population in the Study Area

Province	1980	1990	1995	2000	2007
Bulacan	594,920	769,921	908,081	1,072,923	1,299,400
Nueva Ecija	990,542	1,222,034	1,402,016	1,549,715	1,733,849
Pampanga	1,159,123	1,503,152	1,602,261	1,839,706	2,180,084
Tarlac	260,839	322,431	345,794	396,042	472,676
Others	28,922	40,365	43,744	51,150	70,148
Whole Study Area	3,034,346	3,857,903	4,301,897	4,909,536	5,756,156

Source: (1) Population Census in 1980, 1990, 1995, 2000, and 2007 by NSCB (for Basic Population Data)
(2) JICA Study Team (for Overlapping Ratio of study area with Cities/Municipalities)

The past population growth in the study area was estimated based on the above population censuses. The annual average growth from 1980 to 2007 in the study area is 2.40%, which is slightly higher than the nation average of 2.35% as listed in Table B.1.1.3 (refer to Annex-T B.1.1.2). Among the major four provinces in the study area, Bulacan currently has the intensive urbanization in the south-eastern part of the province, which faces Metro Manila, in particular. Due to such intensive urbanization, the Province recorded the highest growth of 2.94% from 1980 to 2007 among those in the four provinces, while Nueva Ecija the lowest growth of 2.1%.

Table B. 1.1.3 Estimated Annual Ave. Population Growth in the Study Area

Province	1980-1990	1990-2000	2000-2007	1980-2007
Bulacan	2.61%	3.37%	2.77%	2.94%
Nueva Ecija	2.12%	2.40%	1.62%	2.10%
Pampanga	2.63%	2.04%	2.45%	2.37%
Tarlac	2.14%	2.08%	2.56%	2.23%
Whole Study Area	2.43%	2.44%	2.30%	2.40%

Source: (1) Population Census in 1980, 1990, 1995, 2000, and 2007 by NSCB (for Basic Population Data)
(2) JICA Study Team (for Overlapping Ratio of study area with Cities/Municipalities)

The population density of the study area in 2007 is 552 persons/km^2, which is more than double of the national average of 258 persons/km^2 (refer to Table B.1.1.4 and Annex-T B.1.1.3). Among the major four provinces in the study area, Pampanga province has the highest average population density of 1,078 persons/km^2 in 2007 followed by 643 persons/km^2 in Bulacan Province, 567 persons/km^2 in Tarlac and 346 persons/km^2 in Nueva Ecija. Among the ten cities/municipalities in a higher rank of population densities in the study area, four are in Pampanga Province and six are in Bulacan Province as shown in Table B.1.1.4. The cities/municipalities with higher population density of more than 2,000 are in the coastal area in and around Maloros City (the provincial capital of Bulacan) and in the middle reaches of Pasac River in and around Angeles and San Fernando City (the provincial capital of Pampanga) as shown in Annex-F B.1.1.1. Angeles City has the highest population density of 5,008 persons/km^2 followed by 3,928 persons/km^2 of San Fernando City in Pampanga province and 3,598 persons/km^2 of Guiguinto in Bulacan province (refer to Table B.1.1.5).

Table B. 1.1.4 Estimated Population Density in the Study Area

Province	Area (km^2)	Population Density (persons/km^2)				
		1980	1990	1995	2000	2007
Bulacan	2,021	294	381	449	531	643
Nueva Ecija	5,013	198	244	280	309	346
Pampanga	2,022	573	743	792	910	1,078
Tarlac	834	313	387	415	475	567
Whole Study Area	10,434	291	370	412	471	552

Source: (1) Population Census in 1980, 1990, 1995, 2000, and 2007 by NSCB (for Basic Population Data)
(2) JICA Study Team (for Overlapping Ratio of study area with Cities/Municipalities)

Table B. 1.1.5 Ten Cities/Municipalities in a Higher Rank of Population Density in the Study Area

Rank	Name of City/Municipality	Name of Province	Area (km^2)	Population Density (persons/km^2)				
				1980	1990	1995	2000	2007
1	Angeles	Pampanga	63	3,007	3,769	3,726	4,203	5,008
2	San Fernando	Pampanga	69	1,617	2,302	2,815	3,235	3,928
3	Guiguinto	Bulacan	2	1,119	1,796	2,120	2,725	3,598
4	Baliuag	Bulacan	44	1,617	2,057	2,362	2,743	3,140
5	Malolos City	Bulacan	73	1,318	1,725	2,031	2,415	3,073
6	Plaridel	Bulacan	20	1,104	1,494	1,872	2,271	2,816
7	Santo Tomas	Pampanga	14	1,725	2,303	2,048	2,260	2,618
8	Santa Maria	Bulacan	1	747	1,163	1,285	1,834	2,610
9	Guagua	Pampanga	49	1,484	1,804	1,949	1,979	2,131
10	Pulilan	Bulacan	44	874	1,105	1,368	1,563	1,949

Source: (1) Population Census in 1980, 1990, 1995, 2000, and 2007 by NSCB (for Basic Population Data)

B.1.1.3 Urban and Rural

The classification of urban and rural areas remains an important indicator for sound policies and decisions pertaining to urban planning and delivery of basic services. According to NSCB Resolution No.9, Series of 2003, the definition of the urban area is as follows.

- If a barangay has a population size of 5,000 or more, then a barangay is considered urban, or
- If a barangay has at least one establishment with a minimum of 100 employees, a barangay is considered urban, or
- If a barangay has 5 or more establishments with a minimum of 10 employees, and 5 or more facilities within the two-kilometer radius from the barangay hall, then a barangay is considered urban.
- All barangays in the National Capital Region be automatically classified as urban;

The NSO adopted the above-mentioned definition from 2005 and the census in 2007 shows the urban and rural population for each municipality and city. The following table summarizes the urban and rural population for the study area. The urban and rural population for each municipality and city are shown in Annex-T B.1.1.4.

Table B. 1.1.6 Urban and Rural Population in the Study Area in 2007

Province	Population		
	Urban	Rural	Total
Bulacan	849,494	449,907	1,299,401
Nueva Ecija	890,077	843,773	1,733,850
Pampanga	1,494,593	685,491	2,180,084
Tarlac	197,463	275,213	472,676
Others	41,718	28,431	70,149
Whole Study Area	3,473,345	2,282,815	5,756,160

Source: (1) Population Census in 2007 by NSCB (for Basic Population Data)
(2) JICA Study Team (for Overlapping Ratio of study area with Cities/Municipalities)

B.1.2 Economic Characteristics

B.1.2.1 Gross Regional Domestic Product

Due to the inadequate census on the Gross Value Added (hereinafter referred to as GVA)[i] in each of the industrial origin at the municipal and/or provincial levels, the general view on the current regional domestic product of the study area was accessed based on the economic census at the regional level.

As described above, about 60% of the population in Region III is within the study area and, out of 117 cities/municipalities located in the Region, the study area overlaps with 90 cities/municipalities. Judging from these socio economic features of the study area, the peculiarities of regional domestic product in the study area could be substantially delineated through the economic census of the Region.

(1) Contribution Rate of GRDP of Region III to GNP

Region III recorded the GRDP of 501 billion pesos in 2007, which takes 7.5% of the GNP, and ranks third next to National Capital Region (NCR) and Region IV (CALABARZON) (refer to Table B.1.2.1). These three regions in a higher rank of GRDP (i.e., NCR, Region IV and Region III) are tied together with the North and South Super-Highways and produce 56.1% of GNP in total. Thus, the regions form the core economic block in Philippines, and Region III plays a part of the important economic activities in Philippines.

[i] The aggregate of the gross value added from each industrial sector is defined as the Gross Regional Domestic Product (GRDP).

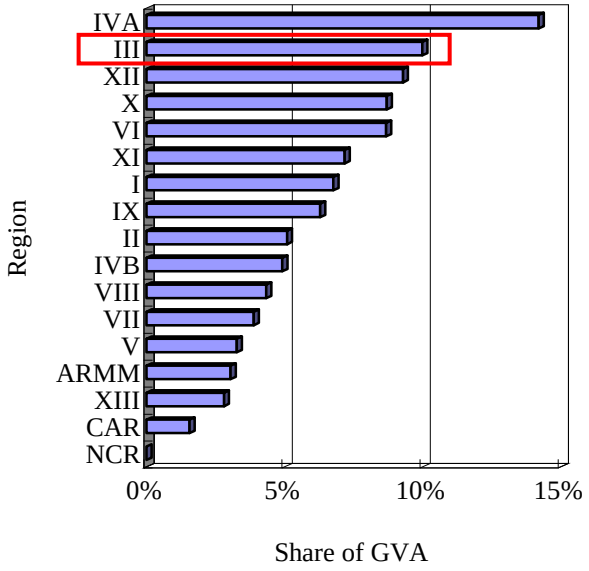
Table B. 1.2.1 GRDPs of Three Regions in a Higher Ranking and their Shares to GNP

Region	GRDP (billion pesos/year)	Share to GNP
NCR	2,479	37.30%
Region-IV.A	752	11.30%
Region-III	**501**	**7.50%**
Total	3,732	56.10%

Source : "Gross Regional Domestic Product" by National Statistical Coordination Board, 2005-2007

Among the industrial sectors in the Region III, the Agricultural Sector shows the highest share of GVA to the national total (10% of the national total) in 2007 followed by 8.3% in the Industrial Sector and 6.4% in the Service Sector (refer to Table B.1.2.2). This 10% of the Agriculture Sector is ranked 2nd among all regions in Philippines next to Region IV, CALABARZON (refer to Figure B.1.2.1).

Moreover, the GVA in the Agriculture Sector of the Region III tend to increase its share to the national total unlike the Industrial and Service Sectors, which tends to decrease thir shares to the national total (refer to Figure B.1.2.2).



Source: "Gross Regional Domestic Product" by National Statistical Coordination Board, 2005-2007"

Figure B. 1.2.1 Share of Gross Value Added by Region to National Total in the Agricultural Sector (year 2007)

Table B. 1.2.2 Share of Gross Value Added of Region III to National Total in 2007

(Unit: million pesos/year)

Description	Agricultural Sector	Industrial Sector	Service Sector	Total
Gross Value Added in Region III	93,539	175,857	231,959	501,356
Gross Value Added in the whole Country	936,415	2,107,287	3,604,542	6,648,245
Share of Gross Value Added of Region III	**10.0%**	**8.3%**	**6.4%**	**7.5%**

Source : "Gross Regional Domestic Product" by National Statistical Coordination Board, 2005-2007"

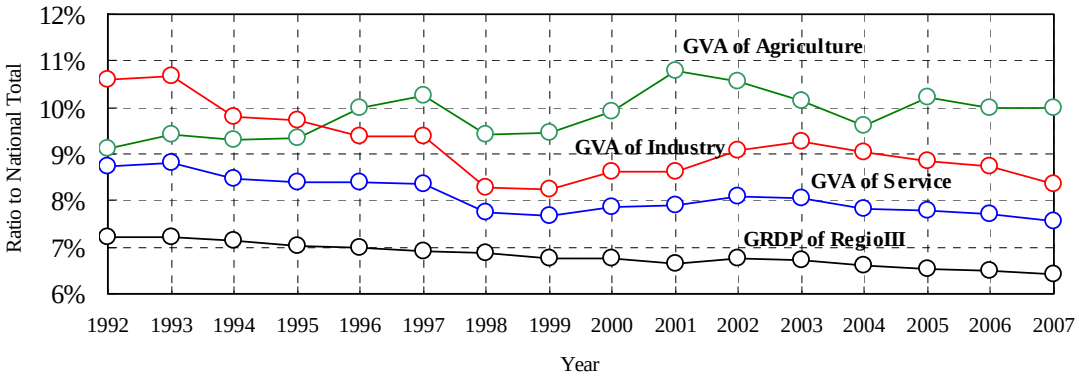


Figure B. 1.2.2 Long Term Variation of Contribution Ratio of GRDP and GVA of Region III to National Total

As described above, Region III contributes the GNP of the Philippines especially in the Agricultural Sector. It is further noted that the Philippines has produced the paddy of 16.8 million metric ton in total, out of which about 3.0 million metric ton or about 18% has been produced in the Region III, in 2007 (refer to Table B.1.2.3). This production volume in the Region III is the largest in those by all regions. Thus, the Region is the principal staple rice-producing district contributing the increment of self-sufficient ratio in the flood, which is one of the national development strategies in the Philippines.

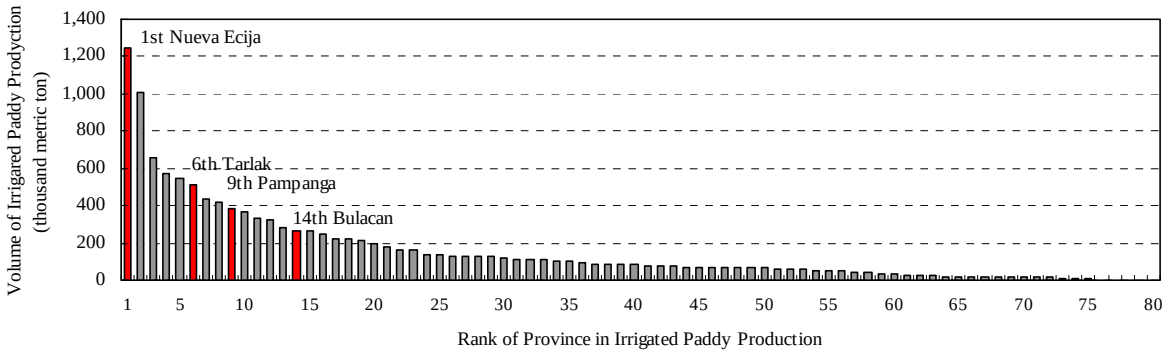
Of the above paddy production volume in the country, 12.6 million metric ton or about 75% is the irrigated paddy production. Again, the Region III is the largest irrigated paddy-producing district taking the share of about 22% of the national total. Moreover, the provinces of Nueva Ecija, Tarlac, Pampanga and Bulacan, the substantial part of which are within in the study area, are ranked as the 1st, 5th, 9th and 14th largest irrigated paddy-producing provinces among 80 provinces in the whole country (refer to Figure B.1.2.3). These four provinces produced the irrigated paddy of 2.4 million metric ton in total, which corresponds to about 19% of the country total. Judging from these irrigated-paddy production, the sustainable water supply for the paddy irrigation in the study area is deemed to be one of the important issues not only the regional economy but also for in the national economy.

Table B. 1.2.3 Volume of Paddy Production by Region in 2007

(unit: metric ton)

Rank	Region	Irrigated Paddy		Rain fed Paddy		Total	
		Production Volume	Share	Production Volume	Share	Production Volume	Share
1	**Region III**	**2,710,433**	**21.6%**	**303,914**	**7.1%**	**3,014,347**	**17.9%**
2	Region VI	1,240,210	9.9%	877,388	20.6%	2,117,598	12.6%
3	Region II	1,872,024	14.9%	208,216	4.9%	2,080,240	12.4%
4	Region I	1,113,627	8.9%	578,002	13.6%	1,691,629	10.1%
5	Region XII	998,390	8.0%	236,367	5.5%	1,234,757	7.3%
6	Region VIII	631,886	5.0%	398,735	9.4%	1,030,621	6.1%
7	Region V	724,258	5.8%	273,323	6.4%	997,581	5.9%
8	Region IV-B	536,497	4.3%	326,718	7.7%	863,215	5.1%
9	ARMM.	250,400	2.0%	381,291	9.0%	631,691	3.8%
10	Region IX	374,836	3.0%	176,474	4.1%	551,310	3.3%
11	Region X	507,939	4.0%	43,307	1.0%	551,246	3.3%
12	CARAGA	312,206	2.5%	135,111	3.2%	447,317	2.7%
13	CAR	372,282	3.0%	72,874	1.7%	445,156	2.6%
14	Region IV-A	340,836	2.7%	87,249	2.0%	428,085	2.5%
15	Region XI	378,087	3.0%	40,867	1.0%	418,954	2.5%
16	Region VII	192,239	1.5%	119,562	2.8%	311,801	1.9%
National Total		12,556,150	100.0%	4,259,398	100.0%	16,815,548	100.0%

Source: Country STAT by Bureau of Agricultural Statistics, Department of Agriculture



Source: Country STAT by Bureau of Agricultural Statistics, Department of Agriculture

Figure B. 1.2.3 Volume of Irrigated Paddy Production by Region

(2) Gross Value Added in Each Industrial Sector for Region III

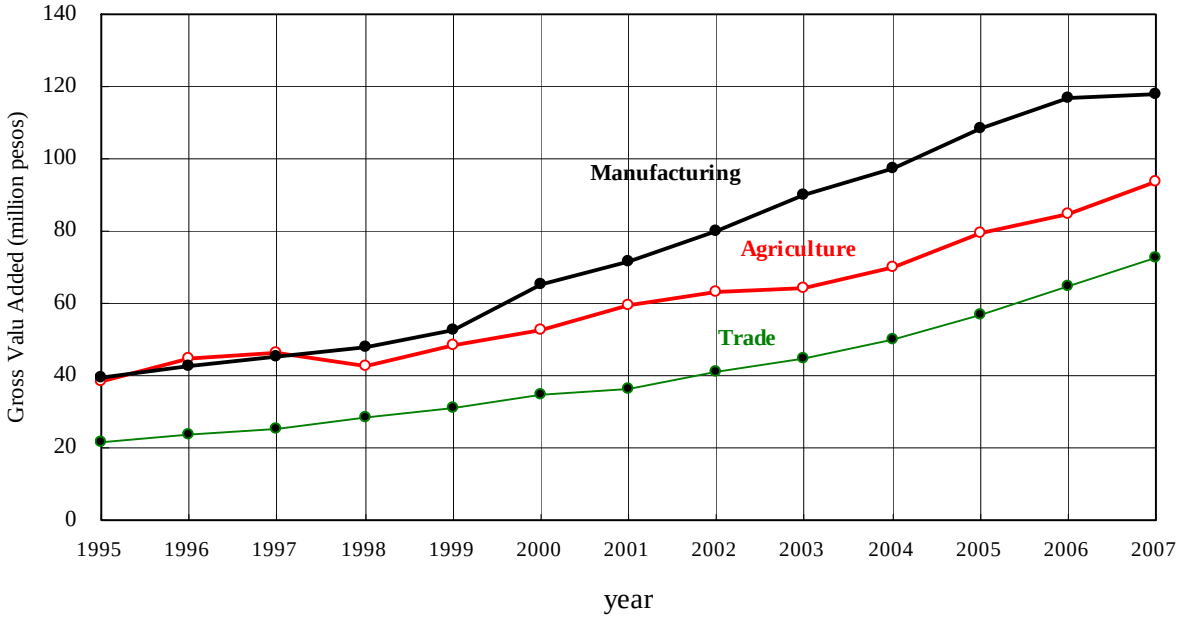
According to the statistics from NSCB, the highest GVA in the Region III has been recorded in the Manufacturing Subsector of Industrial Sector followed by the Agriculture/Fishery Subsector of Agricultural Sector and Trade Subsectors of Service Sector throughout the recent 10 years from 1998 to 2007 (refer to Table B.1.2.4). The GVA in the Manufacturing Subsector makes up 24% of the GRDP of the Region III in 2007, while the GVA in the Agriculture/Fishery Subsector was about 19%. Thus, there is currently a substantial difference between of GVAs in Manufacturing and Agriculture Subsectors. During the years from 1995 to 1997, however, the GVA in the Manufacturing Subsector were almost same as those in the Agriculture/Fishery: both of the subsectors produced about 24% of the GRDP in 1995 as shown in Table B.1.2.5.

Table B. 1.2.4 Gross Value Added in Industrial Origin in Region III

(unit: million pesos)

Sector	Subsector	Amount	Share
Agricultural Sector	(1) Agriculture and Fishery	93,435	18.6%
	(2) Forestry	104	0.0%
Industrial Sector	(3) Mining and Quarrying	639	0.1%
	(4) Manufacturing	118,107	23.6%
	(5) Construction	33,774	6.7%
	(6) Electricity and Water	23,338	4.7%
Service Sector	(7) Transport, Comm., Storage	39,306	7.8%
	(8) Trade	72,669	14.5%
	(9) Finance	9,112	1.8%
	(10) O. Dwellings & Real Estate	33,627	6.7%
	(11) Private Services	48,504	9.7%
	(12) Government Services	28,742	5.7%
Regional Total (GRDP)		501,356	100.0%

Note: The current price as of 2008
Source : “Gross Regional Domestic Product” by National Statistical Coordination Board



Source: "Gross Regional Domestic Product" by National Statistical Coordination Board

Figure B. 1.2.4 Long Term Variation of Gross Value Added in Manufacturing and Agriculture Subsector

The annual average growth rate of the GRDP in Region III from 1995 to 2007 was about 10%. The highest growth rate of GVA was recorded in the Transport, Comm., Storage (14.3%) followed by the Electricity/Water Subsector (13.8%). The Manufacturing Subsector, which currently takes the largest share of GRDP in Region III, also recoded the annual growth rate of 9.6%. In contrast, the Agriculture/Fishery Subsector confines its growth rate below 8%. The degradation of the annual growth rate of the GVA in the Agriculture/Fishery Subsector is the nation-wide general tendency, which could be attributed to the lower productivity per head of worker as compared with the Industry and Service Sectors. Nevertheless, the Agriculture/Fishery is still one of the key industries and currently takes in the largest number of employees in Region III. Moreover, as described in the foregoing item (1), promotion of the sector is indispensable to accord to one of the national policy for increase of the food self-sufficiency rate.

Table B. 1.2.5 Annual Average Growth Rate of Gross Value Added in Industrial Sectors of Region III from 1995 to 2007

Sector	Subsector	Gross Value Added (in million pesos)		Annual Ave. Growth Rate 1995-2007
		In 1995	In 2007	
Agricultural Sector	(1) Agriculture and Fishery	38,532	93,435	7.7%
	(2) Forestry	0	104	-
Industrial Sector	(3) Mining and Quarrying	1,248	639	-5.4%
	(4) Manufacturing	39,226	118,107	9.6%
	(5) Construction	14,002	33,774	7.6%
	(6) Electricity and Water	4,922	23,338	13.8%
Service Sector	(7) Transport, Comm., Storage	7,904	39,306	14.3%
	(8) Trade	21,339	72,669	10.8%
	(9) Finance	2,354	9,112	11.9%
	(10) O. Dwellings & Real Estate	11,749	33,627	9.2%
	(11) Private Services	10,939	48,504	13.2%
	(12) Government Services	7,724	28,742	11.6%
Regional Total (GRDP)		159,939	501,356	10.0%

Note: The current price as of 2008
Source : "Gross Regional Domestic Product" by National Statistical Coordination Board

B.1.2.2 Number of Employees and Gross Regional Product per Head of Employee

The number of the employees in Region III is about 3.4 million, which make up about 35% of the total population in the region. The largest number of employees in the Region belongs to agriculture/ forestry and the wholesale/retail; both of the occupations receive about 22% of the total employees in the Region as shown in Table B.1.2.6.

Table B. 1.2.6 Number of Employees in Each of Occupation

Occupation	Number of Employees (thousand)	Share to Total (%)
Agriculture and Forestry	745	21.9%
Wholesale and Retail*	743	21.9%
Manufacturing	416	12.2%
Social Service Activities**	382	11.2%
Transport, Storage and Communication	375	11.0%
Construction	252	7.4%
Private Household with Employed Persons	151	4.4%
Hotel and Restaurants	124	3.7%
Real Estate, Renting and Business Activities	82	2.4%
Fishing	59	1.7%
Financial Intermediation	45	1.3%
Electricity, Gas and Water	17	0.5%
Mining and Quarrying	5	0.1%
Total	3,396	100.0%

Note: * Including repair of motor vehicles, motorcycles and personal household goods
** Including public administration, and other community, social & personal service activities
Source: "2008 Philippines Statistical Yearbook" by National Statistical Coordination Board

The GVA per head of employee was estimated based on the above GVA and the number of employees in each industrial sector. The highest GVA per head of employee is 255 thousand pesos/employee in the Industrial Sector followed by 122 thousand pesos/employee in Service Sector and 116 thousand pesos/employee in the Agricultural Sector.

Table B. 1.2.7 Gross Value Added per Head of Employee

Sector	Gross Value Added (million pesos)	Number of Employees in Each Industrial Sector (thousand)	Gross Value Added per Head of Employee (pesos/person)
Agricultural Sector	93,539	804	116,342
Industrial Sector	175,858	690	254,867
Service Sector	231,960	1,902	121,956
Total	501,357	3,396	147,632

Note: The current price as of 2008
The current number of Employees as 2007
Source: "2008 Philippines Statistical Yearbook" by National Statistical Coordination Board

B.1.2.3 Income and Poverty Statistics

The annual incomes in Region III for the recent decade from 1997 to 2006 are in a range of 1.05 to 1.14 times of the national average as shown in Table B.1.2.8. At the same time, the annual income in Region III is the third highest value next to NCR and Region VI-A among 17 regions in Philippines. Thus, Region III is rather wealthy as compared with other regions. There is, however, large difference in income in Philippines, and a particular attention should be paid to the families, whose income is below the poverty threshold.

Table B. 1.2.8 Annual Average Family Income in Region III

Region	1997	2000	2003	2006
Average Annual Income (pesos/year/family)	133,130	151,449	160,000	197,640
Ratio to the National Average	108%	105%	108%	114%

Source: "2008 Philippines Statistical Yearbook" by National Statistical Coordination Board

NSCB estimates the "Per Capita Poverty Threshold (herein after referred to as PCPT)", which is the minimum income necessary to enhance an adequate standard of living, by provinces in the Philippines.

The national average PCPT is 15,057 pesos/head/year, and about 33% of the population in the country is regarded as the indigents whose annual incomes are below the average PCPT. The indigents in the major four provinces of Bulacan, Nueva Ecija, Pampanga and Tarlac in the study area form about 20% of the total population.

Table B. 1.2.9 Annual Per Capita Poverty Threshold and Incidences of Population for Whole Country and Four Provinces Overlapped with Study Area

Objective Area	2003			2006		
	Per Capita Poverty Threshold (pesos/head/year)	Poor Population	Poverty Incidence (%)	Per Capita Poverty Threshold (pesos/head/year)	Poor Population	Poverty Incidence (%)
1 National Total	12,309	23,836,104	30.0	15,057	27,616,888	32.9
2. Provinces in Region III	14,378	1,535,784	17 5	17,298	1,914,590	20 7
3. Major Provinces in Study Area	14,629	1,289,078	17.5	17,446	1,584,003	20.3
(1) Bulacan	15,027	307,762	12.3	17,768	358,012	13.4
(2) Nueva Ecija	14,394	484,106	27.1	17,830	662,742	37.7
(3) Pampanga	15,148	289,106	14.7	17,243	234,820	10.8
(4) Tarlac	13,866	208,104	18.4	16,463	328,428	27.6

* Annual Per Capita Poverty Threshold = The minimum annual income per person to meet the basic food and non-food requirement

** Poor Population = The population, whose annual income is less than the per capita poverty threshold.

*** Poverty Incidence = The proportion of the poor population to the total population.

Source: "2008 Philippines Statistical Yearbook" by National Statistical Coordination Board

As stated above, the average ratio of the poor population in the study area is far lower than the national average. However, a particular attention should be given to the ratio of Nueva Ecija province, which is far higher than those in other three provinces and exceeds even above the national average. According to the "Socio Economic Profile of Nueva Ecija province, Series of 2005", the majority of the employees are engaged to the Agricultural Sector (47% in the Agricultural Sector, 40% in the Service Sector, and 13% in the Industry Sector). Accordingly, one of the crucial issues for poverty alleviation in Nueva Ecija province would be addressed to increment of the income of the employees engaged to the agricultural sector. Poverty incidence for each municipality and city is presented in Annex-T B.1.2.1 and Annex-F B.1.2.1.

B.1.3 Land Cover

B.1.3.1 Preparation of Map for Existing Land Cover for the Study Area

There are two available data sources for the existing land cover condition in the study area as follows.

