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SUMMARY REPORT

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JAPAN INTERNATIONAL [redacted]

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REPUBLIC OF THE PHILIPPINES
MINISTRY OF PUBLIC WORKS AND HIGHWAYS

THE PANAY RIVER BASIN-WIDE FLOOD CONTROL STUDY

SUMMARY REPORT

NOVEMBER 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

It is with great pleasure that I present to the Government of Republic of the Philippines this report entitled the Panay River Basin-wide Flood Control Study.

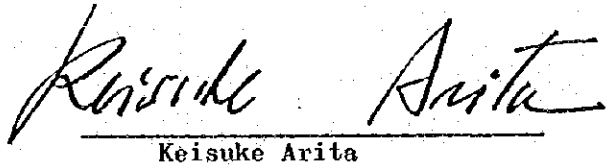
This report embodies the result of a survey which was carried out from August 1983 to November 1985 for the formulation of basin development plan placing emphasis on the flood control plan by a study team commissioned by the Japan International Cooperation Agency following the request of the Government of Philippines to the Government of Japan.

The study team, headed by Mr. Hirosuke Takahashi, had a series of discussions with the officials concerned of the Government of Philippines and conducted a wide scope of survey and data analyses.

I sincerely hope that this report will be useful as a basic reference for development of the Panay river basin as well as the country.

I wish to express my deep appreciation to the officials concerned of the Government of Philippines for their close cooperation extended to the study team.

November 1985



Keisuke Arita
President
Japan International
Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

November, 1985

Mr. Keisuke Arita
President,
Japan International Cooperation Agency,
Tokyo, Japan

Dear Sir,

We have the pleasure of submitting herewith the Final Report on the Panay River Basin-wide Flood Control Study.

For preparation of this report, field investigation and studies were made for about two years starting from August, 1983. The intermediate results of the studies were compiled into a series of reports and submitted to your Agency on schedule. During October 3 and October 12 of 1985, the survey team visited the Philippines again and had the meetings to discuss about the Draft Final Report with the officials of Philippine Government concerned. All the findings and comments obtained in the meetings have been fully incorporated in this Final Report.

The engineering and socio-economic studies of the Report on the level of Master Plan recommend some projects which are technically sound and economically feasible. It is our sincere hope that the projects will be proceeded to the next stage of study for the early realization of the project as soon as possible along the recommendations presented in this Report.

In submitting this report, we wish to express our sincere appreciation and gratitude to the personnel at your Agency, the Japanese Embassy in the Philippines, and the authorities concerned of the Government of Philippines represented by the Ministry of Public Works and Highways for the constant support and cooperation extended to us during our field survey as well as home office work.

Very truly yours,

H. Takahashi

Hirosuke Takahashi
Team Leader
Panay River Basin-wide
Flood Control Study
(Nippon Koei Co., Ltd.)

Notes

1. The currency equivalents applicable to this report are :

   US$ 1 = Peso (₱) 18 = Yen (¥) 234.

2. Construction cost estimates in this Study are expressed in financial costs at mid-1984 price levels.

SUMMARY OF PROPOSED DEVELOPMENT PROJECTS

1. Outlines of Proposed Development Projects

The purpose and timing of implementation of the proposed development projects can be outlined as follows:

1.1 Flood Control Project

(1) 1st Stage work (Short-term provisional plan)

River improvement

River improvements for this stage would comprise the following:

(a) Cogon bypass floodway (9.5 km):
This plan would provide for a bypass floodway from 4 km downstream of Panitan to the mouth of the Hamulauon river. Flood flow exceeding the bankful capacity of the Pontevedra river of 500 m^3/sec would be diverted by this floodway.

(b) River improvement of the Pontevedra river (6.1 km):
This would provide partial improvement of the Pontevedra river from the entrance to the floodway to Pontevedra town. The channel section, where the carrying capacity is less than 500 m^3/sec, would be widened and eroded banks would be revetted.

(c) The stretch between Panitan and Cogon floodway entrance (6.5 km):
The low flow capacity of the river would be expanded by improvement of the existing river channel. Levees would be constructed on the both banks.

By this improvement work, the areas downstream of Panitan town (including the Panitan - Panay irrigation area) would be relieved of flood damages caused by floods of less than 10-year recurrence.

Polder dykes

Polder dykes would be embanked to alleviate flood damages at 4 towns/villages with high flood damage potentiality, i.e. Dao, Cuartero, Mambusao and Sigma.

Multipurpose dam

The Panay B dam would be constructed to reduce flood flows downstream of the dam. The dam is conceived as a multipurpose dam with a power station equipped with 7,100 kW generating facilities.

Non-structural measures

(a) Flood plain management

In areas upstream of Panitan (flood vulnerable area 220 km^2), where flood control projects by structural measures will not be carried out for the time being, development should be regulated to avoid any increase in the risks of future flood damage. For areas downstream of Panitan too (flood vulnerable area 118 km^2), appropriate guidelines for development will have to be set since the proposed Short-term Plan will only give protection against a 10-year flood.

(b) Relocation of housing

Relocation of housing is initially proposed for two sub-areas; (i) the lower reaches of the Maayon river (sub-area Y1) and (ii) the middle reaches of the Mambusao river (sub-area M3, but excluding Mambusao town). Actual implementation should however be subject to further detailed survey to be included in the feasibility investigations in which the practicality of the plan would be examined on the basis of each building.

Flood forecasting and warning system

Advance information on incipient floods will be indispensable for efficient operation of structural and non-structural measures proposed herein. Flood forecasting by a stage-correlation technique is proposed as a provisional step. This would be replaced later by telemetered facilities. (See Figure 4-5 of main text for location of the proposed facilities.)

(2) 2nd Stage work

River improvement

At this stage, the bankful capacity of the river channels would be increased (design discharge: a 25-year flood) in the stretches downstream of Panitan which would have been already improved under the 1st Stage Project. 16.0 km would be so improved including the Cogon floodway.

Polder dykes

Polder dykes would also be constructed at 3 towns/villages, i.e. Maayon, Jamindan and Dumarao.

(3) 3rd Stage work

The 3rd Stage works would protect almost all the flood vulnerable areas and thus raise the protection level up to the 100-year flood. The protective work would include:

(a) Enlargement of bankful capacity of channels improved in 2nd Stage (16.0 km):
This would raise the bankful capacity to accommodate a 100-year flood for the stretches improved in the preceding 2nd Stage work.

(b) Improvement of upstream reaches of main and tributary rivers (93.4 km):
Improvement work would be initiated in this stage for the river stretches previously left unimproved, i.e. (i) middle and upstream reaches of the Panay, (ii) lower reaches of the Maayon and (iii) lower reaches of the Mambusao river.

1.2 Irrigation Development

Panitan - Panay Irrigation Project

This plan would bring a total area of 3,250 ha under irrigation, by integrating the existing sporadic PIS's into one. The target yield was set at 5.0 ton/ha (paddy). A constraint inherent in the proposed development area is that the itself area is prone to flooding. Therefore flood control project in (1) above should precede implementation of the irrigation project.

Mambusao Irrigation Project

This project would aim to rehabilitate existing irrigation facilities and to expand arable areas along the lower reaches of the Mambusao river. The project covers an area of 2,145 ha in total. Like the Panitan - Panay irrigation area, this irrigation project is also located in a flood-prone area. However, evaluation revealed that the project would be feasible without providing specific measure for flood protection.

1.3 Roxas City Water Supply Plan

The Roxas City municipal and industrial water supply project proposed herein, has the following two objectives:

(a) The existing water supply facility suffers from contamination by sea water. The primary objective of this project would therefore be to solve this problem, by diverting the streamflow of the main Panay river to provide a source of uncontaminated water.

(b) The second objective would be to increase the capacity of existing facilities. The required water supply capacity in 1995 is projected to be 11,650 m^3/day, while the present supply capacity is 4,200 m^3/day. The proposed intake and transmission facilities would make available an additional 7,450 m^3 of water a day.

Due to the urgency of item (a), the work should be given priority for its early implementation.

1.4 Hydropower Generation Plan

The Panay B dam, which would be proposed as part of the 1st Stage work of the flood control project, could be completed by 1994. The power supply and demand balance indicates that the Panay Grid will be faced with a shortage in supply capacity around 1995. This would justify the commissioning of the Panay B power station by that date. The electric power generated at the Panay B power station would be transmitted to the Panitan substation (138/69 kV) and thus feed the Panay Grid. The installed capacity of the Panay B power station would be 7,100 kW, and the annual energy production would amount to 31.4 GWh.

2. Implementation Schedule

Selective staged implementation has been proposed for the flood control project; initially a 1st stage project, followed by 2nd and 3rd stage projects. The two latter would be realized when future damage potentials increase and the projects become economically viable (EIRR of more than 8%). The proposed implementation schedules, including those of other projects, are presented in the attached table.

3. Construction Cost Estimate

The total construction cost of the above proposed projects was estimated to be ₱5,820 x 10^6 at 1984 prices. Breakdowns by project are presented in the attached table.

4. Economic Evaluation

The economic viability of the proposed projects was evaluated based on costs and benefits assessed for each project. All the proposed schemes are deemed to be economically favourable projects, as represented by favorable economic indices (EIRR

ranges from 8.1% to 25.7%). The results of evaluation are shown in the attached table.

5. Summary of Recommendations

In view of the economic viability of the projects and increasing social needs in the basin, follow-up action should be taken to achieve early implementation of the proposed projects. The next-phase studies which should be started at the earliest opportunity are:

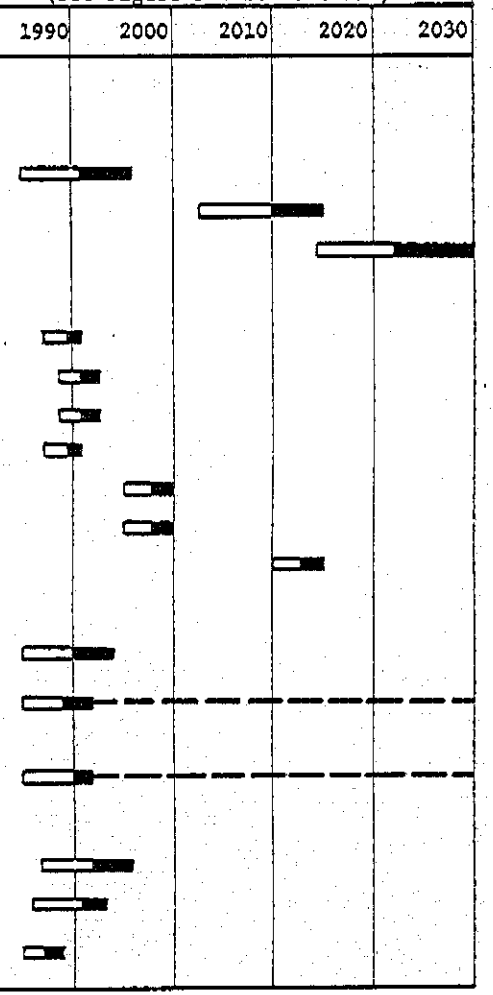
(a) A Feasibility Study of the 1st Stage Flood Control Project, including river improvement work, polders, Panay B dam, non-structural measures and flood forecasting/warning system.

(b) Detailed Design of Roxas City Water Supply Project

(c) Feasibility Studies of Panitan- Panay and Mambusao Irrigation Projects

OUTLINE AND SCHEDULE OF PROPOSED DEVELOPMENT PROJECTS

Project	Description	Construction Cost (₱x10⁶ equiv) Total	FC	LC	EIRR (%)	Implementation Schedule (See Figure 5-4 for details)
Flood Control Project						
(1) River improvement work						
- 1st stage work	Improvement : 22.1 km	589	206	383	9.4	
- 2nd stage work	Enlargement : 16.0 km	440	154	286	9.8	
- 3rd stage work	Impr. & enlarge : 109.4 km	3,486	1,220	2,266	15.2 1/	
(2) Polder dykes						
- 1st stage Dao	Protection area : 1.17 km²	55	27	28	12.7	
Cuartero	" : 0.49 km²	57	29	28	25.7	
Sigma	" : 0.47 km²	42	20	22	10.5	
Mambusao	" : 1.03 km²	78	40	38	11.6	
- 2nd stage Maayon	" : 0.64 km²	49	24	25	9.3	
Jamindan	" : 0.34 km²	39	19	20	9.2	
Dumarao	" : 0.48 km²	58	28	30	8.1	
(3) Multipurpose dam						
- Panay B dam	Hydropower : 7.1 MW, 31.4 GWh	471	277	194	11.2	
(4) Non-structural measures	Objective area : 328 km²	51	-	51	9.6 2/	
(5) Flood forecast/warning system	Telemeter system : 1 lot	84	79	15	4.5 2/	
Irrigation Development						
- Panitan-Panay project	Irrigation area : 3,250 ha	183	108	75	11.7	
- Mambusao project	" : 2,145 ha	79	43	36	12.3	
Roxas city water supply project	Supply capacity : 7,450 m³/day	56	38	18	16.9	



Notes : 1/ See para. 5.6 of Main Text for reason for high EIRR

2/ To be implemented irrespective their economic merits

LEGEND

- Catchment boundary
- Major road
- Railway
- River
- City / Town
- Mountain
- River improvement - 1st stage
- River improvement - 2nd stage
- River improvement - 3rd stage
- Polder - 1st stage
- Polder - 2nd stage
- Dam site
- Water supply project
- Irrigation project
- Flood area under present condition (100 year flood)
- Protected area by 1st & 2nd stage
- Protected area by 3rd stage

