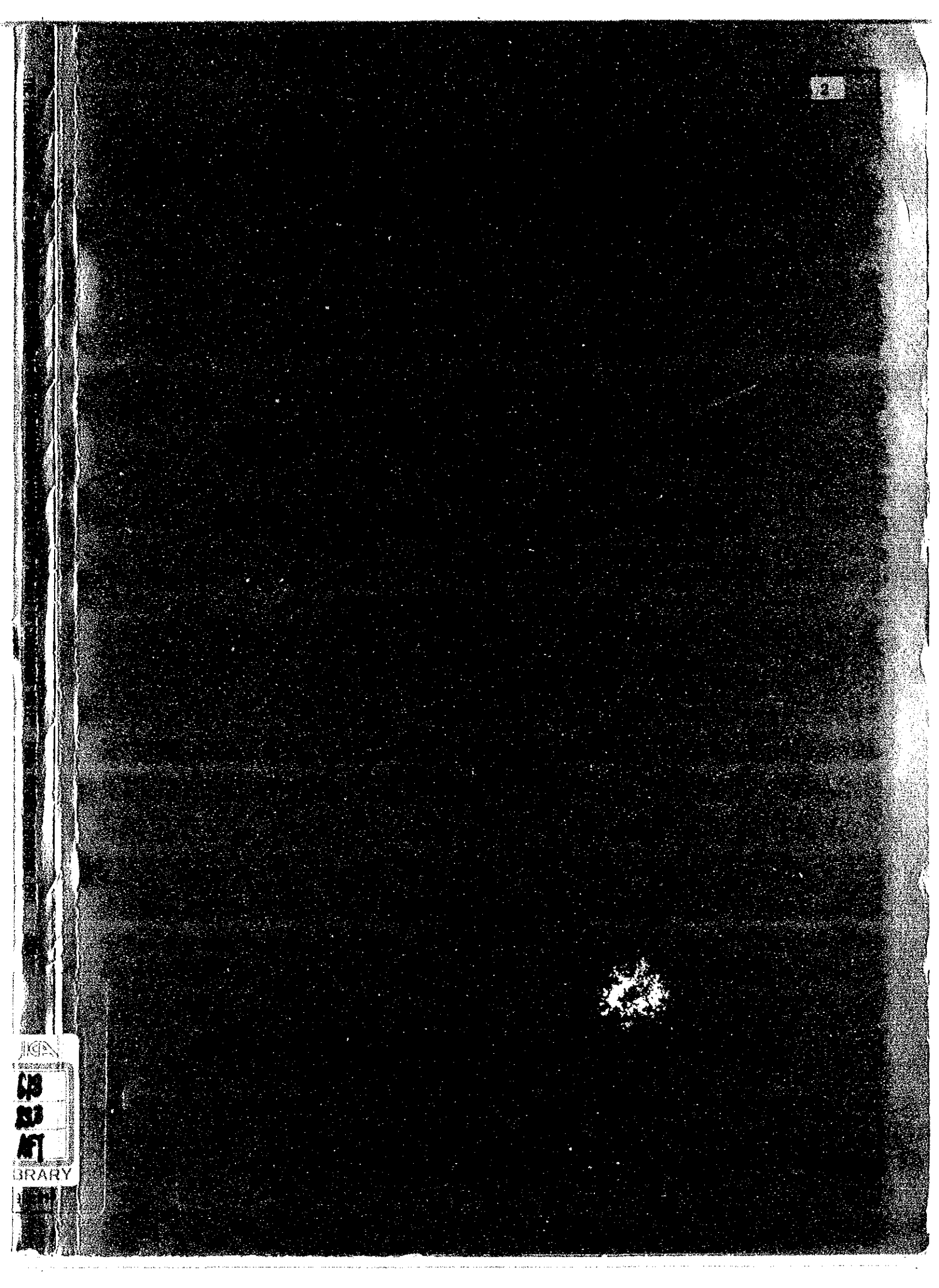


THE REPUBLIC OF HONDURAS

THE FEASIBILITY STUDY ON REHABILITATION OF COYOLAR DAM AND IRRIGATION IMPROVEMENT PROJECT IN COMAYAGUA VALLEY

FINAL REPORT
ANNEX

FEBRUARY 1991

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

PREFACE

In response to a request from the Government of the Republic of Honduras, the Japanese Government decided to conduct a feasibility study on the Rehabilitation of Coyolar Dam and Irrigation Improvement Project in Comayagua Valley and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Republic of Honduras a study team headed by Mr. Yasuro Hagihara, Pacific Consultants International Inc., three times between January and November 1990.

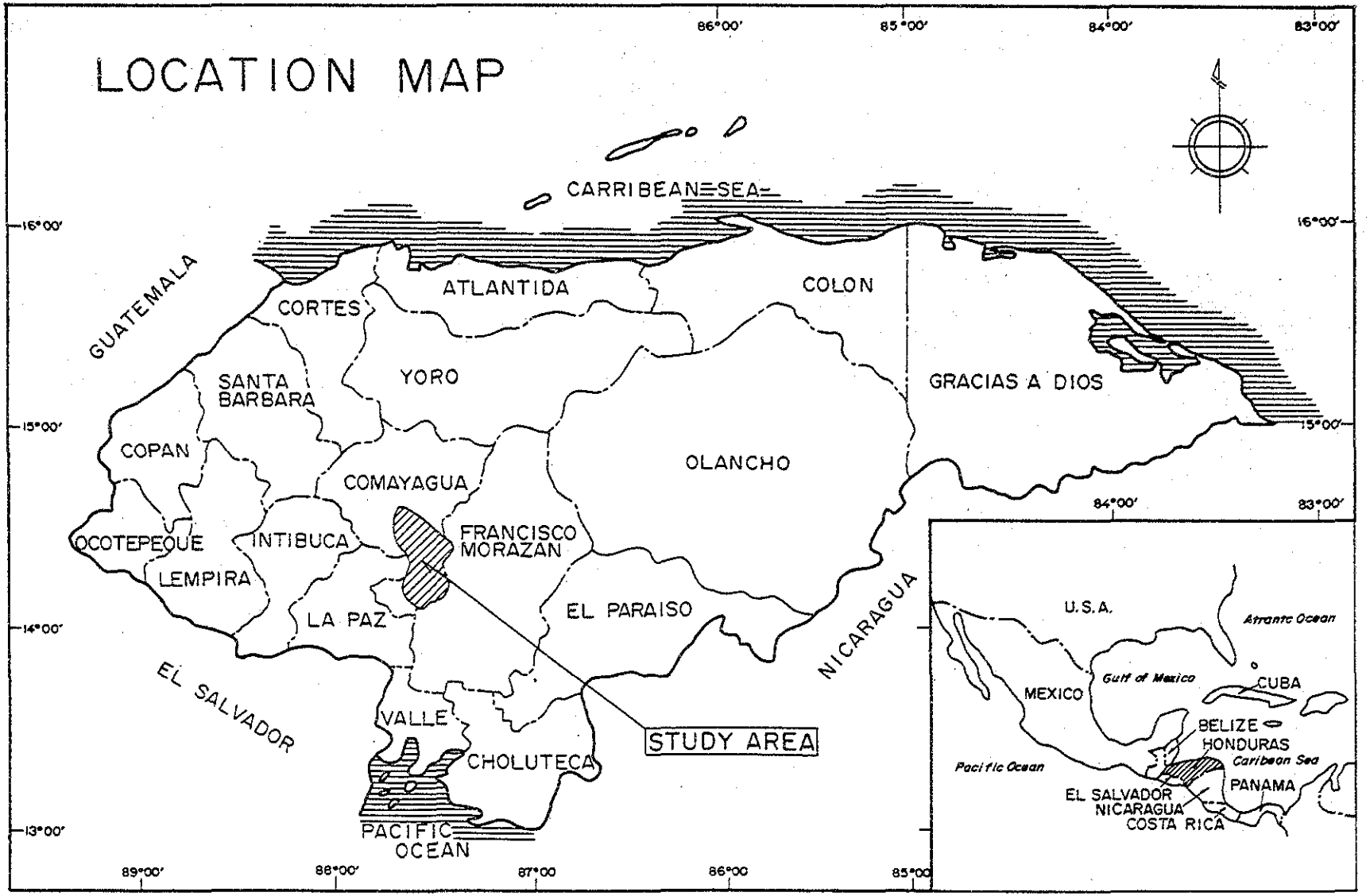
The team exchanged views with the officials concerned of the Government of Honduras and conducted field surveys in the study area. After the team returned to Japan, further studies were made and the present report was prepared.

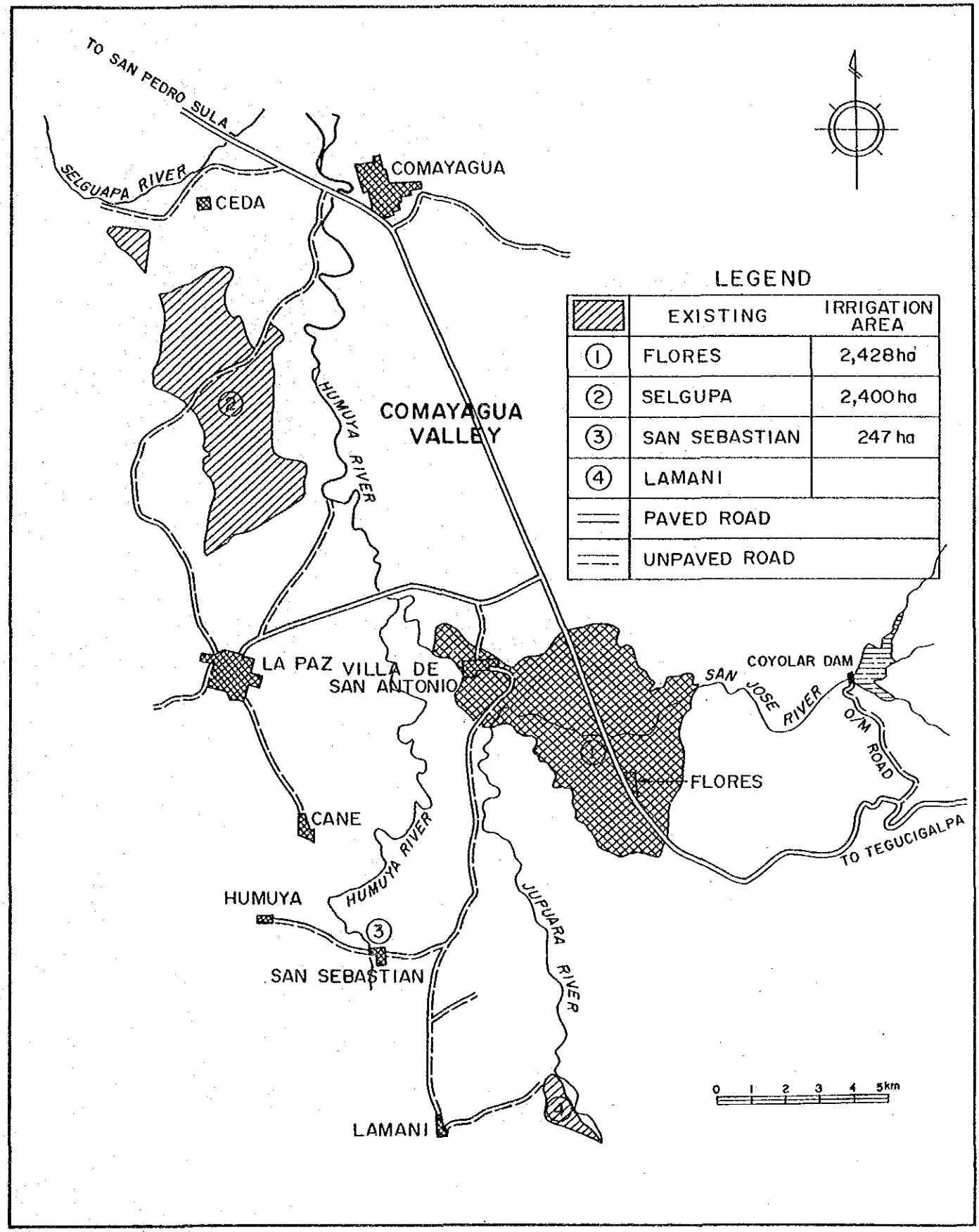
I hope that this report will contribute to the development of the Project and to the promotion of friendly relation between our two countries.

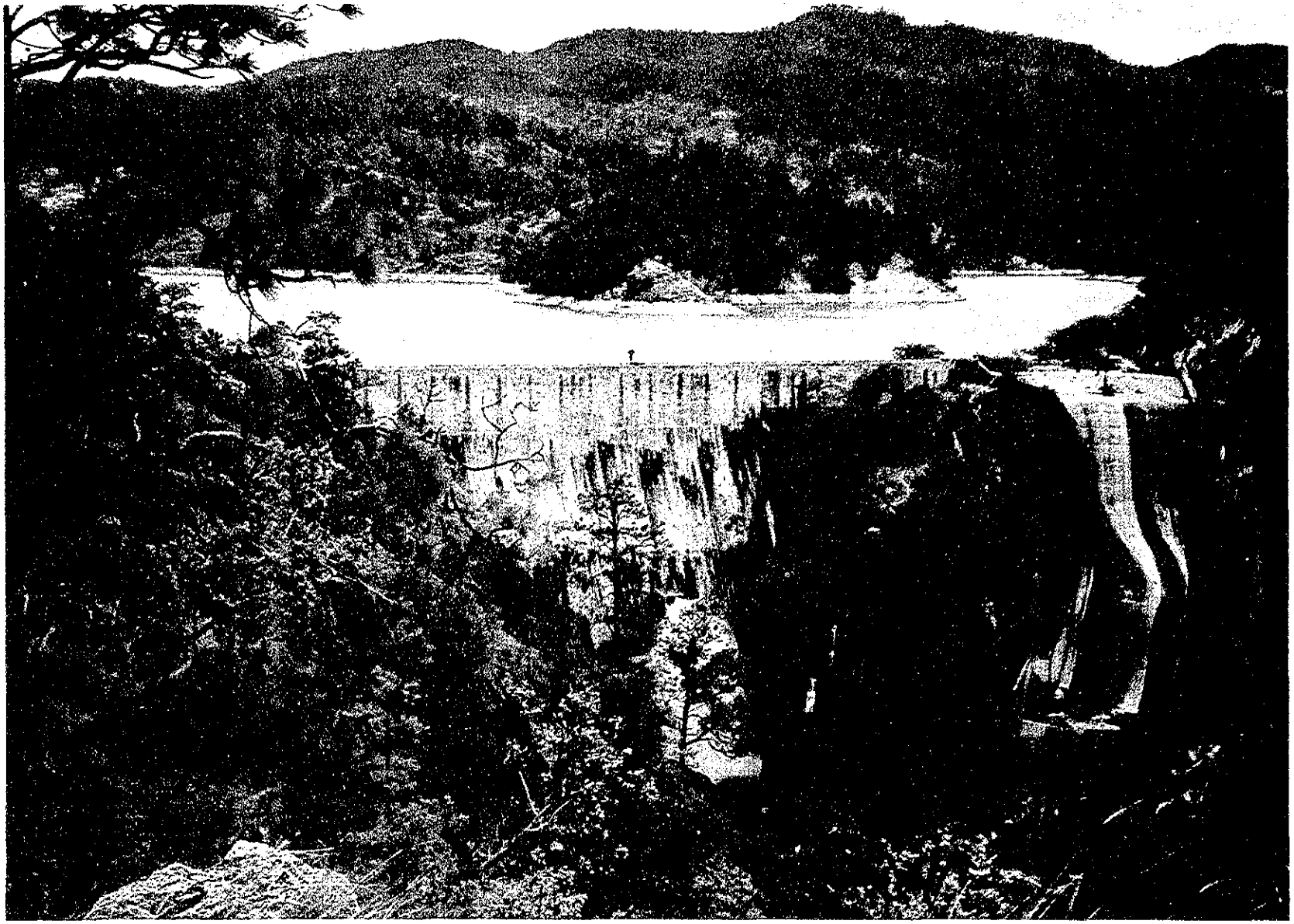
I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Honduras for their close cooperation extended to the team.