- Land cover data based on landsat images taken in 2003 prepared by DENR (available for the entire study area)
- Land cover data for the New NAMRIA topographic map (1:50,000) in 2008 prepared by NAMRIA and JICA (available only for the area where the NEW NAMRIA topographic map is prepared)

After the evaluation by the study team, it is found that the latter data source represents much more realistic condition, especially for built-up area. It has been thereby decided that the latter data source would be utilized as much as possible in the present study, although it does not cover the entire study area.

The existing land cover map has been prepared by combining the above two data sources. The latter data source is utilized for the main part of the study area as long as it is available, whereas the former is applied for the portion where the latter is not available. The categorization of the land cover in the two data sources are different each other. To combine the two data source into one integrated map, re-categorization has been conducted. Annex-T B.1.3.1 shows the categories applied in the present study and those relationships with the categories in the two original data sources.

The combined data have been stored as GIS data for further utilization.

B.1.3.2 Existing Land Cover Condition

Annex-F B.1.3.1 demonstrates the existing land cover condition in the study area based on the newly prepared map as described in Chapter B.1.3.1. One can see that the agricultural area widely extends in the central part of the study area. The mountain area is characterized by forest land and/or brush land. The built-up area is in general scattered. However, around San Fernando and Angels areas is a continuous built-up area. The share of each category of the land cover in the study area is summarized in the following table. It can be understood that more than 40% of the total study area is cultivated area. The most of population is concentrated to the populated area which is about 3% of the total study area.

Table B. 1.3.1 Land Cover Category in the Study Area

Land Cover Category		Area (km^2)	Percentage of the Total Area (%)
Forest		1,875.4	18.0
Brush Land		2,533.9	24.3
Cultivated Area	Paddy Field	3,972.5	38.1
	Other Cultivated Area	706.7	6.8
Populated Area	Built-up Area	268.0	2.6
	Settlement	70.1	0.7
Wetland	Swamp	57.1	0.5
	Fishpond	490.5	4.7
Water Body		149.3	1.4
Others	Others (Natural)	293.5	2.8
	Others (Artificial)	17.5	0.2
Total		10,434.4	100.0

Source: JICA Study Team

Annex-T B.1.3.2 shows the share of the land cover categories for each sub-basin.

B.1.4 Water-related Disease

The pollution of the surface water as well as the groundwater could cause a variety of contagious diseases. Those diseases could outbreak through several routes such as (a) drink of and/or contact with the polluted water, (b) infection by mosquito and other vectors, which breed in and around the water and (c) infection by parasites (such as schistosome), which inhabit in the water. From these points of view, the water-related diseases are categorized into the following four groups.

Table B. 1.4.1 Typical Cases of Water-related Disease

Cause of Disease	Typical Case of Disease
Drinking of Polluted Water	Cholera、Typhoid、Paratyphoid, Hepatitis (Type A and E), Dysentery , Diarrhea*
Contact with Polluted Water	Scabies, conjunctivitis, typhus, trachoma
Infection by Vector	Malaria, Dengue, Yellow Fever, Filariasis
Infection by Parasite	Schistosomiasis

Note: * - The diarrhea caused by drinking of the polluted water, which contains the parasite
Source: JICA Study Team

According to the statistics of the NSCB, the whole country and Region III recorded the water-related diseases as all-year average from 1995 to 2002 as shown in Table B.1.4.2. Among the diseases, the Malaria is the most prevalent in the whole country taking the disease ration of 83.6 to 100,000 in population, and Dengue Fever and Typhoid/Paratyphoid follow after Malaria. On the other hand, the highest disease ratio in Region III is from Dengue Fever (disease ratio of 18.4 to 100,000) followed by Typhoid/Paratyphoid and Malaria. A particular attention is given to Schistosomiasis, which has still rather high disease ratio in the whole country (12.5 to 100,000) but almost expelled in Region III.

It is here noted that the Diarrhea is more prevalent than Malaria and Dengue Fever in Region III as well as in the whole country. However, the Diarrhea is caused not only by drinking of the polluted water but also by other non water-related factors such as eating/drinking of too much foods, spoiled foods, and poisonous materials. Due to this background, it is virtually difficult to know the diseases

rate of the Diarrhea caused by the polluted water, and the Diarrhea is not counted as the part of the water-related disease.

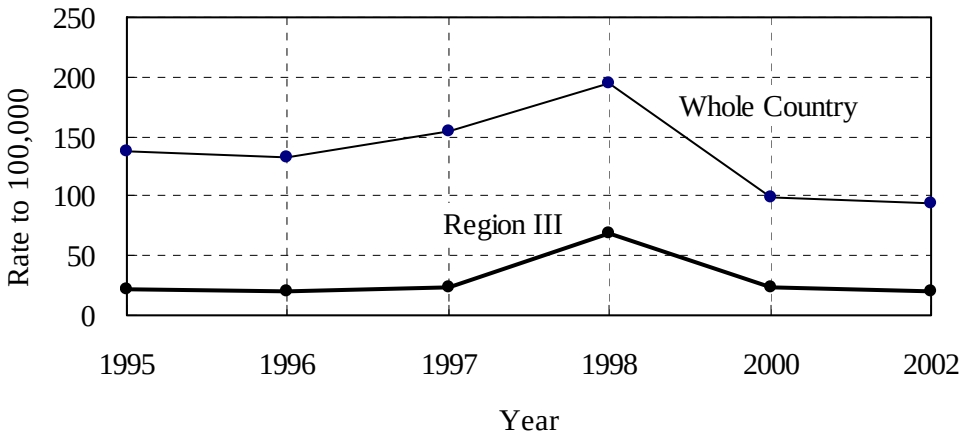
Table B. 1.4.2 Number of Water-related Disease in Philippines and Region III (Five-year Average for 1995 to 1998 and 2002)

Area	Case of Disease	Number of	Rate to Total Number of Water-Related Diseases	Rate per 100,000 Persons
Whole Country	Malaria	59,218	57.6%	83.6
	Dengue Fever	19,408	18.9%	26.3
	Typhoid/Paratyphoid Fever	14,744	14.3%	20.8
	Schistosomiasis	8,845	8.6%	12.5
	Cholera	565	0.5%	0.8
	Total	102,780	100.0%	143.9
Region III	Dengue Fever	1,346	52.6%	18.4
	Typhoid/Paratyphoid Fever	633	24.8%	9.1
	Malaria	542	21.2%	8.2
	Cholera	34	1.3%	0.5
	Schistosomiasis	2	0.1%	0.0
	Total	2,557	100.0%	36.2

Source: 2006 Compendium of Philippines Environmental Statistics, NSCB

As listed above, the disease ratios of all cases in Region III are far lower than those in the whole country. Most of the present drinking water in Region III is from the groundwater, and judging from lower disease ratio of the Typhoid/Paratyphoid Fever in the Region than the country average, the groundwater in the Region is currently controlled under the rather good hygienic conditions. Likewise, the lower disease ratio of Malaria, Dengue Fever and Schistosomiasis in the Region reveals that the surface water has not been seriously deteriorated.

The temporal variation of the annual total number of water-related diseases is as shown in Figure B.1.4.1. The ratio reached to the peak in 1998 and then tends to reduce year by year in the whole country as well as Region III. The ratios in 1998 were about 195 to 100,000 in population in the whole country and 69 to 100,000 in Region III, while they reduced to 94 to 100,000 and 21 to 100,000, respectively in 2002. Thus, the water-related hygiene is likely to be improved in Region III as well as in the whole country.



Source: 2006 Compendium of Philippines Environmental Statistics, NSCB

Figure B. 1.4.1 Temporal Variation of Annual Water-related Disease Ratio

B.1.5 Indigenous Peoples

In the Study Area, there are 133,312 Indigenous Peoples (IPs) which is composed of five groups of tribes, as summarized below. Aeta tribe accounts for 34.2% of the total population of IPs in the Study Area, followed by group of Ibaloi, Kalanguya and Kankanaey tribes.

Table B. 1.5.1 Population of Indigenous Peoples distributed in and around the Study Area as of 2006

(unit: person)

Province / Tribe	Aurora		Bulacan		Nueva Ecija		Pampanga		Tarlac		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Aeta	112	0.8%	0	0.0%	1,032	1.9%	18,920	100.0%	25,503	66.2%	45,567	34.2%
Abelling	0	0.0%	0	0.0%	0	0.0%	0	0.0%	13,032	33.8%	13,032	9.8%
Dumagat/Remontado	5,049	34.4%	6,861	100.0%	10,701	19.7%	0	0.0%	0	0.0%	22,611	17.0%
Ibaoloi/Kalanguya/Kankanaey	0	0.0%	0	0.0%	42,585	78.4%	0	0.0%	0	0.0%	42,585	31.9%
Ilongot/Bugkalot	9,517	64.8%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	9,517	7.1%
Total	14,678	100.0%	6,861	100.0%	54,318	100.0%	18,920	100.0%	38,535	100.0%	133,312	100.0%

Note:

Relevant municipalities in Aurora Province:	Baler, Casiguran, Dilasag, Dinalungan, Dinagalan, Dipaculao, Maria Aurora, San Luis
Relevant municipalities in Bulacan Province:	Dona Remedios de Trinidad, Norzarway and San Jose Del Monte
Relevant municipalities in Nueva Ecija Province:	Carranglan, Lupao, Pantabangan, Rizal, San Jose City, Science City of Muños, Bongabon, Cabanatuan City, Gabaldon, Laur, Licab, Palayan City, Gen.Tino
Relevant municipalities in Pampanga Province:	Angeles, Floridablanca, Mabalacat, Polac, City of San Fernando
Relevant municipalities in Tarlac Province:	Bamban, Camiling, Capas, Mayantoc, San Clemente, San Jose, Tarac City

Source: NCIP Regional Office III

The Republic Act No.8371, known as the Indigenous Peoples Rights Act prescribes the fundamental rights of the indigenous peoples in the country and describes that the ownership and possession of IPs to their ancestral domains shall be recognized and protected. Also, the act institutionalized the National Commission of Indigenous People (NCIP), which is responsible for formulation and implementation of policies as well as issuance of Certification of Ancestral Domain/Land Titles (CADT/CALT). CADT refers to a title recognizing the rights of possession and ownership of IPs over the identified area, while CALT refers to a title recognizing to the right of utilization of the identified lands by the members of IPs. There are four (4) CADT/CALTs in and around the study area as shown in Table B.1.5.2 and Annex-F B.1.5.1.

Table B. 1.5.2 Status of AD/AL (Ancestral Land) Delineation and Titling in and around the Study Area as of March 9, 2010

Location	Claimant Tribe	Area(ha)
A. CADTs/CALTs		
A1. Sitio of Karahume, Barangay of San Isidro, Municipality of San Jose del Monte, Province of Bulacanl	Dumagat	1,817.15
A2. Sitios Maugat, Kambubuyugan, Alulod/Calumpit and Tubigan, portion of Barangay Kalawakan, Municipality of DRT, Bulacan	Dumagat	19,537.68
A3. Barangays of Capintalan, Minuli, Salazar and Putlan, Municipality of Carranglan, Province of Nueva Ecija	Kalanguya	25,373.10
A4. Barrangays of Nabuklod and Mawakat, Municipality of Floridablanca, Province of Pampanga; portion of Municipality of San Marcelino and Portion of Barrangay Batiawan, Municipality of Subic, all in the Province of Zambales	Aeta	5,457.71
A5. Barangay Camias, Diaz, Inararo, Villamaria, Sapang Uwak, Porac, Pampanga and portion of So. Target, Sapang Bato, Angeles City	Aeta	18,659.73
A6. Barangays of San Nicolas, San Vicente, Anupul (portion) and Calumpangm, Municipality of Bamban, Province of Tarlac; portion of Barangay Marcos Village, Municipality of Mabalacat, Province of Pampanga	Aeta	10,323.308
A7. Barangays Belbel, Burgos, Moraza and Villar, Municipality of Botolan, Zambales	Aeta	20,657.89
A8. Barangays Atbu, Bacneng, Balete, Baliling, Bantinan, Baracbac, Canabuan, Imugan, Malico, Poblacion, Sta. Rosa, Sinapaoan, Tarlac, Villaflores and Unib, Municipality of Sta. Fe; Barangays Anayo, Balete, Calitlitan (portion), Canabuan, Canarem, Ocao-Capiniaan and Yaway, Municipality of Aritao; Sitio Kamaring, Barangay Cabalatan-Alang, Muncipality of Kayapa; all in the Province of Nueva Vizcaya	Kalanguya-Ikalahan	30,758.58
A9. Barangays Umiray, Lumutan, Canaway, Sablang, Magsikap, Pagsanghan, Maligaya, San Marcelino and portions of Catablingan, Minahan Norte, Mahabang Lalim, and Minahan Sur, all in the Municipality of General Nakar, Province of Quezon and portion of Brgy. Umiray, Municipality of Dingalan, Province of Aurora; portion of Municipality of Montalban, Province of Rizal; and portions of Municipalities of San Jose del Monte, Norzagaray and San Rafael, all in the Province of Bulacan	Dumagat	144,880.70
Sub-Total		277,465.85
B. ADs/ALs with the survey* completed		
B1. Sitio Mapidya, Rio Chico, Gen. Tino, Nueva Ecija	Dumagat	13,883.20
Sub-Total		13,883.20
C. ADs/ALs with the on-going survey		
C1. Sos. Baguingan, Kawayan, Flora, Yanca, Bilad, Maragulo, and Tarucan, Capas, Tarlac	Aeta	13,723.00
C2. Alfonso Castañeda & Dupax Sur, Nueva Vizcaya	Bugkalot	52,995.0
Sub-Total		66,718.00
D. Areas undergoing social preparation		
D1. Barangay Kabayunan, DRT, Bulacan	Dumagat	60,000.00
D2. Sitio Mabaldog, Barangay Ligaya, Gabaldon, Nueva Ecija	Dumagat	7,283.00
Sub-Total		67,283.00
Total		425,350.05

Note*: NCIP is in charge of implementation of the profile survey for the area.
Source: NCIP

B.1.6 Historical and Religious Sites

In the study area, there is no archeological and/or historical sites designated as World Heritage-listed area by UNESCO. However, there exist other significant historical sites and landmarks in the study area as summarized below (refer to Annex-F B.1.6.1).

Table B. 1.6.1 Historical sites and landmarks in the Study Area

Province	Municipality/City	Historical Site/Landmark
Bulacan	Malolos	Barasoain Church
	Baliuag	Baliuag Church
	Paombong	Paombong Church
	Plaridel	Quingua Church
	San Rafael	San Rafael Church
	Calumpit	St.John the Baptist Church
	Sub-total	6 sites
Nueva Ecija	Carranglan	Dalton Pass
	Cabanatuan	McArthur Statue
	Cabanatuan	Pangatian Shrine
	Guimba	Triala House
	Penaranda	Church of Peneranda
	Gapan	Tabacalero of San Isidro
	Sub-total	6 sites
Pampanga	Angeles city	Church of Sto Rosario
	Bacolor	Church of Bacolor
	San Fernando	Church of San Fernando
	Mabalacal	Marcos Village
	Sub-total	4 sites
Tarlac	Capas	Capas National Shrine
	Capas	Death March Monument
	Tarlac	Tarlac Cathedral
	Sub-total	3 sites
Total		19 sites

Source: Manila Bay Area Environmental Atlas, PAWB- DENR,2007

B.2 Socio-Economic Framework

The following socio-economic framework is adopted as the base for formulation of the IWRM Plan.

B.2.1 Projected Population in the Study Area

The population projection is on the basis of the following principles in the present IWRM plan.

- The population projection in the study area is based on the NSO 40years population projection, five calendar year interval, medium series, by province from year 2000 up to 2040.
- The ratio of urban and rural population is assumed to be unchanged in future.

Since about 99% of the whole extent of the study area belongs to the four provinces of Bulacan, Nueva Ecija, Pampanga and Tarlac, the population projection for the study area is made based on the census for the said provinces. The specific population growth rates for the four provinces are assumed based on the projection by National Statistic Coordination Board (NSCB) as listed below:

Table B. 2.1.1 Projected Population Growth Rates for the Study Area

Province	2006-2010	2011-2015	2016-2020	2021-2025
Bulacan	2.70%	2.41%	2.18%	1.94%
Nueva Ecija	1.62%	1.50%	1.31%	1.10%
Pampanga	1.81%	1.62%	1.42%	1.23%
Tarlac	1.70%	1.55%	1.35%	1.16%
The Study Area	**2.06%**	**1.86%**	**1.66%**	**1.46%**

Source: NSCB

Since about 99% of the whole extent of the study area belongs to the four provinces of Bulacan, Nueva Ecija, Pampanga and Tarlac, the population projection for the study area is made based on the census for the said provinces. The specific population growth rates for the four provinces are assumed based on the projection by National Statistic Coordination Board (NSCB) as listed below:

Table B.2.1.2 summarizes the projected population within the study area and Annex-T B.2.1.1 shows the population projection by cities/municipalities in the study area.

Table D. 2.1.1 Projected Population within the Study Area

Province	Urban:Rural ratio	2008	2015	2020	2025
Bulacan	70:30	1,334,500	1,585,932	1,766,134	1,944,546
Nueva Ecija	50:50	1,761,894	1,960,159	2,092,188	2,210,272
Pampanga	68:32	2,219,624	2,493,194	2,675,248	2,843,509
Tarlac	44:56	480,708	536,813	573,956	607,911
Total		5,796,726	6,576,098	7,107,526	7,606,238

Note: Inside the study area only
Source: JICA Study Team

B.2.2 Projected Gross Regional Domestic Product (GRDP)

The projected growth of GRDP is estimated from the past annual average growth rate of Gross Value Added (GVA) in the industrial sectors recorded for Region III. Region III increased the GVA from 1995 to 2007 as listed below:

Table B. 2.2.1 Annual Average Growth Rate of Gross Value Added in Region III from 1995 to 2007

Sector	Gross Value Added (in million pesos)			Annual Ave. Growth Rate of GVA (1995-2007)	Annual Ave. Growth Rate of GVA (2003-2007)
	In 1995	In 2003	In 2007		
Agriculture, Fishery & Forest	38,532	64,012	93,539	7.7%	8.2%
Industry	59,398	127,901	175,857	9.5%	9.0%
Service	62,009	155,377	231,959	11.6%	10.2%
Total	159,939	347,426	501,356	10.0%	9.4%

Source: NSCB

In the present IWRM plan, it is assumed that GRDP would continuously increase toward 2025 with annual average growth rate of GVA in 2003-2007.

B.2.3 Price Level of the Project Cost

The project cost discussed in this project formulation is converted to the price level as of 2009 with using the following "Wholesale Price Index (WPI) for Construction Material". The following table summarizes the average annual increasing rate of WPI against previous year.

Table B. 2.3.1 Average Annual Increasing Rate of Wholesale Price Index against Previous Year

Year in Interval	1960 – 1969	1970 – 1979	1980 – 1989	1990 – 1999	2000 – 2008	1960 – 2009
WPI- Construction Materials	5.58%	5.65%	5.68%	5.52%	7.39%	5.97%

Source: JICA Study Team

Annex-T B.2.3.1 shows the conversion factor of price indices.

B.3 Budgetary Expenditures and Financial Status of Water-Related Agencies and LGUs

B.3.1 National Budget and Its Allocation to Water-related Infrastructure Development

The national budget in Philippines has increase from 0.948 trillion pesos in 2005 to 1.426 trillion pesos in 2009 by annual average incremental rate of about 11% as listed below.

Table B. 3.1.1 Summary of National Government Budget

(Unit: Billion Pesos)

Year	Allocated to Departments and Agencies	Allocated as Special Purpose Funds	Total
2005	442	506	948
2006	401	652	1,053
2007	458	669	1,126
2008	722	592	1,315
2009	710	716	1,426

Of the above national budget, 15 to 20 billion pesos (about 1.0 to 1.4% of the national budget) are allotted to the infrastructure development of the water source/distribution for irrigation implemented by NIA and the flood mitigation by DPWH as listed in Table B.3.1.2.

Table B. 3.1.2 National Budget Allocated to the Projects for Water-related Infrastructure Development

(Unit: Billion Pesos)

Year	Description	Water Use*	Flood Mitigation**	Total
2007	(1) Whole Nation	7.31	7.93	15.25
	(2) Study Area	1.52	0.27	1.79
	(3) Share {(2)/(1)}	20.80%	3.30%	11.70%
2008	(1) Whole Nation	8.04	6.73	13.67
	(2) Study Area	2.08	0.56	2.64
	(3) Share {(2)/(1)}	25.90%	8.30%	19.30%
2009	(1) Whole Nation	12.55	6.93	19.48
	(2) Study Area	0.36	1.54	1.9
	(3) Share {(2)/(1)}	2.90%	22.30%	9.80%

Note: *: The budget allocated to the project for NIA under the "Agriculture and Fisheries Modernization Program" in "Special Purpose Funds"

**: The budget allocated to the project for DPWH under "Department Fund"

Source: Budget Expenditures/Sources by Department of Budget and Management

B.3.2 Financial Status of NWRB

NWRB includes revenue from 10 sources in total. Following table shows a summary of revenues from water extraction charges (From Annual Water Charges) and others for past several years.

Table B. 3.2.1 Charges of Revenue Due to Water Charges in NWRB

(1,000 Pesos)

Revenue Sources	2000	2001	2002	2003	2004	2005	2006	2007	2008
From Annual Water Charges	4,027	4,472	6,681	4,065	5,747	10,021	10,868	29,909	40,505
From Others	9,075	10,421	12,241	11,068	14,157	22,214	16,673	20,768	22,644
Total	13,102	14,893	18,922	15,133	19,904	32,235	27,541	50,677	63,149
Share Rate of Water Charges to the Total Revenue (%)	30.74%	30.03%	35.31%	26.86%	28.87%	31.09%	39.46%	59.02%	64.14%

Source: NWRB.

As shown in the above table, the revenue due to water charges has been increased from 31 % in 2000 to 64 % in 2008 against the total amount of revenue. Nevertheless, the collection efficiency is still far from 100 % according to officials of NWRB. In case of increase of revenue due to collection efficiency, further painstaking water administration could be expected by using such funds.

NWRB is a national institution, so that the water charges indicated in the above table become a part of national revenue. It means that even the amount of income due to collection of the water charges indicated in the above table, the budget allotted for NWRB is not link with the income from collected water charges. The financial status of NWRB has been following changes showing in a table hereunder.

Table B. 3.2.2 Financial Status of NWRB

(Unit: 1,000 Peso)

Particular	2004			2005			2006			2007			2008		
	Allotment	Obligations incurred	Unobligated Balance	Allotment	Obligations incurred	Unobligated Balance	Allotment	Obligations incurred	Unobligated Balance	Allotment	Obligations incurred	Unobligated Balance	Allotment	Obligations incurred	Unobligated Balance
Personal Services (Salaries/ Wages)	25,208	25,032	175	25,776	25,760	16	27,113	27,107	6	28,585	28,018	567	29,337	28,478	859
Salaries for Permanent Staffs	17,895	17,895	0	17,641	17,641	0	17,239	17,239	0	18,429	18,367	63	19,519	19,008	511
Salaries/Wages for Casual/Contracted Staffs	108	108	0	96	96	0	115	115	0	0	0	0	0	0	0
Other Compensation/ Benefits/ Fixed Expenses	7,205	7,030	175	8,039	8,023	16	9,760	9,754	6	10,155	9,652	504	9,818	9,470	348
Expenses for Maintenance and Operating	3,046	3,032	14	10,476	6,922	3,553	5,866	5,467	399	10,735	7,874	2,861	10,691	7,528	3,163
Travelling Expenses	195	194	1	835	345	491	243	216	28	2,072	1,028	1,044	1,066	800	266
Training & Seminar Expenses	2	2	0	959	9	950	18	0	18	344	29	315	12	5	8
Supplies & Materials	246	239	7	617	313	304	300	231	69	806	499	307	410	380	30
Gasoline, Oil & Lubricants	252	252	0	277	230	47	170	137	33	416	274	142	472	402	70
Utilities Expenses	732	732	0	1,664	1,664	0	980	960	20	1,272	1,272	0	1,697	1,697	0
Communication Expenses	368	368	0	1,021	875	146	495	421	74	830	770	60	795	785	10
Advertising Expenses	0	0	0	1,091	0	1,091	10	0	10	243	0	243	40	0	40
Printing & Binding Expenses	31	31	0	315	78	237	85	61	24	87	38	49	95	85	10
Rent Expenses	41	41	0	76	52	24	56	24	33	185	185	0	294	94	200
Re-presentation Expenses	120	114	6	103	103	0	146	133	13	183	124	59	188	158	30
Transportation & Delivery	0	0	0	0	0	0	1	1	0	0	0	0	13	13	0
Subscription Expenses	17	17	0	31	27	4	18	6	13	9	9	0	18	18	0
Professional Services	577	577	0	1,194	1,194	0	2,886	2,869	17	3,386	2,992	394	4,867	2,367	2,500
Repair and Maintenance	172	172	0	141	91	49	224	195	28	555	353	202	423	423	0
Rewards & Other Claims	130	130	0	1,665	1,665	0	0	0	0	0	0	0	0	0	0
Extraordinary & Miscellaneous Expenses	80	80	0	80	52	28	80	80	0	80	78	2	110	110	0
Taxes, Insurance Premiums & Other Fees	83	83	0	406	223	183	153	133	21	268	223	45	191	191	0
Total Current Operating Expenses	28,254	28,064	190	36,252	32,682	3,570	32,979	32,574	405	39,320	35,893	3,427	40,028	36,006	4,022
Continuing Appropriations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maintenance & Other Operating Expenses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Capital Outlay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total	28,254	28,064	190	36,252	32,682	3,570	32,979	32,574	405	39,320	35,893	3,427	40,028	36,006	4,022

Source: NWRB.

B.3.3 Financial Status of NIA

NISs are national irrigation systems of the Philippines' National Government. Therefore, their financial sources are consisting of the national budget and a part of ISFs collected by NISs themselves. Following table shows a financial status of NIA in the Central Luzon during last several years as a reference. As indicated in the table, NIA Region III have been reckoning deficits during last 5 years. The part of deficits has been filled by budget of the National Government.

