FEASIBILITY REPORT
ON
ILOCOS NORTE IRRIGATION PROJECT
IN
THE PHILIPPINES
(PHASE I)
MAIN REPORT

MAY 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of the Philippines, the Government of Japan decided to conduct a survey of the Ilocos Norte Irrigation Project, and Japan International Cooperation Agency dispatched in November 1977 a survey team to conduct a preliminary survey of the Project.

Based on the findings of the above preliminary survey the Japan International Cooperation Agency conducted a feasibility study of the Project by dispatching a study team headed by Mr. Susumu TAKAMINE of Sanyu Consultants Inc. from August 9 to November 9, 1978. Taking into account the results of the survey and study, as well as the discussion with Philippine Government officials concerned, the study team formulated the present final report.

I hope this report will prove to be useful for the implementation of the Project, and will contribute to the social and economic development in the areas involved as well as to the promotion of the friendship between the two countries.

I express my hearty appreciation to the Government and officials concerned of the Philippines for their close cooperation extended to the teams.

May 1979

Shinsaku HOGEN
President,
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Shinsaku Hogen
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir:

We have the honor to submit herewith our report on the feasibility study for the Ilocos Norte Irrigation Project (Phase I), Republic of the Philippines. The field survey was conducted for the period of three months from August 9 to November 9, 1978. This report has been prepared on the basis of various discussions held between the Philippine Government agencies concerned and the Team.

The Team has completed the feasibility study covering the irrigation component for the area of about 10,200 hectares, located on the Ilocos Norte Province, northern tip of Luzon island.

Prior to the plan formulation of this project, study on overall plan serving the areas of about 21,400 hectares, of which components are irrigation and electric hydropower, has been made through alternative studies including Palsiguan dam on the basis of phasing development. As the result, the right bank area of the Bonga river (10,200 hectares) has been evaluated as the first priority area to be selected. Although the overall plan has still some technical problems to be further studied, we wish to state that this would be one of the best schemes in the area development.

This report consists of two volumes: Volume I - Main Report, summarizes the results of the study, including the conclusions and recommendations; Volume II - Appendix, provides more detailed technical information.

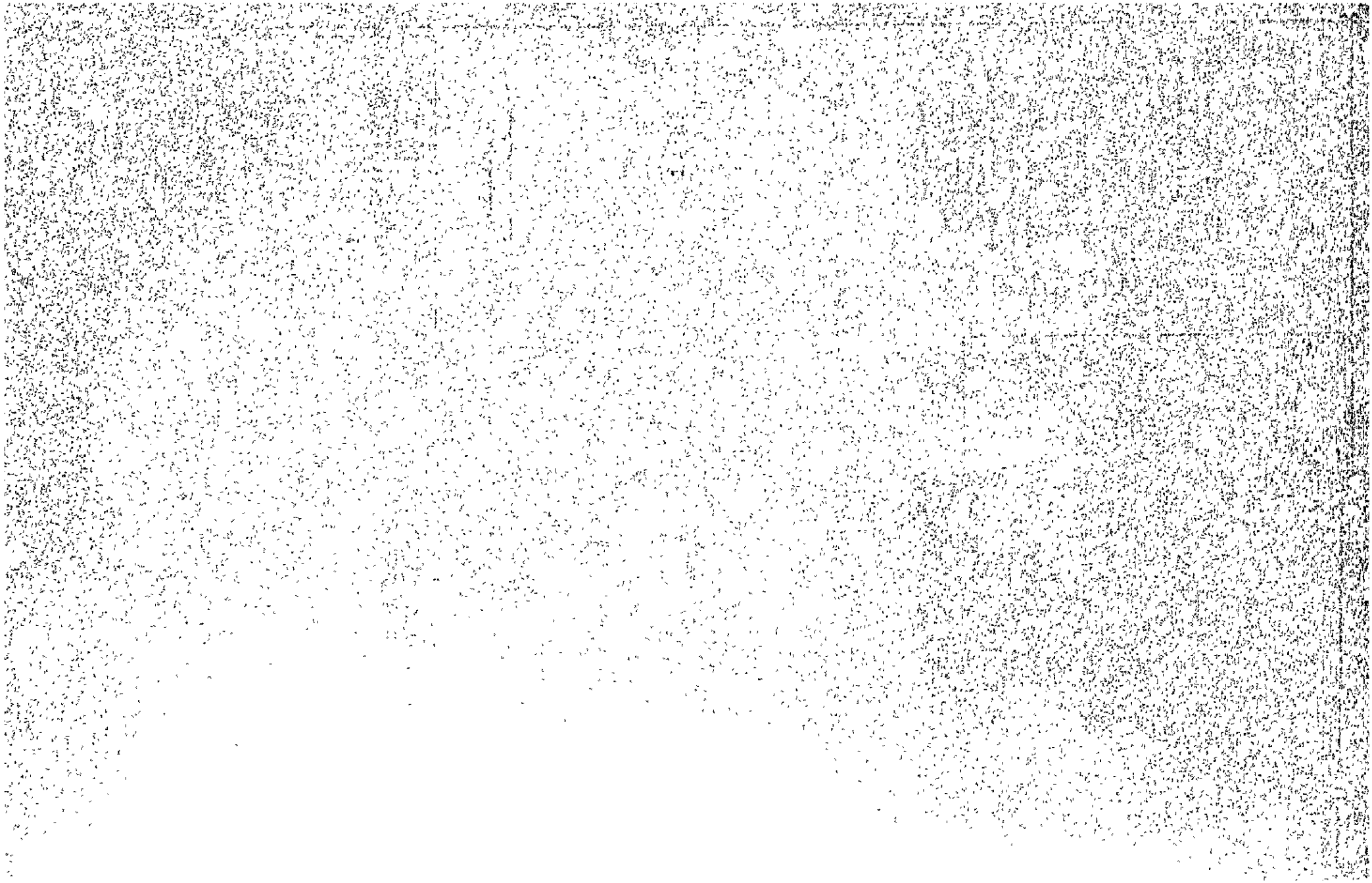
We hope that this irrigation development project would serve as a good example and greatly contribute to the socio-economic development in the Philippines.

Finally, we take this opportunity to express our deep gratitude to the National Economic and Development Authority, National Irrigation Administration, Department of Agriculture, Department of Public Highways, National Power Corporation, Bureau of Plant Industry, Fertilizer and Pesticide Authority, Ministry of Foreign Affairs (Japan), Embassy of Japan in the Philippines, Ministry of Agriculture, Forestry and Fishery, Japan International Cooperation Agency and Advisory Group of the Project for their valuable assistance and cooperation extended to us throughout the survey period and compilation of this report.

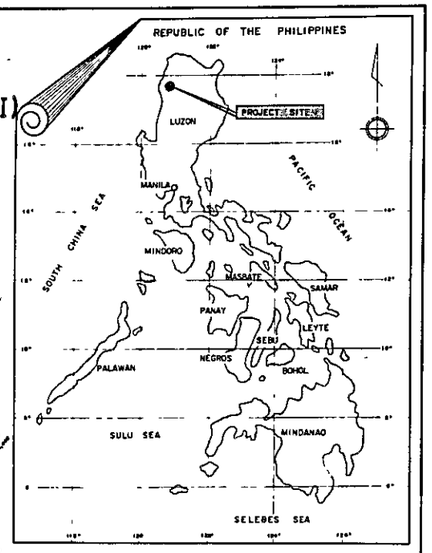
Respectfully yours,

Susumu Takamine
Team Leader for the
Ilocos Norte Irrigation Project

May 1979



GENERAL PLAN FOR ILOCOS NORTE IRRIGATION PROJECT (PHASE I)



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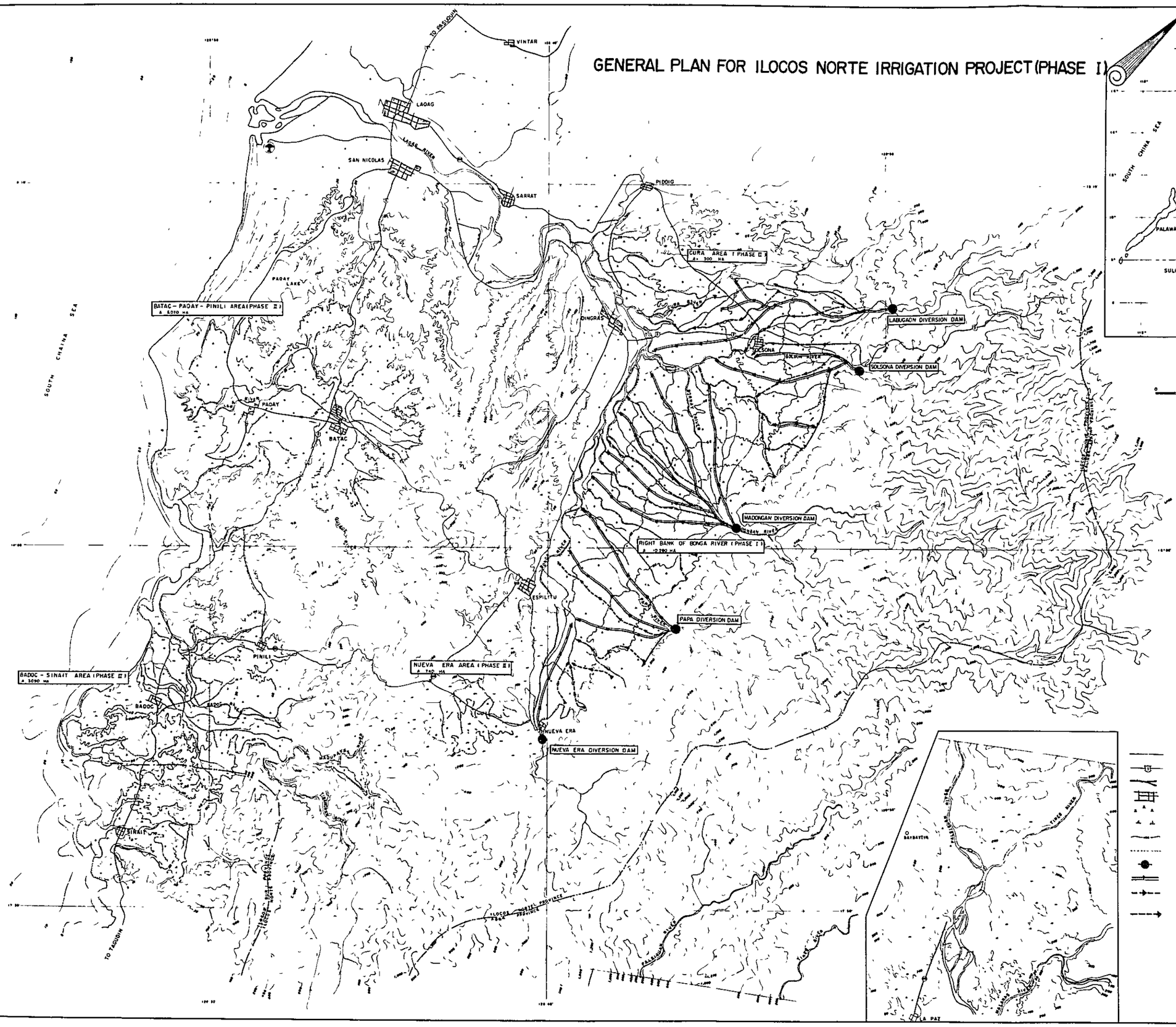
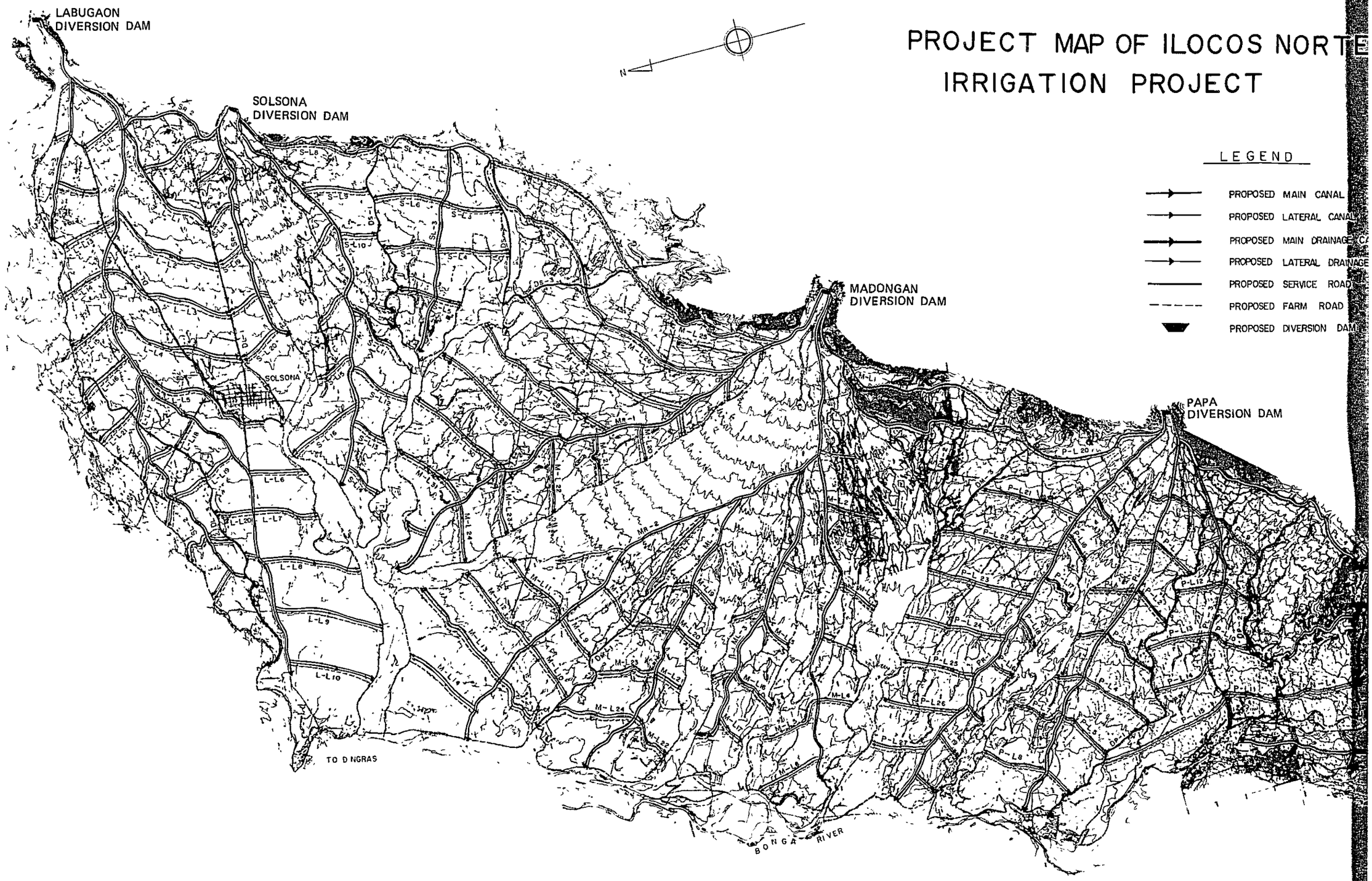