February 1991

Kensuke Yanagiya
President
Japan International Cooperation Agency


LOCATION MAP
CARRIBEAN SEA
GUATEMALA
ATLANTIDA
COLON
CORTES
SANTA BARBARA
YORO
GRACIAS A DIOS
COPAN
OLANCHO
COMAYAGUA
OCOTEPEQUE
INTIBUCA
FRANCISCO MORAZAN
LEMPIRA
LA PAZ
EL PARAISO
NICARAGUA
EL SALVADOR
VALLE
CHOLUTECA
STUDY AREA
PACIFIC OCEAN
86°00'
85°00'
84°00'
83°00'
16°00'
15°00'
14°00'
13°00'
89°00'
88°00'
87°00
86°00
85°00
U.S.A.
Atrantic Ocean
Gulf of Mexico
MEXICO
CUBA
BELIZE
HONDURAS
Caribbean Sea
Pacific Ocean
PANAMA
EL SALVADOR
NICARAGUA
COSTA RICA

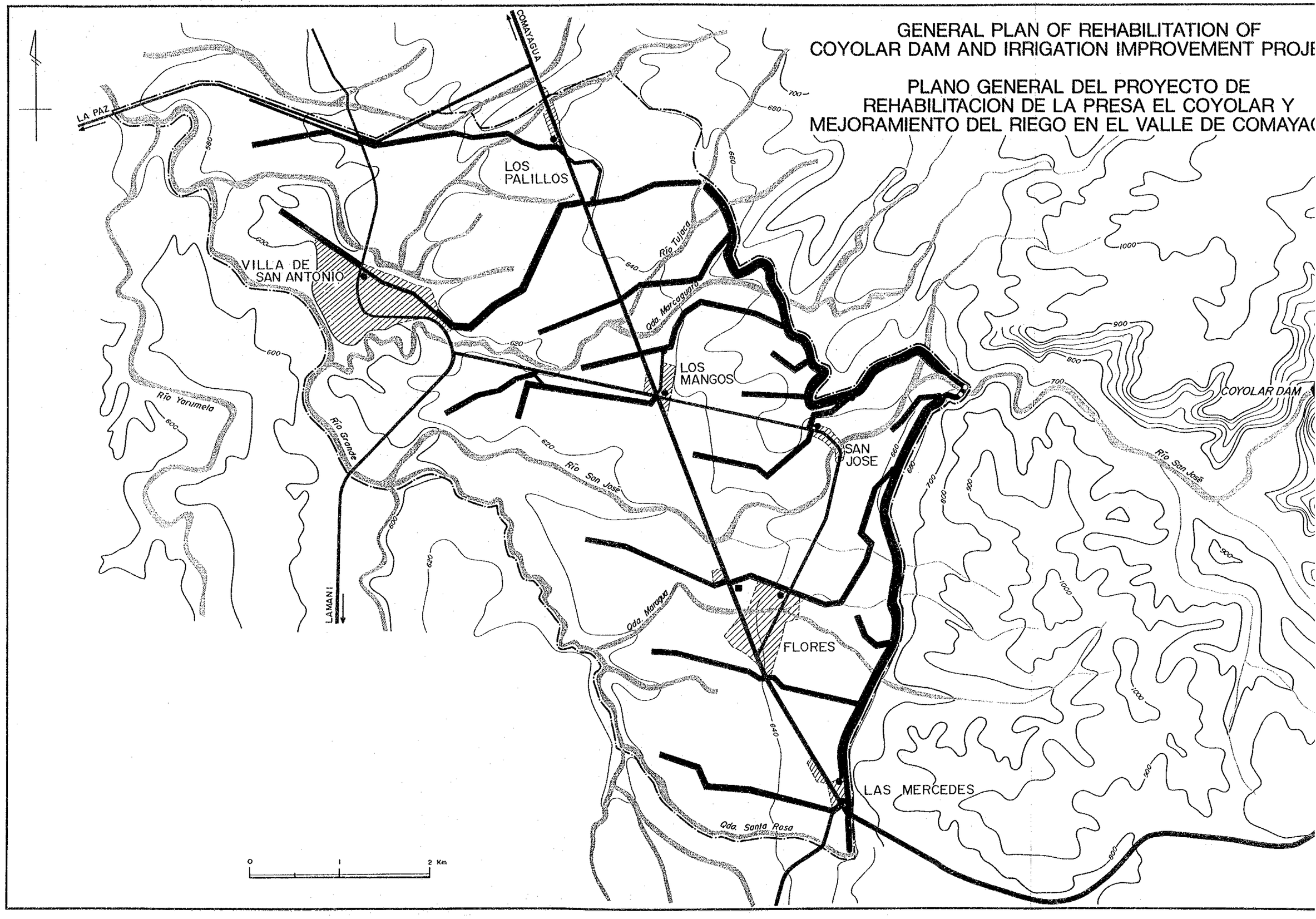

TO SAN PEDRO SULA
SELGUAPA RIVER
CEDA
COMAYAGUA
COMAYAGUA VALLEY
HUMUYA RIVER
LEGEND
EXISTING IRRIGATION AREA
① FLORES 2,428ha
② SELGUPA 2,400ha
③ SAN SEBASTIAN 247 ha
④ LAMANI
PAVED ROAD
UNPAVED ROAD
LA PAZ VILLA DE SAN ANTONIO
COYOLAR DAM
SAN JOSE RIVER
O/M ROAD
FLORES
CANE
HUMUYA RIVER
HUMUYA
JUTUARA RIVER
SAN SEBASTIAN
LAMANI
TO TEGUCIGALPA
0 1 2 3 4 5km



Distant View of Coyolar Dam
Vista Frontal de la Presa El Coyolar

GENERAL PLAN OF REHABILITATION OF COYOLAR DAM AND IRRIGATION IMPROVEMENT PROJE

PLANO GENERAL DEL PROYECTO DE REHABILITACION DE LA PRESA EL COYOLAR Y MEJORAMIENTO DEL RIEGO EN EL VALLE DE COMAYA



GENERAL PLAN OF REHABILITATION OF COYOLAR DAM AND IRRIGATION IMPROVEMENT PROJECT

PLANO GENERAL DEL PROYECTO DE REHABILITACION DE LA PRESA EL COYOLAR Y MEJORAMIENTO DEL RIEGO EN EL VALLE DE COMAYAGUA

COMAYAGUA

LOS PALILLOS

LOS MANGOS

SAN JOSE

FLORES

LAS MERCEDES

COYOLAR DAM

TEGUCIGALPA

Río Tujaca

Qda. Marcaguara

Río San José

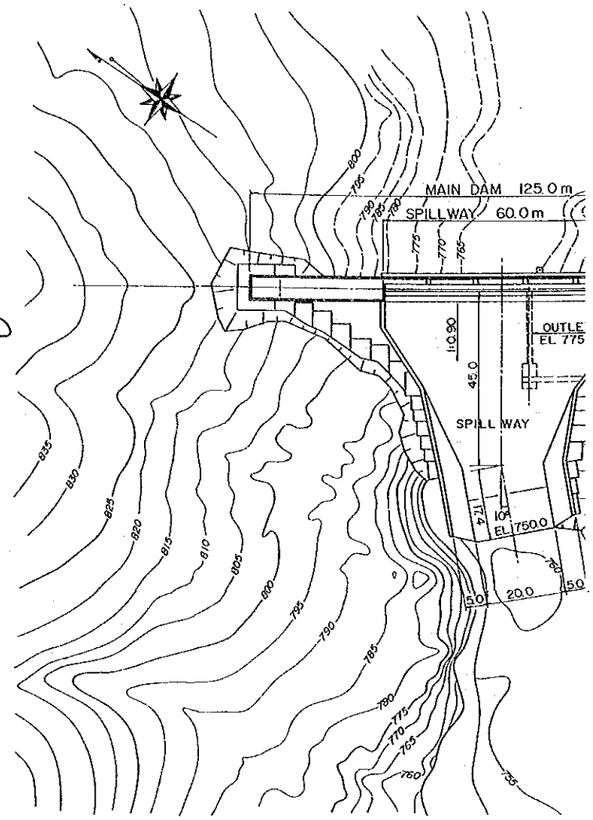
Qda. Moraga

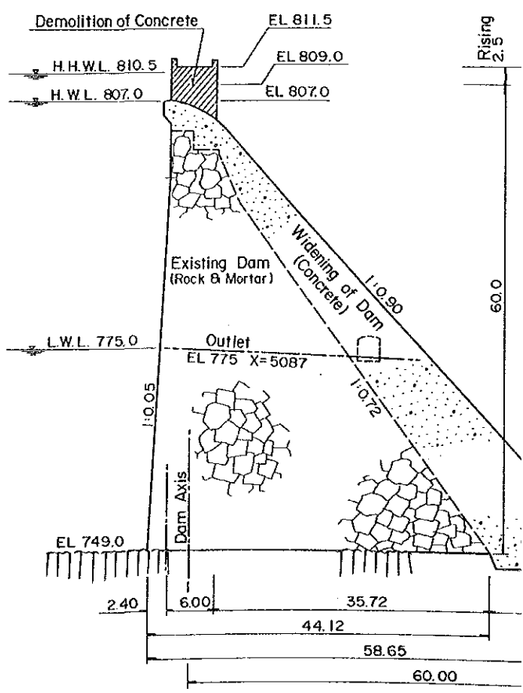
Qda. Santa Rosa

Río Zenon

Río Los Chiros

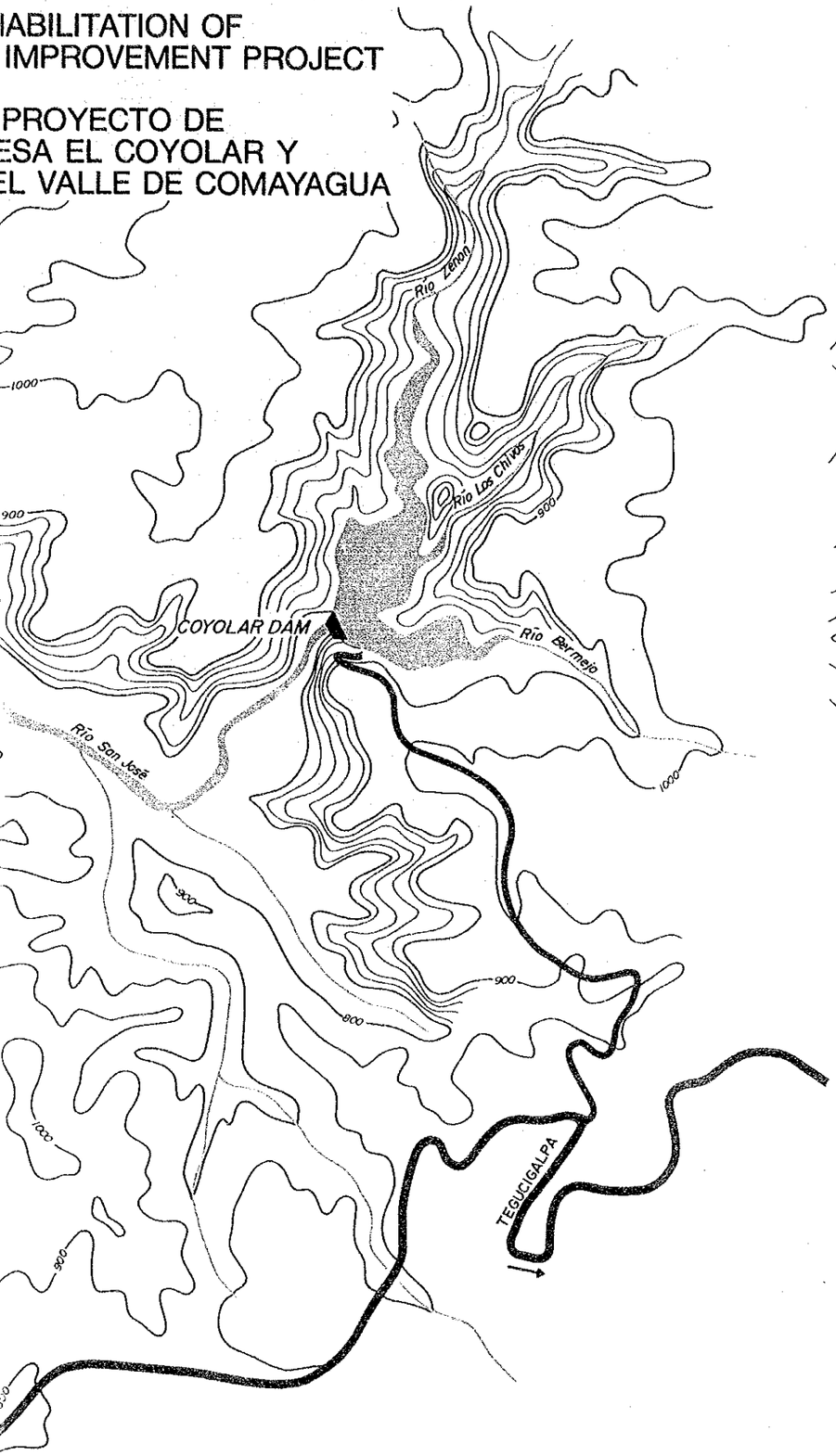
Río Bermejo

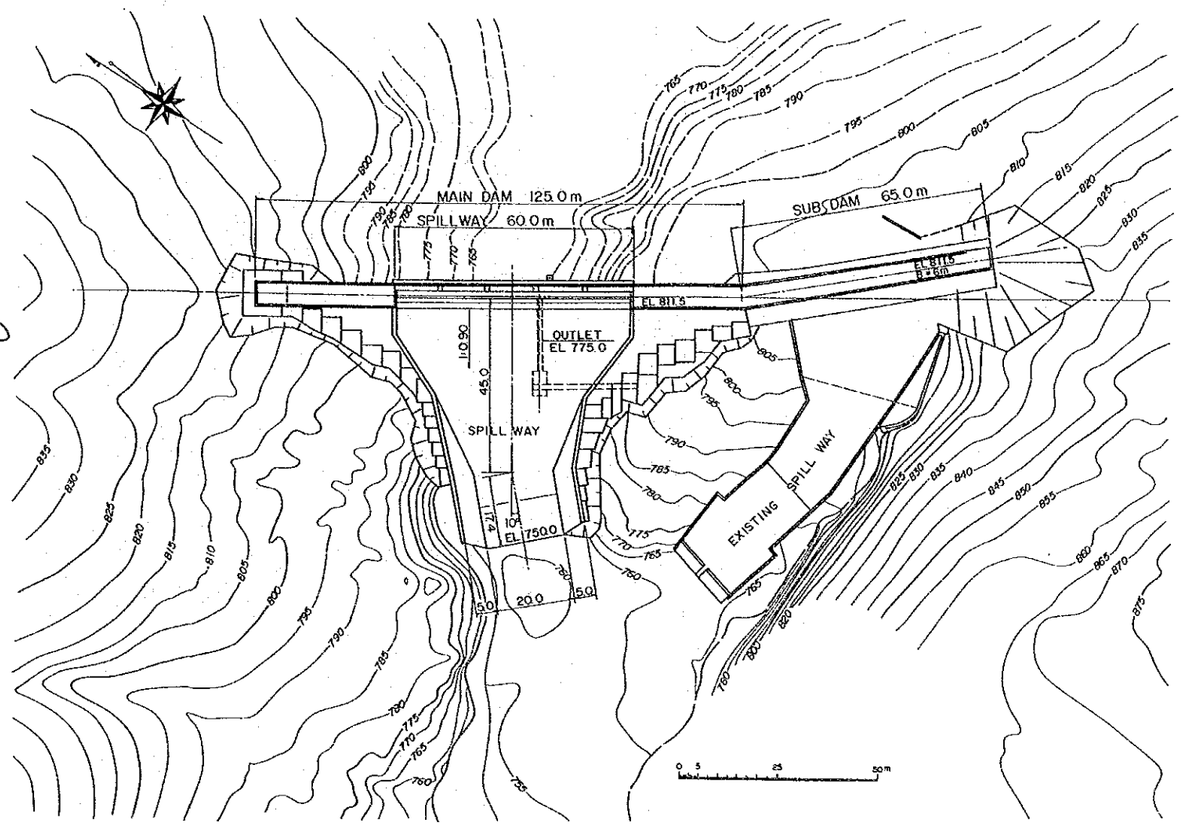


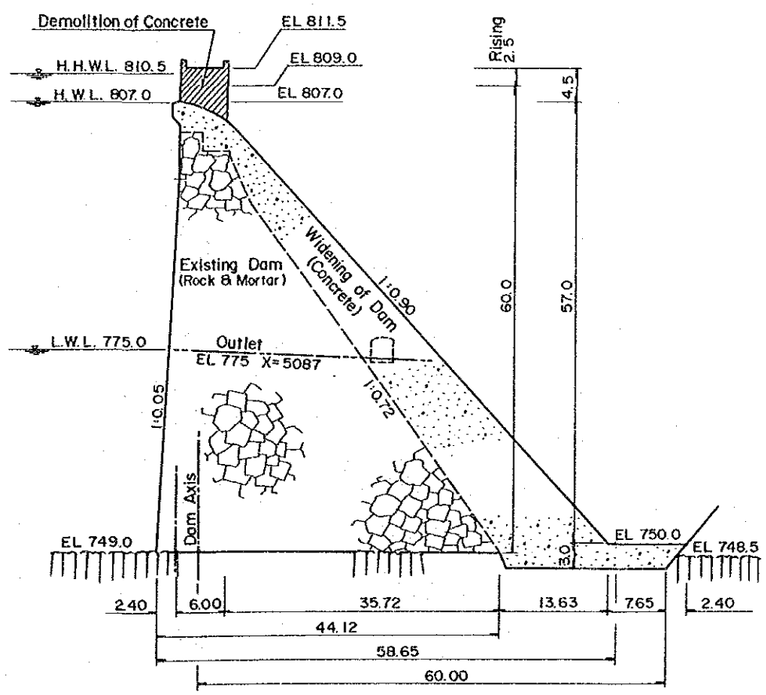


IABILITATION OF
IMPROVEMENT PROJECT

PROYECTO DE
ESA EL COYOLAR Y
EL VALLE DE COMAYAGUA







LEGEND
LEYENDA

- Exsisting Road / Camino Existente
- River/Stream / Río/Quebrada
- Resident Area / Area Residencial
- Main & Lateral Canal with Inspection Road / Canal Principal y Lateral con Camino de Inspección
- Agricultural Extention Facility / Instalación de Extensión Agricola
- Rural Water Supply Facility / Instatacion de Provisionamiento de Agua
- Diversion Weir / Presa Derivadora
- Boundary of Study Area / Limite de Area del Estudio

