OVERALL PLAN
FOR
ILOCOS NORTE IRRIGATION PROJECT
IN
THE PHILIPPINES

DECEMBER 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of the Philippines, the Japanese Government decided to conduct a survey on the Ilocos Norte Irrigation Project and entrusted the survey to the Japan International Cooperation Agency. The J.I.C.A. sent to the Philippines a survey team headed by Mr. Susumu Takamine from August to November, 1978 and January to March, 1980.

The team exchanged views with the officials concerned of the Government of the Republic of the Philippines and conducted a field survey in Ilocos region, Philippines. After the team returned to Japan, further studies were made and the present report has been prepared.

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

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

December, 1980

Keisuke Arita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

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

Dear Sir;

We have the honor to submit herewith our report on the overall development plan for the Ilocos Norte Irrigation Project, Philippines. The field survey was conducted for the six-month's period, i.e., three months from August 9 to November 9, 1978, and three months from January 7 to March 27, 1980. This report has been prepared on the basis of various discussions held between the Philippine Governmental agencies concerned and the team.

The team has completed the overall development study covering the irrigation and hydropower components for the area of about 22,600 hectares, located on the Ilocos region, northern Luzon island.

The study on overall plan has been made through alternative studies including Palsiguan dam in 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 developed (Phase I area) and Batac-Badoc area (12,400 hectares) situated on lowlying area along the seashore has been decided to be the second priority area.

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

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

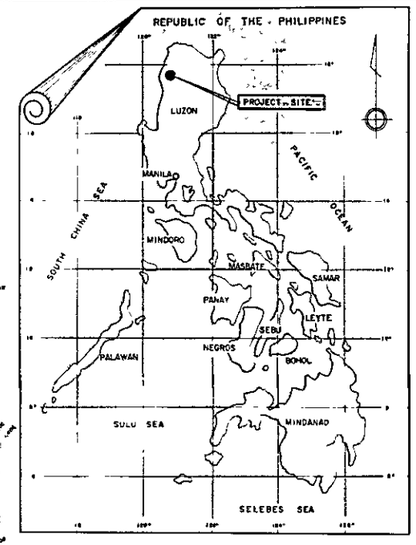
Respectfully yours,

December 1980

S. Takamine

Susumu Takamine
Team Leader for the
Ilocos Norte Irrigation Project

DEVELOPMENT PLAN FOR ILOCOS NORTE IRRIGATION PROJECT



SCALE

0 2 4 6 8(KM)

BATAC-PADAY AREA (PHASE II)
A=6590 HA

CURA AREA (PHASE II)
A=1,410HA

LABUGAON DIVERSION DAM

SOLSONA DIVERSION DAM

LINK CANAL-1

MADONGAN DIVERSION DAM

RIGHT BANK OF BONGA RIVER (PHASE II)
A=10,200HA

PAPA DIVERSION DAM

LINK CANAL-3

BADOC-SINAIT AREA (PHASE II)
A=3,570 HA

NUEVA ERA (B) AREA (PHASE II)
A=670 HA

POING DIVERSION DAM

LINK CANAL-2

MAIN LINK CANAL

NUEVA ERA DAM

OUTLET

MADUPAYAS DIVERSION DAM

MADUPAYAS DIVERSION DAM

LINK CANAL-4

NUEVA ERA POWER STATION

BONGA POWER STATION

MADUPAYAS AREA (PHASE II)
A=160 HA

INTAKE STRUCTURE

PALSIGUAN DAM

TO LAOAG

TO PASUQUIN

VINTAR

LAOAG

SAN NICOLAS

LAOAG RIVER

SARRAT

PIDDIG

DINGRA

SOLSONA

PADAY LAKE

PADAY

BATAC

PINILI

BADOC

SINAIT

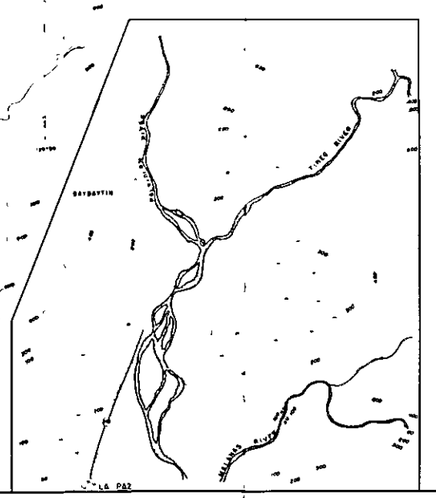
SOUTH CHINA SEA

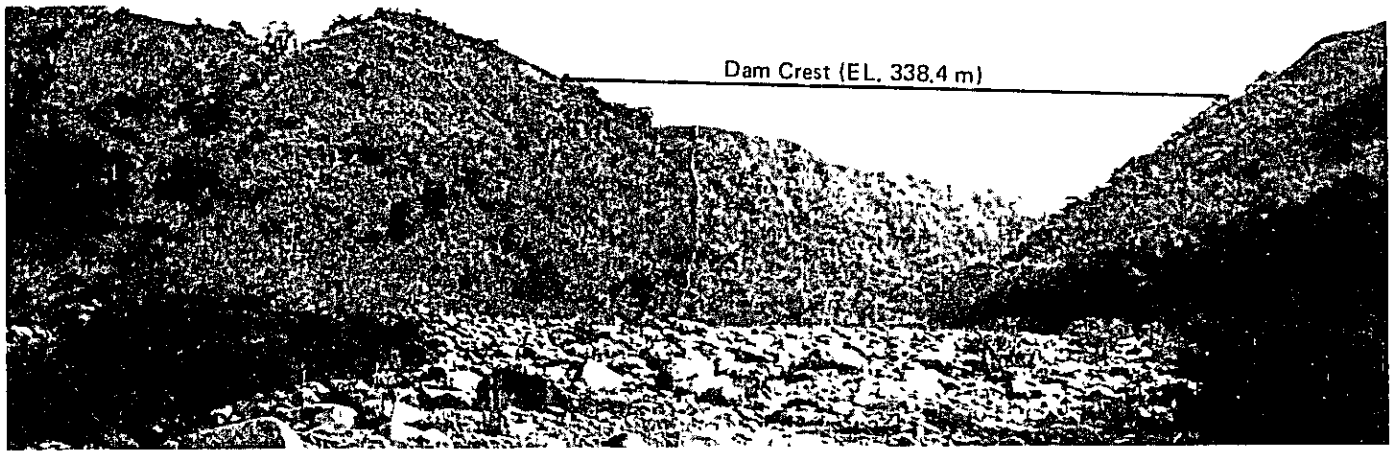
ILOCOS NORTE PROVINCE

ILOCOS SUR PROVINCE

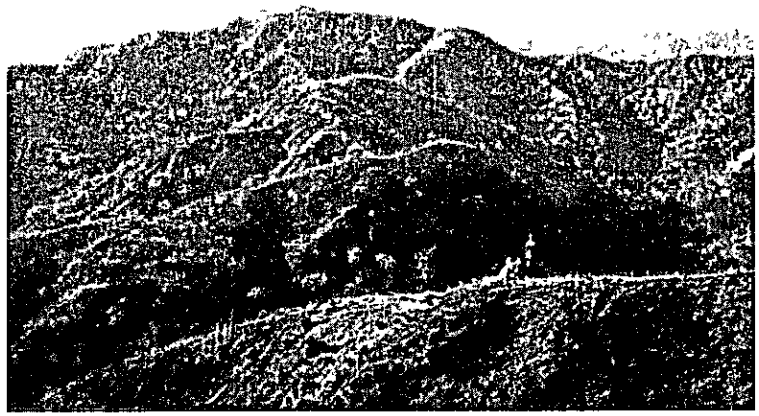
LEGEND

- 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 DAM
- PROPOSED DIVERSION DAM
- PROPOSED TUNNEL
- PROPOSED POWER STATION
- PROPOSED LINK CANAL AND ROAD
- PROPOSED MAIN AND LATERAL IRRIGATION CANAL AND ROAD
- PROPOSED MAIN DRAINAGE CANAL (NEWLY CONSTRUCTED)
- PROPOSED MAIN DRAINAGE CANAL (EXISTNG RIVER OR CREEK)
- PHASE-I PROJECT AREA AND FACILITIES
- PHASE-II PROJECT AREA AND FACILITIES

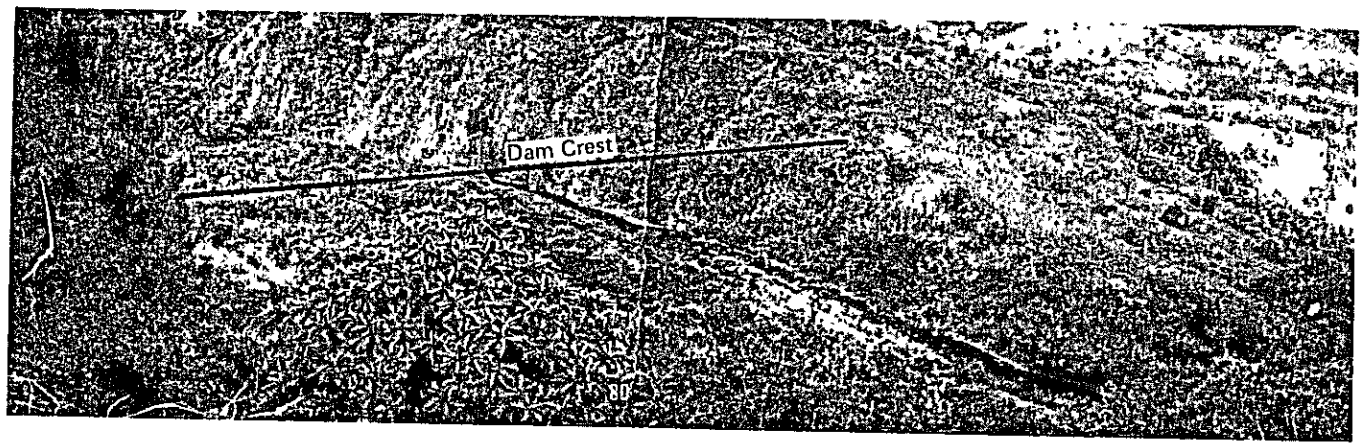




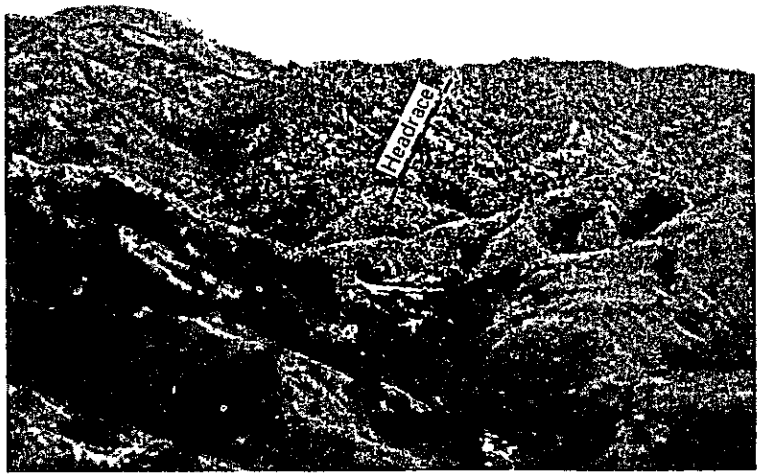
Proposed Palsiguan Dam Site



A View of the Palsiguan Dam



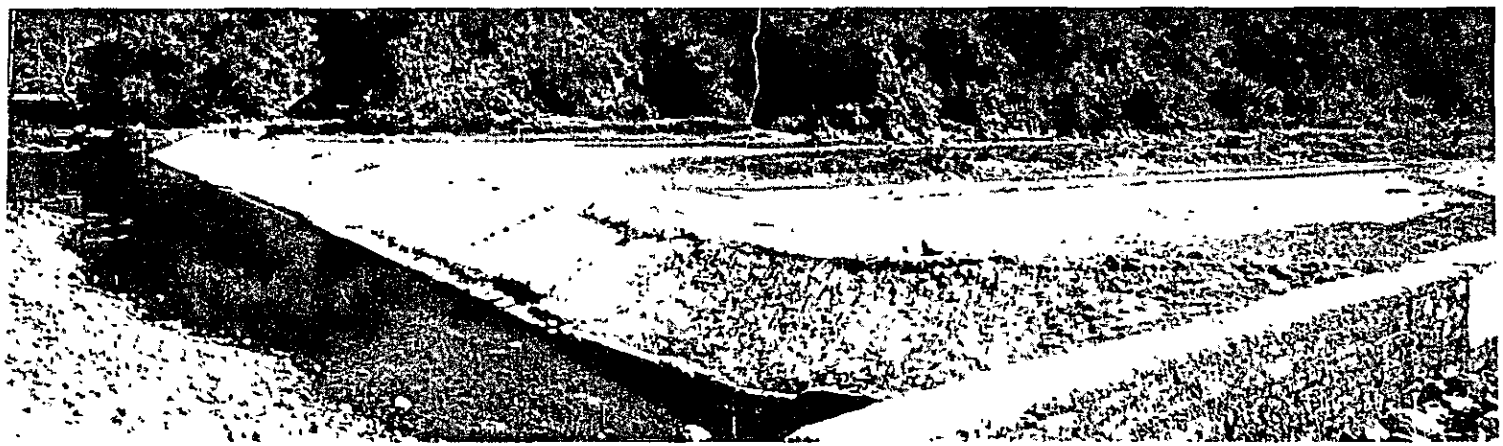
Proposed Nueva Era Dam Site



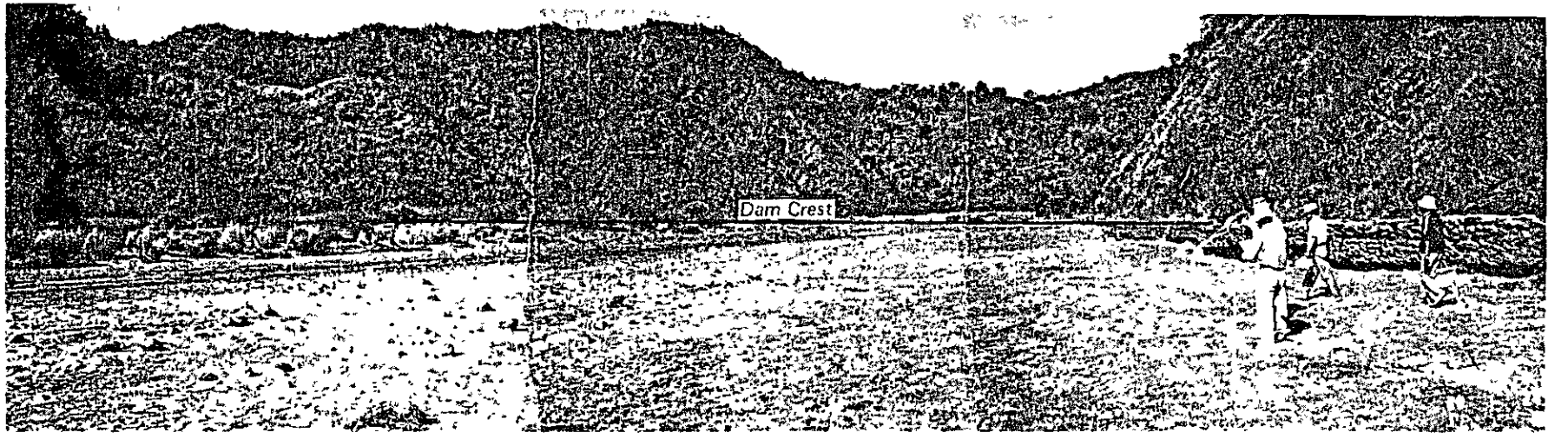
A Distance View of

Proposed Bonga Power Station

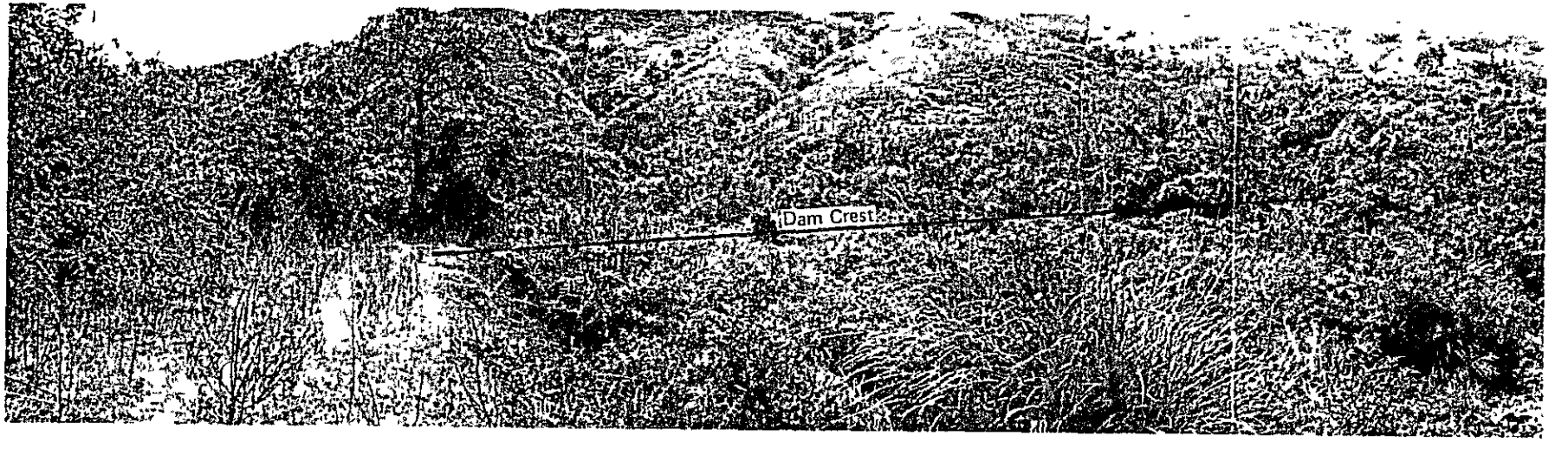
Site of Bonga Power Station to be built under the Ground