LEGEND

- BOUNDARY OF PROVINCE
- NATIONAL AND PROVINCIAL ROADS
- RIVER AND RIVER WASHED AREA
- TOWN
- EXISTNG PADDY FIELDS
- TROPICAL GRASS LAND
- CONTOUR LINE
- BOUNDARY OF BENEFICIAL AREA
- PROPOSED DIVERSION DAM
- PROPOSED MAIN IRRIGATION CANAL AND ROAD
- PROPOSED MAIN DRAINAGE CANAL (NEWLY CONSTRUCTED)
- PROPOSED MAIN DRAINAGE CANAL (EXISTNG RIVER OR CREEK)

PROJECT MAP OF ILOCOS NORTE IRRIGATION PROJECT



PROJECT MAP OF ILOCOS NORTE IRRIGATION PROJECT

LEGEND

- PROPOSED MAIN CANAL
- PROPOSED LATERAL CANAL
- PROPOSED MAIN DRAINAGE CANAL
- PROPOSED LATERAL DRAINAGE CANAL
- PROPOSED SERVICE ROAD
- PROPOSED FARM ROAD
- PROPOSED DIVERSION DAM

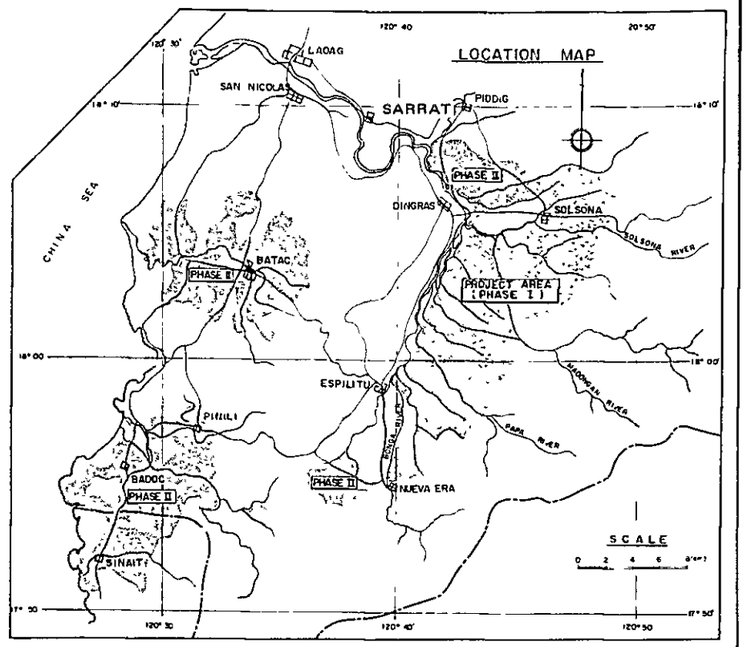
MADONGAN DIVERSION DAM

PAPA DIVERSION DAM

NUEVA ERA DIVERSION DAM

BONGA RIVER

LOCATION MAP



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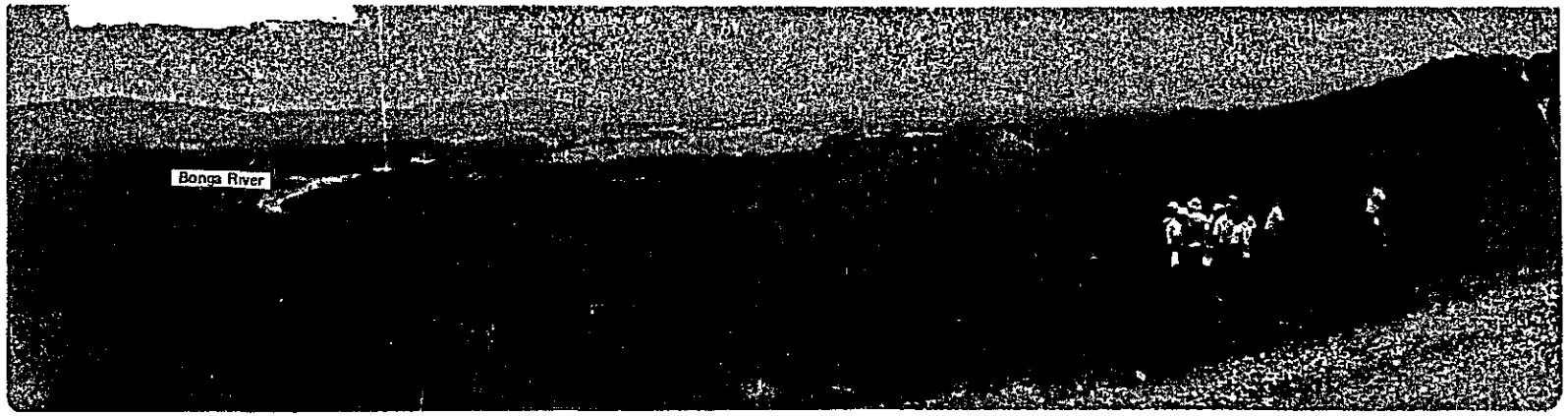
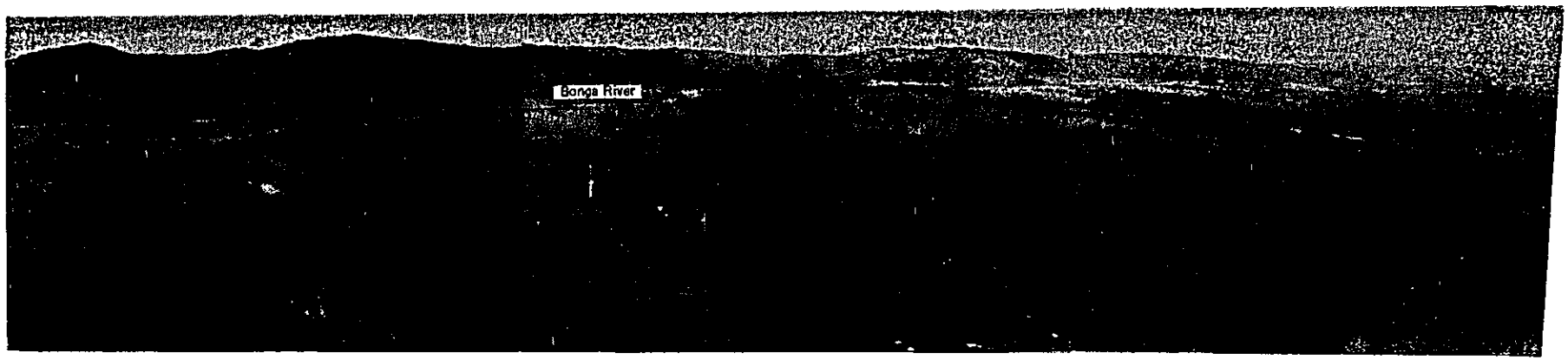


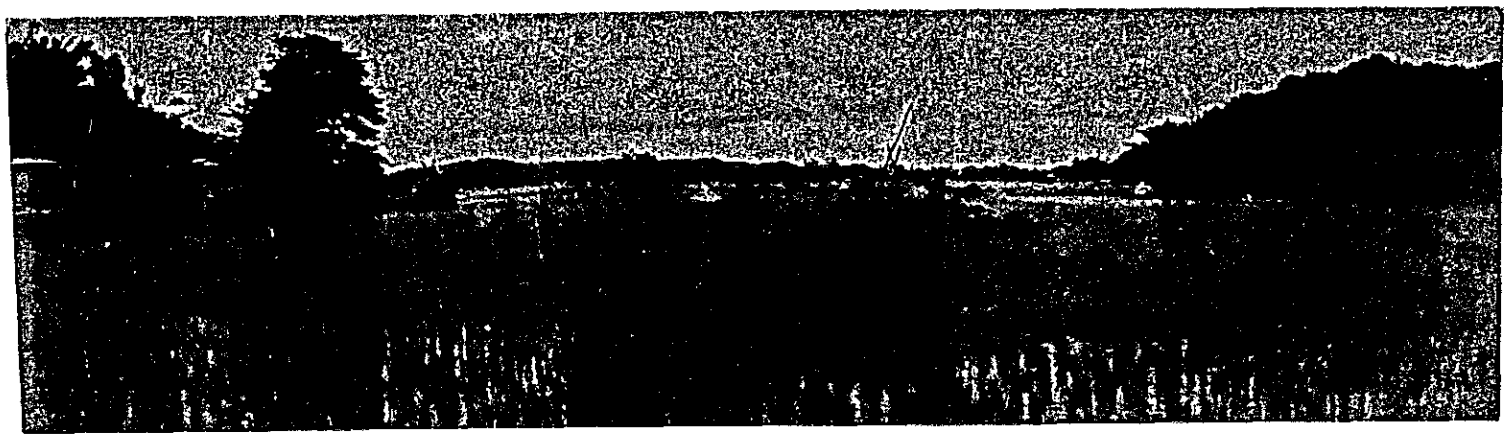
A General View of the Project Area commanded at the Proposed Nueva Era Diversion Site on the Right Bank of the Bonga River



A View of the Project Area Planted with Wet Season Paddy Rice

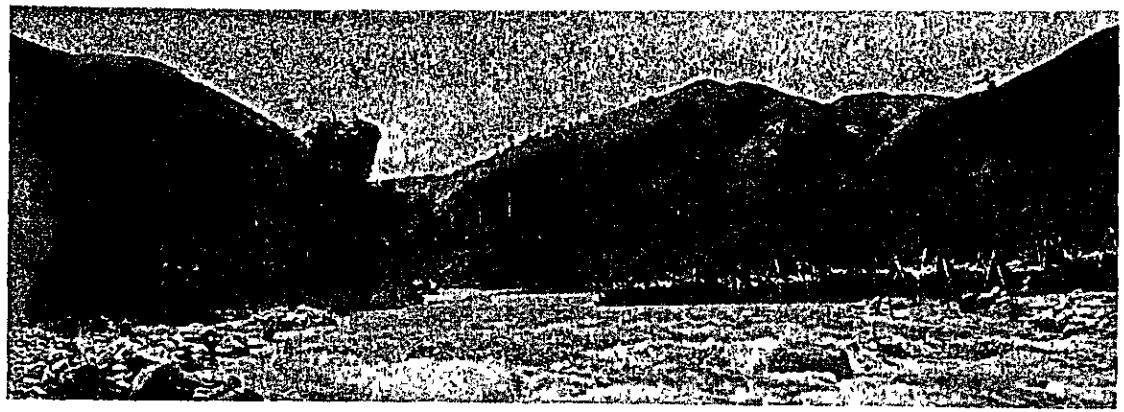
A River-Washed Area along the Madongan River