CONVERSION FACTORS

1. Currency

1 US$ (United States Dollar)	=	Lps. 2	= ¥ 150
1 Lps.(Lempira)	=	US$ 0.5	= ¥ 75

2. Measures

Length

mm	= Millimeter	
cm	= Centimeter	= 0.394 inch
m	= Meter	= 3.281 foot
km	= Kilometer	= 0.6215 mile
yd	= Yard	= 0.9144 m
inch		= 2.54 cm
foot		= 30.48 cm
mile		= 1.609 km

Area, Volume and Weight

cm^2	= Square centimeter	= 0.155 square inch
m^2	= Square meter	=10.76 square foot
km^2	= Square kilometer	=100 ha = $10^6 m^2$ = 0.386 square mile
ha, Ha	= Hectare = $10^4 m^2$	= 1.435 manzana(Mz)
Square inch		= 6.45 cm^2
Square foot		= 0.0929 m^2
Mz	= Manzana	= 0.697 ha
Square mile		= 2.59 km^2
cm^3	= Cubic centimeter	=0.0610 cubic inch
m^3	= Cubic meter	=35.3 cubic foot
ℓ	= Liter	=0.001 m^3 = 0.264 US gallon
US gallon		=3.785 ℓ
g	= Gram	
kg	= Kilogram	=2.205 pond
ton,t	= Ton	=22.05 qq
qq	= Quintal = 100 lb	=45.36kg

Derived measures

m/s, m/sec	= Meter per second	
m^3/s, m^3/sec	= Cubic Meter per second	
lb/Mz	= Pond per manzana	= 6.506 kg/ha

qq/Mz	= Quintal per manzana	= 0.651 ton/há
kg/ha	= Kilogram per hectare	=153.7 lb/Mz
t/ha, ton/ha	= Ton per hectare	=15.37 qq/Mz
m^3/km^2	= Cubic meter per square kilometer	
mm/día	= Millimeter per day	
m^3/km^2/año	= Cubic meter per square kilometer per year	
ℓ/s, ℓ/sec	= Liter per second	
Lps/qq	= Lempiras per quintal	
Lps/kg	= Lempiras per kirogram	
kgf/cm^2	= Kilogram force per square centimeter	

Temperature, Height, others

EL., GL.	= Elevation
A.S.L.	= Above sea level
HWL	= High water level
LWL	= Low water level
%	= Percent
No, N°	= Number
°C	= Degrees in centigrade
pH	= Hydrogen ion concentration
EC	= Electric conductivity
meq	= Milligram equivalent
ppm	= Part per million
dS/m	= Deci-Siemen per meter
TRAM	= Total readily available moisture
CEC	= Cation exchange capacity

Economy

GDP	= Gross domestic product
GNP	= Gross national product
EIRR	= Economic internal rate of return
FIRR	= Financial internal rate of return
NPV	= Net present value

ABBREVIATION

ANACH	: Honduran National Association of Farmers
BANADESA	: National Bank of Agricultural Development
BCH	: Honduran Central Bank
CEDA	: Agricultural Development Training Center
CONADI	: National Investment Corporation
CONSUPLANE	: National Economic Planning Council
DGA	: General Directorate of Agriculture
DGG	: General Directorate of Livestock
DGRH	: General Directorate of Water Resources
ECLA or CEPAL	: Economic Commission for Latin America and The Caribbean
ENEE	: National Power Corporation
FAO	: Food and Agricultural Organization of the United Nations
IBRD	: International Bank of Reconstruction and Development (World Bank)
IDB	: International Development Bank
IHMA	: Honduran Institute of Agricultural Marketing
IICA	: Inter-American Institute for Agricultural Cooperation
INA	: National Agrarian Institute
JICA	: Japan International Cooperation Agency
PRORIEGO	: Irrigation Development Project
SECPLAN	: Planning, Coordination and Budget Bureau

SRN or RRNN	: Ministry of Natural Resources
USAID	: United State of Agency for International Development
USBR	: Bureau of Reclamation of United States
USDA	: United States Department of Agriculture

SUPERVISORY GROUP MEMBERS

Assignment	Name	Charge
Chairman	Mr. Munehito Yamamura	Director, Regional Planning Division, Planning Department, Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries (MAFF)
Member	Mr. Kichiro Miyajima	Manager, Resources Division, Planning Department, Kinki Regional Agricultural Administration Bureau, MAFF
Member	Mr. Tomohiro Shibata	Deputy Manager, Design Division, Construction Department, Agricultural Structure Improvement Bureau, MAFF
Member	Mr. Kazutoshi Yokota	Deputy Manager, Upland Crop Development division, Agricultural Production Bureau, MAFF

MEMBERS OF STUDY TEAM AND COUNTERPART PERSONNEL

Assignment	Name	Counterpart
Team Leader	Mr.Yasuro Hagihara	Mrs.Leslie Burgos de Flores
Deputy Leader & Irrigation/ Drainage	Mr.Hitoki Takada	Mrs.Leslie Burgos de Flores Mr.Guillermo Daccarett Mr.Efraín Ordóñez
Plan of Dam Rehabilitation	Mr.Tsuneo Kudo	Mr.Efraín Ordóñez Mr.Guillermo Daccarett
Meteorology & Hydrology	Mr.Shinobu Maeda	Mr.Roberto Hernández Camacho Mr.Jorge A. Enriquez
Geology & Soil Mechanics	Mr.Katsuhito Yoshida	Mr.Antonio Morales Flores
Agriculture & Cultivation / Soil	Mr.Hisashi Ishikawa	Mr.Javier Velásquez
Agro-economy & Agricultural Organization	Mr.Mobuyuki Matsumoto	Mrs.Leslie Burgos de Flores
Construction Plan & Cost Estimate	Mr.Fujio Matsumoto	Mr.Guillermo Daccarett Mr.Efraín Ordóñez
Project Evaluation	Mr.Toshihide Shibata	Mrs.Leslie Burgos de Flores

SUMMARY AND CONCLUSION

Introduction

This Report describes and explains result of the Feasibility Study on Rehabilitation of Coyolar Dam and Irrigation Improve Project in Comayagua Valley in the Republic of Honduras.

The Report consists of the Main Report, and Annex.

1. BACKGROUND AND OBJECTIVES OF THE STUDY

The Government of Honduras gives the high priority to the Agricultural sector in the Fourth National Development Plan (1986-90) and emphasizes the expansion of irrigation agriculture. The greatest importance is placed to the irrigation development in Comayagua Valley where is situated in the central western of the country. Flores Irrigation District, the study area of this project has the widest irrigation districts in the Valley.

Coyolar Dam was completed in 1965 for the purpose of supplying stable irrigation water to the district, however the dam has been suffering from the following problems and these problems have been hinderring the stable supply of irrigation water to the benefit area.

- strength decline of dam body materials can be observed since the dam was constructed 25 years ago,
- problems lie on the strength of the dam body due to stone masonry and mortar facing of it,
- structural and geological problems of spillway are pointed out, and
- in order to keep the safety of the dam, storage of water is limited.

The objective of the Study is to conduct a feasibility study in order to formulate rehabilitation plan of Coyolar Dam and improvement plan of Flores Irrigation System.

2. GENERAL DESCRIPTION OF HONDURAS

2.1 General Feature

The Republic of Honduras is situated in the central part of Central America, covering an area of about 122,088 km^2, and 65% of the total area is occupied by mountains.

The highland is favored with moderately subtropical highland climate, while the lowland has humid tropical rainy climate. Each high and lowland climate has same period of the wet season (May to October) and the dry season (November to April).
The population of the country is estimated as 4.37 million. The population density in nation average is 39 persons/km^2. and the rate of population growth is about 3.63%.

2.2 National Economy and Agriculture

2.2.1 National Economy

The GDP at current price amounted to 9,299 millions Lps. and 2,109 Lps. per capita, and the average annual growth rate was 2.3% in 1989.

Exports amounted to 1,880 million Lps. in 1989 and of these agricultural products accounted for 70% of the total export amount. Main export goods as coffee and banana accounted for 56.8% of the total amount in 1989.

The current account balance shows a result of 543 million Lps. deficit and the external payments show a deficit of 4,557 million Lps in 1989.

Wholesale price index has been rising since 1987. The highest increase rate was in 1989 with 18.6%. For 1990, the same tendency is expected.

2.2.2 Agriculture

Agricultural sector earns 2/3 of the country's foreign currency by exporting banana, coffee, etc. and absorbs more than half of the economically active population.

Agricultural land in the Republic is estimated to be about 2.8 million ha and approximately 1.10 million ha of land are suitable for intensive agriculture. Only about 650,000 ha are properly developed for that purpose. Irrigable area is estimated to be about 400,000 ha in which irrigated area is estimated only 60,000 ha.

The number of households is estimated as 195,000 and 673,000 people are engaged in agriculture. Average land tenure per household is estimated as 13.5 ha, however farmer's holding less than 5 ha accounting for 64% of the total number of households.

3. THE STUDY AREA

3.1 General Feature

The Study Area consists of Flores Irrigation District and its adjacent area of about 3,600 ha in the Comayagua Valley and Coyolar Dam which is the water source of the irrigation area.

The elevation of the district ranges from 600 m to 670 m and that of the dam is about 800m above the sea level. Wet season (May to October) and dry season (November to April) are clearly discriminated.

The Study Area belongs to San Antonio Municipality in Comayagua Department. According to the National Census of 1988, the population and number of houses of San Antonio Municipal are estimated as 11,400 and 2,123, respectively. Information indicates that the population and number of houses of the Study Area are estimated as 8,570 and 1,670 respectively. Economically active population in the area is estimated about 2,050.

3.2 Natural Features

3.2.1 Geography and Geology

The Comayagua Valley belongs to the Honduran Graben and mountain area has an altitude of approximately 1,300 m, having a relatively eroded figure. Connected with the mountain area, the piedmont has an altitude of 650-670 m and a gradient of 2

-3% with undulation, composing of alluvial fans and debris deposits. The plain area is distributed with a vessel-bottom shape having an altitude of 600-650 m and a gradient of 0.2-2 % except for several monadnocks. The Tertiary pyroclastic deposits distributed in the surrounding mountain area form the base rocks of the Valley. The diluvial lake deposits and the alluvial fan deposits are the main geological units of the Comayagua Valley overlying the base rocks. The diluvial lake deposits are crops out mainly in the Study Area.

3.2.2 Meteorology

Meteorological gauging stations in the Study Area are located in El Coyolar and Flores. El Coyolar gauging station is located at the Coyolar Dam site to measure characteristics of the catchment area of the Coyolar Dam. Flores gauging station in the Flores Irrigation Area measures characteristics of the Flores Irrigation Area. Meteorological characteristics of the Study Area are briefly described below.

Rainy season starts in May and ends in October and around 90% of the rainfall is concentrated in the rainy season. Average total rainfall in the Study Area is around 900 mm/year.

Temperature in the Study Area is stable, ranging from 22 to 26° C and annual average of relative humidity is about 62%.

3.3 Agriculture

3.3.1 Landuse and Land Ownership

Landuse

The Flores Irrigation District, Sector I and Sector II, has a gross area of 3,600 ha. Cultivated land is categorized annual crops land (1120 ha), perennial crops land (140 ha), and improved pasture land (970 ha). Non-cultivated land comprising natural pasture land, forest land, urban area and roads, rivers, existing canals occupies 1,370 ha or 38% of the Study Area.

Natural pasture and a great part of forest lands accounted for 43 % of agricultural land are used as grazing places due to shortage of irrigation water.

Land Holding

There are 412 individual farmers and 11 small scale farmers' group (consists of 131 households) in the Area.
Small scale farmers holding under 5 ha occupy 2/3 of whole land owners, and their lands occupy only 17 % of whole area.

3.3.2 Agricultural Production

Comayagua Valley is known as an outstanding vegetable production area in Honduras. Most of the vegetables produced are shipped Tegucigalpa market and a part of them are exported to USA and near countries. Present major crops in the Study Area are maize, rice, tobacco, tomatoes and other vegetables which are important cash crops for farmers.
Present irrigated area in the dry season is 830 ha. Fallow lands of the wet and dry seasons are estimated as 240 ha (11% of whole cultivated land) and 420 ha (19 %) respectively due to the lack of water.

3.3.3 Household Economy

Representative small scale farmer, member of small scale farmers' group, and middle scale farmers' agricultural income are 4,130, 7,780, and 12,930 Lps, respectively.
Small scale farmer, and member of small scale farmers' group earn 1,100 and 500 Lps respectively by rendering labour force, however the standard living is still lowest level.

3.3.4 Marketing and Processing

Basic grains of Honduras such as maize,rice,sorghum,and kidney-beans, are usually purchased by intermediate brokers and agricultural cooperatives, and IHMA and later retailed in the domestic market through wholesalers. Other agricultural products such as vegetables, fruits, livestock products, etc. are collected and purchased by mainly intermediate broker. Aside from brokers, two agricultural cooperatives in the Study Area, a processing company and export trader, also collect products directly from farmers.

3.3.5 Agricultural Supporting System

Agricultural supporting system for the development of agriculture and livestock in the Comayagua Valley, several governmental organization are functioning such as Region Office of the Ministry of Natural Resources (SRN), Agrarian National Institute (INA) Regional office, Honduran Institute of Agricultural Marketing (IHMA) Center, and Agricultural Development Training Center (CEDA)
As Agricultural Research Institutions, National Livestock Center,and Playitas Experimental Station are under the services.

Agricultural extension services are provided according to the plan formulated by SRN and SRN regional offices. In the Flores local office, the extension section are at service.

Agricultural credit to the farmers in Honduras is given by BANADESA, and commercial banks. BANADESA finances small scale farmers and commercial banks loan medium and large scale of farmers.

3.3.6 Farmer's Organizations

About 131 farmers established 11 small farmers' groups in the Flores Irrigation District. They are scattered to settle in the area of about 385 ha. Currently average farmland area allotted to a group is around 35 ha. Each member has been allotted around 2.9 ha as an average.

Two regional agricultural cooperatives are functioning in the Comayagua Valley namely Cooperative Carcomal and Cooperative Fruta del Sol.

The water users' union in the Flores Irrigation District was established in 1957. The water users union is responsible for operation and maintenance of irrigation facilities in cooperation with the Flores local office of SRN.

3.4 Present Condition of Coyolar Dam

3.4.1 Brief Description of Coyolar Dam

The Coyolar Dam is situated in the southeast of the Comayagua Department, in the northern end of the Honduran Southern Mountains Ranges and is a concrete masonry dam located at the upper reach of the San José River. It has a Dam height of about 60 m and live capacity of reservoir of 12.6 million m^3. The Dam, however continues to suffer deterioration such as strength decline of the Dam body, cracks and leakage, etc.

3.4.2 Dam Geology

The topography of the Dam is an eroded V-shaped valley. According to the rock classification of the foundation, most of the the welded tuff belongs to the class CM except to the one distributed immediately downstream the Dam body. On the other hand, the classes CL and D are prevalent at the foundation of the spillway and the fault zone. The Lugeon test applied with a pressure of 8 kgf/cm^2 as a maximum.

3.4.3 Present Condition of Coyolar Dam

Dam Body

Coyolar Dam was constructed in two phases. The spillway was planned to construct only the flat chute, however the second and the third step construction was continued and completed in 1971. The body surface is mortar covered; however, there is mortar peeling in the upward section of the body and a total peeling below the pipe with exposed rocks and internal mortar. left side of the crest. The posterior crack has a slit crossing the crest towards the downward face.

Spillway

A salient feature of the spillway is its abnormal shape and not hydraulically stable. Several issues are pointed out since the foundation of the spillway is on the geologically weak zone.

Water leakage

The largest leakage reaches around 80 ℓ/sec with good correlation between leakage and water level of the reservoir. The leakage disappear when the water level goes down at El.797.

Stability of the Dam Body

There is a lack of shearing resistance with respect to force including seismic movement. The force vector sum lays outside the middle third. In this case, there is a tension force. Based in the result of the preliminary results above mentioned, and taking into account the seismic factor, the Dam stability cannot be guaranteed to establish a complete safety of the Dam, the reservoir water level must be kept at a lower level than the 797m.

3.5 Present Condition of Flores Irrigation District

The Flores Irrigation District consists of two irrigation systems, namely Sector I on the left bank and Sector II on the right bank of the San José River. Irrigation period in the Study Area starts normally on November and terminates on May. Beside certain period in the wet season, so called CANICURA, about a month from middle of July to middle of August, irrigation is usually practiced.

4 THE PROJECT

4.1 Objectives and Project Components

4.1.1 Objectives

The Project aims to establish the agricultural development plan in order to attain the rising up of productivity and profitability by effective use of water resources all year around. For this purpose, the Project involves two major works: one for the existing Coyolar Dam rehabilitation and another one for the irrigation canal system improvement in the Flores Irrigation District.

Facilities Plan

- Coyolar Dam Rehabilitation :
  Stopping of leakage from Dam body, reinforcement, improvement of the spillway.

- Flores Irrigation System Improvement :
  Installation of new diversion weir, repair of existing canals, arrangement of maintenance of roads, arrangement of rural water supply. However, arrangement of tertiary canal is excluded in this Project.

Agricultural Improvement Plan

- Flores Irrigation System Improvement Plan :
  With an adequate water management, it is expected to introduce agricultural techniques so to cultivate a self-supporting, exportable and cash crops.

- Agricultural Technical Extension Plan :
  Establishment of a model farm to train farmers and to provide technical extension for irrigation agriculture.

4.2 Alternative Plans and Project Formulation

The Project aims to attain the agricultural development of the area by supplying stable irrigation water. In order to realize the above aim, to obtain the stability of the Dam is indispensable and given the first priority and urgency to other related works.

