REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

THE FEASIBILITY STUDY ON THE NIAS ISLAND IRRIGATION AGRICULTURAL DEVELOPMENT PROJECT

Volume I

MAIN REPORT

OCTOBER 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

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LIST OF REPORTS

Volume I	**Main Report**
Volume II	**Agricultural Development Plan in the Nias Island**
Volume III	**Feasibility Study for the Mezawa/How Irrigation Development Project**

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a Feasibility Study on the Nias Island Irrigation Agricultural Development Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Dr. Yasuhiko Kunihiro, Nippon Koei Co., Ltd., twice between August 1990 and March 1991.

The team held discussions with the officials concerned of the Government of Indonesia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

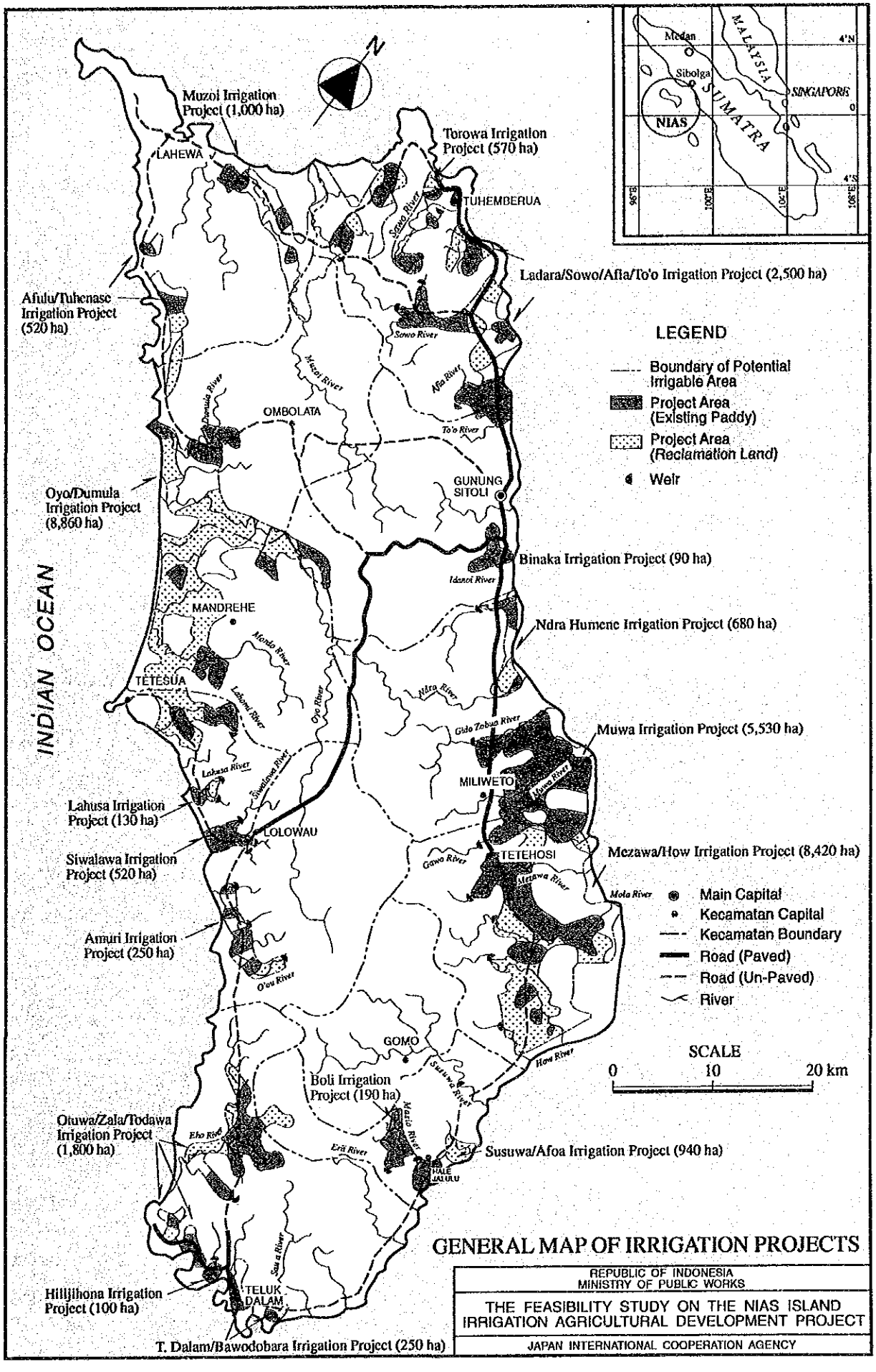
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

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

October, 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



GENERAL MAP OF IRRIGATION PROJECTS

REPUBLIC OF INDONESIA
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THE FEASIBILITY STUDY ON THE NIAS ISLAND IRRIGATION AGRICULTURAL DEVELOPMENT PROJECT

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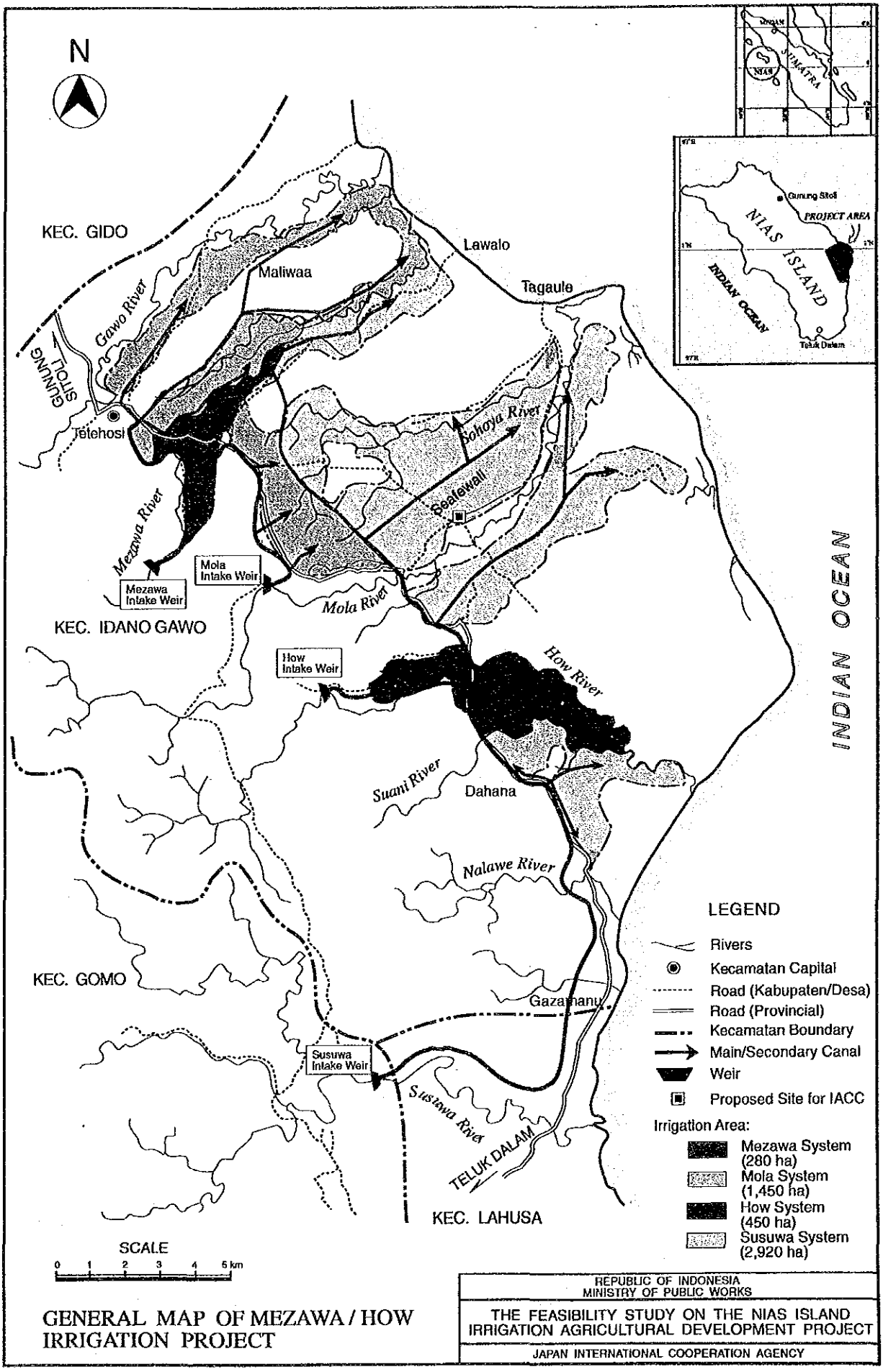

GENERAL MAP OF MEZAWA / HOW IRRIGATION PROJECT

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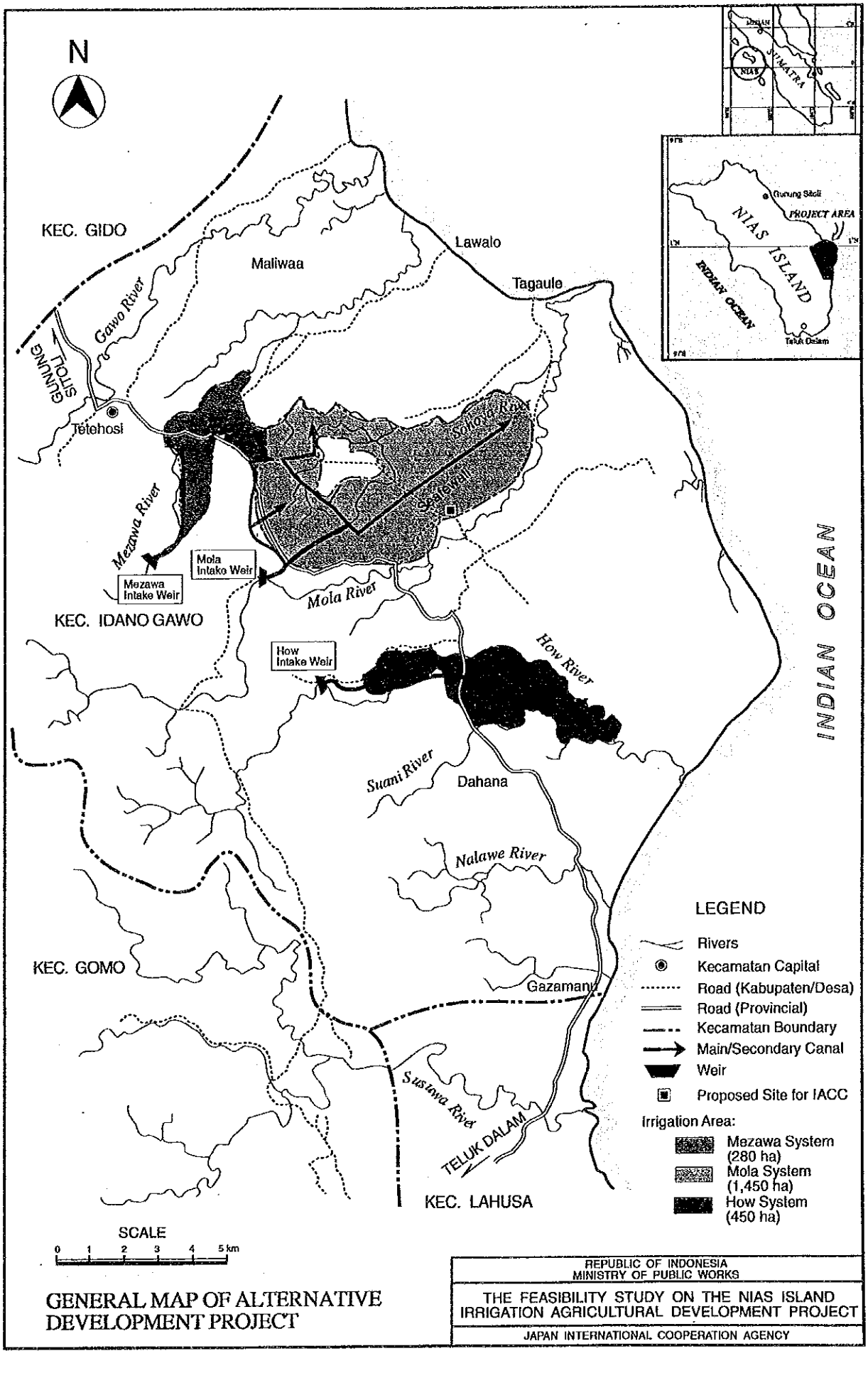

GENERAL MAP OF ALTERNATIVE DEVELOPMENT PROJECT

REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS

THE FEASIBILITY STUDY ON THE NIAS ISLAND IRRIGATION AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

SUMMARY

1. Authority

This is the Final Report for the Feasibility Study on the Nias Island Irrigation Agricultural Development Project prepared in accordance with the scope of work agreed on between the Directorate General of Water Resources Development and the Japan International Cooperation Agency on November 23, 1989.