The Alluvial Fan and River-Washed Area formed by Madongan River Action



Wet Season Paddy Fields in the Nueva Era Area

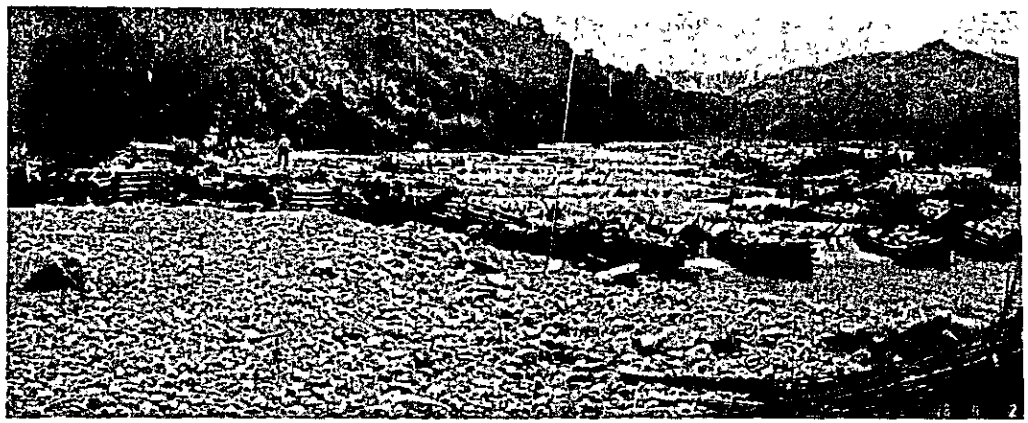
Dry Season Upland Crops Planted after Harvesting Wet Season Paddy Rice in the Solsona Area



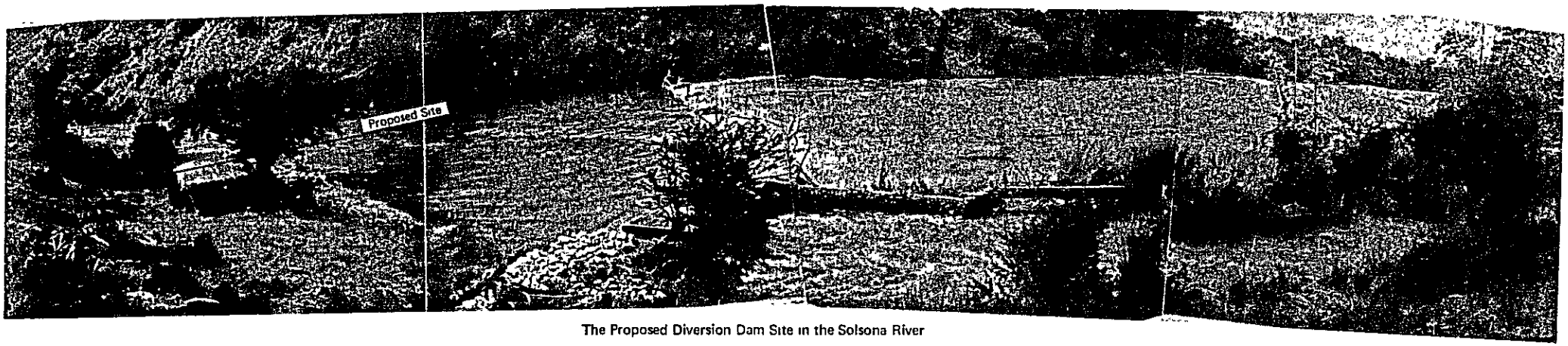
An Existing Brush Dam across the Madongan River

Improvement of an Existing Brush Dam

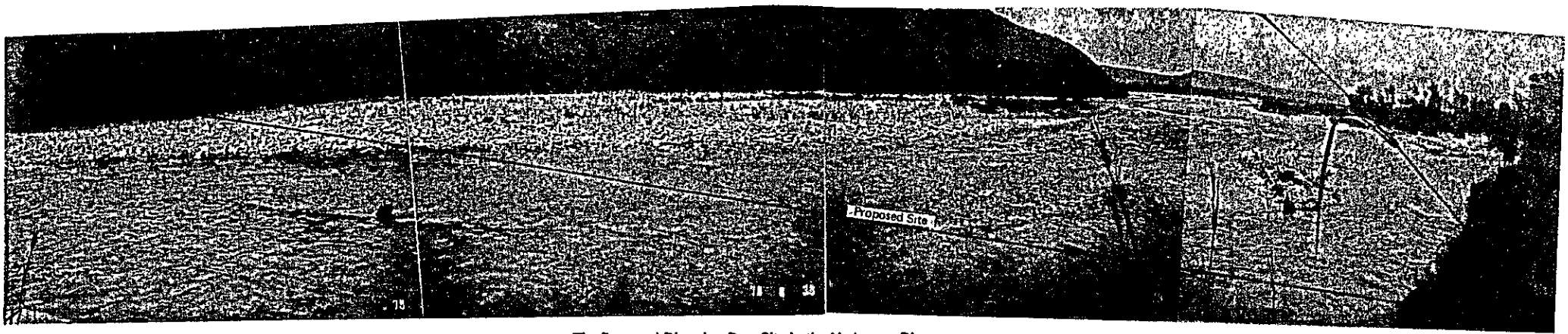
An Intake Canal located Immediately Downstream the Papa Brush Dam



An Existing Brush Dam across the Papa River



The Proposed Diversion Dam Site in the Solsona River



The Proposed Diversion Dam Site in the Madongan River

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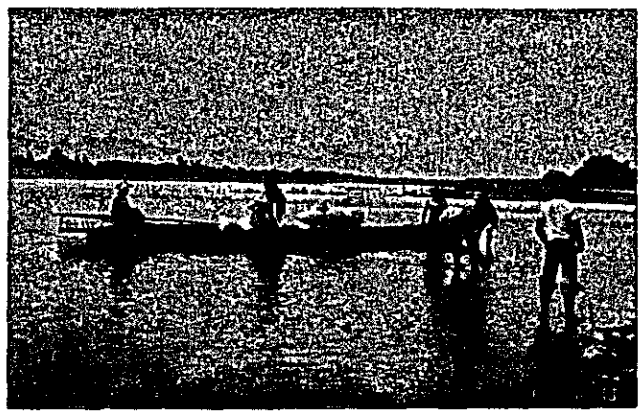
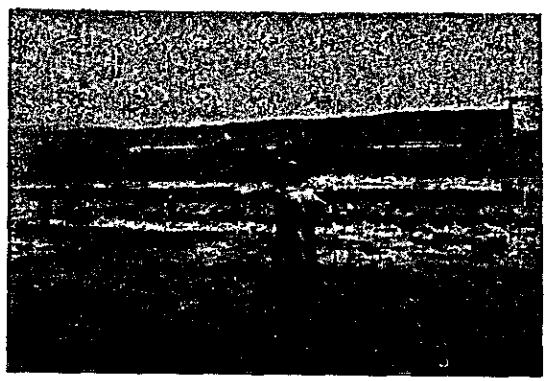
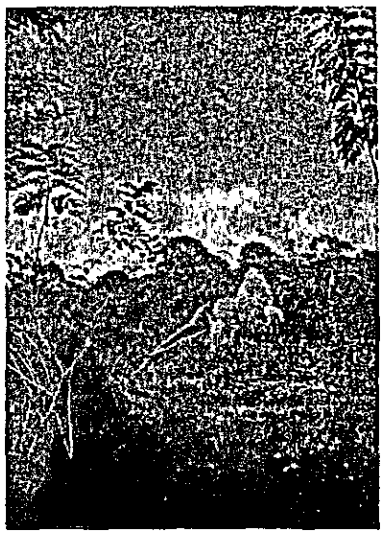
Thrashing Works of Wet Season Paddy Rice in the Solsona Area



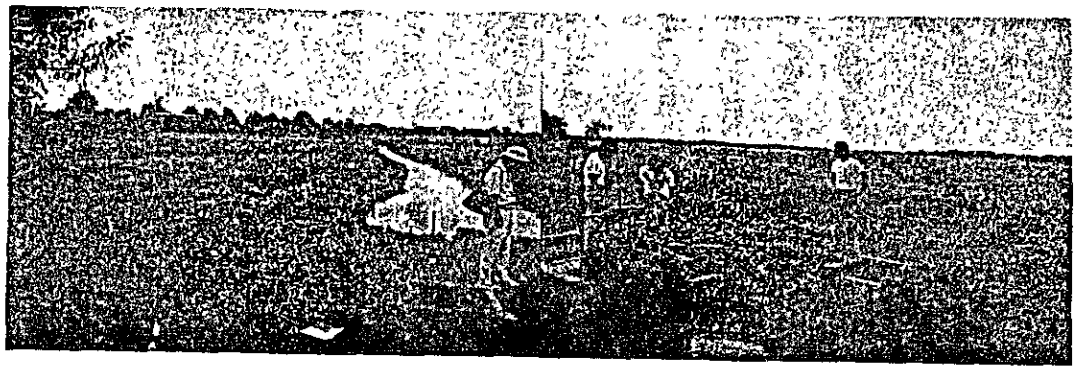
Transportation of Agricultural Products by Boat on the Bonga River



Transplanting of Dry Season Paddy



Seismic Survey at the Proposed Nueva Era Diversion Site



Field Survey of On-farm Facilities at Laoag-Vintar RIS

River Crossing by Bamboo Raft in the Bonga River

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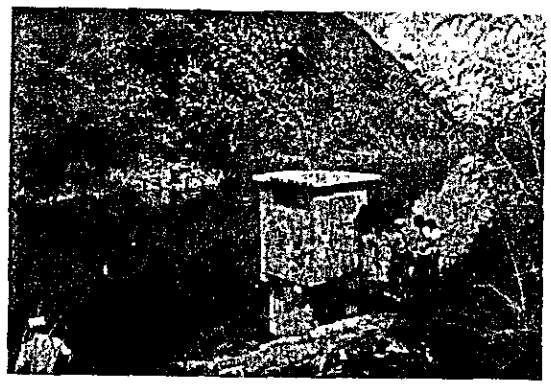

Newly Installed Automatic Water Level Gauge in the Solsona River

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ABBFEVIATIONS AND GLOSSARY

Agencies

ACA:	Agricultural Credit Administration
ADB:	Asian Development Bank
AMC:	Area Marketing Cooperatives
BAEcon:	Bureau of Agricultural Economics
BAEx:	Bureau of Agricultural Extension
BPI:	Bureau of Plant Industry
BS:	Bureau of Soils
BPW:	Bureau of Public Works
CB:	Central Bank of the Philippines
DA:	Department of Agriculture
DANR:	Department of Agriculture and Natural Resources
DAR:	Department of Agrarian Reform
DF:	Department of Finance
DLGCD:	Department of Local Governments and Community Development
DPH:	Department of Public Highways
DPWTC:	Department of Public Works, Transportation and Communication
FPA:	Fertilizer and Pesticide Authority
FaCoMa:	Farmers Cooperatives Marketing Association
IBRD:	International Bank for Reconstruction and Development
IDA:	International Development Association
INECO:	Ilocos Norte Electric Cooperation
ISECO:	Ilocos Sur Electric Cooperation
JICA:	Japan International Cooperation Agency
NACIAD:	National Council of Integrated Area Development
NCSO:	National Census and Statistics Office
NFAC:	National Food and Agricultural Council
NEA:	National Electrification Administration
NEDA:	National Economic and Development Authority
NGA:	National Grains Authority
NIA:	National Irrigation Administration
NISIS:	National Irrigation System Improvement Study
NPC:	National Power Corporation
OECF:	Overseas Economic Cooperation Fund
PNB:	Philippine National Bank

PAGASA:	Philippines Atomospheric Geophysical and Astronomical Services Administration
PVTA:	Philippine Virginia Tobacco Association
RB:	Rural Bank
SN:	Samahang Nayon
UPIP:	University of the Philippines, Institute of Planning
USAID:	United Stated Agency for International Development
USBR:	United States Department of Interior, Bureau of Reclamation

Unit of Measurement

mm:	milimeter
cm:	centimeter
m:	meter
km:	kilometer
sq.cm, cm^2:	square centimeter
sq.m, m^2:	square meter
sq.km, km^2:	square kilometer
MSM, $10^6 m^2$:	million square meter
ℓ, lit:	liter
cu.m, m^3:	cubic meter
MCM, $10^6 m^3$:	million cubic meter
lit/sec:	liter per second
m/sec:	meter per second
PPM:	part per million
g:	gram
kg:	kilogram
ton, m.t.:	metric ton
cavan:	50 kg
EL:	elevation above mean sea level
MSL:	mean sea level
FWL:	full water level
HWL:	high water level
LWL:	low water level

Unit of Measurement

sec:	second
minu:	minute
hr:	hour
min:	minimum
max:	maximum
%:	percent
No.:	number
°C:	degree centigrade
°F:	degree fahrenheit
Cl:	chlorine
HP:	horse power
GWH:	gigawatt hour
ET:	evapotranspiration
N:	nitrogen
P:	phosphorous
K:	potassium
HYV:	high yielding variety
O & M:	operation and maintenance
IRR:	internal rate of return
B/C:	benefit cost ratio
FY:	fiscal year
₱:	Peso, ₱ 1 = approx. US$0.135
$:	Dollar, US$ = approx. ₱ 7.4