Existing Piding Diversion Dam which is to be utilitied after the Project



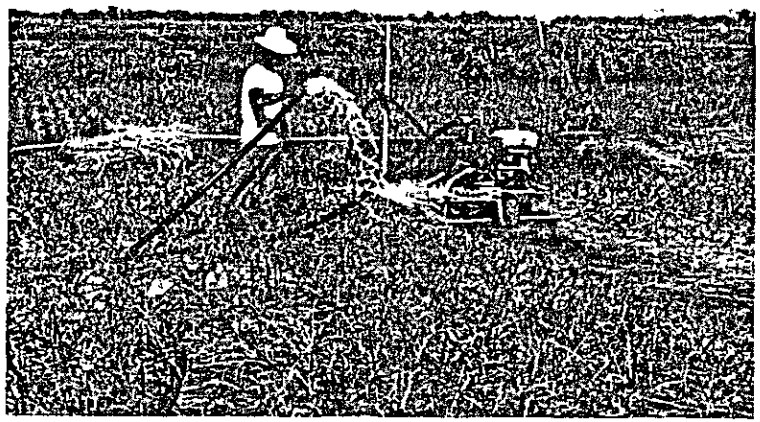
Proposed Tibangran Diversion Dam



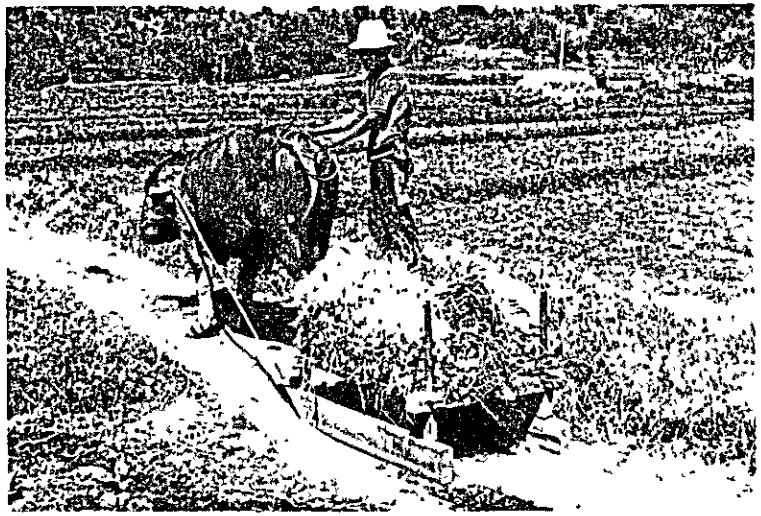
Proposed Madupayas Diversion Dam

General View of Dry Season Crops by Communal Irrigation System

Irrigated Tabacco by Groundwater

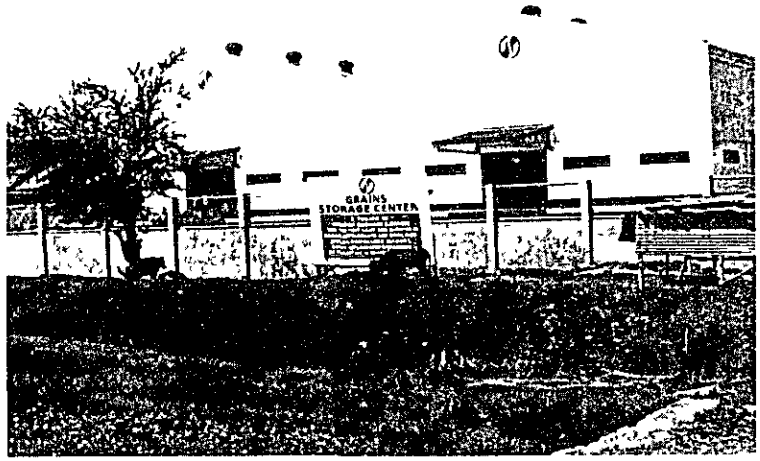


Irrigation of Garlic by Groundwater

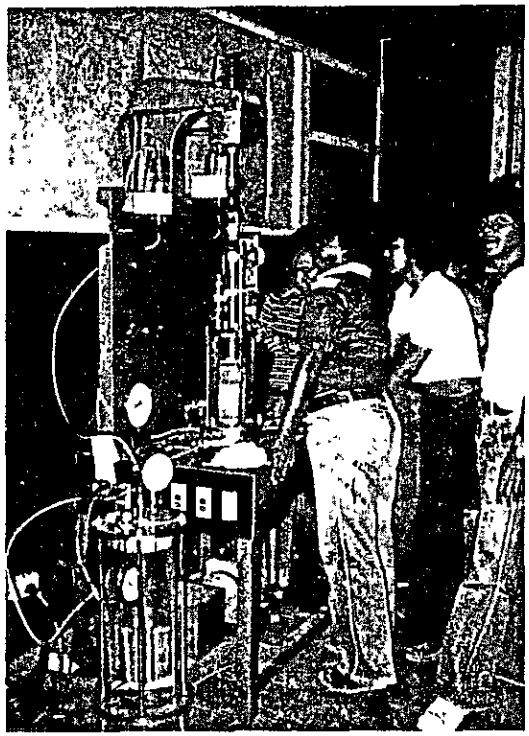


Transportation of the Garlic harvested

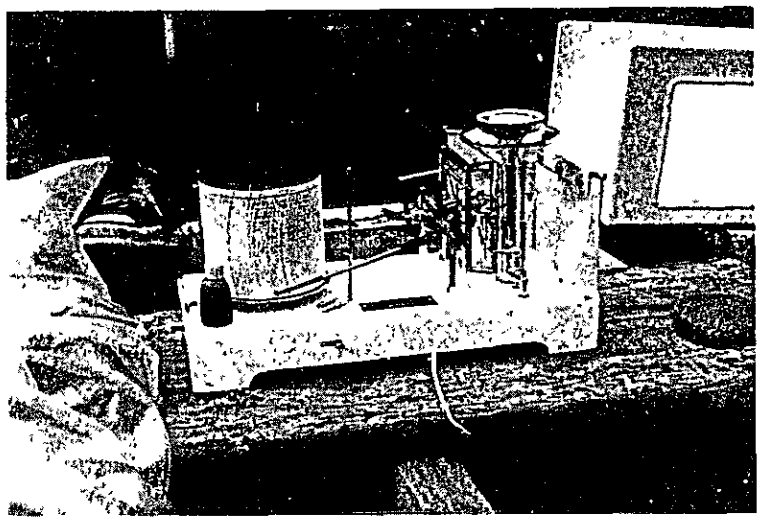
Harvesting of Mungbean



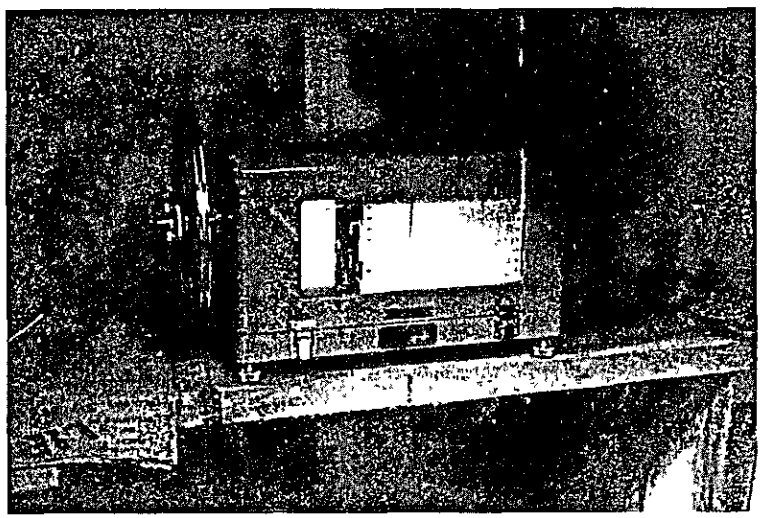
Grain Warehouse in Dingras



Triaxial Shear Machine



Automatic Evaporation Recording Gauge



Automatic Water Level Gauge

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ABBREVIATIONS AND GLOSSARY

Agencies

ACA	:	Agricultural Credit Administration
ADB	:	Asian Development Bank
AMC	:	Area Marketing Cooperatives
BAI	:	Bureau of Animal Industry
BAEcon	:	Bureau of Agricultural Economics
BAEx	:	Bureau of Agricultural Extension
BPI	:	Bureau of Plant Industry
BS	:	Bureau of Soils
CB	:	Central Bank of the Philippines
CRDI	:	Cotton Research and Development Institute
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 Cooperative Inc.
ISECO	:	Ilocos Sur Electric Cooperative Inc.
JICA	:	Japan International Cooperation Agency
MA	:	Ministry of Agriculture
MAR	:	Ministry of Agrarian Reform
MERALCO	:	Manila Electric Cooperative Inc.
MF	:	Ministry of Finance
MLGCD	:	Ministry of Local Governments and Community Development
MNR	:	Ministry of Natural Resources
MOTC	:	Ministry of Transportation and Communication
MPH	:	Ministry of Public Highway
MPW	:	Ministry of Public Works
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
NISIP	:	National Irrigation System Improvement Project
NISIS	:	National Irrigation System Improvement Study
NPC	:	National Power Corporation

OECF	:	Overseas Economic Cooperation Fund
PAGASA	:	Philippines Atomospheric Geophysical and Astronomical Services Administration
PCARR	:	Philippine Council for Agriculture Resources and Research
PNB	:	Philippine National Bank
PTRTC	:	Philippine Tobacco Research and Training Center
PVTA	:	Philippine Virginia Tobacco Administration
RB	:	Rural Bank
SN	:	Samahang Nayon
UPIP	:	University of the Philippines, Institute of Planning
USAID	:	United States Agency for International Development
USBR	:	United States Department of Interior, Bureau of Reclamatoin
ET	:	evapotranspiration
N	:	nitrogen
P	:	phosphorous
K	:	potassium
HYV	:	high yield variety
O & M	:	operation and maintenance
IRR	:	internal rate of return
B/C	:	benefit cost ratio
FY	:	fiscal year

Unit of Measurement

mm	:	millimeter
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
Wh		watt hour
KWh	:	kilowatt hour
MWh	:	megawatt hour
GWh	:	gigawatt hour
EL	:	elevation above mean sea level
MSL	:	mean sea level
FWL	:	full water level
HWL	:	high water level
LWL	:	low water level
sec	:	second
min	:	minute
hr	:	hour
min	:	minimum
max	:	maximum
%	:	percent
No.	:	number
°C	:	degree centigrade
°F	:	degree fahrenheit
Cl	:	chlorine
HP	:	horse power
₱	:	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

Unit	Comparison	English Equivalents
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
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
1 kilowatt hour	= 1,000 watt hour
1 megawatt hour	= 1,000,000 watt hour = 1,000 kilowatt hour
1 gigawatt hour	= 1,000,000,000 watt hour = 1,000,000 kilowatt hour

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 used 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:	Imperate 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 AND CONCLUSION

BACKGROUND

1. Ilocos Norte province is situated in the north-western portion of Luzon island, the main island of the Philippines, and is a province left behind others in the aspect of economic development. In spite that agriculture is the most important industry in the regional economy, only 17 percent of paddy fields is irrigated in the dry season. Furthermore, some existing irrigation facilities have been deteriorated to a considerable extent. Under the circumstances, the per capita income in this region as of 1975 was only 780 pesos which is much lower than the national average per capita income of 895 pesos and about 1,590 pesos of Metro Manila in the same year. A considerable number of population has, therefore, transmigrated from this region to the Metro Manila and other big cities, resulting in a low population growth rate of the region. To improve such economic conditions, the Government of the Philippines has drawn up an economic development plan for this region.

2. The National Irrigation Administration (NIA) conceived a plan for possible irrigation projects in the region in early 1975, and developed it into an Integrated Rural Area Development project in 1976 putting emphasis on agricultural development, which would be implemented under the direct supervision of the Government. For this agricultural project, the NIA furthered the study, and formulated Palsiguan River Multipurpose Project in March 1977 under close cooperation of the National Economic Development Authority (NEDA).

3. In May 1977, the NEDA made a request to the Government of Japan for technical assistance to the subject Project. In accordance with the request, the Ministry of Foreign Affairs, Japan, dispatched a Japanese Governmental Mission headed by Mr. Mitsuo Iijima to the Philippines. In August 1977 the Government of the Philippines made an official request for technical assistance to this Project through the Embassy of Japan in Manila.

In response to this request, the Japan International Cooperation Agency (JICA) dispatched a preliminary survey team for Ilocos Norte Irrigation Project headed by Mr. Tatsuo Asahara to the Philippines for the period of October 30 to December 2, 1977. The preliminary survey team recommended a phased development in order to comply with the strong desire of the Government of the Philippines for early implementation of the Project, taking into consideration that data and information required for finalization of an overall development plan were not fully available. In other words, the survey team proposed to formulate a provisional overall project plan for the Project and conduct a feasibility study in the areas for which data and information required

are available in the Phase I study, and to conduct a feasibility study for the remaining areas inclusive of Palsiguan dam for irrigation water storage and hydropower generation in the Phase II study. In this respect, the both Governments mutually agreed on the above-mentioned development strategy for this region.

4. Taking into consideration the aforementioned facts, the JICA dispatched a survey team to the Philippines from August 9 to November 9, 1978 for the Phase I study and from January 7 to March 27, 1980 for the Phase II study under the scope of works of which brief descriptions are made hereinunder;

i) Formulation of an overall development plan for the whole Project Area premising Palsiguan dam as irrigation water source, based on basic data and information so far collected.

ii) Within the framework of the overall plan metnioned above, the Phase I feasibility study on provisional water supply plan for the area of about 10,200 ha located on the right bank of the Bonga river and Phase II feasibility study on water supply for the remaining area of about 12,400 ha in the Cura and Batac-Badoc areas and hydropower generation.

SUMMARY AND CONCLUSION

A. SUMMARY

1. Location

The Project Area serving an area of 22,600 ha is located in Ilcos Norte and Ilocos Sur provinces, north-western part of the Luzon island being far from Manila by about 480 km. There are ten municipalities in total in the Project Area: nine of them are in Ilocos Norte and one in Ilocos Sur.

As for the transportation to the Project Area from Manila, three means by land, ocean and air are available. For land transportation, the completely paved highway Route 3 runs across a part of the Project Area. An airport is located in Laoag city in Ilocos Norte province. The road networks around the Project Area is well developed by provincial roads and village roads which are connected with the Route 3. However, the roads network in the right bank of the Bonga river is not so developed except the roads to Solsona and Nueva Era from left bank of the Bonga river. To the other area, only the so-called bamboo raft (ferry) is available to proceed across the Bonga river. During the wet season, the ferry services are apt to be stopped due to the river flood, making it quite difficult to transport daily commodities and production materials together with the communication among villages.