Table B. 3.3.1 Financial Status of NIA for Region III (Central Luzon)

(Pesos)

Particulars	2004	2005	2006	2007	2008
RVENUE					
Operating Income	51,496,584	51,414,484	51,318,482	58,491,497	64,164,032
Irrigation Service Fees	45,775,519	49,988,331	52,104,223	54,870,325	60.702.178
Less: 10 % Discount on ISF	1,923,677	2,644,781	3,056,517	3,379,088	3,824,817
Loss on Sales of Palay	0	0	0	0	0
Net Irrigation Service Fees	43,851,842	47,343,550	49,047,706	51,491,237	56,877,361
Income from Rent	7,412,077	4,068,741	1,732,696	5,398,540	6,190,432
Fines and Penalties - Service Income	0	0	529,371	907,630	1,096,239
Interest	232,665	2,193	8,709	694,090	0
Non-Operating Income	21,796,467	25,996,251	16,197,640	19,366,137	20,436,326
Management Fees	0	0	0	0	0
CIP/CIS/RIS Amortization & Equity	7,861,616	5,107,987	2,955,514	2,717,010	6,871,349
Pump Amortization & Equity	1,647,521	6,972,819	3,287,023	5,027,398	3,073,419
Subsidy Income from National Government	0	0	0	0	0
Income from Grants and Donations	0	0	0	0	0
Miscellaneous Income	12,287,330	13,915,445	9,955,103	11,621,729	10,491,558
Other Fines &b Penalties	0	0	0	0	0
Total Revenues	73,293,051	77,410,735	67,516,122	77,857,634	84,600,358
EXPENSE					
Personal Services (Salaries & Wages)	85,496,414	94,129,752	95,511,124	99,101,969	103,300,458
Expenses by Item	22,427,705	26,087,185	25,788,411	19,502,298	22,907,929
Travelling Expenses - Local	654,918	648,601	1,467,629	942,751	1,844,427
Training Expenses	196,038	188,139	174,497	135,214	171,515
Office Supplies Expenses	1,953,005	2,058,008	1,121,274	1,088,191	557,755
Food Supplies Expenses	0	0	4,880	54,500	0
Medical, Dental & Lab Supplies Expenses	0	0	0	1,555,848	0
Gasoline, Oil and Lubricants Expenses	4,005,006	2,660,335	3,477,826	10,705	1,208,970
Other Supplies Expenses	0	0	0	0	1,167,949
Water Expenses	0	0	62,173	35,424	174,111
Electricity Expenses	8,961,131	12,392,380	10,469,040	9,506,755	11,945,555
Postage & Deliveries	0	0	10,989	0	660
Telephone Expenses - Landlines	333,337	371,565	232,334	349,947	367,603
Telephone Expenses - Mobile	0	0	36,358	22,221	71,825
Cable, Satelite, Telegraph & Radio Expenses	0	0	1,479	3,520	8,094
Membership Dues & Contribution to Organizations	1,665	3,632	1,000	0	9,600
Advertising Expenses	0	0	0	0	5,000
Printing & Binding Expenses	43,785	20,653	62,681	13,130	8.255
Rent Expenses	17,250	16,850	700	0	6,600
Representation Expenses	482,517	561,856	454,460	245,361	119,898
Transportation & Delivery Expenses	243,213	329,047	14.579	8,210	0
Subscriptions Expenses	0	2,000	840	440	0
Rewards & Other Claims	238,313	1,459,955	0	0	5,816
Legal Services	0	0	50	400	1,802
Auditing Services	485,752	403,155	323,042	370,366	354,778
General Services	0	0	800	150	22,886
Janitorial Expenses	0	0	0	0	1,200
Repair & Maintenance - Other Structures	0	0	160,777	0	0
Repair & Maintenance - Office Equipment	19,500	459,679	51,512	121,000	2,430
Repair & Maintenance - Furniture & Fixture	77,414	0	9,296	0	0
Repair & Maintenance - IT Equipment & Software	0	0	0	1,900	0
Repair & Maintenance - Construction & Heavy Equipment	0	0	0	0	126,467
Repair & Maintenance - Other Machinery & Equipment	0	0	0	0	11,770
Repair & Maintenance - Motor Vehicles	1,269,000	520,723	1,595,177	1,284,856	41,688
Repair & Maintenance - Other Transportation Equipment	0	0	194,011	161,537	207,367
Repair & Maintenance - Property, Plant & Equipment	0	0	0	42,700	260,967
Repair & Maintenance - Pumping Stations & Conduits	0	0	0	0	202,586
Repair & Maintenance - Irrigation, Canals & Laterals	0	0	287,458	67,816	1,736
Donations	0	0	0	0	2,037
Extraordinary Expenses	12,160	0	9,365	10,609	0
Miscellaneous Expenses	33,275	128,205	155,401	27,228	153,082
Taxes, Duties & Licenses	0	10,536	11,506	11,959	16.674
Fidelity Bod Premiums	47,118	82,598	64,575	38,625	33,375
Insurance Expenses	518,081	408,741	157,480	273,577	185,006
Collection & Viability Bonus	244,842	41,062	1,023,735	0	1,102.133
Collection Expenses	659,751	578,155	914,850	580,884	83,628
Irrigator's Share	1,020,341	2,352,348	1,015,262	887,366	1,676,513
Other Maintenance & Operating Expenses	906,585	388,435	2,219,775	1,649,108	743,861
Bank Charges	1,208	527	1,600	0	2,310
Interest Expenses	2,500	0	0	0	0
Total Expenses	107,924,119	120,216,937	121,299,535	118,604,267	126,208,387
Net Operation Income/Loss	-34,631,068	-42,806,202	-53,783,413	-40,746,633	-41,608,029
Add or Deduct Other Income/Expnses	1,529,431	477,955	0	0	0
Gain or Loss on Foreign Exchange	0	0	0	0	0
Gain or Loss on Sales of of Disposed Assets	1,529,431	477,955	0	0	0
Net Income or Loss before Non-Cash Expenses	-33,101,637	-42,328,247	-53,783,413	-40,746,633	-41,608,029
Non-Cash Expenses	682,943	575,589	4,402,527	0	5,194,713
Bad Debts	107.354	0	39.276	0	805.434
Depreciation	575,589	575,589	4,363,251	0	4,389,279
Net Income or Net Loss	-33,784,580	-42,903,836	-58,185,940	-40,746,633	-46,802,742

Source: NIA.

B.3.4 Financial Status of LWUA

Following tables show a summary of balance sheets, statement of profit and loss, and statement of cash flow for LWUA for the last 2 years.

Table B. 3.4.1 Balance Sheet of LWUA for Last 2 Years

(Peso)

Assets	2007	2008	Liabilities and Equity	2007	2008
Current Assets	2,331,292,548	3,450,672,623	Current Liabilities	1,673,429,772	1,831,231,148
Cash and Cash Equivalent	761,743,673	1,650,526,074	Accounts Payable	573,094,579	100,873,222
Accounts Receivable, net	1,102,822,326	1,047,469,523	Payables to Government Agencies	217,983,000	587,497,052
Receivables from Government Agencies	327,295,322	599,834,371	Other Current Liablities	882,352,193	1,142,860,874
Other Receivables, net	28,619,195	44,224,021	Non-Current Liabilities	9,981,442,593	9,376,265,010
Supplies Inventories	1,450,773	3,092,915	Long-Term Liabilities, net	9,727,886,471	8,966,427,807
Prepaid Expenses	1,033,992	361,809	Deferred Credits	253,556,122	409,837,203
Other Current Assets	108,327,267	105,163,910	Total Liabilities	11,654,872,365	11,207,496,158
Non-Current Assets	14,656,062,515	13,324,732,535	Equity	5,332,482,698	5,567,909,000
Long-Term Receivables, net	14,088,700,866	12,610,641,898			
Long-Term Investments	364,635,362	396,890,811			
Properties and Equipments, net	138,639,944	145,915,695			
Other Non-Current Assets	64,086,343	171,284,131			
Total of Assets	16,987,355,063	16,775,405,158	Total Liabilities and Equity	16,987,355,063	16,775,405,158

Source: LWUA.

Table B. 3.4.2 Statement of Profit and Loss of LWUA for Last 2 Years

(Pesos)

Particulars	2007	2008
Income	1,883,924,698	1,968,065,671
Interest Income	1,727,371,815	1,841,348,135
Service Income	40,643,860	30,673,902
Fines and Penalties	26,460,528	48,428,130
Misscellaneous Income	89,448,495	47,615,504
Operating Expenses	-1,198,942,796	-1,010,645,237
Financial Expenses	-509,944,274	-399,293,309
Net Income from Operations	175,037,628	558,127,125
Other Income	5,325,032	3,432,431
Seminar Fees	4,916,480	3,215,223
Gain on Disposal of Assets	385,452	195,358
Dividend Income	23,100	21,850
Net Profit before Tax Payment	180,362,660	561,559,556
Income Tax Payment	-56,930,389	-193,144,658
Current Tax	-228,523,307	-299,351,777
Dieferred Tax	171,592,918	106,207,119
Net Profit after Tax	123,432,271	368,414,898

Source: LWUA.

Table B. 3.4.3 Statement of Cash Flow of LWUA for Last 2 Years

(Pesos)

Particulars	2007	2008
Cash Flows from Operating Activities	505,142,057	190,219,989
Interest Collected from the Loans to Accounts of WDs/RWSAs	1,267,471,339	1,267,680,479
Principal Collected from the Loans and Accounts of Receivable	350,301,482	387,071,724
Other Collections	5,649,048	139,001,939
Cash Received for Engineering Services Rendered	16,043,164	57,312,092
Interest Collected from Bank Deposits and Short-Term Investments	32,283,597	18,280,037
Payment of Income Taxes	-127,563,995	-478,241,113
Interest and Other Debt Service Charges	-459,325,330	-519,988,036
Cash Paid to Suppliers and Employees	-579,717,248	-680,897,133
Cash Flows from Investment Activities	-619,278,167	-681,702,356
Proceeds from Withdrawal of Investment in Securities	39,133,282	34,588,389
Acquisition of Property and Equipment	-1,045,109	-17,050,384
Loans to Officers and Employees	-33,574,203	-42,511,054
Investments in Agrarian Reform Bonds	-73,078,374	-70,427,777
Disbursement for Projects	-550,713,763	-586,301,530
Cash Flows from Financing Activities	-96,841,266	1,375,035,276
Proceeds from Water Districts' Long-Term Loans	80,834,211	2,308,157,707
Proceeds from Local Borrowings/ Water Districts' Deposits	342,400,000	39,005,145
Proceeds from Government Subsidies	300,000,000	10,400,000
Proceeds from Long-Term Debt	61,463,541	2,995,456
Dividends Paid to the National Government/ Bureau of Treasury	-50,000,000	-187,600,000
Principal Payment of Loans from Foreign and Domestic Lending Institutions	-831,539,018	-797,923,032
Effects of Exchange Rate Changes on Cash and Cash Equivalents	-6,503,247	5,229,492
Net Increase (Decrease) in Cash and Cash Equivalent	-217,480,623	888,782,401
Cash and Cash Equivalent at the Beginning of the Year	979,224,296	761,743,673
Cash and Cash Equivalent at the End of the Year	761,743,673	1,650,526,074

Source: LWUA.

Among the principal 2 financial documents, the balance sheet and the statement of profit and loss express the all the tangible and intangible assets and liabilities, so that the financial status of business institution (in this case, LWUA) can be properly reported. However, incoming and outgoing of cash cannot be made clear by these documents. Accordingly, the statement of cash flow is the most important document for making clear incoming and outgoing of cashes. In some meaning, it may be said that the balance sheet and the statement of profit and loss are classified more super ordinate in rank than the statement of cash flow.

B.3.4.1 Cash Flow

The statement of cash flow consists of 3 parts. Namely, they are “Cash Flow from Operating Activities”, “Cash Flow from Investment Activities”, and “Cash Flow from Financial Activities”. And, in regular sequence from the last one, the documents express “how to collect funds” in the Cash Flow from Financial Activities, “what the collected funds invest to” in Cash Flow from Investment Activities, and “how to get gains” in the Cash Flow from Operating Activities. From this viewpoint, it may say that the statement of cash flow is systematic documents for expressing the fund management. The main purpose of this clause is to make to clear a financing or fund collection capability of LWUA for execution of the proposed water supply projects, so that actual status of finance of LWUA is to be made clear in line with the Statement of Cash flow of LWUA above.

Firstly, refer to the column of Cash Flow from Financial Activities in the Table B.3.4.3. The first item is named as “Proceeds from Water Districts' Long-Term Loans”. This item includes long term borrowings (usually over 5 years up to 40 years) from the domestic financing sources to lend funds to WDs.

The second item named as “Proceeds from Local Borrowings/ Water Districts' Deposits” means incomings as short term borrowings from also domestic financing sources being needed to pay back in short terms within 5 years. In the Philippines, there are investors so called as Water Development Financiers (WDFs), so the borrowings from the WDFs may be included too. LWUA has also

permitted to borrow from WDFs by the Law. The term “Water Districts' Deposits” is included in this item, but it is not clear that LWUA make WDs deposit or not only by this document.

The third item named “Proceeds from Government Subsidies” is the item for recording the formal national budget allocation from DOH as a fund for financing to WDs as mentioned at the start of this clause. Recorded amount in 2007 was 300 million Pesos, and that in 2008 was a quite small amount as 10.4 million Pesos. The year 2008 is a time that super institution of LWUA was shifted to DOH, so that it may be a relation with the amount of the said allocation in 2008. According to information from officials of LWUA, the amount of 1,500 million Pesos of national allocation has been realized in 2009. The national budget may be allocated in any amount when needed and within limitation of national budgetary status.

The fifth item named “Proceeds from Long-Term Debt” includes long-term borrowings other than the financial sources as mentioned above. It must include the loan amount from the international financing institution as a matter of course.

Remarkably, LWUA pay out dividend from their profit to the National Government as indicated in sixth item named as “Dividends Paid to the National Government/ Bureau of Treasury”. The term “dividend” usually means a stock-share, but in this case, LWUA pay out a part of their profit to the Bureau of Treasury.

Final item named as “Principal Payment of Loans from Foreign and Domestic Lending Institutions” means a repayment of principals of several loans from the financing sources in and out of the Philippines.

As the case may be, results of the Cash Flow from Financial Activities may become negative in some times or positive in other times. As a whole of the statement of cash flow, it must be positive, but it depends on the status of the Cash Flow from Operating Activities and Cash Flow from Investment Activities.

Next, the Cash Flow from Investment Activities is to be checked. The first item is an income one named as “Proceeds from Withdrawal of Investment in Securities”. Because of the Cash Flow from Investment Activities, all the items are to be items of outgoings. But, only the said first item only is that of incomings. It may be a kind of Security Bond gotten from contractors for some projects. This is common practice in case of execution of the construction works.

All other items are those for outgoings. The item of “Acquisition of Property and Equipment” is a payment for procurement of equipment and materials including land. The item of “Loans to Officers and Employees Loans to Officers and Employees” is an amount of credits to their staffs and other employees. The item of “Investments in Agrarian Reform Bonds” is for the cost for land reform bonds. And the final item of “Disbursement for Projects” is for disbursement of the projects on expansion, and improvement of water supply systems as the original purpose of LWUA’s business. It may include a cost for development of new water supply systems in certain years. Accordingly, the amount is the highest comparing with others.

Finally, the Cash Flow from Operating Activities is to be checked. As a matter of course, the item of incomings of “Interest Collected from the Loans to Accounts of WDs/RWSAs” means of income of interest loans rendered to WDs being needless to say. In the title of item, the term of “RWSAs” is included in addition to “WDs”. It means that Rural Waterworks and Sanitation Associations (RWSAs) also exist under manages and controls of LWUA, and LWUA also renders loans to RWSAs. So that, some interests of loan amounts for RWSAs may be included too. In this connection, RWSAs’ businesses are improvement of water supply environment and improvement of sanitation situation (toilet and so on).

The second item of incomings of “Principal Collected from the Loans and Accounts of Receivable” is for repayment amount of principals of loans rendered to WDs of course. If the amount of this item is compared with the amount of interest in the first item, incomings of the amount of interests are far greater than that of principals. It is in the nature of the case. As discussed above, the interest rates of the second step loan from LWUA to WDs are generally far greater than those of original loans. For reference, in case of interest rate of 10% per annum, the amount to be paid back becomes 2.6

times including principal after 10 years in case of the compound interest method. Only the amount of interest is to be 1.6 times against principal. Of course, the amount of interest as indicated in the table above must include the amount of interest for the original loans.

The third item named "Other Collections" cannot be made clear what comes from, but from some collections.

The fourth item of "Cash Received for Engineering Services Rendered" is the engineering fees that LWUA rendered to WDs.

The fifth item named as "Interest Collected from Bank Deposits and Short-Term Investments" consists of interest of bank deposits and some other interest of short-term loans. Considering from this naming of the said item, LWUA may have rendered a kind of short-term loans so called as "emergency fund" usually within 5 years of repayment period. And, LWUA may have made a sharp distinction between interest for short-term loans and that for long-term loans.

All other items from sixth item are those for outgoings. the sixth item of "Payment of Income Taxes" is for the corporation income tax of LWUA as a commercial firm, seventh item of "Interest and Other Debt Service Charges" is for interest payment consisting of those for the amount of original loans and other small scale loans, and eighth item of "Cash Paid to Suppliers and Employees" is for payment for suppliers for equipment and materials for LWUA and that for employees including temporary ones.

In the table, the fourth item from the bottom named as "Effects of Exchange Rate Changes on Cash and Cash Equivalents" is for "foreign exchange loss" or "foreign exchange profit" that must be considered because that the fund collection of LWUA includes loans from international financing institutions.

As a result according to the above, the cash balances, so called as "Cash and Cash Equivalent at the End of the Year" in 2007 was a sum of around 762 million Pesos, and that in 2008 was a sum of around 1,651 million Pesos both include the remaining amount at the beginning of the year (it means the balance at the end of previous year). In addition, this table makes clear that the cash balance in 2006 was a sum of around 979 million Pesos.

B.3.4.2 Balance Sheet

The Statement of Cash Flow links with the Balance Sheet. Namely, the said "Cash and Cash Equivalent at the End of the Year" should be transcribed to the item named as "Cash and Cash Equivalent" in "Current Assets" of the Balance Sheet.

By the way, "Capital" of the Balance Sheet consists of "Equity Capital (or Equity)" and "Earned Surplus" in general. However, LWUA's Balance Sheet, Table B.3.4.1 shows the Equity only, but the amounts of this item in 2007 and in 2008 are different. If it is only equity capital, it should be the same amount every year except in a case of a capital increase. On the other hand, there is no any record of LWUA's publicized resolution for the last several years. So that, the Earned Surplus mentioned above may be included in the item named as "Equity".

Anyhow, the portion of "Assets" expresses how to collect the funds and how much assets are remained until the end of the current year, and the other portion of "Liability and Capital" expresses what the funds are invested to or paid out to. Among them, cash and cash equivalent are expressed only in the item of "Cash and Cash Equivalent" in the category of Assets. All the other items express not only the cash movement but also receivable amounts to be received at a certain time in the future For example, the item of "Accounts Receivable, net" means just the net amounts that LWUA has a right to receive in some future. The item of fixed assets (so called as "Non-Current Assets" in LWUA's case) expresses the amount to be statically received or book values of land or other immovable properties belonging to LWUA.

Furthermore, all the 3 items of Account Payables in the column of "Current Liability" in the portion of "Liability and Capital" expresses the payable accounts that are not the amounts of actual payment but includes the amount to be paid at a certain time in the future against principals of short-term loans gotten from the domestic financing sources including interests. And 2 items of "Long-Term Liabilities, net" and "Deferred Credits" in the fixed liabilities (so called as "Non-Current Liability" in

LWUA's case) express the payment of principal to be paid against the loans gotten from the international financing institutions including also interests、but not the actual payment. In a one word, all the remaining amounts of liabilities are expressed by kinds of liabilities in the portion of "Current Liability" and "Non-Current Liability". As a manner as mentioned above, the Balance Sheet expresses a financial status at present as a business firm.

B.3.4.3 Profit and Loss

The Statement of Profit and Loss consists of 5 items of incomes as (1) Gross Income (so called as "Income" only in LWUA's case), (2) Net Income from Operations, (3) Current Income, (4) Net Profit before Tax Payment, and (5) Net Profit after Tax in general.

The "Income (Gross Income)" is the amount coming from total turnover deducted by the sales cost, the "Net Income from Operations" is the amount coming from the "Income (Gross Income)" deducted by expenses for sales and administration cost of the headquarter of LWUA, and the "Current Income" is the total amounts of "Net Income from Operations" and other non-operating incomes as interests deducted by other non-operating expenses. However, in LWUA's case, the said "Current Income" has been omitted. But, LWUA has reported the other items as "Other Income" as indicated in the table and the amounts of them are considered, so LWUA does not make a failure to make the Statement of Profit and Loss. There is no any item as "specific income" or "specific loss" to be considered in the "Net Profit before Tax Payment", so that the amounts of the "Current Income" and the "Net Profit before Tax Payment" are to be the same amounts. Therefore, the "Current Income" has been just omitted. Final item of the "Net Profit after Tax" is the total amount of the "Net Profit before Tax Payment" and the "Differed Tax" meaning of drawback coming from over-payment of tax deducted by the corporation tax for the current year. Depreciation expenses are included in the "Financial Expenses" of the Statement of Profit and Loss. This item does not express actual cash movement, but it is a typical item to be treated as an item of Expense.

The above mentioned "Net Profit after Tax" is so called as the Net Profit of LWUA at the end of the current year. In the last 2 years, there has been no any deficit, so that it makes clear that LWUA has kept a sound operation.

B.3.5 Financial Status of LGUs

B.3.5.1 Financial Status of Provinces

Financial statuses of provinces in the study area are as shown in the following table.

Table B. 3.5.1 Financial Statuses of Provinces in the Project Area for Last 5 Years

(Unit: Peso)

Province/Particular	2004	2005	2006	2007	2008
Bulacan					
Income	1,255,450,000	1,541,913,000	1,804,707,183	1,807,999,878	2,092,982,921
Total Local Sources	445,654,000	667,945,000	715,495,854	751,801,219	749,486,370
Total Shares from National Tax Collections	809,796,000	873,968,000	1,046,211,329	1,056,198,659	1,343,496,551
Loans & Borrowings	0	0	43,000,000	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	1,177,307,000	1,492,025,000	1,711,961,759	1,789,214,907	2,030,912,431
Balance	78,143,000	49,888,000	92,745,424	18,784,971	62,070,490
Nueva Ecija					
Income	757,342,000	1,013,389,000	1,123,911,998	1,050,051,017	1,040,617,122
Total Local Sources	60,243,000	305,486,000	76,492,702	144,557,909	125,695,742
Total Shares from National Tax Collections	697,099,000	697,903,000	896,199,496	905,493,108	914,921,380
Loans & Borrowings	0	0	144,019,800	0	0
Inter-Local Transfers	0	10,000,000	7,200,000	0	0
Expenditures	686,081,000	785,414,000	1,217,746,048	831,647,724	994,585,777
Balance	71,261,000	227,975,000	-93,834,050	218,403,293	46,031,345
Pampanga					
Income	721,770,069	799,614,400	934,290,003	1,102,595,353	1,127,944,299
Total Local Sources	88,213,685	118,907,377	133,053,377	187,890,259	197,754,005
Total Shares from National Tax Collections	633,556,384	680,707,023	793,139,108	911,705,094	930,190,294
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	8,097,518	3,000,000	0
Expenditures	619,824,579	652,057,818	748,639,689	687,059,641	593,686,539
Balance	101,945,490	147,556,583	185,650,314	415,535,712	534,257,761
Tarlac					
Income	568,655,699	622,500,136	702,320,811	767,705,146	1,238,195,404
Total Local Sources	96,986,447	114,431,222	146,326,517	155,910,424	168,356,163
Total Shares from National Tax Collections	471,669,252	508,068,914	555,994,294	611,794,721	709,409,750
Loans & Borrowings	0	0	0	0	360,429,491
Inter-Local Transfers	0	0	0	0	0
Expenditures	507,758,582	472,415,167	552,577,921	725,631,316	1,043,833,386
Balance	60,897,117	150,084,969	149,742,890	42,073,830	194,362,019

Source: Home page of Official Web-site of Bureau of Local Government Finance, Department of Finance.

As shown in the above table, all the provinces have kept sound finances at a glance except Nueva Ecija in 2006. However, if a careful check made for figures in the table, it must be clear that all the provinces have not kept their sound finance by their own revenue only, and they have been financially supported by the National Government. The appropriation from the National Government shares a large part of their revenues in total.

Figure B.3.5.1 shows a fluctuation of share of appropriation from the National Government in the total revenues of the provinces for last several years without loans and borrowings.

There is no any information on fail of finance of the National Government, so that it may say that the National Government can be supporting the provincial governments. Because of appropriation from the National Government, financial balances do not need to turn back to the National Government. The financial balances of the provinces are their own balances, so that those balances could be invested to projects of provinces themselves.

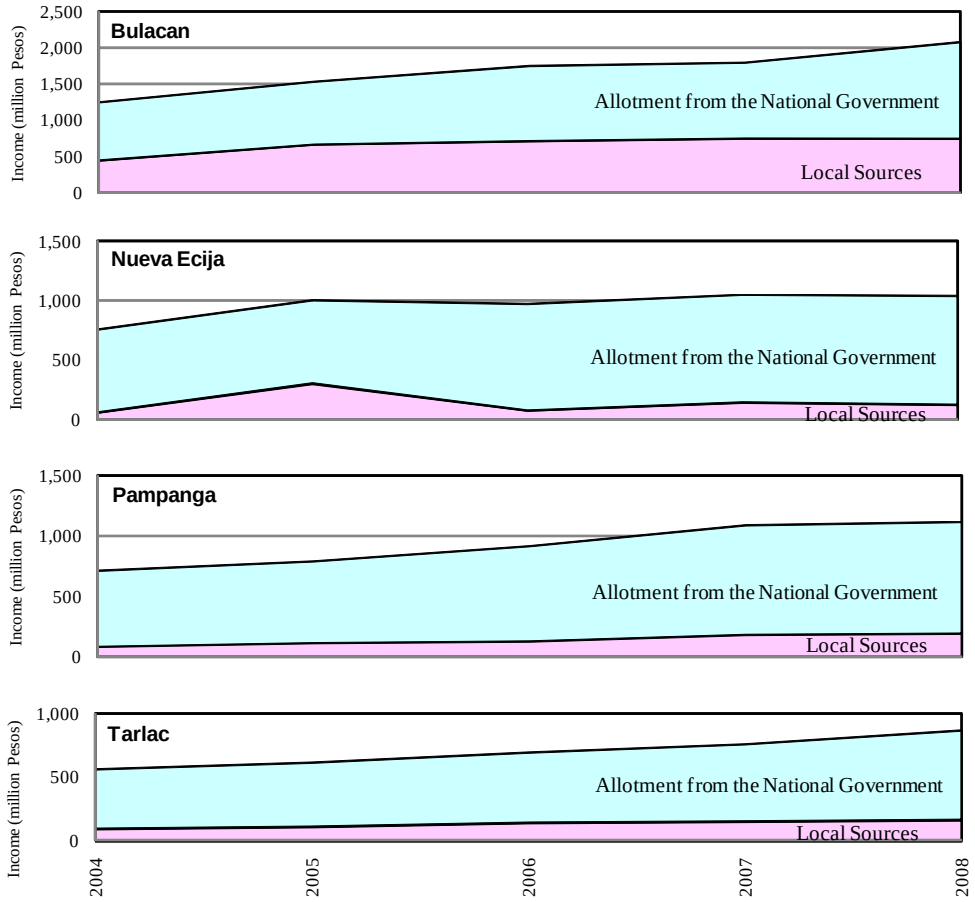


Figure B. 3.5.1 Transition of Appropriation from the National Government Sharing to Total Revenue of Targeted Provinces for Last 5 Years

B.3.5.2 Financial Status of Municipalities/Cities

Financial statuses of municipalities and cities related to the proposed projects of the Study are as shown in the following table. The figures in the table are the total amount in both the incomes and expenditures of all the municipalities and cities related to the said project.

As same as provinces, fluctuation of share of appropriation from the National Government in the total revenues of the municipalities and cities for last several years without loans and borrowings are as shown in Figure B.3.5.2.

For a reference, a summarized financial status of each municipality/city is shown in Annex-T B.3.5.1.

There are LGUs which have abundant financial cash balance much, and there are also LGUs which have not so much financial balance. According to the current book keeping system in the Philippines, they have a kind of financial resources so called as “Inter-Local Transfer”, as indicated in the above table, for supporting each to each of LGUs by means of financing each other. However, this financing system has not utilized so much until the present time according to the table above. In case of a certain amount of funds needed as for developing water supply systems, it seems to be better that LGU which has abundant financial balance supports financially to the other LGU.