Conversion Factors

Unit	Comparison	English Equivalents
Units of Length		
Millimeter (mm)	0.001 meter	0.0394 inch
Centimeter (cm)	0.01 meter	0.3937 inch
Meter (m)		3.2800 feet
Kilometer	1,000 meters	0.6213 mile
Units of Area		
Square centimeter (cm^2)	0.0001 m^2	0.155 square inch
Square meter (m^2)		10.764 square feet
Hectare (ha)	10,000 m^2	2.471 acres
Square kilometer (km^2)	1,000,000 m^2	0.3861 square mile

Unit	Comparison	English Equivalents
Units of Volume		
Cubic centimeter (cm^3)		0.061 cubic inch
Liter (1,000 cm^3)	0.001 m^3	1.0567 quarts (liquid)
Cubic meter (cu.m)	1,000 liters	35.3145 cubic feet
Unit of Weight		
Gram (g)		0.0353 ounce
Kilogram (kg)	1,000 grams	2.2046 pounds
Metric Ton (mt)	1,000 kg	2,204.6 pounds

Miscellaneous

1 cu.m per sec	= 1,000 liters per second (ℓ/s) = 35.3145 cu.ft per second (cfs) = 15,850 gallons per minute (gpm)
1 liter per second for 1 day	= 8.64 mm depth over one hectare
10 mm depth over 1 hectare	= 1.157 liters per second for 1 day = 3,532 cu.ft
1 horsepower (metric)	= 75 kg-m per second
1 horsepower (English)	= 550 ft-lb per second
1 cu.m of water per second under 1 m head	= 9.81 kw @100% efficiency
1 x 10^6 cu.m of water per hour under 1 meter head	= 2,724 kwh @100% efficiency

Terminology

Arable land:	Land identified in the land classification investigation as having adequate productivity to warrant consideration for irrigation
Bamboo:	Bambusa Spinosa Roxb. a woody grass with a big hollow in the center of the internodes, growing in groves or clumps reaching a height of 25 meters or more
Barrio:	A political subdivision of a town
Bolo:	A large single-edged knife for a variety of uses like clearing the field, harvesting and household work
Calesa:	A light, two-wheeled, horse-drawn vehicle commonly used to transport passengers of farm produce for short distances
Carabao:	The animal that most farmers use for plowing and other farm work. It is about the size of an ox and is similar to the water buffalo in other Asian Countries.

Cogon:	Imperata cylindrica (Linn.) Beauv. a coarse grass which usually covers idle lands or abandoned clearing
Fiesta:	Spanish term for feast, celebrated pompously once a year to honor the patron saint
Ganta:	A common unit of volume for rice equivalent to 2.24 kilograms of milled rice.
Hectare:	A metric measure containing 10,000 square meters equivalent to 2.471 acres
IR-8, IR-5, IR-20,	High yielding rice varieties from the IRRI, Los Banos, Laguna, Philippines
Irrigable land:	That portion of the arable land which is included in the irrigation service plan
Monsoon:	Periodic wind that blows from the sea to the continent and oppositely in winter
Nipa:	Heavy-leafed type of reed used in thatching huts
Palay:	The rice plant which bears a staple cereal, or the cereal itself unhulled. Sometimes called rough rice
Province:	A political subdivision of a country comprising several towns
Share tenancy:	A practice where operators rent the land they work and pay as rent a share of the cash or crops grown.
Trade wind:	One of the three Philippine air currents, comprising from a generally easternly direction reaching the islands during the period from February to April
Typhoon:	A storm or system or winds occurring in the Philippines and China Sea regions, known as hurricane in the West Indies and South Pacific, cyclone in the Indian Ocean

BACKGROUND

SUMMARY, CONCLUSION AND RECOMMENDATION

BACKGROUND

1. Ilocos Norte Province is located in the north-western part of the Luzon Island, the Philippines, and is one of the provinces which are left behind others in their economic development. Though agriculture plays the most important role in the regional economy, only 17 percent of paddy field is irrigated in the dry season. Further, those existing irrigation facilities are considerably deteriorated, not functioning properly. Under the circumstances, the per capita income in 1975 in this region is only 955 pesos, which is much lower than that of the national average, 1,601 pesos per annum. Due to the above situations, a considerable number of population has transmigrated to the Greater Manila and other urban areas to reduce the population growth rate of the region. To cope with such an unfavorable situation in terms of economic development in rural areas, the Government of the Philippines has drawn up a plan to promote an economic development in the region.

2. The National Irrigation Administration (NIA) made a study and conceived a plan for possible irrigation projects in the region in early 1975. The plan was then developed to an Integrated Rural Area Development Project in 1976, putting emphasis on the agricultural development, which would be promoted and implemented under the direct supervision of the Government. As the agricultural development under the said Integrated Development Project, the NIA conducted further studies and formulated the Palsiguan River Multi-Purpose Project in March 1977 under close cooperation of the National Economic Development Authority (NEDA).

3. In May 1977, the NEDA made a request for technical assistance in the study on the subject project of the Japanese Government's Mission headed by Mr. Mitsuo IIJIMA which was dispatched to the Philippines by the Ministry of Foreign Affairs, Japan. In August 1977, the request was officially made by the Government of the Philippines to the Government of Japan through the Embassy of Japan in Manila. In response to this request, the Japan International Cooperation Agency (JICA) dispatched a Preliminary Survey Team for the Ilocos Norte Irrigation Project headed by Mr. Tatsuo ASAHARA to the Philippines for a period from October 30 to December 2, 1977. As a result of the preliminary survey, a phased development plan was recommended to be promoted to comply with the strong desire of the Philippine Government for early implementation of the Project although the necessary data/information for finalizing the overall development plan have not yet been fully available. In other

words, firstly, an overall project plan shall be provisionally formulated and a feasibility study will be carried out for those areas where required data/information are available and effect of partial development can be expected from the Phase I program. A feasibility study for the remaining area including the Palsiguan Dam and hydro-power generation shall be carried out as the Phase II program. In this report, both Governments have mutually agreed on the above-stated strategy for the development of the region.

4. Following the aforementioned facts, JICA dispatched a survey team for the Phase I study from August 9 to November 9, 1978 within the scope of works as summarized below.

i) Formulation of an overall development plan for the whole Project Area including Palsiguan Dam as irrigation water resources based on the fundamental data collected.

ii) Within the framework of the overall plan, the feasibility study of a provisional water supply plan for the area of about 10,200 ha located on the right bank of the Bonga river shall be studied.

SUMMARY, CONCLUSION AND RECOMMENDATION

A. SUMMARY

1. The Project Area, approximately 10,200 ha is located about 25 km south-east of Laoag City, the capital of the Ilocos Norte Province which is in the north-western part of Luzon Island being far from Manila by about 480 km. The Area is composed of parts of the five municipalities of Solsona, Dingras, Marcos, Espiritu and Nueva Era and bordered on the north by the Cura river, on the west and south by the Bonga river, and on the east by the Cordillera Central Range.

As for the transportation to the Project Area from Manila, three means by land, ocean and air are available. For land transportation, the highway Route 3, completely paved, runs across Laoag City. An airport is located in Laoag City in Ilocos Norte Province. An all-weather-paved national highway runs along the left bank of the Bonga river, linking Laoag City with Manila via Dingras, but most parts of the Project Area are accessible from the national highway only in crossing the Bonga river by the so-called bamboo raft (ferry), excepting the right bank area of the Solsona river and the left bank area of the Para river both of which have bridges bearable with vehicle traffic. During the wet season, the ferry service across the Bonga river is apt to be stopped, causing difficulty in transportation of daily commodities and production materials together with the communication between villages. The existing road networks in the Project Area are in poor condition and are not passable by vehicle traffic during the wet season.

Topographically, the Project Area is an alluvial fan developed by the Bonga river and its tributaries and generally flat with slope of 1:80 to 1:150. The elevation above the mean sea level ranges from 30 m to 140 m.

2. Rivers

Major rivers in the Project Area are those of Labugaon, Solsona, Madongan, Papa and Nueva Era. Average annual run-off varies considerably from year to year, and sometimes the flow is not sufficient to supply water for the whole Project Area even in the wet seasons. For the dry season, only some 15 percent of paddy fields are irrigated on an average.

Average annual run-off of the above five rivers during 1960 - 1970 is 1,042 MCM and considered to be sufficient for irrigation water as an annual total, though most of the amount flows in the wet season.

3. Climate

The climate in the Philippines can be classified into four types according to the rainfall pattern. Ilocos Norte and Ilocos Sur are classified under Type I. Accordingly, a year can be clearly divided into two seasons, the wet season from May to October and the dry season from November to April.

The annual average temperature is 26.8°C in Laoag, 27°C in Vigan and 26.9°C in the Project Area. The average relative humidity is 77 percent in Laoag and 81 percent in Vigan during 1949 - 1974. The annual average rainfall is 2,049 mm in Laoag, 2,474 mm in Bonga and 3,262 mm in Abra, which indicates that more rainfall is in mountain area and less in plain area. According to the observation in Laoag and Bonga, about 95 percent of annual rainfall is observed in the wet season.

4. Soil in the Project Area

The Area is predominantly composed of alluvial deposits coming from adjacent hills and mountains. Generally, the soils of this Project Area are classified into three main groups based on physiographical position, namely, i) soils of the alluvial fan and alluvial flat which constitute the alluvial plain, ii) soils of the uplands which comprise the rolling and hilly areas and iii) soils of the river washed area. The soils of alluvial fan are formed mainly from alluvial sediments. The upland fields are of residual soils developed through weathering and leaching. These soils are considered most productive for both paddy rice and diversified crops. The soils of the third groups are not suitable for cultivation.

5. Population and Farm Families

The population in the Project Area is about 34,000, of which about 29,200 is agricultural population with about 5,430 farm families in 1975. One farm family is composed of 5.3 persons on an average. The population growth rate is 1.6 percent (1960 - 1970), being far less than the three percent of the national average due to the population outflow.

6. Irrigation and Drainage Conditions

Gravity irrigation method is predominant in the present communal systems, and water supply is practised for all paddy fields in the wet season but partly in the dry season. Under this method, a simple weir made of cobble stones across the river is used to divert irrigation water. Earth canals are aligned in the Area and free flooding irrigation is applied. The canals also function as drainage canals. As for the intake weir, no regulating facility is equipped to prevent an extensive inundation over paddy fields during the flood time.

There are no drainage canals used exclusively for the purpose, but irrigation canals in the communal irrigation systems and existing creeks are used for drainage purpose. Topographically, there exist no problems for ordinary drainage. However, some areas in the alluvial fan are damaged by floods in the wet season.

7. Present Land Use

About 10,860 ha, which is equivalent to 68 percent of the total area of 15,890 ha, is utilized for agricultural production and the remaining of about 5,030 ha consists of village areas, roads, canals, river lands, etc. Almost all farm land is planted with paddy in the wet season and only 190 ha is used as upland field. About 3,400 ha is cultivated with paddy by use of the river flows along the area in the dry season, but the yields are unstable due to the poor river flow.

About 76 percent (8,097 ha) of the total paddy field (10,670 ha) is irrigated by the communal irrigation systems and remaining 2,573 ha are rainfed.

8. Present Cropping Pattern and Production

Single paddy cropping in the wet season is predominant in the Project Area where land use efficiency is rather low.

For the wet season paddy, transplanting is carried out during the period from June to July and harvesting from September to October. For the dry season paddy, which is cultivated in some parts of the Project Area depending on the available water, transplanting is made from October to November soonest possible after harvesting the wet season paddy, because the period is limited due to the seasonal restriction of available water. Harvesting of the dry season paddy, thus, is carried out from January to March.

Paddy varieties are traditional ones and have a long growth period and photo-periodic sensitive nature. For the dry season upland crops, they are planted or seeded after harvesting of paddy from November to December, and harvested from March to April. The average yield per hectare is 1.5 ton of paddy, 1.0 ton of tobacco and 0.5 ton of corn.

9. Farming Status

The average farm size in the Project Area is estimated at 1.4 ha per household, and 20 percent of the total area is possessed by households of which farm size is less than 1.0 ha per household and they are about 43 percent of total households. According to the agro-economic survey in the Project Area, the distribution of farm household of share tenants, full owners, partial owners and partial share tenants are 64, 9, 26 and 1 percent respectively.

10. Agricultural Extension

The networks of agricultural extension services in the Project Area and its vicinity have already been set up under the responsibility of the Government agencies concerned such as the BPI, BAEx and DLGCD. The supplies of input materials such as seeds, fertilizers agricultural chemicals, farm machines and credit have been carried out based upon the programs of Masagana 99 through Farmers' Association and Samahang Nayon under the cooperation of BPI, BAEx and DLGCD.

11. Purposes and Components of the Project

The purposes of the project are to increase agricultural production, create employment opportunity, improve socio-economic conditions, etc. In order to achieve these purposes and to obtain benefit quickly, the following project components are proposed.

Civil Engineering Works

1) Irrigation and Drainage: Construction of diversion dams and irrigation and drainage canals.
2) On-farm Development: Construction of terminal irrigation canals and farm roads in fields.
3) Road: Construction of O & M roads along main and lateral canals.