The study was conducted stepwise, namely Phase-I study and Phase-II study. The Phase-I study aims (1) to identify the constraints and problems for the agricultural development in the whole Nias island, (2) to integrate a basic concept of agricultural development in the Nias island, (3) to formulate the development projects and (4) to select the high priority area. The Phase-II study aims to formulate the irrigated agricultural development plan for the priority area and make verification of feasibility of the plan.

This report presents the results of the whole study in three volumes as follows;

Volume-I	Main report
Volume-II	Agricultural development plan in the Nias island
Volume-III	Feasibility study for the Mezawa/How irrigation development project

2. Conditions of the Nias Island

The Nias island is the medium scale island having an area of about 4,000 km^2 located 130 km west of the Sumatra island. The total population of the Nias island as of 1989 is estimated at 560,000.

The climate of the island is characterized by the monsoons. An annual rainfall averages 3,000 mm. In spite of relatively high

rainfall, long rainless spells sometimes occur and there is a considerable year to year variation in rainfall. There are 27 main rivers in the island. These rivers have a small catchment area of less than 200 km^2 except the Muzoi, the Susuwa, the Oyo and the Eho. The lowest river discharge during the year occurs in February and the total accumulated river discharge in the island is estimated at about 40 m^3/s in February.

The main industry of the island is agriculture. There is no attractive resources except tourism. About 80% of the population of the island is engaged in agriculture and related activities. Most of the farmers are owner operators. About 28% of the total land of the island is used as agricultural land. Of them 6.5% is paddy field and the remainder is perennial crops. About 60% of the total land of the island remains uncultivated land as bush and shrub land. The unit yield of crops is significantly low due to unstable and insufficient water supply, poor farm management, lack of agricultural support services, so forth. The cropping intensity is also low. Up to the present, a self-sufficiency of rice in the island has not been attained and about 24,000 tons of rice have been imported from other provinces.

Though the farmers are mostly owner operators, the farm size is less than one ha. So the farmer's economy remains at the subsistence level under such present low agricultural productivity.

Social infrastructures such as roads, water supply, electricity, sanitation and health services have been provided mainly in urban areas such as Gunung Sitoli and Teluk Dalam. Such infrastructures in the rural area are less developed, which becomes one of the constraints for economic development in the rural area.

3. Agricultural Development Plan in the Nias Island

The agricultural development plan in the Nias island was formulated with the objectives of : (1) raising farmer's income level through enhancement of agriculture, especially rice production, by an efficient utilization of the potential land and water resources of the island and (2) contributing to regional need to increase rice production with the aim of achieving self-sufficiency in rice in the island.

An assessment of the land resources in the island indicated that the lands of 66,800 ha were suitable for paddy cultivation. It was evaluated on the basis of the results of water balance study that the area of 33,770 ha from the lands of 66,800 ha had potential to be irrigated.

To realize the objectives mentioned above, the irrigation development projects were formulated on the basis of the following basic considerations : (1) to assure double cropping of paddy per year by the maximum use of available water sources for irrigation, (2) to rehabilitate the existing irrigation systems, (3) to provide new irrigation systems for the existing rain-fed paddy land and (4) to develop the low productivity lands such as upland crop lands and bush/shrub land into irrigated paddy fields.

Twenty-six individual irrigation projects were identified. The scale of the irrigation projects was determined based on the water balance study. A combination of irrigation projects through an inter-basin transfer of river water was planned to effectively use land and water resources. As a result, 26 irrigation projects were combined into the seventeen (17) irrigation project as shown in the next page:

	Name of irrigation project	Development area(ha)
1.	Mezawa/How	8,420
2.	Muwa	5,530
3.	Ladara/Sowa/To'o/Afia	2,500
4.	Susuwa/Afoa	940
5.	Binaka	90
6.	Boli	190
7.	Siwalawa	520
8.	Anuri	250
9.	Lahusa	130
10.	Ndra Humene	680
11.	Otuwa/Id.Zala/Todawa	1,800
12.	T.Dalam/Bawodobara	250
13.	Hilijihona	100
14.	Torowa	570
15.	Muzoi	1,000
16.	Tuhenase/Afulu	520
17.	Oyo/Dumula	8,860

To evaluate the proposed 17 projects and to determine priority ranking to select a project for urgent implementation, four criteria were applied: (1) economic internal rate of return, (2) magnitude of initial investment, (3) scale merit of the project and (4) number of beneficiaries. As a result, the Mezawa/How irrigation project was selected as the highest priority project.

In the official meeting held on January 9, 1991, it was decided that the feasibility study of the Mezawa/How irrigation project should be performed.

4. Feasibility Study of the Mezawa/How Irrigation Project

The Mezawa/How irrigation project area is located about 30 km southeast of Gunung Sitoli, the capital of Kabupaten Nias. Based on the assessment of land capability, land use condition, irrigability and water resources, the area for irrigation development was delineated to be 7,290 ha as a gross area or 5,100 ha as a net area.

The main constraints for agricultural development in the project area are: (1) no irrigation and drainage facilities, (2) water shortage during the dry season, (3) low provision level of proper farming practices and (4) insufficient extension services. Under such situation, the yield of crops is low and the annual cropping intensity is 117%.

The Mezawa/How irrigation project was formulated in line with objectives and strategy proposed in the agricultural development plan mentioned in the previous section. Double cropping of paddy per year under proper irrigation farming was proposed.

Water sources of the project area are four rivers such as the Mezawa, the Mola, the How and the Susuwa. The basic concept of the irrigation plan is to divert surplus water in the Susuwa river to the lower basin of the remaining three rivers by construction of an inter-basin diversion canal because the discharge of three rivers is insufficient to irrigate their whole basins.

The proposed project works consist of: (1) construction of 4 diversion weirs, (2) construction of primary canal including the inter-basin transfer canal and secondary canals with 101 km in length, (3) construction of 62-km drainage canal, (4) road network including new construction of 101 km-road and rehabilitation of 30 km-existing road, (5) land reclamation of the area of 2,640 ha, (6) on-farm development for the area of 5,100 ha and (7) construction of the irrigation agricultural coordination center.

The project works were planned to be completed in about 5 years including 1.5 year for detailed design and pre-construction arrangement for the project.

The project cost was estimated at Rp. 66,628 million comprising a local currency portion of Rp. 39,010 million and a foreign currency of US$ 14.928 million (or Rp. 27,618 million).

When the project is in the full operation, the unit yield of paddy is expected to reach 5 tons/ha/one crop season. Incremental paddy production is expected to be 47,000 tons/ annum. The irrigation benefit at the full development stage was estimated at Rp. 7,301 million.

The economic internal rate of return of the project was estimated at 10.2% which indicates that the project could be marginally feasible in terms of economic viability. The sensitivity analysis for possible adverse changes in the future indicates that an economic viability of the project is rather insensitive to the project. The results of the environmental assessment study for the project show that the negative impacts to be predicted by the implementation of the project would not be serious to the local peoples in the project area.

5. Alternative Approach to Realization of the Project

The Mezawa/How irrigation project shows that the project was justified to be marginally feasible in terms of economic viability because facilities necessary for an inter-basin transfer of the Susuwa river water require a huge amount of construction cost, resulting in an adverse effect to economic viability of the project.

An alternative irrigation plan was made without considering an inter-basin transfer of the Susuwa river water. Three irrigation projects were identified: the Mezawa, the Mola and the How irrigation projects. The irrigation plan for these projects was made by cost effective development. The area for the project is 280 ha

for the Mezawa, 1,450 ha for the Mola and 450 ha for the How irrigation project. The principal features of these irrigation plans are basically as same as that of the Mezawa/How irrigation project.

The project cost was estimated at Rp. 3,393 million for the Mezawa, Rp. 12,283 million for the Mola and Rp. 5,283 million for the How irrigation project.

When the projects are in full operation, incremental annual paddy production of paddy is expected to be 2,300 tons for the Mezawa, 12,300 tons for the Mola and 4,100 tons for the How project. The irrigation benefit at the full development stage was estimated at Rp. 376 million for the Mezawa, Rp.1,991 million for the Mola and Rp. 653 million for the How project.

The economic internal rate of return was calculated at 11.2% for the Mezawa, 15.3% for the Mola and 12.4% for the How. The internal rate of return of the project combined by three irrigation projects was estimated at 14.0%. These figures of economic internal rate of return indicated that these irrigation projects would be justified to be economically feasible for the realization of the projects.

6. Conclusions and Recommendations

The water sources for the Mezawa/How irrigation project are four rivers of the Mezawa, the Mola, the How and the Susuwa. Since the river discharge of the Mezawa, the Mola and the How is insufficient to irrigate their respective potential suitable lands, an inter-basin transfer of river water of the Susuwa is a prerequisite to ensure efficient use of land and water resources. However the facility necessary for the inter-basin transfer of river water is very expensive, it makes its project economic viability worse, indicating 10.2% of internal rate of return.

The irrigation development plan for each river basin, therefore, was individually formulated without the Susuwa river.

Three irrigation projects were identified: the Mezawa, the Mola and the How irrigation projects. As a result of the study, these projects have higher economic viability for realization of the project.

It is recommended that three individual irrigation development projects for the Mezawa (280 ha), the Mola (1,450 ha) and the How (450 ha) without an inter-basin transfer of the Susuwa river water should be implemented as early as possible.

The total demand of paddy in the Nias island was forecast to be 93,500 tons in the year of 2010, the target year for attaining self-sufficiency in rice. The expected incremental paddy production produced by the three irrigation development projects was estimated to be 18,700 tons or 20% of the total demand of paddy in the year of 2010. It is also recommended that actions aiming at realizing self-sufficiency of rice in the Nias island should be promptly taken in accordance with the priority sequence of the projects proposed in the agricultural development plan.