SIBUYAN SEA

Culasi Port

Roxas-WD Water Supply Project

CAPIZ BAY

SAPIAN BAY

PILAR BAY

ROXAS

VISAN

Panitan - Panay Irrigation Project

SAPIAN

To ALTAVAS

PANITAN

River Improvement

PILAR

To BALASAN

TINAGONGDAGAT INLET

PRESIDENT ROXAS

JAMINDAN

Mambusao River

Mambusao Irrigation Project

Mt Agnata

CUARTERO

DUMALAG

Flood Area

DUMARAO

Panay River

Panay B Dam

TAPAZ

Mt Panginraon (431m)

Mt Naconfong (406m)

Mt Bantanga (1088m)

Mt Ta-ol (486m)

Mt Igabon (966m)

Mt Bacon (482m)

To ILOILO

Mt Agloloton

Mt Agsuboy

Mt Guiscon

Mt Cordon

Mt Putian

Moolon River

Buiburan River

To SAN DIONISIO

SARA

To AJUY

LEMERY

0 2 4 6 8 10km

SCALE

122°30'E 122°40'E 122°50'E 123°00'E

11°30'N 11°20'N 11°10'N

N

LUZON ISLAND

Manila

PANAY ISLAND

Iloilo

Roxas

MINDANAO ISLAND

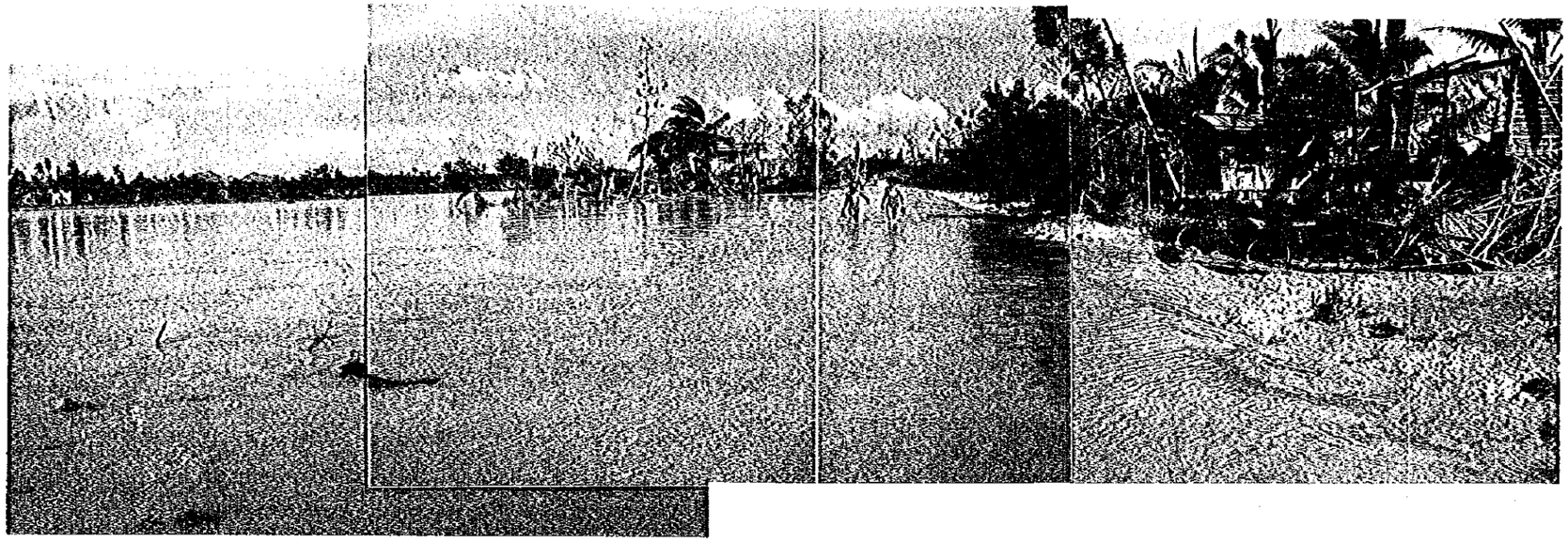
Davao

SULU SEA

SOUTH CHINA SEA

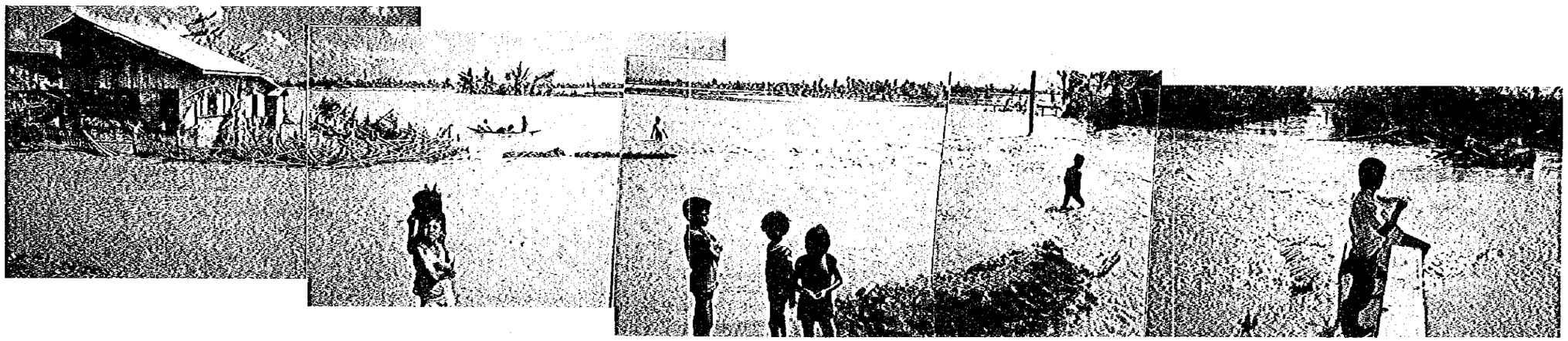
PACIFIC OCEAN

PROPOSED DEVELOPMENT PROJECT



1984 November Flood Photo No. 1 (taken on Nov. 6)

Typhoon "Undang" hit the Panay river basin on Nov. 5, 1984 and caused the flood with serious damage.
This picture shows the scene of submerged road connecting the two towns of Mambusao and Sigma and the surrounding paddy fields.
The water is flooded from the Mambusao river located on the left side of this picture.



1984 November Flood Photo No. 2 (taken on Nov. 8)

This picture shows a view of the submerged road connecting the two towns of Panay and Pontevedra and the surrounding paddy fields/ houses at Agbalo village. The water has overflowed from the Pontevedra river seen at the right side of this picture.

1984 November Flood Photo No. 3 (taken on Nov. 7)

This picture shows the scene of submerged road connecting the two towns of Panay and Pontevedra. The JICA jeep seen in the picture had to give up going to the Pontevedra town on the way due to the deeper water depth and high flow velocity.

1984 November Flood Photo No. 4 (taken on Nov. 9)

This picture shows the paddy fields along the Pontevedra river which are still submerged even 4 days after the typhoon attack.

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ABBREVIATIONS

ADB	Asian Development Bank
AKELCO	Aklan Electric Cooperative
AMC	Area Marketing Cooperative
ANTECO	Antique Electric Cooperative
BAEX	Bureau of Agricultural Extension
BCGS	Bureau of Coast and Geodetic Survey
BAECON	Bureau of Agricultural Economics
BPI	Bureau of Plant Industry
BS	Bureau of Soils
CAPELCO	Capiz Electric Cooperative
CAPLECS	The Law Enforcement Communication System
CIS	Communal Irrigation System
CY	Calendar year
DBP	Development Bank of the Philippines
EIRR	Economic Internal Rate of Return
EL	Elevation
F.C.	Foreign currency
EPA	Fertilizer and Pesticide Authority
F/S	Feasibility study
FSDC	Farm Systems Development Corporation
FWL	Flood Water Level
FY	Fiscal year
GDP	Gross Domestic Product
GNP	Gross National Product
GOP	Government of the Philippines
GRDP	Gross Regional Domestic Product
GVA	Gross Value-Added
HWL	High Water Level
HYV	High yielding variety
ILECO	Iloilo Electric Corporative
IRR	Internal Rate of Return
ISA	Irrigation Service Association
JICA	Japan International Cooperation Agency

KKK	National Livelihood Program
L.C.	Local currency
LBP	Land Bank of the Philippines
LRM	Local Resource Management
LWL	Low Water Level
LWUA	Local Water Utility Administration
MAR	Ministry of Agrarian Reform
MAF	Ministry of Agriculture and Food
MHS	Ministry of Human Settlement
MLG	Ministry of Local Government
MOH	Ministry of Health
MPW	Ministry of Public Works
MPWH	Ministry of Public Works and Highways
MWSS	Metropolitan Waterworks and Sewerage System
NASUTRA	National Sugar Trading Corporation
NCSO	National Census and Statistics Office
NEA	National Electrification Administration
NEDA	National Economic and Development Authority
NFA	National Food Authority
NFAC	National Food and Agricultural Council
NIA	National Irrigation Administration
NIS	National irrigation system
NPC	National Power Corporation
NPCC	National Pollution Control Commission
NPV	Net Present Value
NSDW	National Standards for Drinking Water
NWRC	National Water Resources Council
OECF	Overseas Economic Cooperation Fund
O&M	Operation and maintenance
p.a.	Per annum
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PCARR	Philippine Council for Agriculture and Resources Research
PCIC	Philippines Crop Insurance Corporation
PECO	Panay Electric Company Inc.
PHILSUCOM	Philippine Sugar Commission

PIS	Pump irrigation system
RIS	River irrigation system
ROX-WD	Roxas City Water District
RWDC	Rural Waterworks and Sewerage Corporation
SCF	Standard Conversion Factor
SEAFDEC	Southeast Asia Fisheries Development Center
TWL	Tail Water Level

MEASUREMENTS

Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer

Area

mm^2	=	square millimeter
m^2	=	square meter
km^2	=	square kilometer
ha	=	10^4 m^2 = hectare

Volume

lit	=	1,000 cm^3 = liter
kl	=	1 m^3 = kiloliter
m^3	=	cubic meter
lpcd	=	liter per capita per day

Time

sec	=	second
min	=	minute
h	=	hour
d	=	day
yr	=	year

Money

₱	=	Philippine Peso
US$	=	US dollar
¥	=	Japanese Yen

Electrical Measures

A	=	ampere
V	=	volt
kV	=	kilovolt
kVA	=	kilovoltampere
MVA	=	megavoltampere
W	=	Watt
kW	=	kilowatt
MW	=	megawatt
kWh	=	kilowatthour
MWh	=	megawatthour
GWh	=	gigawatthour
kWh/yr	=	kilowatthour per year
EHV	=	extra high voltage
Hz	=	Hertz (cycle)

Other Measures

%	=	per cent
0/00	=	per thousand
°	=	degree
'	=	minute
''	=	second
10^3	=	thousand
10^6	=	million
10^9	=	billion (milliard)
°C	=	degree centigrade
Kcal	=	kilocalorie
m^3/sec	=	cubic meter per second
pH	=	scale for acidity
ppm	=	parts per million (mg/lit)
PS	=	horse power
ton	=	metric ton
ton/ha	=	ton per hectare

LIST OF EXPERTS ASSIGNED FOR THE INVESTIGATION

ASSIGNMENT	NAME
Team Leader	H. Takahashi
Acting Team Leader	M. Kato
River Planning	T. Nishikawa
Hydrology & River Planning	H. Okada
Structural Design	T. Furukawa
Agriculture	M. Matsui
Agricultural Economy	K. Yamada
Irrigation Planning	H. Sekine
Irrigation Design	N. Nagano
Project Economy	T. Tashino*
Dam Planning	T. Tanaka
Geology & Groundwater	M. Yakou
Water Supply Planning	M. Kasuga**
Power Market Survey	Y. Tomiyama
Cost Estimation	E. Seki
Hydro Data Analyst	M. Ohuchi
Environment Assessment	M. Yanagibayashi***

Note; All the experts other than the following three experts are despatched from Nippon Koei Co., Ltd. (Consulting engineers).

* T. Tashino (Project Keizai Kenkyusho Co., Ltd.)

** M. Kasuaga (Chuo Fukken Co., Ltd.)

*** M. Yanagibayashi (Chiiki Kaihatsu Consultant Co., Ltd.)

CHAPTER I. BACKGROUND

1.1 The Panay river basin suffers from flooding almost every year and flooding has long been a major constraint hampering economic development in the Panay basin area as well as hindering stabilization of the livelihood of inhabitants. The flood problem in the Panay river basin was given preliminary study in the "Nationwide Flood Control Study" carried out from 1979 through 1982 and which recommended the necessity of further detailed planning of flood control measures on the Panay river at a river basin study level. The urgency of this was reinforced when in November 1984 Typhoon Undang caused widespread inundation in the Panay river basin and inflicted heavy damage.

1.2 In response to a request from the Government of the Philippines, the Japan International Cooperation Agency (JICA) carried out the present study, "The Panay River Basin-wide Flood Control Study" (the Study), starting in August 1983. The objective of the Study was to formulate an integrated water resources development plan for the Panay river basin. The Study accordingly covers various aspects related to basin water resources development, including investigation of socio-economy, hydrology, and land use, planning for flood control, agricultural development, multipurpose dam and water supply. Particular emphasis has been placed on the flood control aspect in view of its importance in the framework of the basin development plan.

1.3 Prior to this Study, maps at 1 : 10,000 scale covering the areas along the Panay river and its tributaries were made available under a separate JICA project through supervision of the survey and mapping processes. These maps were essential for clarifying inundation areas, assessing flood damage and estimating work quantities of protective measures. In this context, the rearrangement of work schedule through the courtesy of the Government of the Philippines, which enabled use to be made of the maps in this Study, was of great significance in the timely completion of the Study.