Table B. 3.5.2 Financial Status of Municipalities/Cities Related to the Projects in the Study for Last 5 Years

(Unit: Peso)

Province/Particular	2004	2005	2006	2007	2008
Bulacan					
Income	1,401,355,158	1,591,470,893	1,743,223,917	1,843,520,107	2,170,056,609
Total Local Sources	553,466,524	662,461,563	706,636,592	731,106,082	785,491,541
Total Shares from National Tax Collections	847,888,634	929,009,330	1,034,344,075	1,112,414,025	1,364,684,270
Loans & Borrowings	0	0	2,243,250	0	19,880,798
Inter-Local Transfers	0	0	0	0	0
Expenditures	1,328,525,181	1,399,355,686	1,704,008,724	1,735,863,901	1,980,368,470
Balance	72,829,977	192,115,207	39,215,193	107,656,206	189,688,139
Nueva Ecija					
Income	1,979,094,977	2,305,977,115	2,599,486,654	2,794,283,395	3,280,583,486
Total Local Sources	301,215,436	490,233,370	526,428,614	502,864,174	715,745,861
Total Shares from National Tax Collections	1,585,865,286	1,780,124,488	2,025,952,077	2,176,332,503	2,448,492,874
Loans & Borrowings	92,014,255	35,619,257	47,105,963	114,586,718	116,277,252
Inter-Local Transfers	0	0	0	500,000	67,500
Expenditures	2,082,672,557	2,004,239,767	2,539,794,734	2,776,109,764	3,190,877,634
Balance	-103,577,580	301,737,349	59,691,920	18,173,631	89,705,853
Pampanga					
Income	1,423,601,789	1,583,042,538	1,997,053,782	2,050,496,095	2,418,116,080
Total Local Sources	434,008,165	512,600,123	715,017,553	663,290,155	690,751,022
Total Shares from National Tax Collections	989,593,624	1,070,442,416	1,234,584,025	1,308,689,449	1,715,737,194
Loans & Borrowings	0	0	47,452,203	78,516,492	11,627,864
Inter-Local Transfers	0	0	0	0	0
Expenditures	1,332,204,725	1,472,776,532	1,765,830,957	1,848,266,441	2,074,352,011
Balance	91,397,064	110,266,007	231,222,825	202,229,654	343,764,069
Tarlac					
Income	772,725,011	845,624,870	1,089,594,590	1,127,784,835	1,255,424,374
Total Local Sources	184,725,543	229,173,917	237,544,295	245,349,590	273,170,961
Total Shares from National Tax Collections	587,999,468	612,952,953	727,737,244	770,517,923	841,679,993
Loans & Borrowings	0	3,498,000	124,313,051	111,917,321	140,573,420
Inter-Local Transfers	0	0	0	0	0
Expenditures	632,316,980	716,498,872	952,486,600	945,998,799	1,064,319,124
Balance	140,408,031	129,125,998	137,107,990	181,786,036	191,105,250

Source: Home page of Official Web-site of Bureau of Local Government Finance, Department of Finance.

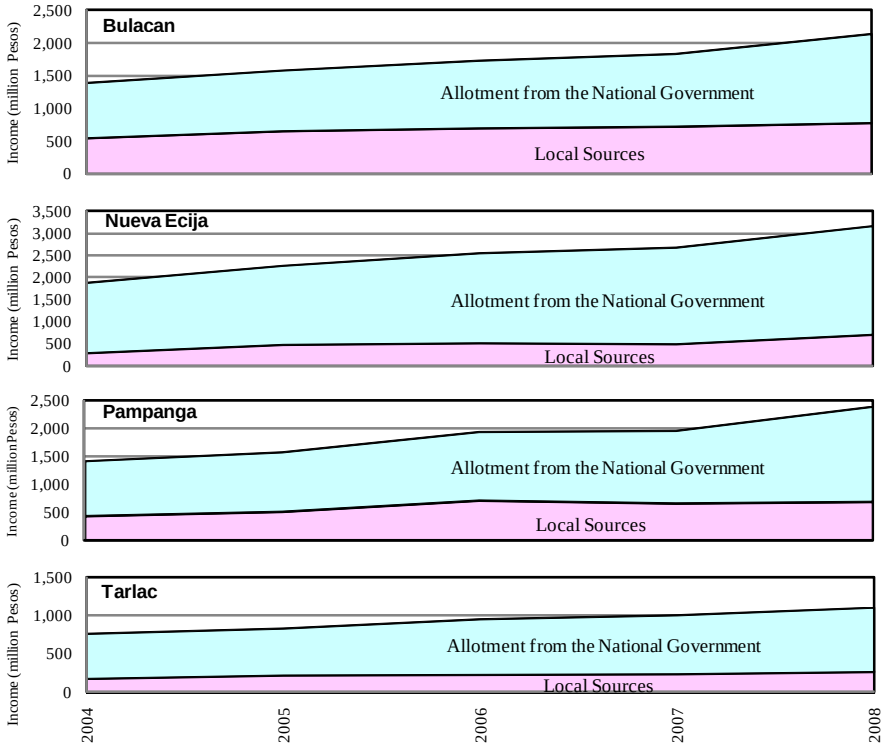


Figure B. 3.5.2 Transition of Appropriation from the National Government Sharing to Total Revenue of Whole Municipalities/Cities Related to the Projects in the Study for the Last 5 Years

Annex-Tables

Annex-T B.1.1.1 Overlapping Ration of Study Area with the Administrative Area of City/Municipality

Province		City/Municipality	Area within Administrative Boundary (km^2)	Area within Basin Boundary (km^2)	Area out of Basin Boundary	Overlapping Ration with Study Area
Bulakan		Angat	59	53	6	89.8%
		Baliuag	44	44	0	100.0%
		Bulacan	69	11	58	16.1%
		Bustos	40	18	23	43.8%
		Calumpit	47	47	0	100.0%
		Dona Remedios Trinidad	879	854	25	97.2%
		Guiguinto	25	2	23	6.6%
		Hagonoy	95	95	0	100.0%
		Malolos City	73	73	0	100.0%
		Norzagaray	247	207	40	83.9%
		Pandi	50	1	49	2.8%
		Paombong	46	46	0	100.0%
		Plaridel	35	20	15	56.5%
		Pulilan	44	44	0	100.0%
		San Ildefonso	167	167	0	100.0%
		San Miguel	236	236	0	100.0%
		San Rafael	105	105	0	100.0%
		Santa Maria	79	1	78	1.0%
		Total	**2,337**	**2,021**	**317**	**86.4%**
Nueva Ecija		Aliaga	92	92	0	100.0%
		Bongabon	229	225	5	97.9%
		Cabanatuan City	198	198	0	100.0%
		Cabiao	113	113	0	100.0%
		Carranglan	739	693	46	93.7%
		Gabaldon	253	252	0	99.9%
		Gapan City	165	165	0	100.0%
		Gen. Mamerto Natividad	98	98	0	100.0%
		Gen. Tinio	581	580	1	99.9%
		Guimba	219	137	82	62.6%
		Jaen	90	90	0	100.0%
		Laur	221	221	0	100.0%
		Licab	60	60	0	100.0%
		Llanera	114	114	0	100.0%
		Lupao	143	130	13	90.9%
		Munoz	142	142	0	100.0%
		Palayan City	136	136	0	100.0%
		Pantabangan	421	421	0	100.0%
		Penaranda	79	79	0	100.0%
		Quezon	68	68	0	100.0%
		Rizal	124	124	0	100.0%
		San Antonio	157	157	0	100.0%
		San Isidro	58	58	0	100.0%
		San Jose City	162	162	0	100.0%
		San Leonardo	52	52	0	100.0%
		Santa Rosa	117	117	0	100.0%
		Santo Domingo	83	83	0	100.0%
		Talavera	135	135	0	100.0%
		Talugtug	73	39	35	52.8%
		Zaragosa	72	72	0	100.0%
		Total	**5,195**	**5,013**	**182**	**96.5%**
Pampanga		Angeles	63	63	0	100.0%
		Apalit	60	60	0	100.0%
		Arayat	177	177	0	100.0%
		Bacolor	74	74	0	100.0%
		Candaba	208	208	0	100.0%
		Floridablanca	121	83	38	69.0%
		Guagua	49	49	0	100.0%
		Lubao	155	149	6	96.0%
		Mabalacat	146	140	6	96.2%
		Macabebe	102	102	0	100.0%
		Magalang	105	105	0	100.0%
		Masantol	46	46	0	100.0%
		Mexico	122	122	0	100.0%
		Minalin	45	45	0	100.0%
		Porac	293	292	1	99.5%
		San Fernando	69	69	0	100.0%
		San Luis	55	55	0	100.0%
		San Simon	60	60	0	100.0%
		Santa Ana	40	40	0	100.0%
		Santa Rita	23	23	0	100.0%
		Santo Tomas	14	14	0	100.0%
		Sasmuan	45	45	0	99.9%
		Total	**2,073**	**2,022**	**51**	**97.6%**
Tarlac		Bamban	251	147	104	58.5%
		Capas	422	134	288	31.7%
		Concepcion	221	221	0	100.0%
		La Paz	117	117	0	100.0%
		Tarlac City	261	132	129	50.6%
		Victoria	112	83	29	74.4%
		Total	**1,384**	**834**	**550**	**39.7%**
Other Provinces	Bataan	Hermosa	126	5	121	4.0%
		Orani	47	9	38	19.0%
	Aurora	Dingalan	330	62	268	18.9%
		Maria Aurora	415	9	406	2.1%
		San Luis	568	123	445	21.7%
	Qezon	General Nakar	1,438	30	1,408	2.1%
	Nueva Vizcaya	Alfonso Castaneda	570	144	426	25.2%
		Aritao	275	7	268	2.6%
		Dupax del Sur	380	5	375	1.3%
		Santa Fe	347	7	339	2.1%
	Pangasinan	Umingan	230	26	204	11.3%
	Rizar	Rodriguez	309	42	267	13.6%
	Zambales	Botolan	654	3	652	0.5%
		San Marcelino	393	71	322	18.0%
		Total	**6,083**	**544**	**5,539**	**8.9%**
Grand Total			**17,073**	**10,434**	**6,639**	**61.1%**

Source: JICA Study Team

Annex-T B.1.1.2 Population and Population Growth within the Study Area

Province	City/Minicipality	Population within the Basin Boundary					Annual Ave. Population Growth Ratio			
		1980	1990	1995	2000	2007	1980-1990	1990-2000	2000-2007	1980-2007
Bulacan	Angat	22,311	30,977	35,057	41,340	47,701	3.34%	2.93%	2.07%	2.85%
	Baliuag	70,555	89,719	103,054	119,675	136,982	2.43%	2.92%	1.95%	2.49%
	Bulacan	5,632	7,866	8,747	10,145	11,659	3.40%	2.58%	2.01%	2.73%
	Bustos	11,283	15,328	18,136	20,643	26,601	3.11%	3.02%	3.69%	3.23%
	Calumpit	45,454	59,042	70,839	81,113	98,017	2.65%	3.23%	2.74%	2.89%
	Dona Remedios Trinidad	4,625	8,372	10,880	13,253	18,551	6.11%	4.70%	4.92%	5.28%
	Guiguinto	1,838	2,950	3,483	4,476	5,911	4.84%	4.26%	4.05%	4.42%
	Hagonoy	73,158	90,190	99,398	111,397	126,298	2.12%	2.13%	1.81%	2.04%
	Malolos City	95,699	125,178	147,414	175,291	223,069	2.72%	3.42%	3.50%	3.18%
	Norzagaray	21,836	28,088	42,792	64,571	88,470	2.55%	8.68%	4.60%	5.32%
	Pandi	624	899	1,115	1,324	1,669	3.71%	3.95%	3.37%	3.71%
	Paombong	26,267	32,052	33,149	41,077	53,510	2.01%	2.51%	3.85%	2.67%
	Plaridel	22,120	29,942	37,519	45,506	56,440	3.07%	4.27%	3.12%	3.53%
	Pulilan	38,110	48,199	59,682	68,188	85,008	2.38%	3.53%	3.20%	3.02%
	San Ildefonso	44,931	59,598	69,319	79,956	93,438	2.87%	2.98%	2.25%	2.75%
	San Miguel	73,113	91,124	108,147	123,824	138,839	2.23%	3.11%	1.65%	2.40%
	San Rafael	36,803	49,528	58,387	69,770	85,284	3.01%	3.49%	2.91%	3.16%
	Santa Maria	559	871	962	1,373	1,954	4.53%	4.66%	5.16%	4.74%
	Total	**594,920**	**769,921**	**908,081**	**1,072,923**	**1,299,400**	**2.61%**	**3.37%**	**2.77%**	**2.94%**
Nueva Ecija	Aliaga	32,349	40,425	45,815	50,004	61,270	2.25%	2.15%	2.95%	2.39%
	Bongabon	31,762	38,775	43,904	48,209	72,076	2.02%	2.20%	5.91%	3.08%
	Cabanatuan City	138,298	173,065	201,033	222,859	259,267	2.27%	2.56%	2.19%	2.35%
	Cabiao	37,922	48,850	55,902	62,624	68,382	2.56%	2.52%	1.26%	2.21%
	Carranglan	18,642	24,427	28,069	29,728	31,146	2.74%	1.98%	0.67%	1.92%
	Gabaldon	17,148	21,718	25,719	28,290	29,583	2.39%	2.68%	0.64%	2.04%
	Gapan City	60,014	70,489	77,735	89,199	98,795	1.62%	2.38%	1.47%	1.86%
	Gen. Mamerto Natividad	17,388	21,984	26,140	29,195	33,354	2.37%	2.88%	1.92%	2.44%
	Gen. Tinio	23,373	29,450	32,867	35,302	38,586	2.34%	1.83%	1.28%	1.87%
	Guimba	36,853	45,944	48,807	54,669	60,193	2.23%	1.75%	1.38%	1.83%
	Jaen	39,064	47,346	53,541	58,274	63,474	1.94%	2.10%	1.23%	1.81%
	Laur	17,729	21,464	25,143	26,902	30,997	1.93%	2.28%	2.04%	2.09%
	Licab	14,543	17,202	21,555	21,593	23,675	1.69%	2.30%	1.32%	1.82%
	Llanera	18,652	23,285	28,127	30,361	33,493	2.24%	2.69%	1.41%	2.19%
	Lupao	20,954	24,982	27,268	31,081	33,483	1.77%	2.21%	1.07%	1.75%
	Munoz	43,211	50,356	60,162	65,586	71,669	1.54%	2.68%	1.28%	1.89%
	Palayan City	14,959	20,393	26,851	31,253	33,506	3.15%	4.36%	1.00%	3.03%
	Pantabangan	13,916	18,341	22,183	23,868	25,520	2.80%	2.67%	0.96%	2.27%
	Penaranda	16,753	20,500	22,661	24,749	26,725	2.04%	1.90%	1.10%	1.74%
	Quezon	20,846	25,574	29,172	31,720	33,988	2.07%	2.18%	0.99%	1.83%
	Rizal	31,407	38,970	45,834	48,166	52,465	2.18%	2.14%	1.23%	1.92%
	San Antonio	42,969	51,815	56,130	63,672	67,446	1.89%	2.08%	0.83%	1.68%
	San Isidro	28,550	34,349	36,283	40,984	44,687	1.87%	1.78%	1.24%	1.67%
	San Jose City	64,254	82,836	96,860	108,254	122,353	2.57%	2.71%	1.76%	2.41%
	San Leonardo	34,706	39,740	46,545	50,478	54,596	1.36%	2.42%	1.13%	1.69%
	Santa Rosa	32,424	40,439	47,522	51,804	58,762	2.23%	2.51%	1.82%	2.23%
	Santo Domingo	29,013	35,864	40,992	45,934	47,960	2.14%	2.51%	0.62%	1.88%
	Talavera	62,225	77,256	85,797	97,329	105,122	2.19%	2.34%	1.11%	1.96%
	Talugtug	6,200	7,453	9,573	9,983	10,922	1.86%	2.97%	1.29%	2.12%
	Zaragosa	24,418	28,743	33,826	37,645	40,355	1.64%	2.73%	1.00%	1.88%
	Total	**990,542**	**1,222,034**	**1,402,016**	**1,549,715**	**1,733,849**	**2.12%**	**2.40%**	**1.62%**	**2.10%**
Pampanga	Angeles	188,834	236,686	234,011	263,971	314,493	2.28%	1.10%	2.53%	1.91%
	Apalit	48,253	62,373	65,720	78,295	97,296	2.60%	2.30%	3.15%	2.63%
	Arayat	56,742	73,189	85,940	101,792	118,312	2.58%	3.35%	2.17%	2.76%
	Bacolor	50,942	67,259	13,097	16,147	25,238	2.82%	-13.30%	6.59%	-2.57%
	Candaba	52,945	68,145	77,546	86,066	96,589	2.56%	2.36%	1.66%	2.25%
	Floridablanca	35,612	45,608	52,874	58,880	71,287	2.50%	2.59%	2.77%	2.60%
	Guagua	72,609	88,290	95,363	96,858	104,284	1.97%	0.93%	1.06%	1.35%
	Lubao	74,387	95,698	105,260	120,648	137,309	2.55%	2.34%	1.87%	2.30%
	Mabalacat	77,903	116,533	125,073	164,575	195,616	4.11%	3.51%	2.50%	3.47%
	Macabebe	45,830	55,505	59,469	65,346	70,332	1.93%	1.65%	1.06%	1.60%
	Magalang	34,840	43,940	52,607	77,530	98,595	2.35%	5.84%	3.49%	3.93%
	Masantol	35,350	41,964	45,326	48,120	50,984	1.73%	1.38%	0.83%	1.37%
	Mexico	53,491	69,546	91,696	109,481	141,298	2.66%	4.64%	3.71%	3.66%
	Minalin	27,414	34,795	35,670	35,150	40,084	2.41%	0.10%	1.89%	1.42%
	Porac	50,672	67,901	75,061	80,386	102,489	2.97%	1.70%	3.53%	2.64%
	San Fernando	110,891	157,851	193,025	221,857	269,365	3.59%	3.46%	2.81%	3.34%
	San Luis	25,701	31,920	36,005	41,554	47,517	2.19%	2.67%	1.93%	2.30%
	San Simon	23,518	30,678	35,474	41,253	48,050	2.69%	3.01%	2.20%	2.68%
	Santa Ana	25,361	32,540	37,975	42,990	49,756	2.52%	2.82%	2.11%	2.53%
	Santa Rita	24,995	28,296	32,321	32,780	36,723	1.25%	1.48%	1.64%	1.44%
	Santo Tomas	24,951	33,309	29,628	32,695	37,866	2.93%	-0.19%	2.12%	1.56%
	Sasmuan	17,881	21,125	23,121	23,333	26,601	1.68%	1.00%	1.89%	1.48%
	Total	**1,159,123**	**1,503,152**	**1,602,261**	**1,839,706**	**2,180,084**	**2.63%**	**2.04%**	**2.45%**	**2.37%**
Tarlac	Bamban	15,244	20,838	21,701	27,106	36,043	3.18%	2.66%	4.15%	3.24%
	Capas	14,755	19,412	25,701	30,200	38,720	2.78%	4.52%	3.61%	3.64%
	Concepcion	80,647	103,146	101,243	115,171	135,213	2.49%	1.11%	2.32%	1.93%
	La Paz	35,330	41,946	45,207	52,907	61,324	1.73%	2.35%	2.13%	2.06%
	Tarlac City	88,879	105,589	116,586	132,785	158,926	1.74%	2.32%	2.60%	2.18%
	Victoria	25,984	31,500	35,356	37,873	42,450	1.94%	1.86%	1.64%	1.83%
	Total	**260,839**	**322,431**	**345,794**	**396,042**	**472,676**	**2.14%**	**2.08%**	**2.56%**	**2.23%**
Bataan	Hermosa	1,023	1,380	1,544	1,843	2,091	3.04%	2.94%	1.82%	2.68%
	Orani	6,291	8,270	9,259	9,983	11,320	2.77%	1.90%	1.81%	2.20%
Aurora	Dingalan	1,643	2,733	3,649	3,806	4,152	5.22%	3.37%	1.25%	3.49%
	Maria Aurora	576	610	662	721	758	0.57%	1.69%	0.72%	1.02%
	San Luis	2,570	3,637	4,551	4,618	5,164	3.53%	2.42%	1.61%	2.62%
Quezon	General Nakar	255	385	444	498	523	4.21%	2.60%	0.72%	2.70%
Nueva Vizcaya	Alfonso Castaneda	705	945	1,121	1,212	1,677	2.98%	2.51%	4.75%	3.26%
	Aritao	582	686	771	838	905	1.66%	2.03%	1.09%	1.65%
	Dupax del Sur	125	159	180	212	225	2.47%	2.90%	0.84%	2.20%
	Santa Fe	136	214	254	278	288	4.62%	2.66%	0.51%	2.82%
Pangasinan	Umingan	4,681	5,433	5,850	6,632	7,073	1.50%	2.02%	0.92%	1.54%
Rizal	Rodriguez	5,709	9,149	10,867	15,709	30,498	4.83%	5.55%	9.94%	6.40%
Zambales	Botolan	123	161	186	211	234	2.76%	2.73%	1.49%	2.42%
	San Marcelino	4,504	6,603	4,407	4,590	5,241	3.90%	-3.57%	1.91%	0.56%
	Total	**28,922**	**40,365**	**43,744**	**51,150**	**70,148**	**3.39%**	**2.40%**	**4.62%**	**3.34%**
Grand Total		**3,034,346**	**3,857,903**	**4,301,897**	**4,909,536**	**5,756,156**	**2.43%**	**2.44%**	**2.30%**	**2.40%**

Source: (1) Population Census in 1980, 1990, 1995, 2000, and 2007 by NSCB (for Basic Population Data)
(2) JICA Study Team (for Overlapping Ratio of Study Area with Cities/Municipalities)

Annex-T B.1.1.3 Rank of Cities/Municipalities in Terms of Higher Population Density in the Study Area

Rank	City/Minicipality	Province	Area (km2)	Population Desity				
				1980	1990	1995	2000	2007
1	Angeles	Pampanga	63	3,007	3,769	3,726	4,203	5,008
2	San Fernando	Pampanga	69	1,617	2,302	2,815	3,235	3,928
3	Guiguinto	Bulacan	2	1,119	1,796	2,120	2,725	3,598
4	Baliuag	Bulacan	44	1,617	2,057	2,362	2,743	3,140
5	Malolos City	Bulacan	73	1,318	1,725	2,031	2,415	3,073
6	Plaridel	Bulacan	20	1,104	1,494	1,872	2,271	2,816
7	Santo Tomas	Pampanga	14	1,725	2,303	2,048	2,260	2,618
8	Santa Maria	Bulacan	1	747	1,163	1,285	1,834	2,610
9	Guagua	Pampanga	49	1,484	1,804	1,949	1,979	2,131
10	Calumpit	Bulacan	47	977	1,269	1,523	1,744	2,107
11	Pulilan	Bulacan	44	874	1,105	1,368	1,563	1,949
12	Apalit	Pampanga	60	803	1,038	1,094	1,303	1,619
13	Santa Rita	Pampanga	23	1,078	1,220	1,394	1,414	1,584
14	Bustos	Bulacan	18	636	864	1,022	1,163	1,499
15	Mabalacat	Pampanga	140	556	831	892	1,174	1,395
16	Hagonoy	Bulacan	95	774	954	1,051	1,178	1,336
17	Cabanatuan City	Nueva Ecija	198	698	873	1,014	1,125	1,308
18	Orani	Bataan	9	699	919	1,029	1,110	1,258
19	Santa Ana	Pampanga	40	627	805	939	1,063	1,230
20	Pandi	Bulacan	1	450	648	804	954	1,203
21	Tarlac City	Tarlac	132	673	799	883	1,005	1,203
22	Paombong	Bulacan	46	573	699	723	896	1,167
23	Mexico	Pampanga	122	438	570	752	897	1,158
24	Masantol	Pampanga	46	770	913	987	1,047	1,110
25	San Leonardo	Nueva Ecija	52	671	769	901	977	1,056
26	Bulacan	Bulacan	11	503	703	782	907	1,042
27	Magalang	Pampanga	105	333	420	503	742	943
28	Lubao	Pampanga	149	500	643	707	811	923
29	Angat	Bulacan	53	424	589	667	786	907
30	Minalin	Pampanga	45	603	766	785	773	882
31	San Luis	Pampanga	55	465	578	652	752	860
32	Floridablanca	Pampanga	83	427	547	634	706	855
33	San Rafael	Bulacan	105	351	472	556	665	813
34	San Simon	Pampanga	60	392	512	592	688	802
35	Talavera	Nueva Ecija	135	461	572	635	721	778
36	San Isidro	Nueva Ecija	58	492	592	625	706	770
37	San Jose City	Nueva Ecija	162	397	512	599	669	756
38	Rodriguez	Rizal	42	135	217	257	372	723
39	Jaen	Nueva Ecija	90	432	523	592	644	702
40	Macabebe	Pampanga	102	448	542	581	638	687
41	Arayat	Pampanga	177	321	414	486	576	670
42	Aliaga	Nueva Ecija	92	351	439	497	542	665
43	Concepcion	Tarlac	221	364	466	457	520	611
44	Cabiao	Nueva Ecija	113	334	430	493	552	603
45	Gapan City	Nueva Ecija	165	365	428	473	542	601
46	Sasmuan	Pampanga	45	400	472	517	521	594
47	San Miguel	Bulacan	236	310	386	458	525	588
48	Santo Domingo	Nueva Ecija	83	351	434	496	555	580
49	San Ildefonso	Bulacan	167	270	358	416	480	561
50	Zaragosa	Nueva Ecija	72	339	399	470	523	561
51	La Paz	Tarlac	117	303	360	388	454	526
52	Victoria	Tarlac	83	312	378	424	454	509
53	Santa Rosa	Nueva Ecija	117	278	347	408	445	504
54	Munoz	Nueva Ecija	142	303	354	422	460	503
55	Quezon	Nueva Ecija	68	305	374	427	464	497
56	Candaba	Pampanga	208	254	327	372	413	464
57	Guimba	Nueva Ecija	137	268	335	355	398	438
58	San Antonio	Nueva Ecija	157	274	330	358	406	430
59	Norzagaray	Bulacan	207	106	136	207	312	428
60	Rizal	Nueva Ecija	124	254	315	370	389	424
61	Hermosa	Bataan	5	204	275	307	367	416
62	Licab	Nueva Ecija	60	241	285	357	357	392
63	Porac	Pampanga	292	174	233	257	275	351
64	Gen. Mamerto Natividad	Nueva Ecija	98	177	224	267	298	340
65	Penaranda	Nueva Ecija	79	213	261	289	315	340
66	Bacolor	Pampanga	74	686	906	176	217	340
67	Bongabon	Nueva Ecija	225	141	173	196	215	321
68	Llanera	Nueva Ecija	114	163	204	246	266	293
69	Capas	Tarlac	134	110	145	192	225	289
70	Talugtug	Nueva Ecija	39	160	192	247	257	281
71	Umingan	Pangasinan	26	180	208	224	254	271
72	Lupao	Nueva Ecija	130	162	193	210	240	258
73	Palayan City	Nueva Ecija	136	110	150	197	230	246
74	Bamban	Tarlac	147	104	142	148	185	246
75	Laur	Nueva Ecija	221	80	97	114	122	140
76	Aritao	Nueva Vizcaya	7	80	94	106	115	124
77	Gabaldon	Nueva Ecija	252	68	86	102	112	117
78	Maria Aurora	Aurora	9	65	68	74	81	85
79	Botolan	Zambales	3	41	54	63	71	79
80	San Marcelino	Zambales	71	64	93	62	65	74
81	Dingalan	Aurora	62	26	44	59	61	67
82	Gen. Tinio	Nueva Ecija	580	40	51	57	61	67
83	Pantabangan	Nueva Ecija	421	33	44	53	57	61
84	Dupax del Sur	Nueva Vizcaya	5	25	32	37	43	46
85	Carranglan	Nueva Ecija	693	27	35	41	43	45
86	San Luis	Aurora	123	21	29	37	37	42
87	Santa Fe	Nueva Vizcaya	7	18	29	34	37	39
88	Dona Remedios Trinidad	Bulacan	854	5	10	13	16	22
89	General Nakar	Quezon	30	8	13	15	16	17
90	Alfonso Castaneda	Nueva Vizcaya	144	5	7	8	8	12

Source: (1) Population Census in 1980, 1990, 1995, 2000, and 2007 by NSCB (for Basic Population Data)

(2) JICA Study Team (for Overlapping Ratio of Study Area with Cities/Municipalities)