Agricultural Development Plan

1) Agricultural Development Plan: Double cropping of high yield variety, and cultivation of cash crops in the dry season.
2) Agricultural Extension Services: Execution of extension services and training, and reinforcement of supply of production materials, financial aids, marketing and processings.
3) Farmers' Organizations: Establishment of farmers' organizations such as Farm Irrigators' Association, Agricultural Cooperatives, etc.

12. Proposed Scheme of Development

The following four alternative studies have been made so as to find the optimum scale of the project; i) Diversion Dam Plan (CASE I), ii) Single Reservoir Plan (CASE II) and iii) Multi-Reservoir Plan (CASES III-1 & III-2).

The above four cases were studied from technical and economical view points in the manner of the phasing and non-phasing development, and through the study the CASE II was recommended to be the most optimum plan for the project. The following table shows the result of study.

13. Irrigation Plan

Based upon the proposed cropping pattern, the irrigation water requirement for the Project Area was estimated by taking into account the climatological data. The maximum unit irrigation water requirements is 2.33 lit/sec/ha, and the required water to serve the area will be diverted from the five diversion dams.

The proposed diversion dam sites in each river were selected at a little upper-stream of the starting points of the alluvial fan and these diversion dams have been planned to be of fixed type so that they can be constructed directly on the bed rock foundation, except Madongan diversion dam which is to be constructed on the river deposit by the floating type.

Rotation irrigation has been recommended to distribute the water in the Project Area. One rotation area is decided at about 30 ha on an average, although the area will vary depending upon the topographic conditions. Water management in one rotation area served by one turn-out is planned to be carried out within 25 days.

Results of Alternative Studies

Item	Non-Phasing Development				Phasing Development			
	Case I	Case II	Case III-1	Case III-2	Case II		Case III-1	
	Overall	Overall	Overall	Overall	Overall	Phase I	Overall	Phase I
1. Proposed Area (ha)	21,400	21.400	21,400	21,400	21,400	10,200	21,400	10,200
2. Irrigable Area (ha)								
1st Crop (Wet season)	13,150	21,400	21,400	18,600	21,400	8,080	21,400	8,980
2nd Crop (Dry season)	4,630	21,400	21,400	11,270	21,400	2,960	21,400	7,740
3. Power Capacity (MW)	–	42	51	11	42	–	51	–
4. Project Cost (Million Pesos)								
Irrigation	475	1,151	1,233	1,080	1,151	215	1,233	452
Power	–	280	330	60	280	–	330	60
Total	475	1,431	1,561	1,140	1,431	215	1,563	512
(1,000 US$)	64,190	193,380	211,220	154,050	193,380	29,050	211,220	69,190
5. Irrigation Project Cost								
Cost per hectare (US$/ha)	3,000	7,270	7,790	6,820	7,270	2,850	7,790	5,990
Allocated Joint Cost (US$/ha)	–	6,580	6,780	6,470	6,580	–	6,780	5,260
6. Annual Full Benefits (Million Pesos)								
Irrigation	47	173	176	135	172	32	172	66
Power	–	37	45	11	37	–	45	11
Total	47	210	221	146	209	32	217	77
7. IRR (%)	8.7	13.1	12.7	10.5	12.2	12.3	12.1	12.3
8. Construction Period (Year)	7	7	7	7	8	4.5	8	5.5

14. Proposed Cropping Pattern and Production

The Proposed cropping pattern in the Project is as follows:

Proposed Cropping Pattern

	Pattern			Area	Cropping Area
	Wet Season		Dry Season	(ha)	(ha)
1.	Paddy	+	Paddy	9,200	18,400
2.	Paddy	+	Upland Crop		
	a. Paddy	+	Tobacco	300	600
	b. Paddy	+	Garlic	350	700
	c. Paddy	+	Onion and Others	350	700
	Sub-total			1,000	2,000
	Total			10,200	20,400 (200%)

Note: Irrigable area based on overall development

An average yield of paddy per hectare at present is 1.5 tons but the target yield of paddy after the completion of the Project will be 3.9 tons in the wet season and 4.2 tons in the dry season respectively. Consequently, the present total production is about 21,530 tons, which will be increased to 77,780 tons after the completion, resulting from the increment of about 56,250 tons. The production after completion of the Project, therefore, will be more than three times of the present production as shown below:

Crop Production

Crop	At Present (ton)	With Project (ton)	Incremental Value (ton)
Paddy	21,527	77,780	56,253
Tobacco	23	390	367
Garlic	–	945	945
Others	286	4,900	4,614

15. Farmers' Organization

The farmers' organization functions for water management, operation and maintenance of on-farm facilities, farm management and supporting services such as necessary input material supply, credit, marketing and processing under the assistance of Samahang Nayon and Kilusang Bayon. At the same time, agricultural extension services are to be strengthened by newly established Farmer Irrigators' Association (FIA), inclusive of existing communal irrigation systems through aforesaid cooperatives such as Samahang Nayon and Kilusang Bayon.

16. Diversion Dam

To divert the irrigation water, following five diversion dams, Labugaon, Solsona, Madongan, Papa and Nueva Era, are to be provided on each river. Major features of the diversion dams are summarized as below:

Diversion Dams	Proposed Diversion Dams		
	Service Area (ha)	Dam Type	Dam Height (m)
Labugaon	1,560	Fixed type	2.30
Solsona	2,140	Fixed type	2.30
Madongan	3,190	Floating type	2.50
Papa	2,560	Fixed type	2.30
Nueva Era	750	Fixed type	13.65
Total	10,200		

17. Irrigation and Drainage Canals

Earth irrigation canals with trapezoidal cross-section are planned to be provided in order to convey the irrigation water. The layout of the canal networks were plotted on the topographic map of 1:10,000 in scale so as to expect a maximum beneficial area at the reasonable cost. The proposed total length of the main and lateral irrigation canals for the Project Area is estimated at about 208 km, which is equivalent to the canal intensity of about 20 m/ha.

In the same way as the irrigation canal, the plan of drainage canal alignment, of which cross-section is also trapezoidal without lining, was made based on the map of 1:10,000 in scale. The existing waterway like rivers, creeks, etc. will be utilized as main or lateral drainage canals. Most of these natural channels have to be dredged and widened to meet the designed discharges. The proposed total length of the main and lateral drainage canals for the Project Area is estimated at about 147 km.

18. Road

The proposed roads in the Project Area are classified into two kinds; i) service roads to be provided along the main and lateral irrigation canals in order to carry out operation and maintenance works of the irrigation and drainage facilities, and the widths of the roads along main and lateral canals are six meters and four meters, respectively, and ii) On-farm roads, which are the terminal roads in the cultivated area for farming, and the width of the on-farm roads is two meters.

19. On-farm Facility

The land parcelling for farm land development should be planned taking into account topographical condition of the Project Area, farm management plan, and irrigation and drainage water management.

In order to get the suitable plan for the proposed terminal facilities, the model design of roads, irrigation and drainage canals as well as land parcelling were actually carried out at the two sample areas, and their results were applied to the design of on-farm development works in the whole Project Area.

The proposed on-farm facilities are main and supplementary farm ditches, farm drains, farm roads, etc.

20. Project Cost

The Project Cost, excluding the cost for price escalation during construction period and related interest, is estimated at US$31.1 million on the January 1978 price basis with breakdown as follows:

Foreign Cost	US$14.86 million	(48%)
Local Cost	US$16.24 million	(52%)
Total	US$31.10 million	(100%)

21. Project Implementation

Major project works are the rehabilitation of the existing communal irrigation systems and the construction of irrigation and drainage facilities including diversion dams for the new irrigation systems.

The construction period is scheduled to last five years from January 1980 to December 1984, including one year of the final design.

NIA will function as the executing agency of the Project and this agency will be responsible for the design, supervision and construction of the Project. NEDA will coordinate all the relevant government agencies in their activities, because the Project is a part of the Ilocos Norte Integrated Development Project. (INIDP)

The INIDP office will be organized as a government's force for construction and on-site coordination of the Project. This office will be headed by a Project Director appointed by the Cabinet Coordinator of the INIDP, and will be the direct executing agency.

The entire project works, upon completion of the Project, will be turned over to the NIA Region Office No.1, and the responsibility of operation and maintenance of all irrigation and drainage facilities will fall under the Ilocos Norte Irrigation System Office (INISO), which will be newly organized.

22. Method of Economic Evaluation

The project economic justification, in general, is evaluated by using direct benefit and cost which are measured in monetary terms. From the economic view point, these procedures are expressed in the incremental benefit and cost which will be created by the difference between those of with-Project and without-Project. The agricultural benefit was expressed in annual incremental net production value (NPV).

23. Evaluation of Agricultural Benefit

The formulation of annual benefit area was determined to match the annual construction schedule of diversion dams. Annual cropping area of paddy during the wet and dry seasons in the Project would become 2,140 ha in 1983, 4,310 ha in 1984 and 11,040 ha in 1985. Gross productions in the full development stage are estimated at about 46,000 tons of paddy, while gross productions without-project will be forecasted of about 24,500 tons of paddy. The economic farm gate price of paddy is US$ 150/ton (₱ 1,230/ton) in 1978 and US$ 188/ton (₱ 1,540/ton) in 1985.

Based upon these increased productions, the incremental NPV in 1989, full development stage, is estimated at about US$4.35 million (₱32.2 million).

24. Economic Cost

The economic cost to be used for the study on project economic justification consists of construction cost of relevant facilities, and O & M cost for irrigation. The economic cost is revised from the financial cost under the economic consideration of the items of interest, tax, depreciation cost, unskilled labor cost, oil cost and land acquisition cost. The Project ecnomic life and escalation factor are decided by 50 years and 8 percent respectively. According to these procedures mentioned above, the economic cost is estimated at US$24.3 million (₱180 million) from the financial project cost of US$31.5 million (₱230 million) exclusive of escalation factor.

25. Internal Rate of Return

The Internal Rate of Return (IRR) is computed at 13.2 percent, in which benefit and cost stream during 50 years of project economic life are discounted to the present worth with the rate of 5, 10, 15 and 20 percent, respectively. As a result, irrigation project would be considered to be justifiable in the economic view point.

26. Sensitivity Analysis

Sensitivity analysis of following cases is made, namely, i) falling of paddy prices, ii) increase of construction cost, iii) slower built-up of the target yield, iv) delay in start of construction, v) costing farm labor, vi) costing construction equipment, etc.

27. Farm Budget Analysis

Financial analysis is made on the farmers' capability for burden of irrigation fees. The remaining values of net production value, deducted irrigation fee and annual payment for land, would be enough to pay a living allowances in future.

28. Cost Recovery

The extent of cost recovery would be studied by measuring the cost recovery index. This index is measured at the ratio of incremental water charges paid by all project beneficiaries to incremental project construction and operation and maintenance costs.

The proposed water charges (7.7 cavans) would result in a cost recovery index of 17 percent.

The tax to be levied upon beneficiaries in future would contribute to cost recovery.

29. Socio-Economic Impact

In a view point of national or provincial economy, the following indirect benefits would be expected from the Project in future: 1) contribution to self-sufficiency of staple food, 2) increase of employment, 3) correction of income inequality, 4) effect of supporting services, 5) income increase during construction, etc.

B. CONCLUSION

1. The development problems of Ilocos Norte revolve around low production in rice and upland crop, which was aggravated by inadequate irrigation facilities, poor roads and inadequate power.

To cope with these present status, the Government has proposed the strategy for Ilocos Norte Integrated Development Project, especially putting emphasis on rural development so as to remove the income gap between the rural and urban levels.

2. Through the careful study on the overall and the Phase I Projects, in which various alternative studies were made to decide the most optimum scale of the Project from technical and economical view points. Out of the alternative studies, the Case II (Single Reservoir Plan) is revealed to be technically recommendable as the project plan. With Project, the area of about 10,200 ha will enjoy the irrigation benefit which will contribute not only to the acceleration of regional development as well as enhancement of the standard of people's living in the area, but also to give a greater effect to the future socio-economic development of Ilocos Norte region and the country as a whole.

3. Proposed scope of the Project is as follows, as a conclusion of the feasibility study.

Diversion Dam

	Height (m)	Length of Weir (m)	Type
1. Labugaon	2.3	85	Fixed type
2. Solsona	2.3	67	Fixed type
3. Madongan	2.5	181	Floating type
4. Papa	2.3	172	Fixed type
5. Nueva Era	13.6	206	Fixed type

Irrigation Canal

The Project Area	10,200 ha
Length of Canals	
Main Canal	116.5 km
Lateral	92.0 km
Total	208.5 km
Intensity	20.4 m/ha

Drainage Canal

Length of Canal	
Main Canal	55.0 km
Lateral	92.1 km
Total	147.1 km
Intensity	14.4 m/ha

On-farm Facility

	Sample Area	
Intensity (m/ha)	No.1 Area	No.2 Area
Farm Ditch	95	106
Farm Drain	55	54
Farm Road	15	15

Project Cost (Financial)

Foreign Currency:	US$19.79 million (47%)
Local Currency:	US$22.27 million (53%)
Total:	US$ 42.06 million (100%)

Project Economics

Internal Rate of Return:	13.2%

C. RECOMMENDATION

1. For carrying out the final design of the Project, following additional topographical survey and geological investigation will be essentially required in order to obtain sufficient information before proceeding with the design works.