CHAPTER II. PROJECT AREA

Panay River Basin

2.1 The Panay river drains an area of approximately 2,181 km^2. The basin is located in the northeastern part of Panay island, covering almost the entire area of Capiz province. The location of the basin is shown in Figure 2-1. It includes a principal city (Roxas) and 12 municipalities with a total estimated basin population of 448,000 in 1980. The gross regional domestic product of the basin at 1972 constant prices was ₱917 x 10^6 in 1982 ($2,950 x 10^6 at current price). The per capita GRDP of the basin was ₱1,766 at 1972 price in the same year ($5,620 x 10^6 at current price). Projections of population and GRDP are respectively summarized in Tables 2-1 and 2-2.

2.2 The climate of the basin falls in Type III of the Philippines climate classification and is characterized by no pronounced seasonal climatic variation, although it is relatively wet from May to October and dry from November to April. The average annual rainfall in the basin is 2,550 mm. Its areal distribution however varies from 3,500 mm in the western mountainous area to 2,000 mm in the southeastern area, as shown in the iso-hyetal map of the basin presented in Figure 2-2. The average annual total runoff of the Panay river is 2,920 x 10^6 m^3 at the bifurcation point of the Lower Panay river and the Pontevedra river. Its annual average discharge is 92.6 m^3/sec.

2.3 The geology of the river basin was studied from the regional geological maps and by field investigation. The geological map of the river basin is presented in Figure 2-3. The groundwater potential of the basin was found to be limited especially in terms of water quality due chiefly to poor quality aquifers, intrusion of seawater and contamination by sewage.

Land Use

2.4 Land use in the basin is mainly for food production. Of the total basin area of 2,181 km^2, 48,530 ha (21%) is used for sugarcane; 40,960 ha (19%) for paddy fields; and 10,560 ha (5%) for fishponds. The remaining 55% is occupied by scrub, orchards, pasture, grassland, marsh/swamp and others. The land use of the Panay river basin is summarized in Table 2-3, and illustrated in Figure 2-4.

Agricultural Production

2.5 Rice is the main crop in the basin followed by sugarcane. Total annual production of paddy in the basin stands at about 215,000 tons. Double cropping is practiced in most of the existing irrigated and rainfed fields. The total annual production of sugarcane in the basin reaches about 60,000 tons on an average.

2.6 Present average yields of paddy are about 3.2 tons per ha for irrigated paddy and 2.8 tons per ha for rainfed paddy. The price of rice is controlled by the Government. In September 1984, the buying price of milled rice was ₱2.65 per kg. As the typical farmer has a paddy farm of 1.5 - 2.0 ha, a family of 7 to 8 members, and an annual income ranging from ₱16,000 to ₱19,500, if his annual expenditure is ₱15,500 to ₱18,500, his Capacity to Pay is ₱500 to ₱1,000.

Flood Records

2.7 Floods in the basin are caused mainly by passing typhoons and by tropical depressions. According to the record, the basin was visited by 19 typhoons and 11 major tropical depressions during the 37 years from 1948 through 1984. Severe floods were experienced in November 1973, May 1976 and November 1984. The flood of 1973, caused by Typhoon Openg, was the largest on record and caused the loss of 18 human lives. The second largest was the Undang flood in 1984. The Undang flood induced an instantaneous peak discharge of 1,080 m3/sec at Cuartero, which is comparable to 1,420 m3/sec of the Openg. The area inundated by the flood

Undang is shown in Figure 2-5, and the flood flow profiles are shown in Figure 2-6.

Flood Analysis and Damage Estimate

2.8 A computerized river basin model was constructed, as shown schematically in Figure 2-7, to conduct flood flow analysis. The model was chiefly calibrated by the Undang flood records. Distribution of flood flow of representative probable floods is shown by river stretches in Figure 2-8. Estimated depths of inundation in the basin for the 5-, 25- and 100-year floods are shown in Figures 2-9 to 2-11. Estimated inundation areas flooded by the 5- and 100-year floods are shown in Figure 2-12.

2.9 Consequently, the areas likely to be inundated and population affected by floods of varying return periods were estimated through simulation of flood flow, as summarized in Table 2-5. Land at risk from a 100-year flood, denoted in this Study as the flood vulnerable area, was estimated to amount to 33,820 ha, or 16% of the basin area. The flood vulnerable area includes 18,944 ha of paddy fields, 3,849 ha of sugarcane fields and 1,137 ha of fish ponds. The flood vulnerable area is inhabited by residents numbering 121,300, or 27% of the basin population. Land use in the flood vulnerable area is illustrated in Figure 2-13 and summarized in Table 2-6 by sub-area. The sub-area divisions are shown in Figure 2-14.

2.10 The average annual loss caused by flood damages was estimated to be ₱105 x 10^6, mostly in respect of crops and buildings. Itemized flood damages for 1984 are summarized in Table 2-4.

CHAPTER III. BASIC CONCEPTS OF BASIN DEVELOPMENT

(Flood Control Plan)

Basic Concept

3.1 A flood control plan must be implemented through both structural and non-structural measures. For the safety of facilities and social benefits, it is always desirable to establish a high protection level (say against a 100-year flood) in designing structural measures, for instance, by river channel improvement and dyking. Such measures are not necessarily viable from an economic viewpoint, however, because of the heavy costs and in the present state of development in the objective region. It is proposed therefore that the flood control project should be implemented in stages, to match the growth of the region's economic activities. Accordingly a threshold EIRR value of 8% was adopted for judging economic viability.

3.2 To achieve this progressive development, flood control plans by structural measures were conceived for three different protection levels, namely: Long-term Plan (LP), Mid-term Plan (MP) and Short-term Provisional Plan (SP). The design floods and protection targets of the three planning phases are summarized below:

Basic Development Criteria for Formulation of Flood Control Projects

Development Level Alternatives	Development Target	Protection Level (Design Flood)
LP : Long-term Plan	About 90% of the population[1/] to be relieved from flood hazard	100-year flood
MP : Mid-term Plan	About 70% of the population to be relieved from flood hazard	25-year flood

(continued)

Development Level Alternatives	Development Target	Protection Level (Design Flood)
SP : Short-term Provisional Plan	More than 50% of the population to be relieved from normal floods 2/	2 to 10-year flood

Notes; 1/ : Total population in the flood vulnerable area : 121,300
2/ : With some damage reduction effect to be attained also in large floods.

Proposed Protection Area - Structural Measures

3.3 The protection of areas with a potentially high risk of flood damage should receive priority. Figures 3-1 and 3-2 respectively illustrate the damage intensities caused by 5- and 100-year floods, and Table 3-1 shows damage potential by sub-area, in which priority protection areas are defined. Since protection work in a river stretch would naturally increase the discharge in the downstream reaches, there are other costs to be taken into consideration to preserve the position of areas with a relatively low damage potential, which should be used positively as natural retarding basins. Thus priority areas for protection must be selected carefully taking all factors into consideration including the provision of retarding basins.

3.4 Six flood protection area alternatives were considered as shown in Figures 3-3 to 3-5. The area conceived in Alternative-4 (See Figure 3-4) was eventually selected as the most practicable action area after comparison of numbers of people to benefit, the area of protected farmland and the cost-effectiveness of alternative plans (as illustrated in Figure 3-6). The action area, for which a long-term master plan was proposed, would include the stretches up to Dumalag along the Panay river and stretches along the Maayon and Mambusao rivers.

Protection Measures

3.5 Protection measures fall into two categories, structural and non-structural. Structural measures which would protect specific action areas would comprise:

(a) River improvements
    a-1) Improvement of existing river channels
    a-2) Excavation of floodways (diversion channels)
(b) Flood control dams
(c) Combinations of (a) and (b)
(d) Polder dykes

3.6 Non-structural measures would be considered mainly as a substitute for structural measures outside the protection action area. Some of the non-structural measures practicable in the Panay river basin would be as follows:

(a) Flood plain management
(b) Structural changes to buildings
(c) Relocation of housing
(d) A flood forecasting and warning system

A more comprehensive list of non-structural measures is given in Table 3-2, with comments on their applicability to the Panay river basin.

(Irrigation, Municipal Water Supply and Hydropower Development)

3.7 Water resources of the Panay river are abundant in relation to the demand for present water uses in the basin area. There are therefore great opportunities for effective development of water resources in the basin. Thus the possibilities of irrigation development, improved municipal water supply and hydropower generation have also been assessed in the Study, as part of the comprehensive water resources development plan.

CHAPTER IV. FORMULATION OF SPECIFIC DEVELOPMENT PLAN

(Flood Control Plan)

4.1 The flood control plan conceived in this Study would comprise plans at three protection levels as set out in Paragraph 3.2. The approaches to achieve each protection level would include both structural and non-structural measures. The procedures used in selecting the recommended plan are shown in Figure 4-1.

Structural Measures

Long term Plan (LP)

4.2 The Long-term Master Plan (LP) was conceived as an ultimate overall framework of flood control measures, to provide the maximum protection under full development in the future. The planned protection at the LP level was assumed to relieve 90% of the affected population from flood damage and save farmland to the maximum degree practical in the event of a 100-year flood. The LP action area is presented in Figure 3-4 (Alternative-4).

4.3 The facility plan to achieve the above LP protection level was selected by economic comparison of alternatives including river improvement plans, bypass floodways, multipurpose dam plans and combinations thereof. The location of bypass floodways and dam plans examined in the Study are shown in Figures 4-2 and 4-3 respectively. The LP facility plan finally selected would comprise river improvement for the action stretches selected in Paragraph 3.4 above (total length 115 km), a bypass floodway at Cogon and a multipurpose dam development at Panay B site.

4.4 Economic evaluation for the selected LP facility plan revealed that the Long-term Plan, which would involve large-scale construction work and an EIRR of 4.5%, would not be economically justifiable under present

conditions. Nevertheless, since the economic activity in the Panay river basin was expected to increase in the future, it was tentatively considered that implementation of Long-term Plan would become economically viable around the year 2020 (commencement of the work).

Mid term Plan (MP)

4.5 The Mid-term Plan (MP) for flood control was formulated to provide an interim protection level, with the target of relieving about 70% of the affected population from risk of damage from a 25-year flood. The proposed facility plan would include improvement of 72.6 km of the Panay, Mambusao and Pontevedra rivers. The action area of MP would almost correspond to Protection Area Alternative-3 as presented in Figure 3-4. Economic evaluation revealed, however, that implementation of MP with an EIRR estimated at 6.7% would not be justifiable under the current economic conditions. It was tentatively considered that MP should be left in abeyance until around the year 2020 (commencement of the work). This implementation timing is similar to that assessed for the LP (See 4.4 above), thus there would be no specific merit of implementation of MP ahead of LP.

4.6 A further study on MP attempted to identify selective development works which would be worthy of earlier implementation. As its outcome, recommended were the enlargement of river channel to a 25-year flood capacity in the stretches downstream from Panitan and the construction of 3 additional polders in addition to 4 polders to be included in the SP (See 4.7 below). Accordingly these selective development works were deemed to constitute the mid-term implementation plan instead of the plan described in 4.5 above, but the target set out originally (relief of about 70% population) had to be disregarded.

Short term Provisional Plan (SP)

4.7 The Short-term Plan (SP) would provide some immediate relief from the risks of flood damage responsive to the most urgent needs for protection and justifiable in terms of economic viability. The proposed

flood control projects for the Short-term Plan would include improvement of the river stretches downstream from Panitan town including the Cogon floodway, against 10-year flood, construction of polder dykes around 4 towns and construction of Panay B dam. The location of towns selected for polder plans is shown in Figure 4-4.

4.8 The EIRR value of the selected flood control projects for SP was assessed to be 11.4%, which indicates that the implementation of SP would be economically justifiable under present conditions.

Non-structural Measures

4.9 In this Study, two particular non-structural measures were considered to be applicable to the Panay river basin:

Flood plain management:
The objective flood plain management would be to restrain future growth of damage potential within the areas prone to flooding by means of regulations and administrative guidelines. Specific measures would cover 1) designation of flood vulnerable areas by ranks of damage frequency and grades of risk, 2) management of development within the flood vulnerable area and 3) information and education of residents.

Relocation of housing:
In place of devising measures to protect certain areas from flooding, it will be more economical to have the inhabitants relocated from their original settlements, to reducing the value of flood damage.

4.10 Based on preliminary estimation of cost and benefits of specific measures in the sub-areas, flood plain management and relocation of housing were proposed for the whole basin area, and in two sub-areas respectively.

Flood Forecasting and Warning System

4.11 The flood forecasting and warning system would be effective in reducing the damage to property and human lives, by providing information of floods at an early stage in their development. An economic evaluation was made of a telemeter system, and the EIRR value was assessed as 4.5%. Notwithstanding a relatively low economic return, since the early warning of a flood event is an indispensable element in successful operation of flood control measures, both structural and non-structural, implementation of a flood forecasting and warning system was positively recommended in this Study.

4.12 In order to obtain operational knowledge of flood runoff characteristics and correlation of flood levels, it is proposed as a first-step that staff gauges should be installed on the upper reaches of the Panay river and its tributaries, these will be replaced by a comprehensive telemeter system after the necessary operational experience has been gained as proposed above. The proposed facilities for the flood forecasting and warning system are shown in Figure 4-5.

Formulation of Flood Control Plan

4.13 Based on the considerations stated in paragraphs 4.2 to 4.11 above, the specific projects selected for implementation respectively for the Long-, Mid- and Short-term Plans were as given in Table 4-1 and as summarized below:

Proposed Flood Control Projects of Long-, Mid- and Short-term Plans

Proposed Project	Long-term Plan (LP)	Mid-term Plan (MP)	Short-term Plan (SP)
Design flood	100-year	25-year	10-year
Facility plan			
River improvement work	115.5 km	22.1 km	22.1 km

(continued)

Proposed Project	Long-term Plan (LP)	Mid-term Plan (MP)	Short-term Plan (SP)
Dam construction			
-Panay B dam	*	*	*
Polder dykes	-	7 towns	4 towns
Non-structural measures	*	*	*
Flood forec./warning system	*	*	*

Notes: * Contemplated - Not contemplated

4.14 As stated in Paragraph 3.1 above, the flood control project should be implemented in stages. The three protection levels, namely LP, MP and SP, are conceived as consecutive implementation stages.