Topographically, the Project Area is generally flat; the right bank area of the Bonga river is of alluvial fan and the Batac-Badoc area is of alluvial plain.

2. Population and Farm Families

The population in the Project Area is about 100,000, of which about 92,000 is agricultural population with 17,500 farm families. One farm family is composed of 5.3 persons on an average. The population growth rate is 1.6 percent (1970 - 1975), being far less than 2.7 percent of the national average due to the population outflow.

3. Climate

The climate in the Philippines can be classified into four types, according to the rainfall pattern. Ilocos Norte and Ilocos Sur provinces 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 27.0°C in Laoag in Ilocos Norte province. An average relative humidity is 79 percent in Laoag during 1949 - 1979. The annual average rainfall is 2,016 mm in Laoag and 3,216 mm in Langasilang of Abra province, which indicates that more rainfall is in the mountain area and less in the plain area. According to the observation in Laoag, about 96 percent of annual rainfall is observed in the wet season.

4. Hydrology

Major rivers running through in the Project Area are the Labugaon, Solsona, Madongan, Papa, Nueva Era (which is so-called the upstream of the Bonga river), Madupayas and Tibangran rivers Their annual discharges vary considerably year by year, and in some years the flow is not sufficient to supply irrigation water for the whole Project Area even in the wet season For the dry season, only some 17 percent of paddy fields are irrigated on an average.

The average annual run-off of the above seven rivers of 11 years, 1960 - 1970, is found by 1,150 million cubic meter. Since, however, most of the amount flows in the wet season, the irrigation water in the dry season is not sufficient.

Meanwhile, an average annual run-off during 11 years at the proposed dam site on the Palsiguan river is 354 million cubic meter.

5. Groundwater

According to the groundwater survey of existing wells, the annual safety yield of the groundwater is estimated at 35 to 49 million cubic meter per year.

Groundwater lift-up by this quantity in the dry season causes the groundwater table lowered by two or three meters on an average, and lifting from existing shallow wells will become impossible sometimes in the dry season.

The deep wells, although recommendable to follow the variation of groundwater table, are not favorable for groundwater exploitation due to small transmissibility in the lower layers. Generally, the groundwater lifting is required not in the wet season but in the dry season when groundwater table is low.

Taking into account the above-mentioned, large-scaled and systematic groundwater exploitation for irrigation in the dry season is not recommendable.

6. Geology

The geology of the Project Area is based on marine effusive rock of prohilitic basalt or andesite mainly composed of neogene diorite, marine clastics of olygocen, miocene and pliocene which penetrate the basement, sediment of alluvial fan, river bed, littoral, etc. since quaternary.

The andesitics, as basement, are main components 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, headrace, Nueva Era dam 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 is widely outcropped at Labugaon, Solsona and Papa diversion dam sites and the upstream of Palsiguan dam site where some lithofacies of granodiorite may be found.

The geology of Palsiguan dam and reservoir site is composed of volcanic producgs of basalt, quartz andesite and penetrated diorite.

As for these rocks, a considerable number of well-developed creacks and joints are observed, but the rocks themselves are hard enough. Accordingly, little attention will be necessary for bearing capacity of the rocks but much on leakage.

The site is mainly composed of agglomerate, and partly shale wedged is observed. Ground surface is much weathered, as gravels are weathered onion-like, and matrix is reddish. The lower strata, as found on the river bed, is very hard and compact and forms good foundation rock.

7. Soil

Soils in the Project Area consist of the Oligocene, Miocene or Pliocene oceanic deposits or Sub-Quaternary alluvial fan, river bed and seaside deposits as the materials rocks of metamorphic andesitic or basaltic submarine eruptions as well as the Tertiary diorite.

The medium to fine textured surface soils which lean over clayey or laomy layer, are considered to have high potentiality for growing rice.

8. Irrigation and Drainage Conditions

Gravity irrigation method is predominant in the present communal irrigation systems, and water supply is practiced for 52 percent of 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 function also as drainage canals. The intake weir, having no regulating devices, causes an extensive inundation of paddy fields during the flood time.

On the other hand, some small-scaled pump irrigation is applied to upland crop areas in the dry season; partly in Batac-Badoc areas. However, unstable farming, depending on rainfall, is still being practiced, and rainfed paddy field amounts to about 11,150 ha.

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

9. Present Land Use

An area of about 23,690 ha, which is equivalent to 63 percent of the whole area of 37,790 ha, is utilized for agricultural production and the remaining of about 14,100 ha consists of village areas, roads, canals, river beds, etc. All farm land is planted with paddy in the wet season. An area of about 4,000 ha is cultivated for paddy in the dry season by use of the river flows along the area, but the yields are unstable due to the unsteady river flows.

The area of about 6,950 ha is characterized by the production of cash crops such as tobacco, garlic, etc., which are planted during the dry season by use of private/individual small-scaled pump irrigation system. The area is famous for its production of such cash crops in the Philippines.

10. Present Cropping Pattern and Production

Single paddy cropping is predominant in the right bank area of the Bonga river where land use efficiency is rather low. While in the Batac-Badoc area, paddy is planted in the wet season in whole land and upland crops in the dry season in 51 percent of farm land.

For the wet season paddy, transplanting is undertaken 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 above 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 available for irrigation is limited. Harvesting of the dry season paddy, then is carried out from January to March.

Traditional paddy varieties which are cropped in the farm land of about 22 percent have a long growth period and photo-periodic sensitive nature. For the dry season upland crops, they are planted or sown after harvesting of paddy, from November to December, and harvested from February to April. The average yield per hectare is 1 6 ton of paddy, 1.0 ton of tobacco and 1.4 ton of garlic.

The average land holding per farm family in the Project Area is 1.4 ha and less than the national average. Due to the equal inheritance defined by the legal regulations, a trend of its decrease may be continuously observed.

11. Electric Power Supply

Power supply to the Ilocos area is made through the cable of Luzon Grid from Baguio. In the Project Area, no power source development had been planned until the Ilocos Norte Project took up the hydropower generation scheme; accordingly the electrification of the Area, coupled with the poverty of the farmers, is left behind and only a quarter of the houses enjoys electric power supply.

Each of the provinces of Ilocos Norte, Ilocos Sur and Abra has Electric Cooperative, who is an intermediator in power supply by National Power Corporation to individual consumers. The yearly total power consumption is, at present, only about 53 million KWh in Ilocos Norte, Ilocos Sur and Abra provinces in 1979.

12. Objectives 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 quickly obtain benefit, the following project components are proposed.

Civil Engineering Works

1) Irrigation and Drainage:
   Construction of a storage dam, diversion dams and irrigation and drainage canals.

2) On-farm Development
Construction of terminal irrigation and drainage canals and farm roads in the fields.

3) Road:
Construction of service roads and inter-village roads along the main and lateral canals.

4) Power Station.
Construction of two power stations to promote the electrification in the Project Area and its vicinity.

Agricultural Development Plan

1) Agricultural Development Plan·
Establishment of irrigated agriculture by paddy double cropping with high yield varieties and introduction of cash crops in the dry season in a part of the Project Area.

2) Agricultural Extension Services:
Execution of extension services and training, and reinforcement of supply of production materials, financial aids, marketing and processings.

3) Farmers' Organization:
Establishment of farmers' organization such as Farmer Irrigators' Association, Agricultural Cooperatives, etc.

13. Alternative Studies on Optimum Plan

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 (CASE III-1 & III-2).

The above four cases were studied from technical and economical viewpoints in the manner of the phasing and non-phasing development, and through the study the CASE II was recommended as the most optimum plan for the Project.
(See Appendix A)

14. Irrigation Plan

Based upon the proposed cropping pattern, the irrigation water requirement for the Project Area was estimated in taking into account the climatological data. The maximum water requirement of the irrigation canal is estimated at 2.33 lit/sec/ha for Phase I area and 2.16 lit/sec/ha for Phase II area.

The maximum design discharges of the main and supplementary farm ditches are decided at 1.78 lit/sec/ha for the Phase I area and 1.64 lit/sec/ha for the Phase II area, inclusive of 35 percent of application losses, depending upon the following criteria.

	Phase I Area	Phase II Area
One rotational area	30 ha	40 ha
Land preparation period for one rotational area	25 days	35 days
Water requirement for land soaking and preparation		
Wet season	250 mm	250 mm
Dry season	230 mm	230 mm
Application losses		
Wet season	35%	35%
Dry season	25%	25%

15. Reservoir Plan

To determine the required capacity of dam, water balance on Palsiguan dam was studied for the period of ten years from 1960 to 1969 for irrigation use only. Considering the minimum water requirement for peak power generation at Nueva Era dam and losses, the storage capacity is determined at 232 million cubic meters as shown below;

◦ Required storage for irrigation	172.4 MCM
◦ Minimum requirement for peak generation	13.1
◦ Reservoir losses	3.5
Effective capacity	189.0
◦ Dead water volume	43.0
Total storage capacity	232.0

16. Drainage Plan

The design drainage modulus for paddy field is computed with the convenience method for Phase I and Ekdahl's method for Phase II with the base flow of 0.02 cu m/sec/sq.km, and the results are as follows;

Phase I	8.72 lit/sec/ha
Phase II	8.66 lit/sec/ha

The storm discharge from hilly land is analized by applying the Rational method. As a result, specific discharge of storm run-off is estimated at 3.06 cu.m/sec/sq.km.

17. Proposed Land Use

The proposed land use is as follows:

Proposed Land Use

(Unit. ha)

Area	Arable Lands	Rights of Ways	Residential Areas	Others	Total
Phase I	10,200	816	445	4,426	15,887
Phase II	12,400	1,010	930	7,560	21,900
Overall	22,600	1,826	1,375	11,986	37,787

The Project proposes the full-scale irrigation of the whole arable land in both the wet and the dry seasons. The proposed land use pattern has two types, "double cropping of paddy rice in the wet and the dry seasons" and "paddy rice in the wet season and upland crops in the dry season". The dry season upland cultivation is proposed to occupy 10 percent of irrigation area in the Phase I area and 60 percent in the Phase II area.

18. Proposed Cropping Pattern and Production

The proposed cropping pattern and production are as shown below;

Cropping Pattern (Wet Season)	(Dry Season)	Phase I (ha)	Phase II (ha)	Total (ha)
1. Paddy	+ Paddy	9,200	4,970	14,170
2. Paddy	+ Diversified Crops			
(1) Paddy	+ Tobacco	300	2,130	2,430
(2) Paddy	+ Garlic[1/]	700	2,205	2,905
(3) Paddy	+ Garlic + Mungbeans	–	2,065	2,065
(4) Paddy	+ Cotton	–	1,030	1,030
	Sub-total	1,000	7,430	8,430
Total (Physical Area)		10,200	12,400	22,600
(Cropping Area)		20,400	26,865	47,265
Cropping Intensity		200%	217%	209%

Note. 1/ Including 350 and 70 hectares of onion cultivation in Phase I and II areas respectively.

An average yield of paddy per hectare at present is 1.6 tons but the target yield of paddy in the Project will be 4.0 tons in the wet season and 4.3 tons in the dry season

respectively. Consequently, the present total production is about 45,279 tons, which will be increased to 152.225 tons after the Project completion, resulting from the increment of 106,946 tons The production after the completion of the Project, therefore, will be more than four times of the present production as shown below;

Crop Production

(Unit: ton)

Crop	At Present	With Project	Incremental Value
Paddy	45,279	152,225	106,946
Tobacco	2,368	4,011	1,643
Garlic	5,358	11,865	6,507
Others	999	12,439	11,440

19. 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.

20. Palsiguan Dam and Reservoir

The foundation of the Palsiguan dam consists of basalt and diorite penetrated. Judging from the results of borings, the foundation rock has cracks and joints but the rock itself is hard. The embankment materials such as rocks, sand and gravels are abundant around the site but impervious core materials are hardly found.

The proposed dam with the height of 143.5 m will be constructed across the Palsiguan river, one of tributaries of the Tineg river in the Abra river basin. The scale of the reservoir and dam is as follows.

Reservoir

Total Storage	:	232.0 MCM
Effective Storage	:	189.0 MCM
Dead Storage	:	43.0 MCM
Full Water Level	:	EL 334.5 m
DeadWater Level	:	EL 275.0 m

Dam

Type	:	Earth and rock fill dam
Crest elevation	.	EL 338.5 m
Dam height	:	143.5 m
Dam volume	:	9.1 MCM

Spillway

Type	·	Gated chute with flip-bucket
Design discharge	.	3,070 cu.m/sec
Gate	:	H = 12.5 m, B = 11 5 m, 3 units

21. Palsiguan Headrace Tunnel

The headrace is the facility to convey the water from the Palsiguan reservoir to the Nueva Era river for the purpose of irrigation and hydropower generation. The headrace route is determined in the shortest line between Palsiguan reservoir and the surge tank of the Bonga power station. The total length of the tunnel is 6,210 m including intake of 60 m, and the maximum design discharge is 28.225 cu.m/sec.

The section of the headrace is the standard horseshoe shape type and its diameter is 3.60 m. The headrace is lined with reinforced concrete and its thickness of 0.40 m.

22. Nueva Era Dam

The dam site is mainly underlain by agglomerate, river deposit is distributed to the depth of about 15 m, and terrace deposit with about 18 m thick exists on the right abutment portion. On the other hand, the base rock is weathered five to ten meters deep on the both abutment portions Crushed zones, which hinder the construction of a concrete dam, are not found in the geological surveys.

The major dimentions of the dam are as follows;

Reservoir

Total Storage	:	4.99 MCM
Effective Storage	:	0.50 MCM
Full Water Level	:	EL 150.00 m
Low Water Level	:	EL 148.50 m

Dam

Type	:	Roller compacted concrete gravity dam
Dam height	:	45.5 m
Dam volume	:	141,000 cu.m

Spillway

Design discharge	:	970.0 cu.m/sec
Gate	:	H = 6 0, B = 7.0 m, 5 units

23. Irrigation and Drainage Facilities

The irrigation and drainage facilities such as diversion dam, irrigation and drainage canals will be provided for the Project Area of 22,600 ha. Major facilities are as follows;

Diversion Dam

Labugaon diversion dam	(Phase I)	H = 2.30 m
Solsona diversion dam	(Phase I)	H = 2.30 m
Madongan diversion dam	(Phase I)	H = 2.50 m
Papa diversion dam	(Phase I)	H = 2.30 m
Nueva Era diversion dam	(Phase I)	H = 2.15 m
Madupayas diversion dam	(Phase II)	H = 3.00 m
Tibangran diversion dam	(Phase II)	H = 2.50 m

Irrigation Canal

Phase I area	:	208.5 km
Phase II area	:	432.8 km
Total length	:	641.3 km
Canal intensity	:	28.4 m/ha

Drainage Canal

Phase I area	:	147.1 km
Phase II area	:	123.1 km
Total length	:	270.2 km
Canal intensity	:	12.0 m/ha

24. Hydropower Plan

The water stored in the reservoir will be led through the 6.150 m long headrace to the 36,000 KW capacity underground Bonga power station located in the upstream of Nueva Era river. The discharge from the Bonga power station will be regulated by the afterbay, and the released water from the afterbay will be effectively utilized again by a low-head Nueva Era power station with a generating capacity of 6,800 KW. Annual energy production will be 159.7 GWh and 39.5 GWh by Bonga and Nueva Era power stations, respectively. The both power stations will be connected to the NPS's Luzon Grid in Badoc by total 35.5 km long transmission line.

25. Project Cost

The project cost, excluding the cost for price escalation during construction period and related interest, is estimated at 2,761 million pesos (US$373 millions) on the January 1980 price basis with breakdown as follows;

		Overall	Phase I	Phase II
1)	Irrigation			
	Investment Cost (Million Pesos)	1,778	311	1,467
	Cost per Hectare (US$/ha)	9,880		
2)	Hydropower			
	Investment Cost (Million Pesos)	983	–	983
3)	Total (Million Pesos)	2,761	311	2,450

26. Project Justification

An annual incremental benefit by irrigation, which will be fully achieved in the fifth year after the completion of the Project, is estimated at 290 million pesos (US$39 2 millions) and the benefit by power generation is estimated at 110 million pesos (US$14.9 millions), resulting in the annual total benefit of 400 million pesos (US$54.1 millions) based upon economic value.