THE FEASIBILITY STUDY
ON
THE NIAS ISLAND IRRIGATION
AGRICULTURAL DEVELOPMENT PROJECT

VOLUME I

MAIN REPORT

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FIGURES

GLOSSARY OF TERMS AND ABBREVIATIONS

ADB	- Asian Development Bank
AGRARIAN	- Badan Pertanahan Nasional
BAPPEDA	- Badan Perencana Pembangunan Daerah (Provincial Development Planning Board)
BAPPENAS	- Badan Perencanaan Pembangunan Nasional (National Development Planning Board)
BIMAS	- Bimbingan Massal
Bina Marga	- Directorate General of Highways
BPP	- Balai Penyuluhan Pertanian (agricultural extension center)
BRI	- Bank Rakyat Indonesia (People's Bank of Indonesia)
BRIUD	- Bank Rakyat Indonesia Unit Desa (village branch of BRI)
BULOG	- Badan Urusan Logistik
Bupati	- District Chief, Head of Kabupaten
Cabang Dinas	- PU Seksi, (Administrative area for Irrigation with the PU-Wilayah)
Camat	- Sub-district Chief, Head of Kecamatan
CRIFC	- Central Research Institute for Food Crops
CS	- Construction supervision
Desa	- Village or group of small villages
DGFCA	- Directorate General of Food Crops Agriculture, Ministry of Agriculture
DGWRD	- Directorate General of Water Resources Development, Ministry of Public Works
DIP	- Project Implementation Budget
DOI	- Directorate of Irrigation
Dolog	- Depot Logistik
DPT	- Dinas Pertanian Tanaman Pangan
DPU	- Direktorat Pekerjaan Umum Ministry of Public Works
FC	- Foreign currency
E/S	- *Engineering services*
FY	- Fiscal year (April 1 to March 31)
GDP	- Gross Domestic Product

GOI	- Government of Indonesia
Golongan	- Division of an irrigation area in order to phase planting and reduce peak water demand
Gotong royong	- Mutual assistance system
HYV	- High yielding variety
IACC	- Irrigation Agrucultural Coordination Center
IBRD	- International Bank for Reconstruction and Development (World Bank)
ICB	- International competitive bidding
IGGI	- Inter-governmental Group on Indonesia
INMAS	- Intensifikasi Massal (massive intensification for self sufficiency in food)
INMUM	- Intensifikasi Umum
INSUS	- Intensifikasi Khusus (Special intensification program)
ISSP	- Irrigation Sub-Sector Project
JICA	- Japan International Cooperation Agency
Julu	- Official responsible for the day-to-day operation of an irrigation area, generally no greater than 1,000 ha
Kabupaten	- District (sub-division of province)
Kecamatan	- Sub-district within the Kabupaten
KUD	- Koperasi Unit Desa (Village unit co-operative)
KUPEDES	- Kredit Umum Pedesaan (general rural credit program)
KUT	- Kredit Usaha Tani
LC	- Local currency
LCB	- Local competitive bidding
LPT Bogor	- Lembaga Penelitian Tanah Bogor (Soil Classification System of Bogor)
LP3ES	- Lembaga Penelitian Pendidikan dan Penuangan, Ekonomi dan Social (Institute of Research, Education & Information for Social & Economy)
LS	- Lump sum
M & E	- Monitoring and evaluation
MCM	- million cubic meter (1,000,000 m^3)
MOPE	- Ministry of Popilation and Environment
M/M	- Man-months
OECF	- the Overseas Economic Cooperation Fund, Japan

O&M	- Operation and maintenance
PBME	- Project benefit monitoring and evaluation
PDAM	- Perusahaan Daerah Air Minum (Ministry of Drinking Water)
Pelita	- Five Year Development Plan
Pengamat	- Water distribution supervisor
PLN	- Perusahaan Listrik Negara
PMF	- Probable maximum flood
PMP	- Probable maximum precipitation
Polowijo	- All annual crops other than rice, sugar or vegetables grown on wet paddy land
PPA	- Penjaga Pintu Air (Gate operator)
PPK	- Penyuluhan Pertanian Kecamatan (Extension workers on Camat Level)
PPL	- Penyuluhan Pertanian Lapangan (Field extension worker)
PPM	- Penyuluh Pertanian Madya (agricultural extension supervisor)
PPS	- Penyuluh Pertanian Spesialis (agricultural extension specialist)
PPUP	- Penyuluh Pertanian Utama Pratama (subject-sector supervisor)
PRPTE	- Program for the rehabilitation and expansion of export crops, Ministry of Agriculture
PT	- Dinas Pertanian Tanaman Pangan (agricultural service)
PUSRI	- Pupuk Sriwijaya
P2AT	- Proyek Pengembangan Air Tanah (Groundwater Development Project)
P3A	- Perkumpulan Petani Pemakai Air (Water Users Association)
P3SA	- Proyek Pengembangan dan Penyelidikan Sumber-sumber Air (Water Resources Development and Planning Project)
RMG	- Rheinische Missiongesellschaft
Rp.	- Indonesian Rupiah
Sawah	- Wet rice field
SCF	- Standard conversion factor
SHS	- Sang Hyang Seri Seed Company
SUPRA INSUS	- Super Intensifikasi Khusus

S/W	- Scope of Work
TA	- Technical Assistance
TOR	- Terms of reference
TSP	- Triple Super Phosphate
T & V	- Training and Visiting
Ulu-ulu	- an employee of the P3A responsible for O&M of tertiary unit
UNDP	- United Nations Development Program
USDA	- United States Department Agriculture
VOC	- Dutch East Indies Company
Waker	- Assistant to the Juru stationed at the main river offtake
WKBPP	- Wilayah Kerja Balai Penyuluh Pertanian
WKPP	- Wilayah Kerja Penyuluh Pertanian (working area of field extension worker)
WUA	- Water User Association
WUAO	- Water User Association Organizer

CONVERSION FACTORS

	Metric to Imperial		Imperial to Metric	
Length	1 cm	= 0.394 inch	1 inch	= 2.54 cm
	1 m	= 3.48 feet	1 feet	= 30.48 cm
	1 km	= 0.621 mile	1 mile	= 1.609 km
Area	1 sq.m	= 10.76 sq.ft	1 sq.ft	= 0.0929 sq.m
	1 ha	= 2,471 acres	1 acre	= 0.4047 ha
	1 sq.km	= 0.386 sq.mile	1 sq.mile	= 2.59 sq.km
Volume	1 lit	= 0.22 gal (imp)	1 cu.ft	= 28.33 lit
	1 cu.m	= 35.3 cu.ft	1 gal (imp)	= 4.55 lit
	1 mil. cu.m	= 811 acre-ft	1 acre-ft	= 1,233.5 cu.m
Weight	1 kg	= 2.20 lb	1 lb	= 0.4536 kg
	1 ton	= 0.984 long ton	1 long ton	= 1.016 ton
Derived	1 cu.m/s	= 35.3 cusec	1 cusec	= 0.0283 cu.m/s
Measures	1 ton/ha	= 891 lb/acre	1 lb/acre	= 1.12 kg/ha
	1 cu.m/s	= 19.0 mgd	1 mgd	= 0.0526 cu.m/s
Temperature	°C	= (°F-32) x 5/9	°F	= 1.8 x °C + 32

CURRENCY EQUIVALENT
(as of end 1990)

US$ 1.0 = Rp. 1,850

1. INTRODUCTION

1.1 Authority

This is the Final Report for the Feasibility Study (the Study) on the Nias Island Irrigation Agricultural Development Project, prepared in accordance with the scope of work agreed on between the Directorate General of Water Resources Development (DGWRD) and the Japan International Cooperation Agency (JICA) on November 23, 1989.

The Study was conducted stepwise, namely Phase-I and Phase-II. The Phase-I was undertaken from August to December 1990. In this phase, constraints and problems for the agricultural development in the whole Nias island were identified and integrated to form the basic concept for agricultural development in the island. Agricultural development projects were also formulated and a high priority area was selected. The Phase-II study was performed from January to August 1991. In this phase, an irrigated agricultural development plan in the high priority area was formulated and verification of the feasibility for the plan was undertaken.

This report presents the results of the whole Study in three volumes as follows;

Volume-I	Main report
Volume-II	Agricultural development plan for the Nias island
Volume-III	Feasibility study of the Mezawa/How irrigation development project.

1.2 Project History

The Government has made every endeavor to increase production of foodstuffs, especially paddy, since the first Five Year Development Plan (Pelita I). In 1985 self-sufficiency of rice for the whole Indonesia was attained. Since then, there has been, however,

no substantial increase in paddy production. Thus domestic paddy demand has gradually gained upon domestic production.

The Pelita V started from April, 1989. In this plan, the Government's economic development strategy placed strong emphasis on rural and regional development, one of the key factors of which was the agricultural sector. The agricultural sector aims at enhancing food production, especially rice, to meet the increasing domestic demand, to provide rural employment, and to achieve balanced regional development. Besides the main outer-islands, development of the medium scale islands (remote islands), which usually remain economically depressed at present, is one of the highest priority objectives to be contemplated by the Government.

The Nias island is one of the remote islands, located about 130 km west of the Sumatra island. It has an area of about 4,000 km^2 with a population of 560,000. Agriculture is the main industry in the island. About 80% of the total population of the island are engaged in agriculture and its related activities. There are about 26,000 ha of paddy field. Out of them, about 10% are irrigated. Under such situation the cropping intensity of paddy field is low and rice yield is also low. Up to the present, self-sufficiency of rice has not been achieved in the island and about 24,000 tons of rice have been imported from other provinces. The GDP per capita in the island is so low equal to 50% of GDP of North Sumatra province or 40% of average GDP of the whole Indonesia.

Under such situation, the Government of Indonesia requested the Government of Japan to execute the Feasibility Study on the Nias Island Irrigation Agricultural Development Project. In reply to the request, the Government of Japan dispatched a preliminary survey team of JICA to the site. The scope of work was agreed upon between DGWRD and JICA on November 23, 1989.

1.3 Objective of the Study

The objective of the study is to evaluate the feasibility of the irrigated agricultural development project in the Nias island, in the framework of the Nias island integrated development program.

1.4 Transfer of Knowledge

Transfer of knowledge to Indonesian counterpart personnel was undertaken on the basis of the on-the-job training. Regular meetings also were held between the counterpart personnel and the JICA experts for smooth execution of transfer of knowledge and project survey and studies.

1.5 Acknowledgment

In undertaking the work during the survey period, the JICA study team received great support and cooperation from the departments and agencies concerned of the Government of Indonesia. The contribution to the Study by the officials concerned who provided information and data and other forms of assistance to the study team is gratefully acknowledged. The study team would like to particularly acknowledge DPU North Sumatra Province for day-to-day support, guidance and coordination for the study. Heartfelt gratitude is also extended to the members of DGWRD in Jakarta who gave advice in performing the Study.

2. BACKGROUND

Economic development in Indonesia is closely linked with price trends in the international oil market. Indonesia's gross domestic product grew at an average annual rate of 8.1% during the 1970s. Since the early 1980s, the economy of Indonesia has been stagnant and deteriorated in 1985/86 due to a sharp drop in international oil market prices. To improve the economic condition, the Government of Indonesia devised a series of countermeasures which included devaluation of domestic currency, acceleration of non-oil export, encouragement of direct foreign investment and a drastic cut in the financial budget. Through execution of such countermeasures, the Indonesian economy has been recovering gradually.

The Government's economic development strategy placed strong emphasis on rural and regional development and included intervention in key areas of the agricultural sector. The aim of this has been to enhance food production, especially rice, to meet the increasing domestic demand, to provide rural development, and to achieve balanced regional development.

During Pelita I and II, the main emphasis was placed on increase of rice production. More than half of the agricultural sector development expenditure was allotted to rehabilitation and expansion of irrigation facilities with the aim of increasing rice production. During Pelita III and IV, emphasis has been widened to include intensification programs for other crops.