Therefore, the Project is phased in Rehabilitation of the Coyolar Dam (Phase I) and Improvement of the Flores Irrigation System (Phase II).
To achieve the objectives of the optimum plan stated in Chapter 4.1.1, the alternatives must be studied from a technical point of view considering the financial and economic factors. Therefore, in analysing the three alternative planes, the following basic criteria are considered.

- Chosen rehabilitation method must not be difficult to implement;

- Construction cost must be the lowest and multiplier investment effects must be the highest;
- The maximum potential irrigable area must be expected;
- The most efficient use of present facilities must be made.

In order to determine an optimum development plan following three alternative plans considering the full water level, dam stability, effective capacity, benefited area are proposed.

Case A :Keeping the full water level at EL.797 m To secure the Dam stability without any further treatment.

Case B :Keeping the full water level at EL.807m which was originally planned.
To recover the originally designed effective capacity of 12.6 million m^3 of the reservoir.

Case C: Elevate the full water level at EL.812m to increase effective capacity.
To raise the Dam body in order to increase the effective capacity of the reservoir in order to increase the irrigation area.

To formulate the optimum development plan, each case study is discussed from the point of view of technical and economical study related to the Coyolar Dam rehabilitation and improvement of the irrigation system in the Flores District.

4.3 The Optimum Plan

To achieve the objectives of an optimum plan, alternatives must be studied from a technical point of view considering the financial and economic factors.
As a result of the evaluation of the alternatives, case B is the most adequate. The main reasons are described below.

- Potential irrigable area, including the natural pastures of the diversion area, is 2,140ha which can be benefited.
- The rehabilitation plan is feasible from a technical point of view and can secure the initial designed effective water capacity of 12.6 million m^3.
- Both the FIRR, EIRR for the three cases are high.
- Actual irrigation facilities cover the original 2,400ha

initially designed, making it possible to try to make a better and efficient use of the irrigation system.

4.4 Proposed Agricultural Improvement Plan

4.4.1 Land Use Plan

Net cultivated area including improved pasture has been delineated as 2,500 ha. and irrigation area under the condition of gravity irrigation system is 2,140 ha.

4.4.2 Agricultural Production Plan

Crops to be produced in the Area have been screened from the conditions such as Soil suitability, Requirement for self-supply in the country, Marketability (domestic and overseas markets), Technical familiarity, and Profitability. As a result of total assessment, Basic food grain crops, Vegetables and fruits, Cash crops, Tree fruits, Pasture of 17 crops have been selected.

The cropping area will be 5,010 ha corresponds to double of present cropping area and cropping intensity in the proposed cropping pattern is expected to reach 200 % of the present one. With complete irrigation and improvement of farming practices in the project area, as well as with the proper supporting services, productions of basic food grains increase 9,500 tons and total production corresponds about four times of that of present. In case of vegetable/fruits ,46,000 tons (12 times of the present), tree fruits 1,000 (1.7 times) will increase respectively. Beef (live) production keeps 65 tons as present production.

Total required labour force of 570,000 person-day are expected to be able to supply within the area.

Present gross production of 5.36 and net profit of 3.88 million Lps are expected to be about 5.6 and 5.1 times namely 30 and 19.82 million Lps.

4.4.3 Farm Household Economy

Agricultural income of representative farmers is estimated 25,100-59,700 Lps accounting for 4.6-6.1 times of the present. Household income is also expected to be increase to 25,600-59,700 Lps (4.4-4.9 times of the present).

4.4.4 Demand Forecast of Agricultural Products

Basic food grains are planned to object domestic markets and other vegetable are planned to be consumed for processing.

4.4.5 Agricultural Extension Service

To attain benefit planned in the Project, integrated organization for operation & maintenance of irrigation facilities and agricultural extension services with Model Farm is planned.

4.5 Irrigation Plan

The total water requirement is calculated 26.5 million m^3 of which water requirement in the rainy and dry seasons are calculated 9.9 and 16.6 million m^3. Existing main canal for Sector I and Sector II will be utilized and the maximum discharge of main canals for Sector I and II are 1.1 and 1.8 m^3/sec, respectively. Unit water requirement for each lateral canal is 1.378 ℓ/sec/ha. Furrow irrigation is suitable in the area.

4.6 Improvement Plan of Facilities

4.6.1 *Coyolar Dam Rehabilitation Plan*

In order to stop or decrease the leakage from the dam body, curtain grouting at joint of dam body and base rock, along the full dam length is planned. The Dam body is widened for securing the stability of structures by pouring additional concrete at the downstream side.

4.6.2 Other Facility Plans

Other Facility Plans involve improvement of irrigation facility, rural water supply system, and operation and maintenance/agricultural extension facility.

Irrigation Facility; the existing two diversion weir will be combined into one permanent structure as concrete fixed type weir. The design intake water level is EL 667.15 m above sea

level and amount of intake is planned 3.5 m^3/sec. The canal system, total length of main and lateral 40.2km, is planned to lining with brick and to expand whenever flow area is lacking. And also maintenance roads of 3.0m width with gravel pavement are designed along the canals.

Rural water supply; Water for rural supply is conducted from the nearest lateral canal and driven to proposed six villages. a facility for common use for bathing and washing necessary for village life is designed in each village.

Operation and Maintenance/Agricultural Extension Facility; Present Operation and Maintenance office in Flores is enforced and demonstration farm is constructed for the extension services.

4.7 Project Cost

The total project cost excluding price escalation can be divided into foreign currency and local currency. The project cost estimated is 40.7 million Lps in local currency and 17.3 US$ in foreign currency.

5 PROJECT IMPLEMENTATION PLAN

SRN will be given the entire responsibility for the Project implementation. The irrigation/drainage section under the DGRH governs all works relevant to the Project implementation and shift the actual works to the site office. The site office should have tight connection with DGRH is also requires cooperation with relevant organizations. As project implementaion method contract basis with contractor(s) is employed. The project implementation program is roughly divided into pre-engineering and detailed design for 12 months (Phase I, Phase II 12 months), tender, evaluation and contract for 18 months, and construction work for 41 months (Phase I 41 months, Phase II 31 months). In total the Project is scheduled for five year and eight months.

6 OPERATION AND MAINTENANCE PLAN

For the effective use of existing facility, present Flores O & M office should be enforced. In order to promote the

activities on O & M of facility and agricultural extension services, the existing Flores O & M office with 22 staffs will be increased to 40 staffs. Machineries necessary for operation/maintenance of facilities and agricultural extension are procured in this project.

7 PROJECT EVALUATION

The results of EIRR and FIRR analyses of of the Project become 11.11 and 11.11 percent respectively which are higher levels than the rate of overall opportunity cost of 12% for investment in Honduras. And B/C ratios by economic and financial prices at the discount rate of 12% ranges 1.3-1.4. The results obtained from sensitivity analysis implies that FIRR and EIRR still remain the level of above 12% even though construction cost is escalated by 30% with and extra rate added on the long term trend or target benefit is under fulfilled by 20%.

8. CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

Implementation of the Project is judged as valid technically as a result of economic and financial evaluation. In addition, Socio-economic impact evaluated from unquantifiable benefit is also judged as sufficiently expectable.

8.2 Recommendations

Early Implementation of the Project

Considering possible economical damages and loss of people's life by the accidental collapse of the Dam the early implementation of the Project is recommended. Implementation of the Project promotes the irrigation agriculture in the area as a result bring to the country economical and social profits.

Construction of Facilities

In the light of the scale of the Project, it is recommended to phase in the construction works; Rehabilitation of the Coyolar

Dam (Phase I) and Improvement of the Flores Irrigation System (Phase II).

- Cropping adjustment by O & M office in Flores will be required during the construction period due to limited irrigation water.
- Farmers living in the area should be given priority in employment of labors for the construction works in order not to reduce their income.

Management of the Project and Operation and Maintenance

- For the purpose of efficient management of the Project, operation and maintenance of facilities is quite importance. The present O & M system is enforced and composed of relevant institutes headed by DGRH and of beneficiaries.

- DGRH is responsible for operation and maintenance of fundamental facilities such as the Dam Diversion Weir, Main and lateral canal, however beneficiaries should be responsible for the tertiary canal.

Agricultural Extension

- For the effective agricultural extension, backup of institutions such as CEDA is required.

- Expansion of cropping rate requires finance for farmers. DGRH is requested to respond to demand of farmers for finance in close cooperation with finances.

- In order to rising up the household income, promotion, encouragement etc. to individual farmers are required in order to let them establish the cooperative.

Installment of Meteorological and Hydrological Observation System

- In order to carry out effective dam operation, observation of inflow to the reservoir and rainfall in the catchment area are necessary. Therefore, installation of observation station on the three inflow rivers of reservoir is recommended.

Further Survey Required

- Prior to the implementation of the Project further geological and topographical surveys should be carried out. Necessary survey in details are described in Annex-E and F.

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CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The economic structure of the Republic is monoculture based on agricultural products such as banana,coffee,wood,and so on. The Gross National Products (GNP) of the Republic is estimated about 3,627 million dollars and per capita of that is 671 dollars in 1987.

Recent low international prices of agricultural products has depressed the economic activities of the Republic and placed the public finance in a severe condition.
The basic agricultural policies in the Fourth National Development Plan (1986-90) aims to achieve the followings:

① effective use of natural resources,
② expansion of export agricultural products, and
③ increasing farm productivity and amount of production through improvement of production technology.

Comayagua Valley is situated in the central western part of the Republic. The Government of Honduras place the greatest importance to the Valley, the only government-operated irrigation district, and several irrigation districts are existing.

Coyolar Dam was completed in 1965 for the purpose of supplying stable irrigation water to Flores Irrigation District which is the widest irrigation districts in the Valley.

The Dam, however, continues to suffer from the following problems and these problems have been hinderring the stable supply of irrigation water to the benefit area.

- strength decline of dam body materials can be observed since the dam was constructed 25 years ago,
- problems lie on the strength of the dam body due to stone masonry and mortar facing of it,
- structural and geological problems of spillway are pointed out, and
- in order to keep the safety of the dam, storage of water is limited.

In this connection, the Government of Honduras requested from the Government of Japan technical assistance on the captioned project.

In response to the request of the Government of Honduras ,the Government of Japan dispatched a Preliminary Study Team on April 1989 and the Scope of Work for the Project was concluded and agreed upon between the Ministry of Natural Resources of Honduras and Japan International Cooperation Agency. As a result, the study was started in December, 1989.

1.2 Objectives of the Study

The objective of the Study is to conduct a feasibility study in order to formulate rehabilitation plan of Coyolar Dam and improvement plan of Flores Irrigation System.

CHAPTER 2 GENERAL DESCRIPTION OF HONDURAS

2.1 General Feature

2.1.1 Topography and Climate

The Republic of Honduras is situated in the central part of Central America and extends at a latitude of 13°00' - 16°32' north and 83°10' - 89°25' west. The Republic borders the Caribbean Sea and Honduras Bay to the north , Nicaragua to the east and south, Fonceca Bay and the Pacific Ocean to the south, El Salvador to the southwest, and Guatemala to the west.

The Republic covers an area of about 122,088 km^2 and 65% of it is occupied by mountains. Clear differentiation in the type of the climate can be found in the highland and lowland reflecting the topographical characteristics.

The highland is favored with moderately subtropical highland climate, while the lowland has humid tropical rainy climate. Each high and lowland climate has same period of the wet season (May to October) and the dry season (November to April). Annual average temperature and precipitation are estimated 21.6°C and 1,264.4 mm, respectively.

2.1.2 Political and Administrative System

The Republic became independent in 1838. Ever since the Republic was released to civil administration in 1982, a constitutional republic form has been adopted under the new constitution.

Concerning local administration, the Republic consists of two Central Districts, consisting of Tegucigalpa and Comayaguela, and 18 Departments composed by 282 municipalities.

2.1.3 Population

According to the census in 1988, the population of the Republic is estimated as 4.37 million, which is about 1.6 times the population in 1974. The population density in nation average is 39 persons/km^2. The rate of population growth

between 1974 and 1988 is about 3.63%. On the other hand, data originated from Central Bank of Honduras (BCH) gives total population as 4.6 million in 1989, and the share of urban population is about 40%.

Economically active population accounts for 1.4 million and 30.5% of total population, of which agricultural sector has the largest share, about 47.8% of it (673,000 people). Rate of unemployment is 11.5% in 1988.

2.2 National Economy and Agriculture

2.2.1 National Economy

The GDP at current price of Honduras amounted to 8.641 million Lps. in 1989 and its average annual growth rate was 8.5% (1984-1989). However, real average annual growth rate was 3.6% . The agriculture sector had the biggest share in the GDP, around 28.6%.

The GDP at current price amounted to 9,299 millions Lps. and 2,109 Lps. per capita. Real average annual growth rate was 3.4% during the same period. The average annual growth rate was 2.3% in 1989 and felled much in comparing with the one of 4.2% in 1988.

Exports amounted to 1,880 million Lps.in 1989 and of these, agricultural products represented 70% of the total. Main export goods as coffee and banana accounted for 56.8% of the total in 1989.

Honduras imports amounted to 1,962 million Lps. (CIF) in 1989. Main imported agricultural goods were fertilizers, insecticides, etc.

Recently, the international financial situation of the Republic has not been good. The current account balance shows a result of 543 million Lps. deficit and the external payments show a deficit of 4,557 million Lps. Also, due to bad economic conditions, from the 29,998 million Lps. for public expenditures, 779 million Lps. are representing a deficit.

From the 2,173 million Lps. 1989 national budget, the part allocated to the SRN was 111 million Lps. or around 3.7% of the budget.

Wholesale price index has been rising since 1987. The highest increase rate was in 1989 with 18.6%. For 1990, the same tendency is expected.

As part of an Economic Structure Reorganization Policy implemented to face the crisis, the Government has started a process of privatization of the economy, a more restrictive monetary policy, floated the exchange rate of the Lempira, etc.

2.2.2 Agriculture

Agriculture in the Republic is the most important sector. Agricultural sector earns 2/3 of the country's foreign currency by exporting banana, coffee, etc. This sector absorbs more than 60% of the economically active population.

Agricultural land in the Republic is estimated to be about 2.8 million ha, accounting for 25% of the total area of the nation. About 48% or 1.34 million ha is used as pasture land.

Approximately 1.10 million ha of land, 10% of total area of Honduras, are suitable for intensive agriculture. Only about 650,000 ha are properly developed for that purpose. Irrigable area is estimated to be about 400,000 ha. Existing irrigated area is estimated to be only 60,000 ha, 16.7% of the total irrigable area, due to an insufficient availabilty of irrigation facilities for the effective use of land and water resources. Most of the irrigated area is used upland; banana plantation in the northern part and sugar cane plantation in the southern part share most of the irrigated area.

The number of households is estimated as 195,000 and 673,000 people are engaged in agriculture. Average land tenure per household is estimated as 13.5 ha, however, most of the households are of the small scale farmers. Farmer's holding less than 5 ha accounting for 64% of the total number of households and occupy only 9% of the total agricultural land.

On the other hand, households belonging to the large scale farm type, more than 50 ha, share only 4% of the total number of households. However, they occupy 55% of the total agricultural land in the Republic.

The proportion of planted major crops in relation to the whole cultivated land is shown below:

Maize	46 %
Coffee	17 %
Kidney-beans	12 %
Sorghum	8 %
Sugar cane	6 %
Others (rice,banana,cotton,etc.)	11 %

These products can be ranked according to their production amount: banana, maize, citrus, and kidney-beans. Rice, kidney-beans, and coffee increased their production in recent years, however maize remains unchanged. Tobacco and sugar cane production decreased in recent years.

The annual growth rate of basic crops is only 1.4%. Domestic consumption of such basic crops does not meet growing demand and depends partially on import. One of the reasons for the low growth rate of basic grains production is that most of those grains are produced by small and/or middle scale farmers who use low productivity yielding farming techniques.

The low productivity and annual fluctuation of production are caused by lack of irrigation facilities, low production system and unarrandged marketing system. Furthermore, insufficient capital, insufficient financial system, poor management of farm, lack of technical assistance etc. are also pointed out as main issues to be improved the situation of agriculture in Honduras.

2.3 National Development Plan and Agriculture

The Forth National Development Plan in 1987-1990 aimed to achieve mainly the following five goals:

① attainment of sustainable economic growth;
② attainment of equilibrium in balance of payments;

③ to create / increase employment opportunities;
④ to balance regional development level minimizing regional disparities; and
⑤ attainment of food self-sufficiency / self-reliance.

Agricultural policy in the National Development Plan emphasizes an effective use of land, water and human resources and aims to attain the following:

① increase of agricultural production;
② increase of agricultural productivity;
③ improvement of domestic food conditions; and
④ expansion of exports range of agricultural products.

Especially, an increase of basic grains production is emphasized. For expansion of exports range, pineapple, tomato, melon, and cucumber are expected to double their production during the period. Part of the increased maize, beans, and rice and most of fruits production is planned to be exported.

Water resources development has also an important place in the National Plan and involves new construction of irrigation facilities and rehabilitation of existing irrigation facilities. In this connection, the Government propels an irrigation development project.

2.4 Foreign Aid

77% of the technical cooperation is concentrated on the agricultural/forestry/fisheries, health, education and industrial sectors. Bilateral technical cooperation accords are mainly made with the United States and they represented US$81.57 million in 1988. This type of capital contribution represented 80.1% of total contributions. Next came the United Nation Programmes which contributed with US$16.63 million, mainly for food programs.