Implementation Stage	Proposed Project
1st Stage Work	Implementation of Short-term Provisional Plan
2nd Stage Work	Upgrading to Mid-term Plan level
3rd Stage Work	Upgrading to Long-term Plan level

(Irrigation Development Plan)

4.15 Agricultural production is the largest provider of employment in the Panay river basin but development of the basin is constrained by the limited areas of arable land and the still relatively low unit yields of rice. The irrigation development plan aims to extend technical irrigation to new irrigable areas and to rehabilitate the existing systems.

4.16 Potential irrigable areas in the basin were delineated at 10 locations, with a total area of 11,700 ha, of which 5,640 ha (48%) are already under irrigation. Amongst the above, the Panitan - Panay and the Mambusao areas were selected as appropriate for development as national irrigation systems (NIS). The proposed irrigation areas cover 3,250 ha and 2,145 ha respectively. The Panitan - Panay area is proposed as a new scheme by integrating the numerous existing pump irrigation systems

(PIS), which are dispersed in the area. The Mambusao area is proposed to rehabilitate and extend the existing irrigation facilities. The general plans of the Panitan - Panay and Mambusao irrigation areas are respectively shown in Figures 4-6 and 4-7.

4.17 Paddy was selected as the main crop for cultivation in the new development areas. Yields of 5.0 tons per hectare are anticipated for both wet season and dry season paddies under proposed irrigation systems. Irrigation water for the Panitan - Panay area would be taken from the main Panay river by pumping and for the Mambusao area from the Mambusao river by gravity.

4.18 The total construction cost of the Panitan - Panay scheme was estimated to be ₱183 x 10^6 and of the Mambusao scheme to be ₱79 x 10^6. The annual operation and maintenance cost was estimated to be ₱6.0x 10^6 for the Panitan-Panay scheme and ₱1.4 x 10^6 for the Mambusao scheme.

4.19 The economic viability of the both irrigation schemes will depend on the flood control measures to be devised in the proposed irrigation areas. If flood damages caused by floods of less than 10-year recurrence are eliminated, the EIRR value of Panitan - Panay area would be 11.7%, while the EIRR of the Mambusao scheme would be as high as 12.3% even without the provision of flood protection work. If the areas could be improved to be flood-free (100-year flood protection), the EIRR values would be 12.8% and 17.8%, respectively. It was concluded that the both irrigations projects would be economically viable.

(Water Supply Plan)

4.20 Notwithstanding improvement work undertaken in 1976, the Roxas City Water District (ROX-WD) still has unsolved problems with its water supply system. The most serious problem that awaits solution is the intrusion of sea water at the water intake site on the Lower Panay river during high tides in dry seasons.

4.21 The water demand of the Roxas City Water District in 1995 is

projected to reach 7,765 m3/day, which will need a waterworks supply capacity of 11,650 m3/day if 16-hour supply is adopted, whereas the present supply capacity is only 4,200 m3/day. The second requirement of the proposed ROX-WD supply system, therefore, is an increase in the supply capability to the required supply capacity level of 1995 by adding new pumping and conveyance facilities of 7,450 m3/day.

4.22 After a study of possible alternative plans, an improvement plan for the ROX-WD is proposed in this report on the basis of the following two measures:

- Construction of a water intake on the Main Panay river and excavation of the upstream reach of the Lower Panay river to El. -1.0 m to permit gravitational inflow of about 2.0 m3/sec from the main Panay river, and

- Construction of a tidal gate 6 km downstream of the existing pumping station to prevent intrusion of sea water into the Lower Panay river.

The total construction cost of the proposed improvement plan was estimated to be ₱56 x 10^6 on a financial cost basis. A general plan of the proposed ROX-WD Improvement project is shown in Figure 4-8.

4.23 Economic evaluation indicated that the proposed ROX-WD Improvement project would be highly efficient economically, with an estimated EIRR value of 16.9%

(Hydropower Generation Plan)

4.24 The electric power supply in Panay island is still elementary. Household connections account for only about 36% of the potential users, with a relatively low consumption level of about 272 kWh p.a. per connected household.

4.25 According to the demand projection employed for this Study, as

shown in Table 4-2, the system peak demand of the Panay Grid will double in 12 years, from 41 MW in 1984 to 84 MW in 1996. On the supply side, the dependable output of the Panay Grid will grow from the present 41 MW to 75 MW by 1989, by the commissioning of new diesel plants at Dingle and Power Barge Stations. The balance, as shown in Figure 4-9, is suggestive of the need for a new power source in 1995. In this context, possibility of hydropower generation was assessed in relation to storage development proposed as part of the flood control plan.

4.26 Panay B dam was planned and optimized as a multipurpose dam, serving flood control and hydropower generation. It would be a 52 m high concrete gravity dam of 96 x 106 m3 in gross storage with an installed capacity of 7,100 kW, and would generate about 31.4 GWh of electric energy annually. The total construction cost would be about ₱471 x 10^6. A general plan of the proposed Panay B dam is shown in Figure 4-10.

4.27 Economic evaluation indicated that the Panay B dam would be economically justifiable as a multipurpose project with an EIRR value estimated to be 11.2%.

CHAPTER V. BASIN DEVELOPMENT PROGRAM

Proposed Development Project

5.1 Development projects identified in Chapter IV comprise a series of flood control plans including one multipurpose dam scheme which would be implemented stage-wise, two irrigation projects and one water supply project. Items and proposed phasing of the proposed projects are summarized below. Stagewise implementation of flood control projects are as shown in Figures 5-1 to 5-3.

Summary of Proposed Development Projects

Proposed Project	Short-term Project	Mid-term Project	Long-term Project
Flood Control Project			
Implementation phasing:	1st Stage (Short-term Provision Plan)	2nd Stage (Extension to Mid-term Plan)	3rd Stage (Extension to Long-term Plan)
River improvement:			
- Improvement of Pontevedra river	6.1 km	-	-
- Improvement of new sections	16.0 km[1/]	None	93.4 km
- Enlargement of previously improved sections	None	16.0 km	16.0 km
Total	22.1 km	16.0 km	109.4 km
Polder plans	4 locations	3 locations	-

(continue)

Proposed Project	Short-term Project	Mid-term Project	Long-term Project
Multipurpose dam[2/]:			
- Panay B dam	x	-	-
Non-structural measures	x	-	-
Flood forecasting and warning system	x	-	-
Irrigation Project			
Panitan - Panay Project	3,250 ha	-	-
Mambusao Project	2,145 ha	-	-
Water Supply Project			
Roxas City Water Supply Project	7,450 m^3/day	-	-

Notes: 1/ : Includ. Cogon floodway
2/ : Flood control and power generation
x : Contemplated, - : Assumed to have been completed in previous stage

5.2 The outline and purpose of each project were presented in Chapter IV and also in the summarized descriptions given in the "Summary" at the beginning of this report. The detailed features of the proposed project are contained in Table 5-1.

Implementation Schedule

5.3 A proposed implementation schedule is presented as "the Master Schedule" in Figure 5-4. The scheduling is based on the following considerations:

- In view of their high economic viabilities and social needs, the Flood Control Project - 1st Stage and ROX-WD Water Supply Project should be started at the earliest opportunity.

- Flood Control Project - 2nd and 3rd Stage works would be implemented when future damage potentials increase and the projects become economically viable (EIRR of more than 8%). The Study revealed that these projects would become economically viable if the implementations start around 2010 for the 2nd Stage Project and 2020 for the 3rd Stage Project.

- The Panitan-Panay Irrigation Project would be completed after the 1st Stage Flood Control Project is realized in its areas. As the Mambusao Irrigation Project would have a high economic viability even without provision of flood protection works in the area, its implementation could be advanced.

Construction Cost Estimate

5.4 The total construction cost of the above proposed projects was estimated to be ₱5,820 x 10^6 at 1984 prices. Breakdowns by project are given on the next page.

Development Cost Estimates of Specific Projects (1984 base price)

Project (Stage)	Project Cost (₱ x 10^6)	Breakdown by Currency 1/ F/C (US$ x 10^6)	L/C (₱ x 10^6)
Flood Control Project			
a) River improvement			
- 1st Stage work	589	11.5	383
- 2nd Stage work	440	8.6	286
- 3rd Stage work	3,486	67.7	2,266
Sub-total	4,515	87.8	2,935
b) Polder dykes			
- 1st Stage work (4 towns)	231	6.4	116
- 2nd Stage work (3 towns)	146	4.0	75
Sub-total	377	10.4	191
c) Multipurpose dam			
- Panay B dam 2/	471	15.4	194
d) Non-structural measures 3/	51	-	51
e) Flood forecasting and warning system	84	3.8	15
Irrigation Development Project			
- Panitan - Panay Project	183	6.0	75
- Mambusao Project	79	2.4	36
Sub-total	262	8.4	111
Roxas City Water Supply Project	56	2.1	18.1

Notes: 1/ : Rough estimation. Exchange rate: US$ = ₱18
2/ : Including power generating facilities.
3/ : Initial cost only.

Economic Evaluation

5.5 Flood control benefits were considered to accrue from damage reductions to be realized by the project and taking into account future increases in damage potential. Irrigation benefits were defined as the incremental economic value of net production between "with-Project" and "Without-project" conditions. Benefits of the water supply project were assessed on the beneficial value of water, incremental value of lands in the service area, health benefits and reduction in fire damages.

5.6 The economic viability of the proposed projects was thus evaluated from the estimated costs and benefits. The results are shown on the next page. In the evaluation, the 2nd and 3rd stage flood control projects were assumed to be implemented in line with principles described in paragraph 5.3 above. The high EIRR evaluated for the 3rd stage project (15.2%) is due to inclusion of benefits from year 2031 onward which had previously been provided by polder facilities and pumped drainage will no longer be required once the 3rd stage project is completed in 2030 and therefore the benefits thereof would be taken over by the 3rd stage project.

Summary of Economic Evaluation of Proposed Projects

Project	Const. Cost (₱x10^6)	EIRR (%) 1st Stage	2nd Stage	3rd Stage
Flood Control Project				
(a) River improvement:	4,515	9.4	9.8	15.2
(b) Polder dyke:				
- Dao	55	12.7	-	-
- Cuartero	57	25.7	-	-
- Sigma	42	10.5	-	-
- Mambusao	78	11.6	-	-
- Maayon	49	-	9.3	-
- Jamindan	39	-	9.2	-
- Dumarao	58	-	8.1	-
(c) Panay B dam 1/	471	11.2	-	-
(d) Non-structural measures	51	9.6 2/	-	-
(e) Flood forecasting/ warning system	84	4.5 2/	-	-
(f) Overall	5,499	11.4	9.8	15.2
Irrigation Development				
- Panitan - Panay	183	11.7	-	-
- Mambusao	79	12.3	-	-
Roxas City Water Supply Project	56	16.9	-	-

Note: 1/ Incl. hydropower development

2/ For reference. These projects to be implemented irrespective of their economic merits

CHAPTER VI. RECOMMENDATIONS

6.1 The economic evaluation of the proposed program of works revealed high economic viability of all the proposed projects. Amongst these, the projects proposed for immediate implementation with priority with respect to both economic viability and compliance with social needs will be (i) Flood Control - 1st Stage (incl. polder plans and Panay B multipurpose dam) and (ii) ROX-WD Water Supply Project. For both of the above projects, the next-phase studies should be started immediately. The studies required, and which should be carried out simultaneously, will be as follows:

Flood Control Project: Feasibility Study (F/S) of the 1st stage development plan including river improvement, polders, Panay B hydropower development, non-structural measures and flood forecasting/warning system.

ROX-WD Water Supply: Detailed design including overall review and updating of the present study.

Panitan-Panay and Mambusao Irrigation Projects: Feasibility study for both projects, wherein the study of the Panitan-Panay scheme should take into account the flood control project to be provided in the area.

6.2 Although this Study recommends that the 2nd and 3rd Stages of the Flood Control Project should be left in abeyance until the future damage potential reaches a level that would provide an EIRR value in excess of 8% p.a., consideration should be given to earlier implementation if economic circumstances and government policies permit, since they would have important social and regional developmental benefits.

6.3 It should be noted that the peak flood flows are not fixed values, but are liable to change in accordance with the land use and the retardation effects of the upstream areas. In this context, the

possibilities of developing flood control storages at dam sites discarded in this Study, such as the Panay C, Badbaran A and Mambusao B, should not be completely ruled out at this study stage, but be left in for future consideration as additional candidates.

6.4 Future land use on the flood plains will be largely dependent on the protective measures to be implemented in the area. This Study provisionally categorized the area presently prone to flooding into three:

(a) The areas where the flood control project will be carried out under a short-term program by structural measures,

(b) The areas where no flood control project will be carried out for the time being, and

(c) The areas to be preserved as future flood channel.

Basic policies of management and administrative guidelines are tentatively proposed in Table 6-1 on the basis of the three categories above. The zoning of the three areas is shown in Figure 6-1.

6.5 The limited availability of basic data, such as of storm rainfall and flood hydrology, will substantially constrain the accuracy of subsequent studies for flood control. It is emphasized therefore that hydrological observations should be continued at all gages including those installed during this Study.

6.6 The characteristics of river behabior is diffeent at each river. Therefore, the long-term observation of river behavior, including the river bed change, meandering, and hydrological observation, is suggested to be done for future flood control study. Especially, it is necessary to know the behavior of natural rivers like the Panay river.