The Internal Rate of Return (IRR) of the Project, taking the project life as 50 years, is 14 percent for the Overall Project Area and 13 percent for the Phase I and 14 percent for Phase II, respectively.

B. CONCLUSION

1. The conclusion derived from the thorough alternative studies to pursue the optimum scale of the Project is that the single reservoir plan of Palsiguan dam is most advantageous as the project plan from technical and economical point of view.

2. The Project implementation is devided into two stages. The first stage (Phase I) includes the construction works of five diversion dams and irrigation and drainage canal facilities for the area of 10,200 ha. While the second stage (Phase II) is composed of the construction works of the Palsiguan dam, the headrace, the Nueva Era dam, two diversion dams and irrigation and drainage canal facilities for the area of 12,400 ha and two power stations with the installed capacity of 42.8 MW.

Major facilities constructed in the respective phases are described below and schematic diagram of proposed facilities are given in the attached figure.

Phase I

Diversion Dam

- Labugaon diversion dam
- Solsona diversion dam
- Madongan diversion dam
- Papa diversion dam
- Nueva Era diversion dam

Irrigation Canal

Main Canal	116.5 km
Laterals	92.0 km
Total	208.5 km

Drainage Canal

Main Drainage Canal	55.0 km
Lateral Drainage Canal	92 1 km
Total	147.1 km

On-farm Facilities	10,200 ha

Phase II

Palsiguan Dam

Palsiguan Headrace

Nueva Era Dam

Diversion Dam

- Madupayas diversion dam
- Tibangran diversion dam

Irrigation Canal

Link Canal	96.0 km
Main Canal	240.2 km
Lateral Canal	96.6 km
Total	432.8 km

Drainage Canal

Main Drainage Canal	75.3 km
Lateral Drainage Canal	47.8 km
Total	123.1 km

On-farm Facilities	12,400 ha

Power Station

Bonga Power Station

Nueva Era Power Station

Total transmission Line ---------- 35.5 km

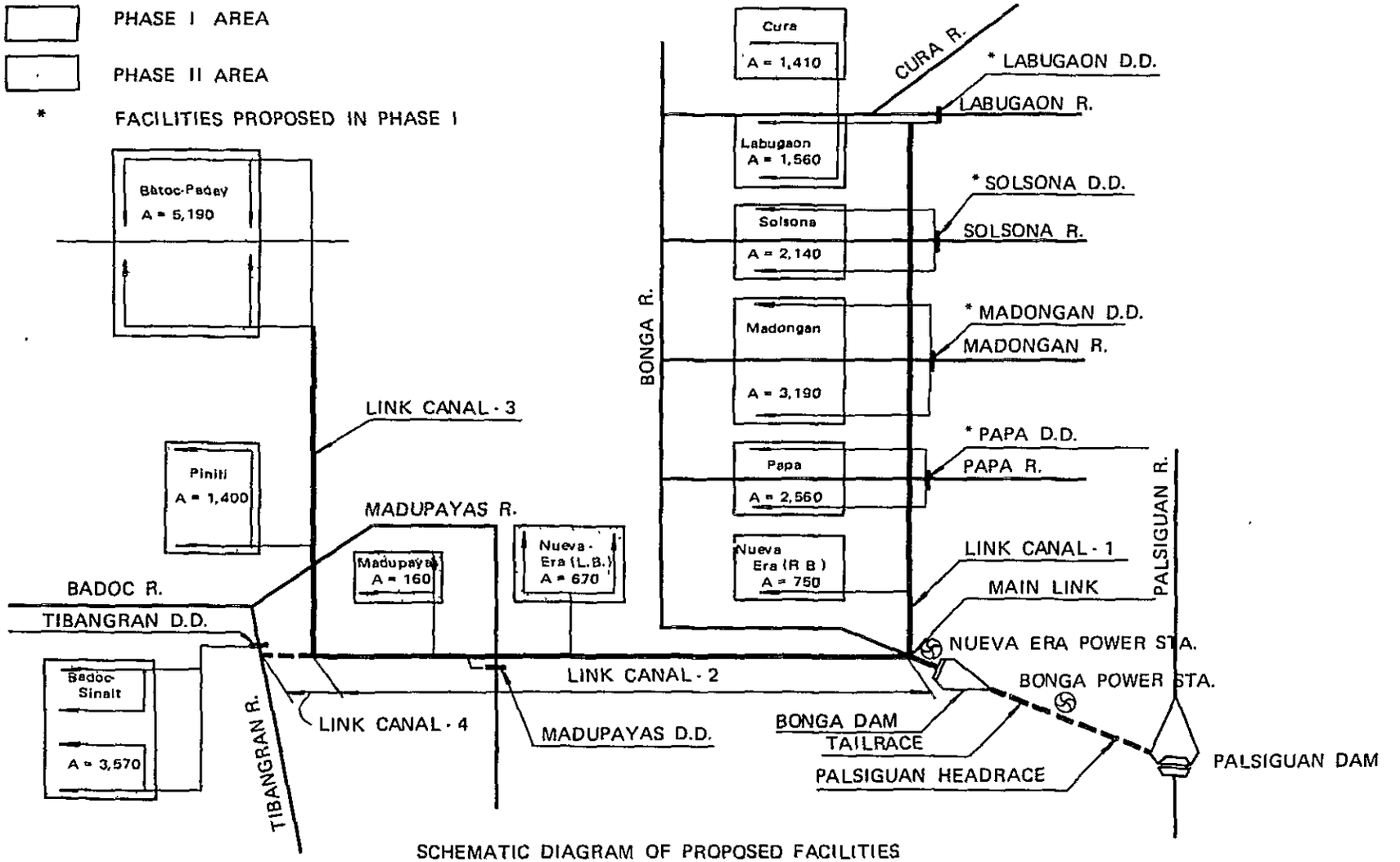
The cultivation areas according to the phased development scheme are shown below based on the irrigation water available by the Project.

Cultivation Areas with Project

(Unit: ha)

Sub Area	Project Area	Cultivation Area			
		Wet Season		Dry Seaton	
		Phase I	Phase II	Phase I	Phase II
Labugaon	1,560	1,560	–	780	780
Solsona	2,140	2,140	–	610	1,530
Madongan	3,190	2,290	900	720	2,470
Papa	2,560	1,340	1,220	400	2,160
Nueva Era (R.B)	750	750	–	450	300
Sub-total	10,200	8,080	2,120	2,960	7,240
Cura	1,410	–	1,410	–	1,410
Nueva Era (L.B)	670	–	670	–	670
Madupayas	160	–	160	–	160
Batac-Paoay	5,190	–	5,190	–	5,190
Pinili	1,400	–	1,400	–	1,400
Badoc-Sinait	3,570	–	3,570	–	3,570
Sub-total	12,400	–	12,400	–	12,400
Total	22,600	8,080	14,520	2,960	19,640

3. The irrigation benefit to be created by the Project will result not only in promoting economic development and realizing higher living standard in the provinces concerned but also affecting favourably the social and economic development of the entire nation.



SCHEMATIC DIAGRAM OF PROPOSED FACILITIES

CHAPTER I. INTRODUCTION

CHAPTER 1. 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 Multipurpose 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 between the two Governments on the plan of approach to the Project. Finally, the Ilocos Norte Irrigation Project has been selected for further study because of its promising features among those included in the overall development plan. As a matter of course, this Project involves a large-scaled development which requires a variety of time-consuming works of fundamental surveys together with water resources development for finalizing the plan. However, taking into account the strong desire of the Philippine Government and the local people concerned for realizing the Project possibly early, the project development plan was staged into two phases as follows:

i) An overall project plan for the area of 22,600 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 Cura and Batac-Badoc areas covering a total area of about 12,400 ha, in which the Palsiguan dam and hydropower generation plants will be included.

According to the above strategy, the Team carried out the feasibility study for the area of about 10,200 ha on the right bank of the Bonga river as well as the formulation of the overall development plan for the whole area of about 22,600 ha, from August to November 1978 and submitted the final feasibility study and draft overall development plan in May 1979. Furthermore, after this Phase I survey, the Phase II survey for the area of about 12,400 ha was carried out by the Team under the cooperation of the Philippine counterparts personnel from January to March 1980. This report covers the results of overall plan for the area, and also incorporates all the matters discussed between the Philippine Government and the Team.

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

Advisory Group Assigned to the Project

1.	Chief Adviser (Mr. Tatsuo ASAHARA)	Director of Construction Dept., Agricultural Structural Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries (MAFF)
2.	Adviser (Irrigation) (Mr. Yasuo SUDA)	Deputy Director of Design Div., Construction Dept., Agricultural Structural Improvement Bureau, MAFF
3.	Adviser (Dam) (Mr. Tadashi YOSHIMITSU)	Project Manager, Agricultural Water Utilization Office in Lower Tenryu River Basin, MAFF
4.	Adviser (Agronomy) (Mr. Yoshihide SHIBATA)	Depty Director of Planning Div , Planning Dept., Agricultural Structural Improvement Bureau, MAFF
5.	Adviser (Economy) (Mr. Hiromiki ITOH)	Deputy Manager, 2nd Div., Loan Dept. II, The Overseas Economic Cooperation Fund (OECF)
6.	Adviser (Economy) (Mr. Masakazu ISHIGURO)	Assistant Manager, 2nd Div., Loan Dept. II, The Overseas Economic Cooperation Fund (OECF)

Mission Members Assigned to the Project (Phase I)

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 Hydro-power (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 (Phase I)

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. Timonera	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

Mission Members Assigned to the Project (Phase II)

1.	Team Leader (Mr. Susumu TAKAMINE)	7 January –	27 March, 1980
2.	Meteorology and Hydrology (Mr Fumimichi OHBU)	7 January –	27 March, 1980
3.	Hydrological Observation (Mr. Kiyoshi OGAWA)	20 August –	23 September, 1979
4.	Soil (Mr. Hajime TAKAHASHI)	18 January –	17 March, 1980
5.	Geology (Mr. Yukio YAMAGISHI)	20 August – 7 January –	23 September, 1979 16 March, 1980
6.	Irrigation (Mr. Seiji TAKEUCHI)	7 January –	27 March, 1980
7.	Drainage and On-farm (Mr. Hiroshi KONDO)	7 January --	27 March, 1980
8	Dam (Mr. Tadao INABA)	7 January –	27 March, 1980
9.	Canal and Diversion Dam (Mr. Tsutomu IWAMURA)	18 January –	27 March, 1980
10.	Agronomy, Agricultural Supporting Services (Mr. Yasunori HASEGAWA)	7 January –	27 March, 1980
11.	Electric Hydro-power (Mr. Yuhya HIRASE)	18 January –	24 March, 1980
12.	Agro-Economy (Mr. Shoji YAMADA)	18 January –	27 March, 1980

Counterpart Personnel Assigned to the Project (Phase II)

1.	Mr. Jose B. del Rosario, Jr.	Director, Project Development Dept., NIA (Overall Coordinator)
2.	Mr. Isidro R. Digal	Head, Planning Section, PDD, NIA
3.	Mr. Erdolfo B. Domingo	Senior Planning Engineer, PDD, NIA (Project Coordinator)
4.	Mr. Deoloses Suelen	Senior Agro-Economist, PDD, NIA
5.	Mr. Alfonso V. Galapon	Senior Agronomist, Land Use Section, PDD, NIA

6.	Mr. William L. Reodica	Senior Planning Engineer, PDD, NIA
7.	Mr. Jovito A. Navarro	Supervising Hydrographic Engineer, PDD, NIA
8.	Mr. Francisco A. Alhambra	Senior Drainage Engineer, PDD, NIA
9.	Mr. Manuel U. Estefanio	Senior Design Engineer, PDD, NIA
10.	Mr. Orlando F. Gascon	Senior Electrical Engineer, PDD, NIA
11.	Mr. Orlando C. Villalon	Geologist, PDD, NIA
12.	Mr. Teofilo C. Anyaya	Senior Soil Technologist, PDD, NIA

CHAPTER II. ECONOMIC BACKGROUND

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A. National Economy

The Philippines has the national land area of about 300,000 sq.km, and population of about 42.50 million (as of 1975), from which the population density is estimated at 140 persons/sq.km. The population had increased at the rate of 2.9 percent annually between 1960 and 1969, but the annual growth rate has been reduced to 2.7 percent since 1970. An average family is composed of 6.1 persons, among whom persons over 15 years of age can be counted as workable population. The estimated workable population in 1975 in the country was about 23.58 millions, about 61 percent of which, 14.43 millions, were occupied persons The sectoral ratios to the total occupied persons recorded in 1975 were 53.5 percent for agriculture and fisheries, 15.2 percent for industry, 31 percent for commerce and service and 0.3 percent for others, respectively. Comparison of this composition with that in 1960 revealed the tendency of decreasing in agriculture and fisheries sector, increasing in commerce and service and remaining uncharged in industry.

The Philippines has 12 administrative Regions, each of which is composed of many provinces. The gross national product (GNP) of the nation amounted to 77.28 billion pesos in 1977 on the 1972 price basis and reached 81.96 billion pesos in 1978 with the annual growth rate of 6.1 percent. The economic growth, however, has shown a slightly decreasing tendency as learnt from the comparison of GNP growth rate by 6.9 percent in 1975 - 1976 and 6.3 percent in 1976 - 1977. GNP per capita was increased by 3.1 percent for 1977 - 1978, exceeding the population growth rate in the same period. GNP per capita in 1978 was converted into ₱ 3,745 on the current price basis.

The prices of commodities in the country, although being stable up to 1978, has begun to show upward tendency since 1979, and the price hike of the petro-chemical goods in February, 1980, has resulted in instability of the prices of the general commodities. The price index for consumer goods has been increasing gradually on the national on the 1972 price basis by 9.6 percent in February, 1978, 8.4 percent in February, 1979 and 21.9 percent in Februayr, 1980, respectively. The retail price index for the general items in Metro Manila has also been increasing annually, by 3.8 percent in February, 1978, by 10.2 percent in February, 1979 and 26.3 percent in February, 1980, respectively, on the 1972 price basis. The price increasing rates of construction materials are recorded by 3.8 percent, 21.4 percent and 20.5 percent in the respective years as above, and those of fuel oil by 3.5 percent, 2.9 percent and

54.1 percent respectively. The indexes of the above two items have been marked considerably higher than those of the general items.

In the national economy in 1975, the revenue was 15 7 billion pesos, while the expenditure 17.0 billion pesos. Approximately 88 percent of the total revenue was earned in tax, and the major items of expenditure were those costs for economical developments of 49 percent, social development of 17 percent, defense of 16 percent, etc.

Gross domestic product (GDP) in 1978 amounted to 82.09 billion pesos on the 1972 price basis, and the sectoral ratios were 26.4 percent for agriculture and fisheries, 24.4 percent for manufacturing industry, 7.3 percent for construction 2 2 percent for mining, 0.9 percent for electricity/gas/water supply, 5.2 percent for transportation and communication, 20.8 percent for commerce, and 12.9 percent for services

Comparison of annual GDP growth rates in 1975 - 1976 and 1977 - 1978 on the 1972 price basis suggests that declining tendency has appeared in construction sector from 28 1 percent to 6.8 percent and agriculture and fisheries from 8.0 percent to 4.8 percent, whereas upward tendency in manufacturing from 5.7 percent to 6.8 percent and services from 5.5 percent to 6.3 percent.

The major farm products of the Philippines are paddy rice, sugar cane, coconuts (including copra) and banana.

The study on these products in terms of shares by values added on the 1972 price basis reveales that the shares of sugar cane and coconuts have been decreasing whereas that of banana has been increasing. On the other hand, the share of paddy shows steady upward tendency by 28 percent in 1976 and 30 percent in 1978 to the total value added of these products.

The international trade of the Philippines is characterized by export of primary products and import of industrial manufactured goods, and the balance of payment is in deficit by over-import every year. The turnovers in 1976 were 2.57 billion dollars in export and 3.63 billion dollars in import.

Sugar and copra have been decreasing in their export since these few years. Fuel oil occupies about 25 percent and machinery 17 percent of the total import amount. Of the total import in 1976, about 27 percent was occupied by Japanese origin goods, 22 percent by American origin, 17 percent by Mid- and Near-East origin, 12 percent by EC origin and 13 percent by ESCAP member countries origin, respectively.