Annex-T B.1.1.4 Urban and Rural Population in the Study Area in 2007

Province	City / Municipality	Urban Ratio	Rural Ratio	Population (Whole City/Municipality)			Population (Study Area)		
				Urban	Rural	Total	Urban	Rural	Total
Aurora	Dingalan	0%	100%	0	21,992	21,992	0	4,152	4,152
	Maria Aurora	33%	67%	11,656	23,633	35,289	250	508	758
	San Luis	33%	67%	7,957	15,809	23,766	1,729	3,435	5,164
Bataan	Hermosa	16%	84%	8,420	44,064	52,484	335	1,756	2,091
	Orani	87%	13%	51,746	7,784	59,530	9,840	1,480	11,320
Bulacan	Angat	28%	72%	14,888	38,229	53,117	13,370	34,331	47,701
	Baliuag	100%	0%	136,982	0	136,982	136,982	0	136,982
	Bulacan	8%	92%	6,047	66,242	72,289	975	10,684	11,659
	Bustos	26%	74%	16,002	44,679	60,681	7,015	19,586	26,601
	Calumpit	100%	0%	98,017	0	98,017	98,017	0	98,017
	Doña Remedios Trinidad	0%	100%	0	19,086	19,086	0	18,551	18,551
	Guiguinto	100%	0%	89,225	0	89,225	5,911	0	5,911
	Hagonoy	100%	0%	126,329	0	126,329	126,298	0	126,298
	Malolos City	100%	0%	223,069	0	223,069	223,069	0	223,069
	Norzagaray	34%	66%	36,319	69,151	105,470	30,465	58,005	88,470
	Pandi	100%	0%	60,637	0	60,637	1,669	0	1,669
	Paombong	19%	81%	10,078	43,432	53,510	10,078	43,432	53,510
	Plaridel	100%	0%	99,817	0	99,817	56,440	0	56,440
	Pulilan	100%	0%	85,008	0	85,008	85,008	0	85,008
	San Ildefonso	16%	84%	14,680	78,758	93,438	14,680	78,758	93,438
	San Miguel	21%	79%	28,613	110,226	138,839	28,613	110,226	138,839
	San Rafael	10%	90%	8,950	76,334	85,284	8,950	76,334	85,284
	Santa Maria	100%	0%	205,258	0	205,258	1,954	0	1,954
Nueva Ecija	Aliaga	69%	31%	42,282	18,988	61,270	42,282	18,988	61,270
	Bongabon	4%	96%	3,212	70,427	73,639	3,144	68,932	72,076
	Cabanatuan City	94%	6%	243,934	15,333	259,267	243,934	15,333	259,267
	Cabiao	96%	4%	65,383	2,999	68,382	65,383	2,999	68,382
	Carranglan	46%	54%	15,448	17,785	33,233	14,478	16,668	31,146
	Gabaldon	42%	58%	12,321	17,298	29,619	12,306	17,277	29,583
	Gapan	68%	32%	67,323	31,472	98,795	67,323	31,472	98,795
	Gen Mamerto Natividad	22%	78%	7,427	25,927	33,354	7,427	25,927	33,354
	General Tinio	52%	48%	20,012	18,628	38,640	19,984	18,602	38,586
	Guimba	20%	80%	18,803	77,313	96,116	11,775	48,418	60,193
	Jaen	33%	67%	21,214	42,260	63,474	21,214	42,260	63,474
	Laur	28%	72%	8,822	22,175	30,997	8,822	22,175	30,997
	Licab	22%	78%	5,154	18,521	23,675	5,154	18,521	23,675
	Llanera	16%	84%	5,431	28,062	33,493	5,431	28,062	33,493
	Lupao	6%	94%	2,273	34,559	36,832	2,066	31,417	33,483
	Palayan City	32%	68%	10,809	22,697	33,506	10,809	22,697	33,506
	Pantabangan	0%	100%	0	25,520	25,520	0	25,520	25,520
	Penaranda	0%	100%	0	26,725	26,725	0	26,725	26,725
	Quezon	27%	73%	9,015	24,973	33,988	9,015	24,973	33,988
	Rizal	13%	87%	6,781	45,684	52,465	6,781	45,684	52,465
	San Antonio	28%	72%	18,836	48,610	67,446	18,836	48,610	67,446
	San Isidro	100%	0%	44,687	0	44,687	44,687	0	44,687
	San Jose City	41%	59%	49,572	72,781	122,353	49,572	72,781	122,353
	San Leonardo	68%	32%	36,954	17,642	54,596	36,954	17,642	54,596
	Santa Rosa	3%	97%	1,611	57,151	58,762	1,611	57,151	58,762
	Santo Domingo	77%	23%	37,064	10,896	47,960	37,064	10,896	47,960
	Science City of Munoz	41%	59%	29,689	41,980	71,669	29,689	41,980	71,669
	Talavera	91%	9%	95,319	9,803	105,122	95,319	9,803	105,122
	Talugtug	12%	88%	2,378	18,293	20,671	1,256	9,666	10,922
	Zaragosa	44%	56%	17,760	22,595	40,355	17,760	22,595	40,355
Nueva Vizcaya	Alfonso Castañeda	47%	53%	3,107	3,548	6,655	783	894	1,677
	Aritao	20%	80%	6,761	27,445	34,206	179	726	905
	Dupax del Sur	24%	76%	4,114	13,240	17,354	53	172	225
	Santa Fe	8%	92%	1,080	12,341	13,421	23	265	288
Pampanga	Angeles City	100%	0%	314,493	0	314,493	314,493	0	314,493
	Apalit	100%	0%	97,296	0	97,296	97,296	0	97,296
	Arayat	17%	83%	20,570	97,742	118,312	20,570	97,742	118,312
	Bacolor	35%	65%	8,786	16,452	25,238	8,786	16,452	25,238
	Candaba	12%	88%	11,445	85,144	96,589	11,445	85,144	96,589
	City of San Fernando	98%	2%	264,496	4,869	269,365	264,496	4,869	269,365
	Floridablanca	38%	62%	39,318	64,070	103,388	27,110	44,177	71,287
	Guagua	100%	0%	104,284	0	104,284	104,284	0	104,284
	Lubao	38%	62%	54,876	88,182	143,058	52,671	84,638	137,309
	Mabalacat	100%	0%	203,222	85	203,307	195,534	82	195,616
	Macabebe	12%	88%	8,117	62,215	70,332	8,117	62,215	70,332
	Magalang	69%	31%	68,358	30,237	98,595	68,358	30,237	98,595
	Masantol	31%	69%	15,558	35,426	50,984	15,558	35,426	50,984
	Mexico	42%	58%	59,818	81,480	141,298	59,818	81,480	141,298
	Minalin	37%	63%	14,631	25,453	40,084	14,631	25,453	40,084
	Porac	57%	43%	58,394	44,568	102,962	58,126	44,363	102,489
	San Luis	55%	45%	26,084	21,433	47,517	26,084	21,433	47,517
	San Simon	34%	66%	16,289	31,761	48,050	16,289	31,761	48,050
	Santa Ana	100%	0%	49,756	0	49,756	49,756	0	49,756
	Santa Rita	100%	0%	36,723	0	36,723	36,723	0	36,723
	Santo Tomas	100%	0%	37,866	0	37,866	37,866	0	37,866
	Sasmuan	25%	75%	6,589	20,041	26,630	6,582	20,019	26,601
Pangasinan	Umingan	13%	87%	8,356	54,141	62,497	946	6,127	7,073
Quezon	General Nakar	5%	95%	1,133	23,762	24,895	24	499	523
Rizal	Rodriguez	84%	16%	187,750	35,844	223,594	25,609	4,889	30,498
Tarlac	Bamban	77%	23%	47,367	14,277	61,644	27,695	8,348	36,043
	Capas	15%	85%	18,195	103,889	122,084	5,771	32,949	38,720
	Concepcion	33%	67%	44,237	90,976	135,213	44,237	90,976	135,213
	La Paz	19%	81%	11,445	49,879	61,324	11,445	49,879	61,324
	Tarlac City	65%	35%	203,606	110,549	314,155	103,001	55,925	158,926
	Victoria	13%	87%	7,146	49,939	57,085	5,314	37,136	42,450
Zambales	Botolan	9%	91%	4,441	47,234	51,675	20	214	234
	San Marcelino	37%	63%	10,682	18,370	29,052	1,927	3,314	5,241
Total				4,315,601	2,911,108	7,226,709	3,473,345	2,282,815	5,756,160

Source: (1) Population Census in 2007 by NSCB (for Basic Population Data)
(2) JICA Study Team (for Overlapping Ratio of study area with Cities/Municipalities)

Annex-T B.1.2.1 Poverty Incidence of Each of Municipalities in the Study Area

City and Municipal - level Small Area Poverty Estimates, 2003

Region	Province	Municipality	Poverty Incidence	Standard error (SE)	Coefficient of variation (CV)	Rank (Poorest = 1)	Magnitude of Poor Population	Poverty Gap	SE	Severity of Poverty	SE
Region III	**Bulacan**	ANGAT	10.81	2.57	23.8	1496	5,478	2.11	0.69	0.63	0.26
		BALAGTAS (BIGAA)	10.97	3.55	32.4	1491	6,240	2.16	0.94	0.64	0.35
		BALIUAG	7.89	1.79	22.7	1539	10,428	1.49	0.45	0.43	0.17
		BOCAUE	7.17	2.29	31.9	1550	7,225	1.31	0.58	0.37	0.21
		BULACAN	12.27	3.60	29.3	1474	8,512	2.46	1.01	0.75	0.39
		BUSTOS	3.47	2.05	59.1	1596	1,990	0.58	0.38	0.15	0.11
		CALUMPIT	7.22	1.69	23.4	1548	6,879	1.31	0.41	0.37	0.14
		GUIGUINTO	6.90	2.11	30.6	1554	5,480	1.28	0.49	0.37	0.18
		HAGONOY	9.60	1.86	19.4	1517	11,983	1.87	0.50	0.56	0.20
		CITY OF MALOLOS (Capital)	7.41	1.34	18.1	1544	15,773	1.42	0.36	0.42	0.14
		MARILAO	4.20	1.58	37.6	1581	6,009	0.75	0.34	0.21	0.12
		MEYCUAYAN	7.97	1.85	23.2	1536	14,272	1.50	0.42	0.44	0.15
		NORZAGARAY	20.12	4.75	23.6	1297	18,331	4.63	1.40	1.55	0.58
		OBANDO	6.00	2.34	39.0	1564	3,252	1.07	0.52	0.30	0.19
		PANDI	11.46	2.49	21.7	1484	6,384	2.28	0.64	0.69	0.25
		PAOMBONG	15.20	3.27	21.5	1491	8,107	3.30	1.03	1.08	0.45
		PLARIDEL	7.08	2.14	30.2	1552	6,702	1.34	0.52	0.39	0.19
		PULILAN	11.59	2.58	22.3	1483	9,588	2.27	0.70	0.68	0.28
		SAN ILDEFONSO	16.34	1.95	11.9	1389	14,626	3.55	0.56	1.16	0.24
		CITY OF SAN JOSE DEL MONTE	8.61	1.69	19.6	1527	31,092	1.66	0.46	0.49	0.18
		SAN MIGUEL	16.91	2.11	12.5	1378	23,103	3.75	0.64	1.24	0.26
		SAN RAFAEL	13.29	2.36	17.8	1461	10,762	2.76	0.64	0.87	0.25
		SANTA MARIA	11.13	2.40	21.6	1488	20,700	2.19	0.62	0.66	0.23
		DOÑA REMEDIOS TRINIDAD	51.58	6.36	12.3	365	8,564	15.36	3.17	6.16	1.72
	NUEVA ECIJA	ALIAGA	22.58	2.64	11.7	1242	12,972	5.28	0.88	1.80	0.39
		BONGABON	24.87	2.94	11.8	1182	17,429	6.04	1.01	2.13	0.46
		CABANATUAN CITY	10.01	1.08	10.8	1508	24,292	2.09	0.32	0.67	0.13
		CABIAO	17.94	3.18	17.7	1354	11,397	3.86	0.93	1.25	0.38
		CARRANGALAN	33.81	4.08	12.1	940	10,590	8.83	1.64	3.25	0.81
		CUYAPO	27.23	2.40	8.8	1129	14,873	6.86	0.87	2.47	0.41
		GABALDON (BITULOK & SABANI)	34.05	4.48	13.2	930	9,414	9.03	1.74	3.38	0.85
		CUTY OF GAPAN	13.44	2.37	17.6	1457	12,841	2.80	0.65	0.89	0.26
		GENERAL MAMERTO NATIVIDAD	24.11	3.68	15.3	1201	7,587	5.85	1.23	2.06	0.54
		GENERAL TINIO (PAPAYA)	12.48	3.39	27.2	1470	4,612	2.60	0.97	0.81	0.39
		GUIMBA	28.27	2.45	8.7	1102	26,414	7.13	0.84	2.57	0.38
		JAEN	20.36	2.33	11.4	1291	12,328	4.63	0.73	1.56	0.32
		LAUR	33.11	3.83	11.6	958	9,660	8.86	1.51	3.32	0.73
		LICAB	27.61	4.31	15.6	1118	6,292	6.82	1.62	2.42	0.78
		LLANERA	20.95	2.78	13.3	1272	6,510	4.85	0.96	1.65	0.43
		LUPAO	25.22	2.82	11.2	1175	8,998	6.24	1.01	2.23	0.47
		SCIENCE CITY OF MUÑOZ	17.19	2.06	11.5	1355	12,358	4.12	0.68	1.40	0.30
		NAMPICUAN	31.22	3.89	12.5	1014	3,609	8.26	1.46	3.09	0.71
		PALAYAN CITY (Capital)	23.22	2.77	11.9	1222	6,841	5.73	0.95	2.04	0.45
		PANTABANGAN	28.78	3.68	12.8	1091	6,757	7.34	1.35	2.67	0.67
		PEÑARANDA	23.76	5.78	24.3	1209	6,070	5.67	1.90	1.97	0.84
		QUEZON	32.08	3.80	11.8	993	10,343	8.36	1.42	3.09	0.69
		RIZAL	19.78	2.69	13.6	1308	9,758	4.56	0.84	1.55	0.35
		SAN ANTONIO	23.73	4.11	17.3	1210	15,405	5.59	1.34	1.92	0.59
		SAN ISIDRO	12.34	3.54	28.7	1473	5,330	2.53	0.95	0.79	0.36
		SAN JOSE CITY	14.93	2.20	14.7	1425	17,058	3.35	0.68	1.11	0.29
		SAN LEONARDO	16.69	3.07	18.4	1385	8,577	3.56	0.93	1.15	0.39
		SANTA ROSA	12.86	1.90	14.8	1466	7,047	2.69	0.55	0.86	0.23
		SANTO DOMINGO	20.76	2.86	13.8	1282	9,406	4.83	0.97	1.65	0.43
		TALAVERA	19.34	2.37	12.3	1323	19,032	4.42	0.69	1.49	0.28
		TALUGTUG	38.31	3.28	8.6	780	7,648	10.77	1.38	4.17	0.71
		ZARAGOZA	24.30	3.35	13.8	1198	9,355	5.81	1.13	2.02	0.50
	PAMPANGA	ANGELES CITY	6.44	1.56	24.2	1562	19,274	1.18	0.39	0.34	0.15
		APALIT	15.14	3.51	23.2	1421	13,720	3.08	0.93	0.95	0.36
		ARAYAT	16.23	2.34	14.4	1392	17,934	3.52	0.70	1.14	0.29
		BACOLOR	15.25	4.13	27.1	1417	3,573	3.20	1.02	0.99	0.37
		CANDABA	21.80	2.62	12.0	1254	19,637	4.93	0.85	1.64	0.37
		FLORIDABLANCA	18.30	2.09	11.4	1345	17,612	4.30	0.64	1.49	0.28
		GUAGUA	8.48	1.72	20.3	1529	8,367	1.65	0.45	0.49	0.17
		LUBAO	18.08	2.01	11.1	1350	24,157	4.02	0.64	1.34	0.28
		MABALACAT	7.86	2.95	37.5	1541	14,554	1.48	0.71	0.43	0.26
		MACABEBE	11.17	2.26	20.2	1487	7,514	2.21	0.58	0.67	0.22
		MAGALANG	9.92	2.41	24.3	1512	8,740	2.03	0.62	0.63	0.23
		MASANTOL	20.16	3.10	15.4	1295	9,894	4.40	0.94	1.42	0.39
		MEXICO	14.23	2.50	17.6	1442	18,465	3.01	0.70	0.95	0.28
		MINALIN	19.70	4.02	20.4	131	7,436	4.38	1.22	1.43	0.50
		PORAC	19.68	3.00	15.2	1315	18,452	4.57	0.95	1.56	0.41
		CITY OF SAN FERNANDO (Capital)	6.55	1.68	25.6	1561	16,033	1.26	0.46	0.38	0.18
		SAN LUIS	15.75	3.54	22.5	1406	7,027	3.28	0.90	1.02	0.35
		SAN SNIMON	11.42	3.13	27.4	1485	5,042	2.32	0.86	0.72	0.34
		SANTA ANA	15.52	3.60	23.2	1409	6,959	3.37	1.09	1.10	0.46
		SANTA RITA	16.42	4.46	27.2	1338	5,681	3.57	1.39	1.17	0.59
		SANTO TOMAS	8.12	3.62	44.6	1534	3,015	1.54	0.82	0.46	0.29
		SASMUAN (Sexmoan)	18.38	4.07	22.1	1339	4,769	3.95	1.21	1.28	0.51
	Tarlac	ANAO	12.16	2.33	19.2	1476	1,273	2.54	0.66	0.80	0.27
		BAMBAN	15.58	4.12	26.4	1408	8,715	3.40	1.20	1.12	0.51
		CAMILING	13.88	1.56	11.2	1448	10,827	3.05	0.48	1.00	0.20
		CAPAS	21.71	4.21	19.4	1257	24,109	5.07	1.31	1.74	0.57
		CONCEPCION	19.77	2.12	10.7	1309	24,919	4.45	0.62	1.49	0.27
		GERONA	19.47	1.81	9.3	1319	15,280	4.54	0.60	1.56	0.27
		LA PAZ	22.56	3.07	13.6	1245	13,264	5.28	1.04	1.81	0.45
		MAYANTOC	20.15	2.72	13.5	1296	5,219	4.74	0.84	1.63	0.38
		MONCADA	16.12	2.62	16.3	1396	8,407	3.61	0.84	1.20	0.36
		PANIQUI	16.17	2.07	12.8	1394	12,877	3.63	0.64	1.21	0.27
		PURA	12.50	2.80	22.4	1469	2,665	2.67	0.85	0.86	0.36
		RAMOS	20.86	3.85	18.5	1277	3,927	4.89	1.30	1.68	0.59
		SAN CLEMENTE	17.77	3.75	21.1	1360	2,096	4.14	1.23	1.40	0.53
		SAN MANUEL	21.77	3.41	15.7	1256	4,787	5.02	1.04	1.70	0.45
		SANTA IGNACIA	15.60	2.51	16.1	1407	6,462	3.49	0.78	1.16	0.33
		CITY OF TARLAC (Capital)	12.59	1.38	11.0	1467	37,289	2.72	0.40	0.88	0.16
		VICTORIA	17.77	2.44	13.7	1361	9,807	3.98	0.74	1.32	0.30
		SAN JOSE	47.93	5.42	11.3	470	14,214	14.13	2.52	5.64	1.32

2003 Cuty and Municipal Level Poverty Estimates
NSCB/WB Intercensal Updating of Small Area Poverty Estimates

Annex-T B.1.3.1 Category for Land Cover

Category in data source \ Category in the present study		Forest	Brushland	Cultivated Area		Populated Area		Wetland		Fishpond	Water Body	Others	
				Paddy Field	Other Cultivated Area	Built-up Area	Settlement	Swamp	Mangrove			Others (Natural)	Others (Artificial)
NEW NAMRIA topographic map	Cultivated Land, 150mx150m or more				x								
	Orchard, Plantation and nursery, 150mx150m or more				x								
	Rice paddy, 150mx150m or more			x									
	Fish ponds or Hatcheries, 150mx150m or more									x			
	Woods-bushwood (Dense forest, mixed coniferous and deciduous trees) 150mx150 or more	x											
	Airport Area with hard surface												x
	Cemetery, 150mx150m or more												x
	Park, 150mx150m or more												x
	Park, less than 150mx150m												x
	Runway with hard surface												x
	Awashed Rocks, Large Group											x	
	Fill, 150m or more in length and 3.0m or more in height difference											x	
	Foreshore flat (Sand, Mud, Gravel, etc)											x	
	Gravelly Sand											x	
	Mining site, 150mx150m or more											x	
	Open area, 150mx150m or more											x	
	Runway with loose surface											x	
	Salt evaporator, 150mx150m or more											x	
	Sandbank											x	
	Sandy Area											x	
	Soil Cliff											x	
	Densely Built-up area and moderately built-up area 100mx100m or more					x							
	Settlement						x						
	Bush (Scrub), 150mx150m or more		x										
	Clearing, 150mx150m or more		x										
	Scattered Trees		x										
	Topical grass, 150mx150m or more		x										
	Lake										x		
	River (Wide), Perennial 50m or more in width										x		
	Mangrove, 150mx150m or more								x				
	Swamp, 150mx150m or more							x					
Land Cover by DENR	Other land, natural, grassland		x										
	Other wooded land, fallow		x										
	Other wooded land, shrubs		x										
	Other wooded land, wooded grassland		x										
	Other land, cultivated, pastures				x								
	Other land, cultivated, annual crop			x									
	Other land, cultivated, perennial crop			x									
	Other land, fishpond	x								x			
	Bamboo/palm formation	x											
	Closed forest, broadleaved	x											
	Closed forest, coniferous	x											
	Closed forest, mixed	x											
	Forest plantation, broadleaved	x											
	Forest plantation, coniferous	x											
	Forest plantation, mangrove	x											
	Open forest, broadleaved	x											
	Open forest, coniferous	x											
	Open forest, mixed	x											
	Other land, natural, barren land											x	
	Other land, built-up area					x							
	Inland Water										x		
	Mangrove forest								x				
	Other land, natural, marshland							x					

Source: JICA Study Team

Annex-T B.1.3.2 Land Cover for Each Sub- Basin

Sub-Basin	Area (km^2)											
	Forest	Brushland	Paddy Field	Other Cultivated Area	Built-up Area	Settlement	Swamp	Fishpond	Water Body	Others (Natural)	Others (Artificial)	Total
PAM01		0.7	9.7	0.5	7.4	2.3	5.5	119.4	11.7	1.9	0.1	159.2
PAM02	200.7	225.5	892.1	91.8	31.5	13.3	2.6	34.2	9.3	15.5	0.8	1,517.3
PAM03		6.8	6.5	15.7	3.0	1.2	0.8	0.0	4.2	1.6	0.0	39.8
PAM04	16.6	168.7	488.4	46.7	17.2	7.6	4.3	3.3	8.9	36.5	0.6	798.7
PAM05	88.7	186.7	128.1	2.7	7.0	0.6	0.4	0.0	3.0	19.4	0.1	436.6
PAN01	213.7	511.2	57.6		2.7				27.9	36.4		849.4
RCH01	108.8	532.3	1,795.8	223.7	67.0	25.2	19.4	13.1	17.7	83.4	9.0	2,895.3
PEN01	329.5	139.2	60.2	21.8	5.0	0.7	0.2	0.0	5.8	7.1	0.1	569.7
COR01	350.7	222.8	120.7	1.0	3.4	1.1		0.2	3.8	8.5	0.0	712.0
ANG01		2.8	56.0	1.6	16.1	1.5	6.5	85.3	7.7	15.7	0.3	193.5
ANG02	45.7	153.8	65.8	39.8	15.7	2.5	1.2	1.1	10.1	9.5	0.4	345.8
ANG03	500.2	23.3		0.8					20.7	0.9		545.9
PAS01	20.9	360.3	291.6	260.6	92.0	14.1	16.2	233.9	18.4	57.2	6.1	1,371.3
Total	1,875.4	2,533.9	3,972.5	706.7	268.0	70.1	57.1	490.5	149.3	293.5	17.5	10,434.4