6.7 Similarly, the present studies of non-structural measures had to remain at a preliminary study level due to the limited data available.

Details of the proposed measures need to be clarified in subsequent feasibility studies, including the recommendations for legislation required for effective enforcement of the measures.

6.8 As one of non-structural measures, the preparation of flood risk map is required. Though the comparatively detailed survey for Undang flood was carried out during the additional ivestigation in June 1985, the further detailed survey is suggested to be carried out in the next stage of study for the preparation of flood risk map which would be available not only for the reduction of flood damage but also for the proper land use.

6.9 The present study assumes the sediment yield to be 1,400 $m^3/km^2/$ year in the upper reaches in terms of denudation rate, which was derived from the observation records in the Jalaur river located in Panay island. In view of the importance of heavy siltation in the limited reservoir storage capacity, the estimated figure should be further confirmed in the subsequent studies.

6.10 In this master plan study, a simplified operation of the reservoir was proposed by providing independent storage allocation each for flood control and hydropower. In the next-phase study, more sophisticated reservoir operation can be proposed in order to make the scheme more beneficial.

6.11 A preliminary economic evaluation included in this master plan study was based on alternative thermal plant costs. The output of this study should be further refined in the forthcoming feasibility study, in which the optimization study would take into account the least cost solution of power development program of the Panay Grid.

6.12 The Present study takes into account only the retirement of old diesel plants in planning the system development. However, other than the transmission and distribution losses, deterioration in the efficiency of the existing plants should be considered. It is suggested that this matter will be clarified in the feasibility study based on more detailed

inventory survey of the existing plants.

6.13 In the present schedule for feasibility study of irrigation project, the study for Mambusao area is scheduled to start about 1 year earlier than that for Panitan-Panay area. However, it is suggested to consider to undertake the study of both areas at the same time for administrative convenience and economics of scale.

6.14 In regard to projections for future water demand, an increase of per capita consumption is expected after completion of the project. It is suggested that a sophisticated analysis on this matter is examined in the next-phase detailed study.

6.15 In the present study, the cost of water supply project is allocated only for the water supply project, nevertheless the subsidiary benefit is expected for irrigation due to the increment of fresh water. Therefore, it is suggested to consider the necessity of cost allocation for saving the cost of water supply project. However, it is noted that the benefit for irrigation cannot be included after the proposed Panitan-Panay irrigation scheme is put in service.

6.16 In the present implementation schedule of water supply project, the project is executed without phase. However, the phased execution can be also considered in case the preparation of project budget has difficulties. The phased execution is suggested to be studied in the next stage of study, if required. For example, the following phase seems to be reasonable.

(a) Construction of tidal barrier

(b) Excavation/dredging of the lower Panay river including the cut-off channel and construction of intake gate at the entrance to the lower Panay river.

(c) Construction of additional pumping facilities

6.17 In paragraph 6.1 above, a comprehensive feasibility study was proposed for the 1st stage flood control project to examine all the component plans, such as river improvement, polder and dam plans, on an integral basis. Nevertheless, where separate studies are proposed due chiefly for financial reasons, priority should be given first to polder dykes, secondary to Panay B dam and thirdly to river improvement cum non-structural measures, following economic indices (EIRR) evaluated for each component plan.

TABLES

Table 2-1 Population Projection by City and Municipality (Panay River Basin)

City and Municipality	1985	1990	1995	2000	2005	2010	2015	2020
Roxas City	92,398	104,049	113,269	123,239	131,027	137,602	143,576	149,669
Cuartero	20,250	21,981	23,134	24,407	25,949	27,252	28,435	29,641
Dao	26,937	30,037	32,404	34,967	37,176	39,042	40,737	42,466
Dumalag	24,936	27,742	29,867	32,167	34,200	35,916	37,475	39,066
Dumarao	33,439	26,966	39,657	42,527	45,214	47,483	49,544	51,647
Ivisan 1/	19,770	22,213	24,132	26,205	27,861	29,259	30,530	31,825
Jamindan 1/	28,387	31,146	33,105	35,242	37,469	39,349	41,058	42,800
Maayon	29,076	32,546	35,234	38,141	40,552	42,586	44,435	46,321
Mambusao	36,100	40,208	43,332	46,714	49,666	52,158	54,422	56,732
Panay 1/	35,811	40,107	43,442	47,050	50,023	52,533	54,814	57,140
Panitan	30,226	32,813	34,537	36,440	38,742	40,686	42,453	44,254
Pontevedra 1/	34,403	38,434	41,535	44,890	47,727	50,122	52,298	54,517
Sapian	20,791	22,854	24,332	25,942	27,581	28,965	30,223	31,506
Sigma	22,254	24,495	26,111	27,868	29,629	31,116	32,467	33,845
Tapaz 1/	40,200	45,499	49,760	54,369	57,805	60,705	63,341	66,029
Lemery 1/ 2/	18,496	20,912	24,733	26,268	27,928	29,329	30,602	31,901
Bingawan 1/ 2/	10,239	10,954	12,315	12,488	13,277	13,943	14,549	15,166
Total - Panay River Basin	523,713	572,956	630,899	678,924	721,826	758,046	790,959	824,525
Capiz Province	550,674	604,263	656,884	706,400	751,038	758,725	822,967	857,892
Region VI	5,092,413	5,672,211	6,249,677	6,799,926	7,301,346	7,728,445	8,119,370	8,520,815
Philippines	54,668,332	61,460,180	68,424,077	75,223,851	81,590,921	87,206,451	92,431,710	97,613,831

Source : ◦ Perspective for Population and Development Planning : Revised Population Projections for the Philippines and its Origines, 1980 - 2030, (MEDIUM - ASSUMPTION), NCSO
◦ Population Projections by Province, City and Municipality : 1980 - 2000 Region VI - Western Visayas, NCSO.

Notes : 1/; Population covers the whole municipality, though some parts of the municipality are not included by the Panay River Basin.
2/; Municipality of Iloilo.

Table 2-2 Projected Gross Regional Domestic Product

(1972 Constant Price)

Year	The Philippines		Region VI				The Province of Capiz			
	GDP		GRDP[1]				GRDP[2]			
	Amount (₱ x 10⁶)	Growth rate (%)	Amount (₱ x 10⁶)	Growth rate (%)	Per Capita GRDP (₱)	(US$)[5]	Amount (₱ x 10⁶)	Growth rate (%)	Per Capita GRDP (₱)	(US$)[5]
1982	99,097[3]	-	8,334[3]	-	1,730(R)[3]	244	917	-	1,766	249
1987	104,362[4]	1.0	9,025[4]	1.6	1,696	239	993	1.6	1,736	245
1992	125,287	3.7	10,126	2.3	1,717	242	1,114	2.3	1,783	251
1997	171,654	6.5	13,490	5.9	2,087	294	1,484	5.9	2,194	309
2000	207,349	6.5	16,081	6.0	2,365	333	1,769	6.0	2,504	353
2010	389,223	6.5	29,279	6.2	3,788	534	3,221	6.2	4,083	575
2020	730,624	6.5	54,053	6.3	6,344	894	5,946	6.3	6,931	976

Notes; 1/: Y = 0.07256 X + 1099.97 where, Y : GRDP and X : GDP

2/: GRDP in Capiz is assumed to occupy approximatdly 11% of GRDP of Region VI

3/: Real Figure

4/: Preliminary Projection by NEDA

5/: Foreign exchange rate US$1 = ₱7.10

Table 2-3 Present Land Use by Province, City and Municipality in the Panay River Basin

(Unit: ha)

Prov./City/Municipality[1/]	Land Use									
	Paddy	Sugarcane	Orchard (coconut)	Pasture/ Grassland	Shrub	Forest	Marshes/ Swamp	Fishpond	Builtup Area/ Village Yard	Total[2/]
Prov. of Capiz	37,140	41,910	7,590	6,040	77,860	11,880	1,850	10,560	1,540	195,170 (89
Roxas City	2,030	970	490	160	1,330	150	450	2,300	710	8,590 (4
Cuartero	2,640	2,520	300	650	3,640	190	-	-	40	9,980 (5
Dao	3,900	1,580	620	-	2,230	410	10	-	80	8,830 (4
Dumalag	2,770	2,910	430	260	3,660	1,690	-	-	80	11,800 (5
Dumarao	3,850	6,280	510	1,440	9,210	400	-	-	50	21,740 (10
Ivisan	-	40	-	-	60	10	-	-	-	110 (-
Jamindan	1,780	3,940	540	540	16,090	1,690	-	-	30	24,610 (11
Maayon	2,450	7,310	320	1,040	6,350	-	-	-	30	17,500 (8
Mambusao	3,690	1,500	1,440	160	3,700	730	10	-	130	11,360 (5
Panay	3,660	100	130	-	110	10	1,210	6,620	190	12,030 (6
Panitan	2,710	2,660	770	180	710	100	-	-	60	7,190 (3
Pilar	-	-	-	-	-	-	-	-	-	- (-
Pontevedra	760	1,820	230	70	280	-	110	1,640	50	4,960 (2
Pres. Roxas	-	-	-	-	-	-	-	-	-	- (-
Sapian	50	170	210	210	710	200	-	-	-	1,550 (1
Sigma	3,410	1,840	1,370	230	2,850	290	60	-	40	10,090 (5
Tapaz	3,440	8,270	230	1,100	25,730	6,010	-	-	50	44,830 (21
Prov. of Iloilo	3,820	6,620	150	2,370	10,070	-	-	-	-	23,030 (11
Total	40,960 (19)	48,530 (21)	7,740 (4)	8,410 (4)	86,730 (40)	11,880 (5)	1,850 (1)	10,560 (5)	1,540 (1)	218,200 (100)

Notes; 1/: Boundaries of Province/City/Municipality are in accordance with an administrative map prepared by the Ministry of Human Settlement.

2/: These areas are decided by the planimetric method based on the administrative map and land use map.

Remarks; Figures in parenthesis are proportions in percentage to the total.

Table 2-4 Flood Damage by Return Period under Economic Condition in 1984

(Unit: 1,000 Pesos at 1984 price constant)

Categories	Return Period (Year)							
	1	1.1	2	5	10	25	50	100
1. Crop Damage								
Irrigated Paddy	0	2,460	5,585	9,473	13,457	16,905	19,706	21,798
Rainfed Paddy	0	2,602	5,446	8,855	11,525	14,161	16,213	17,787
Vegetables	0	369	805	1,337	1,823	2,267	2,622	2,889
Sugarcane	0	85	102	184	301	467	616	731
Sub-total	0	5,516	11,938	19,849	27,106	33,800	39,157	43,205
2. Live Stock	0	358	775	1,290	1,761	2,197	2,545	2,808
3. Building Damage								
Residential Buildings	0	5,001	10,809	20,665	37,181	65,189	88,674	109,874
Household Effects	0	1,862	4,424	8,618	14,872	23,980	31,157	37,559
Other Buildings	0	4,682	17,464	36,473	68,592	100,938	124,088	147,559
Commercial Stock	0	506	1,892	3,915	7,564	11,405	14,005	16,707
Sub-total	0	12,052	34,590	69,673	128,211	201,514	257,926	311,701
4. Infrastructure Damage	0	4,218	12,106	24,385	44,873	70,529	90,274	109,095
5. Fishpond Damage	0	0	1,622	6,531	12,574	23,980	33,980	46,337
6. Indirect Damage	0	3,321	9,154	18,259	32,179	49,803	63,582	76,972
Total Damage/1	0	25,467	70,187	139,989	246,706	381,825	487,464	590,119

Note: /1 Average annual flood damage in 1984 is ₱104,521 x 10^3.

Table 2-5 Estimated Area and Number of Buildings Susceptable to Flooding

Item	Flood Magnitude (Recurrence Probability)				
	2-year	5-year	10-year	25-year	100-year
Inundation Area (km^2)/1					
Paddy	85	114	140	160	189
Sugarcane	17	24	29	32	39
Fishpond	2	10	10	10	11
Others	59	65	74	82	99
Total	163	213	253	286	338
Buildings (no., 1000)/1					
Residential	7.1	10.4	13.7	16.2	20.2
Non-residential	0.5	0.9	1.2	1.3	1.7
Total	7.7	11.3	14.9	17.5	21.9
Population affected/2 (1000)	42.1	62.0	79.6	94.0	121.3

Notes: /1 Based on information appeared on 1 : 10,000 map.
/2 No. of residential buildings x 6 persons/family.

Table 2-6 Land Use and Buildings in Flood Vulnerable Area

Sub-area	Land Use (ha)				Buildings (nos.)	
	Paddy	Sugar-cane	Fishpond	Others	Residential	Non-residential
Panay River						
P1	4,388	337	1,136	4,801	6,807	430
P2	750	150	0	188	1,083	93
P3	658	267	0	292	702	3
P4	56	31	0	27	32	0
P5	1,782	433	0	630	1,315	4
P6	77	40	0	50	617	94
P7	436	175	0	273	107	17
P8	1,168	331	0	354	998	132
P9	638	401	0	314	882	186
P10	986	454	1	400	961	86
Sub-total	(10,939)	(2,619)	(1,137)	(7,329)	(13,504)	(1,045)
Maayon River						
Y1	28	12	0	14	21	0
Y2	580	256	0	249	643	67
Y3	118	127	0	84	120	2
Y4	996	23	0	137	449	0
Sub-total	(1,722)	(418)	(0)	(484)	(1,233)	(69)
Mambusao River						
M1	127	14	0	31	128	23
M2	710	95	0	200	786	91
M3	640	55	0	344	753	110
M4	274	24	0	148	323	47
M5	700	113	0	204	419	13
M6	291	171	0	85	603	82
M7	2,432	123	0	588	1,733	31
Sub-totsl	(5,174)	(595)	(0)	(1,600)	(4,745)	(397)
Badbaran River						
B1	103	29	0	56	136	0
B2	796	104	0	285	600	174
Sub-total	(899)	(133)	(0)	(341)	(736)	(174)
Total	(18,734)	(3,765)	(1,137)	(9,754)	(20,218)	(1,685)

Note: The above figures are estimated based on information appeared on 1 : 10,000 map.