Through the performance of sector development from Pelita I to Pelita IV, rice production has been greatly increased. Paddy production increased from 18 million tons in 1969 to 41 million tons in 1988. Self-sufficiency in rice was realized in 1985. Since then, there has been, however, no substantial increase in annual paddy production in Indonesia, mainly due to conversion of highly productive paddy fields into urban and industrial areas in Java, the

home of the leading producers of rice in Indonesia. Thus, domestic paddy demand has gradually gained on domestic production.

Under such situation Pelita V started from April 1989. The targets of Pelita V are : (1) to raise the living standards, to enlighten the mind and improve the well-being of the whole of the people more evenly and equitably, and (2) to lay a solid foundation for subsequent development.

To achieve the above targets, priority was given to economic development, putting emphasis on agriculture and industry. Sustaining of self-sufficiency in rice is one of the most important policies in the agricultural sector.

For this purpose, Pelita V includes an irrigation sub-sector development program which consists of ; (1) a program for rehabilitation and maintenance of the existing irrigation/drainage systems; (2) a program for construction of new irrigation systems and (3) a program for swamp area development.

Since Pelita III, the Government has gradually shifted irrigation development emphasis to the outer islands. In Pelita-V, the Government gave high priority to irrigation development in the outer islands.

The Nias island is one of the remote islands Agriculture is the main industry in the island. About 80% of the total population of the island are engaged in agriculture and its related activities. There are about 26,000 ha of paddy field. Out of them, about 10% are irrigated. However, these irrigation systems are under the categories of semi-technical and/or simple irrigation system. In spite of abundant land and water resources, development of irrigation in the Nias island has not yet been performed because investment for irrigation sector has been concentrated to the main islands such as Java, Sumatra, Kalimantan and Sulawesi. Under such situation the cropping intensity of paddy fields and yield of rice are low. Up to the present, self-sufficiency in rice has not been attained in the island. Rice

movement to the island has gradually increased and reached 24,000 tons in 1989.

In addition to the paddy field, tree crops such as coconut and rubber have been cultivated and played an important role in agricultural income sources. However, the international market price of these crops has been stagnant and production of these crops has been also stagnant

The Gross Domestic Product per capita in the island is so low equal to 50% of GDP of North Sumatra province or 40% of average GDP of whole Indonesia. The GDP per capita in the Nias island varies according to locations, ranging from Rp. 414,000 in Kecamatan Gunung Sitoli to Rp. 86,000 in Kecamatan Gomo.

3. THE STUDY AREA AND BASIC DIRECTION OF AGRICULTURAL DEVELOPMENT

3.1 The Study Area

The Nias island is a medium scale island having an area of about 4,000 km^2 located 130 km west of the Sumatra island as illustrated in the general map. Administratively, the Nias island is within the jurisdiction of Kabupaten Nias, North Sumatra province. The total population of the Nias island as of 1989 was estimated at 560,000.

The climate of the Nias island is characterized by the monsoons. The annual rainfall averages 3,000 mm. The wettest season is from September to December. There is a considerable year to year variation in rainfall. The annual rainfall with a 5 year return period is estimated at about 2,600 mm. In spite of relatively high rainfall, long rainless spells sometimes occur, lasting up to 17 days with a 5-year return period. The annual average temperature is about 26 °C with very little seasonal variation throughout the year. The relative humidity averages about 90%. The annual mean sunshine duration is 49%. The features of the climate in the study area are shown in Table 3.1.

There are 27 main rivers in the Nias islands. These rivers have a small catchment area of less than 200 km^2 except the Muzoi, the Susuwa, the Oyo and the Eho. The stream gradient of these rivers is very steep. There are not reliable discharge data on these rivers. The available discharge of the rivers was estimated at the proposed intake sites based on the following empirical formula.

$$Q = 1/3.6 \times F1 \times F2 \times R \times A$$

in which
- Q = possible intake discharge (m^3/s)
- F1 = run-off percentage (0.5)
- F2 = intake percentage (0.8)
- R = rainfall intensity (mm/hr)
- A = catchment area at intake site (km^2)

The estimated available river discharge is shown in Table 3.2. The lowest river discharge during the year occurs in February. The total accumulated river discharge of the proposed intake sites was estimated to be about 40 m^3/s in February.

The main industry of the Nias island is agriculture. About 80% of the total population of the island are engaged in agriculture and its related activities. Most of the farmers are owner-operators having small landholding size. Land use condition of the island is shown below: At present 28% of the island is used as agricultural land. 10% of the total existing paddy field are irrigated under simple irrigation systems.

Land use categories	Area (ha)	Percentage (%)
1. Agricultural land		
1.1 paddy fields	26,200	6.5
1.2 upland crop field	11,100	2.8
1.3 coconut estate	25,200	6.3
1.4 rubber estate	47,100	11.7
1.5 other tree crop estate	1,200	0.3
sub-total	110,800	27.6
2. Unused land		
2.1 forests	28,600	7.1
2.2 swamp forest	8,400	2.1
2.3 bush/shrub land	243,900	60.5
sub-total	280,900	69.7
3. Settlement land	9,500	2.4
4. Others	1,200	0.3
Total	**402,400**	**100.0**

Available water supply is insufficient and unsteady because water is taken at present from small tributaries. About 60% of the land remains uncultivated as bush and shrub land. The present land use in the island is illustrated in Fig. 3.1.

The main staple food crops in the Nias island are paddy, followed by upland rice, cassava, sweet potato and maize. The main tree crops are rubber, followed by coconut, clove, coffee and nilam. Of them, paddy, rubber and coconut are the most important crops. These crops are cultivated by intensive manpower from sowing to harvesting. Most of the varieties used are local. In general, the yields of crops in the Nias island are significantly low due to (1) low level of dosages of farm inputs and improper farming practices, (2) damages accrued by pests, diseases and rats, (3) improper water management of the existing irrigation systems, (4) water shortage and (5) lack of effective extension services to farmers. The cropping intensity is also low.

In spite of the fact that most of the farmers are owner-operators, the farm size per farm household is as small as less than one ha, and the farmer's economy remains at the subsistence level under such present low agricultural productivity. It is essential to raise the farmer's living standards through enhancement of agriculture.

Social infrastructures such as roads, water supply, electricity, sanitation and health services in the island have been provided mainly in urban areas such as Gunung Sitoli and Teluk Dalam. Such infrastructures are less developed in the rural areas, and this constitutes one of the constraints for economic development in the latter areas.

3.2 Development Potential

3.2.1 Land Resources

Land resources in the Nias island were assessed from the viewpoint of possibility of practicing profitable irrigated agriculture in

accordance with the land capability criteria prepared by the Department of Agriculture and North Sumatra University. The lands were assessed for cultivation of paddy, upland and tree crops. The results are summarized below and illustrated in Figs 3.2 to 3.4.

Land Class	Paddy area(ha)	(%)	Upland crops area(ha)	(%)	Tree crops area(ha)	(%)
Suitable	66,800	17	98,100	24	258,300	64
Marginally suitable	0	0	30,200	8	62,800	16
Not suitable	335,600	83	274,100	68	81,300	20
Total	402,400	100	402,400	100	402,400	100

It was concluded that 66,800 ha, 128,300 ha and 321,100 ha can be used for paddy, upland crops and estate crops, respectively, from the standpoint of the land resources in the island.

3.2.2 Water Resources

There are 27 main rivers in the island. The estimated available discharge of these rivers at the proposed intake sites is as shown in Table 3.2. The lowest river discharge occurs in February. The total accumulated river discharge of the proposed intake sites was estimated to be about 40 m^3/s in February.

In addition to rivers, two springs are available at Afulu and Tuhenase in Kecamatan Lahewa.

Regulated water resources by creating reservoirs were studied for the purpose of irrigation use. Ten reservoir sites were selected. As a result, the total effective capacity of these reservoirs was estimated to be 900 million m^3.

3.2.3 Development Potential for Agriculture

Based on the results of studies on development potential of land and water resources, the potential area for irrigation development was studied. Twenty-six (26) individual irrigation projects were identified as shown in Table 3.3 and illustrated in Fig. 3.5. Among these, 24 projects would be irrigated by river water and the remainders by springs. The total potential area for irrigation development of these projects was delineated to be 53,450 ha including 1,430 ha irrigated by springs.

It was envisaged in the irrigation plan that double cropping of paddy per year would be introduced into the irrigation development projects if irrigation water would be available. As a principle, irrigation water would be distributed by gravity irrigation system. Since reuse of irrigation water is seldom practiced in the Nias island and data to assess return flow are not sufficient, use of return flow was not taken into consideration in the irrigation plan. As for the water intake method, (1) diversion weir on main river and (2) regulating dam were considered.

As a result of water balance study, the total area to be irrigated by construction of diversion weirs was estimated to be 33,770 ha (65% of the potential area to be irrigated by surface water). Furthermore if the regulating dams are created, 38,550 ha or 74% of the potential area could be irrigated.

3.2.4 Basic Direction of Agricultural Development

The Nias island is one of the remote islands blessed with ample land and water resources. Agriculture is the main industry in the island. About 80% of the total population of the island are engaged in agriculture and its related activities. Other attractive development resources except tourism could not be expected.

The basic direction of the agricultural development for the island was formulated based on (1) maximum utilization of land and water resources, (2) attainment of self-sufficiency of foodstuff,

(3) raising of family income level, (4) enhancement of regional economy, (5) harmonization with socio/physical environment, and (6) proper use of land and up-grading of agricultural technology.

The objectives of agricultural development in the island is considered to mainly involve productions of paddy, upland crops, tree crops such as rubber, coconut, clove, oil palm, etc., fruit crops, livestock and fishery.

Among the various agricultural productions contemplated, the first priority should be given to paddy production under irrigated condition considering that (1) profitability of paddy cultivation under double cropping system is the highest among all the crops, (2) economic impacts such as increasing farm income, creating job opportunities and eliminating farmer's poverty are expected to be greater than those of any other productions, and (3) upgrading of the economy of the Nias island would be achieved through reducing rice import.

The second priority should be put on promotion of export of such crops as rubber, coconut, clove and oil palm. Since international prices of these crops have been stagnant, improvement of farm land and farming practices has not been made for these crops. It has been, however, recognized that the promotion of these crops is promising in the long-term development plan for the island.

As for development of fruit crop production, it is expected in the future that fruit crop production in the island can be supplied to the tourists in the Nias island through up-grading of cultivation technology, improvement of quality, introduction of new varieties and increase in production. However, it is not expected that the development scale becomes greater. Upland crops are cultivated on hills and in home yards on a small scale mainly for self consumption at present. Taking into consideration unstable climatic condition, pests/diseases and farmer's reluctance to cultivate upland crops, it seems that this kinds of crop cultivation would remain for self consumption even in the future.

4. AGRICULTURAL DEVELOPMENT PLAN

4.1 Development Needs

The Nias island is one of the remote islands blessed with ample land and water resources. Agriculture is the main industry in the island. About 80% of the total population of the island are engaged in agriculture and its related activities.

Although land and water resources are abundant in the island, they have not yet been developed because investment for such development has been concentrated to the main islands such as Java, Sumatra, Kalimantan and Sulawesi. Up to now about 26,000 ha or about 40% of the land suitable for paddy cultivation (66,800 ha) have been developed into paddy fields. Only about 10% of this total area is irrigated while 90% is still under rain-fed condition.

Under such situation, paddy production in the Nias island is far below its potential because of mainly (1) shortage of irrigation and drainage system, (2) shortage of irrigation water, and (3) poor water and farm management. Consequently income level of the farmers in the Nias island is quite low. The gross domestic product per capita in the island is so low as equivalent to 50% of GDP of the North Sumatra province or 40% of average GDP of the Indonesia.