83% of the financial aid was aimed towards agricultural development projects. Within this, the non-refundable financial aid increased from US$0.31 million in 1987 to US$19.66 million in 1988. Refundable financial aid decreased from US$ 90.88 million to US$ 42.94 million in the same period. There is a tendency to plan development based on non-refundable financial

aid and it is expected that this tendency will not change in the near future.

The Government of Japan has financially contributed to 8 projects of the DGRH in 1990. Japan has contributed with Lps.444.6 million 77% of the total project cost (Lps.575.6 million).

CHAPTER 3 THE STUDY AREA

3.1 General Feature

3.1.1 Topography and Climate

The Study Area consists of Flores Irrigation District and its adjacent area of about 3,600 ha in the Comayagua Valley and Coyolar Dam which is the water source of the irrigation area. The Comayagua Valley is located in the central western part of the Republic.

The elevation of the district ranges from 600 m to 670 m and that of the dam is about 800m above the sea level. The Valley is surrounded by a mountain range with a height ranging from 1,200 m to 1,500 m, Comayagua mountain ranges in the east and Montecillos mountain ranges.

As to the ecology, the area belongs to a subtropical arid forest zone classified by its natural vegetation and most of the flat land is utilized as agricultural land.

The Comayagua Valley belongs to the Ulua River basin, which borders on the Choluteca River basin at the southern rim of the Valley. The Humuya River runs through the Valley from the south to the north into the Cajon reservoir, gathering her confluents. The Humuya River joins the Ulua River at around 40 km downstream of the Cajon Dam.

There are two clearly discernible seasons: wet season (May to October) and dry season (November to April). Annual amount of precipitation in the Valley is around 900 mm, 90% of which is concentrated in the wet season. Temperature and relative humidity in the Valley are 24° C and 63%, respectively fluctuating within a narrow annual range.

3.1.2 Political and Administrative System

The Study Area belongs to San Antonio Municipality. Villa de San Antonio, located to the east of the municipality, is the center of the municipality.
The Study Area consists of villages such as Villa de San Antonio, Flores, Las Mercedes, San José, and Los Palillos.

3.1.3 Population

According to the National Census of 1988, the population and number of houses of San Antonio Municipal are estimated as 11,400 and 2,123, respectively. According to the information from the branch office of the SRN regional office, the population and number of houses of the Study Area are estimated as 8,570 and 1,670 respectively as shown Table 3.1-1.

Table 3.1-1 Population in Study Area

	Population	No.of Houses
Villa de San Antonio	11,429	2,123
Study Area total	8,570	1,670
Urban area (Flores & Villa de San Antonio)	5,746	1,160
Rural area	2,820	510

Source : Population Census (1988)and research by the Study Team

3.1.4 Social Infrastructure

Main road in the Study Area is the international road No.5, connecting Tegucigalpa and San Pedro Sula, running through the center of Flores Irrigation District from north to south. The distance from the Flores to the capital and Comayagua is 63 km and 20 km, respectively.

Transportation in the area is made by buses connecting villages. However, most roads in the area other than the international road are not well maintained and on some of them, traffic is not possible during the wet season.

Most villages are electrical energy supplied. Water supply services is available at Villa de San Antonio and Flores. People living in other settlements in the area obtain their domestic water from the nearest canal. No sewerage system is available in the whole area.

Medical clinics, where nurses provide services with insufficient facilities, are available in San Antonio and Flores villages. Poor living conditions in the rural area

increase the incidence of respiratory, digestive and parasitic diseases.

In the Study Area there are 6 elementary schools and Villa de San Antonio and Flores have a high school and technical school. The rate of attendance to school in the rural area is relatively low because school-aged children are often engaged in household labor and/or employed in agricultural activities. The incidence of illiteracy is approximately 48%.

In the urban area, a police station, a post office, a telephone station, a local office of SRN are functioning.

3.2 Natural Features

3.2.1 Geography and Geology

The Comayagua Valley may belongs to the Honduran Graben and surrounded by mountains with an altitude of 2,000 m. Geographically, the Valley and surrounding area are divided into a mountain area, piedmont and plane area. The Study Area, except the Coyolar Dam area, corresponds to a plain area. The mountain area has an altitude of approximately 1,300 m, having a relatively eroded figure. Connected with the mountain area, the piedmont has an altitude of 650-670 m and a gradient of 2 -3% with undulation, composing of alluvial fans and debris deposits. The plain area is distributed with a vessel-bottom shape and extends from north to south, having an altitude of 600-650 m and a gradient of 0.2-2 % except for several monadnocks.

The Tertiary pyroclastic deposits distributed in the surrounding mountain area form the base rocks of the Valley. The diluvial lake deposits and the alluvial fan deposits are the main geological units of the Comayagua Valley overlying the base rocks. The diluvial lake deposits are crops out mainly in the Study Area, and composed of whitish to grayish silt and clay sediments. The alluvial fan deposits are mainly composed of sand and gravel supplied from the eastern mountain area, and distributed in the eastern parts of the Study Area.

3.2.2 Meteorology

Meteorological gauging stations in the Study Area are located in El Coyolar and Flores. El Coyolar gauging station is located at the Coyolar Dam site to measure characteristics of the catchment area of the Coyolar Dam. Flores gauging station in the Flores Irrigation Area measures characteristics of the Flores Irrigation Area. Meteorological characteristics of the Study Area are briefly described below.

(1) Rainfall

In accordance with rainfall records in El Coyolar gauging station and Flores gauging station, the rainy season is clearly distinguished from the dry season. Rainy season starts in May and ends in October. Around 90% of the rainfall is concentrated in the rainy season, and the rest falls during the dry season. Average total rainfall in the Study Area is around 900 mm/year.

On the other hand, patterns of monthly total precipitation at the gauging stations indicate two rainfall peaks in the rainy season. The typical dip of rainfall pattern is observed in July during the rainy season.

(2) Temperature and Relative Humidity

Temperature in the Study Area is stable, ranging from 22 to 26° C. Relative humidity in the Study Area ranges from 50% to 70%, and its annual average is about 62%.

These stable conditions give benefit to cropping if sufficient water is ensured.

(3) Solar Radiation and Sunshine Hours

Solar radiation in this area is fairly enough to satisfy botanical needs. Monthly average sunshine hours show that most of the months enjoy enough sunshine, even during the rainy season. Around 200 hours of sunshine are available each month.

(4) Wind Velocity and Direction

Wind velocity in this area is moderate, especially small in the rainy season. Average wind direction in the Study Area is N - NE for all the year.

(5) Pan Evaporation and Evapotranspiration

Pan evaporation is observed both at El Coyolar gauging station (the Coyolar Dam site) and at Flores gauging station (the Flores Agricultural Extension Office). Pan evaporation increases from January to March, then it decreases in May. Evaporation rate is stable from June to December. Evapotranspiration in the Flores area was calculated by the SRN with FAO formula, and the figures are used as standard value for the Study Area. Results are shown below.

Table 3.2-1 Evapotranspiration in Flores (by Penmann method)

(unit : mm/day)

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1-10	3.4	4.1	4.2	5.3	5.1	4.3	4.4	4.5	4.1	3.9	2.4	3.3
11-20	3.6	4.1	5.1	5.2	5.0	4.3	4.5	4.4	3.9	3.9	3.4	3.2
21-31	4.1	4.4	5.4	5.2	4.4	4.3	4.5	4.4	3.8	3.7	3.4	3.4

Table 3.2-2 shows average monthly meteorological data at the Flores meteorological station. Also, Fig. 3.2-1 shows meteorological characteristics.

Table 3.2-2 Climatological Data at Flores Station

Month	Rainfall (mm)	Temp. (C°)	Pan Ev. (mm)	Relative Humidity (%)	Wind V. (m/s)	Sunshine Hours (hr)
Jan.	1.8	22.1	160.8	59.7	5.3	215.2
Feb.	6.2	23.2	183.4	55.6	4.2	232.7
Mar.	7.2	24.7	239.8	51.9	4.6	265.4
Apr.	33.4	25.8	221.2	53.3	3.6	198.6
May	129.3	25.9	181.5	59.0	2.8	211.5
Jun.	170.3	25.0	144.4	66.6	2.0	175.3
Jul.	104.3	24.8	153.4	63.5	3.0	185.2
Aug.	125.8	24.9	154.3	64.4	2.4	204.7
Sep.	171.8	24.5	127.6	67.8	1.8	175.6
Oct.	106.9	23.9	130.8	68.6	3.5	190.1
Nov.	25.2	22.9	123.2	66.5	3.4	185.5
Dec.	6.2	22.5	139.2	62.7	3.8	207.6
Total	888.4		1959.6			2447.4
Average	74.0	24.2	163.3	61.6	3.4	204.0
Period	1945-88	1958-88	1945-88	1945-88	1945-88	1945-88

Source : Feasibility Study on Underground Water Development in the Comayagua Valley, JICA; data from the Government of Honduras

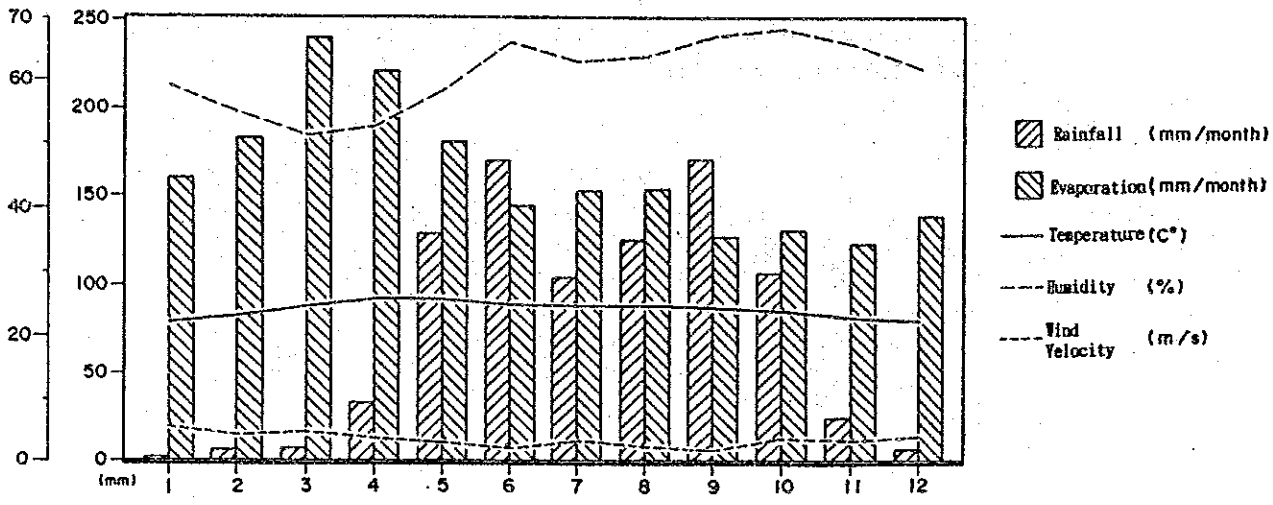


Fig.3.2-1 Meteorological Characteristics at Flores Station

3.2.3 Hydrology

(1) Rainfall

Active rain gauging stations in the Study Area as of 1990 are: El Coyolar and Flores gauging stations. Both of the stations gauge hourly and daily rainfall.

Daily rainfall data at El Coyolar meteorological station is used for runoff analysis in the upper San José River basin upto the Flores Diversion Work, while daily rainfall data at Flores gauging station is used for calculation of water requirement in the Flores Irrigation Area.

For the purpose above mentioned, lack of daily data needs to be corrected by correlating data from the other stations.

Even though the correlation coefficient between daily rainfall data groups of the two gauging stations is only 0.68, this is the best correlation among gauging stations in and around the Study Area (see ANNEX B). Summary of supplemented monthly rainfall data of both stations are shown in ANNEX B.

(2) River

1) River Discharge

River basins relevant to the Study Area are the San José River basin, the Tujaca River basin and basins of small streams. Fig. 3.2-2 shows their river basins.

However, on most of the rivers shown in Fig. 3.2-2, stream gauging has not been made recently. Only daily and monthly discharge records (1954-1959) of the San José River at El Coyolar gauging station (at present at the El Coyolar Dam) are found in the "Department of Hydrological and Climatological Study Bulletin No.6, Summary of 1954-59 and 1964-66" published by the Irrigation Department of the Ministry of Natural Resources.
El Coyolar hydrological gauging station had worked until 1960, observation was halted since construction of the Coyolar Dam started. However, daily rainfall data during the same period of the discharge observation (1954-1959) is not available.

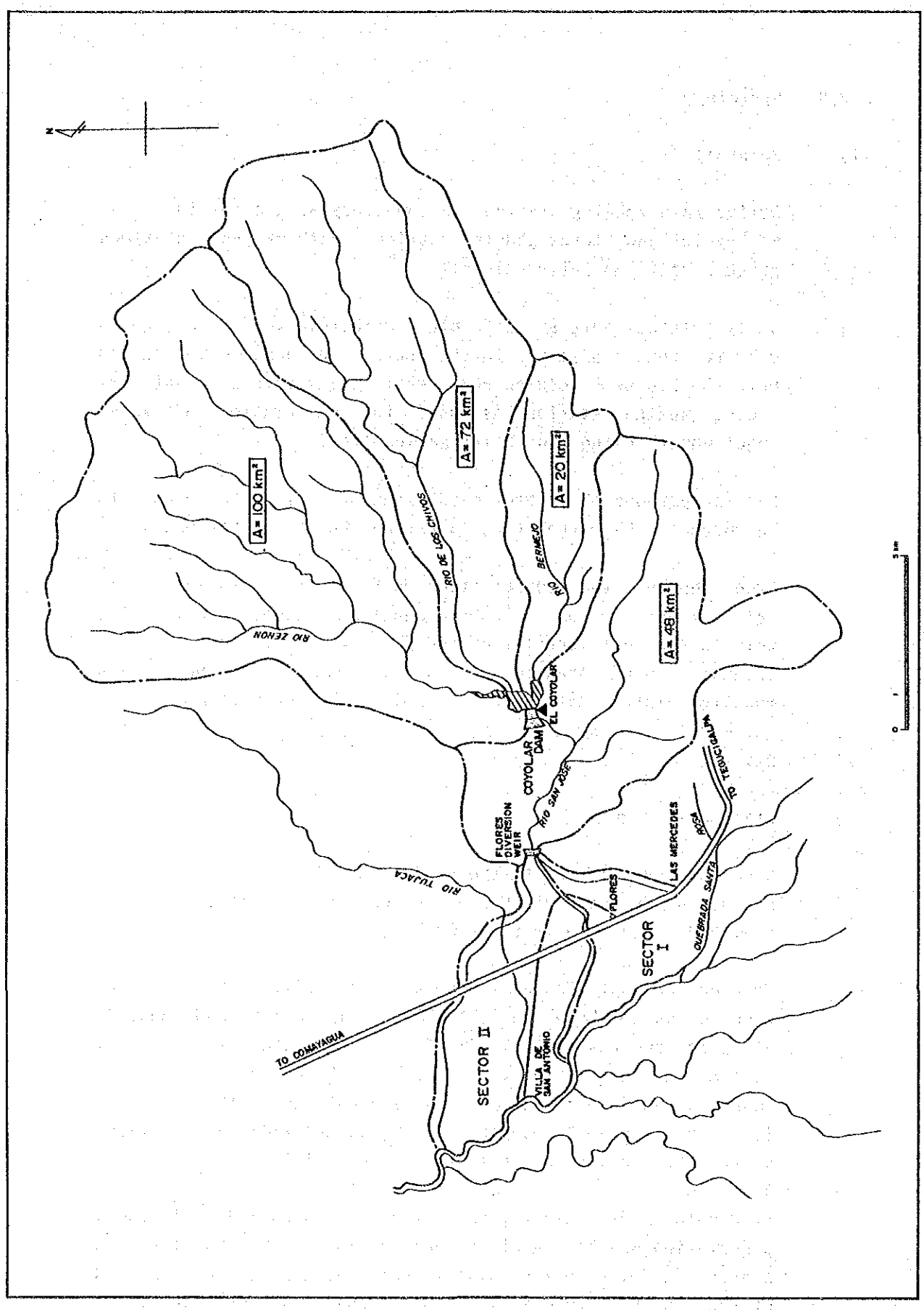


Fig.3.2-2 River System

Annual average of specific discharge of the San José River at El Coyolar is 0.34 million $m^3/km^2/yr$, annual runoff coefficient is 0.37, from these figures.

The Study Team has gauged discharge at the Zenon, Bermejo, Chivos, San José, Tujaca rivers and Mamegua, Agua Fria, Seca streams to estimate their dry season's base flow. It was found that the discharge of the Zenon and Bermejo rivers fluctuates between 0.6 and $0.4m^3/sec$. In the other cases, the discharge fluctuates within a very narrow range between 0.1 to $0.0m^3$. Detailed data is shown in Annex B.

2) Inflow to the Reservoir

The Coyolar Dam has three inflow rivers, namely the Zenon River, the Bermejo River and the Chivos River. Discharge observation along the three rivers has not been made before, however. Meanwhile, reservoir water level at the Coyolar Dam site has been observed twice a day (at 6:00 and 18:00) since 1981. This record can be utilized for estimation of inflow to the Coyolar Dam.
At the beginning of the rainy season,reservoir water level rises sharply. The evaporation from the surface of the reservoir is computed based on the pan-evaporation at the Coyolar gauging station.

For estimation of runoff by use of rainfall, the relation between rainfall and runoff is required. However, since the actual inflow discharge to the Coyolar Dam has not been measured before, the estimated inflow discharge from the reservoir water level is treated as the actual value.