Table 3-1 Flood Damage Potential by River Stretch and Major Town

Item	River Stretch No.	River Length[1] (km)	Flood Area[2] (km^2)	Annual Average Damage (10^3 Pesos) Total[2]	Per km	Per km^2	Population in Flood Prone Area (10^3 Pesos) Total	Per km	Per km^2	Damageability[3] Level	Remarks
1. Whole Basin:		162.5	338.2	104,521	641	309	121.3	0.74	0.36	–	
2. By River Stretch:											
Panay river	P1	13.0	106.6	21,550	1,658	202	35.4	2.72	0.34	Level-1	
				(31,784)	(2,445)	(298)	(40.8)	(3.14)	(0.38)		(Incl. Pontevedra and Panay)
	P2	4.0	10.9	1,375	344	126	4.1	1.03	0.38	Level-2	To be protected as an integral part of P1.
				(3,652)	(913)	(335)	(6.5)	(1.63)	(0.60)		(Incl. Panitan)
	P3	9.0	12.2	2,237	249	183	4.2	0.47	0.34	Level-3	Right bank area worthy for protection
	P4	2.2	1.1	130	59	118	0.2	0.09	0.18	Level-3	
	P5	7.0	28.5	5,424	774	190	7.9	1.07	0.28	Level-1	
	P6	1.8	1.5	24	13	16	1.2	0.67	0.80	Level-3	To be protected as an integral part of P5.
				(4,607)	(2,559)	(3,071)	(3.7)	(2.06)	(2.47)		(Incl. Dao)
	P7	8.8	13.1	952	108	73	0.6	0.07	0.05	Level-3	Protection of left bank area to be considered.
	P8	5.4	18.5	5,576	1,032	801	5.2	0.96	0.28	Level-1	
				(16,136)	(2,988)	(872)	(6.0)	(1.11)	(0.32)		(Incl. Cuartero)
	P9	8.6	13.5	1,390	161	103	3.4	0.40	0.25	Level-2	
				(1,791)	(208)	(133)	(5.3)	(0.62)	(0.39)		(Incl. Dumalag)
	P10	16.8	18.4	1,972	117	107	4.4	0.26	0.24	Level-3	
				(2,027)	(121)	(110)	(5.8)	(0.35)	(0.32)		(Incl. Tapaz)
Maayon river	Y1	1.8	0.5	152	84	304	0.1	0.06	0.20	Level-3	
	Y2	6.4	10.9	2,050	320	188	2.6	0.41	0.24	Level-2	
				(4,585)	(716)	(421)	(3.9)	(0.61)	(0.36)		(Incl. Maayon)
	Y3	5.0	3.3	465	93	141	0.7	0.14	0.21	Level-3	
	Y4	12.0	11.6	2,626	219	226	2.7	0.23	0.23	Level-2	
Mambusao river	M1	2.2	1.7	626	285	368	0.8	0.36	0.47	Level-2	
	M2	9.0	10.1	1,329	148	132	3.2	0.36	0.32	Level-2	
				(4,064)	(452)	(402)	(4.7)	(0.52)	(0.46)		(Incl. Sigma)
	M3	10.0	10.4	2,825	283	272	2.3	0.23	0.22	Level-2	
				(8,634)	(863)	(830)	(4.5)	(0.45)	(0.43)		(Incl. Mambusao)
	M4	3.2	4.5	1,009	315	224	1.0	0.31	0.22	Level-2	
	M5	11.3	10.2	1,509	134	148	2.5	0.22	0.25	Level-3	
	M6	5.2	5.5	1,948	375	354	1.8	0.35	0.33	Level-2	To be improved only after M1-M5 are improved.
				(3,567)	(686)	(649)	(3.6)	(0.69)	(0.65)		(Incl. Jamindan)
	M7	8.6	31.4	6,217	723	198	10.4	1.21	0.33	Level-1	To be improved only after M1 to M5 are improved.
Badbaran river	B1	3.4	1.9	240	70	126	0.8	0.24	0.42	Level-3	
	B2	7.8	11.9	1,001	128	84	2.1	0.27	0.18	Level-3	
				(2,077)	(266)	(174)	(3.6)	(0.46)	(0.30)		(Incl. Dumarao)
3. By Major Town:											
Pontevedra	P1	-	1.30	9,859	-	7,583	3.0	-	2.30	Level-1	
Panay	P1	-	0.51	374	-	733	2.4	-	4.70	Level-3	
Panitan	P3	-	1.00	2,277	-	2,277	2.4	-	2.40	Level-2	
Dao	P6	-	1.17	4,582	-	3,916	2.5	-	2.14	Level-2	
Cuartero	P8	-	0.49	10,560	-	21,551	0.8	-	1.63	Level-1	
Dumalag	P9	-	0.66	400	-	606	1.9	-	2.88	Level-3	
Tapaz	P10	-	0.64	54	-	84	1.4	-	2.19	Level-3	
Maayon	Y2	-	0.23	2,534	-	11,017	1.3	-	5.65	Level-1	
Sigma	M2	-	0.47	2,735	-	5,819	1.5	-	3.19	Level-1	
Mambusao	M3	-	1.03	5,809	-	5,640	3.2	-	3.11	Level-1	
Jamindan	M6	-	0.18	1,619	-	8,994	1.8	-	10.0	Level-1	
Dumarao	B2	-	0.48	1,075	-	2,240	1.5	-	3.13	Level-2	

Notes: [1] Length along proposed channel improvement.

[2] Area and annual flood damage at 100-year flood occurrence.

( ) Including major town.

[3] Damage potential level:

	River Stretch (10^3 P/km)	Major Town (10^3 P/km^2)
Level 1	500 over	5,000 over
Level 2	500 - 150	5,000 - 1,000
Level 3	150 under	1,000 under

Table 3-2 Non-structural Measure Alternatives

Measure	Appropriate Applications	Application to Panay River Basin
Modify damage susceptibility		
Flood plain management	Where uses other than agricultural are competing, especially where they involve urban and industrial uses.	This measure is applicable to all areas of the basin, though agricultural land use is prominent.
Structural change	Where building/property damage is remarkable with frequent inundation, especially where the depth of flooding is not large.	This measure is applicable to the Panay river basin, in areas where floading is less than 1 m deep.
Flood proofing	Where buildings are scattered and frequently flooded, especially where flooding is less than 1 m, 3-hr advanced warning is possible.	Such measures as closure of openings and waterproofing interior would be impractical in view of type of local buildings. This plan was, therefore, not examined in this study.
Subsidised relocation	Essentially, this is a part of measures included in flood plain management. This measure is appropriate in areas where building/property damages are severe with possible risk to human life.	This measure is worthy of evaluation for all areas in the basin.
Disaster relief	Elsewhere.	This measure is presently undertaken. Excessive adoptio of this measure tends to remove the incentive to avoid future flood losses, and, therefore, this measure would not be an ultimate measure for the basin. No detailed evaluation was attempted in this study.
Modify the loss burden		
Tax write-offs	Elsewhere, if approved by the government.	As in the case of disaster relief, this measure provides little incentive to reduce flood losses. Moreover, this is not supported by present legislation. Therefore no further study was attempted.
Flood insurance	Elsewhere, if insurance system is available.	This type of insurance system is presently not available and, therefore, not applicable to the basin. Moreover, this measure cannot be studied at a river basin study level, but to be left to a specific nation level study.
Flood forecasting and warning system	Elsewhere, and especially where flood-to-peak interval is longer than 1 day.	Applicable. This system is prerequisite as a supporting measure to any type of structural methods or other non-structural methods.
Modify the flood		
Watershed management	Where enough runoff remains in low-water period, even if this program is undertaken.	No detailed study was attempted in view of lack of data. While, forestation in the watershed area is worthy of encouragement not only for flood control purpose but als other development purposes.

Note: * Specific program as a part of "flood plain management" in a borad meaning.

Table 4-1 Summary of Flood Control Projects under Long-, Mid- and Short-term Plans (1)

Location of Work	Q'ty	Long-term Plan (LP)	Mid-term Plan (MP)	Short-term Plan (SP)
Design Flood		100-year flood	25-year flood	10-year flood
River Improvement				
Panay River:				
(1) Pontevedra river (P1)	6.1 km	Partial improvement of existing channel between Cogon floodway inlet and Hamulauon bifurcation	- do left -	- do left -
(2) Cogon floodway	9.5 km	Construction of a bypass floodway ($Q = 3,900$ m^3/sec)	- do left ($Q = 2,200$ m^3/sec) -	- do left ($Q = 1,000$ m^3/sec) -
(3) Cogon floodway inlet - Panitan (P1 and P2)	6.5 km	Improvement with levees	- do left -	- do left -
(4) Panitan - Maayon confluence (P3)	10.2 km	Improvement of existing channel with a levee for partial protection of right bank area	(No improvement)	(No improvement)
(5) Maayon confluence - Mambusao confluence (P4 and P5)	2.2 km	Partial improvement of existing channel, only at bottleneck sections (P4)	(No improvement)	(No improvement)
	7.0 km	Improvement with levees (P5)	(No improvement)	(No improvement)
(6) Mambusao confluence - Badbaran confluence (P6, P7 and P8)	7.2 km	Improvement with levees (P6 and P8)	(No improvement)	(No improvement)
	8.8 km	Improvement of existing channel with a levee for protection of partial area on left bank	(No improvement)	(No improvement)
(7) Badbaran confluence - Dumalag (P9)	8.6 km	Improvement with levees	(No improvement)	(No improvement)
Maayon River:				
(1) Downstream of Ilas confluence (Y1)	1.8 km	Partial improvement of existing channel, only at bottleneck sections	(No improvement)	(No improvement)
(2) Along Maayon and Ilas river (Y2 and Y4)	18.4 km	Construction of back levees, with improvement of existing channels	(No improvement)	(No improvement)

Table 4-1 Summary of Flood Control Projects under Long-, Mid- and Short-term Plans (2)

Location Work	Q'ty	Long-term Plan (LP)	Mid-term Plan (MP)	Short-term Plan (SP)
Mambusao River:				
(1) Downstream of Mambusao (M1, M2 and M3)	21.2 km	Improvement of existing channel with low levees. Construction of a bypass channel on right bank at Mambusao town.	(No improvement)	(No improvement)
(2) Balacuan river (M7)	8.6 km	Construction of a drainage sluice at Balacuan river mouth, with partial improvement of existing channel, only at bottleneck sections.	(No improvement)	(No improvement)
Polder Plan				
(1) Dao town (P6)	1.17 km^2	(Not applicable. To be protected by river improvement work.)	Construction of polder dyke (100-year flood protection)	Construction of polder dyke (100-year flood protection)
(2) Cuartero town (P8)	0.49 km^2	- do above -	- do above -	- do above -
(3) Sigma town (M2)	0.47 km^2	- do above -	- do above -	- do above -
(4) Mambusao town (M3)	1.03 km^2	- do above -	- do above -	- do above -
(5) Maayon town	0.64 km^2	- do above -	Staged construction of polder dyke	(No work)
(6) Jamindan town	0.34 km^2	- do above -	- do above -	(No work)
(7) Dumarao town	0.48 km^2	- do above -	- do above -	(No work)
Multipurpose Dam				
Panay B dam		Construction of a flood control dam, with installation of hydropower facilities.	- do left -	- do left -
Non-structural Measures				
(1) Flood plain management	220 km^2	Application to areas where protection by structural measures is not scheduled	- do left -	Applicable to all areas including P1 and P2 areas
(2) Relocation of housings	11 km^2	(Not planned)	(Not planned)	To be applied to subdivision areas Y1 and M3 (but excluding Mambusao town), subject to further review in detailed survey.
Flood Forecasting and Warning System		To be installed.	To be installed.	To be installed.