The Philippines has recently accomplished its target of self-sufficiency in paddy, which has resulted in enabling the nation to export paddy by about 230,000 tons annually since 1977. And it is reported that about 250,000 tons of exportable surplus will be secured from June, 1980 to March, 1981.

In compliance with the Presidential Decree issued January 1, 1978, the Philippine Authorities concerned have established the development plans for the short range, the medium range and the long range, covering five years between 1978 and 1982, 10 years between 1978 and 1987 and the long term up to the year of 2000, respectively. All of these plans are of consistency with the philosophy of development to pursue the New Society.

An old concept for the development merely implied that the development was a movement toward economic growth represented by GNP and income per capita. The new development programs prepared under the Presidential Decree, however, aim at not only economic development but improvement of social welfare. Such an intention of the Government can be learnt from the fact that the projects planning involves pursuit of Social Justice as nucleus of the development.

One of the characteristic feature of these plans is that agricultural development shall go together with industrial development with the same magnitude of stress placed on. A steady increase in agricultural productivity will allow farming labor to transfer to the industrial sector, and furthermore, an increase in farm income will raise the demands for the industrial products, giving impacts to manufacturing industries in their production promotion, as well as resulting in expansion of not only the domestic market but the international market.

The weights to be placed on the agricultural sector and the industrial sector will be identical in their levels by 1987. The industrial development is never realized at the expense of agricultural sector, but the incessant development of agriculture will maintain its vitally important role in the national development as supplier of foods and primary products, creator of effective demands and offerer of additional labor opportunity.

The water resources development plans have a prospect that the irrigated paddy fields to be required for meeting the national food demand are 1.77 million hectares in 1977 and 1.92 million hectares in 1987, respectively. The irrigated field available, however, are short in acreage of 770 thousand hectares at present, and the 10-year development plan states that about 1.4 million hectares of paddy fields will have to be additionally turned into irrigable fields by 1987. The irrigated paddy fields available

in 1987 are expected to reach 2.17 million hectares, accordingly. The investment to be required for accomplishing the said irrigated field development program will have to be made by 11.86 billion pesos from 1978 to 1982 and 12.74 billion pesos from 1983 to 1987, respectively. The sum of these two investments occupies about 50 percent of the total investment amount allotted for the water resources development plan, including water works, sewerage, flood control, etc.

The water resources development plan involves a power generation scheme. According to the Government's energy development program, the energy consumption was 83.4 MMB in oil equivalence in 1977, and the prospective value in 1987 will be 190 MMB in oil equivalence. In order to cope with the situation, the authorities concerned have made an energy supply plan that the oil-thermal powers generation, the share of which was about 94.3 percent in 1977, will be reduced to 68.1 percent in 1987 by substituting hydropower, coal-thermal and geo-thermal powers in increasing from 5.3 percent to 10.9 percent, 0.6 percent to 7.4 percent and 3.8 percent to 5.6 percent, respectively.

The major economic indices of the relevant 10-year development plan are shown as follows

The annual growth rate of GNP and GNP per capita from 1977 to 1978 were 7.0 percent (1972 price basis) and 3.9 percent, and those rates from 1982 to 1987 are set at 8.0 percent and 5.0 percent, respectively. When converted into current prices, GNP per capita in 1987 will be raised up to 10,580 pesos from 3,376 pesos in 1977.

The sectoral annual growth rates of the NDP (Net Domestic Production) in the period from 1978 to 1987 are expected to be 5.3 percent in agriculture and fisheries, 10.8 percent in industries, and 7.4 percent in services.

B. Regional Economy

The Ilocos Norte province is located in the northwestern part of the north Luzon. The total land area of the province is 3,399.3 sq.km, equivalent to 1.1 percent of the total national land area. It takes about 1.5 hours by plane or about 11 hours by bus from Manila to Laoag, the provincial capital.

Population of the Province was 371,724 persons in 1975, and its density per square kilometer was estimated at 109 persons. The population growth rate from 1970 to 1975 was marked by 1.6 percent, which is below the growth rate of 1.8 percent from 1960 to 1970.

The population growth rates as to the Project related municipalities were found by increase from 1.2 percent to 1.8 percent in the Phase I Area and decrease from 2.4 percent to 1.3 percent in the Phase II Area.

The population of people over 15 years of age in the Province was estimated at 226,772 persons, about 45 percent of which was occupied person. Furthermore, the population of these gainful occupations was specified into those engaged in the primary industry by 65.5 percent, the secondary industry by 10 percent and the tertiary industry by 24.5 percent, respectively. The mining and manufacturing industries include the industrial establishments of mining by 420 firms, manufacturing by 2,929 firms and electricity supply by 11 firms. Scarcity in number of electricity enterprises has resulted from inability to easily secure electric power in the most part of the Province. The Ilocos Norte Province is famous for its hand weaving cottage industry holding about 3,000 weavers who are working in mainly Paoay, Batac, Espirit, Solsona, Dingras, San Nicolas and Laoag. Other cottage industries comprise ceramic manufacturing, salt manufacturing, mat weaving, bamboo craft works, and processing of local alcholic drinks.

Non-industrial establishments include wholesaling by 3,540 firms, transportation by 1,001 firms and money lenders by 61 firms.

The Ilocos Norte provides a great deal of potential for mining development with plenty of resources such as copper, manganese, silver, cement, feldspar, iron, limestone, graphite, etc.

The Ilocos Norte province involves about 32,300 ha of arable lands, 2,700 ha of perenial crops growing fields and 4,100 ha of permanent grass lands. The arable lands included in the Project related municipalities occupy about 28 percent of the total provincial arable lands in the Phase I Area, and 26 percent in the Phase II Area.

The agricultural census conducted in 1977 revealed that the respective actual cropping acreages of paddy, tobacco, garlic and mungbeans in the Province are about 31,500 ha, 3,050 ha, 1,920 ha and 1,680 ha. And the shares of the respective cropping acreages in the Project Area (Phase I Area plus Phase II Area) of the above are 53 percent, 77 percent, 72 percent and 55 percent. In particular cropping acreages of tobacco and garlic in the Phase II Area occupy about 66 percent and 76 percent of those in the Province.

The paddy rice produced in the Province has been consumed locally, and the good harvest of paddy in 1979 allowed to export about 1,300 tons of rice in surplus.

Tobacco and garlic, being major cash crops in the Province, have contributed to the national economy as foreign exchange earners The agricultural production in the Province, however, has been said not to meet with the provincial demand. The farm management survey has revealed that lowness in productivity and growing ratio of the dry season paddy as well as high land rents for the tenants have reduced the amount of disposable rice by farmers. The major cash gainers in the Phase II Area are tobacco and garlic. The originally small farm-size per farmer in Ilocos Norte has accelerated discharge of the labour to some extent. This will come from the fact of imbalance between human resources and land resources.

Of 3,399.3 sq.km of the total land area of the Province, the public forest land occupies 1,950 sq.km, and a reforestation plan is made for 562 sq.km of the above public forest land. The said reforestation plan covers 16 municipalities out of toral 23 municipalities in the Province, and all of nine municipalities of the Phase I and II Area are involved. The reforestation plan, however, has not been smoothly promoted, resulting in insufficiency of water supply due to basin conservation.

Passengers cars, trucks, buses, jeeps, trailors, motorcycles and tricycles are the major means of transportation, but no railway services available at present. The Laoag airport is in the Laoag city and two flights a week available in the route of Manila-Appari-Laoag-Basco.

The total extension of roads in the Province is about 2,657 km, which include 291 km of the national highway, 434 km of provincial roads and 1,932 km of community roads (municipality and village roads). The national highway is specified to concrete paved roads of 79 km, asphalt paved roads of 46 km and gravel paved roads of 166 km. In the province, navigation is not so popular means of transportation at those by land, and Crimao is only one port site available in the Province.

The major farm products in the Province are paddy, Virginian tobacco and garlic. The marketing of rice has been carried out by the NGA and some rice merchants. The NGA has been handling about 12 percent of rice in the market in the Province, providing the warehouses in Laoag and Dingras. The former warehouse is used for controlling rice produced in the Phase II Area, while the latter in the Phase I Area. Furthermore, rice produced in the north of the Province will be controlled by the warehouse to be constructed in Bantay.

The so-called trading centers, which are located concentratively in the Phase II Area, are the facilities to handle Virginian tobacco produced in the Area.

Garlic has been marketed through very intricated channels. The public markets in Laoag, Batac, Pinili, Badoc and Sinait are the trading centers for collecting garlic. Tobacco and garlic are forwarded to Manila through national highways. Rice produced in the Area is supplied to the Region I, La Union and Bagio, which tends to suffer from shortage in rice, and any surplus rice, if produced, will be exported from the port of San Fernando

The Region I has established a five-year Regional Development Investment Program (1981 - 1985) for seven provincies and five municipalities under its jurisdiction, and the authorities of the Ilocos Norte province has announced the Provincial Development Investment Plan as a component of the above regional program. This plan aims at accomplishing the following targets; i) to increase the labor opportunity, ii) to increase income and wealth with their reasonable distribution, iii) to expand infrastructures as well as to upgrade them, iv) to make social development and to promote the social justice and v) to keep ecological balance and to conserve the environment.

The planned investment for five years is 6.56 billion pesos for the Region I, and 550 million pesos will be invested to the Ilocos Norte province. The sectoral investments to the Province can be specified as 49.7 million pesos for crops production, 7.7 million pesos for fisheries, 11.6 million pesos for animal husbandary, 56.5 million pesos for forestry, 14.4 million pesos for soil and land conservation, 206. million pesos for industry, trading and tourism, 20.0 million pesos for social services, and 372.0 million pesos for infrastructures.

The investment for infrastructures occupies about 68 percent of the total investment, and 10 irrigation development projects are involved, comprising the Palsiguan River Multipurpose Project. The first priority is assigned to these 10 projects in the general planning.

CHAPTER III. THE PROJECT AREA

CHAPTER III. THE PROJECT AREA

A. Locational Conditions

1. Location and Road Systems

The Project Area is located at the north end of Luzon island, facing the South China Sea at the south and the west and being bordered by the Cordillera Mountain Range and the Ilocos Mountain Range at the northeast and the south-east, respectively. The area is included in the Region I and extends to three provinces of Ilocos Norte, Ilocos Sur and Abra, and most of the Project Area belongs to Ilocos Norte; the Project Area of 22,600 ha of farm land consists of the flat land extending south of Laoag city, provincial capital, and of alluvial fan developed south-eastward.

As for road networks, a national road, Route 3, runs northward through Badoc, Batac and Laoag city. On the other hand, the road system leading to the right bank of the Bonga river has two bridges to access to Solsona and Papa areas, but only ferry, although it frequently stops services during flood time, is available to access to the other areas from the right bank area.

In the Area, gravel-paved village roads are partly available, but crossing structures over canals are heavily deteriorated. Batac-Paoay and Pinili-Badoc-Sinait areas are rather convenient in being connected by provincial roads and the national road, Route 3, and these roads are paved mostly with gravel but partly by concrete.

2. Population and Living Conditions

The Project Area consists of parts of ten administrative blocks (municipalities) and includes 150 villages. The population in 1975 is 788,000 in Ilocos Norte and Ilocos Sur provinces. In the ten blocks, the statistics for the Project Area indicates 100,550 of population, 19,000 of farm families, 1.6 percent of annual population growth rate which is less than the Luzon average. The average size of farm family is 5.3 persons.

As for power supply, the NPC, in accordance with the electrification program, proceedingly electrifies and supplies power to the subject areas. In the Project Area, 64 barrios, as of the date, have been electrified and 86 barrios have not. However, the Project is expected to give an impact to accelerate electrification for the whole Project Area. As for drinking water, utilizing abundant groundwater, farmers take water from their private wells. Most poblacions in the Project Area have their own water supply systems.

B. Physical Conditions

1. Topography and Rivers

The Project Area is roughly divided into three areas, i.e. [1] 11,610 ha of the right bank of the Bonga river, the alluvial fan developed by the Bonga river and its tributaries, [2] 5,190 ha of sedimentary plain around Batac and Paoay, developed by the Quiaot and the other rivers, and [3] 5,800 ha of the alluvial fan and sedimentary plain developed by the Badoc river.

For the area [1], the land slope ranges from 1/80 to 1/150 and the elevation is 30 - 140 m above sea level. As for water resources, the rivers running through the area, the Labugaon, Solsona, Madongan and Papa rivers are utilized. For the area [2], no water source is available from the river flow throughout the year and only rain water in the wet season is available.

The area [3] is divided into two by the Badoc river; the right bank area is 1,400 ha around Pinili, and the left bank consists of hills about 100 m in elevation and flat plain below EL. 40 m, and the Project Area extends from foot of the hills to the coast.

2. Climate and Hydrology

a) Climate

The hydrologic characteristics prevailing in the Project Area are determined largely by the climate of the region which is classified into the Type I climate zone having two pronounced seasons, i.e., the dry season in November to April, and the wet season in the rest of the year.

Climate factors to characterize the Project Area are magnitude and distribution of rainfall, effect of wind, temperature, humidity and evaporation.

Rainfall

Rainfall observation relevant to the Project Area has been made at Laoag, Bonga, Alabaan, Solsona, Vigan and Langangilang stations. Of these stations, rainfall observed at Laoag Airport is selected as a representative record which covers long term with high accuracy.

Average annual rainfall amounts to 2,016 mm, of which 96 percent concentrates in the wet season (May to October), and the climate is distinguished by two seasons.

Rainfall in mountainous regions has not been observed; however, the data at Langangilang station in the Abra river basin adjacent to the Project Area presents one of the mountainous rainfall. The average annual rainfall is 3,216 mm and 89 percent of it is distributed in the wet season.

Temperature

Daily mean temperature at Laoag indicates that variation of temperature for each month is little from 24.4°C in January to 29.2°C in May, and the annual mean is 27.0°C. Under such conditions, the Project Area is considered to be favorable to growth of various crops.

Relative Humidity

Relative humidity varies as little as temperature and its annual average is measured by 79 percent.

Wind

Wind observations indicate that the wind direction is rather variable from June to September but the northerly wind prevails from October to May in the Ilocos region. Wind velocity ranges from five to seven kilometers per hour.

Evaporation

Although long term observations have not been made within the Project Area, modified evaporation is adopted for the area by applying the ratios of monthly mean evaporation observed from 1970 to 1974 at Laoag and Vigan, while for the computation of evaporation at Vigan during the period of 1951 to 1979 is made by using Penman method. The monthly evaporation varies from 109 to 274 mm and its mean value is 191 mm. The annual mean evaporation is 2,292 mm.

Typhoons

Northern parts of the Archipelago where the Project Area is located are visited by typhoons, mainly from June to October, which bring a great deal of rainfall.

b) Present Status of Hydro-Meteorological Observations and Available Data

Hydro-meteorological observations relevant to the project studies have been made under the control of the NIA, the MPW and the PAGASA. The main stations including those providing the equipment prepared by the JICA are shown in the following table.

Table 3-1 Hydro-meteorological Observation Networks

Item	Station	Location	Recorder	Installed Date	Agency	Available Period	Note
Rainfall							
	Laoag	Laoag Airport, Laoag City	Automatic	1935	PAGASA	1949-present	
	Bonga	Bonga RGS Bangay, Dingras	Standard	1948	MPW & PAGASA	1950-present	No record period included
	Lumbad	Lumbad, Dingras	-do-	Aug. 11, 1976	NIA	1976-present	-do-
	Alabaan	Alabaan, Dingras	-do-	Apr. 1, 1976	MPW & NIA	1946-present	-do-
	Solsona	Manalpac, Solsona	-do-	Sept. 1976	NIA	1976-present	-do-
	Madongan	San Marcelino, Padong, Dingras	Automatic	July 11, 1978	NIA	1978-present	Newly installed Station
	Palsiguan	Baybayation	-do-	July 28, 1978	NIA	1978-present	-do-
	Badoc	Badoc, Ilocos Norte	-do-	June 21, 1978	NIA	1978-present	-do-
Evaporation							
	Lumbad	Lumbad, Dingras	-do-	July 5, 1978	NIA	1978	-do-
	Alabaan	Alabaan, Dingras	-do-	June 22, 1978	NIA	1978	-do-
	Badoc	Badoc, Ilocos Norte	-do-	June 21, 1978	NIA	1978	-do-
River-stage							
	Labugaon	Maananteng, Solsona	Staff Gauge	Aug. 9, 1978	NIA	1978	No cable way
	Solsona	Manalpac, Solsona	Automatic	June 20, 1978	NIA	1978	Newly installed Station
	-do-	-do-	Staff Gauge	Apr. 1, 1946	MPW	1946-present	
	Madongan	San Marcelino, Padong, Dingras	Automatic	July 24, 1978	NIA	1978	Newly installed Station
	Bangay	Bangay, Dingras	Staff Gauge	1946	MPW	1946-1976	
	Pablacion	Pablacion, Laoag City	-do-	1959	MPW	1959-1974	
	Madupayas	Balbaldez, Badoc	-do-	Nov. 4, 1978	NIA	1978-present	Newly installed Station
	Tibangran	Balbaldez, Badoc	-do-	Oct. 1, 1978	NIA	1978-present	-do-
	Palsiguan	Baybayatin, Lagayan, Abra	Automatic	July 28, 1978	NIA	1978-present	-do-

Available Data

As shown in the preceding table, eight rainfall stations are provided within the Project Area. However, the data from the seven stations except Laoag involve no recording periods and problems in accuracy; accordingly, it was judged that those were not suitable as a typical rainfall of the area.