Water level at a reservoir is a function of inflow, outflow and reservoir losses such as evaporation. The analysis is carried out only during the rainy season when the water level is rising and the function to purse the inflow discharge is decided from the analysis result. Reasons to choose the season for analysis are as follows:

① Water release is restricted (at the beginning of rainy season)
② Raising of reservoir water level is obvious due to large amount of inflow.

Errors included in the analysis result can be minimized by choosing the above season. Therefore, during this period, reservoir water level may be considered as a function of inflow volume and evaporation volume. Flood runoff coefficient is 24.8 %. This analysis result is obtained on the assumption of raining in the whole area and by not considering factor of regional rainfall which is the characteristic in the catchment area.

(3) Runoff Analysis

- Runoff Model

Since there is no adequate long period discharge data in the Coyolar Dam, a runoff model which calculate the runoff from rainfall is needed.

In this section, runoff at the Coyolar Dam site and at the Flores Diversion Work are to be estimated.

Based on the flood data at El Coyolar, direct runoff of flood is derived by the following equation ;

$$Q_{do} = f \times (a_o R_o + a_1 R_1)$$

Q_{do} : direct runoff of today (mm)
f : flood runoff coefficient (0.248)
a_o, a_1 : regression coefficients (0.85, 0.15, respectively)
R_o : today's rainfall (mm)
R_1 : rainfall in yesterday (mm)

Daily runoff is a suming up of direct runoff mentioned above and base flow:

$$Q = Qd0 + Qb$$

Q : daily runoff (mm)
$Qd0$: flood runoff (mm)
Qb : base flow (mm)

Comparison of the estimated runoff recieved from rainfall data (inflow to the Coyolar Reservoir) and observed water level is shown in Fig. 3.2-3. According to the Fig.3.2-3, estimated inflow from the reservoir matches to the observed inflow basically well. Difference of pattern may be come from spotty rainfall in the drainage area.

(4) Runoff Estimation

Though available daily rainfall data at El Coyolar gauging station is from 1963 to 1989, data for 1963 and 1989 include lacked data which is not supplemented by the data at Flores gauging station. Therefore, runoff simulation is made for El Coyolar's daily rainfall data from 1964 to 1988. The annual runoff is 69 million m^3 in average.
Summary of estimated runoff at El Coyolar is shown in ANNEX B.

Meanwhile, runoff between the Coyolar Dam and the Flores Diversion Work is estimated from a specific discharge of the runoff at the Coyolar Dam. Its catchment area is 48 km^2. Also, taking into consideration of difference of annual rainfall at El Coyolar gauging station and Flores gauging station, specific discharge at the Flores Diversion Work is estimated as 90 % of specific discharge at the Coyolar Dam. Annual average runoff for this area is around 150 million m^3.

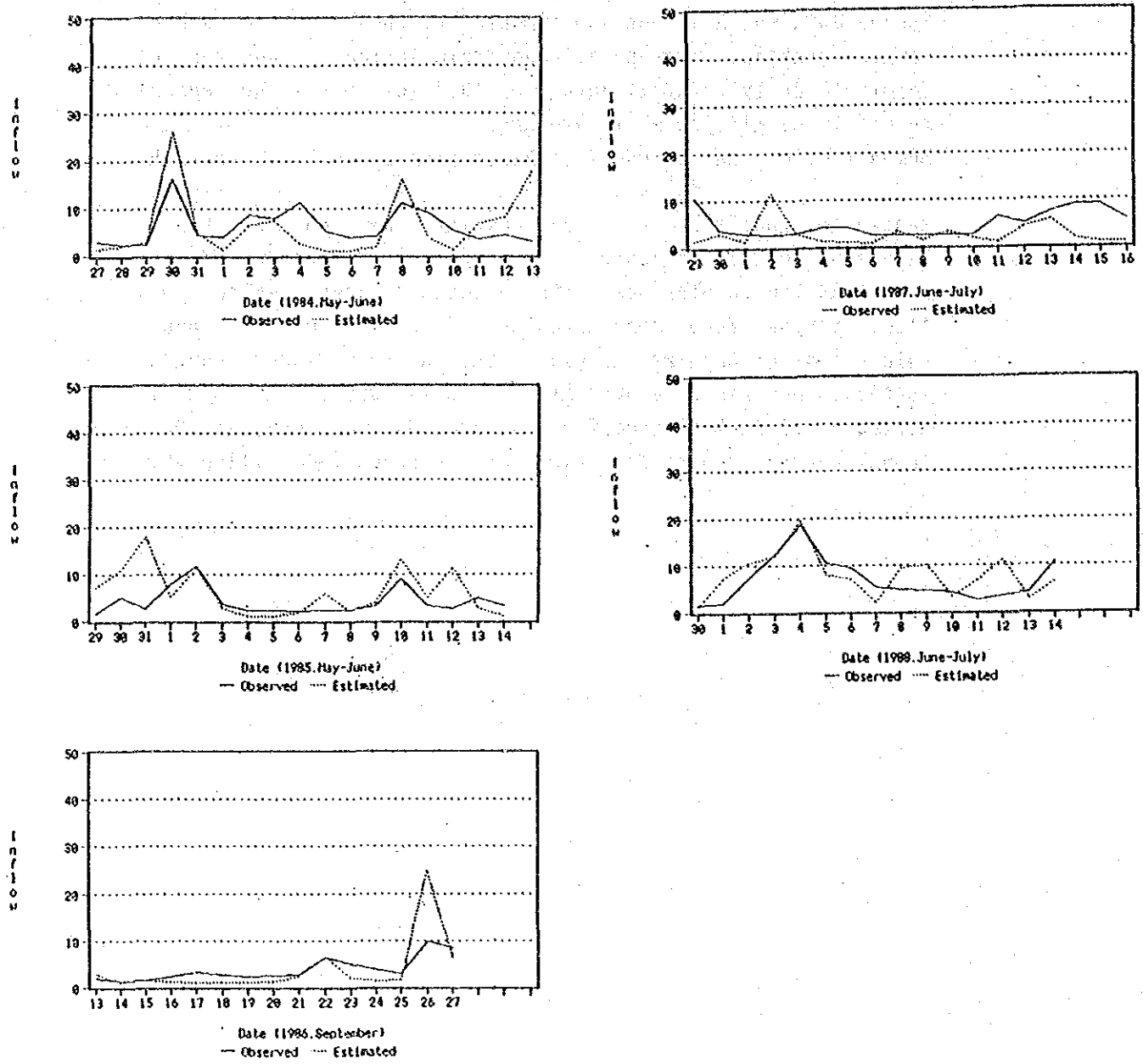


Fig.3.2-3 Comparison of Estimated Inflow with Observed Inflow

3.2.4 Flood Analysis

(1) Design Flood Discharge

Since there is no available flood observation at the Coyolar Dam site and at the Flores Diversion Work, flood analysis for the Coyolar Dam site and the Flores Diversion Work needs to be made by use of estimated probable flood. Hourly/daily rainfall data at El Coyolar gauging station is used in this analysis

For estimation of probable flood discharge, the runoff function method, which is a kind of unit hydrograph method is adopted. By this method, the direct flood discharge caused by rainfall of r(mm.hr) during an unit time t_o(hr) is expressed as follows;

$$Q = 0.2778\ A \cdot f \cdot r \cdot [e^{-at'}(at'+1) - e^{-at}(at+1)] \cdot s$$
$$= 0.2778\ A \cdot f \cdot r \cdot D \cdot s$$
$$t' = t - t_o$$

where;

- A : watershed area (km^2)
- f : runoff coefficient
- r : rainfall in unit time t_o for calculation
  (effective rainfall=total rainfallx65%)
- D : distribution rate of discharge
- t_o: unit time for calculation (= 1.0 hr)
- s : coefficient of recession
  (real area of rainfall=total areax60%)
- a : flood modules defined by the following equation
  $a = 2.303 \log [Tp/(Tp-1)]$
- Tp: time of concentration (hr) obtained by
  Rziha's formula
  $Tp = L/(3600\ V)$
  $V = 20(H/L)^{0.6}$
  L : river length from the origin (m)
  V : average velocity of river flow (m/s)
  H : height difference in the section of L (m)

Runoff caused by a long-term rainfall can be produced by synthesizing direct runoff by unit time.
In order to estimate design rainfall for the Coyolar Dam and the Flores Diversion Work, rainfall intensity equation must be derived by applying the specific coefficient method.

(2) Rainfall Intensity

To estimate rainfall intensity equation, a return period of 200 years and 50 years of probable rainfall is calculated for Coyolar Dam and Flores diversion works site respectively.

Based on Coyolar gauging station data and using Iwai's method, probable annual peak rainfall (daily) was calculated. For a return period of 50 years and 200 years, they are 117mm/day and 140mm/day, respectively. The probable annual peak rainfall (hour) of 50 years and 200 years return period are 53mm/hr and 60mm/hr,respectively.

The rainfall intensity equations are decided with the above probable rainfalls as follows:
Details are expressed in ANNEX B.

(mm/hr)

Project	Return Period 200yrs	50yrs
Coyolar Dam	149/(t+1.5)	-----
Flores Diversion Work	-----	123/(t+1.3)

On the hourly arrangement for a maximum 1-day rainfall, distribution of central heading type has been taken.

As an effective rainfall, 65% of the design rainfall is deemed to be conservative.

(3) Coyolar Dam and Flores Diversion Work Site Design Flood

Design flood discharge for a return period of 50 years and 200 years has been calculated using the design rainfall and unit hydrograph.

Design flood discharges at Coyolar dam and Flores diversion works site are shown below.

(m^3/sec)

Return Period	Coyolar Dam	Flores Diversion Works Site
50	--	520
200	685	--

3.2.5 Soils and Land Classification

(1) Soils

Soil survey has been carried out on the basis of "Semidetailed Soil Survey of Comayagua Valley" by the Council of Economic Planning, Direction of National Land Register in 1982, with additional field survey and soil analysis to review it.

Almost all soils in the Study Area are composed of terrace deposits and alluvial fan deposits originated from tuff. Many of the soils on the terrace are fine textured with clay subsoils which frequently have poor porosity and low permeability. These characteristics lead to imperfect drainage within the soil and erosion under inadequate land use. Soil consistency is very hard and compact in dry condition, and muddy in wet condition. The permeability and consistency of recent alluvial soils are generally more favorable for agriculture, but the area is more limited and smaller than that ofsoils on the terrace.

In the Study Area, 16 soil series have been recognized as shown in Table 3.2-3, and illustrate the soil map in Fig.3.2-4. Soil analysis and laboratory test indicate the following characteristics: With these results, it is possible to classify soils from regular to good productivity.

Chemical characteristics

- pH values are slight acid to slight alkali.
- EC values are under 1.0 dS/m. There is no problem in soil salinization.
- Cation Exchange Capacity(CEC) ranges from 15 to 40meq/100g. Soil fertility is evaluated in medium to good.
- Contents of total nitrogen are few.
- Soluble nutriments in the soils are evaluated as below:
  Potassium; abundant to medium,
  Phosphorus, calcium and magnesium; few to medium.
- Micro-nutrients in the soils are evaluated as below:
  Iron, manganese and copper; medium,
  Zinc; few

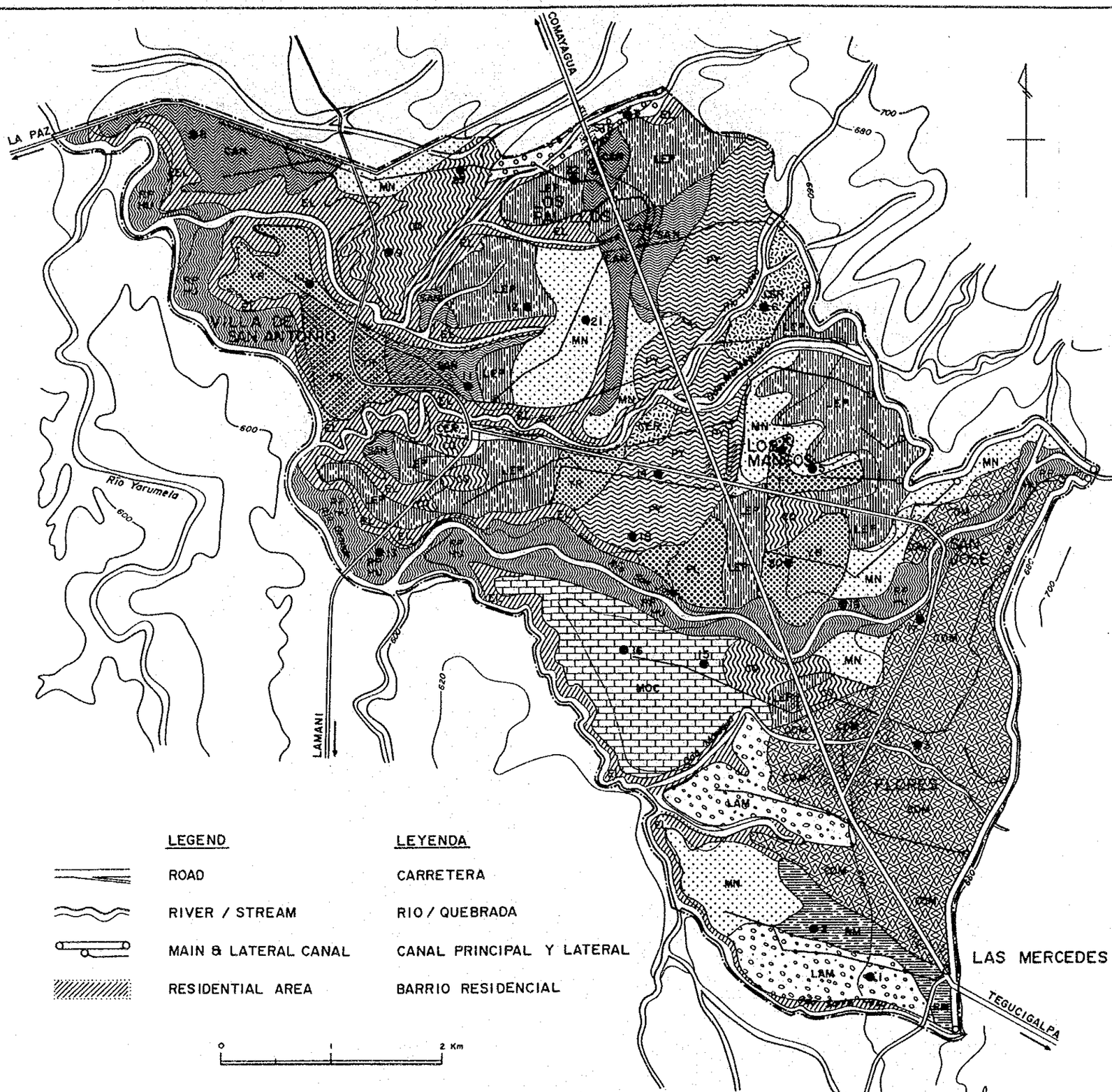
Soil moisture

- Average of available moisture is 103mm in root zone(0-80cm).
- Average of Total Readily Available Moisture(TRAM) is 60mm.
- Basic intake-rate ranges from 16 to 67mm/hr, 31mm/hr in average.

Table 3.2-3 Soils in the Study Area

Soil series	Symbol	Soil taxonomy	Area (ha)	Ratio (%)	Relief	Internal drainage	Texture top/subsoil
A. Soils on Quaternary Alluvial Deposits							
1 Mocoron	MOC	Mollic Haplustalf	210	6	Flat to undulated	Moderately slow	Medium/ medium
2 Cerrito	CER	Ultic Haplustalf	60	2	Undulated	Moderately slow	Medium/ fine
3 Comayagua	COM	Mollic Ustifluvent	490	14	Flat	Moderately slow	Fine/ medium
4 Playitas	PY	Mollic Ustifluvent	290	8	Flat	Slow	Fine/ fine
5 Cane	CAN	Typic Ustifluvent	140	4	Flat to undulated	Slow	Fine/ fine
6 Flores	FL	Typic Ustifulvent	70	2	Undulated	Good	Medium/ fine
7 Yarumera	YR	Tipic Ustifluvent	200	6	Flat	Moderately slow	Medium/ Medium
8 Santa Eliza	STE	Typic Ustropept	20	1	Slightly undulated	Moderate	Medium/ medium
B. Soils on Ignimbites							
9 San Antonio	SAN	Lithic Ustrothent	80	2	Undulated	Slow	Medium/ fine
10 Lepaterique	LEP	Lithic Ustrothent	490	14	Undulated	Good	Medium/ gravel
11 El Coquito	CQ	Typic Ustropept	170	5	Slightly undulated	Moderate	Medium/ medium
C. Soils on Quaternary and Recent Fan Deposits							
12 Lamani	LAM	Mollic Ustifluvent	180	5	Flat	Slow	Medium/ fine
13 Los Mangos	MN	Mollic Ustifluvent	320	9	Slightly undulated	Good	Medium/ gravel
14 Palmerola	PM	Typic Chromudert	60	2	Flat	Moderate	Medium/ medium
D. Soils on Recent Alluvial Deposits							
15 Rio Pujaca	RP	Mollic Ustifluvent	230	6	Almost flat	Moderate	Fine/ medium
16 Humuya	HU	Typic Ustifluvent	140	4	Almost flat	Good to moderate	Medium/ med.gravel
Eroded Land	EL		450	12			
Total			3,600	100			

Fig. 3.2-4
SOIL MAP
MAPA DE SUELOS



LEGEND
LEYENDA

SYMBOL SIMBOLO	SOIL SERIES SERIES DE SUELOS	AREA AREA
MOC	MOCORON	210 ha
CER	CERRITO	60
COM	COMAYAGUA	490
PL	PLAYITAS	290
CAN	CANE	140
FL	FLORES	70
YR	YARUMERA	200
SE	SANTA ELIZA	20
SAN	SAN ANTONIO	80
LEP	LEPATERIQUE	490
CO	EL CONQUITO	170
LAM	LAMANI	180
MN	LOS MANGOS	320
PM	PALMEROLA	60
RP	RIO PUJACA	230
HU	HUMUYA	140
EL	(ERODED LAND)	450
●	LOCATION OF TEST PITS. LOCALIZACION DE CALICATAS.	