Table 4-2 NPC Demand Forecasts and Study Forecasts

Year	Sales target 1/		NPC forecast 2/		Study forecast
	Peak power (MW)	Energy (GWh)	Peak power (MW)	Energy (GWh)	Peak power (MW)
1984	45.9	210.7	40	211	41.2
85	51.8	243.5	41	216	44.8
86	57.3	265.8	46	240	48.3
87	63.4	293.2	47	249	51.8
88	70.6	325.3	50	264	55.4
89	75.7	344.5	58	303	58.9
1990	81.6	365.8	62	324	62.4
91	87.3	400.6	64	343	66.0
92	93.9	434.7	67	362	69.5
93			69	392	73.0
94			72	413	76.6
95			74	437	80.1
96					83.6
97					87.2
98					90.7
99					94.3
2000					97.8
01					101.3
02					104.9

Sources: 1/ By NPC Panay Grid, 1983
2/ By NPC, 1984

Table 5-1 General Features of Proposed Projects

Flood Control Project

1. River Improvement - 1st Stage

a)	Design flood	: 10-year flood
b)	Improvement section	
	- Cogon bypass floodway	: 9.5 km
	- Partial improvement of Pontevedra river (P1 partial)	: 6.1 km
	- Improvement of Panay lower reach (Panitan - Congon floodway inlet)	: 6.5 km
	Total	: 22.1 km
c)	Major works	
	- Excavation	: 3,410,000m^3
	- Embankment	: 570,000m^3
	- Revetment works	: 58,000m^2
	- Groin	: 4,400m
	- Drainage sluices/gates	: 9 nos.
	- Sluiceway structure at inlet of Pontevedra river	: 1 no.
	- Fixed weir at inlet of Cogon floodway	: 1 no.
	- Road and railway relocation	: 2.8 km
	- Bridge	: 2 nos.
d)	Construction cost (1984 base price)	: ₱589 x 10^6

2. River Improvement - 2nd Stage

a)	Design flood	: 25-year flood
b)	Improvement section	
	- Enlargement of previously improved section (Cogon floodway - Panitan)	: 16.0 km
c)	Major works	
	- Excavation	: 4,708,000 m^3
	- Embankment	: 743,000 m^3

- Revetment works : 81,100 m^2
- Groin : 0 m
- Drainage sluices/gates : 0 no.
- Road and railway relocation : 0 km
- Bridge : 2 nos.

d) Construction cost (1984 base price): Peso 440 x 10^6

3. River Improvement - 3rd Stage

a) Design flood : 100-year flood

b) Improvement section

- Enlargement of previously improved sections (Cogon floodway - Panitan) : 16.0 km
- Improvement of Panay Middle reach (Panitan - Badbalan confluence): 35.4 km
  - . Improvement with leavees (P5, P6 & P8) : (14.2 km)
  - . Partial improvement with Levee on one bank (P3 & P7) : (19.0 km)
  - . Partial improvement of low water channel (P4) : (2.2 km)
- Improvement of Mambusao lower reaches (M1, M2 & M3) : 21.2 km
- Improvement of Panay upper reach (P9) : 8.6 km
- Improvement of Maayon river : 20.2 km
  - . Improvement with levees (Y2 & Y4) : (18.4 km)
  - . Partial improvement of low water channel (Y1) : (1.8 km)
- Construction of a sluice gate structure at Balacuan river mouth, with partial improvement of existing Balacuan river channel : 8.0 km

Total : 109.4 km

c) Major works

- Excavation : 25,515,000 m^3
- Embankment : 7,936,000 m^3
- Revetment works : 1,157,600 m^2
- Groin : 36,900 m
- Drainage sluices/gates : 28 nos.

- Sluice gate structure at Balacuan river mouth: 1 no.
- Road and railway relocation : 3.8 km

d) Construction cost (1984 base price): ₱3,486 x 10^6

4. Polder Plan - 1st Stage Project

Location	Protection Area	Length of Dyke	Construction Cost
- Dao	1.17 km^2	3.0 km	₱54.7 x 10^6
- Cuartero	0.49 km^2	2.0 km	₱56.7 x 10^6
- Sigma	0.47 km^2	2.8 km	₱41.8 x 10^6
- Mambusao	1.03 km^2	4.9 km	₱77.6 x 10^6

5. Polder Plan - 2nd Stage Project

Location	Protection Area	Length of Dyke	Construction Cost
- Maayon	0.64 km^2	2.5 km	₱49.3 x 10^6
- Jamindan	0.34 km^2	2.3 km	₱38.7 x 10^6
- Dumarao	0.48 km^2	2.3 km	₱58.4 x 10^6

6. Non-structural Measures - 1st Stage Project

a) Flood plain management
- Main objective area : 220 km^2 (upstream of Panitan)
- Management in integration with structural measures : 118 km^2 (downstream of Panitan)

b) Relocation of housings
- Objective area : Sub-areas Y1 - 0.5 km^2, Sub-area M3 - 10.4 km^2 (excl. Mambusao town)
- Estimated No. of buildings : 250 nos.

c) Initial capital cost : Peso 52 x 10^6

Annual operation cost : Peso 4.0 x 10^6

7. Flood Forecasting/Warning System - 1st Stage Project

a) Proposed facility
- Staff stream gage : 10 gages
- Telemeter rain gage : 4 stations
- Telemeter stream gage : 5 stations

- Repeater station : 2 stations
- Central receiving station : 1 station (Roxas)

b) Installation cost : Peso 84 x 10^6

Annual operating cost : Peso 4.2 x 10^6

Multipurpose Dam Project

Panay B Dam:

a) Hydrology

- Catchment area : 239 km^2
- Average runoff : 14.3 m^3/sec
- Flood discharges :

Return Period	Inflow	Outflow
100-year	2,420 m^3/sec	1,210 m^3/sec
25-year	1,250 m^3/sec	625 m^3/sec

b) Reservoir

- Gross storage : 96.0 x 10^6 m^3
- Effective storage : 64.3 x 10^6 m^3
  - Flood control : (33.8 x 10^6 m^3)
  - Hydropower : (30.5 x 106 m3)
- Normal high water level : El. 65.0 m
- Surcharge water level (100-year flood control) : El. 71.3 m

c) Dam

- Type : Concrete gravity dam
- Crest El. : El. 77.4 m
- Crest length : 160 m
- Dam Height : 52.4 m
- Dam volume : 93 x 10^3 m^3

d) Generating facilities

- Max. plant discharge : 27.2 m^3/sec
- Head, max. static : 35.0 m
  , rated : 31.7 m
- Installed capacity : 7.1 MW
- Annual energy output : 31.4 GWh

e) Power transmission facilities

- Voltage : 69 kV
- Transmission line length : 45 km

- Receiving substation : Panitan substation (Existing)

f) Construction cost (1984 base price) : ₱471.2 x 10^6

Irrigation Project

1. Panitan - Panay Scheme

a) General data:

- Location : Panitan - Panay area
- Net irrigation area : 3,250 ha
- Water source : Panay river
- Diversion requirement : 4.75 m^3/sec

b) Intake/Headreach:

- Location of intake : 1 km u/s of Panitan
- Type of intake : By pumping
- Pump capacity : 284.4 m^3/min
- Headreach length (2 systems) : 1.8 km
- Type of headreach : Concrete-lined

c) Main canal:

- Type : Trapezoidal earth canal
- Total length : 17.8 km

d) Lateral canal:

- Type : Trapezoidal earth canal
- Total length : 39.6 km

e) Drainage facilities:

- Main drain : 13.0 km
- Collector drain : 17.7 km

f) Construction cost (1984 base price): ₱182.3 x 10^6

2. Mambusao Scheme

a) General data:

- Location : Mambusao downstream reaches
- Net irrigation area : 2,145 ha
  (Improvement of existing area : 1,640 ha)
  (Extension area : 505 ha)
- Water source : Mambusao river
- Diversion requirement : 2.6 m^3/sec

b) Intake:

- Location	:	6 km u/s of Mambusao
- Type of intake	:	By gravity
- Design discharge	:	2.6 m^3/sec

c) Main canal:

- Type	:	Trapezoidal earth canal
- Length	:	14.6 km (rehabilitation)

d) Lateral canal:

- Type	:	Trapezoidal earth canal
- Length	:	33.2 km (rehabilitation) 5.5 km (new const.)

e) Drainage facility:

- Drain	:	25 km
- Rehabilitation of creeks	:	11 km

f) Construction cost (1984 base price): ₱79 x 10^6

Water Supply Project

ROX-WD Water Supply Project:

a) General data:

- Supply area	:	Roxas City and surrounding area
- Water source	:	Main Panay river
- Water abstraction rate	:	3.0 m^3/sec incl. water for existing irrigation areas and surplus supply capacity of 1.0 m^3/sec
- Water supply to ROX-WD	:	7,450 m^3/day

b) Proposed facilities/works:

- Shortcut channel between Main Panay river and Lower Panay river	:	344 m
- Intake gate at shortcut channel inlet	:	2 m wide x 2 m high x 2 nos.
- Dredging of the Lower Panay riverbed	:	20 km (85 x 10^3 m^3)
- Construction of a new pumping station	:	7,450 m^3/day
- Installation of a new conveyance pump	:	300 mm dia., 1.0 km
- Construction of a tidal gate	:	5 m wide x 4.5 m high x 3 nos.

c) Construction cost (1984 base price) : ₱56 x 10^6

Table 6-1 Tentative Plan for Future Land Use and Development in Flood Prone Area (1)

Item	AREA - 1 where flood protection work (structural measure) is provided or scheduled to be provided under short-term programs.	AREA - 2 where no protection work is proposed or the work will be implemented only in distant future.	AREA - 3 Area to be procured for river improvement work in future, i.e. area confined by levees to form a future river channel.
Land Use	Policy No specific regulation of land uses. However, inhabitants should be informed of remaining flood risks which are not removed by the protection works provided in the area.	Policy Present land uses can be continued with some intensification within limits set by people's acceptance of loss burden.	Policy In principle, present land uses will be allowed until the lands are procured for river improvement work. People should be informed that the area is defined as essential floodway of design flood.
	Guideline Agriculture: - uses for labour intensive and value-added agricultural productions - uses for value-added aquacultural productions such as fishponds Town proper: - promotion of intensive commercial and industrial uses - positive uses for public facilities such as public buildings, schools, hospitals, etc. - uses for residential buildings - promotion of orderly urbanization development	Guideline Agriculture: - uses for labour-saving agricultural productions - change of cropping schedule /1 in heavily damageable areas - no extensive land development (such as new irrigation), unless it is clarified not to receive excessive flood damage - reinforcement of fishpond dykes Town proper: - restricted expansion of existing towns - encouragement of land uses in high level areas Other uses: - uses of lands for temporarily used facilities such as recreation, sports and fiesta facilities - positive uses for water storage and that they will have flood retarding function - positive provision of evacuation area on highlands	Guideline Agriculture: - restriction to present land use - No new reclamation Town proper: - restriction of further expanding uses Other uses: - only open land uses to be allowed - prohibition of excessive land fill/deposits and permanent obstructions

Notes: The above shows preliminary guidelines for future land uses and development activities. Details of the implementation methods. (incl. legislation, planning and enforcing organizations, public information, etc.) should be examined in a separated study.

/1 For example, plantation of Mung beans instead of cropping of the 2nd paddy (See Appendix IV for details).

Table 6-1 Tentative Plan for Future Land Use and Development in Flood Prone Area (2)

Item	AREA - 1 where flood protection work (structural measure) is provided or scheduled to be provided under short-term programs.	AREA - 2 where no protection work is proposed or the work will be implemented only in distant future.	AREA - 3 Area to be procured for river improvement work in future, i.e. area confined by levees to form a future river channel.
Building	Policy No specific restriction of building development. Guideline - encouragement of non-combustible and durable buildings - construction of residential areas according to land use zoning - construction of buildings on land fill or elevated floor buildings in areas where only low-level protection work is provided.	Policy No positive enforcement of restriction. However, people should be educated to make them incentive to reduce flood damages on their buildings and properties. Guideline - guidance to people to have their new buildings in flood-free area or on elevated lands, or otherwise to construct elevated floor buildings - relocation of housings in areas which are exposed to danger to life - preparedness for emergency (stock of foodstuffs, rescue boat, etc.)	Policy Any new settlement/building development should be discouraged through dissemination of flood risks to people.
Public Facilities/ Government Projects	Policy No specific constraints in implementing facilities and/or projects. However, the plan and design should take into account the remaining risks of occurrence of larger floods than the design one. Guideline - promotion of irrigation, fishpond and other productive facilities - positive provision of infrastructures for amplification of social capitals	Policy Restricted development in this area. All facilities should be built in due consideration of present/future flood conditions in the area. Guideline - no implementation of large scale projects, unless they are proven to be free from flood damage - construction of flood-free structures (e.g. construction of roads above flood water level with proper drainage facilities)	Policy In principle, no new public facilities will be added and no government project proposed in this area. Bridges and other river facilities are planned in consideration of future river improvement works.

Notes: The above shows preliminary guidelines for future land uses and development activities. Details of the implementation methods. (incl. legislation, planning and enforcing organizations, public information, etc.) should be examined in a separated study.

/1 For example, plantation of Mung beans instead of cropping of the 2nd paddy (See Appendix IV for details).