Rainfall data at Laoag station are collected for 29 years from 1949 to 1979 for the selection of the design year, computation of the water requirement and the drainage capacity.

Evaporation is mainly based on the monthly data at Vigan computed by Penman method. As for the river discharge, the recorders were installed at the proposed sites and observations were commenced from June or July, 1978, and hence only limited records are available.

The discharge data of the Solsona river observed under the MPW are available for estimation of the long term river run-off within the Area by applying its specific dishcarge to each river. The observations under the MPW have been made since April 1946.

The obtained data show annual runoff in some years during the period from 1946 to 1959, having a tendency to present excessive values comparing with its catchment area, whereas, run-off since 1971 indicates too low values.

Considering the above-mentioned conditions, the data available for the project studies such as computation of water balance are selected for 11 years, 1960 to 1970.

Regarding run-off of the Palsiguan river, river-stage and discharge measurements have been commenced recently. For the overall studies, the estimation on Palsiguan run-off is primarily based on specific discharge observed at Pang-ot station of the Tineg river closely to the Palsiguan river, judging from observed run-off of the Palsiguan river in 1979.

c) Water Resource of the Project

The water resources to be developed consist of five rivers in Phase I area located at the right bank of the Bonga river; Labugaon, Solsona, Madongan, Papa, Nueva Era, and three rivers in Phase II area; Madupayas, Tibangran, and Palsiguan.

The amount of water resources at each river is shown in Table 3-2 on the basis of the specific discharge of the Solsona except the Palsiguan.

Table 3-2 Water Resources at Each River in the Project Area

(Unit: MCM)

Year	Phase I						Phase II					
	Labugaon	Solsona	Madongan	Papa	Nueva Era	Sub-total	Madupayas	Piding[1/]	Tibangran	Palsiguan	Sub-total	Total
	(100.5 sq.km)	(79.0)	(153.8)	(51.4)	(52.4)		(24.3)	(50.5)	(72.7)	(153.0)		
1960	188.4	148.1	201.8	96.4	98.3	733.0	20.4	42.4	61.0	356.3	480.1	1,213.1
1961	284.9	224.0	300.9	145.7	148.7	1,104.2	35.9	74.6	107.4	396.7	614.6	1,718 8
1962	293.0	230.3	394.5	149.8	152.9	1,220.5	37.0	76.9	110.6	389.0	613.5	1,834 0
1963	237.7	186.8	323.7	121.6	124.0	993.8	29.5	61.3	88.2	326.2	505.2	1,499 0
1964	399.7	314.2	446.5	204.4	208.6	1,573.4	46.2	96.0	138.3	444.6	725 1	2,298.5
1965	259.3	203.8	285.7	132.6	135.3	1,016.7	29.9	62.1	89.4	285.7	467.1	1,483 8
1966	246.5	193.8	271.7	126.1	128.7	966.8	27.5	57.2	82.3	245.8	412.8	1,379.6
1967	346.4	272.3	440.0	177.2	180.8	1,416.7	36.8	76.5	110.0	346.3	569.6	1,986.3
1968	241.3	189.7	251.1	123.4	125.9	931.5	28.6	59.4	85.6	351.2	524.8	1,456.3
1969	179.0	140.7	241.0	91.5	89.4	750.6	21.0	43.6	62.9	384.6	512.1	1,262.7
1970	170.8	134.3	156.8	86.4	89.1	637.3	15.4	32.0	46.0	371.3	464.7	1,102.0
Mean	258.8	203.5	301.2	132.3	135.5	1,031.3	29.8	62.0	89.2	354.3	535.4	1,566 7

Note: 1/ Runoff amount at the existing weir, Piding.

As for the estimate of the water resources in the Madongan, considering that the relation between the catchment area and the annual run-off per square kilometer has a general tendency of inverse proportion, an applied discharge of the Solsona was modified by comparing each specific discharge of Bongay and Laoag stations located at downstream of the Bonga river.

The annual water resources available in Phase I and Phase II areas including that of the Palsiguan amount to 1,031 MCM, 535 MCM respectively, and total 1,567 MCM, which are abundant to meet the water demand However, 80 percent of it is distributed in the wet season and this fact brings a limitation to the crop cultivation in the dry season.

To store the surplus water in the wet season for supplying to the area suffering from water shortage will exert a great effect to the agicultural development of the area, and in addition, will reduce flood damages taking place in the area at present.

At the proposed Palsiguan dam site the water resources estimated by the Tineg run-off range from 246 to 445 MCMper annum and come to 354 MCM as a mean.

d) Design Flood Discharge

A flood analysis to determine design flood discharge for each proposed structures has been made on the basis of observed peak discharge at the Laoag river basin - Solsona, Bonga, Laoag rivers - and at the Abra river basin - Tineg, Abra rivers.

Probable flood discharge obtained by Hazen Formula is shown as follows:

Probable Flood Discharge at Each Basin

o Laoag River Basin

Proba-bility	Solsona River (C.A. = 73 sq.km)		Bonga River (C.A.=534 sq.km)		Laoag River (C.A.=1,355 sq.km)	
	Flood (cu.m/sec)	Specific Dis. (cu.m/sec/sq.km)	Flood	Specific	Flood	Specifc
1/5	295	4.0	1,700	3.2	8,600	6.3
1/10	450	6.2	2,500	4.7	10,500	7.7
1/50	940	12.9	5,000	9.4	15,000	11.1
1/100	1,220	16.7	6,400	12.0	17.000	12.5

o Abra River Basin

Probability	Tineg River (C.A. = 1,024 sq km) Flood (cu.m/sec)	Specific (cu m/sec/sq.km)	Abra River (C A. = 2,575 sq.km) Flood	Specific
1/5	1,900	1.9	3,900	1.5
1/10	2,400	2.3	4,500	1.7
1/50	3,500	3.4	5,600	2.2
1/100	4,100	4.0	6,000	2.3

Each specific discharge at both river basins shown in the above table has a considerable difference in the same probability, i.e. the values in the Abra river basin become lower than those in the Laoag river basin.

For computation of design flood discharge at each proposed diversion site, specific discharge obtained from the Solsona river was selected, taking into consideration the scale of the catchment area and similarity of hydrologic characteristics of the river basin of those of the proposed sites.

Concerning the design flood discharge for the proposed Palsiguan dam, direct application of specific discharge obtained in the Abra river basin is not suitable due to its conservativeness, considering the scale of the catchment area.

Generally, specific discharges have a tendency to decrease in accordance with the increase in the catchment area. The catchment area at the Palsiguan dam site is too small at 153 sq.km, as compared with those of other rivers except the Solsona as listed in the table mentioned above.

Therefore, the estimation of design flood discharge for the Palsiguan dam is more favorably made on the basis of the specific discharge obtained from the Solsona, in considering additionary the applied values for the existing and proposed fill type dam in the Luzon island.

The applied return period, allowance and selected design flood discharge for each structure are shown as follows:

Design Flood Discharge

Area	Structures	Catchment Area (sq.km)	Return Period (years)	Allowance (%)	Design Flood Discharge (cu.m/sec)
Phase I	Labugaon Div. Dam	100.5	50	0	1,310
	Solsona Div. Dam	79.0	50	0	1,030
	Madongan Div. Dam	153.8	50	0	2,000
	Papa Div. Dam	51.4	50	0	670
Phase II	Madupayas Div. Dam	24.3	50	0	320
	Tibangran Div. Dam	72.7	50	0	950
	Nueva Era Dam 1/	52.4	100	10	970
	Palsiguan Dam 2/	153.0	100	20	3,070

Note: 1/ Concrete dam
2/ Fill Dam

e) Sediment

No observation has been so far made on the amount of sediment materials in the rivers to be developed. Therefore, sediment amount to the Palsiguan Reservoir is estimated at 1,500 cu.m/sq.km/year on the basis of the existing data measured at the Pampanga, Agno and Cagayan river basins and the applied value by the NIA (refer to "Palsiguan River Multi-Purpose Project" Report p.42). This value is also applied to the Nueva Era Dam.

Structures	Life Time (years)	Sediment Amount (MCM)
Palsiguan Dam	100	23.3
Nueva Era Dam	50	3.9

3. Groundwater

A groundwater survey was performed at 42 existing wells in 1979 for supplemental irrigation in the dry season, and it has been revealed that the groundwater table ranges between two to three meters below ground surface in the middle and lower portions and 10 meters below ground surface in the upper portion. In general cases, however, the groundwater table is high in the upper portion, and low in the lower portion. The groundwater sharply rises at the beginning of the wet season, and stands nearly at the elevation of ground surface almost throughout the wet season.

Survey data indicate that the composite alluvial fan formed by the Cura, Labugaon, Solsona, Madongan, Papa rivers, etc., is considered as one groundwater

basin. The groundwater recorvery and annual safety yield of this groundwater basin are estimated as follows:

Safety Yield

The survey data indicate that groundwater flows toward the Bonga river along the ground surface of the alluvial fan throughout the year. As mentioned above, infiltrating water from paddy fields causes a sudden rise of groundwater level at the beginning of the wet season to keep a high water level nearly equal to the ground surface throughout the wet season. The annual groundwater recovery is estimated from the groundwater hydrograph and specific yield at 145 MCMin the whole Project Area, and about 90 percent of the groundwater recharge is concentratedly made during May to October. A half of the groundwater recovery is presumably made from rain water, and the other half from the other sources such as river water.

Annual Safety Yield

In general, the annual safety yield for lifting water is limited to 20 to 30 percent of the annual groundwater recovery in the technical and economic terms. The paddy fields of about 2,400 ha will be newly developed in the Project resulting from increase in groundwater recovery. The annual safety yield is computed at 35 to 49 MCM taking into consideration the annual safety yield mentioned above and the groundwater recovery brought about by irrigation water in newly developed paddy fields.

The groundwater exploitation has been taken up for the supplemental irrigation in the dry season from November to April. Therefore, the groundwater might draw down by two to three meters in the Project Area. The existing wells in the Project Area are mostly shallow. Hence, groundwater lifting would become impossible sometimes in the dry season unless any proper countermeasures are taken.

According to the above, it can be said as follows:

1) The safety yield of groundwater in the whole Project Area ranges from 35 to 49 MCM per year. This quantity is smaller than the water requirements from the whole Phase I Project area;

2) If this quantity of groundwater is lifted in the dry season, it causes to lower the groundwater table by two to three meters on an average, and lifting from existing shallow wells will become impossible for some times in the dry season. Some measures will be required against this problem;

3) In general, deeper wells are recommendable to cope with the variation of groundwater table; however, the pumping-out test conducted at Solsona

area suggests that the transmissibility in lower layers is small, and not favorable for groundwater exploitation. If groundwater is lifted from shallow layers through shallow wells, etc., whose transmissibility is large, groundwater table will lower, and make it difficult to lift groundwater. Furthermore, groundwater is required not in the wet season when the groundwater table is high but in the dry season when groundwater table is low. Laege-scaled water supply facilities are needed, which makes the groundwater exploitation economically not feasible, and

4) Taking into account the above-mentioned, a large-scaled and systematic groundwater exploitation for supplemental irrigation in the dry season is not recommendable.

4. Geology and Soil

a) Geology

The geology of the Project Area is based on marine effusive rock of prophilitic basalt or andesite, mainly composed of neogene diorite, marine clastics of olygocen, miocene and pliocene which penetrate the basement, and sediment of alluvial fan, river bed, littoral, etc. since quaternary.

The andesitics, as basement, are main components of Cordillera Central Mountain of Northern Luzon, extending widely in the east part of the Project Area. The main structure sites such as Palsiguan dam, headrace, Nueva Era dam 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, widely outcropping at Labugaon, Solsona and Papa diversion dam sites and the upstream of Palsiguan dam site where some lithofacies of granodiorite may be found.

The Bonga area is located in the composite alluvial fan developed by the main and the tributaries of the Bonga river such as the Labugaon, Solsona, 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 shellfish fossils, 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 river systems from the hills.

The area along the coast at the back of the sand dune is also a part of Project Area.

The structural lines in the Project Area are estimated at three fault lines: one runs NNE-SSW along the main direction of North Luzon structural line, another along the starting points of the alluvial fans in Bonga area, and the rest along the hilly area in the center of the Project Area.

Palsiguan Dam

The geology of Palsiguan dam and reservoir site is composed of volcanic products of basalt, quartz andesite and penetrated diorite.

As for these rocks, well-developed beddings and joints are numerously observed, but the rocks themselves are hard enough. Accordingly, little attention will be necessarily paid to bearing capacity of the rocks, whereas much to leakage. All over the catchments located in the Cordillera Central Mountain of Northern Luzon, faults and joints along N-S structural line are estimated.

Nueva Era Dam

The site is mainly composed of agglomerate, and partly wedged shales are observed. The ground surface is much weathered, as gravels are weathered onion-like, and the matrix is reddish. The lower strata, as found on the river bed, is very hard and compact, and forms good foundation rock.

From the viewpoint of the elevation, the foundation rock up to 200 m is good and no problem will be found. Also with respect to topography and geology, construction of concrete dams is possible and little trouble will occur on leakage.

b) Soil

Soil in the Phase I Area

The soils of the Phase I area are predominantly composed of alluvial deposits transported from adjacent hills and mountains. The parent materials of soils are fine to coarse sediments deposited on gravelly alluvial strata. Residual red soils were identified to a limited extent in this area.

Generally the soils of this sub-project area were classified into three main groups based on landscape and physiographical conditions, 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, blonging to first group, 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 is shallow to very deep and the internal drainage is poor to good. The organic matter contents and natural fertility range from medium to high in root zone of crops. The cation exchange capacity and the base saturation are also in the range from medium to high. The pH (H_2O, 1:1) of the top soils ranges from 5.3 to 6.4. These soils are considered to provide high productivity in growing both paddy rice and diversified crops. According to the soil survey and investigation by the NIA and JICA team, the six soil series were identified, namely, Austin, Gapan, San Manuel, Solsona, Tagulod and Umigan series.

The soils found in highlands, belonging to the second group, constitute the upland soils. These are composed mainly of residual soils developed through weathering and leaching. The characteristic features of the soils are to provide the very friable A and B horizons and reddish color. The soil texture is clay loam to clay and internal drainage is from fair to good. The identified soil series of this group in the Project Area was named Cervantes series.

The soils belonging to the third group developing along the tributaries of the major rivers including the Bonga river, are composed of clean sand and gravels There are no developed soil cover and soil profile. The land with these soils is specified into barren strip, brush or grass growth and secondary forest in terms of land use.

Soils in the Phase II Area

The soils of this sub-project area were classified into four main groups based on landscape and physiographical conditions, namely: i) soils of the alluvial plain which constitutes the lowland, ii) soils of the upland which comprises the rolling and hilly areas, iii) soils of the dune land and iv) soils of the riverwash.

The soils of the alluvial plain, specified into the first group, are formed mainly with alluvial sediment. Their color ranges from pale brown to dark gray and their texture varies from sandy loam to fine clay. The soil depth is medium to very deep, internal drainage is poor to good, and cation exchange capacity and exchangeable cation contents are generally high except the soils of Cura area. The soil reaction (pH-H_2O) of the soils in Cura and Nueva Era (left bank) area ranges from 5.3 to 6.5. On the other hand, the reaction of the soils in Batac-Paoay, Pinili and Badoc-Sinait areas ranges from 7.1 to 8.0. This fact suggests that the soils in the latter are influenced by the geology with limestone in adjacent hills. Available phosphate contents are generally low in the most parts of the Project Area. With phosphate added, the alluvial soils in the Project Area are considered to be highly suitable for both paddy rice and diversified crop productions.