(2) Land Classification

The system of land capability classification is based on the manual of the Bureau of Reclamation of United States. The land classes have been evaluated in accordance with the Manual, as follows:

Class 1 : Highly suitable for irrigated farming, without limitation.

Class 2 : Moderately suitable for irrigation farming, with moderate limitations due to coarse texture, rather steep slope or impermeable subsoils.

Class 3 : Rather suitable for irrigated farming, with limitations due to shallow soils, stony soils or low fertility.

Class 4 : Marginally or conditionally suitable for irrigated farming, with relatively serious limitations due to very shallow soils, steep slope or imperfect drainage.

Class 5,6: Unsuitable for irrigated farming, with serious limitations.

The land capability is classified class 1 to class 6. Class 1 is highly suitable for irrigated farming of annual and permanent crops. The lands of classes 2 and 3 have some deficiencies,such as heavy texture, gravel or cobble, shallow soil, or slopes. These lands are suitable for grain crops and orchard under irrigation. The lands of class 4 have limitation for irrigated crop cultivation. It can be utilized for fruits and coffee under irrigation, and non-irrigated pasture. The lands of class 5 and 6 should be utilized for natural pasture for cattle raising or forest. Land classification and their areas are shown in Table 3.2-4 and land capability map is illustrated in Fig.3.2-5.

Table 3.2-4 Land Classification of the Study Area

Land class	Area (ha)	Ratio (%)
Class 1	370	10
Class 2	680	19
Class 3	1,060	29
Class 4	390	11
Class 5	350	10
Class 6	400	11
Others *	350	10
Total	3,600	100

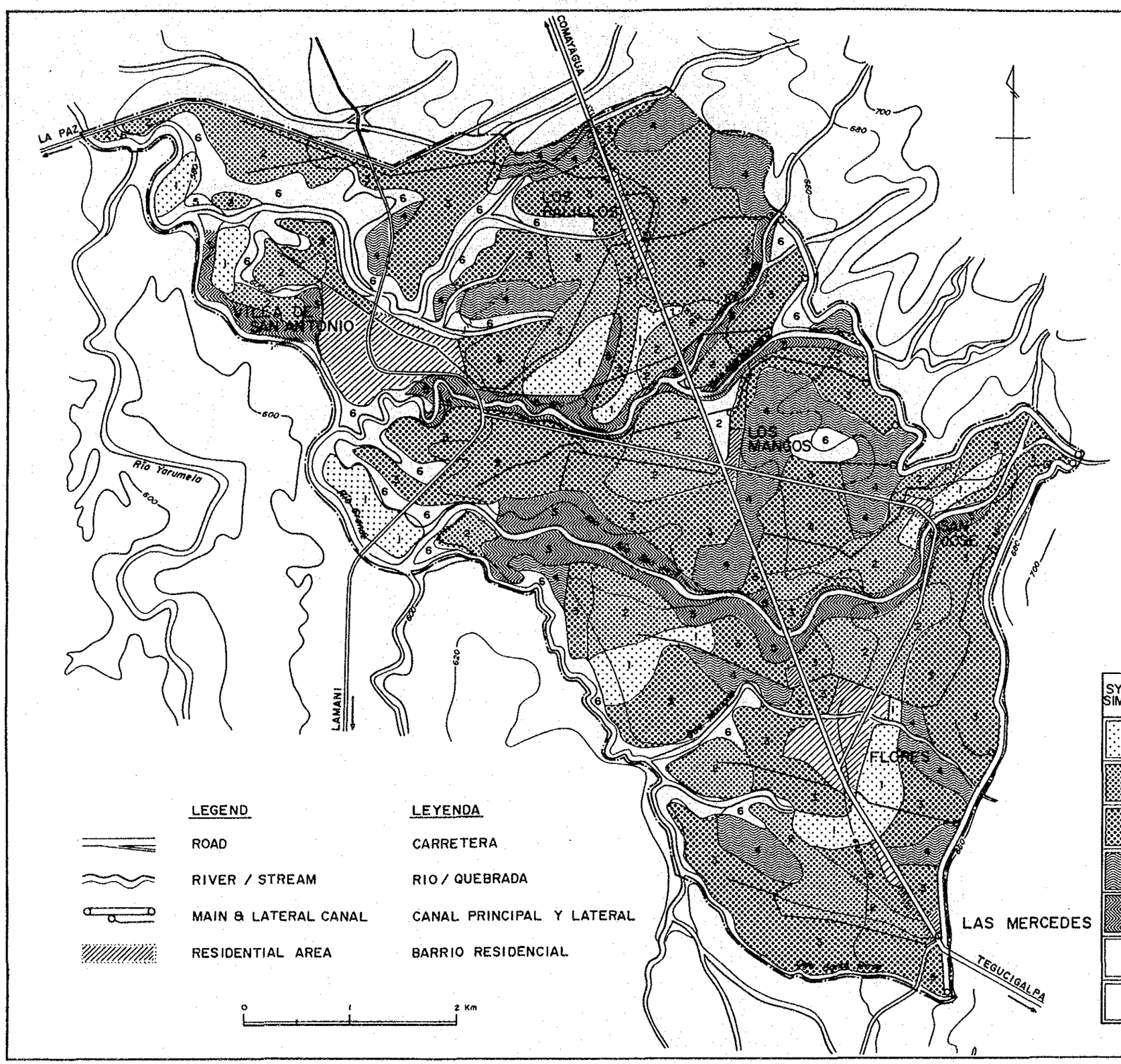
* : Urban area, roads, canals, rivers, etc.

3.2.6 Water Quality

Irrigation water has been also utilizing for domestic use for habitants. Water of canal is used not only for irrigation but also for inhabitants' life. Table of Annex C shows sampling points, results of water analysis and water quality standards for irrigation and drinking water.

According to the results, the water quality is suitable for irrigation and drinking water good for irrigation and suitable except pollution by bacteria and coliform.

Fig.3.2-5
LAND CAPABILITY MAP
MAPA DE CAPACIDAD DE LA TIERRA



LEGEND
LEYENDA

SYMBOL SIMBOLO	LAND CLASS CASE DE TIERRA	AREA AREA
		ha
1	CLASS I	370
2	CLASS II	680
3	CLASS III	1060
4	CLASS IV	390
5	CLASS V	350
6	CLASS VI	400
	OTHERS OTRAS	350

3.3 Agriculture

3.3.1 Landuse and Land Ownership

(1) Landuse

The Flores Irrigation District, Sector I and Sector II, has a gross area of 3,600 ha. Present landuse in the district is shown in the Table 3.3-1 and Fig. 3.3-1. Cultivated lands comprises 2,230 ha or 62% of the total area. The cultivated lands are further divided into three categories; annual crops lands, perennial crops lands and improved pasture lands.

Annual crops lands are mainly planted maize, rice, kidney beans, sorghum and vegetables such as tomato, watermelon, onion, etc. Perennial crops lands which are planted with coffee, mango, citrus etc. are irrigated lands.

Non-cultivated lands comprising natural pasture lands, forest lands, urban area and roads, rivers, existing canals occupy 1,370 ha or 38% of the Study Area. Natural pasture and almost part of forest lands are used for grazing places.

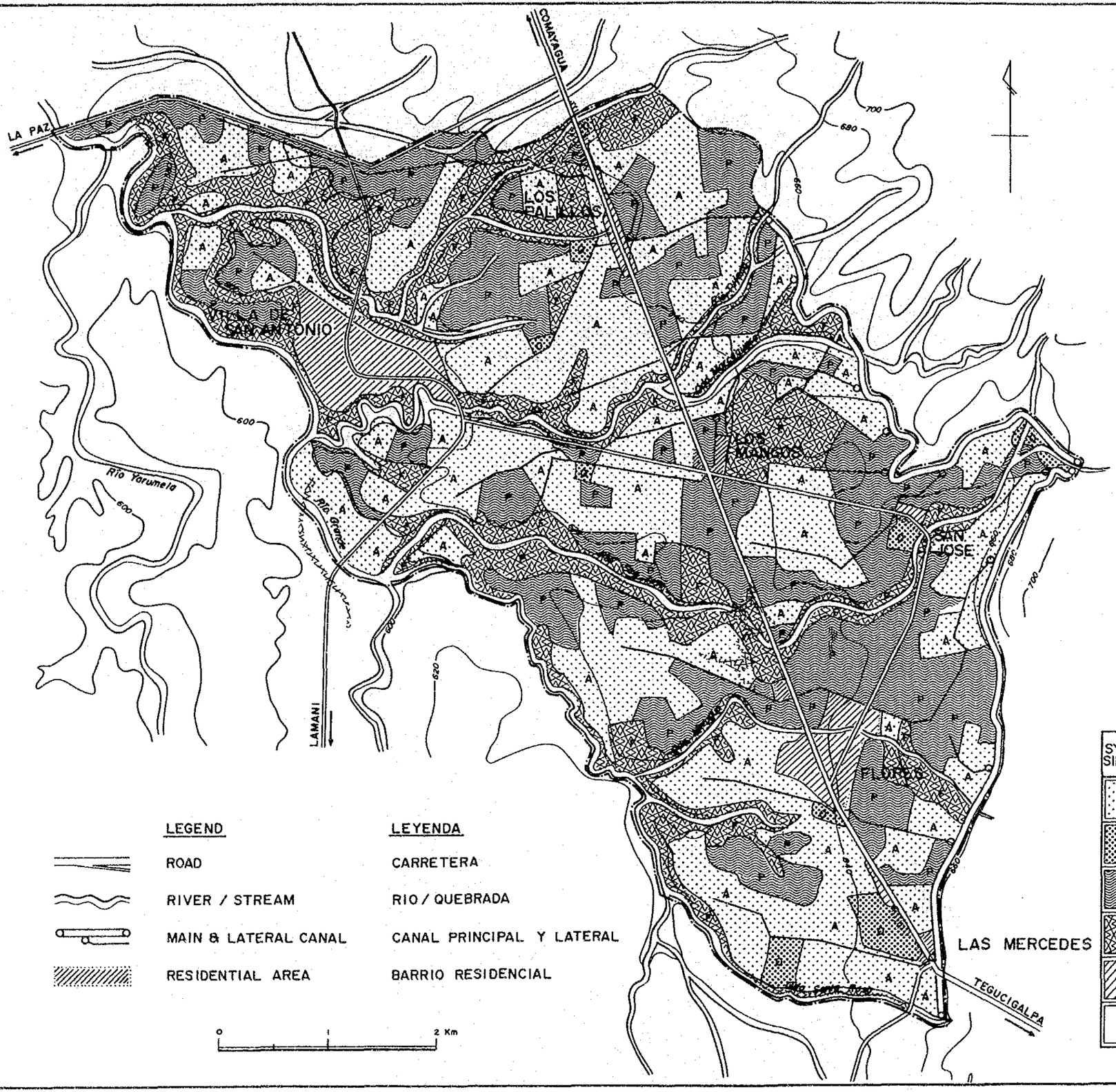
Table 3.3-1 Present Landuse in the Flores District

(unit : ha)

	Sector I	Sector II	Total
Cultivated land	850	1,380	2,230
Annual crops land	(400)	(720)	(1,120)
Perennial crops land	(90)	(50)	(140)
Improved pasture land	(360)	(610)	(970)
Natural pasture land	160	300	460
Forest land	160	400	560
Urban and settlement area	60	110	170
Roads, canals, rivers, etc.	70	110	180

Source: Landuse survey conducted by the Study Team and aerial photography.

Fig. 3.3 - 1
PRESENT LAND USE MAP
MAPA DEL USO ACTUAL DE LA TIERRA



LEGEND
LEYENDA

SYMBOL SIMBOLO	LAND USE USO DE TIERRA	AREA AREA
A	ANNUAL CROPS LAND TIERRA DE CULTIVOS ANUALES	1120 ha
P	PERMANENT CROPS LAND TIERRA DE CULTIVOS PERENNES	140
F	IMPROVED PASTURE LAND PASTO MEJORADO	970
F	NATIONAL PASTURE AND FOREST LAND TIERRA DE PASTO NATURAL Y BOSQUE	1020
	RESIDENTIAL AREA AREA RESIDENTIAL	170
	OTHERS OTRAS	180

(2) Land Holding

The present situation of land holding is estimated on the basis of land owners list of Flores Irrigation District. There are 412 individual farmers and 11 small-farmers groups which are organized under the Agrarian Reform program by INA. The land holding sizes are very inequitably distributed as shown in Table 3.3-2. Only 2% of large-scale farmers over 50 ha have 22% of whole land. Whereas small-scale farmers under 5 ha occupy 2/3 in whole owners, and their lands occupy only 17% of whole area.

The operating areas for small farmers' groups' members varies from 1.5 ha to 4.6 ha with an average of 2.9 ha. As can be seen in ANNEX D, these areas are small. It is estimated that average of land holding size is about 7 ha per farmers including members of small-farmers groups.

Table 3.3-2 Land Size Distribution by Ownership
(Individual land owners)

Land holding Size	No.of owner	(%)	Holding area (ha)	(%)
under 1 ha	63	(15%)	37	(1%)
1 ~ 2 ha	65	(16%)	98	(3%)
2 ~ 3 ha	81	(20%)	193	(6%)
3 ~ 5 ha	61	(15%)	249	(7%)
5 ~ 10 ha	55	(13%)	391	(11%)
10 ~ 20 ha	48	(12%)	674	(20%)
20 ~ 30 ha	16	(4%)	392	(12%)
30 ~ 50 ha	16	(4%)	627	(18%)
50 ~100 ha	4	(1%)	291	(9%)
above100 ha	3	(1%)	455	(13%)
Total	412	(100%)	3,407	(100%)

Source : Land owners' list of Flores Irrigation District, DGRH.
Note: Excluded number of small-farmers groups

3.3.2 Agricultural Production

Comayagua Valley has an outstanding contribution in the agricultural sector of Honduras. According to the 1974 agricultural census (ANNEX D), about 86% of the tomatoes in the country were produced in the Valley. Other vegetables produced in significant quantities were chili 86 %, cucumber 39 % and onion 41 %. Much amount of the vegetables is transported to Tegucigalpa market. A part of melons and cucumber are exported to USA and near countries.

Present major crops are maize, rice, tobacco, tomatoes and other vegetables. Maize is widely planted under irrigation as one of the traditional grain crops. Rice production is recently increasing due to an increased interest from the farmers. Vegetables are important cash crops for farmers.

(1) Cropped area

Cropped area and cropping pattern of Flores Irrigation District are shown in Table 3.3-3 and illustrated in Fig.3.3-2, respectively. Rice, vegetables, tobacco and coffee are irrigated all over the whole planted area. Some portions of maize and almost of beans and sorghum in the wet season are under non-irrigation condition. Coffee and fruits such as mango, papaya, citrus, avocado are generally irrigated in the dry season. Improved pasture is irrigated only 30 ha in the dry season.

As the result, it is estimated that present irrigated area in the dry season is 830 ha. Fallow lands of the wet and dry seasons are estimated as 240 ha (11% of whole cultivated lands) and 420 ha (19 %) respectively due to the lack of water.