A detailed program of recommended surveys and investigations are shown in Appendix 4E-3 and the main items are summarized as follows:

i) Survey and Investigation for Civil Work

Diversion Dams (Labugaon, Solsona, Madongan, Papa and Nueva Era)

(a) Survey

- o Detailed topographic survey on scale of 1:500 around the proposed site, 300 m upstream and 200 m downstream from the site is requested to be carried out and on the surveyed map the following contour line should be indicated: 0.2 m interval in the river and 1.0 m interval in the others.
- o Cross-sectional survey of the river, of which scale is 1:200 at the proposed site, is requested to be carried out to the extent of 800 m upstream and 600 m downstream with an interval of 200 m each.

o Longitudinal section survey of stream centerline is requested to be carried out to the extent of about 1,000 m upstream and downstream from the proposed site, respectively, and its scale is as follows: vertical 1:100, horizontal 1:1,000.

(b) Geological Investigation

o Madongan Diversion Dam

5 bore-hole drillings

Dam axis	15 m x 3 holes = 45.0 m
Right side river bed of downstream	15 m x 2 holes = 30.0 m

o Papa Diversion Dam

2 bore-hole drillings

Left side river bed of downstream	10 m x 2 holes = 20.0 m

Core boring at three points with a total depth of 47.40 m has been conducted by NIA at the proposed dam axis. It is found that some portions of the rock covering the left side of the river bed and bank has been found soft to a certain degree. So, core boring should be conducted to study the cut-off depth and the necessity of river protection works of the dam body at the proposed end of the apron.

o Nueva Era Diversion Dam

5 bore-hole drillings

Dam axis	15 m x 5 holes = 75.0 m
Seismic prospecting	4 lines 0.73 km

Irrigation and Drainage Canals

The profile and cross section surveys for the proposed main and lateral irrigation and drainage canals shall be performed for the detail design of the canals and related structures.

The following table shows the proposed length of survey.

Item	Profile (km)	Related Structures (places)
Irrigation Canal	116.5	20
Drainage Canal	55.0	–

ii) Soil and Cadastral Survey

o Soil Survey

The more detailed survey by digging test pits is requested to be carried out to study in the Project Area.

o Cadastral Survey
Cadastral survey covering the whole Project Area shall be implemented in the early stage of the construction, and the present status of land tenure shall be cleared for smooth execution of organization of compact farming systems.

2. Steering Committee for the Ilocos Norte Integrated Development Project (INIDP) should be established for the smooth implementation and operation of the Project covering the related activities under the relevant agencies concerned, such as road projects under DPH and flood control projects under BPW., etc.

3. The existing river-washed areas, especially in the service area of the Madongan river, which have been formed by the big flood pose a serious problem to the area, that is, devastation of cultivation lands and villages by them is proceeding year by year in the area. To prevent the project facilities and lands from their expansion, an adequate countermeasures are recommended to be taken in the early stage by Government agencies concerned.

4. The Project aims to increase agricultural production in the area of 10,200 ha by means of gravity irrigation systems using isolated water resources diverted through diversion dams to be newly constructed in each river basin. However, this Project is a part of overall project serving the area of 21,400 ha, which is recognized as Ilocos Norte Irrigation Project, so that the target agricultural production in the area will be achieved after full accomplishment of water resources development including Palsiguan dam to be constructed in the Phase II development. Under such planning of stage development, an early commencement of Phase II development for the area is emphatically recommended to attain the object of the project.

CHAPTER I. INTRODUCTION

CHAPTER I. INTRODUCTION

In May 1977, the Government of the Philippines requested the Government of Japan for the technical assistance in the study of the Palsiguan River Multi-Purpose Project as a part of the Ilocos Norte Integrated Rural Development Project. Toward this end, the Japanese Government dispatched the preliminary survey team to the Philippines, and as a result of the field surveys, a series of discussions has been made on the plan of approach between the two Governments. Finally, the Ilocos Norte Irrigation Project has been selected for further study because of its promising plan among those included in the overall development plan. As a matter of course, this Project involves a large-scale development in which various fundamental surveys together with water resources development plan require considerable period before the final plan of development is formulated. However, taking into account the strong desire of the Philippine Government and the local people in the region to carry out the project possibly early, project development plans were staged into two phases as follows:

i) An overall project plan for the area of 21,400 ha shall be formulated based on the available data. At the same time, within the framework of the overall plan, feasibility of a provisional water supply plan for about 10,200 ha on the right bank of the Bonga river shall be studied as the Phase I project.

ii) The Phase II project involves a feasibility study for the Batac-Badoc areas covering a total benefit area of about 11,200 ha, in which the Palsiguan dam and hydro-power generation will be included.

In compliance with the above strategy, the Team carried out the feasibility study for the area of about 10,200 ha located on the right bank of the Bonga river as well as the formulation of the overall development plan for the whole area of about 21,400 ha. This report covers the results of feasibility study for the area of about 10,200 ha, which was carried out by the Team together with the Philippine Government staff from August 9 to November 9, 1978 and also incorporates all the matters discussed between the Philippine Government and the Team.

Listed herein are the Advisory Group, Team members and Counterpart personnel of NIA assigned to the Project.

Advisory Group Assigned to the Project

1.	Chief Advisor (Mr. Tatsuo ASAHARA)	Director of Design Div., Construction Dept., Agricultural Structural Improvement Bureau, Ministry of Agriculture, Forestry and Fishery (M.A.F.F.)
2.	Advisor (Irrigation) (Mr. Yasuo SUDA)	Deputy Director of Design Div., Construction Department, Agricultural Structural Improvement Bureau, M.A.F.F.
3.	Advisor (Dam) (Mr. Tadashi YOSHIMITSU)	Project Manager, Agricultural Water Utilization Office in Lower Tenryu River Basin, M.A.F.F.
4.	Advisor (Agronomy) (Mr. Toshihide SHIBATA)	Deputy Director of Planning Div., Planning Dept., Agricultural Structural Improvement Bureau, M.A.F.F.
5.	Advisor (Economy) (Mr. Hiromiki ITOH)	Deputy Manager, 2nd Div., Loan Dept. II, The Overseas Economic Cooperation Fund (OECF)

Mission Members Assigned to the Project

1.	Team Leader (Mr. Susumu TAKAMINE)	9 August – 9 November 1978
2.	Meteorology and Hydrology (Mr. Fumimichi OHBU)	9 August – 9 November 1978
3.	Soil (Mr. Hajime TAKAHASHI)	11 August – 15 October 1978
4.	Geology (Mr. Yukio YAMAGISHI)	9 August – 26 October 1978
5.	Irrigation & Drainage (Mr. Seiji TAKEUCHI)	9 August – 9 November 1978
6.	On-farm (Mr. Ryuji YAMASHITA)	17 August – 29 October 1978
7.	Dam & Canal (Mr. Kohichi INOUE)	9 August – 9 November 1978
8.	Diversion Dam (Mr. Tsutomu IWAMURA)	9 August – 26 October 1978
9.	Agronomy (Mr. Yasunori HASEGAWA)	9 August – 9 November 1978
10.	Agricultural Supporting Services (Mr. Tatsuo HAMAJIMA)	21 August – 12 October 1978

11.	Electric Hydropower (Mr. Yuhya HIRASE)	21 August – 9 November 1978
12.	Agro-Economy (Mr. Shoji YAMADA)	21 August – 9 November 1978
13.	Hydrological Observation (Mr. Kiyoshi OGAWA)	5 September – 9 November 1978

Counterpart Personnel Assigned to the Project

1.	Mr. Jose B. del Rosario, Jr.	Director, Project Development Dept., NIA) (Overall Coordinator)
2.	Mr. Clemente T. Alanano	Head, Dams & Reservoirs Section, PDD, NIA
3.	Mr. Erdolfo B. Domingo	Senior Planning Engineer, PDD, NIA (Project Coordinator)
4.	Mr. Epifanio C. Gacusan	Head, Economics Section, PDD, NIA
5.	Mr. Dominador D. Pascua	Head, Land Use Section, PDD, NIA
6.	Mr. Roberto M. Antonio	Head, Hydrogeology Section, PDD, NIA
7.	Mr. Jovito A. Navarro	Supervising Hydrographic Engineer
8.	Mr. Francisco A. Alhambra	Senior Planning Engineer
9.	Mr. Calixto P. Tomonera	Senior Hydrologist
10.	Mr. Rogelio N. Barwelo	Planning Engineer
11.	Mr. Orlando F. Gascon	Senior Electrical Engineer
12.	Mr. Orlando C. Villalon	Geologist
13.	Mr. Bernado O. Valenzuela	Supervising Soil Technologist
14.	Mr. Leonardo T. Costa	Agronomist III

CHAPTER II. ECONOMIC AND SECTORAL BACKGROUND

CHAPTER II. ECONOMIC AND SECOTRAL BACKGROUND

A. National Level

The Philippines has a total land area of about 300,000 sq.km and a population of about 42,500,000 in 1975. The population density is 142 persons per sq.km and population growth rate is about 2.7 percent on the national average.

The national long-term development plan forecasts that the population will be 59,200,000 by 1987 and 84,300,000 by 2000. This growing population thus forecasted will be one of the most important national problems to be encountered.

In 1977 the Government of the Philippines has prepared a draft of a national long-term development plan orienting Year 2000 and a five-year development plan of 1978-1982. In the draft, the vital issues of the country are pointed out, i.e., sufficient supply of basic materials, correction of income inequality, increase of employment, counter-policy to rapid population growth, redress of international trade balance, stabilization of prices, and energy conservation. To settle these national issues and to realize them as targets in the national long-term development plan, stabilized politics, self-sufficiency of basic materials, high level industrialization, rural and regional developments and reasonable arrangement and development of resources should be stressed in the plan.

Among the above, increase of employment and supply of food and other basic materials to meet the growing labor population and rapid urbanization are mainly focused so that correction of income inequality among social classes and regions can be fairly achieved.

Infrastructural plan is stressed on the development of transportation, water resources, energy and communication. For the water resource development plan, 30.2 billion pesos in 1972 was estimated to be invested during the 23-year period. Among the investment, 55 percent (16.6 billion pesos) is for water supply programs, 9.22 billion pesos for irrigaton, 4.37 billion pesos for flood control and drainage, 2.0 million pesos for data/systems development; thus, one-third of the total is to be invested for the initial ten years.

The net GNP of the Philippines (fixed value in 1967) had grown by six percent annually during 1966-1970 and ten percent in 1973, but during 1974-1975, it was six percent due to recession.

As for GNP (fixed value in 1972), an overall annual growth rate during 1974-1975 was 6.78 percent, and 6.27 percent in 1975-1976. During the period, the growth rate of construction section is the highest and that of industrial section comes next. Agricultural section occupies 26 percent of GNP.

Annual consumers' price escalation rate in Manila was 11 percent in 1973 and 34 percent in 1974; however, it was comparatively stable for these years. Consumers' price index increased to 7.8 percent during February 1977 to February 1978. The Central Bank of the Philippines estimated in August 1978 that annual inflation would be 7.8 percent for other items.

B. Provincial Level

The Philippines consists of 13 administrative regions; and Ilocos Norte, Ilocos Sur and Abra Provinces, together with four other provinces, belong to the Region I. The population of this region is 3,254,000 in 1975, equivalent to 7.6 percent of the national population. The per capita gross domestic product of the region is 955 pesos and less than both of the national average of 1,601 pesos and Luzon average of 1,911 pesos. This production is 8th place among the 13 regions of the Nation. According to the long-term plan orienting 2000, the order will remain unchanged but the gap between national average or Luzon average will be narrowed (See Appendix 2B-1).

The Region I consists of mountainous area of Mountain, Abra and Benguet, coastal area of Ilocos Norte, Ilocos Sur and La Union and flat area of Pangasinan. Especially in Pangasinan, the population is 1,500,000 and 50 percent of the total population of the Region I is concentrated. An international harbour, San Fernando, is located in La Union. Benguet where Baguio City is located, and La Union are the provinces with the shortage in rice production and the shortage is forecasted to last in future. In the coastal area of Ilocos Norte, Ilocos Sur, and La Union, land-holding per farm family is the smallest in Luzon, so that Ilocos Norte and Ilocos Sur are known as the provinces of much population outflow from the old days. Nowadays, however, trading products such as tobacco, garlic, onion, etc. are becoming popular in these provinces. It seems that they are economically well-located to supply their products to the big market of Manila and the trading harbour of San Fernando.

The mountainous area of Abra and Mountain, on the other hand, has small population of 149,000 and 94,000, respectively, but has rich water resources.

The irrigation development of the Region I is left rather behind the other regions. According to the 10-year irrigation development program of 1975-1984 prepared by NIA, only three projects covering about 6,000 ha in Ilocos Norte are scheduled in the region, and the Package I of NISIS has been implemented in the said province since 1977 by the financial assistance of the World Bank.

Ilocos Norte has the area of about 3,400 sq.km, equivalent to 1.1 percent of the national total. Annual population growth rate during 1970-1975 is 1.6 percent and less than the national average of 2.7 percent due to the population outflow as mentioned previously.