The Nias island is a region of rice shortage. At present 24,000 tons of rice have to be imported from other provinces. The total population in the Nias island was 560,000 as of 1989. The population in 2010 that is taken as the target year of the irrigated agriculture development in the island was estimated at about 796,500. Demand of paddy in the target year was forecast to be about 188,000 tons. On the other hand, production of paddy in the target year would be 94,500 tons if new irrigation projects would have not been implemented before that year. This would leave a shortage of 93,500 tons of paddy as shown in Table 4.1.

It is, therefore, important to place a development priority on increasing rice production to achieve self-sufficiency in rice in the Nias island and to raise income level of the farmers through the agricultural development.

4.2 Objectives and Strategy of Development

Reflecting the development needs and the national development policy, the following objectives were set up in the irrigated agriculture development plan for the Nias island: (1) to raise farmer's income level through enhancement of agriculture, especially rice production, by efficient utilization of the potential land and water resources of the Nias island, and (2) to contribute to regional need to increase rice production with the aim of achieving self-sufficiency in rice in the Nias island.

To realize these objectives, the following development strategy was proposed for the formulation of individual plans.

(1) rehabilitation of the existing irrigation systems,
(2) provision of irrigation and drainage systems for the existing rain-fed paddy fields,
(3) transformation of upland and bush/shrub land into irrigated paddy fields,
(4) raising rice production through increase of unit yield of paddy, increase of annual cropping intensity of the existing paddy fields, and
(5) strengthening agricultural support organization.

4.3 Formulation of Overall Development Plans

4.3.1 Agricultural Farming Plan

Future land use was planned for the 66,800 ha that are suitable for irrigation farming, taking into consideration the present land use condition and some specific conditions as shown in the next page ;

(1) The Gido Zebua irrigation project area (1,660 ha), which is under implementation by the Government with assistance of ADB, will be excluded from the study area in the future land use plan.
(2) The forest in the objective area should remain as it is as a forest reserve and reserve for wild animals
(3) The upland and bush/shrub land will be developed into the paddy fields considering their low land productivity and farmer's expectation for expansion of cultivated area.
(4) The lands of coconut and rubber will remain as they are.

It is expected that after implementation of the projects, land use in the area will be changed considerably as follows;

(Unit : ha)

Land categories	Present condition	With project condition
irrigated paddy field	2,370	32,350
rain-fed paddy field	16,430	0
upland field	780	80
bush/shrub land	18,380	2,130
coconut field	4,940	4,940
rubber field	3,500	3,500
forest and settlement	14,020	14,020
other	4,720	8,120
Total	65,140*	65,140

* excluding Gido Zebua project area (1,660 ha)

Based on the development needs, double cropping of paddy per year was proposed as the cropping pattern for the project as illustrated on Fig. 4.1. High yielding varieties and appropriate farming practices will be introduced along with developing and strengthening the existing institutional support.

4.3.2 Identification of Projects

Formulation of the irrigation and drainage projects was carried out within the framework of the concept mentioned in Sections

3.3 and 4.1. Twenty six irrigation projects were identified as shown in Table 3.3 and illustrated in Fig. 3.5.

Determination of the scales of the irrigation projects was made based on a water balance study. A combination of irrigation projects through an inter-basin transfer of river water was planned to effectively use land and water resources. Based on this idea, 26 irrigation projects were combined into the following seventeen (17) irrigation projects as illustrated in general map of irrigation projects.

Name of irrigation projects	Development area (ha)
1. Mezawa/How	8,420
2. Muwa	5,530
3. Ladara/Sowa/To'o/Afia	2,500
4. Susuwa/Afoa	940
5. Binaka	90
6. Boli	190
7. Siwalawa	520
8. Anuri	250
9. Lahusa	130
10. Ndra Humene	680
11. Otuwa/Id.Zala/Todawa	1,800
12. T.Dalam/Bawodobara	250
13. Hilijihona	100
14. Torowa	570
15. Muzoi	1,000
16. Tuhenase/Afulu	520
17. Oyo/Dumula	8,860
Total	32,350

The main features of each project are summarized in Table 4.2.

4.3.3 Selection of High Priority Project

For the purpose of evaluating the proposed projects and selecting the priority project for urgent implementation among them, four evaluation criteria were applied. The first criterion is the level of economic feasibility expressed by the economic internal rate of return (EIRR). The second one is the magnitude of initial

investment expressed as the construction cost per ha. The third is the scale merit of the project expressed as the difference between benefit and cost (in terms of total present value at 10% discount rate). .The fourth is the distribution of benefits expressed by the number of beneficiaries. Reflecting the importance of each indicator, weighted points are given to each category: (X 3) for the first; (X 2) for the second; (X 1) for the third and the fourth respectively. The evaluation criteria applied are shown below;

Criteria	Indicator	Grade	Points	Magnitude
Economic Feasibility	EIRR (%)	A(high)	9	>13
		B(medium)	6	13-10
		C(low)	3	10-7
		D(very low)	0	<7
Investment Cost	US$/ha	A(low)	6	<4,000
		B(medium)	4	4,000-6,000
		C(high)	2	6,000-8,000
		D(very high)	0	>8,000
Scale merit of the project	B-C (Rp.million)	A(high)	2	>10,000
		B(medium)	1	10,000-5,000
		C(low)	0	<5,000
Distribution of benefit	Number of beneficiaries	A(high)	2	>5,000
		B(medium)	1	1,000-5,000
		C(low)	0	<1,000

The values of indicators for each irrigation project are shown below;

Name of irrigation Project	EIRR (%)	Cost/ha (US$)	B-C (Rp.million)	Number of beneficiaries
Mezawa/How	13.1	4,800	18,530	9,400
Ladara/Sowo/To'o/Afia	12.4	6,300	5,394	3,500
Binaka	12.0	6,200	193	200
Siwalawa	8.5	8,500	-476	700
Lahusa	10.0	8,600	63	100
Otuwa/Id.Zala/Todawa/Sorake	10.3	7,700	1,363	3,800
Hilijihona	16.3	4,500	435	200
Muzoi	11.7	6,900	1,856	1,200
Oyo/Dumula	11.4	6,900	14,098	9,800
Muwa	12.3	3,800	7,675	7,600
Susuwa/Afoa	11.8	7,400	2,030	1,000
Boli	11.6	7,000	377	200
Amuri	11.4	6,900	462	300
Ndra Humene	12.4	5,400	1,469	1,200
T.Dalam/Bawodobara	9.8	8,200	82	500
Torowa	6.8	11,100	-1,965	700
Tuhenase/Afulu	10.1	9,200	342	600

Based on the figures in the above tables, points for each criterion were given. The priority ranking was given to each project following the order of points. When the points of some projects were same, priority was given to the project with higher EIRR. The total points and the priority ranking were shown below;

Name of irrigation project	EIRR	Cost	B-C	Number of beneficiaries	Total point	Rank of priority
Mezawa/How	9	4	2	2	17	1
Ladara/Sowo/To'o/Afia	6	2	1	1	10	6
Binaka	6	2	0	0	8	10
Siwalawa	0	0	0	0	0	16
Lahusa	6	0	0	0	6	14
Otuwa/Id.Zala/Todawa/Sorake	6	2	0	1	9	9
Hilijihona	9	4	0	0	13	3
Muzoi	6	2	0	1	9	8
Oyo/Dumula	6	2	2	2	12	4
Muwa	6	6	1	2	15	2
Susuwa/Afoa	6	2	0	1	9	7
Boli	6	2	0	0	8	11
Amuri	6	2	0	0	8	12
Ndra Humene	6	4	0	1	11	5
T.Dalam/Bawodobara	3	0	0	0	3	15
Torowa	0	0	0	0	0	17
Tuhenase/Afulu	6	0	0	0	6	13

As a result, the Mezawa/How irrigation project shows the highest priority.

4.3.4 Overall Implementation Schedule

The implementation schedule for these projects will be determined so as to meet the increasing demand for paddy in the future in the Nias island. Supposing that the target year of this project is 2010, i.e. 20 years from now, the increased demand for paddy in the Nias island was estimated at 93,500 tons as shown in Table 4.1. To meet this demand in 2010, the two irrigation projects ranked first and second in the priority sequence should be implemented in the years indicated below;

Name of project	Year of start of construction
Mezawa/How	1991
Muwa	1996

5. FEASIBILITY STUDY OF THE MEZAWA/HOW IRRIGATION PROJECT

5.1 General

The overall agricultural development plan was discussed between DGWRD and JICA at the meeting held on 9 January 1991, and it was decided to proceed with the feasibility study of the Mezawa/How irrigation project.

The field survey work for the feasibility study was commenced immediately after the said meeting and finished at the end of July 1991. During this period, further detailed survey and investigations were conducted to elaborate the original plan proposed in the overall development study. The differences in the accuracy of surveys and features of development plans between the overall development study and the feasibility study are summarized in Table 5.1.

The main difference between the development plans conceived by the two studies is that the net irrigation area of the project (8,420 ha) delineated in the overall development study is reduced to 5,100 ha based on the results of the feasibility study. The main causes are :

(1) According to the results of topographical review based on the new topographic maps (1/5,000 scale) prepared by the JICA topographic survey team in December 1990, a lot of small hills in the project area not to be irrigated were revealed and a micro-relief topography was also revealed.

(2) The results of the semi-detailed soil survey conducted in the feasibility study revealed that some lands were not suitable for paddy cultivation .

As a result, the irrigation development plan for the project was formulated for a net area of 5,100 ha .

5.2 The Project Area

Administratively, the Mezawa/How irrigation project area lies entirely within a single district, Kecamatan Idano Gawo, of Kabupaten Nias. It is located about 30 km southeast of Gunung Sitoli, capital of Kabupaten Nias. It covers fully or partly 24 villages with a total population of 25,500 as of 1990. The total number of households in the area is about 4,500. The average population density is estimated at about 70 persons per km^2. The average family size is estimated at 6. Over 90% of the population are engaged in agriculture and its related activities. It is estimated that 96% of the total farmers are independent owner operators having less than one ha in farm holding size.

The climate in the project area is characterized by monsoons. The daily mean temperature is about 26°C throughout the year. The annual rainfall is about 3,000 mm. However there is a considerable year to year variation in rainfall. The annual rainfall with a 5 year return period is estimated at about 2,600 mm. In spite of relatively high annual rainfall, long rainless spells sometimes occur in the year; a rainless spell with a 5-year return period is estimated to last 17 days.

The water sources in the project area are the Mezawa, the Mola, the How and the Susuwa river. A drought discharge at the proposed weir site was estimated and the available water for irrigation use was calculated at 80% of the this drought discharge as follows;

River	Catchment area (km^2)	Discharge (m^3/s)
Mezawa	14	0.42
Mola	73	2.16
How	23	0.68
Susuwa	175	5.19

There are seven major soil groups, namely Regosols, Marine swamp soils, Peat soils, alluvial soils, Gray hydromorphic soils, Gley

humic soils and Red yellow podzolic soils. Based on the land capability criteria defined by the DGFCA and North Sumatra University, it was assessed that 8,090 ha or about 50% of the project area (16,330 ha) are suitable for paddy cultivation under irrigation.

The present land use condition in the project area is as follows: agricultural land (20%), primary forest (49.5%), bush/shrub land (25.2%) and other uses. Agricultural land consists of paddy fields (15.1% of the project area), upland field (4.3%) and estate crop land (0.6%). All the agricultural land is under rain-fed cultivation. There are not irrigation and drainage systems in the project area. Moreover, the farm roads as well as rural roads within the project area are in poor conditions and can be used only by motorcycles. The road network connecting the project area with the urban area is poor, hampering the transportation of agricultural products to the central markets such as Gunung Sitoli and T. Dalam and also of agricultural inputs from Gunung Sitoli.