Source: JICA Study Team

Annex-T B.2.1.1(1/2) Service Area Population Projection 2007-2025

Province	City / Municipality	Ratio of C/M to SA	Urban Ratio	Rural Ratio	2007						2008		
					Population (Whole City/Municipality)			Population (Study Area)			Population (Study Area)		
					Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Bulacan	Angat	0.898	28%	72%	14,888	38,229	53,117	13,370	34,331	47,701	13,731	35,259	48,990
	Baliuag	1.000	100%	0%	136,982	0	136,982	136,982	0	136,982	140,682	0	140,682
	Bulacan	0.161	8%	92%	6,047	66,242	72,289	975	10,684	11,659	1,002	10,972	11,974
	Bustos	0.438	26%	74%	16,002	44,679	60,681	7,015	19,586	26,601	7,204	20,115	27,319
	Calumpit	1.000	100%	0%	98,017	0	98,017	98,017	0	98,017	100,665	0	100,665
	Doña Remedios Trinidad	0.972	0%	100%	0	19,086	19,086	0	18,551	18,551	0	19,052	19,052
	Guiguinto	0.066	100%	0%	89,225	0	89,225	5,911	0	5,911	6,071	0	6,071
	Hagonoy	1.000	100%	0%	126,329	0	126,329	126,298	0	126,298	129,709	0	129,709
	Malolos City	1.000	100%	0%	223,069	0	223,069	223,069	0	223,069	229,095	0	229,095
	Norzagaray	0.839	34%	66%	36,319	69,151	105,470	30,465	58,005	88,470	31,288	59,572	90,860
	Pandi	0.028	100%	0%	60,637	0	60,637	1,669	0	1,669	1,714	0	1,714
	Paombong	1.000	19%	81%	10,078	43,432	53,510	10,078	43,432	53,510	10,350	44,605	54,955
	Plaridel	0.565	100%	0%	99,817	0	99,817	56,440	0	56,440	57,964	0	57,964
	Pulilan	1.000	100%	0%	85,008	0	85,008	85,008	0	85,008	87,304	0	87,304
	San Ildefonso	1.000	16%	84%	14,680	78,758	93,438	14,680	78,758	93,438	15,077	80,885	95,962
	San Miguel	1.000	21%	79%	28,613	110,226	138,839	28,613	110,226	138,839	29,386	113,203	142,589
	San Rafael	1.000	10%	90%	8,950	76,334	85,284	8,950	76,334	85,284	9,192	78,396	87,588
	Santa Maria	0.010	100%	0%	205,258	0	205,258	1,954	0	1,954	2,007	0	2,007
Nueva Ecija	Aliaga	1.000	69%	31%	42,282	18,988	61,270	42,282	18,988	61,270	42,966	19,295	62,261
	Bongabon	0.979	4%	96%	3,212	70,427	73,639	3,144	68,932	72,076	3,195	70,047	73,242
	Cabanatuan City	1.000	94%	6%	243,934	15,333	259,267	243,934	15,333	259,267	247,879	15,581	263,460
	Cabiao	1.000	96%	4%	65,383	2,999	68,382	65,383	2,999	68,382	66,440	3,048	69,488
	Carranglan	0.937	46%	54%	15,448	17,785	33,233	14,478	16,668	31,146	14,712	16,937	31,649
	Gabaldon	0.999	42%	58%	12,321	17,298	29,619	12,306	17,277	29,583	12,505	17,557	30,062
	Gapan	1.000	68%	32%	67,323	31,472	98,795	67,323	31,472	98,795	68,412	31,981	100,393
	Gen Mamerto Natividad	1.000	22%	78%	7,427	25,927	33,354	7,427	25,927	33,354	7,547	26,346	33,893
	General Tinio	0.999	52%	48%	20,012	18,628	38,640	19,984	18,602	38,586	20,307	18,903	39,210
	Guimba	0.626	20%	80%	18,803	77,313	96,116	11,775	48,418	60,193	11,966	49,201	61,167
	Jaen	1.000	33%	67%	21,214	42,260	63,474	21,214	42,260	63,474	21,557	42,944	64,501
	Laur	1.000	28%	72%	8,822	22,175	30,997	8,822	22,175	30,997	8,965	22,533	31,498
	Licab	1.000	22%	78%	5,154	18,521	23,675	5,154	18,521	23,675	5,237	18,821	24,058
	Llanera	1.000	16%	84%	5,431	28,062	33,493	5,431	28,062	33,493	5,519	28,516	34,035
	Lupao	0.909	6%	94%	2,273	34,559	36,832	2,066	31,417	33,483	2,100	31,924	34,024
	Science City of Munoz	1.000	41%	59%	29,689	41,980	71,669	29,689	41,980	71,669	30,169	42,659	72,828
	Palayan City	1.000	32%	68%	10,809	22,697	33,506	10,809	22,697	33,506	10,984	23,064	34,048
	Pantabangan	1.000	0%	100%	0	25,520	25,520	0	25,520	25,520	0	25,933	25,933
	Penaranda	1.000	0%	100%	0	26,725	26,725	0	26,725	26,725	0	27,157	27,157
	Quezon	1.000	27%	73%	9,015	24,973	33,988	9,015	24,973	33,988	9,161	25,377	34,538
	Rizal	1.000	13%	87%	6,781	45,684	52,465	6,781	45,684	52,465	6,891	46,423	53,314
	San Antonio	1.000	28%	72%	18,836	48,610	67,446	18,836	48,610	67,446	19,141	49,396	68,537
	San Isidro	1.000	100%	0%	44,687	0	44,687	44,687	0	44,687	45,410	0	45,410
	San Jose City	1.000	41%	59%	49,572	72,781	122,353	49,572	72,781	122,353	50,374	73,958	124,332
	San Leonardo	1.000	68%	32%	36,954	17,642	54,596	36,954	17,642	54,596	37,552	17,927	55,479
	Santa Rosa	1.000	3%	97%	1,611	57,151	58,762	1,611	57,151	58,762	1,637	58,075	59,712
	Santo Domingo	1.000	77%	23%	37,064	10,896	47,960	37,064	10,896	47,960	37,664	11,072	48,736
	Talavera	1.000	91%	9%	95,319	9,803	105,122	95,319	9,803	105,122	96,860	9,962	106,822
	Talugtug	0.528	12%	88%	2,378	18,293	20,671	1,256	9,666	10,922	1,277	9,822	11,099
	Zaragosa	1.000	44%	56%	17,760	22,595	40,355	17,760	22,595	40,355	18,047	22,961	41,008
Pampanga	Angeles City	1.000	100%	0%	314,493	0	314,493	314,493	0	314,493	320,197	0	320,197
	Apalit	1.000	100%	0%	97,296	0	97,296	97,296	0	97,296	99,061	0	99,061
	Arayat	1.000	17%	83%	20,570	97,742	118,312	20,570	97,742	118,312	20,943	99,515	120,458
	Bacolor	1.000	35%	65%	8,786	16,452	25,238	8,786	16,452	25,238	8,945	16,751	25,696
	Candaba	1.000	12%	88%	11,445	85,144	96,589	11,445	85,144	96,589	11,653	86,688	98,341
	Floridablanca	0.690	38%	62%	39,318	64,070	103,388	27,110	44,177	71,287	27,602	44,978	72,580
	Guagua	1.000	100%	0%	104,284	0	104,284	104,284	0	104,284	106,175	0	106,175
	Lubao	0.960	38%	62%	54,876	88,182	143,058	52,671	84,638	137,309	53,626	86,173	139,799
	Mabalacat	0.962	100%	0%	203,222	85	203,307	195,534	82	195,616	199,081	83	199,164
	Macabebe	1.000	12%	88%	8,117	62,215	70,332	8,117	62,215	70,332	8,264	63,344	71,608
	Magalang	1.000	69%	31%	68,358	30,237	98,595	68,358	30,237	98,595	69,598	30,785	100,383
	Masantol	1.000	31%	69%	15,558	35,426	50,984	15,558	35,426	50,984	15,840	36,069	51,909
	Mexico	1.000	42%	58%	59,818	81,480	141,298	59,818	81,480	141,298	60,903	82,958	143,861
	Minalin	1.000	37%	63%	14,631	25,453	40,084	14,631	25,453	40,084	14,896	25,915	40,811
	Porac	0.995	57%	43%	58,394	44,568	102,962	58,126	44,363	102,489	59,180	45,168	104,348
	City of San Fernando	1.000	98%	2%	264,496	4,869	269,365	264,496	4,869	269,365	269,293	4,957	274,250
	San Luis	1.000	55%	45%	26,084	21,433	47,517	26,084	21,433	47,517	26,557	21,822	48,379
	San Simon	1.000	34%	66%	16,289	31,761	48,050	16,289	31,761	48,050	16,584	32,337	48,921
	Santa Ana	1.000	100%	0%	49,756	0	49,756	49,756	0	49,756	50,658	0	50,658
	Santa Rita	1.000	100%	0%	36,723	0	36,723	36,723	0	36,723	37,389	0	37,389
	Santo Tomas	1.000	100%	0%	37,866	0	37,866	37,866	0	37,866	38,553	0	38,553
	Sasmuan	0.999	25%	75%	6,589	20,041	26,630	6,582	20,019	26,601	6,701	20,382	27,083
Tarlac	Bamban	0.585	77%	23%	47,367	14,277	61,644	27,695	8,348	36,043	28,166	8,489	36,655
	Capas	0.317	15%	85%	18,195	103,889	122,084	5,771	32,949	38,720	5,869	33,509	39,378
	Concepcion	1.000	33%	67%	44,237	90,976	135,213	44,237	90,976	135,213	44,989	92,522	137,511
	La Paz	1.000	19%	81%	11,445	49,879	61,324	11,445	49,879	61,324	11,639	50,727	62,366
	Tarlac City	0.506	65%	35%	203,606	110,549	314,155	103,001	55,925	158,926	104,751	56,875	161,627
	Victoria	0.744	13%	87%	7,146	49,939	57,085	5,314	37,136	42,450	5,404	37,767	43,171
Total			61%	39%	4,008,398	2,561,901	6,570,299	3,431,627	2,254,384	5,686,011	3,499,431	2,297,295	5,796,726

Source: JICA Study Team

Annex-T B.2.1.1(2/2) Service Area Population Projection 2007-2025

Province	City / Municipality	Ratio of C/M to SA	Urban Ratio	Rural Ratio	2015 Population (Study Area)			2020 Population (Study Area)			2025 Population (Study Area)		
					Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Bulacan	Angat	0.898	28%	72%	16,318	41,902	58,220	18,172	46,663	64,835	20,008	51,377	71,385
	Baliuag	1.000	100%	0%	167,188	0	167,188	186,185	0	186,185	204,993	0	204,993
	Bulacan	0.161	8%	92%	1,190	13,040	14,230	1,326	14,521	15,847	1,460	15,988	17,448
	Bustos	0.438	26%	74%	8,562	23,904	32,466	9,534	26,621	36,155	10,498	29,310	39,808
	Calumpit	1.000	100%	0%	119,631	0	119,631	133,224	0	133,224	146,682	0	146,682
	Doña Remedios Trinidad	0.972	0%	100%	0	22,641	22,641	0	25,214	25,214	0	27,761	27,761
	Guiguinto	0.066	100%	0%	7,214	0	7,214	8,034	0	8,034	8,846	0	8,846
	Hagonoy	1.000	100%	0%	154,148	0	154,148	171,663	0	171,663	189,004	0	189,004
	Malolos City	1.000	100%	0%	272,259	0	272,259	303,194	0	303,194	333,821	0	333,821
	Norzagaray	0.839	34%	66%	37,183	70,796	107,979	41,408	78,840	120,248	45,591	86,805	132,396
	Pandi	0.028	100%	0%	2,037	0	2,037	2,269	0	2,269	2,498	0	2,498
	Paombong	1.000	19%	81%	12,300	53,009	65,309	13,698	59,032	72,730	15,082	64,995	80,077
	Plaridel	0.565	100%	0%	68,885	0	68,885	76,712	0	76,712	84,461	0	84,461
	Pulilan	1.000	100%	0%	103,753	0	103,753	115,542	0	115,542	127,214	0	127,214
	San Ildefonso	1.000	16%	84%	17,917	96,125	114,042	19,953	107,047	127,000	21,968	117,861	139,829
	San Miguel	1.000	21%	79%	34,923	134,532	169,455	38,891	149,818	188,709	42,819	164,953	207,772
	San Rafael	1.000	10%	90%	10,924	93,166	104,090	12,165	103,752	115,917	13,394	114,233	127,627
	Santa Maria	0.010	100%	0%	2,385	0	2,385	2,656	0	2,656	2,924	0	2,924
Nueva Ecija	Aliaga	1.000	69%	31%	47,801	21,466	69,267	51,021	22,912	73,933	53,900	24,206	78,106
	Bongabon	0.979	4%	96%	3,554	77,929	81,483	3,794	83,178	86,972	4,008	87,873	91,881
	Cabanatuan City	1.000	94%	6%	275,774	17,334	293,108	294,349	18,502	312,851	310,962	19,546	330,508
	Cabiao	1.000	96%	4%	73,918	3,390	77,308	78,896	3,619	82,515	83,349	3,823	87,172
	Carranglan	0.937	46%	54%	16,367	18,844	35,211	17,470	20,113	37,583	18,456	21,248	39,704
	Gabaldon	0.999	42%	58%	13,913	19,532	33,445	14,849	20,848	35,697	15,688	22,024	37,712
	Gapan	1.000	68%	32%	76,110	35,580	111,690	81,237	37,976	119,213	85,822	40,120	125,942
	Gen Mamerto Natividad	1.000	22%	78%	8,397	29,311	37,708	8,962	31,285	40,247	9,468	33,051	42,519
	General Tinio	0.999	52%	48%	22,592	21,030	43,622	24,114	22,446	46,560	25,475	23,713	49,188
	Guimba	0.626	20%	80%	13,312	54,738	68,050	14,209	58,424	72,633	15,011	61,722	76,733
	Jaen	1.000	33%	67%	23,983	47,776	71,759	25,598	50,994	76,592	27,043	53,872	80,915
	Laur	1.000	28%	72%	9,974	25,069	35,043	10,645	26,758	37,403	11,246	28,268	39,514
	Licab	1.000	22%	78%	5,827	20,938	26,765	6,219	22,349	28,568	6,570	23,610	30,180
	Llanera	1.000	16%	84%	6,140	31,725	37,865	6,553	33,862	40,415	6,923	35,773	42,696
	Lupao	0.909	6%	94%	2,336	35,517	37,853	2,493	37,910	40,403	2,634	40,049	42,683
	Science City of Munoz	1.000	41%	59%	33,564	47,460	81,024	35,825	50,656	86,481	37,847	53,515	91,362
	Palayan City	1.000	32%	68%	12,220	25,659	37,879	13,043	27,388	40,431	13,779	28,934	42,713
	Pantabangan	1.000	0%	100%	0	28,851	28,851	0	30,794	30,794	0	32,532	32,532
	Penaranda	1.000	0%	100%	0	30,213	30,213	0	32,248	32,248	0	34,068	34,068
	Quezon	1.000	27%	73%	10,192	28,232	38,424	10,878	30,134	41,012	11,492	31,835	43,327
	Rizal	1.000	13%	87%	7,666	51,647	59,313	8,182	55,126	63,308	8,644	58,237	66,881
	San Antonio	1.000	28%	72%	21,294	54,955	76,249	22,729	58,656	81,385	24,012	61,967	85,979
	San Isidro	1.000	100%	0%	50,520	0	50,520	53,923	0	53,923	56,966	0	56,966
	San Jose City	1.000	41%	59%	56,042	82,281	138,323	59,817	87,823	147,640	63,193	92,780	155,973
	San Leonardo	1.000	68%	32%	41,777	19,945	61,722	44,592	21,288	65,880	47,108	22,490	69,598
	Santa Rosa	1.000	3%	97%	1,821	64,611	66,432	1,944	68,963	70,907	2,054	72,854	74,908
	Santo Domingo	1.000	77%	23%	41,902	12,318	54,220	44,724	13,148	57,872	47,248	13,890	61,138
	Talavera	1.000	91%	9%	107,760	11,083	118,843	115,019	11,829	126,848	121,510	12,497	134,007
	Talugtug	0.528	12%	88%	1,420	10,927	12,347	1,516	11,663	13,179	1,602	12,321	13,923
	Zaragosa	1.000	44%	56%	20,078	25,544	45,622	21,430	27,265	48,695	22,640	28,804	51,444
Pampanga	Angeles City	1.000	100%	0%	359,662	0	359,662	385,924	0	385,924	410,197	0	410,197
	Apalit	1.000	100%	0%	111,270	0	111,270	119,395	0	119,395	126,904	0	126,904
	Arayat	1.000	17%	83%	23,524	111,780	135,304	25,242	119,942	145,184	26,830	127,486	154,316
	Bacolor	1.000	35%	65%	10,048	18,815	28,863	10,781	20,189	30,970	11,460	21,458	32,918
	Candaba	1.000	12%	88%	13,089	97,372	110,461	14,044	104,483	118,527	14,928	111,054	125,982
	Floridablanca	0.690	38%	62%	31,004	50,521	81,525	33,267	54,211	87,478	35,360	57,620	92,980
	Guagua	1.000	100%	0%	119,262	0	119,262	127,970	0	127,970	136,019	0	136,019
	Lubao	0.960	38%	62%	60,236	96,794	157,030	64,634	103,862	168,496	68,699	110,395	179,094
	Mabalacat	0.962	100%	0%	223,617	94	223,711	239,947	100	240,047	255,038	107	255,145
	Macabebe	1.000	12%	88%	9,283	71,150	80,433	9,961	76,346	86,307	10,587	81,148	91,735
	Magalang	1.000	69%	31%	78,176	34,580	112,756	83,884	37,105	120,989	89,160	39,439	128,599
	Masantol	1.000	31%	69%	17,792	40,514	58,306	19,092	43,472	62,564	20,292	46,207	66,499
	Mexico	1.000	42%	58%	68,409	93,183	161,592	73,404	99,987	173,391	78,021	106,276	184,297
	Minalin	1.000	37%	63%	16,732	29,109	45,841	17,954	31,234	49,188	19,083	33,199	52,282
	Porac	0.995	57%	43%	66,474	50,735	117,209	71,328	54,439	125,767	75,814	57,863	133,677
	City of San Fernando	1.000	98%	2%	302,484	5,568	308,052	324,571	5,975	330,546	344,985	6,351	351,336
	San Luis	1.000	55%	45%	29,831	24,511	54,342	32,009	26,301	58,310	34,022	27,955	61,977
	San Simon	1.000	34%	66%	18,628	36,323	54,951	19,989	38,975	58,964	21,246	41,426	62,672
	Santa Ana	1.000	100%	0%	56,902	0	56,902	61,057	0	61,057	64,897	0	64,897
	Santa Rita	1.000	100%	0%	41,997	0	41,997	45,064	0	45,064	47,898	0	47,898
	Santo Tomas	1.000	100%	0%	43,304	0	43,304	46,467	0	46,467	49,389	0	49,389
	Sasmuan	0.999	25%	75%	7,527	22,894	30,421	8,077	24,566	32,643	8,585	26,111	34,696
Tarlac	Bamban	0.585	77%	23%	31,453	9,480	40,933	33,630	10,136	43,766	35,619	10,736	46,355
	Capas	0.317	15%	85%	6,554	37,420	43,974	7,007	40,009	47,016	7,422	42,376	49,798
	Concepcion	1.000	33%	67%	50,240	103,320	153,560	53,716	110,469	164,185	56,893	117,005	173,898
	La Paz	1.000	19%	81%	12,998	56,647	69,645	13,897	60,567	74,464	14,719	64,150	78,869
	Tarlac City	0.506	65%	35%	116,977	63,514	180,491	125,071	67,908	192,979	132,470	71,926	204,396
	Victoria	0.744	13%	87%	6,035	42,175	48,210	6,453	45,093	51,546	6,834	47,761	54,595
Total			61%	39%	3,976,579	2,599,519	6,576,098	4,302,492	2,805,034	7,107,526	4,609,286	2,996,952	7,606,238
	Bulacan		70%	30%	1,036,817	549,115	1,585,932	1,154,625	611,509	1,766,134	1,271,262	673,284	1,944,546
	Nueva Ecija		50%	50%	1,006,254	953,905	1,960,159	1,074,032	1,018,156	2,092,188	1,134,651	1,075,621	2,210,272
	Pampanga		68%	32%	1,709,251	783,943	2,493,194	1,834,061	841,187	2,675,248	1,949,415	894,094	2,843,509
	Tarlac		44%	56%	224,256	312,557	536,813	239,773	334,183	573,956	253,958	353,953	607,911
	Total		61%	39%	3,976,579	2,599,519	6,576,098	4,302,492	2,805,034	7,107,526	4,609,286	2,996,952	7,606,238

Source: JICA Study Team

Annex-T B.2.3.1(1/2) Conversion Factor of Price Indices

Year	**CPI** (2000 = 100)		**WPI** (1985 = 100)		**PPI (Paddy)** (1994 = 100)		**PPI (Corn)** (1994 = 100)		**PPI (Industries)** (1994 = 100)		**Reference:** CPI (Cereal) (2000 = 100)	
	Consumer Price Index of All Consumables		Wholesale Price Index for Construction Materials		Producer's Price Index of Paddy		Producer's Price Index of Corn		Producer's Price Index of Industries (Wood, Cement, Metals)		Consumer Price Index of Cereal Preparations (Paddy, Corn)	
	Index (2000 - 100)	Conversion Factor	Index (1985 - 100)	Conversion Factor	Index (1994 - 100)	Conversion Factor	Index (1994 - 100)	Conversion Factor	Index (1994 - 100)	Conversion Factor	Index (2000 - 100)	Conversion Factor
2009	158.9	1.000	460.8	1.000	231.5	1.000	201.8	1.000	153.1	1.000	182.3	1.000
2008	155.0	1.025	465.1	0.991	219.9	1.053	192.4	1.049	149.2	1.026	171.0	1.066
2007	141.8	1.121	382.8	1.204	205.6	1.126	194.6	1.037	125.9	1.216	157.5	1.157
2006	137.9	1.153	367.6	1.254	191.2	1.211	178.3	1.132	154.6	0.990	153.4	1.188
2005	129.8	1.224	294.4	1.565	197.6	1.172	156.8	1.287	146.1	1.048	142.9	1.276
2004	120.6	1.318	306.1	1.505	173.4	1.335	175.4	1.151	134.7	1.137	132.4	1.376
2003	113.8	1.397	266.5	1.729	160.4	1.443	134.1	1.505	122.8	1.247	123.0	1.482
2002	110.0	1.445	250.1	1.843	158.2	1.463	133.7	1.509	135.1	1.133	111.0	1.643
2001	106.8	1.488	243.4	1.894	154.6	1.497	133.3	1.514	136.0	1.126	109.5	1.665
2000	100.0	1.589	234.0	1.969	155.5	1.489	129.9	1.554	123.8	1.237	100.0	1.823
1999	96.2	1.652	227.3	2.027	135.9	1.703	122.8	1.643	119.5	1.281	96.2	1.895
1998	90.8	1.750	227.1	2.029	128.5	1.802	116.8	1.728	116.6	1.313	93.2	1.956
1997	83.1	1.913	219.5	2.099	121.9	1.899	111.0	1.818	113.7	1.347	82.0	2.223
1996	78.7	2.020	214.5	2.148	115.4	2.006	105.7	1.909	110.9	1.381	78.0	2.337
1995	73.2	2.171	180.0	2.560	109.6	2.112	100.7	2.004	108.0	1.418	73.2	2.490
1994	68.6	2.317	170.3	2.706	100.0	2.315	100.0	2.018	100.0	1.531	68.9	2.646
1993	62.1	2.559	160.9	2.864	98.6	2.348	90.9	2.220	102.9	1.488	64.4	2.831
1992	58.2	2.731	151.2	3.048	93.6	2.473	86.8	2.325	100.3	1.526	60.3	3.023
1991	53.6	2.965	142.2	3.241	88.5	2.616	82.5	2.446	97.8	1.565	56.7	3.215
1990	44.9	3.540	134.3	3.431	83.7	2.766	78.3	2.577	95.5	1.603	53.1	3.433
1989	40.0	3.973	126.4	3.646	79.5	2.912	74.6	2.705	93.0	1.646	49.7	3.668
1988	35.7	4.452	118.7	3.882	75.6	3.062	70.9	2.846	90.9	1.684	46.6	3.912
1987	31.3	5.078	111.7	4.125	71.7	3.229	67.7	2.981	88.7	1.726	43.7	4.172
1986	30.1	5.280	105.0	4.389	67.8	3.414	64.2	3.143	86.3	1.774	41.0	4.446
1985	29.8	5.333	100.0	4.608	64.2	3.606	61.1	3.303	84.2	1.818	38.3	4.760
1984	24.3	6.541	92.9	4.960	60.9	3.801	58.1	3.473	82.2	1.863	35.9	5.078
1983	16.2	9.811	87.7	5.254	57.8	4.005	55.2	3.656	80.1	1.911	33.7	5.409
1982	14.8	10.739	82.3	5.599	54.8	4.224	52.6	3.837	78.1	1.960	31.7	5.751
1981	13.4	11.861	77.5	5.946	51.8	4.469	50.1	4.028	76.2	2.009	29.7	6.138
1980	12.1	13.157	72.9	6.321	49.2	4.705	47.7	4.231	74.3	2.061	27.8	6.558
1979	10.3	15.461	68.7	6.707	46.7	4.957	45.2	4.465	72.7	2.106	25.9	7.039
1978	8.8	18.144	64.4	7.155	44.1	5.249	43.0	4.693	70.8	2.162	24.2	7.533
1977	8.2	19.430	60.7	7.591	41.9	5.525	41.0	4.922	69.1	2.216	22.8	7.996
1976	7.4	21.391	57.0	8.084	39.8	5.817	38.9	5.188	67.3	2.275	21.3	8.559
1975	6.8	23.373	53.6	8.597	37.7	6.141	37.1	5.439	65.8	2.327	20.0	9.115
1974	6.5	24.452	50.5	9.125	35.8	6.466	35.2	5.733	64.0	2.392	18.8	9.697
1973	4.9	32.239	47.7	9.660	33.9	6.829	33.7	5.988	62.7	2.442	17.7	10.299
1972	4.3	37.309	44.8	10.286	32.1	7.212	32.0	6.306	60.9	2.514	16.4	11.116
1971	3.8	42.383	42.2	10.919	30.3	7.640	30.3	6.660	59.4	2.577	15.4	11.838
1970	3.1	51.105	39.7	11.607	28.9	8.010	29.0	6.959	58.0	2.640	14.6	12.486
1969	2.7	58.866	37.3	12.354	27.2	8.511	27.5	7.338	56.6	2.705	13.7	13.307
1968	2.7	59.527	35.1	13.128	25.9	8.938	26.2	7.702	55.2	2.774	12.8	14.242
1967	2.6	60.663	33.0	13.964	24.6	9.411	24.9	8.104	53.8	2.846	11.9	15.319
1966	2.5	63.830	31.0	14.865	23.2	9.978	23.7	8.515	52.6	2.911	11.2	16.277
1965	2.4	66.224	29.2	15.781	22.1	10.475	22.4	9.009	51.2	2.990	10.4	17.529
1964	2.4	66.780	27.5	16.756	20.9	11.077	21.3	9.474	49.9	3.068	9.8	18.602
1963	2.2	71.917	25.9	17.792	19.9	11.633	20.3	9.941	48.7	3.144	9.2	19.815
1962	2.1	77.154	24.3	18.963	18.8	12.314	19.3	10.456	47.5	3.223	8.7	20.954
1961	2.0	78.682	22.8	20.211	17.8	13.006	18.4	10.967	46.3	3.307	8.1	22.506
1960	2.0	81.506	21.7	21.235	16.9	13.698	17.7	11.401	45.3	3.380	7.6	23.987

Annex-T B.2.3.1(2/2) Conversion Factor of Price Indices

Remarks 1: Average Annual Inflation Rate against Previous Year (CPI of All Consumables):

Year in Interval	Philippines	NCR	AONCR
1960 – 1969	3.82	3.84	3.88
1970 – 1979	14.54	13.06	15.01
1980 – 1989	15.21	15.43	15.08
1990 – 1999	9.24	10.39	8.83
2000 – 2008	5.46	5.49	5.46
1960 – 2008	**9.74**	**9.73**	**9.74**

Remarks 2: Average Annual increasing Rate of WPI, PPIs against Previous Year

Year in Interval	WPI-Construction Materials	PPI-Paddy	PPI-Corn	PPI-Industries	**Reference**: CPI-Cereal Preparations
1960 – 1969	5.58%	4.89%	4.52%	2.25%	6.09%
1970 – 1979	5.65%	4.93%	4.55%	2.29%	5.92%
1980 – 1989	5.68%	4.93%	4.59%	2.27%	6.00%
1990 – 1999	5.52%	5.00%	4.64%	2.30%	6.17%
2000 – 2008	7.39%	4.17%	5.00%	2.66%	6.25%
1960 – 2009	**5.97%**	**4.78%**	**4.66%**	**2.36%**	**6.09%**

Note 1: Figures from 1960 to 1984 for Wholesale Price Index for Construction Materials are estimated by means of extrapolation based on given figures after 1985.

Note 2: Wholesale Price Index consisting of (1) Sand, stone and gravel, (2) Cement, (3) Lumber, (4) Plywood, (5) Wood products, (6) Fuels and lubricants, (7) Asphalt, (8) Glass and glass products, (9) Hardware, (10) Metal pipes, (11) Polyvinyl chloride (PVC) pipes, (12) Concrete products, (13) Plumbing fixtures, (14) Paints, (15) Reinforcing steel, (16) Structural steel, (17) Galvanized iron (G.I.) sheets, (18) Aluminum and other metal products, (19) Exterior electrical equipment and supplies, (20) Interior electrical fixtures and devices, (21) Tile works, (22) Blasting materials, (23) Machinery and equipment rental, (24) Electrical rough-in materials, (25) UPVC water pipes according to the NSCB.

Note 3: Note 3: Figures from 1960 to 1993 for Producer's Price Index Paddy, Corn and Industries are estimated by means of extrapolation based on given figures after 1994.

Note 4: Note 4: PPI of Industries represents "Wood & Wooden Products, Cement, and Fabricated Metal Products".

Source: National Statistic Cordination Board (NSCB).