FIGURES

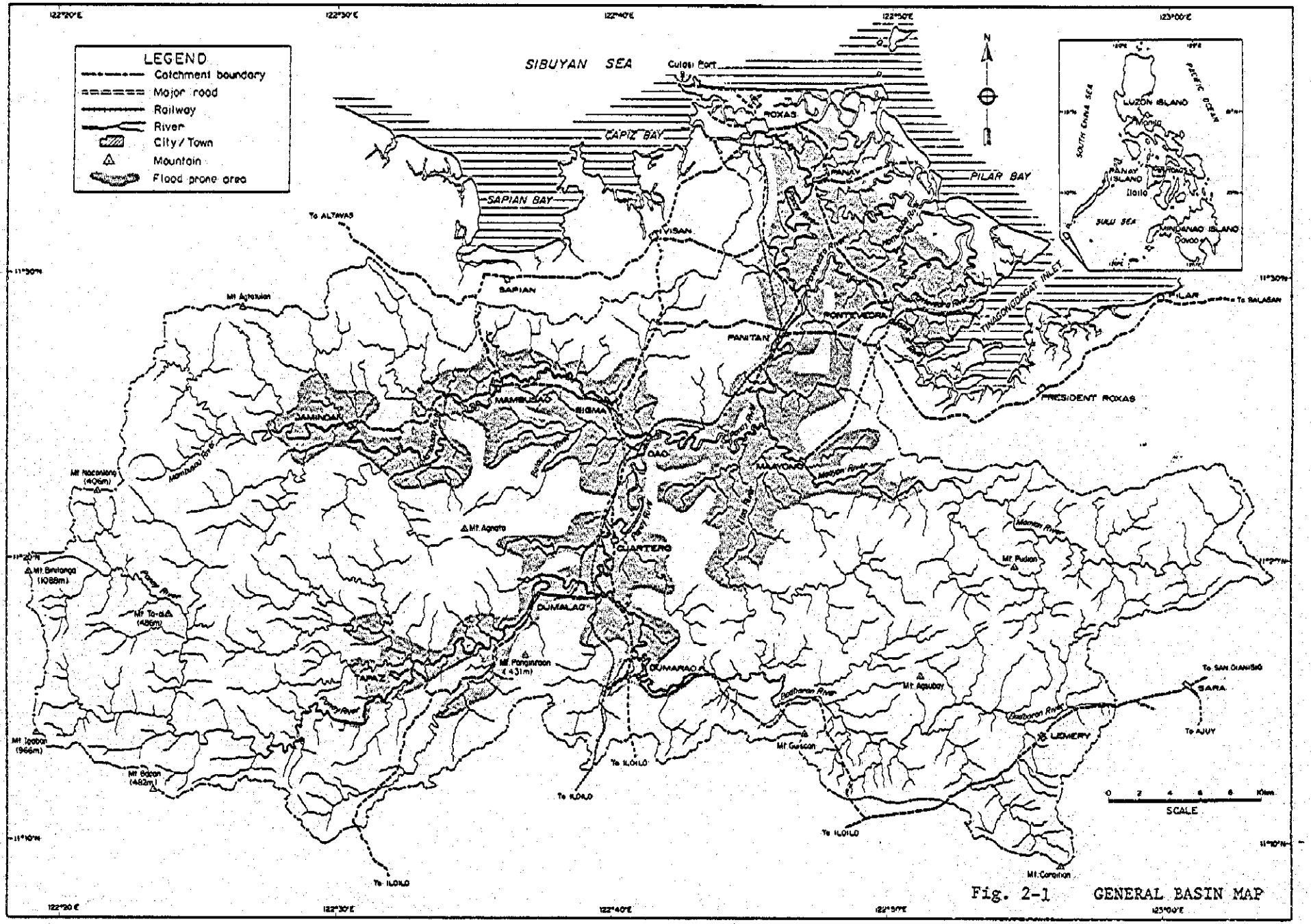

Fig. 2-1 GENERAL BASIN MAP

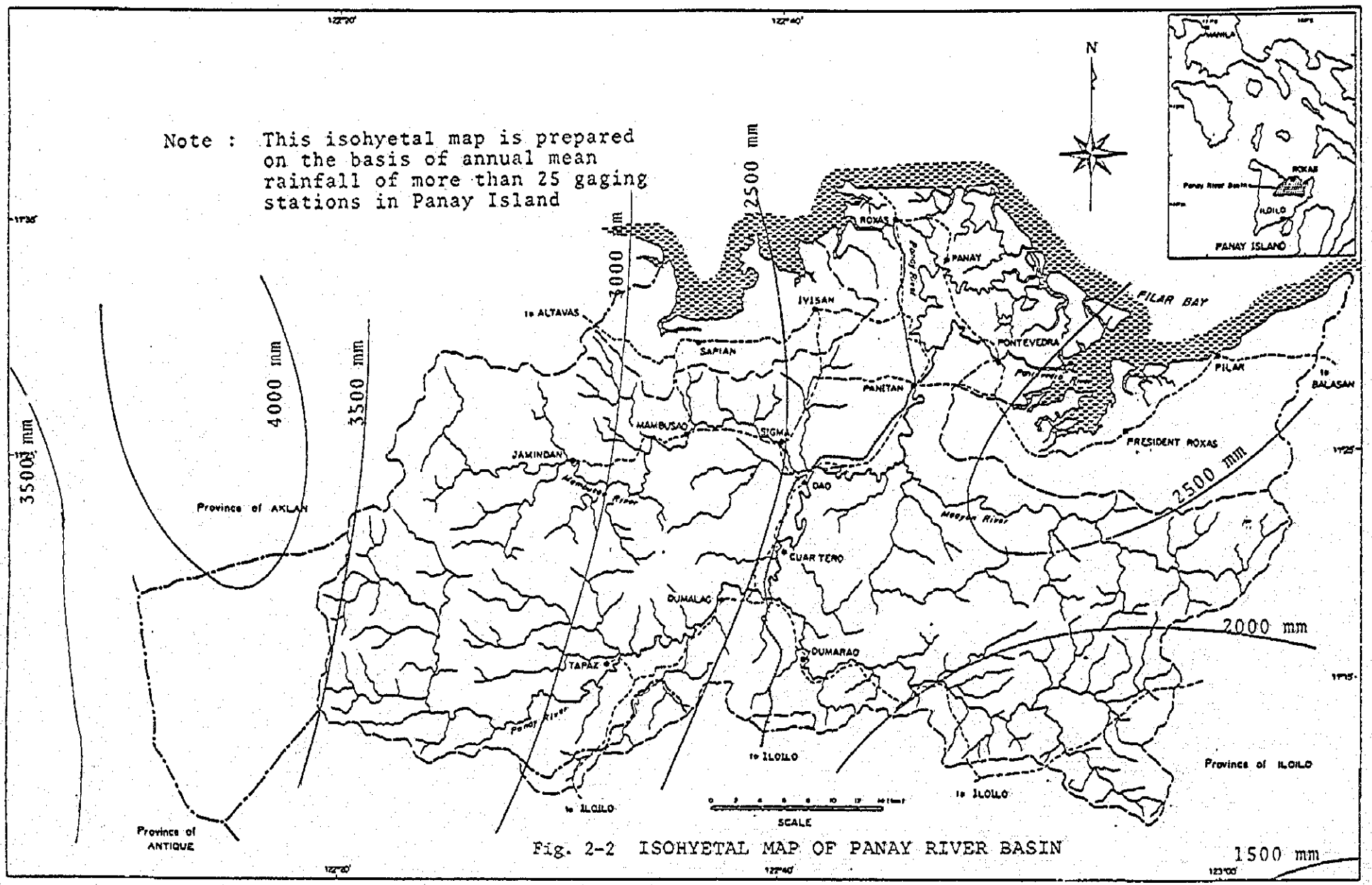

Fig. 2-2 ISOHYETAL MAP OF PANAY RIVER BASIN

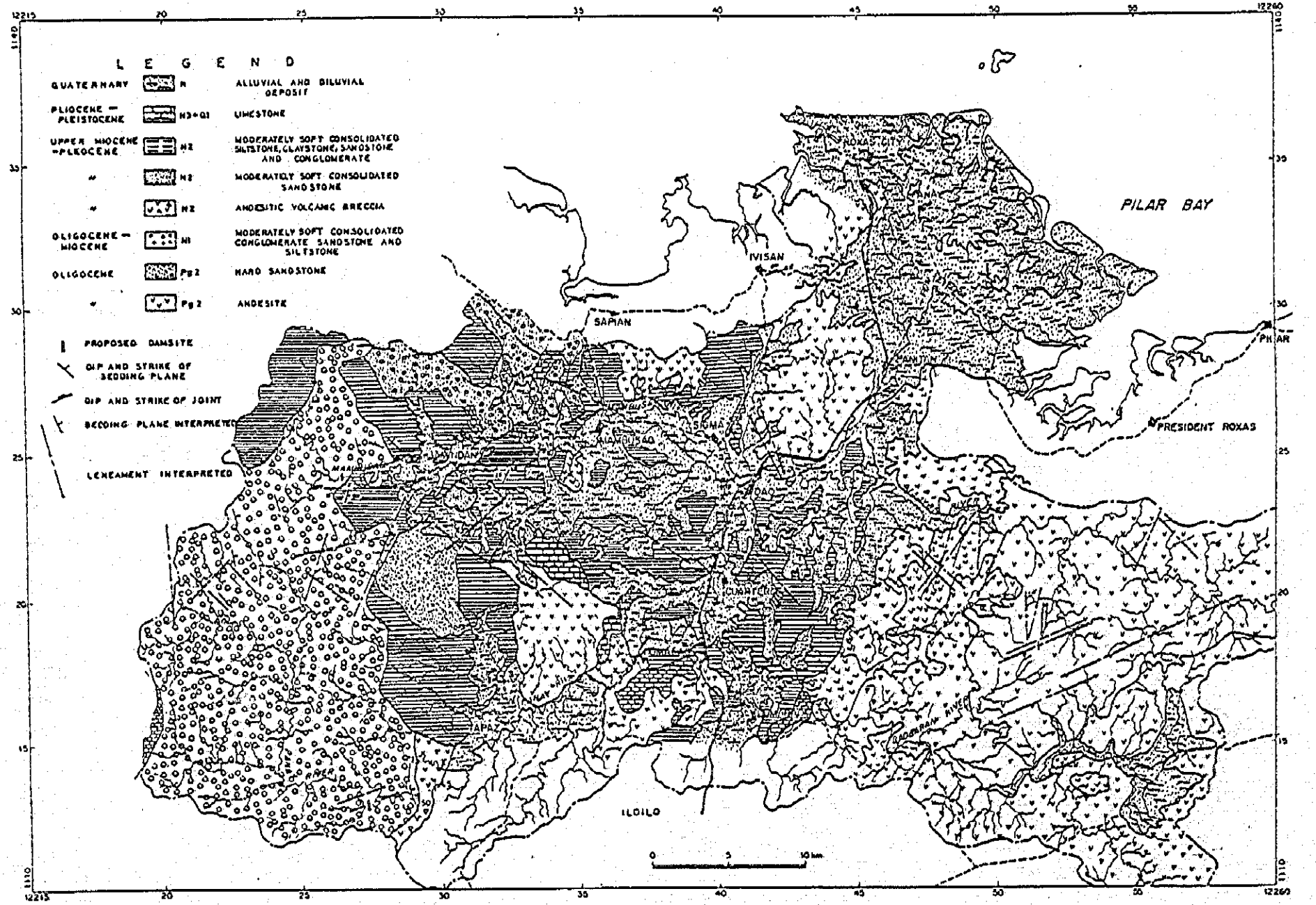

Fig. 2-3 REGIONAL GEOLOGICAL MAP OF THE PROJECT AREA

LEGEND

Symbol	Land Use
R	Lowland/Paddy field
S	Sugercane
G	Pasture/Grass land
C	Coconuts
B	Shrub
F	forest
P	Fish pond
M	Marshes/ Swamp area
H	Built-up area

Remarks: S/G,R means that sugarcane is dominant the area,followed by grassland and rice area.

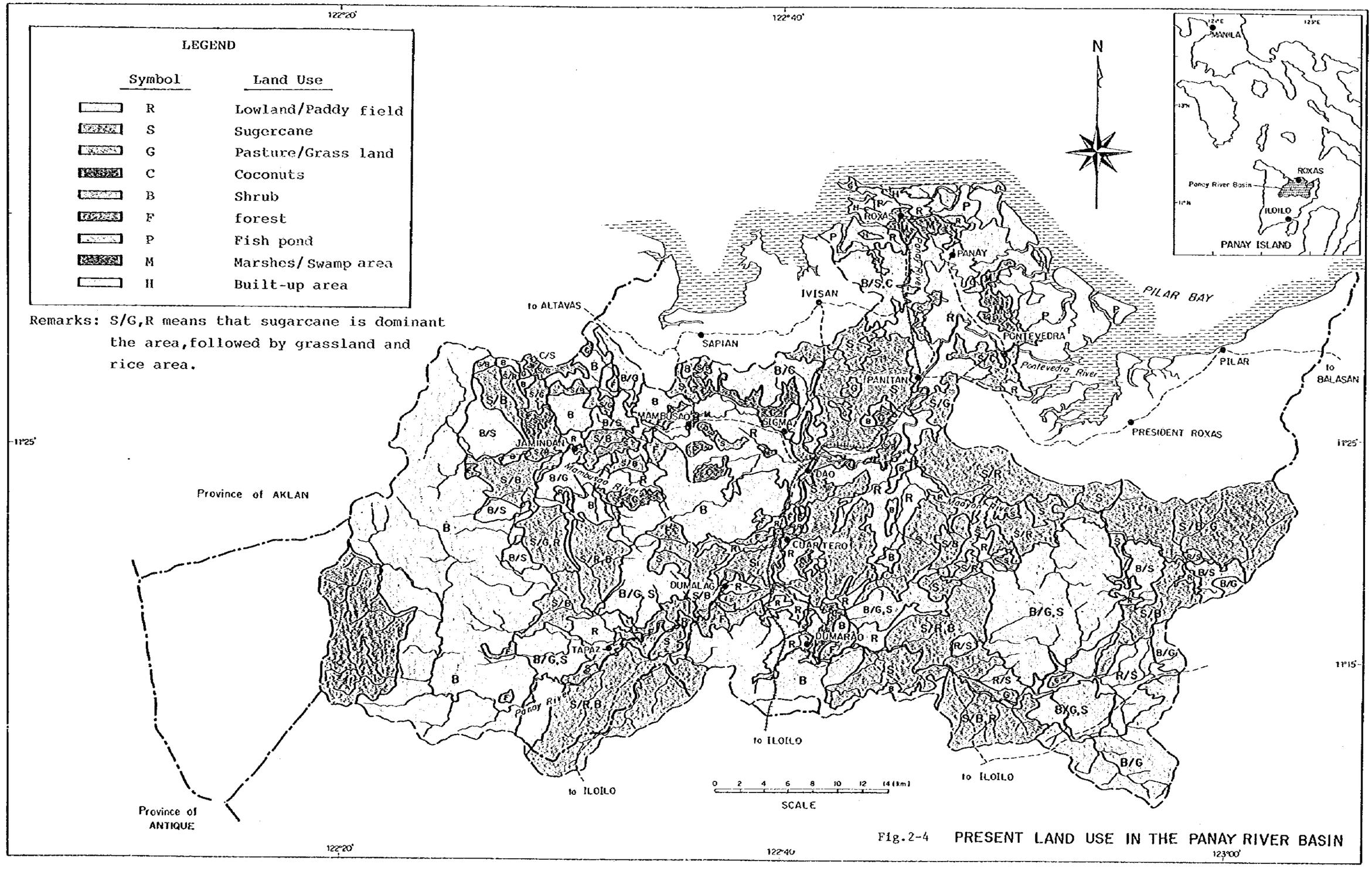

Fig.2-4 PRESENT LAND USE IN THE PANAY RIVER BASIN