Table 3.3-3 Cropped Area in the Study Area

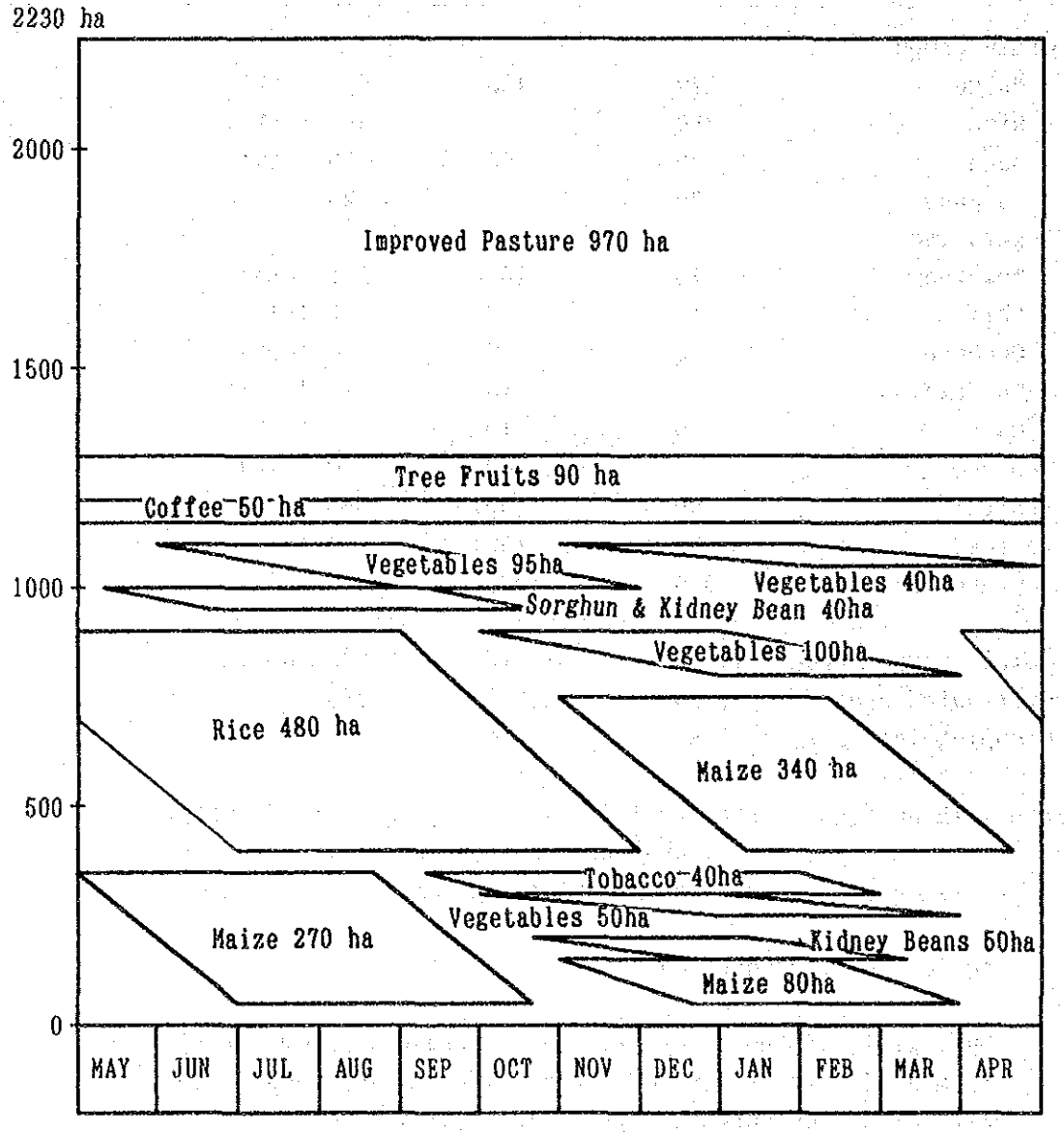
(Unit : ha)

	Wet season	Dry Season	Total
Grain crops			
Maize	270	420	690 (26%)
Rice	480	-	480 (18%)
Bean	20	50	70 (3%)
Sorghum	20	-	20 (1%)
Vegetables			
Tomatoes	70	150	220 (8%)
Chili	10	15	25 (1%)
Cucumber	5	5	10 (0%)
Watermelon	5	10	15 (5%)
Onion	5	10	15 (1%)
Tobacco	-	40	40 (1%)
Fruits	90	(90)	90 (3%)
Coffee	50	(50)	50 (2%)
Improved Pasture	970	(970)	970 (36%)
Total cropped area	1,995	1,810	2,695(100%)
Cultivated area	2,230	2,230	2,230
Cropping intensity	89%	81%	121%

Note : These figures are preliminary estimated by field survey of landuse, aerial photographs and irrigation area which is applied from users to Flores Local Office of SRN.

(2) Agricultural Production

Unit yield of the Study Area was estimated from statistics, farm household survey conducted by the Team and interviews with extension workers. It fluctuates by year due to the climatic conditions. Furthermore, it varies from farmer to farmer depending on farming techniques and practices.



Tree Fruits : Papaya, Avocado, Mango and Orange

Vegetables : Tomato, Cucumber, Onion, Chili and Water Melon

Fig.3.3-2 Present Cropping Pattern

Table 3.3-4 Crop Production in the Study Area

	Cropped Area (ha)	Unit Yield (ton/ha)	Production (ton)
Grain crops			
Maize	690	1.6	1,104
Rice	480	2.6	1,329
Kidney Beans	70	0.6	56
Sorghum	20	1.2	14
Vegetables			
Tomatoes	220	15.5	3,410
Cucumber	10	10.5	105
Onion	15	8.0	120
Chili	25	4.3	20
Watermelon	15	10.0	150
Tobacco	40	1.6	64
Coffee	50	1.0	50
Papaya	30	12.0	360
Avocado	30	4.0	120
Mango	20	5.0	100
Orange	10	3.5	35
Improved pastures			
(Milk)	970	1.38	1,339
(Beef, livestock)	970	0.069	67

(3) Livestock

Livestock sub-sector has also an important role. One third of the farmers are raising cattle for milk or meat. The average carrying capacity of improved pasture is approximately 2 to 3 animals per ha. About 43% (970 ha) of cultivated area is improved-pasture. Furthermore, includes natural pasture of 460 ha. Number of the animals in the Study Area is shown in Table 3.3-5.

Table 3.3-5 Number of Livestock in the Study Area

Livestock	No. of heads
Cattle	2,234
Horses	172
Pigs	327
Poultry	16,900

Source : Flores Local Office of SRN (1988)

Cattle graze on improved or natural pasture during the whole season. A major problem in livestock sub-sector is shortage of animal feed in the dry season. At the end of the rainy season, a considerable number of cattle is sold, and milk production in the dry season decreases to half of the rainy season. Some large or middle scale farmers irrigate a portion of their pasture. After harvest of maize and sorghum in the dry season, the remaining stalks and leaves are provided for animal in the farm.

As for meat cattle, average weight at slaughter time is 400 kg at 4 year age. The milk production per cow is 3 to 5 liters per day.

(4) Rural Labour Force

According to the results of the rural households survey, each household contributes with approximately 2.2 persons to the working labour force. During the busy period, one part of the housewives and children also participate in the agricultural tasks. Small farmers who even though work their own parcels, offer their services to medium or big scale farmers in order to increase their monetary income. In the study area it has been found that that the annual potential labour force is 527,000 persons/day while the required labour force is 108,000 persons/day.

(5) Agricultural Mechanization

For cropping, human power is widely used while mechanical devices for agricultural purposes are not generally employed. In the Study area, there are 10 tractors mainly used for

plowing and farrowing. Seeding, transplanting, and harvesting are almost all done by human power while harrowing, farrowing, weeding, etc. are done by animal power. Fumigation is done by back-carried fumigators.

In accordance with the agricultural mechanization plan, in the area there was an organization which offered rental service of machines to the farmers of the area. However, due to a bad administration and machinery maintenance, it had to close down. Big or medium scale farmers, who have their own tractors, rent them to neighboring farmers during the idle period. however, it is noticed that the existing number of tractors is not enough to satisfy the demand of the Study Area and had to ask for services coming from Comayagua.

(6) Farming Materials

According to the interview survey and field investigation, the quantity of farming materials applied is shown in ANNEX D. Lack of fertilizer and chemical materials cause low unit yield and damage caused by insects. Moreover, the application is carried out inadequately.

(7) Price of Agricultural Products and Farming Materials

The farm gate price of agricultural products and farming materials in 1989/90 is shown in ANNEX D.

(8) Actual Cropping and Profitability

Gross production amount, production cost and net profit per hectare are shown in Table 3.3-6. For the Study Area, the total gross production amount is around Lps. 5.36 million., net profit is Lps.3.88 million.

Table 3.3-6 Gross Production Amount, Production Cost, Net Profit per Hectare

(unit : Lps./ha)

Product	Gross Prod.	Prod. Cost	Net Profit
Maize	992	465	527
Rice	1,664	867	797
Kidney-beans	840	556	284
Sorghum	576	309	267
Tomato	6,975	1,159	5,816
Cucumber	2,310	1,001	1,309
Onion	7,840	1,256	6,584
Chili	6,020	1,147	4,873
Watermelon	3,100	908	2,192
Tobacco	7,040	1,141	5,899
Coffee	4,200	1,141	3,059
Papaya	7,920	3,173	4,747
Avocado	4,000	845	3,155
Mango	3,000	852	2,148
Orange	3,360	895	2,465
Improved pastures	1,021	123	898

See ANNEX D

3.3.3 Farm Household Economy

In order to know the present economic conditions of a representative individual farmer and small-farmers group member, 60 farmer households have been surveyed. Together with the information of the profitability of crops mentioned above, the survey results helped to elaborate Table 3.3-7.

Table 3.3-7 Economy of Representative Farmer

	Small scale	Medium scale	Group member *
Operating area scale (ha)	1.67	10.14	2.59
Farmer income (Lps.)	5,210	12,930	7,780
Crops income (Lps.)	(4,130)	(12,930)	(7,240)
Wages income (Lps.)	(1,080)	(0)	(540)
Total Living expenditures (Lps.)	4,950	10,730	7,130
Remains (Lps.)	260	2,200	650

* : 11 cooperative members; average operating area per household 30.9 ha

Note : See ANNEX D

3.3.4 Marketing and Processing

(1) Marketing of Agricultural Products

Basic grains of Honduras such as maize,rice,sorghum,and kidney-beans, are usually purchased by intermediate brokers and agricultural cooperatives, and IHMA and later retailed in the domestic market through wholesalers.

To inhibit excess price fluctuations of these grain, which is the main staple food of the nation, IHMA is authorized to intervene in the grain market. More particularly, IHMA purchases grain when wholesale price falls, and discharges grain when whole prices rises.

Other agricultural products such as vegetables, fruits, livestock products, etc. are collected and purchased by mainly intermediate broker. Aside from brokers, two agricultural cooperatives in the Study Area, a processing company and export trader, also collect products directly from farmers.

In the area of Comayagua, concerning agricultural products beside basic grains, specially for the vegetables wholesale prices, the fluctuation within a year is very big, i.e., the highest price reached at one time could represent 3 or 4 times the lowest price for the same product at another time.

In a general way, farm products are collected on a contract basis by cooperatives, middlemen and processors prior to the crop harvests, which are generally performed by hand by recollectors. Trading negotiations with middlemen or processing companies are made by individual farmers. In very few cases negotiations are performed by groups. Also, farmers do not count with great facilities where to discharge their products.

In Comayagua Valley, specifically in Comayagua city, there is no wholesale market. There is a small city-managed market, but it does not have adequate facilities. Therefore, producers should be provided with discharge and storage facilities.

Tomato processed from companies established in Comayagua has been exported to neighboring Central America countries and cucumber has been exported to the United States. Even though melon is not being exported at present, domestic produced melon has a good chance to be exported in the future.

(2) Processing Companies

Agricultural products from Comayagua Valley are not only being processed by companies located in the Comayagua area but also by companies located in Tegucigalpa and San Pedro Sula. The main processing companies in Comayagua are two tomato and fruits processing companies, one maize flour producer and one rice mill.

According to information given by the managers of the main tomato processing companies, the problem they face nowadays is not a technical problem but one related to the irregularity and low in supply of raw material.

3.3.5 Agricultural Supporting System

Agricultural supporting encompasses technical assistance and guidance,marketing of agricultural products, experimental research, and agricultural credit. The flow chart of the agricultural supporting system is shown in Fig. 3.3-3 .

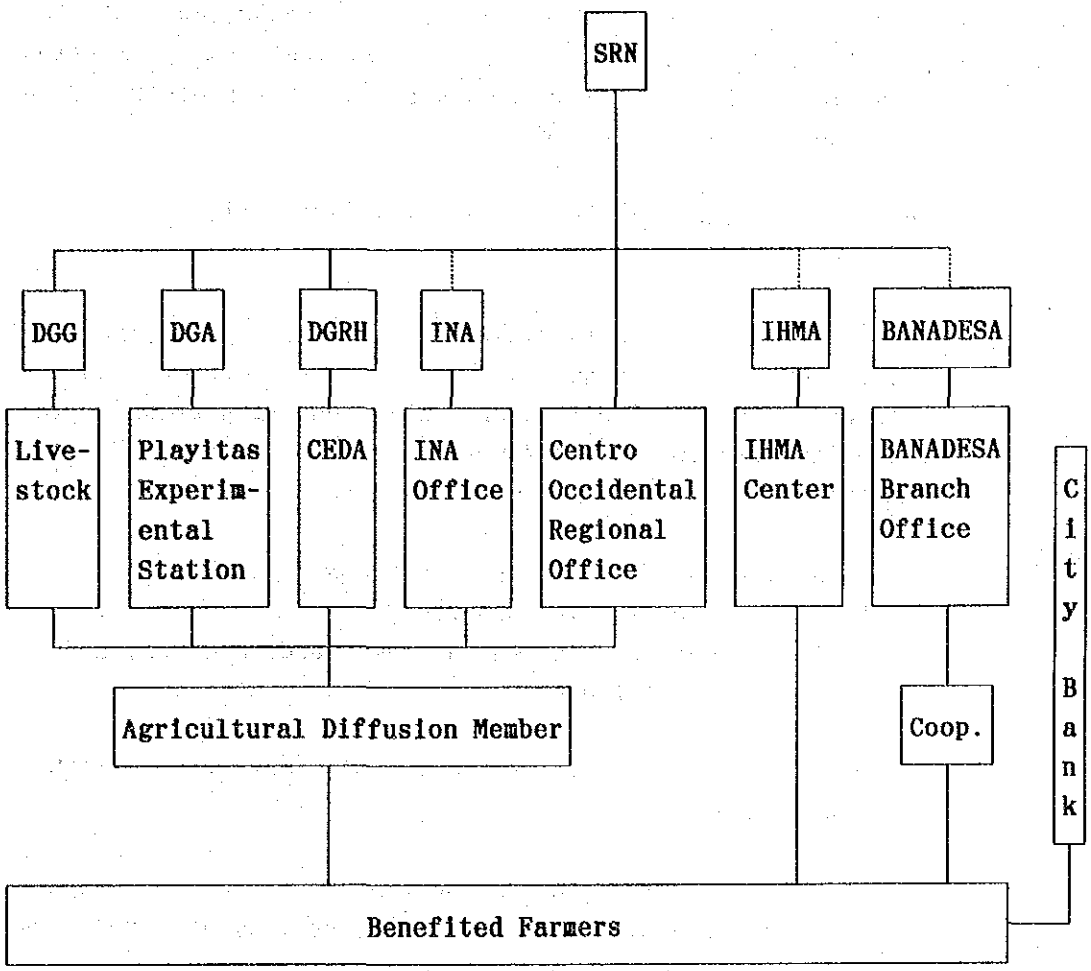


Fig. 3.3-3 Agricultural Supporting System

(1) Agricultural Supporting Organization

- Region Office of the Ministry of Natural Resources (SRN)

SRN divides the whole nation into 11 regions and establishes agricultural supporting organization for each region, SRN in Comayagua belongs to the Central Occidental Region which consists of Comayagua and La Paz Departments. SRN has a planning division (unidad) and several departments (departamento) such as agriculture, livestock, agricultural extension, water resources, project development and national project. Furthermore, SRN has 4 local offices (agencia de desarrollo agropecuario). The Flores local office situated in the Study Area (Fig. A.3.3-X) has an irrigation and

agricultural extension sections. The irrigation section is in charge of control for facilities and water management of the Flores Irrigation District, and the agricultural extension section is in charge of extension services in the southeastern part of the Comayagua Valley.

- Agrarian National Institute (INA) Regional office in Comayagua

  INA's regional office in Comayagua covers Comayagua, La Paz and Intibuca departments and has 4 local offices and 3 branches. Regional office of INA in Comayagua extends the following services to the 256 settlers who belong to "grupos campesinos" benefited by the agrarian reform.

  a. Advice on efficient organizational systems,
  b. Guidance of farming practices,
  c. Educational service to the women and children, and
  d. Agricultural finance.

- Honduran Institute of Agricultural Marketing (IHMA) Comayagua Center

  IHMA has authorization to decide the governmental support prices of basic grains . Other major functions of IHMA are purchasing storage and selling those grains.

- Agricultural Development Training Center (CEDA)

  It was created in order to train farmers and technicians for agricultural development and irrigation, and was completed in 1985 by a grant aid from the Japanese Government. CEDA is situated in the town of Comayagua as a dependency of the DGRH. Various training course are held for that purpose.

(2) Agricultural Research Institutions

- National Livestock Center

  The objectives of the Center are as follow:

  a. To produce frozen semen for artificial insemination of cattle,

b. To conduct research for cattle breed improvement of cattle,
c. To train technicians and assistant staff of the General Directrate of Livestocks (DGG), and
d. To train the producer in order to increase productivity of cattle.

- Playitas Experimental Station

The agricultural experimental station which belongs to the DGA of the SRN, is located near place Comayagua. It is mainly in charge of new varietal trials and fertilizer application tests for basic grains.

(3) Agricultural Extension Services

Agricultural extension services are provided according to the plan formulated by SRN and SRN regional offices. In the Flores local office, three local extension workers in the extension section are at service (see ANNEX D). Their services covers 1,500 households which comprise 600 small scale farmers and 17 small farmers' groups (240 members) in the Flores Irrigation District and its adjacent area. Major services are giving technical advice on proper crops and livestock husbandry. The propblems they face are the small number of extension worker and inadequate number of transportation means.

Regional offices of INA in Comayagua extends also their services to the settlers (grupos campesinos) who are settled by agrarian reform in line with SRN policy.

(4) Agricultural Credit

Usually agricultural credit to the farmers in Honduras is given by BANADESA, and commercial banks. BANADESA is the national bank for the agricultural finance to farmers and cooperatives. There is branch office of BANADESA in Comayagua. BANADESA finances small scale farmers and commercial banks loan medium and large scale of farmers. Credit is granted for the purchasing of agricultural inputs and facilities for cultivation and livestock, purchasing farm land, expenses for irrigation facilities. Credit is asked to be applied mainly for these crops: coffee, rice, maize.