According to the soil survey and investigation by the BS, the NIA and JICA team, the four soil series were identified, namely, San Manuel, Maligaya, San Fernando and Bantay series.

The second group of soils constitutes the upland soils. Cervantes series developed in Nueva Era (left bank) area is the residual red soil. The characteristics of this soil are its very friable A and B horizons and reddish color Bantay series mapped on the hills in Batac-Paoay, Pinili and Badoc-Sinait areas is the brownish residual soils developed from weathered shale. They are fine loamy to clayey, friable and well-drained soils.

Most of the areas composed of these upland soils are covered with grass, brush and secondary forest. Only a small portion is cultivated with paddy rice, corn, tobacco and vegetables.

The soils of dune land are composed of clean sand or loamy sand. The riverwash is likewise covered by clean sand and gravels The productivity of these lands are very low. They are not suited for farming by usual method. These lands are mapped as the non-arable land.

C. Irrigation and Drainage Conditions and On-Farm Conditions

1. Irrigation Conditions

a) Irrigation Area

Most parts of the Project Area fall in the province of Ilocos Norte, but a part of the area is located in the province of Ilocos Sur. In the Project Area, about 12,290 ha of lands, which are equivalent to 52 percent of the total irrigable area, are under the irrigated condition by the communal irrigation systems, which employ mainly gravity and pump irrigations.

Major water source for gravity irrigation is river water in the Labugaon, Solsona, Madungan, Papa, Bonga, Tibangran and Madupayas river.

Gravity Irrigation Area

The major water distribution under the communal irrigation systems has been made by gravity and their irrigation water is diverted by the permanent concrete dams or brush dams across the rivers. The systems provide numerous irrigation canals reticulately for water distribution, and the canals have both functions of irrigation and drainage.

Pump Irrigation Area

In order to serve for the upland crops such as tobacco, garlic and vegetables in the Phase II area, pumping irrigation is privately operated during the dry season due to scarce water source in the river. Small-size pumps are used for this purpose. Total pump irrigation area is about 1,930 ha in 1980.

Table 3-3 shows detail figures of irrigation area under the communal irrigation systems as of 1980.

b) Irrigation Conditions

Even in the communal irrigation areas of about 12,350 ha, no systematic water distribution facilities are provided to convey water to the terminal areas, and the so-called continuous flowing irrigation has been practiced for both the wet and the dry seasons cultivations. On the other hand, the paddy fields of about 11,150 ha are relying upon rainfall throughout a year (rainfed paddy field), which results in poor production of crops.

Under the circumstances, the water sources development as well as the provision of systematized irrigatoin facilities inclusive of the on-farm facilities are the prerequisite to materialize the double cropping of rice with high yield varieties and upland crops under the Project.

2. Drainage Conditions

a) Drainage Systems

The drainage systems in the Project Area could be divided into two systems by major rivers to drain the Project Area, that is, right bank area of the Bonga river, in which the Bonga river is the main drainage river, and Batac-Badoc area is drained to the Quiaot and Badoc rivers.

The former is subdivided into five blocks by four rivers, Labugaon, Solsona, Madongan and Papa, which are tributaries of the Bonga river. Each block is drained to the Bonga river directly or its tributaries. Topography of the area has a gentle slope from east to west with an elevation ranging from 100 m to 20 m above mean sea level. In this area, no terminal drainage systems are provided, and hense, the communal irrigation canals and existing creeks and used for drainage purposes. On the other hand, the latter, Batac-Badoc area is located in relatively low-lying area ranging from 40 m to 5 m in elevation above mean sea level, and the communal irrigation canals and creeks are also utilized as drainage canals.

Table 3-3 Area of Communal Irrigation System (CIS) in the Project Area

Province	Municipality	No. of CIS	Potential Area (ha)	Wet Season: Irrigated Area (ha)	Wet Season: Non-Irri. Area (ha)	Wet Season: Sub-Total (ha)	Dry Season: Irrigated Area: Gravity: Paddy (ha)	Dry Season: Irrigated Area: Gravity: Upland (ha)	Dry Season: Irrigated Area: Pump (ha)	Dry Season: Non-Irrigated Area: Non-cultivated Area (ha)	Dry Season: Non-Irrigated Area: Upland Crop (ha)	Dry Season: Sub-Total (ha)
Ilocos Norte	Solsona	49	2,373	2,373	–	2,373	1,436	–	–	937	–	2,373
	Dingras	55	2,923	2,923	–	2,923	1,264	–	–	319	1,340(O)1/	2,923
	Marcos	22	1,791	1,791	–	1,791	548	100(V C)2/	0(C)	1,123	20(C)	1,791
	Espiritu	16	1,407	1,351	56	1,407	281	–	73(V T)	953	100(V T)3/	1,407
	Nueva Era	7	53	53	0	53	11	–	–	42	–	53
	Batac	34	1,119	1,119	–	1,119	220	–	647(T.G.M)4/	252	–	1,119
	Paoay	9	320	320	–	320	62	–	120(T G.C)	138	–	320
	Pinili	5	411	411	–	411	76	–	335(T.G)	0	–	411
	Badoc	36	1,007	1,007	–	1,007	185	–	755T G)	67	–	1,007
	Sub-total	233	11,404	11,348	56	11,404	4,083	100	1,930	3,831	1,460	11,404
Ilocos Sur	Sinait	10	945	945	0	945	10	–	–	935	–	945
	Sub-total	10	945	945	0	945	10	–	–	935	–	945
	Total	243	12,349	12,293	56	12,349	4.093	100	1.930	4,766	1,460	12,349

Source: Provincial Irrigation Office in Ilocos Norte and Ilocos Sur as of 1977 and 1980.

Note: 1/ Other crops. 2/ Vegetable, Corn. 3/ Vegetable, Tobacco. 4/ Tobacco, Garlic, Mungbeans

b) Drainage Conditions

There is no drainage damage in the Phase I area which is characterized by the alluvial fan with an average slope of about 1/120. However, in the communal irrigation areas located upstream in the Project Area, flooding scenes in the fields can be seen during the flooding period because of no provision of regulating structures for intake water at diversion site. And besides the drainage problem, devastation of cultivation lands and villages by riverwash, which has been caused by the flooding water as seen generally in the alluvial fan, poses a serious problem to the area. Therefore, it is considered necessary to take adequate countermeasures to prevent the lands from expansion of the river-washed area in the early stage of the development.

In the Phase II area located in relatively low-lying area, some poor drainage conditions are seen in the area along the seashore, especially at the lower reach of the Paoay area during the wet season. The principal causes of the poor-drainage are the lack of adequate well-defined drainage ways to collect and transport the discharge across the land to the outlets, and also the absence of adequate terminal drainage systems. Furthermore, the overflows of the rivers encrossing or traversing the area is observed. Under the situations, it is considered that the adequate countermeasures to prevent the area from flooding and to improve the drainage conditions should be taken in the Project.

3. On-Farm Conditions

Water Distribution Systems

In the Project Area, there are many communal canals with dual purposes of water supply and drainage of surplus water to and from the paddy fields. These communal canals are running across the contour lines The water diverted from the canal flows from the high plots to the low plots and finally reaches the other communal canals or drainage canals. Almost all service areas of the communal canal systems are irrigated by this method, so-called plot-to-plot irrigation.

Farm Roads

The existing farm fields in the Project Area have been scarcely provided with terminal farm roads. Manpower and carabao are the major labor forces in farming works and transportation of farm inputs and outputs. For daily farming practices, farmers access on foot to the fields through the other farmers' fields.

Size and Shape of Farm Fields

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

D. Present Agriculture

1. Present Land Use

About 23,690 ha, 63 percent of the total Project Area, are currently cultivated The remaining 14,095 comprise residential area, right-of-ways, river washed areas, etc as shown in Table 3-4 Most of the cultivated areas are paddy fields except upland crop fields in small acreage

Table 3-4 Present Land Use

(Unit: ha)

Land Category	Phase I	Phase II	Total
Cultivated Area			
Paddy field, Irrigated[1/]	8,097	4,252	12,349
Paddy field, Rainfed[2/]	2,573	8,580	11,153
Upland field[3/]	190	-	190
Sub-total	10,860	12,832	23,692
Non-cultivated Area			
Residential	445	930	1,375
Right-of-ways	156	510	666
Other non-arable land	4,426	7,628	12,054
Sub-total	5,027	9,068	24,095
Total	15,887	21,900	37,787

1/ Communal irrigation area, the NIA Provincial Office, as of 1977.

2/ Paddy field area classified by the NIA, the LRED 1978 minus the area of 1/

3/ Classified areas by the NIA, the LRED 1978.

In 23,502 ha of the total paddy field area, 12,349 ha or about 53 percent are under the irrigated condition by communal irrigation systems, and the balance of 11,153 ha or 47 percent is rainfed.

Almost all the irrigated and rainfed paddy fields are utilized to grow the wet season paddy rice during the wet season. After harvesting the wet season paddy rice, 17 percent of the total paddy fields is grown with the dry season paddy and 30 percent within upland crops, respectively, while the remaining 53 percent left followed. The dry season paddy area is mostly limited to the part of the Phase I area where the irrigation water is supplied by the existing communal irrigation systems. As for the upland crops, 94 percent of the total upland cropping area belongs to the Phase II area. Two major crops of tobacco and garlic occupy 6,233 ha the most cropped area, in the Phase II area, where the irrigation water is available in the very limited area, by the groundwater through operating private small pumps or communal irrigation systems. The fallow land during the dry season occupies 64 percent of the total paddy field in the Phase I area,

and 44 percent in the Phase II area. The lack of the irrigation water is considered as the main reason that such a large area remains as fallow land during the dry season.

In the Phase II area excluding Cura and Nueva Era area, the farm land is intensively utilized. In this area, the farm size is very small due to the high population density against limited cultivated areas. Under the circumstance, numerous small wells have been dug some parts in paddy field areas for the purpose of watering upland crops during the dry season. However, the operation and maintenance cost of pump facilities is a burden to farmers in farm management, according to the result of interviews with many farmers. Moreover, the poor irrigation for the wet season paddy rice often makes the following cropping of upland crops delayed. Generally, the late seeding of the upland crops results in low yields. Therefore, farmers are eager to provide the stable gravity irrigation systems.

2. Number of Farm Families and Farm Size

The number of farm households in the Project Area is estimated at 17,365, which are brokendown as follows:

Table 3-5 Number of Farm Households and Average Farm Size

Area	Cultivated Area (ha)	No of Farm Households	Average Farm Size (ha)
Phase I	10,860	6,774 1/	1.6
Phase II	12,832	10,621	1.2
Total	23,692	17,365	1.4

Source: Population Census, 1975, the NCSO and the BAEcon Barangay Screening Survey, 1976

Note: 1/ Including such farm households who live outside the Project Area but come and stay in the area only during the busy seasons.

The number of those farm households who live outside the Project Area and come to stay working in the area during the busy seasons is estimated at 20 percent of the total farm households in the Phase I area.

The proportion of farm households to the total households is estimated at 86 percent in the Phase I area, at 77 percent in the Phase II area, and at 80 percent in the overall area, respectively, according to the above-mentioned data.

3. Cropping Pattern and Crop Production

a) Cropping Pattern

In the Phase I area, mono-cropping of paddy rice is prevalent in land use, but in the Phase II area, the cropping pattern of "paddy in wet season and upland crops in dry season" is prominently practiced (See Table 3-6) The cropping intensity is computed by 135 percent in the Phase I area, 162 percent in the Phase II area, and 150 percent in the overall area, respectively.

Table 3-6 Present Cropping Pattern

(Unit: ha)

Cropping Pattern (Wet Season)	(Dry Season)	Area Phase I	Phase II	Total
1. Paddy	+ Paddy	3,411	682	4,093
2. Paddy	+ Upland Crops			
- Paddy	+ Tobacco	23	2,322	2,345
- Paddy	+ Garlic	–	3,129	3,129
- Paddy	+ Garlic + Mungbeans	–	782	782
- Paddy	+ Others	389	309	698
(Sub-total)		(412)	(6,542)	(6,954)
3. Paddy (Wet season only)		6,819	5,608	12,427
4. Upland crops (Dry season only)		190	–	190
5. Sugar cane		28	–	28
Total (Physical area)		10,860	12,832	23,692
(Cropping area)		14,660	20,838	35,498
Cropping Intensity		135%	162%	150%

In the Phase I area, the double cropping of paddy rice with high yield varieties has been carried out in about 42 percent of the communal irrigation system areas. The wet season paddy rice is transplanted during June to July, and harvested in Spetember to October. The dry season paddy rice is transplanted as early as possible in October to November since irrigation is available only in the very limited period, and harvested in January to March. In more than half of the areas other than the above-mentioned paddy rice double cropping areas inclusive of the rainfed areas, paddy rice of traditional varieties is planted in the remaining areas. Both varieties of paddy rice are transplanted in little staggering to the above-mentioned wet season paddy rice. But the traditional varieties are harvested December through January because of their photo-periodic sensitivity. After harvesting, most paddy fields are left fallowed throughout the dry seasons

Some farmers grow vegetables in a part of paddy fields after harvesting wet season paddy rice in order to sell at the local markets. However, the area where this pattern can be applied is limited because stable irrigation water supply throughout the year is prerequisite to this pattern. These cropping patterns in Phase I area take about two months from the beginning to the ending of each cropping operation, and the cropping time is easily affected by natural conditions like rainfall patterns.

As for the cropping pattern in the Phase II area, the wet season paddy cropping starts about one month later than that in the Phase I area because irrigation water available is much more limited than that in the Phase I area Almost all varieties are planted in the irrigated area and about 2/3 of the rainfed area is grown to the high yield varieties. The high yield varieties are transplanted July through August, and harvested October through December.

As seen in Table 3-7, the cropping pattern of "paddy rice in wet season and upland crops in dry season" is practiced in 51 percent of the total paddy field in the Phase II area. Among the upland crops, garlic is one of the major crops in terms of the coverage. Although garlic requires to finish seeding by November for securing favorable yield, the seeding time seems to go into December in relatively large area because it is not easy to harvest the wet season paddy before November in the whole area. All of these cropping patterns have comparatively short time lag of around one and a half month for each cropping operation due to such small farm size.

b) Crop Production

An average paddy rice yield in the rainfed area is about 1.3 ton/ha in the Phase I area, and 1.4 ton/ha in the Phase II area. The average paddy rice yield in the irrigation area is about 1.7 ton/ha in the Phase I area, and 2.4 ton/ha in the Phase II area in case of the wet season croppings. But the yield of dry season crop is about 1.4 ton/ha in the Phase I area and 2.3 ton/ha in the Phase II area. (See Table 3-7) Comparing the unit yield of the irrigated dry season paddy rice with that of the wet season, the dry season paddy has less yield. Poor irrigation condition might cause this less yield of the dry season paddy rice.

In the Phase II area, the unit yield of each kind of paddy rice is higher than that in the Phase I area in both cases of the irrigated and rainfed cultivations. One of the major reasons is that the paddy rice cultivation is more intensive in the Phase II area as seen from the fact that the high yield varieties occupy a large coverage in cropping. Moreover, much excessive discharge from the mountainous areas has been left uncontrolled in the Phase I area. Under such conditions, all roads except a few main roads become unpassable throughout the wet season, and this results in the extensive farm

Table 3-7 Present Crop Production

	Crop	Phase I Area Planted (ha)	Phase I Unit Yield (ton/ha)	Phase I Production (ton)	Phase II Area Planted (ha)	Phase II Unit Yield (ton/ha)	Phase II Production (ton)	Total Area Planted (ha)	Total Production (ton)
1.	Paddy Rice								
	Irrigated, Wet	8,041	1.65	13,268	4,252	2.38	10,119	12,293	23,387
	Irrigated, Dry	3,411	1.43	4,878	682	2.25	1,535	4,093	6,413
	Rainfed	2,601	1.30	3,381	8,580	1 41	12,098	11,181	15,479
	Sub-total	14,053		21,527	13,514		23,752	27,567	45,279
2.	Tobacco	23	1 01	23	2,322	1.01	2,345	2,345	2,368
3.	Garlic	–	–	–	3,911	1.37	5,358	3,911	5,358
4.	Corn & Others[1/]	584	0.49	584	1,091	0.38	415	1,675	999
	Total	14,660			20,838			35,498	

Note: 1/ Corn and mungbeans are treated as representative crop among the crops for Phase I Area and Phase II Area respectively.