The main crops in the project area are paddy, followed by some upland crops such as cassava and sweet potatoes, as well as estate crops. Under the present poor condition of agricultural infrastructure, farmers in the project area cannot apply proper farming with appropriate farming practices. Agricultural crop production is unstable due to damages by droughts, rats, pests and diseases. The unit yield of paddy is low, being 1.8 tons of paddy per ha in the rainy season and 1.1 tons per ha in the dry season. The unit yield of other crops is also low.

The cropping intensity of paddy fields is as low as 117%. The size of a farm household is as small as less than one ha. The economy of farmers in the project area remains at the subsistence level. It is essential to raise the farmer's income levels through enhancement of agriculture, especially through rice production.

With respect to agricultural support systems, especially farmers organizations such as KUD, P3A and farmer groups. These organizations do not function properly and are insufficient in number. The low participation rate of the farmers in KUD and shortage of self-

determination for joint activities of the farmers groups are one of the main constraints for agricultural development. The Government support in the field of extension services, research and credit services is not sufficient at present in the project area and this constitutes also one of the constraints for agricultural development.

5.3 Delineation of the Development Area for the Project

Delineation of the development area for the Mezawa/How irrigation project was made based on four factors: (1) land capability, (2) land use condition, (3) irrigability and (4) water resources.

The results of land capability studies indicated that an area of 8,090 ha was classified as suitable land for paddy cultivation among the total project area of 16,330 ha. Among 8,090 ha, there were 520 ha of forest lands. These forest lands were excluded from the development area because they should remain as a forest reserve and reserve for wild animals. Furthermore, an area of 280 ha was excluded for reasons of non irrigability. As a result, the delineated area for development was 7,290 ha gross or 5,100 ha net. The water sources for the project are the Mezawa, the Mola, the How and the Susuwa, which would be sufficient to irrigate an estimated maximum area of 5,700 ha based on the results of water balance study. It was concluded that the net irrigation development area of the project would be 5,100 ha.

5.4 Agricultural Development Plan

Proper irrigation and drainage systems should be provided in order to establish a base for increasing unit yield of crops and production. After the implementation of the project, all the land will become paddy fields equipped with all year round irrigation systems. The present land use conditions will therefore change into the figures when the project is implemented as shown in the next page.

(Unit : ha)

Land Use Categories	Persent Condition	with Project Condition
irrigated paddy field	0	5,100
rain-fed paddy field	2,460	0
upland crop field	710	0
primary forest	520	520
bush/shrub and others	4,400	2,470
Total	8,090	8,090

Double cropping of paddy per year was proposed. Introduction of upland crops in dry season was not adopted because of pests and diseases and the farmer's reluctance to cultivate upland crops. The proposed cropping pattern as shown in Fig. 5.1, was worked out on the basis of climatic factors, plant physiological features, farming practices, prevention against damages by pests and diseases and rats, and water management. The overall cropping intensity in the future with project condition was expected to be 200% per annum.

Proper farming practices will be expected to be applied after implementation of the project. High yielding varieties and/or improved varieties will be introduced. Proper amount of fertilizers and chemicals will be applied through proper irrigation farming. Also draft animal was planned to be introduced into the project area for proper land preparation for paddy fields.

The unit yield of paddy under the with project condition was estimated on the basis of information supplied by the Department of Agriculture in North Sumatra province as well as the yield on well-irrigated land in and around the project area. The anticipated yield of paddy was estimated to be 5 tons /ha in both wet and dry seasons. And incremental paddy production was estimated at about 47,000 tons.

5.5 Irrigation and Drainage Plan

5.5.1 Basic Concept for the Plan

The irrigation and drainage plan was formulated to realize profitable irrigated agriculture giving serious attention to (1) cost effective development and full utilization of available land and water resources, (2) harmonization with environment to avoid adverse effects, and (3) proper design of canal layout under gravity irrigation systems.

The basic concept of project formulation is to divert surplus water in the Susuwa river to the lower basin of the Mezawa, the Mola and the How by construction of the inter-basin diversion canal because the discharge of the Mezawa, the Mola and the How is insufficient to irrigate their whole basins. The general layout of the project is illustrated in Fig. 5.2.

5.5.2 Water Requirement and Irrigable Area

The irrigation water requirement for paddy was estimated respecting the DGWRD's planning guideline. Consumptive use of water was estimated by the modified Penman method proposed by FAO. The effective rainfall was estimated based on the 5-year low rainfall in the project area. The overall irrigation efficiency was assumed to be 60%. The diversion requirement used for the design was estimated to be 1.47 lit/s/ha. Water resources for the project are four rivers such as the Mezawa, the Mola, the How and the Susuwa. The discharge of these rivers was estimated under low flow condition of 80% dependability of which 80% was planned to be available for irrigation water supply. Based on the result of water balance study, the net irrigable area was decided as shown in the next page;

Intake weir	Intake discharge (m^3/s)	Net irrigable area (ha)
Mezawa	0.41	280
Mola	2.13	1,450
How	0.66	450
Susuwa	4.29	2,920
Total		5,100

5.5.3 Proposed Irrigation and Drainage Systems

Planning and preliminary design of the irrigation and drainage facilities were made based on the topographic maps on a scale of 1/5,000 and 1/50,000. Design of the weirs and the inter-basin diversion canals were made based on the results of the supplemental topographic survey for the said facilities.

The main project works proposed are : (1) construction of 4 diversion weirs, (2) construction of irrigation and drainage canal networks including the inter-basin transfer canal, (3) construction of road networks and (4) land reclamation and on-farm development.

The locations of the proposed weirs were selected so as to ensure the intake water level and structural stability of the weirs. The fixed type weir was proposed taking account of cost effective development, easiness of operation/maintenance, prevention of adverse effects to the upper stream of the weir, cheaper operation and maintenance cost, etc,.

The proposed irrigation network consists of four systems. The total length of the main and secondary canals amounts to 101.1 km comprising 4.5 km in the Mezawa system, 32.2 km in the Mola system, 8.5 km in the How system and 55.9 km in the Susuwa system. These canals were proposed to be lined with masonry, taking into consideration the fact that (1) the canals routes pass through the land with high permeability, and (2) the topographic gradient is rather steep.

Planning and design of tertiary/quaternary canals, farm roads and related structures were made principally based on the DGWRD's irrigation design standards. The basic design concept was : (1) one irrigation block is about 50 ha, (2) the irrigation area commanded by a quaternary canal is less than 8 ha, and (3) irrigation water supply is designed to serve irrigation blocks within 300 m from a quaternary canal.

The unit drainage requirement in the fields was determined to be 5.14 lit/s/ha so as to drain 5-year 3-consecutive storm rainfall within 3 days based on the DGWRD's criteria. The small tributaries in the project area was planned to be improved as drainage canals. The proposed length of the drainage canals is about 62 km in total.

The inspection roads were proposed to be constructed along the proposed irrigation canals. Gravel pavement was proposed for the road along the main and secondary canals. In addition, it was planned to rehabilitate the existing public roads. The total length of the proposed roads is 130 km including 30 km of existing roads to be rehabilitated.

5.5.4 Operation and Maintenance Plan

The operation and maintenance works are important activities to realize the project objectives. They include daily irrigation water management to secure the irrigation schedule, and periodic maintenance of the project facilities. An O&M office would be established in Tetehosi under the jurisdiction of provincial irrigation service of North Sumatra. Water management will be undertaken by both the O&M office and P3A. The former will be responsible for operation of the major irrigation facilities down to turnouts at the heads of tertiary irrigation canals, while the latter will be responsible for operation and water management within the respective tertiary blocks.

5.6 Agricultural Support Plan

For successful implementation of the project, it is considered essential to strengthen the existing support systems with emphasis on quality improvement of the farmers and staff involved in the project. Especially, it is a prerequisite that self-reliance of the farmers for water management should be setup. In the project, reorganization of the existing water user's associations (P3As), and farmer's cooperatives (KUDs) and creation of new such organizations were planned to be made during the construction stage. Also " a Irrigation Agricultural Coordination Center " was planned to be established to carry out the technical and institutional support programs for successful realization of the project.

P3As were planned to be established at a density of one P3A every 4 irrigation blocks or so having 200 ha in total. The number of P3As to be established would amount to 30 in the project area. The number of necessary staff such as chairman, treasurer, secretary, water master and ditch tender was estimated to be 226.

It was planned that KUDs were instituted at a density of one KUD per village. The total number of KUD to be established was estimated at 24 for the project.

The irrigation agricultural coordination center (the Center) having the farm of 5.3 ha will be established in Seafewari village located in the center of the project area. The Center will implement technical and institutional programs: (1) seed multiplication work, (2) research and experiments, (3) pilot demonstration (4) distribution of draft animals to farmers, and (5) training of farmers (P3A staff and KUD staff) and the government staff (O&M staff of DPU and PPLs).

5.7 Cost Estimate

The project cost was estimated on the basis of the preliminary design of the project facilities with the following conditions;

(1) Construction cost was estimated on the basis of the current prices as of late 1990.

(2) The exchange rate used in cost estimate is US$ 1.0 = Rp.1,850

(3) Construction works will be carried out on contract basis.

(4) Physical contingency was assumed to be 15% of direct construction cost.

(5) Price escalation was assumed to be 8% per annum for local currency portion and 3% for foreign currency portion.

The project cost comprises cost for detailed design, land acquisition, direct construction cost, procurement cost of O&M equipment, engineering services, administrative cost and training cost.

The project cost was estimated at Rp.66,628 million comprising a local currency portion of Rp.39,010 million and a foreign portion of US$ 14.928 million (equivalent to Rp.27,618 million). Details are shown in Table 5.2.

The annual O&M cost for the project was assumed to be about 1% of the project cost. The estimated O&M cost per ha is Rp.131,000.

Some of the facilities proposed will have lives shorter than the useful life of the project (50 years). The replacement cost of these facilities was calculated on the basis of their useful life such as 30 year for diversion gate, 20 years for small gates on canal facilities and 20 years for O&M equipment.

5.8 Project Implementation and Organization

The project works were planned to be implemented within the period of about 5 years including 1.5 years for project preparatory work such as detailed design, implementation program, financial arrangement and pre-construction arrangements as shown in Fig. 5.3.

The irrigation agricultural coordination center was planned to be operated for about 5 years including one year for preparatory work.

Rearrangement and/or new creation of P3As and KUDs will be made within the period of 3 years including training of staff of these organizations.

The Directorate of Irrigation, DGWRD, will become the executing agency of the project. It will be responsible for design, construction works and supervision of the project. The director of Irrigation I will be responsible for the overall execution of the proposed project. He will coordinate activities of all relevant governmental agencies in connection with implementation of the project.

The project execution office will be established at Tetehosi. A project manager will manage all field works in the project execution office, assisted by three divisions. After their completion, all the project facilities will be transferred to DPU, North Sumatra province and the construction office will be phased out. A proposed organization chart for the project construction office is illustrated in Fig. 5.4. The district office of Kabupaten Nias will be responsible for the overall management of the irrigation agricultural coordination center.

5.9 Project Justification

(1) Economic evaluation

Economic evaluation of the project was made on the following basic assumptions:

- The economic useful life of the project is 50 years.
- All prices are expressed in constant prices in late 1990
- The exchange rate of US$ 1.0 = Rp. 1,850 was applied.
- The transfer payments such as tax, duty, subsidy and interest were excluded from the project cost in economic analysis.
- The economic price of traded goods such as urea, TSP, KCl and paddy was estimated based on IBRD projections of world market prices for 1995.