Compared with the demand, supply of rice in the Province has some surplus though the amount varies year by year.

The industrial structure of the Province is represented mainly by agriculture; namely, 65.5 percent of labor population is engaged in agriculture and fishery, and only 5.5 percent in manufacturing and mining. A provincial industry development plan, however, is now under preparation by the provincial administration staff. This plan aims to promote provincial industry by use of agricultural products and mineral resources, and to create employment opportunities for the increasing population. The necessary water resources and electricity will be developed in and/or near the area to produce power and irrigation water. It is believed that the said plan is indispensable not only for the industrial development but also for settlement of social welfare.

The Project Area has an area of about 15,890 ha and the inhabitant of about 34,000. The annual population growth rate in the Project Area was higher than Phase II area during the period from May 1970 to May 1975. The transportation facilities are rather poor in the absence of bridges across the Bonga river. As for the topography of the area, alluvial fan is predominant and some farm lands had been desolated due to floods. Under the circumstances, the social and economic development in the area has remained at lower level. Provision of irrigation water and power under the Project is expected to boost development in the area.

CHAPTER III. THE PROJECT AREA

CHAPTER III. THE PROJECT AREA

A. Location and General Features

1. Geographical Location and Road Systems

The Project Area is located in the north-western region of the Luzon Island, about 480 km far from Manila and about 25 km south of Laoag City, the capital of the Ilocos Norte province, and covers approximately 10,200 ha, composed of respective parts of five municipalities of Solsona, Dingras, Marcos, Espiritu and Nueva Era and bordered on the north by the Cura river, on the west and the south by the Bonga river, and on the east by the Cordiella Central Range.

The road networks in the Project Area are provided sparsely. A national highway Route 2 runs along the left bank of the Bonga river. Only two roads branching from the highway are accessible to the right bank area of the Solsona and the Papa areas in crossing the Bong river by bridges, and the so-called bamboo raft - ferry service - is used for accessing to the other parts of the Project. The ferry service, however, is sometimes interrupted by floodings in the wet season. Therefore, in the wet season, it is unavoidable to take a detour through the outside of the Project Area for reaching the destination in the Area.

In the Area, village roads are partly available and paved with gravel, but crossing structures of canals are heavily deteriorated.

2. Population and Living Conditions

Population

Ilocos Norte Province has a land area of about 3,400 sq.km and population of about 371,700 as of May 1, 1975. The population density is 109 persons per square kilometer while those of the national average, Ilocos Sur, Abra and La Union are 151, 162, 38 and 277 persons, respectively. During the period from 1970 to 1975, the populaton grew annually at the rate of 1.6 percent which is smaller 2.7 percent of the whole country. This lower annual growth rate of population means an outflow of labor population.

The Project Area concerns with five municipalities and four barangays. The total population in the Project Area is about 34,000 persons in Phase I area and about 66,600 in Phase II area as of May 1, 1975. The annual growth rate of Phase I area was 1.6 percent and 2.2 percent of Phase II area during May 1970 to May 1975. These lower growth rates in the Phase I area compared with Phase II area are derived from the lower rate of 1.3 percent in Solsona and 1.5 percent in Dingras municipalities due to low income.

Living Condition

It is said that the Project Area usually becomes like an isolated land during the wet season. This means an unfavorable living condition, i.e. the inhabitants in the Project Area excluding the right side of the Solsona river and the left side of Papa are obliged to cross the swelled Bonga river by a bamboo raft. The electric facilities and even simple water supplying works are not implemented yet. The inhabitants in barangay has private wells and public wells which were constructed about 15 years ago.

They cross the Bonga river to go to the municipality office and/or stores to buy daily necessities. While, in order to sell paddy to NGA and buy fertilizer at dealers' shop, farmers go out to Laoag City by using the traffic facilities as private bus and jeep in the Project Area, bamboo raft and public bus on the provincial road. Enjoyment of farmers are to do a big shopping at the public market and to watch a movie. Houses in barangay are concentratedly located in one place. Such temporary houses where the outside farmers stay during a peak season are scattered here and there in and around barangays.

B. Physical Conditions

1. Topography

The Project Area is located on the right bank of the Bonga river, and consists mainly of alluvial fan developed by the Bonga river and its tributaries, and these areas belong to the jurisdiction of municipalities of Solsona, Dingras, Marcos, Espilitu and Nueva Era.

The Project Area of 10,200 ha is divided into four blocks by tributaries of the Bonga river; i.e. [1] 2,290 ha lying between the Labugaon and Solsona rivers, [2] 2,610 ha lying between the Solsona and Madongan rivers, [3] 3,210 ha lying between Madongan and Papa rivers, and [4] 2,090 ha lying between the Papa and Bonga rivers. The land slope of the area ranges from 1:80 to 1:150 and the elevation above mean sea level is from 30 m to 140 m. As for water resource, the rivers running through the area, the Labugaon, Solsona, Madongan, Papa and Bonga rivers are utilized.

2. Climate and Hydrology

a) Climate of the Project Area

The climate of the Project Area falls under the type I climate zone as shown in Figure 3B-1, Appendix 3B-1 which has two pronounced seasons, i.e., dry season from November to April and wet season in the rest of the year. Climate factors to form such specific features are the magnitude and distribution of rainfall and effects of wind, temperatu e) humidity and evaporation.

Rainfall

Rainfall records observed at Laoag station present that an average annual rainfall during the period 1949 to 1977 amounts to 2,030 mm, of which 96 percent concentrates in the wet season, May to October (see Table 3B-1, Appendix 3B-2).

Temperature and Relative Humidity

Mean annual temperature is 26.8°C at Laoag station and January is the coolest at 24.4°C and May is the warmest at 29.0°C; hence, the annual range of temperature is small (see Table 3B-2, Appendix 3B-2). Similarly, seasonal variation of relative humidity is slight and annual mean value is 77 percent (see Table 3B-3, Appendix 3B-2).

Wind

The wind direction over the area tends to be north or northeasterly during the period of October to February. With the incoming of the wet season, the winds blow from northwest. In the wet season, specially in June to September, the area is influenced by south-east monsoon. Maximum wind speed extending over June to September ranges from 18 to 56 kilometers per hour (30 to 90 miles per hour). In general, April and May are the calmest period of the year and large-scale wind variations are not frequently observed.

Observed data on wind direction and maximum wind speed are shown in Table 3B-4 and 3B-5, Appendix 3B-2.

Evaporation

Long-term observation has not been made within the Project Area, thus, total evaporation is estimated on the basis of data computed by Penman Method using climatic factors at Vigan station and monthly mean ratio of observed open-pan evaporation at Vigan and Laoag (see Table 3B-6 to 3B-7, in Appendix 3B-2).

Table 3B-8 shows that mean annual evaporation is 2,291.8 mm and seasonal variations of mean monthly evaporation range 167.5 mm in July to 213.9 mm in October.

Typhoons

As shown in Figure 3B-1 (see Appendix 3B-2), the Project Area is located in the northern part of Luzon island where typhoons visit frequently in June to October. According to the data, about 50 major storms passed through the region from 1968 to 1975.

b) Available Data

Hydro-meteorological observations relevant to the Phase I area have been made under the control of NIA, BPW and PAGASA. (See Table 3B-9, Figure 3B-2, in Appendix 3B-3). Concerning rainfall, a long-term observations are made at Laoag, Bonga, and Alabaan stations; however, continuous observed records are obtained only at Laoag station. Therefore, selection of design year, computation of effective rainfall, irrigation water requirements and drainage modulus are based on daily rainfall records at this station.

As for evaporation, adjusted total evaporation data as mentioned in the above paragraph are applied to estimation of consumptive use of proposed crops.

As listed in Table 3B-9, streamflow gauging stations were newly installed at the proposed diversion dam sites under the control of NIA and their observation has been continued since 1978. At those stations, discharge measurements have been done only at the time of low river stage due to lack of cable ways; hence, river-stage discharge relations are not given yet.

Available records for estimation of river run-off and flood analysis are, therefore, those from Solsona station, Bangay and Poblacion established by BPW in the Laoag river basin.

c) Run-off at Proposed Sites

Water resources development of Phase I area depends upon five rivers located at the right bank of the Bonga river, namely, Labugaon, Solsona, Madongan, Papa and Nueva Era. As aforementioned in paragraph b), observation of streamflow for a long period has not been made in four rivers except the Solsona river; therefore, run-off volume at each river is estimated on the basis of the observed data at Solsona station under the control of BPW as listed in Table 3B-10, Appendix 3B-3.

In Table 3B-10, run-off volume is converted into run-off depth and run-off coefficient using rainfall observed at Langangilang station in the Abra river basin, adjacent to the Phase I Area. As shown in the following, annual run-off in some periods has a tendency to present excessive or too low values considering the scale of the catchment area and characteristics of river basin covered with mountains.

Average Run-off Depth and Coefficient in Specific Period

Period	Annual Run-off Depth (mm) (A)	Annual Rainfall at Langangilang (mm) (B)	Annual Run-off Coefficient (%) (A)/(B)
1946 – 1959	3,301	3,342 1/	99
1960 – 1970	2,576	3,345 2/	75
1971 – 1976	1,125	3,342 1/	34

Note: 1/ average annual rainfall during 1955 – 1972
2/ average annual rainfall during 1960 – 1970

Therefore, as a period selected for studies of water resources development, 1960 to 1970 is considered to be a suitable one. As for run-off volume of the Labugaon, Solsona, Papa and Nueva Era rivers, direct drainage proportion was applied, considering each drainage area is within 100 sq.km and its hydrologic characteristic is similar to that of the Solsona river. On estimation of run-off volume of the Madongan river, specific discharge of the Solsona river was modified by using relations between catchment area and annual run-off volume obtained from observed data at Bangay and Poblacion stations located in the downstream of the Bonga river.

Estimated run-off volume at each proposed sites under above-mentioned conditions is tabulated in Table 3B-11 to 3B-14, in Appendix 3B-3 and its summary is shown as follows:

Run-off Volume at Each River

(Unit: MCM)

Year	Labugaon (C.A.=100.5 sq.km)	Solsona (79.0)	Madongan (153.8)	Papa (51.4)	Nueva Era (57.0)	Total
1960	188.4	148.1	201.8	96.4	106.9	741.6
1961	284.9	224.0	300.9	145.7	161.6	1,117.1
1962	293.0	230.3	394.5	149.8	166.2	1,233.8
1963	237.7	186.8	323.7	121.6	134.8	1,004.6
1964	399.7	314.2	446.5	204.4	226.7	1,591.5
1965	259.3	203.8	285.7	132.6	147.1	1,028.5
1966	246.5	193.8	271.7	126.1	139.9	978.0
1967	346.4	272.3	440.0	177.2	196.5	1,432.4
1968	241.3	189.7	251.1	123.4	136.9	942.5
1969	179.0	140.7	241.0	91.5	101.5	753.7
1970	170.8	134.3	156.8	86.4	96.9	645.1
Mean	258.8	203.5	301.2	132.3	146.8	1,042.6

Average annual run-off volume is 1,042.6 MCM in five rivers, which has abundant amount to meet irrigation water requirements for the proposed area. However, in the case that diversion dams are only provided, available run-off volume will be limited due to the following reasons:

- o Approximately 80 percent of the annual run-off volume concentrates in the wet season. When year-round irrigation is applied, supplied water during the dry season becomes less.
- o Diversion dam has no function of storage; thus, surplus water during the wet season cannot be used for irrigation in the dry season.
- o Intake amount by run-off-river type is influenced by run-off of the river.

d) Flood Analysis

The basic data subjected to probable flood analysis have been collected on the maximum flood peak during each year of record at three stations in the Laoag river basin, i.e., Manalpac of the Solsona, Bangay of the Bonga and Poblacion of the Laoag (see Table 3B-16, Appendix 3B-4). Plotting positions computed by Hazen Formula are listed in Table 3B-17, Appendix 3B-4 and those are plotted on logarithmic probability paper (see Figure 3B-3, in Appendix 3B-4). The following is a summary of probable flood at each river.

Probable Flood in the Laoag River Basin

	Solsona River (73 sq.km)[1]		Bonga River (534 sq.km)		Laoag River (1,355 sq.km)	
Frequency	Qp[2]	Qs[2]	Qp	Qs	Qp	Qs
5	295	4.0	1,700	3.2	8,600	6.3
10	450	6.2	2,500	4.7	10,500	7.7
50	940	12.9	5,000	9.4	15,000	11.1
100	1,220	16.7	6,400	12.0	17,000	12.5

Note: 1/ Catchment area

2/ Qp: flood peak (cu.m/sec)
Qs: specific discharge (cu.m/s/sq.km)

For computation of design flood discharge at each proposed diversion site, applied specific discharge was selected for that of the Solsona river, considering the scale of the catchment area and similarity of hydrologic characteristics of the river basin at proposed sites. Taking 50-year flood for diversion dam, design flood discharge is computed as follows:

Design Flood Discharge

Diversion Dam	Catchment Area (sq.km)	Design Flood Discharge (cu.m/sec)
Labugaon	100.5	1,310
Solsona	79.0	1,030
Madongan	153.8	2,000
Papa	51.4	670
Nueva Era	57.0	750

e) Rainfall Analysis

On the basis of daily rainfall data observed at the Laoag station, consecutive rainfall was analyzed to determine drainage modulus of the Project Area. As shown in Table 4B-18, in Appendix 3B-4, one to five-day consecutive rainfall during the period 1951 to 1977 is selected and probable rainfall for 5 and 10-year frequencies is given by using Hazen Formula as follows:

Probable Rainfall

(Unit: mm)

Frequency	1-day	2-day	3-day	4-day	5-day
5-year	335	440	490	540	580
10-year	420	520	580	650	700

3. Geology and Soil

a) Geology

In terms of geology, the Project Area is composed of the mother rock of marine effusive rock of prophilitic basalt or andesite, which are penetrated by neogene diorite, marine clastics of olygocene, miocene and pliocene, and of sediment of alluvial fan, river bed, littorals, etc. that have been developed since the Quarternary.