Source: (1) Area Planted; "Soils and Land Classification Survey, NIA, LRED, 1978" and "Area of Communal Irrigatoin System is Overall Project Area, NIA Provincial Office, as of 1977 for Phase I Area and 1979 for Phase II Area.

(2) Unit yield; "Farm Management Survey, the NIA, the LRED. 1978"

management. Furthermore, top soils in the Phase I area is shallow in some parts of the area due to big floods.

E. Electric Hydropower Condition

1. Introduction

The northwestern Luzon, is populated by some 938,000 people, most of whom are engaged in agriculture as a major industry in the area, and has been currently covered by the Luzon Grid of the National Power Corporation (NPC) in its power supply. A new power supply plan, however, has been eagerly required for meeting sharply increasing power demand in the region as well as for reducing transmission losses caused from long distance transmission from the source.

On top of the above, hydropower generation has come to be highlighted again with price hike of crude oil; particularly, the power generation scheme in multipurpose projects plays a vitally important role in contributing to national economy. The proposed plan, serving to reducing oil consumption and effectively utilizing precious water resources, will provide a plant for supplemental power supply to medium-scaled power market in the hinterland of the Project, but not to the Greater Manila. The new power plant will favorably affect the government's policy for the regional energy supply program.

The plan, however, should be taken up as a chainlink of the total Luzon Grid and formulated as a part of the total development program of the power in Luzon island, and not as an independent project in an isolated area.

2. Present Demand and Supply

a) Luzon Island

The recent rising trend in living standard as well as in growth rate of mining and manufacturing industries has been spurring on the increase in power demand. The total national power production reached some 17,000 GWh in 1978 The Luzon island, involving the Greater Manila as the largest consumer in the Nation, has consumed as much as 87 percent of the total production, and in 1978 the energy request of the Luzon island was estimated at 15,000 GWh and the peak demand at 2,400 MW.

The major power suppliers in the Philippines are the NPC, the MERALCO (Manila Electric Cooperative, Inc.) and some other organizations such as the NEA (National Electrification Administration), and those owned by provinces, municipalities and privates have taken part in power supply services

The installed capacity of the NPC in the Luzon island in 1979 was 2,991 MW in total, including 541 MW for hydropower, 220 MW for geothermal and 2,230 MW for oil thermal, and the total amount in its supply reached 11,965 GWh in the same year. The sales of electric power has been carried out usually by regional Electric Cooperatives financed by regional NEA, and the regional Cooperatives are in charge of the power sales and the construction of the power distribution facilities.

The total consumption of the sold power can be broken down into 21.6 percent for home use, 62.7 percent for industrial use and 15.0 percent for commercial use, and the relevant load factor is about 70.0 percent.

b) Ilocos Region

The NEDA has proposed in the report of "Regional Development Investment Program" that a cigarette factory, a pig-iron smelting plant, a ceramic factory, a charcoal briquette factory and a copper mining plant (on-going) are to be provided in this Area. Furthermore, a rice mill with 200 ton/day capacity is expected to be constructed to meet the need for processing incremental paddy under the Project.

The Ilocos region has gradually been under the service network of the NPC through 115 KV transmission lines starting from the Ambuklao Power Station by the successive installation of transmission lines, to Bantay-Laoag in 1966, Bantay-Narvacan and Narvacan-San Esteban both 1971, etc., although had been supplied with power generated by diesel generators operated by the local small-scaled enterprises Following these developments in power supply, NEA-financing provincial Electric Cooperative Inc have been established to merge various local small power companies for promoting the full-scaled electrification of the Area. The Ilocos Norte Electric Cooperative Inc. (INECO), for instance, successfully and remarkably increased its connected consumers in number from 10,620 houses in 1975 to 37,732 houses in 1979 that occupies about 57.3 percent of the target consumers of 65,800 houses, and similarly, the Ilocos Sur Electric Cooperative Inc. and the Abra Electric Cooperative Inc. have been promoting electrification works at their utmost. Hence, the electrification rate of the region has reached, as a whole, about 55 percent of the target.

The total power consumption of the region in 1979 was 52,810,000 KWh, including 26,921,000 KWh in Ilocos Norte province, 25,376 KWh in Ilocos Sur and 513,000 KWh in Abra province, respectively, while the total demand was 22,050 KW, including 10,500 KW, 9,700 KW and 1,850 KW, respectively. The load factor for the case is estimated at 39 percent. This indicates that the annual growth rate of electrification is about 13 percent to the consumption of 41,372,000 KWh in 1977.

The breakdown of such demand is shown by 84.9 percent for residential use, 11.0 percent for industrial use, 2.1 percent for commercial use, 0.4 percent for public building use, 0.1 percent for irrigation use and 1.5 percent for street lights. A greater part of consumption is occupied by residential use and power rate per connection is estimated at 50 KWh/month. The monthly load factor ranges from 30 3 percent to 44.5 percent with the highest seasonal load factor taking place in April and May.

3 Load Demand Estimation

a) Luzon Grid

The NPC's forecast made in 1979 suggests that while the energy request in the past ten years has grown at the rate of 7.6 percent per annum, the growth rate up to 1983 from 1980 is expected to remain by 6.8 percent with necessary electric energy of 15,500 GWh and from 1984 to 1990 it is forecasted to keep 7.0 percent growth rate level to require the electric energy of about 24,900 GWh in 1990.

On the other hand, while the peak load recorded in the past ten years has grown at the rate of 7.0 percent, the growth rate up to 1983 from 1980 is expected to increase to increase to 7.6 percent with necessary load of 2,569 MW in 1983, and from 1984 and onward it is forecasted to remain at the level of annual 7.0 percent in growth rate with necessary load of about 24,130 MW in 1990. In 1990, the load factor to be required is forecasted by 68.8 percent.

The power supply program to cope with the situation is contemplated by securing about 3,000 MW (installed capacity) by hydropower in 1990, which is six times as much as at present, 880 MW by geothermal power, four times as much as at present, 600 MW by coal thermal power which will be started in operation in 1984 and 620 MW by nuclear power which will be started in operation 1986. Contrarily, the oilthermal power generation is planned to be levelled down from 2,230 MW at present to 875 MW in 1990. As a result, the electric power will be developed to reach 6,000 MW (installed capacity) in 1990, which is almost double as much as at present.

A thorough consolidation of the transmission networks is also under contemplation, and the 500 KV double circuit trunk lines will be provided running through the central part of Luzon island from north to south, and the 230 KV branch lines will be provided and furthermore 115 KV and/or 69 KV branch lines laid down as well.

b) Ilocos Region

In 1967, the power demand of the Ilocos region was only 1,985 KW (installed capacity) and the energy request was as small as some 6,400,000 KWh. The Region,

however, has been rapidly electrified, according to the power development plan, to the remarkable extent that the growth of electrification rate was 25.4 percent on the peak demand basis and 19.5 percent per annum on the energy request basis, respectively. In view of such rapid progress of electrification in the Region, the NPC has estimated the load factor by 39.3 percent on the basis of the Demand and Sales Forecast that was derived from the forecast of the average annual growth rate of peak demand by 14.4 percent for 10 years up to 1990, as well as the energy request by 18 2 percent. The forecast of the power development has seemed to be made on consideration of such factors as copper mining development and industrialization of the Region. This is suggested from the fact that the proposed 230 KV transmission line laying between the Ambuklao power station and the Narvacan Substation (on-going project), located in the center of the Region, will meet a sharp increase in energy request brought about by mining development and industrialization.

Practically, however, it is rather difficult to forecast the demand and supply of the power in a limited small region, because a new plant, for instance, to be constructed in the small region will considerably change the relationship of demand and supply of the power. Actually, the forecast made in 1977 on the demand and the energy in 1987 indicates 34.5 MW and 169.5 GWh, respectively, whereas the latest forecast on the same shows a large change to 72.26 MW and 247.7 GWh, respectively. The latest forecast, accordingly, has been made in taking to a large extent into account the development of mining and industries in the Region

4. Power Rates

The NPC has taken the pricing system for the entire Luzon island that the power is sold to the local Cooperatives at the fixed wholesale price (utilities charge) and to the large-scaled industries at the fixed retail prices (industries charge) under the direct contract with consumers.

The local Cooperatives, which are responsible for construction of distribution lines in need, sell the power to the consumers at their own retail prices in adding their managerial cost to the NPC's wholesale price. That is to say, the Cooperatives take their own retail pricing system with different classification of consumers.

The NPC sells the power at ₱ 0.31 per KWh for utilities use and ₱0.33 per KWh for industries use, while the Cooperatives retail the power commonly at ₱0.48 - 0 75 per KWh for residential and commercial use and at ₱10.00 - 12.00 per KW at demand charge with ₱0.33 - 0.57 KWh as energy charge for small-scaled industries.

F. Related Activities to the Project

1 National Irrigation and FSDC Irrigation Projects

National Irrigation Project

There exist following six National Irrigation Projects serving the total area of about 7,240 ha in the vicinity of the Project Area, and they are under rehabilitation and improvement in the NISIP I Project.

	Project	Service Area (ha)
1.	Bolo River Irrigation System (RIS)	487
2.	Pasuquin Irrigation System (IS)	670
3.	Laoag-Vintar (IS)	2,364
4.	Cura (RIS)	814
5.	Dingras (RIS)	1,100
6.	Bonga Pump (IS)	
	No. 1	500
	No. 2	827
	No. 3	480
	Total	7,242

Source: Ilocos Norte, NISIP Sub-Region Office, 1977

FSDC Irrigation Project

The Farm System Development Corporation (FSDC) has executed three pumping irrigation projects and, at present, is implementing or studying four irrigation projects in the vicinity of the Project Area The total irrigation area under the FSDC is estimated at about 690 ha as of 1977. But, no FSDC irrigation projects exist in the Project Area.

2. Road Project

According to the report on "Ilocos Norte Rural Areal Development Project[1/]" the MPH has a plan to improve and construct the Barangay roads as the road component in rural development program. Total length of proposed roads in the program is estimated at 135.2 km in the Project Area of about 22,600 ha. The MPH, furthermore, is constructing two national roads near the Project Area; one is the road from Nueva Era to the Abra province and the other is from Solsona to the Kalinga-Apayao Province.

3. Flood Control Project

Flood control seems to be vital and urgent problems in the Phase I area,

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1/ Prepared by Planning & Project Development Office MPH in 1977

especially in the Madongan service area, which has the largest catchment area of about 150 sq.km among the related rivers to the Project Area. Figure 3-1 indicates the comparison of river-washed area in the Madongan service area during 20 years from 1956 to 1976. As is seen in the figure, about 540 ha of lands have been turned into the river-washed area during the year.

Under the status, the MPW has a program to carry out a feasibility study for flood control and other purposes in the river basins of the Labugaon and Solsona rivers.

4. Reforestation Project

Denudation in the watersheds of the major rivers has been one of the main problems that hinder the country's development and appears to result in the serious floods year by year. Illegal and indiscriminated logging is still observed and in this case, the Ilocos region is not an exception, although the Government has conducted a massive reforestation campaign throughout the nation.

To overcome these problems and to develop water resource in the project-related watersheds, the Bureau of Forest Development has been proceeding reforestation programs in the vicinity of the Project Area under the 5-year plan since 1977. One of the main reforestation project near the Project Area is the Marcos Reforestation Project in Nueva Era district, of which reforestated areas are about 5,000 ha out of the target areas of about 11,000 ha.

5. Communal Irrigation Areas in Palsiguan River Basin

Three communal irrigation systems exist in the area between the immediate downstream of the proposed Palsiguan dam and the junction of two rivers Palsiguan and Tineg rivers, and these areas are estimated at 323 ha in total; Lagayan CIS 255 ha, Calambat CIS 29 ha, Collago CIS 39 ha. These areas are at present irrigated by the diverted water from the Palsiguan river, so that the water right for irrigation should be taken into consideration in the project planning.

6. Mariano Marcos State University

Mariano Marcos State University was established on January 6, 1978 by Presidential Decree 1279 in honor of the late Congressman Mariano Marcos.

The decree merged the Mariano Marcos Memorial College of Science and Technology, Ilocos Norte and the Norhtern Luzon State College and integrated the college courses of the Ilocos Norte College of Arts and Trades and the Ilocos Norte Agricultural College.

The University has occupied about 300 ha of land, and a half of which is used as experimental farm of Agricultural Faculty. This experimental farm will be included in the objective area of this Project.

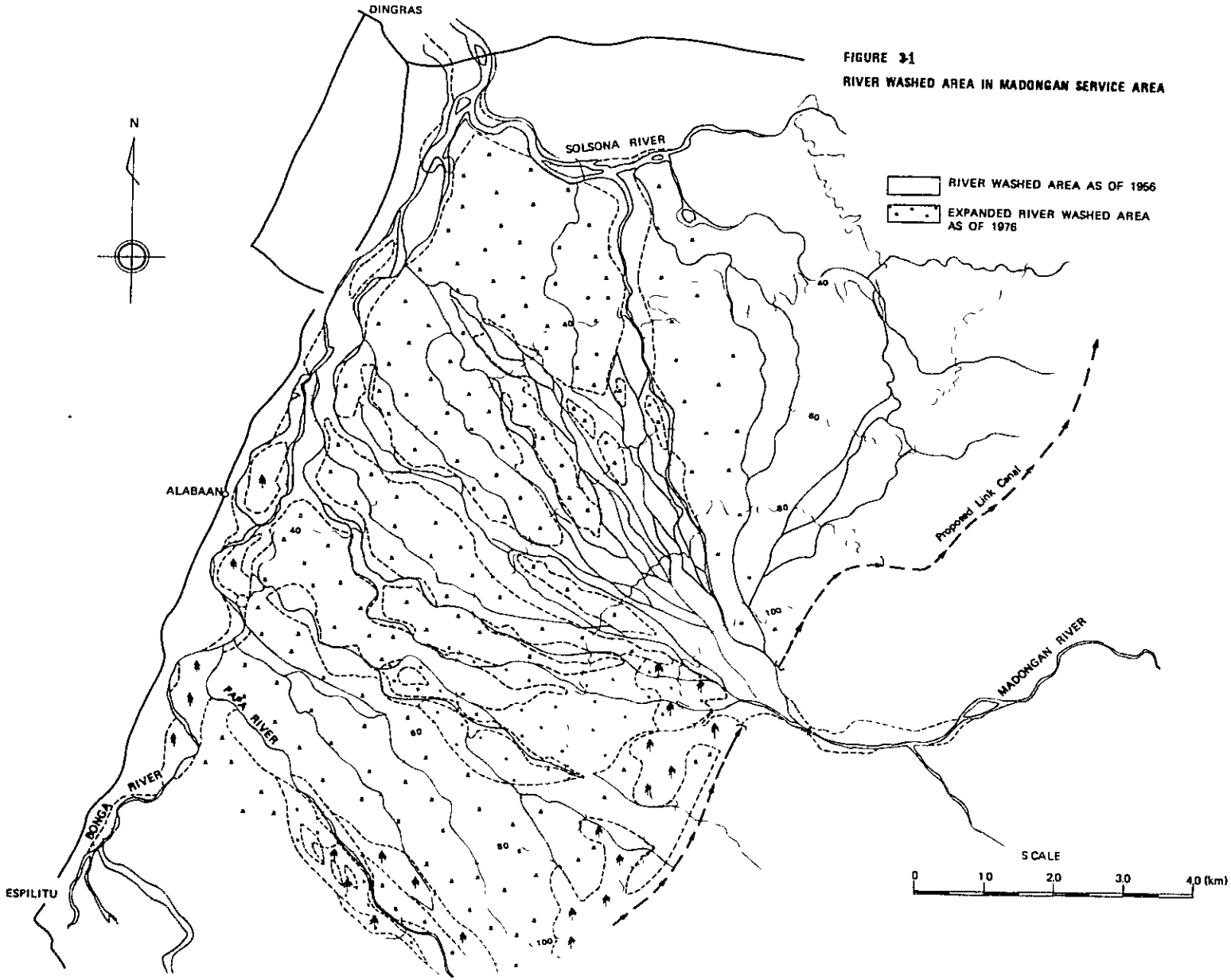

FIGURE 3-1

RIVER WASHED AREA IN MADONGAN SERVICE AREA