The economic benefit expected from the project is irrigation benefit. Irrigation benefit is defined as the difference of primary profit from crops between future conditions "with project" and "without project". The irrigation benefit will be expected to increase year by year and reach the full benefit in and after 6 years after completion of irrigation facilities. Since an area-wise development for the project was planned to be carried out, the irrigation benefit would be generated from the 4th construction year and reach its maximum in the 11th year. The annual irrigation benefit at the full stage development was estimated at Rp.7,301 million as shown in Table 5.3.

The economic cost was estimated based on the project cost, taking account of transfer payment and standard conversion factor for non-traded goods. The economic construction cost was estimated at Rp. 56,408 million.

The economic internal rate of return was calculated on the basis of cost and benefit flow as shown in Table 5.4. The internal rate of return is 10.2%.

A sensitivity test was carried out to evaluate the soundness of the project against possible adverse changes in the future in the following cases; (1) reduction of irrigation benefit by 10% due to unexpected decrease in forecast price, (2) cost overrun by 10% and (3) combination by cases of 1 and 2. The result is presented as follows:

		IRR(%)
Case 1	Reduction of irrigation benefit	9.2
Case 2	Cost overrun	9.2
Case 3	Combined effect of case 1 and 2	8.3

The above figure of IRR indicates that the project could be marginally feasible in terms of economic viability. The sensitivity analysis indicates that the economic viability of the project is rather insensitive to the possible adverse changes.

5.10 Environmental Assessment

In addition to the direct benefits, various positive or negative environmental and/or socio-economic impacts are expected from the implementation of the project. The environmental assessment of the project was made principally based on the guidelines for preparation of environmental impact analysis proposed by the Ministry of Population and Environment.

The environmental assessment was made based on three categories of project impacts on : (1) physio-chemical environment including climate/noise, physiography, geology, water quality and soil/land use, (2) biological environment including flora, fauna and aquatic bigot, and (3) socio-economic/cultural environment including income level, job opportunity, perception of local people, transportation, social problems, housing, socio-cultural organization and formal/non-formal institution. The environmental assessment was done according to the construction stages, i.e. (1) pre-

construction stage, (2) construction stage, and (3) operation and maintenance stage.

The results of assessment of impacts by the project activities and recommendation to avoid negative impacts are shown in Tables 5.5 and 5.6. It was concluded that the negative impacts to be predicted would not be serious to the local people in the project area.

5.11 Alternative Approach to Realization of the Project

As explained in the previous section, the project has an internal rate of return of 10.2% which indicates that the project is justified to be marginally feasible in terms of economic viability.

Water sources for the project are dependent on four rivers. An inter-basin transfer of the Susuwa river water to the other three river basins of the Mezawa, the Mola and the How was planned for effective use of land and water resources, because water sources of these three rivers are insufficient to irrigate the land in their river basins as shown below

River	Possible intake discharge (m^3/s)	Possible irrigable land by discharge (ha)	Suitable land for paddy cultivation (ha)	Irrigation area to be irrigated (ha)
(1) Mezawa	0.42	282	1,455	280
(2) Mola	2.16	1,471	2,655	1,450
(3) How	0.68	463	990	450
(4) Susuwa	5.19	3,527	0	2,920
Total		5,743	5,100	5,100

However, necessary facilities for the inter-basin transfer of the Susuwa river water require a long conveyance canals with about 25 km long and a huge amount of construction cost, resulting in an adverse effect to the economic feasibility of the project. The

economic feasibility of each irrigation system commanded by each river was studied to assess such low economic viability of the project.

The result is shown as follows;

		Mezawa	Mola	How	Susuwa
Irrigation area	(ha)	280	1,450	450	2,920
Const. cost	(million Rp.)	3,137	15,787	5,283	42,354
Cost/ha*	(US$/ha)	6,056	5,885	6,345	7,840
EIRR	(%)	12.1	12.4	12.4	8.9

*: Details are shown in Table 5.7 and cost for the irrigation agricultural coordination center is excluded.

An alternative irrigation plan without an inter-basin transfer of the Susuwa river was examined. The suitable land for paddy cultivation within the river basin was planned to be irrigated by water source of respective river. Three irrigation projects were identified: the Mezawa, the Mola and the How irrigation projects. The irrigation plan was formulated so as to be cost effective development.

A general layout of the irrigation systems of these areas is illustrated in Fig. 5.5. The principal features of the plan for these three irrigation systems are basically as same as those of the Mezawa/How irrigation project. The features of the project of three irrigation systems are shown in Table 5.8. The construction cost is shown in Table 5.9 and summarized below;

	Mezawa	Mola	How
Irrigation area(ha)	280	1,450	450
Project cost(mill.Rp.)*	3,393	12,283	5,283
Const.cost/ha(US$/ha)	6,550	4,579	6,345

* excluding construction cost necessary for irrigation agricultural coordination center

After implementation of the project, it is expected that the target yield of paddy, 5 tons/ha, will be obtained at the full

development stage. The total incremental production of paddy under each irrigation project is shown below;

the Mezawa project	2,300 tons
the Mola project	12,300 tons
the How project	4,100 tons

The irrigation benefits of the three irrigation projects were estimated based on the procedure used in Section 5.8. The irrigation benefits were estimated at Rp. 376 million for the Mezawa project, Rp. 1,991 million for the Mola project and Rp. 653 million for the How project.

The economic cost was estimated at Rp. 2,857 million for the Mezawa project, Rp. 10,407 million for the Mola project and Rp. 4,484 million for the How project, respectively.

The economic internal rate of return for three projects and of the project combined by three projects was calculated based on the irrigation benefit and economic cost as shown in Tables 5.10 to 5.13. The internal rate of return is shown below;

Mezawa project	11.2%
Mola project	15.3%
How project	12.4%
Combined project	14.0%

The above figures indicate that the Mola project has the highest economic viability for realization. The figure also shows that the combined has a higher economic viability.

6. CONCLUSIONS AND RECOMMENDATIONS

The water sources for the Mezawa/How irrigation project are four rivers of the Mezawa, the Mola, the How and the Susuwa. Since the river discharge of the Mezawa, the Mola and the How is insufficient to irrigate the potential suitable land within their respective basin, an inter-basin transfer of water of the Susuwa river is a prerequisite to ensure efficient use of land and water resources. However the facility necessary for the inter-basin transfer of river water is very expensive, it makes its project economic viability worse, indicating 10.2% of internal rate of return.

Three irrigation projects were formulated without considering an inter-basin transfer of the Susuwa river water: the Mezawa, the Mola and the How irrigation projects. As a result, these projects have a higher economic viability for realization of the project.

It is recommended that three irrigation projects for the Mezawa, the Mola and the How without an inter-basin transfer of the Susuwa river water should be implemented as early as possible.

The total demand for paddy in the Nias island was forecast to be 93,500 tons in the year of 2010, the target year for attaining self-sufficiency in rice. The expected incremental paddy production produced by the above three irrigation development projects was estimated to be 18,700 tons or 20% of the total demand of paddy in the year of 2010. It is also recommended that actions aimed at realizing self-sufficiency of rice in the Nias island should be taken promptly in accordance with the priority sequence of the projects proposed in the agricultural development plan.

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TABLES

Table 3.1 SUMMARY OF CLIMATIC CONDITION

Meteoro-logical Station	Station No.	Annual Rainfall (mm)	Temperature (°C)	Humidity (%)	Sunshine (%)	Wind Velocity (m/s)
Teluk Dalam	92	2,854	-	-	-	-
Tetehosi	92C	1,727	-	-	-	-
G.Sitoli	93	2,941	25.6	89	49	2.97
Mandrehe	94C	(2,836)	-	-	-	-
Lolofitu	9	(3,487)	26.4	(97)	35	0.40
Tefao	11	*	*	(95)	(43)	0.23
Lolowau	12	*	27.2	88	39	0.43
Awa'ai	28	(2,247)	-	-	-	-
Tetehosi	29	(3,151)	-	-	-	-

Note: 1) ( ); data is only a year
2) Mark(*); the lack of data

Table 3.2 LIST OF WATER RESOURCES

No.	Water Resource (Name of River)	Effective Catchment (km^2)	Total Catchment (km^2)	Normal Discharge at Weir Site (m^3/s)											
				J	F	M	A	M	J	J	A	S	O	N	D
1	Muzoi	310	459	7.9	7.0	9.0	9.2	8.2	7.7	10.2	8.7	13.0	15.6	14.8	11.6
2	Sawo	34	44	0.9	0.8	1.0	1.0	0.9	0.8	1.1	1.0	1.4	1.7	1.6	1.3
3	Sowo	86	194	2.2	1.9	2.5	2.5	2.3	2.1	2.8	2.4	3.6	4.3	4.1	3.2
4	Afia	7	24	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2
5	To'o	6	20	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.2
6	Ndra	6	7	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2
7	Idanoi	64	78	1.6	1.5	1.9	1.9	1.7	1.6	2.1	1.8	2.7	3.2	3.1	2.4
8	G. Zebua	71	103	1.8	1.6	2.1	2.1	1.9	1.8	2.3	2.0	3.0	3.6	3.4	2.7
9	Gidosido	46	50	1.2	1.0	1.3	1.4	1.2	1.2	1.5	1.3	1.9	2.3	2.2	1.7
10	Muwa	42	83	1.1	1.0	1.2	1.2	1.1	1.1	1.4	1.2	1.8	2.1	2.0	1.6
11	Mezawa	17	68	0.4	0.4	0.5	0.5	0.4	0.4	0.6	0.5	0.7	0.9	0.8	0.6
12	Mola	75	134	1.9	1.7	2.2	2.2	2.0	1.9	2.5	2.1	3.2	3.8	3.6	2.8
13	Gawo	76	121	1.9	1.7	2.2	2.3	2.0	1.9	2.5	2.1	3.2	3.8	3.6	2.9
14	How	30	92	0.8	0.7	0.9	0.9	0.8	0.8	1.0	0.8	1.3	1.5	1.4	1.1
15	Susuwa	168	203	4.3	3.8	4.9	5.0	4.4	4.2	5.5	4.7	7.1	8.5	8.0	6.3
16	Masio	42	81	1.1	1.0	1.2	1.2	1.1	1.1	1.4	1.2	1.8	2.1	2.0	1.6
17	Sau'a	44	50	1.1	1.0	1.3	1.3	1.2	1.1	1.4	1.2	1.9	2.2	2.1	1.7
18	Gomo	20	233	0.5	0.5	0.6	0.6	0.5	0.5	0.7	0.6	0.8	1.0	1.0	0.8
19	Armo	50	55	1.3	1.1	1.5	1.5	1.3	1.3	1.6	1.4	2.1	2.5	2.4	1.9
20	Eho	38	233	1.0	0.9	1.1	1.1	1.0	1.0	1.2	1.1	1.6	1.9	1.8	1.4
21	O'ou	46	48	1.2	1.0	1.3	1.4	1.2	1.1	1.5	1.3	1.9	2.3	2.2	1.7
22	Siwalawa	34	56	0.9	0.8	1.0	1.0	0.9	0.9	1.1	1.0	1.4	1.7	1.6	1.3
23	Dumula	18	97	0.5	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.8	0.9	0.9	0.7
24	Oyo	380	497	9.7	8.6	11.1	11.3	10.0	9.5	12.5	10.7	16.0	19.2	18.1	14.3
25	Mordo	44	92	1.1	1.0	1.3	1.3	1.2	1.1	1.4	1.2	1.9	2.2	2.1	1.7
26	Lahomi	36	84	0.9	0.8	1.1	1.1	1.0	0.9	1.2	1.0	1.5	1.8	1.7	1.4
27	Lahusa	9	10	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.4	0.4	0.4	0.3
	Total	1,796	3,216	45.7	40.7	52.4	53.2	47.4	44.9	59.0	50.7	75.7	90.6	85.6	67.4