The andesites, as basement, are the main component of Cordillera Central Mountain of Northern Luzon, extending widely to the east part of the Project Area. The main structure sites such as Palsiguan dam, power tunnel, after-bay and diversion dams, are composed of the rock zone of this stuff.

The diorite is also one of the major component rocks of the Cordillera Central Mountain and widely outcrops at Labugaon, Solsona and Papa diversion dam sites and the upstream of Palsiguan damsite where some lithofacies of granodiorite can be found.

The Bonga area is located in the composite alluvial fan developed by the main stream of the Bonga river and its tributaries, the Labugaon, Solsona and Papa originating from the Ilocos Mountain Range. The west of the fan is hilly area with the summit level of 370 m running SSW direction which divides the Project Area into two. The hills are composed of oceanic sedimentary rock of shale with fossil shelfish, sandstone and conglomerate formed during tertiary miocene to pliocene. The Paoay-Batac area and Pinili-Badoc-Sinait area are located in the alluvial plain developed by the Lawa river system.

Along the coast of the areas, some littoral sand dunes are included in the service areas.

The three structural lines are detected in the Project Area: the first one runs NNE-SSW along the main direction of North Luzon structural line, the second along the apex of the alluvial fans in Bonga area, and the last one along the hilly area in the center of the Project Area.

b) Soil

The soils of the Project Area are predominantly composed of alluvial deposits coming from adjacent hills and mountains. The parent materials of soils are fine to coarse sediments silting on gravelly alluvial strata. A limited extent of residual red soils were identified in this area.

Generally, soils of the Project Area were classified into three main groups based on landscape and physiographical position, namely: i) soils of the alluvial fan and alluvial flat which constitute the alluvial plain, ii) soils of the uplands which comprise the rolling and hilly areas and iii) soils of the river wash.

The soils of the alluvial fan and alluvial flat are formed mainly with alluvial sediments. Their color ranges from pale brown to dark gray while their texture varies from sandy loam to fine clay. The soil depth ranges from shallow to very deep and the internal drainage fluctuate from poor to good. The organic matter contents and natural fertility range from medium to high in crop root zone. Cation exchange capacity and base saturation are likewise medium to high. The pH (H_2O, 1:1) of the soils ranges from 5.3 to 6.4 for the top soils. These soils are considered most productive for both paddy rice and diversified crops.

According to the soil survey and investigation by NIA and JICA feasibility study team, the six soil series were identified, namely, Agustin, Gapan, San Manuel, Solsona, Tagulod and Umingan Series.

The second group of soils constitutes the upland soils. These are residual soils developed through weathering and leaching. The characteristics of this soil are specified by its very friable A and B horizons and reddish color. The soil texture is clay loam to clay and internal drainage is fair to good. The identified soil series of this group in the Project Area was named Cervantes series.

The gross Project Area (15,887 ha) was classified into two major land categories, namely about 10,860 ha of arable land and about 5,027 of non-arable land from the result of soil and land classification survey conducted by NIA and JICA Feasibility Study Team. (See Figure 3B-6, Appendix 3B-5)

Following table shows the summary of land classification:

Table 3-1 Land Classification in the Project Area

Land Classification	Area (ha)
1. Arable Land 1/	
(a) Diversified Crop Land	
3	190
(b) Rice Land	
1R	740
2R	160
3R	80
Sub-total	980
(c) Dual Class Land	
1R (2)	5,250
2R (2)	870
3R (2)	3,570
Sub-total	9,690
Total	10,860
(Irrigation Area "with Project") 1/	(10,200)
2. Non-arable Land 2/	5,027
Grand Total	15,887

Note: 1/ Excluding rights-of-way, which is estimated at 15 percent of arable land "without Project" and at 7.5 percent of arable land "with Project")

2/ Including river washed area, brush land, high land, stream rights-of-way, residential area etc.

As learned from the above figures, 10,860 ha of arable land were categorized into three groups of arable lands from their crop suitability by the soil, topography, drainage and other physical factors: 9,690 ha of land, which are suitable for both paddy rice and diversified crops (89 percent of total land), 980 ha of rice land (9 percent) and 190 ha of diversified crop land (2 percent). The whole arable lands belong to those specified by the first class and the second and the third namely 55 percent of the first class land, 9 percent of the second class land and 35 percent of the third class land.

Under the present soil conditions, the soils in the Project Area are considered to be blessed with the potentiality of high yield of both paddy rice and diversified crops for most of the area. The betterment of cultivation practices with adequate application of fertilizers and organic matters for soil amendment and construction of irrigation and drainage facilities up to on-farm level will develop the potentialities in the whole arable land.

The detailed resultants of the study based on the said survey are shown in Appendix 3B-5.

C. Irrigation and Drainage Conditions and On-farm Conditions

1. Irrigation Conditions

a) Irrigation Area in the Project

In the Project Area of about 10,200 ha located on the right bank of the Bonga river, there exist, at present, about 8,100 ha of irrigated areas served by 138 communal irrigation systems (See Table 3C-1, Appendix 3C-1). Water source for irrigation of the said systems is river waters, such as the Labugaon, Solsona, Madungan and Papa rivers, which are tributaries of the Bonga river. The irrigable areas during the wet season are about 8,040 ha for paddy cultivation, but those during the dry season are only about 3,580 ha in accordance with the decrease of river flows. Water distribution in the area is carried out by gravity irrigation prevailing in the alluvial fan, though pump irrigation is seen in some parts of area during the dry season.

Following table indicates the irrigation area under communal irrigation systems in each municipality as of 1977.

Irrigation Area (1977)

Municipality	No. of CIS	Potential Area (ha)	Wet Season Irrigated Area (ha)	Wet Season Non-Irri. Area (ha)	Dry Season Irrigated Area (ha)	Dry Season Non-Irri. Area (ha)
Solsona	49	2,373	2,373	–	1,436	937
Labugaon	47	2,476	2,476	–	1,136	1,340
Marcos	22	1,791	1,791	–	648	1,143
Espiritu	16	1,407	1,351	56	354	1,053
Nueva Era	8	251	251	0	10	40
Total	138	8,097	8,041	56	3,584	4,513

Source: Provincial Irrigaton Offices in Ilocos Norte and Ilocos Sur. Details are given in Table 3C-1, Appendix 3C-1.

b) National Irrigation Project around the Project Area

There exist six national irrigation projects serving the total area of about 7,240 ha in the vicinity of the Project Area, and they are under the status of rehabilitation and improvement in the NISIS I Project. Detail descriptions are given in Table 3C-2, Appendix 3C-1.

c) Irrigation Conditions

Even in the communal irrigation area, no systematic water distribution systems have been provided to convey water to the terminal areas, and so-called continuous flowing irrigation has been practiced for both wet and dry season cultivations. On the other hand, the paddy fields of about 1,910 ha are relying upon rainfall throughout the year (rainfed paddy field), and these facts result in poor production of crops.

Under the circumstances, the development of water source as well as the provision of systemized irrigation systems inclusive of those of the on-farm level, which will be carried out by upgrading the existing communal irrigation system to NIA standard, are prerequisite to materialize the double cropping of high yield variety rices and upland crops under the project.

d) Irrigation Facilities

Major irrigation facilities in the communal irrigation systems are irrigation canals and diversion dams to divert irrigation water to the area.

In regard to the communal irrigation canals, as noted previously, no systematic water distribution systems are provided, so that there is a need to upgrade these existing communal irrigation systems to NIA standard. On the other hand, the many diversion dams have been constructed on the rivers of Labugaon, Solsona, Madongan, and Papa,

which are major water source and are unstabilized rivers having a plenty of earth and sand discharges with relatively steep slope. These diversion dams, so-called brush dam, are only temporary weir made of bamboo, wood and cobble stone. Consequently, when the dams are flashed away by flood, reconstruction of the dams is easily made by farmers. However, no provision of regulating structures of intake water has caused the flood to the area during flood time.

Under the conditions, such major irrigation facilities as canals and diversion dams should be improved and re-constructed as permanent structures in the Project in order to increase and stabilize the agricultural production under well-controlled water management.

2. Drainage Conditions

a) Drainage Systems

The drainage systems in the Project Area could be divided into five blocks by the four rivers, the Labugaon, Solsona, Madongan and Papa, which are tributaries of the Bonga river. Drainage discharges in each block are drained to each tributary or the Bonga river directly.

Topography of the area has a gentle slope from the east to the west with an elevation ranging from 100 m to 20 m above mean sea level. In this area, no terminal drainage systems are provided; therefore, communal irrigation canals and existing creeks are used for drainage purposes.

b) Drainage Conditions

There is no severe drainage damages in the area due to characteristics of the alluvial fan with an average slope of about 1/120. However, in the communal areas located in upstream of the Project Area, some flooding conditions in the fields can be seen during the flooding period, because of no provision of regulating structures of intake water at diversion site. And also, although it is different problems from draiange, devastation of cultivation lands and villages by river wash which is caused by the flooding water as seen generally in the alluvial fan poses a serious problems to the area; so it is considered that adequate countermeasures to prevent from the expansion of the river-washed area should be taken in the early stage.

3. On-farm Conditions

Water Distribution Systems

In the service areas, there are at present many communal canals, which have dual purpose of water supply and drain of surplus water to and from the paddy fields. These

communal canals run across the contour lines. The water diverted from the canal flows from the high plot to the low plot and finally reaches the other communal canals or drainage canals. With these methods (called plot-to-plot irrigation), almost all service areas are irrigated.

Farm Roads

Present farm fields in the Project Area have been scarcely provided with terminal farm roads. Farming practices and transportation of agricultural inputs and outputs are mostly made by manpower or carabao. For daily farming practices, farmers enter in to the fields through the fields of others on foot.

Size and Shape of Farm Fields

An average size of existing farm plots ranges from 100 sq.m to 2,000 sq.m and their shapes are very pleomorphic.

D. Present Agriculture

1. Land Use

The area of 10,860 ha, which is equivalent to 68 percent of the total gross area of about 15,890 ha, are currently cultivated. The remaining areas of about 5,030 ha consist of rights-of-way, residential area and others (See Table 3-2). Almost all cultivated areas (98 percent of the total cultivated area) belong to paddy fields (10,670 ha) except small acreage of upland crop field (190 ha).

Out of 10,670 ha of total paddy field, about 8,100 ha or 76 percent are irrigated area under communal irrigation system, and the remaining about 2,570 ha or 24 percent are rainfed area. As for the land utilization of paddy field one cropping of paddy rice per year is prevailing in the Project Area though double cropping of paddy rice is introduced in about 3,410 ha within the communal irrigation area, relying upon river flow. And some communal irrigation areas are not irrigated every year, in other words, irrigated area varies year by year under the conditions that the available quantity of irrigation water through the systems depends on river discharge directly. And the facilities in the communal irrigation systems are not adequate one to control the irrigation water at on-farm level appropriately.

Table 3-2 Present Land Use

	Land Category		Area
1.	Cultivated Area		
	a)	Paddy Field	
		Irrigated	8,097
		Rainfed	2,573
		Sub-total	10,670
	b)	Upland Field	190
		Total	10,860
2.	Non-Cultivated Area		
	a)	Rights-of-Way	156
	b)	Residential area	445
	c)	Others 1/	4,426
		Total	5,027
		Grand Total	15,887

Source: Irrigated paddy fields: NIA provincial Office Ilocos Norte as of 1977

The other area: Land Classification Section, NIA in 1978

1/ : Consists of river washed area, brush area, highland, etc.

After harvest of the wet season paddy rice, almost all areas are not planted with any crop during the dry season due to no irrigation water. Although some upland crops like corn, mongo beans and vegetables, etc. are grown in small-scale area, these crops are mainly for home consumption except for the vegetables for local markets.

In the upland crop fields which are located in high land area, only one cropping of upland crops mentioned above and tobacco is carried out throughout the year.

There are about 4,430 ha of non-cultivated area including wasted area of river washed lands, rights-of-way and residential area. Most of this non-cultivated area belongs to the river-washed land along four big tributaries in the Project Area, where gravels and sands cover the washed land with too thick layer to cultivate. Since there is the possibility that big flooding will occur and damage some existing cultivated areas in future, some measures to protect the enlargement of this non-cultivated area are requested to be taken in the early stage.