Annex-T B.3.5.1 Financial Status of Each Municipality/City

(Peso)

Province/Particular	2004	2005	2006	2007	2008
Bulacan					
Angat					
Income	56,213,615	53,468,487	63,508,345	65,323,129	80,788,937
Total Local Sources	16,490,183	18,128,058	21,029,806	21,468,373	26,279,706
Total Shares from National Tax Collections	39,723,432	35,340,430	42,478,539	43,854,756	54,509,231
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	56,983,474	54,546,930	56,719,234	61,962,520	69,731,695
Balance	-769,859	-1,078,443	6,789,112	3,360,609	11,057,242
Baliuag					
Income	119,066,000	136,702,000	145,141,086	157,547,706	186,487,681
Total Local Sources	52,671,000	64,569,000	65,953,312	69,860,044	83,188,671
Total Shares from National Tax Collections	66,395,000	72,133,000	79,187,774	87,687,662	103,299,010
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	116,834,000	133,860,000	148,721,697	157,436,501	169,031,536
Balance	2,232,000	2,842,000	-3,580,611	111,205	17,456,145
Bulacan					
Income	54,499,000	62,245,000	70,260,556	76,413,122	78,966,894
Total Local Sources	13,667,000	17,970,000	18,417,857	15,636,334	15,620,745
Total Shares from National Tax Collections	40,832,000	44,275,000	51,842,699	60,776,788	63,346,149
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	52,861,000	54,701,000	59,504,579	68,381,658	89,838,053
Balance	1,638,000	7,544,000	10,755,977	8,031,464	-10,871,159
Bustos					
Income	43,034,031	n.a	53,944,715	56,414,714	72,639,258
Total Local Sources	9,499,825		10,948,460	11,902,352	13,066,794
Total Shares from National Tax Collections	33,534,206		42,996,255	44,512,362	59,572,464
Loans & Borrowings	0		0	0	0
Inter-Local Transfers	0		0	0	0
Expenditures	41,249,767		50,770,084	56,638,169	63,640,729
Balance	1,784,264		3,174,631	-223,455	8,998,528
Calumpit					
Income	92,150,000	103,030,000	117,858,995	117,505,941	138,904,126
Total Local Sources	42,959,000	49,683,000	53,408,246	52,253,188	56,740,140
Total Shares from National Tax Collections	49,191,000	53,347,000	64,450,750	65,252,753	82,163,986
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	104,648,000	107,303,000	107,255,988	113,257,921	138,700,839
Balance	-12,498,000	-4,273,000	10,603,007	4,248,021	203,287
Dona Remedios Trinidad					
Income	61,408,000	61,313,000	61,979,623	71,594,168	83,539,803
Total Local Sources	5,188,000	6,437,000	5,272,168	4,469,866	4,066,084
Total Shares from National Tax Collections	56,220,000	54,876,000	56,707,455	67,124,302	79,473,718
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	46,775,000	55,450,000	58,743,118	45,673,405	57,148,809
Balance	14,633,000	5,863,000	3,236,505	25,920,763	26,390,994
Guiguinto					
Income	85,035,000	95,909,000	107,006,022	113,616,730	144,507,855
Total Local Sources	43,701,000	50,946,000	53,501,050	58,106,084	69,575,557
Total Shares from National Tax Collections	41,334,000	44,963,000	53,504,972	55,510,645	74,932,298
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0

Expenditures	81,548,000	87,500,000	99,838,093	116,300,418	130,592,343
Balance	3,487,000	8,409,000	7,167,929	-2,683,688	13,915,513
Hagonoy					
Income	86,856,000	100,963,508	101,904,792	112,765,376	131,452,465
Total Local Sources	24,572,000	33,116,026	25,434,186	26,428,797	30,705,260
Total Shares from National Tax Collections	62,284,000	67,847,482	76,470,606	86,336,579	100,747,205
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	83,562,000	100,148,129	95,214,870	100,528,525	130,168,192
Balance	3,294,000	815,379	6,689,922	12,236,851	1,284,273
Mololos City					
Income	331,760,326	328,688,359	371,571,471	385,985,336	434,981,268
Total Local Sources	140,481,083	123,624,003	135,928,433	138,220,793	156,393,146
Total Shares from National Tax Collections	191,279,243	205,064,355	235,643,037	247,764,542	278,588,122
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	281,333,443	283,599,335	379,772,956	351,343,053	439,291,431
Balance	50,426,883	45,089,024	-8,201,486	34,642,282	-4,310,163
Norzagaray					
Income	140,288,000	185,774,881	211,262,641	211,262,641	237,816,172
Total Local Sources	81,789,000	123,406,669	139,132,797	139,132,797	115,029,598
Total Shares from National Tax Collections	58,499,000	62,368,212	72,129,844	72,129,844	102,905,776
Loans & Borrowings	0	0	0	0	19,880,798
Inter-Local Transfers	0	0	0	0	0
Expenditures	129,621,000	150,113,016	217,374,772	217,374,772	245,228,245
Balance	10,667,000	35,661,865	-6,112,131	-6,112,131	-7,412,073
Pandi					
Income	47,897,000	50,330,000	88,575,664	61,104,943	72,099,300
Total Local Sources	16,064,000	15,799,000	27,005,811	19,135,423	19,232,364
Total Shares from National Tax Collections	31,833,000	34,531,000	61,569,853	41,969,520	52,866,936
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	42,986,000	53,382,000	73,456,543	53,523,157	56,755,078
Balance	4,911,000	-3,052,000	15,119,121	7,581,787	15,344,221
Paombong					
Income	41,142,968	44,421,371	52,203,532	52,093,348	60,950,713
Total Local Sources	11,359,744	12,223,718	11,867,277	13,021,679	8,735,745
Total Shares from National Tax Collections	29,783,224	32,197,653	38,093,005	39,071,669	52,214,968
Loans & Borrowings	0	0	2,243,250	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	37,206,570	50,648,204	53,153,164	50,049,748	59,307,366
Balance	3,936,398	-6,226,833	-949,632	2,043,600	1,643,346
Plaridel					
Income	84,137,000	101,374,000	106,191,319	115,131,446	126,708,682
Total Local Sources	36,322,000	47,599,000	50,112,745	52,191,572	53,846,100
Total Shares from National Tax Collections	47,815,000	53,775,000	56,078,574	62,939,874	72,862,583
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	60,636,000	64,875,000	86,916,520	83,338,854	104,943,204
Balance	23,501,000	36,499,000	19,274,798	31,792,592	21,765,478
Pulilan					
Income	84,224,250	127,543,686	122,535,340	131,306,922	154,921,474
Total Local Sources	42,340,680	57,112,811	68,862,571	74,346,076	84,190,122
Total Shares from National Tax Collections	41,883,570	70,430,875	53,672,769	56,960,846	70,731,352
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	90,459,100	120,409,030	97,009,214	124,145,778	131,999,415
Balance	-6,234,850	7,134,656	25,526,126	7,161,144	22,922,059

San Ildefonso						
	Income	63,355,137	76,079,345	81,568,882	88,678,785	102,503,623
	Total Local Sources	16,231,354	20,881,823	20,093,341	20,429,403	23,137,130
	Total Shares from National Tax Collections	47,123,783	55,197,522	61,475,541	68,249,382	79,366,493
	Loans & Borrowings	0	0	0	0	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	69,586,140	70,835,002	80,100,542	78,547,918	97,637,307
	Balance	-6,231,004	5,244,343	1,468,340	10,130,867	4,866,316
San Miguel						
	Income	101,717,831	113,301,208	121,165,520	128,726,899	146,557,727
	Total Local Sources	26,056,656	31,447,000	30,494,670	29,011,880	31,066,595
	Total Shares from National Tax Collections	75,661,176	81,854,208	90,670,851	99,715,020	115,491,132
	Loans & Borrowings	0	0	0	0	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	109,533,687	89,062,336	101,058,590	101,795,990	110,661,326
	Balance	-7,815,855	24,238,872	20,106,931	26,930,910	35,896,401
San Rafael						
	Income	62,894,000	74,252,525	76,705,002	91,554,670	106,259,548
	Total Local Sources	15,952,000	23,061,656	20,203,809	26,796,319	28,322,453
	Total Shares from National Tax Collections	46,942,000	51,190,869	56,501,193	64,758,351	77,937,096
	Loans & Borrowings	0	0	0	0	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	58,126,000	59,399,066	67,074,480	80,103,930	89,990,461
	Balance	4,768,000	14,853,458	9,630,522	11,450,741	16,269,088
Santa Maria						
	Income	156,717,000	188,738,000	204,371,183	213,001,937	279,135,655
	Total Local Sources	78,039,000	103,154,000	104,931,043	108,704,081	126,819,194
	Total Shares from National Tax Collections	78,678,000	85,584,000	99,440,140	104,297,856	152,316,461
	Loans & Borrowings	0	0	0	0	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	156,408,000	147,982,000	234,168,202	226,110,043	226,269,753
	Balance	309,000	40,756,000	-29,797,019	-13,108,105	52,865,902
Pampanga						
Angeles City						
	Income	533,971,400	610,327,706	676,006,795	705,817,486	825,671,722
	Total Local Sources	196,667,020	210,136,778	259,933,903	347,626,419	417,377,348
	Total Shares from National Tax Collections	281,464,257	295,416,303	352,526,976	358,191,067	383,087,607
	Loans & Borrowings	55,840,124	104,774,625	63,545,916	-	25,206,767
	Inter-Local Transfers	0	0	0	-	0
	Expenditures	583,519,762	666,096,845	597,940,281	715,901,855	737,382,674
	Balance	-49,548,361	-55,769,139	78,066,513	-10,084,369	88,289,048
Apalit						
	Income	68,881,000	89,144,373	100,980,764	96,923,594	116,572,256
	Total Local Sources	21,387,000	25,496,479	29,423,875	31,579,352	35,311,993
	Total Shares from National Tax Collections	47,494,000	51,547,894	60,327,525	62,630,742	81,260,263
	Loans & Borrowings	0	12,100,000	11,229,364	2,713,500	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	72,500,000	85,581,005	100,032,835	93,780,262	114,506,737
	Balance	-3,619,000	3,563,368	947,929	3,143,332	2,065,519
Arayat						
	Income	67,642,359	73,180,105	84,330,459	89,673,320	123,215,511
	Total Local Sources	5,847,467	6,342,264	5,403,216	5,423,510	9,518,657
	Total Shares from National Tax Collections	61,794,892	66,837,841	78,927,243	84,249,810	113,696,854
	Loans & Borrowings	0	0	0	0	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	71,080,082	72,084,304	81,997,030	89,657,089	117,717,836
	Balance	-3,437,724	1,095,802	2,333,429	16,232	5,497,675
Bacolor						

Income	48,528,000	45,739,454	44,333,499	45,094,350	55,397,855
Total Local Sources	28,103,000	23,833,368	20,672,834	18,951,935	20,900,321
Total Shares from National Tax Collections	20,425,000	21,906,086	23,660,665	26,142,415	34,497,534
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	47,232,000	45,331,118	44,230,846	47,218,536	53,527,105
Balance	1,296,000	408,336	102,653	-2,124,186	1,870,750
Candaba					
Income	59,787,495	65,564,316	79,559,513	83,737,728	96,898,651
Total Local Sources	3,542,631	4,597,500	4,702,050	6,025,879	7,553,149
Total Shares from National Tax Collections	56,244,864	60,966,816	66,870,260	73,949,052	89,345,502
Loans & Borrowings	0	0	7,987,203	3,762,797	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	56,374,764	63,617,888	57,848,670	66,778,393	89,713,892
Balance	3,412,731	1,946,428	21,710,844	16,959,335	7,184,759
Floridablanca					
Income	69,313,776	77,422,702	83,483,710	97,363,911	
Total Local Sources	13,212,145	16,806,439	12,310,015	23,761,362	
Total Shares from National Tax Collections	56,101,631	60,616,263	71,173,695	73,602,550	
Loans & Borrowings	0	0	0	0	n.a
Inter-Local Transfers	0	0	0	0	
Expenditures	41,693,206	41,693,206	41,693,206	41,693,206	
Balance	27,620,570	35,729,495	41,790,503	55,670,705	
Guagua					
Income	83,035,829	87,840,566	99,366,023	101,431,913	118,221,679
Total Local Sources	25,804,615	25,960,623	26,101,935	25,476,828	26,161,000
Total Shares from National Tax Collections	57,231,215	61,879,943	73,264,088	75,955,086	85,330,182
Loans & Borrowings	0	0	0	0	6,730,497
Inter-Local Transfers	0	0	0	0	0
Expenditures	79,130,090	82,099,142	99,136,896	99,850,402	117,433,732
Balance	3,905,739	5,741,425	229,127	1,581,511	787,947
Lubao					
Income	89,894,000	95,042,000	109,447,871	115,580,955	138,700,007
Total Local Sources	13,943,000	13,923,000	15,858,273	16,964,452	19,448,915
Total Shares from National Tax Collections	75,951,000	81,119,000	93,589,597	98,616,503	119,251,091
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	82,809,000	91,635,000	108,273,546	118,100,760	134,918,899
Balance	7,085,000	3,407,000	1,174,325	-2,519,806	3,781,108
Mabalacat					
Income	155,008,493	159,754,389	217,593,697	215,732,935	348,280,123
Total Local Sources	63,127,561	62,273,542	92,965,863	95,560,830	84,358,434
Total Shares from National Tax Collections	91,880,931	97,480,847	124,627,834	120,172,105	263,921,690
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	131,408,766	137,017,050	196,206,839	210,089,169	213,059,095
Balance	23,599,726	22,737,339	21,386,858	5,643,766	135,221,028
Macabebe					
Income	54,557,000	59,776,904	69,642,039	71,257,369	93,361,511
Total Local Sources	15,510,000	16,414,570	17,585,581	15,910,682	12,226,988
Total Shares from National Tax Collections	39,047,000	43,362,334	52,056,458	55,346,687	81,134,523
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	54,175,000	59,611,173	68,778,917	69,679,760	92,580,772
Balance	382,000	165,731	863,121	1,577,608	780,739
Magalang					
Income	63,366,905	68,228,370	75,289,869	82,064,056	103,839,106
Total Local Sources	14,250,179	14,982,200	16,839,739	17,498,590	19,307,949

Total Shares from National Tax Collections	49,116,726	53,246,170	58,450,130	64,565,466	84,531,157
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	60,686,800	65,529,010	73,262,790	80,595,765	98,425,825
Balance	2,680,105	2,699,360	2,027,079	1,468,291	5,413,281
Masantol					
Income	40,335,295	44,394,970	51,284,422	52,432,686	82,250,697
Total Local Sources	7,391,461	8,705,380	9,262,764	7,119,309	7,858,392
Total Shares from National Tax Collections	32,943,834	35,689,590	42,021,658	45,313,377	74,392,305
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	37,712,800	43,282,608	47,627,671	49,793,708	82,187,794
Balance	2,622,495	1,112,362	3,656,751	2,638,978	62,903
Mexico					
Income	96,360,949	109,916,533	153,990,074	143,545,439	172,778,526
Total Local Sources	32,147,323	40,094,340	60,652,058	58,233,085	59,050,603
Total Shares from National Tax Collections	64,213,627	69,822,193	78,338,017	85,312,354	113,727,923
Loans & Borrowings	0	0	15,000,000	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	94,930,161	98,832,648	148,127,876	137,202,998	167,024,913
Balance	1,430,788	11,083,885	5,862,199	6,342,441	5,753,613
Minalin					
Income	31,193,489	32,727,110	32,727,110	39,901,718	49,835,223
Total Local Sources	3,562,651	3,354,807	3,354,807	4,381,894	5,917,681
Total Shares from National Tax Collections	27,630,838	29,372,303	29,372,303	35,519,824	43,917,542
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	33,065,893	32,613,158	32,613,158	32,989,110	48,848,648
Balance	-1,872,404	113,952	113,952	6,912,608	986,575
Porac					
Income	86,628,000	103,992,213	116,931,647	133,933,871	173,387,197
Total Local Sources	26,860,000	37,281,156	40,263,265	54,805,526	64,917,018
Total Shares from National Tax Collections	59,768,000	66,711,057	76,668,382	79,128,345	108,470,179
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	86,722,000	98,060,746	116,041,788	123,617,603	146,966,439
Balance	-94,000	5,931,467	889,859	10,316,268	26,420,758
City of San Fernando					
Income	410,744,724	478,513,795	676,070,518	672,962,809	646,686,925
Total Local Sources	189,313,188	244,819,578	394,450,573	315,255,827	330,724,826
Total Shares from National Tax Collections	221,431,536	233,694,217	257,154,945	282,953,287	304,334,235
Loans & Borrowings	0	0	24,465,000	74,753,695	11,627,864
Inter-Local Transfers	0	0	0	0	0
Expenditures	390,692,886	474,538,686	564,673,145	572,907,627	577,804,807
Balance	20,051,838	3,975,110	111,397,373	100,055,183	68,882,118
San Luis					
Income	33,693,002	36,519,551	42,023,617	43,773,038	53,216,468
Total Local Sources	3,034,507	3,360,300	3,256,556	3,674,462	4,498,209
Total Shares from National Tax Collections	30,658,495	33,159,251	38,767,061	40,098,576	48,718,259
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	34,940,630	28,717,231	37,859,601	51,731,089	45,454,401
Balance	-1,247,629	7,802,320	4,164,016	-7,958,051	7,762,067
San Simon					
Income	36,622,000	39,749,000	45,271,242	47,802,752	n.a
Total Local Sources	6,156,000	6,794,000	6,741,697	7,936,244	
Total Shares from National Tax Collections	30,466,000	32,955,000	38,529,545	39,866,508	
Loans & Borrowings	0	0	0	0	

		Inter-Local Transfers	0	0	0	0	
		Expenditures	31,294,000	37,009,000	43,139,449	46,731,042	
		Balance	5,328,000	2,740,000	2,131,793	1,071,709	
	Santa Ana						
		Income		33,453,290	45,998,987	43,522,527	51,436,122
		Total Local Sources		2,995,595	3,586,993	3,602,420	4,617,798
		Total Shares from National Tax Collections		30,457,695	42,411,993	39,920,107	46,818,324
		Loans & Borrowings	n.a	0	0	0	0
		Inter-Local Transfers		0	0	0	0
		Expenditures		30,549,850	43,516,311	36,619,362	36,451,473
		Balance		2,903,440	2,482,676	6,903,166	14,984,648
	Santa Rita						
		Income	28,317,000	30,852,000	35,678,000	38,719,123	45,317,609
		Total Local Sources	2,649,000	2,902,000	3,209,000	4,281,880	5,165,203
		Total Shares from National Tax Collections	25,668,000	27,950,000	32,469,000	34,437,243	40,152,405
		Loans & Borrowings	0	0	0	0	0
		Inter-Local Transfers	0	0	0	0	0
		Expenditures	25,322,000	25,683,000	27,261,000	40,182,109	43,660,763
		Balance	2,995,000	5,169,000	8,417,000	-1,462,986	1,656,846
	Santo Tomas						
		Income	29,292,810	31,496,883	36,790,080	38,761,079	49,466,301
		Total Local Sources	4,197,380	4,377,776	5,054,345	6,010,663	9,394,216
		Total Shares from National Tax Collections	25,095,430	27,119,107	31,735,735	32,750,416	40,072,085
		Loans & Borrowings	0	0	0	0	0
		Inter-Local Transfers	0	0	0	0	0
		Expenditures	29,025,980	31,699,521	36,115,245	38,728,612	48,110,650
		Balance	266,830	-202,638	674,835	32,466	1,355,651
	Sasmuan						
		Income	26,049,162	28,215,837	33,397,508	33,397,508	38,347,886
		Total Local Sources	2,796,390	3,120,084	3,902,268	3,902,268	2,989,273
		Total Shares from National Tax Collections	23,252,772	25,095,753	29,495,240	29,495,240	35,358,613
		Loans & Borrowings	0	0	0	0	0
		Inter-Local Transfers	0	0	0	0	0
		Expenditures	25,812,062	26,970,856	32,679,115	32,679,115	37,585,100
		Balance	237,100	1,244,980	718,392	718,392	762,786
Nueva Ecija							
	Aliaga						
		Income	40,499,875	42,986,705	63,884,919	52,608,523	79,614,097
		Total Local Sources	3,537,029	3,663,694	4,368,079	4,593,828	7,575,566
		Total Shares from National Tax Collections	36,962,846	39,323,011	59,516,840	47,514,695	64,688,531
		Loans & Borrowings	0	0	0	0	7,350,000
		Inter-Local Transfers	0	0	0	500,000	0
		Expenditures	34,394,709	37,076,050	45,164,951	46,432,118	48,219,014
		Balance	6,105,166	5,910,655	18,719,968	6,176,405	31,395,083
	Bongabon						
		Income	61,724,000	49,934,191	60,595,147	61,024,923	83,646,562
		Total Local Sources	3,740,000	3,099,597	5,352,647	4,351,287	6,447,390
		Total Shares from National Tax Collections	43,136,000	46,834,594	55,242,501	56,673,635	77,199,172
		Loans & Borrowings	14,848,000	0	0	0	0
		Inter-Local Transfers	0	0	0	0	0
		Expenditures	52,802,000	54,604,548	56,369,092	58,146,700	69,850,576
		Balance	8,922,000	-4,670,357	4,226,056	2,878,222	13,795,986
	Cabanatuan City						
		Income	339,605,316	450,917,180	602,582,423	567,852,304	612,676,048
		Total Local Sources	121,254,861	156,421,942	246,043,369	210,012,916	236,012,315
		Total Shares from National Tax Collections	218,350,455	294,495,238	356,539,054	357,839,387	376,663,732
		Loans & Borrowings	0	0	0	0	0
		Inter-Local Transfers	0	0	0	0	0

Expenditures	450,874,913	381,627,290	585,303,001	598,147,031	711,489,478
Balance	##########	69,289,889	17,279,422	-30,294,728	-98,813,431
Cabiao					
Income	47,699,233	51,707,328	61,136,438	64,355,100	75,922,351
Total Local Sources	5,121,788	5,582,478	7,190,187	8,371,684	9,191,021
Total Shares from National Tax Collections	42,577,445	46,124,850	53,946,251	55,983,416	66,731,330
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	51,037,066	47,632,025	58,016,159	64,801,018	74,251,654
Balance	-3,337,833	4,075,303	3,120,280	-445,918	1,670,697
Carranglan					
Income	52,208,763	56,438,657	64,425,205	67,928,709	67,928,709
Total Local Sources	2,309,794	2,515,035	3,164,637	2,341,761	2,341,761
Total Shares from National Tax Collections	49,898,969	53,923,622	61,260,568	65,586,948	65,586,948
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	41,947,191	41,312,651	56,484,974	55,909,292	55,909,292
Balance	10,261,572	15,126,006	7,940,231	12,019,417	12,019,417
Gabaldon					
Income	37,231,684	48,141,460	41,291,078	42,599,941	59,831,924
Total Local Sources	1,412,852	1,679,503	1,931,295	1,826,077	2,137,560
Total Shares from National Tax Collections	33,139,532	35,641,257	39,359,783	40,773,864	45,975,528
Loans & Borrowings	2,679,300	10,820,700	0	0	11,718,836
Inter-Local Transfers	0	0	0	0	0
Expenditures	33,506,946	47,830,159	41,936,907	41,736,036	56,267,603
Balance	3,724,739	311,302	-645,829	863,905	3,564,320
Gapan					
Income	189,898,975	205,465,123	230,808,257	249,182,228	253,030,127
Total Local Sources	25,272,811	30,974,406	34,254,986	37,925,979	39,256,018
Total Shares from National Tax Collections	164,626,164	174,490,717	196,553,270	211,256,249	213,774,109
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	243,483,167	180,460,986	197,511,379	216,634,039	227,322,911
Balance	-53,584,192	25,004,136	33,296,878	32,548,189	25,707,216
Gen. Mamerto Natividad					
Income	34,275,000	29,802,944	32,985,524	36,186,373	47,321,494
Total Local Sources	2,284,000	2,513,768	3,466,280	3,164,066	5,805,721
Total Shares from National Tax Collections	31,991,000	27,289,176	29,519,244	33,022,307	41,515,773
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	27,140,000	28,469,366	37,690,536	30,011,378	49,262,377
Balance	7,135,000	1,333,578	-4,705,013	6,174,995	-1,940,883
General Tinio					
Income	n.a	53,814,352	59,561,551	66,163,557	75,187,214
Total Local Sources		4,105,900	5,452,229	5,902,050	5,713,908
Total Shares from National Tax Collections		49,708,452	54,109,322	60,261,506	69,473,305
Loans & Borrowings		0	0	0	0
Inter-Local Transfers		0	0	0	0
Expenditures		47,966,795	55,578,721	61,397,677	76,014,001
Balance		5,847,557	3,982,831	4,765,880	-826,787
Guimba					
Income	74,287,000	81,726,384	92,550,611	97,816,323	118,105,436
Total Local Sources	12,287,000	14,290,715	16,384,253	16,623,784	21,901,041
Total Shares from National Tax Collections	62,000,000	67,435,669	76,166,359	81,192,539	96,204,395
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	72,451,000	77,926,273	80,087,494	96,578,364	112,573,567
Balance	1,836,000	3,800,110	12,463,118	1,237,959	5,531,868

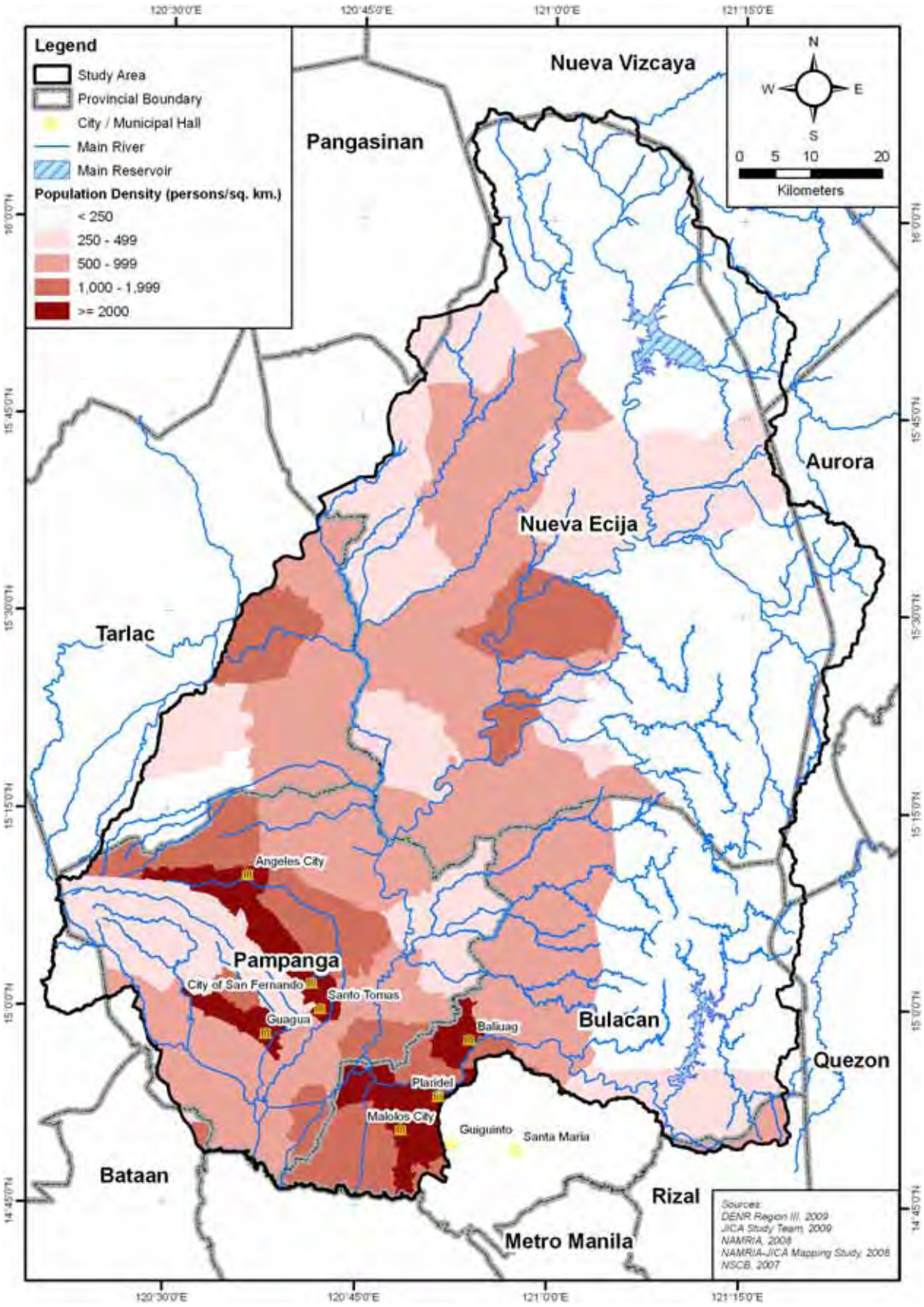
Jaen						
	Income	43,820,000	50,172,000	50,172,000	60,294,060	75,874,395
	Total Local Sources	2,374,000	3,475,000	3,475,000	8,128,625	11,960,188
	Total Shares from National Tax Collections	41,446,000	43,797,000	43,797,000	52,165,435	63,914,208
	Loans & Borrowings	0	2,900,000	2,900,000	0	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	43,835,000	49,541,000	49,541,000	53,797,857	75,014,484
	Balance	-15,000	631,000	631,000	6,496,203	859,911
Laur						
	Income	n.a	36,345,291	40,697,358	40,697,358	61,668,897
	Total Local Sources		3,634,576	2,554,559	2,554,559	3,461,375
	Total Shares from National Tax Collections		32,710,715	38,142,799	38,142,799	50,142,096
	Loans & Borrowings		0	0	0	8,065,426
	Inter-Local Transfers		0	0	0	0
	Expenditures		28,379,354	19,661,343	19,661,343	61,359,485
	Balance		7,965,938	21,036,015	21,036,015	309,412
Licab						
	Income	31,027,272	26,446,164	25,611,904	37,010,933	45,046,322
	Total Local Sources	1,226,269	1,454,859	1,271,250	2,398,373	2,939,790
	Total Shares from National Tax Collections	21,814,048	24,991,305	24,340,654	28,027,560	34,416,532
	Loans & Borrowings	7,986,955	0	0	6,585,000	7,690,000
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	25,219,715	27,507,298	27,507,298	32,473,252	53,242,502
	Balance	5,807,558	-1,061,134	-1,895,394	4,537,681	-8,196,181
Llanera						
	Income	36,675,154	33,497,734	53,728,617	41,538,532	53,410,540
	Total Local Sources	2,916,070	3,484,832	4,613,844	4,518,707	5,489,337
	Total Shares from National Tax Collections	27,759,084	30,012,902	35,908,810	37,019,825	47,921,202
	Loans & Borrowings	6,000,000	0	13,205,963	0	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	30,398,389	32,197,424	44,054,453	41,060,891	50,743,006
	Balance	6,276,764	1,300,309	9,674,164	477,641	2,667,534
Lupao						
	Income	34,711,000	32,705,321	42,034,923	42,816,186	51,316,542
	Total Local Sources	5,157,000	3,501,645	4,801,399	4,180,802	5,073,397
	Total Shares from National Tax Collections	29,554,000	29,203,676	37,233,524	38,635,384	46,243,145
	Loans & Borrowings	0	0	0	0	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	40,048,000	35,395,363	40,293,380	39,822,048	47,895,799
	Balance	-5,337,000	-2,690,043	1,741,543	2,994,138	3,420,743
Science City of Munos						
	Income	223,221,822	185,225,363	209,714,124	295,916,938	225,348,975
	Total Local Sources	18,406,132	19,752,340	19,693,359	18,785,025	22,979,817
	Total Shares from National Tax Collections	150,815,690	150,473,023	175,020,766	198,399,212	202,369,158
	Loans & Borrowings	54,000,000	15,000,000	15,000,000	78,732,700	0
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	208,511,417	217,633,144	216,495,888	293,832,245	194,769,125
	Balance	14,710,406	-32,407,781	-6,781,764	2,084,693	30,579,850
Palayan City						
	Income	117,342,000	130,669,000	151,219,064	200,268,000	183,367,000
	Total Local Sources	4,289,000	5,884,000	6,714,652	5,114,000	5,488,000
	Total Shares from National Tax Collections	113,053,000	119,670,000	144,504,412	170,154,000	156,771,000
	Loans & Borrowings	0	5,115,000	0	25,000,000	21,108,000
	Inter-Local Transfers	0	0	0	0	0
	Expenditures	114,348,000	130,581,000	148,830,278	181,663,000	157,177,000
	Balance	2,994,000	88,000	2,388,786	18,605,000	26,190,000
Pantabangan						
	Income	n.a	180,121,648	101,145,522	n.a	258,175,615

Total Local Sources		139,205,220	54,702,144		198,222,558
Total Shares from National Tax Collections		40,916,429	46,443,377		59,953,057
Loans & Borrowings		0	0		0
Inter-Local Transfers		0	0		0
Expenditures		44,767,499	198,460,431		259,004,164
Balance		135,354,149	-97,314,910		-828,549
Penaranda					
Income	26,374,235	29,205,729		35,761,831	41,966,532
Total Local Sources	1,973,088	2,296,832		4,446,112	5,146,739
Total Shares from National Tax Collections	24,401,147	26,908,897		31,315,719	36,819,793
Loans & Borrowings	0	0	n.a	0	0
Inter-Local Transfers	0	0		0	0
Expenditures	29,317,220	30,301,933		36,571,971	40,485,049
Balance	-2,942,985	-1,096,204		-810,140	1,481,484
Quezon					
Income	51,312,508	59,704,561	64,116,646	74,901,603	73,564,367
Total Local Sources	2,423,498	2,402,618	3,186,270	4,514,584	4,086,507
Total Shares from National Tax Collections	48,889,010	57,301,942	60,930,377	70,387,019	39,517,204
Loans & Borrowings	0	0	0	0	29,960,655
Inter-Local Transfers	0	0	0	0	0
Expenditures	39,039,271	46,543,470	56,988,768	44,792,601	73,834,804
Balance	12,273,237	13,161,091	7,127,878	30,109,002	-270,437
Rizal					
Income	41,978,038	45,609,814	71,775,431	69,943,308	69,893,288
Total Local Sources	4,968,773	5,632,559	7,317,079	7,316,640	10,024,446
Total Shares from National Tax Collections	37,009,265	39,977,255	48,458,352	62,626,668	56,730,035
Loans & Borrowings	0	0	16,000,000	0	3,138,806
Inter-Local Transfers	0	0	0	0	0
Expenditures	43,678,109	46,153,225	71,821,128	68,807,577	67,098,188
Balance	-1,700,071	-543,411	-45,698	1,135,731	2,795,100
San Antonio					
Income	50,332,274	54,795,744	61,766,045	65,947,041	78,460,991
Total Local Sources	4,623,848	5,547,255	6,459,419	6,421,485	8,923,159
Total Shares from National Tax Collections	45,708,426	49,248,489	55,306,626	59,525,556	69,537,832
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	45,552,553	42,213,938	56,815,205	60,961,090	60,206,745
Balance	4,779,721	12,581,806	4,950,840	4,985,951	18,254,246
San Isidro					
Income	38,383,269	44,313,649	35,886,308	54,044,016	61,749,956
Total Local Sources	7,169,893	10,909,112	11,110,485	14,200,836	12,126,677
Total Shares from National Tax Collections	30,713,376	31,620,980	24,775,823	39,843,180	49,623,279
Loans & Borrowings	500,000	1,783,557	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	36,080,896	42,776,961	39,380,552	51,276,554	60,851,993
Balance	2,302,373	1,536,688	-3,494,244	2,767,462	897,963
San Jose City					
Income	294,677,499	255,593,751	301,569,928	306,654,355	315,530,071
Total Local Sources	59,400,509	63,499,639	70,309,233	73,957,877	79,550,171
Total Shares from National Tax Collections	189,531,504	192,094,112	231,260,695	232,696,478	235,979,900
Loans & Borrowings	45,745,485	0	0	-	0
Inter-Local Transfers	0	0	0	-	0
Expenditures	266,891,753	240,221,593	283,443,702	301,689,377	288,324,161
Balance	27,785,745	15,372,157	18,126,226	4,964,978	27,205,910
San Leonardo					
Income	63,320,637	60,714,408	66,791,340	72,401,891	158,227,580
Total Local Sources	17,334,597	17,033,035	20,942,324	21,895,355	26,847,206
Total Shares from National Tax Collections	39,986,040	43,681,373	45,849,016	50,506,536	131,380,374

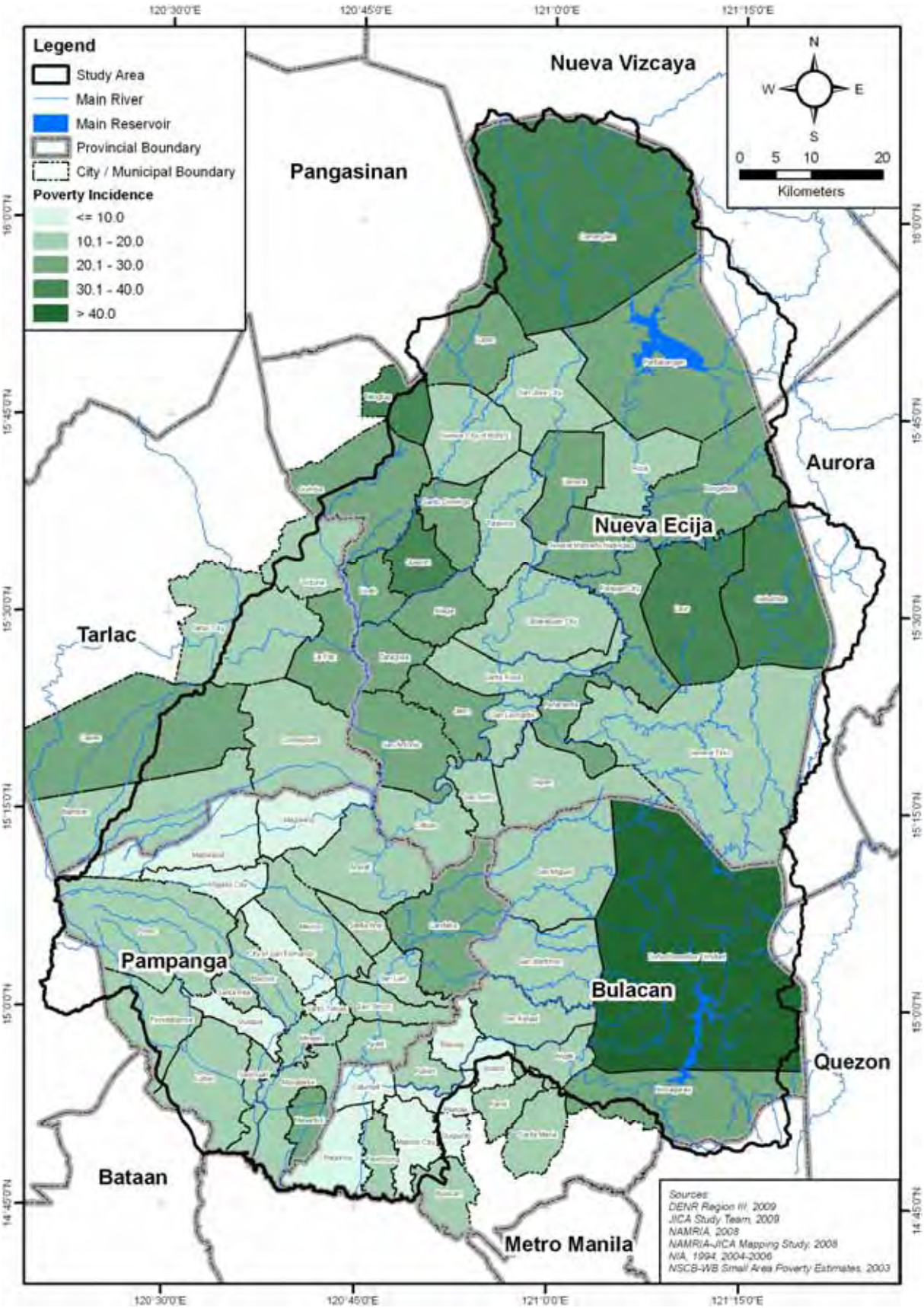
		Loans & Borrowings	6,000,000	0	0	0	0
		Inter-Local Transfers	0	0	0	0	0
	Expenditures		59,256,255	58,046,201	54,584,573	68,471,202	150,342,917
	Balance		4,064,381	2,668,207	12,206,767	3,930,690	7,884,663
Santa Rosa							
	Income		48,486,144	52,790,969	63,580,748		74,434,377
		Total Local Sources	9,144,367	9,889,115	12,417,577		14,598,249
		Total Shares from National Tax Collections	39,341,777	42,901,854	51,163,171		59,836,128
		Loans & Borrowings	0	0	0	n.a	0
		Inter-Local Transfers	0	0	0		0
	Expenditures		51,971,556	50,531,406	61,890,356		69,570,872
	Balance		-3,485,412	2,259,563	1,690,392		4,863,505
Santo Domingo							
	Income		38,811,000	41,695,216	49,199,586	50,643,077	59,247,788
		Total Local Sources	5,384,000	5,530,582	7,004,514	6,725,869	7,949,080
		Total Shares from National Tax Collections	33,427,000	36,164,634	42,195,072	43,917,207	48,509,699
		Loans & Borrowings	0	0	0	0	2,789,009
		Inter-Local Transfers	0	0	0	0	0
	Expenditures		36,626,000	38,333,842	45,159,321	49,313,406	60,158,521
	Balance		2,185,000	3,361,374	4,040,265	1,329,671	-910,733
Talavera							
	Income		76,729,160	107,533,523	99,430,946	105,875,672	145,506,886
		Total Local Sources	14,796,229	17,668,662	21,294,573	20,598,156	23,589,452
		Total Shares from National Tax Collections	61,932,931	89,864,861	78,136,373	81,008,499	97,460,915
		Loans & Borrowings	0	0	0	4,269,017	24,456,519
		Inter-Local Transfers	0	0	0	0	0
	Expenditures		77,959,367	79,261,168	93,042,405	129,274,942	137,730,017
	Balance		-1,230,207	28,272,356	6,388,540	-23,399,270	7,776,869
Talugtug							
	Income		23,407,993	25,667,612	30,004,744	30,424,163	34,958,329
		Total Local Sources	2,135,325	2,707,577	2,915,044	2,641,307	3,338,428
		Total Shares from National Tax Collections	21,272,668	22,960,035	27,089,700	27,782,856	31,552,401
		Loans & Borrowings	0	0	0	0	0
		Inter-Local Transfers	0	0	0	0	67,500
	Expenditures		23,226,550	25,286,511	29,952,012	31,219,305	37,390,615
	Balance		181,442	381,101	52,732	-795,142	-2,432,286
Zaragosa							
	Income		33,608,128	37,829,047	43,584,467	45,354,535	55,101,147
		Total Local Sources	3,577,562	5,376,516	6,050,329	6,190,582	7,119,154
		Total Shares from National Tax Collections	30,030,566	32,452,532	37,534,137	39,163,952	47,981,993
		Loans & Borrowings	0	0	0	0	0
		Inter-Local Transfers	0	0	0	0	0
	Expenditures		32,187,768	33,882,887	40,871,197	42,966,038	52,841,875
	Balance		1,420,361	3,946,161	2,713,270	2,388,496	2,259,272
Tarlac							
	Bamban						
		Income	46,460,836	55,917,232	57,748,632	63,547,807	77,122,733
			Total Local Sources	4,882,442	7,075,121	7,476,462	9,615,336	10,382,574
			Total Shares from National Tax Collections	41,578,394	45,344,111	50,272,170	53,932,471	66,740,159
			Loans & Borrowings	0	3,498,000	0	0	0
			Inter-Local Transfers	0	0	0	0	0
		Expenditures	41,323,376	54,836,153	53,750,881	59,337,020	69,156,958
		Balance	5,137,460	1,081,079	3,997,751	4,210,787	7,965,774
	Capas						
		Income	91,877,966	96,750,504	128,164,474	121,445,825	143,344,035
			Total Local Sources	19,806,425	21,249,205	32,654,081	23,592,933	23,068,741
			Total Shares from National Tax Collections	72,071,541	75,501,299	87,507,393	91,097,346	120,275,294
			Loans & Borrowings	0	0	8,003,000	6,755,546	0

Inter-Local Transfers	0	0	0	0	0
Expenditures	81,357,623	89,819,325	125,014,700	111,568,321	136,737,650
Balance	10,520,343	6,931,178	3,149,775	9,877,505	6,606,385
Concepcion					
Income	85,390,952	95,331,854	108,960,496	113,640,484	140,201,024
Total Local Sources	13,046,640	16,801,104	16,435,869	17,667,194	19,258,508
Total Shares from National Tax Collections	72,344,312	78,530,749	92,524,627	95,973,289	114,802,475
Loans & Borrowings	0	0	0	0	6,140,041
Inter-Local Transfers	0	0	0	0	0
Expenditures	41,693,206	41,693,206	41,693,206	41,693,206	41,693,206
Balance	43,697,746	53,638,648	67,267,290	71,947,278	98,507,818
La Paz					
Income	45,048,959	48,483,077	75,569,870	59,829,281	70,183,249
Total Local Sources	6,144,555	6,448,544	7,044,525	8,704,955	10,096,326
Total Shares from National Tax Collections	38,904,404	42,034,533	46,884,095	51,124,326	60,086,922
Loans & Borrowings	0	0	21,641,250	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	36,191,142	44,829,232	48,628,647	59,025,308	68,962,525
Balance	8,857,817	3,653,845	26,941,223	803,973	1,220,724
Tarlac City					
Income	459,139,644	505,438,537	661,260,849	701,782,818	753,588,425
Total Local Sources	132,907,709	169,201,452	160,808,708	172,362,152	195,019,073
Total Shares from National Tax Collections	326,231,935	336,237,085	405,783,340	424,258,891	424,135,974
Loans & Borrowings	0	0	94,668,801	105,161,775	134,433,379
Inter-Local Transfers	0	0	0	0	0
Expenditures	397,839,731	449,028,976	643,418,207	627,067,694	692,986,476
Balance	61,299,913	56,409,562	17,842,642	74,715,124	60,601,949
Victoria					
Income	44,806,654	43,703,666	57,890,267	67,538,620	70,984,909
Total Local Sources	7,937,773	8,398,491	13,124,649	13,407,019	15,345,740
Total Shares from National Tax Collections	36,868,882	35,305,175	44,765,618	54,131,601	55,639,169
Loans & Borrowings	0	0	0	0	0
Inter-Local Transfers	0	0	0	0	0
Expenditures	33,911,902	36,291,980	39,980,958	47,307,249	54,782,310
Balance	10,894,753	7,411,686	17,909,309	20,231,371	16,202,600

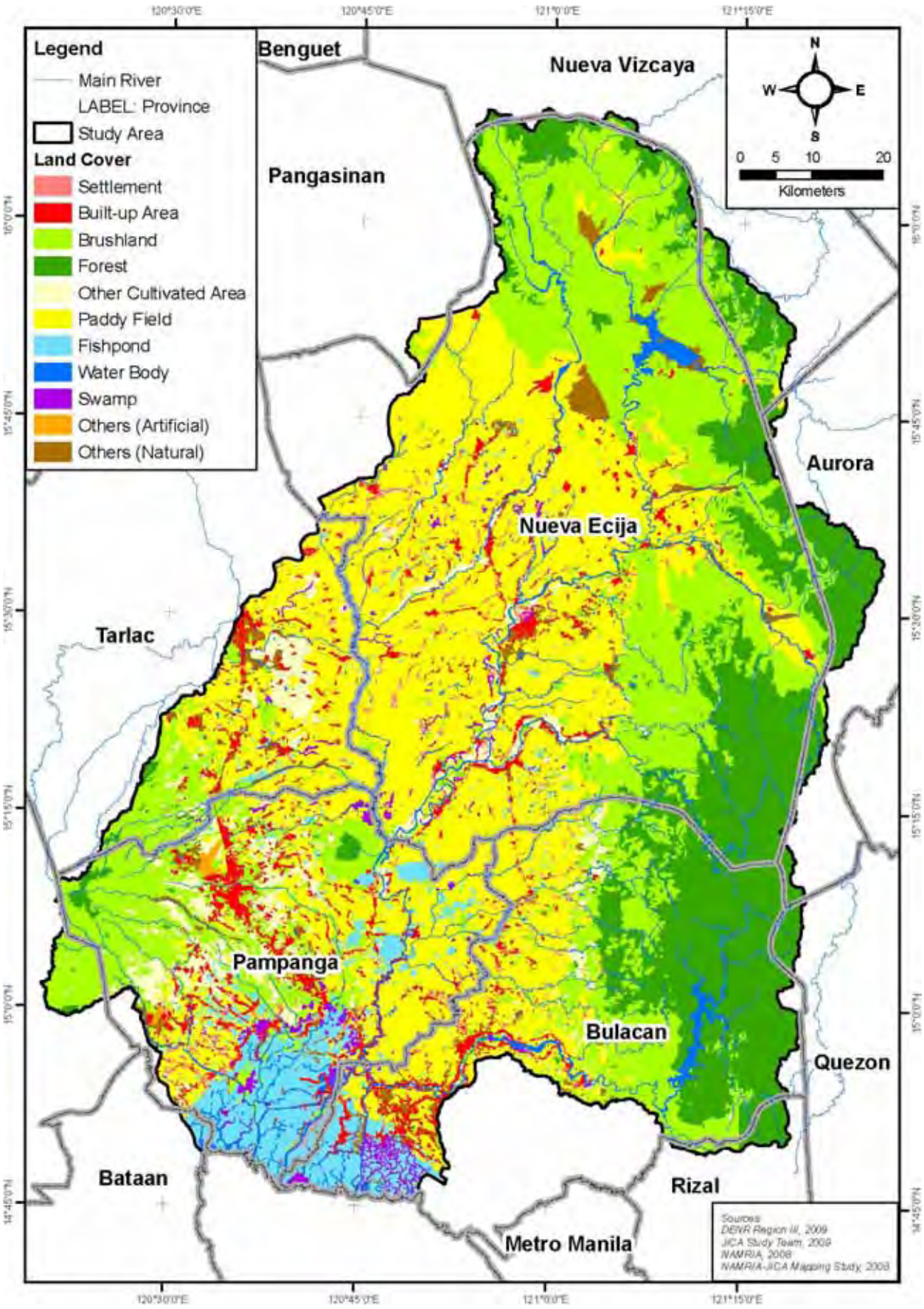
Annex-Figures



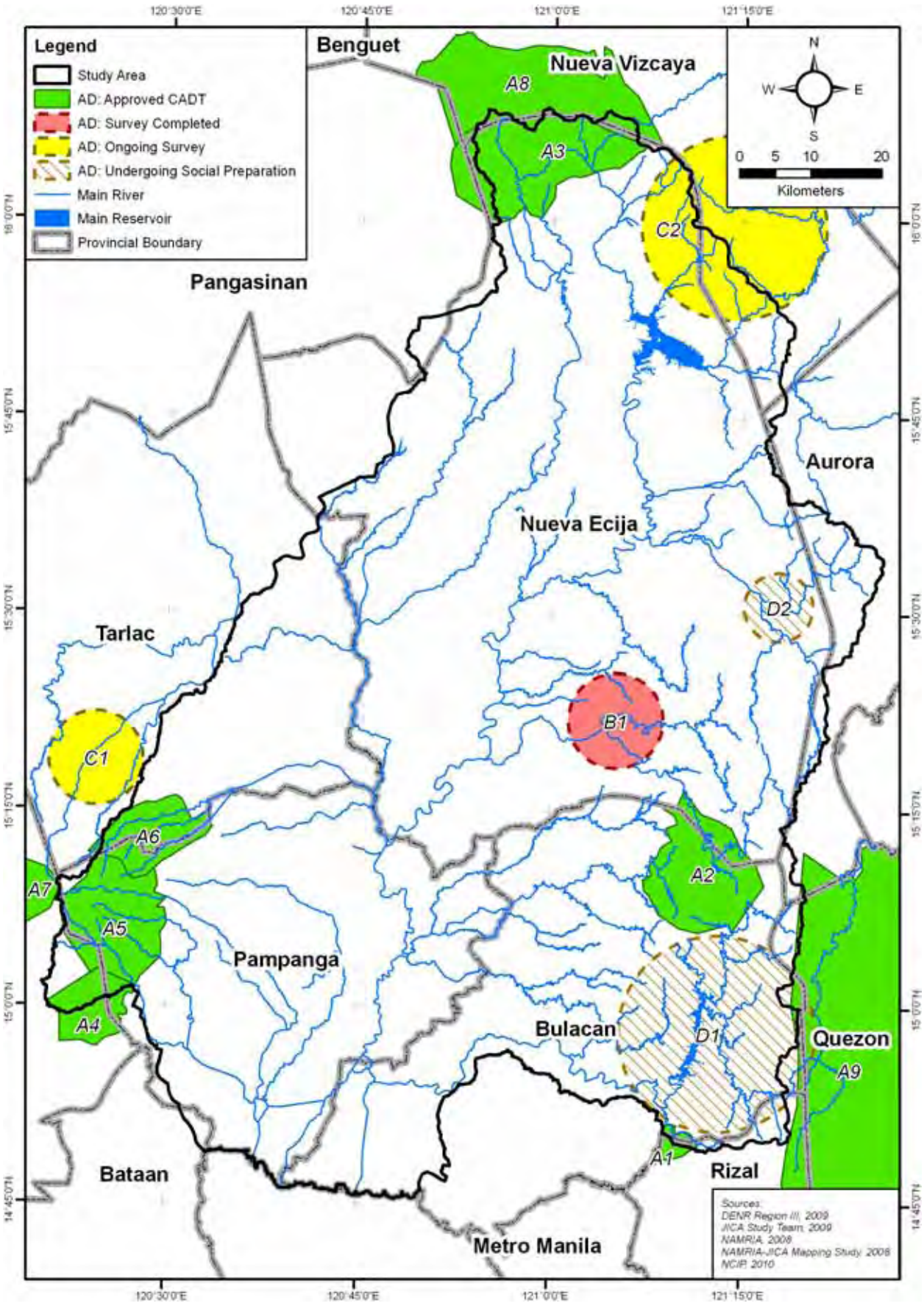
Annex-F B.1.1.1 Population Density of Each of Municipalities in the Study Area



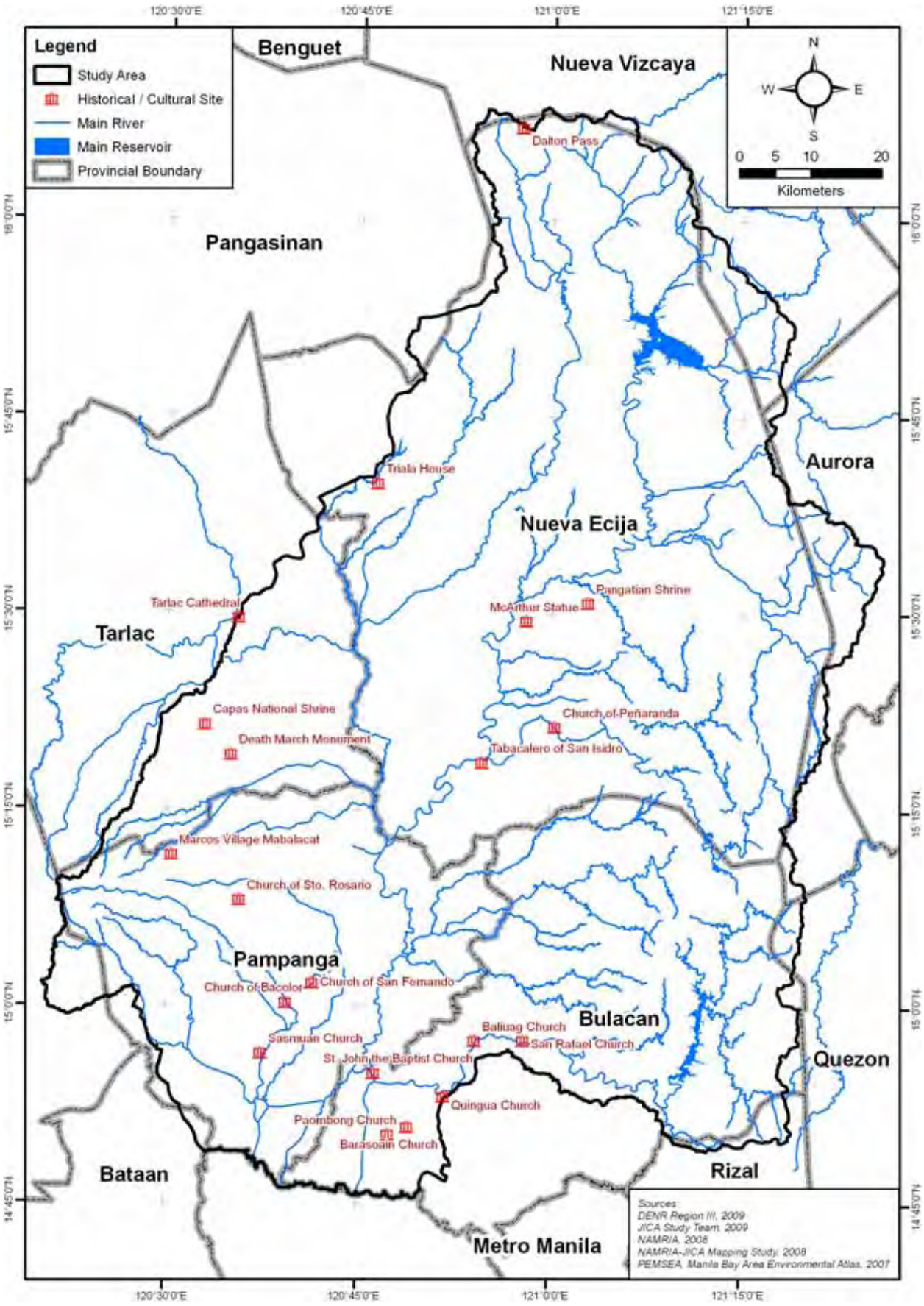
Annex-F B.1.2.1 Poverty Incidence of Each of Municipalities in the Study Area



Annex-F B.1.3.1 Land Cover in the Study Area



Annex-F B.1.5.1 Status of AD/AL (Ancestral Land) Delineation and Titling in and around the Study Area as of March 9, 2010



Annex-F B.1.6.1 Historical sites and landmarks in the Study Area