Table 3.3 LIST OF DEVELOPMENT POTENTIAL AREAS

No	Name of Schemes	Kecamatan	Potential Area (ha)	Water Resources	Effective Catchment (km^2)
1.	Muzoi	Tuhemberua	5,330	Muzoi	310
2.	Torowa	Tuhemberua	1,040	Sawo	34
3.	Ladara	Tuhemberua	380	Sowu	86
4.	Sowo	Tuhemberua	1,610	Afia	7
5.	Afia / To'o	Tuhemberua	1,440	To'o	6
				Olora	20
6.	Ndra Humene	Gido	1,360	Ndra	6
				Idanoi	64
7.	Binaka	Gido	300	Small Rivers	
8.	Gido Zebua	Gido	1,340	Gido Zebua	71
9.	Muwa	Idano Gawo	7,170	Muwa	42
				Gidosiido	46
				Gawo	76
10.	Mezawa	Idano Gawo	6,620	Mezawa	17
				Mola	75
11.	How	Idano Gawo	6,450	How	30
12.	Susuwa	Lahusa	1,580	Susuwa	168
13.	Afoa	Lahusa	590		
14.	Boli	Lahusa	190	Masio	42
15.	Bawodobara	Teluk Dalam	170	Sau'a	41
16.	Teluk Dalam	Teluk Dalam	320	Small River	20
17.	Hilijihona	Teluk Dalam	100	Small River	5
18.	Sorake	Teluk Dalam	270	Gomo	20
19.	Todawa	Teluk Dalam	350	Eho	38
20.	Otuwa and Idano Zala	Teluk Dalam	1,720	Armo	50
21.	Amuri	Lolowau	540	O'ou	46
22.	Siwalawa	Lolowau	530	Siwalawa	34
23.	Oyo, Dumula	Alasa	12,480	Dumula	18
				Oyo	380
				Mordo	44
				Lahomi	36
24.	Lahusa	Sirombu	140	Lahusa	9
	Sub-total (*)		**52,020**		
25.	Afulu	Lahewa	1,280	-	-
26.	Tuhenase	Lahewa	150	-	-
	Sub-total (**)		**1,430**		
	Total		**53,450**		

Note: (*): potential irrigation area dependent on surface run-off
(**): potential irrigation area dependent on spring water

Table 4.1 DEMAND PROJECTION OF PADDY IN THE NIAS ISLAND

Year	Popu-lation*	Per-Capita Consumption of Rice (Kg/person/yr)	Total Paddy Consumption (ton/year)	Other Requirement** (ton/year)	Total Paddy Requirement (ton/year)	Supply of Paddy*** (ton/year)	Demand of Paddy (ton/year)
1989	558,700	135	116,000	15,800	131,800	94,500	37,300
1990	570,100	135	118,400	16,100	134,500	94,500	40,000
1995	624,700	135	129,700	17,700	147,400	94,500	52,900
2000	679,600	135	141,100	19,200	160,300	94,500	65,800
2005	735,700	135	152,800	20,800	173,600	94,500	79,100
2010	796,500	135	165,400	22,600	188,000	94,500	93,500
2015	858,100	135	178,200	24,300	202,500	94,500	108,000
2020	924,400	135	192,000	26,200	218,200	94,500	123,700

* : population growth rate 1989-1990 ;2.04 %
* : population growth rate 1990-1995 ;1.85 %
* : population growth rate 1995-2000 ;1.7%
* : population growth rate 2000-2005 ;1.6 %
* : population growth rate 2010-2015;1.5 %
* : population growth rate 2015-2020;1.5 %
** : including seed requirement,waste and feed requirement(about 12% of total demand of paddy)
*** : total production of paddy of the Nias island (80 % of average total production of lowland paddy and upland between 1985 and 1989)

Table 4.2 FEATURES OF IRRIGATION PROJECTS

Name of Irrigation Projects	River	Total Irrigation Area Net(ha)	Present Condition			Major Project Works				
			Irrigated paddy(ha)	Rainfed paddy(ha)	Non-paddy field(ha)	Weir (No.)	Irrigation Canal (km)	Drainage Canal (km)	Road (km)	Reclamation (ha)
(1)Muzoi	Nalua	1,000	250	380	370	9	44.8	0.0	66.0	370
(2)Torowa	Sowo	570	250	140	180	4	31.5	33.5	33.5	180
(3)Afia/To'o, Ladara, Sowo	Sawo/Olora/Afia.To'o	2,500	600	1,350	550	7	88.8	9.5	64.5	550
(4)Ndra Humene	Idanoi	680	300	140	240	1	21.3	3.5	2.5	240
(5)Binaka	tributary	90	0	90	0	1	8.0	2.0	2.0	0
(6)Muwa	Gidosido/Muwa/Gawo	5,530	0	5,530	0	6	100.5	18.0	52.0	0
(7)Mezawa, How	Mezawa/Mola/How/Susuwa	8,420	0	4,540	3,880	8	159.0	43.0	122.0	3,880
(8)Afoa, Susuwa	Masio	940	0	270	670	1	27.3	3.3	23.5	670
(9)Boli	tributaries	190	40	150	0	2	9.0	0.0	12.5	0
(10)Bawodobara, T.Dalam	tributary	250	40	150	60	1	16.0	11.0	2.5	60
(11)Hilijihona	tributary	100	0	100	0	1	6.5	0.0	0.0	0
(12)Todawa, Otuwa/Ie. Zala Sorake	Eho/Armo/Gomo	1,800	520	720	560	4	68.9	7.0	46.0	560
(13)Amuri	O'ou	250	0	180	70	3	16.0	0.0	10.0	70
(14)Siwalawa	Siwalawa	520	180	240	100	5	26.5	1.0	24.0	100
(15)Oyo/Dumula	Oyo/Mordo/Lahomi	8,860	190	2,180	6,490	12	134.0	33.0	110.0	6,490
(16)Lahusa	tributaries	130	0	50	80	4	8.0	0.0	8.0	80
(17)Afulu, Tuhenase	spring	520	0	220	300	1	12.5	24.0	55.0	300
Total		32,350	2,370	16,430	13,550	70	778.6	188.8	634.0	13,550

Table 5.1 COMPARISON BETWEEN AGRICULTURAL DEVELOPMENT PLAN STUDY AND FEASIBILITY STUDY

No.	Item	Agricultural Development Plan Study (Phase I)	Feasibility Study (Phase II)	Description (Main reason of changes or confirmed matter)
I. Employed Data and Information				
	1.1 Topographic map	1/50,000 (CI=25m)	1/5,000 (CI=1m) 1/50,000 (CI=25m)	New detailed map of 1/5,000 for Mezawa area was prepared by JICA topo-survey team in Dec., 1990
	1.2 Topographic survey	Not conducted	- Pain table survey and cross section survey at proposed weir sites - Longitudinal and cross section survey along the Susuwa main canal	Conducted by local consultant
	1.3 Present land use condition	Existing land use map(1/50,000) , land sat data and field survey	Topographic map(1/5,000) , aerophoto and field survey	Land use condition was clarified based on the map c 1/5,000 and field investigations
	1.4 Soil survey	Existing soil map of 1/50,000 and field survey	Detailed field investigations	Detailed investigation (19 points of soil profile and 100 points of auger boring) was carried out by the study team
	1.5 Present farming practice and cropping pattern	Interview survey and field survey	Interview survey(193 farmers) and field survey	
	1.6 Crop yield	Existing data and interview survey	Rice yeild survey(25 points) and interview survey	
	1.7 Survey of farmers expectation for agriculture	Interview survey	Detailed interview survey (193 farmers)	
	1.8 Environmental assessment	-	Conducted by local consultant	Assessed for the area of 10,000ha. Evaluation criteria of DGWRD was applied
II. Agricultural Development Plan				
	2.1 Basic agricultural plan	Increase of paddy production by introducing double cropping of paddy per year	Same as left	No change
	2.2 Project area	10,530 ha in gross 8,420 ha in net	7,290 ha in gross 5,100 ha in net	(Topographic condition) - A lot of small hills in the project area that cannot b irrigated by gravity are recognized and micro-rerie topography is also recognized. - Difference of elevations between two kinds of topc maps is about 80m at max. (Soil condition) - The result of detailed soil survey indicate that land where are not suitable for paddy cultivation is recognized - Net irrigation area is determined 70% of gross area taking the topopraphic conditions into consideratio
	2.3 Proposed cropping pattern	Double cropping of paddy	Same as left	No change
III. Project Works				
	3.1 Intake weir	Fixed type weir : 8 places	Fixed type weir : 4 places	
	3.2 Irrigation and drainage canals	- Irr. canals : 159 km in total -Drain. canals : 43 km in total	101 km in total 62 km in total	(Irrigation canals) Total length was become shorter by reduction of project area (Drainage canals) Tributaries of river are used as drainage canals through improvement

Note : CI = Contour Interval

Table 5.2 SUMMARY OF PROJECT COST

	Cost Item	F/C (1,000 US$)	L/C (Rp.million)	Total (Rp.million)
I	**Detailed Design**	**946**	**2,217**	**3,968**
II	**Land Acquisition**	**0**	**2,670**	**2,670**
III	**Construciton Cost**			
1	Direct Construction Cost			
	1) General Items	852	2,201	3,777
	2) Intake Weir	557	1,921	2,951
	3) Irrigation Canals	5,854	14,666	25,496
	4) Drainage Canals	449	1,592	2,423
	5) Farm Roads	450	786	1,619
	6) On-farm Development	1,212	3,050	5,292
	7) IACC	6	37	48
	Sub Total	9,380	24,253	41,606
2	Contingencies			
	1) Physical Contingency (15%)	1,407	3,638	6,241
	Sub Total	1,407	3,638	6,241
3	*Total for Item 1&2*	*10,787*	*27,891*	*47,847*
4	Tax on Civil Works, VAT (10%)	1,079	2,789	4,785
	Total for Item III	**11,866**	**30,680**	**52,632**
IV	**O&M Equipment**	**897**	**41**	**1,700**
V	**Engineering Services**	**938**	**2,425**	**4,161**
VI	**Administration Cost**	**281**	**728**	**1,248**
VII	**Training Program**	**0**	**250**	**250**
	GRAND TOTAL	**14,928**	**39,010**	**66,628**

Table 5.3 IRRIGATION BENEFIT

Irrigation Scheme	Cropping Season	With Project Condition						Without Project Condition						Irrigation Benefit(7) (Rp.million)
		Project Area (ha)	Cultivated Area (ha)	Unit Yield (ton/ha)	Gross Income(1) (Rp.million)	Production Cost(2) (Rp.million)	Primary Profit(3) (Rp.million)	Existing Paddy Field (ha)	Cultivated Area (ha)	Unit Yield (ton/ha)	Gross Income(4) (Rp.million)	Production Cost(5) (Rp.million)	Primary Profit(6) (Rp.million)	
1. Mezawa	Wet	280	280	5.0	417	204	213	230	230	1.8	123	79	44	169
	Dry	-	280	5.0	417	204	213	-	39	1.1	13	12	1	212
	Annual	-	560	-	834	408	426	-	269	-	136	91	45	381
2. Mola	Wet	1,450	1,450	5.0	2,161	1,054	1,107	1,160	1,160	1.8	622	397	225	882
	Dry	-	1,450	5.0	2,161	1,054	1,107	-	197	1.1	65	62	3	1,104
	Annual	-	2,900	-	4,322	2,108	2,214	-	1,357	-	687	459	228	1,986
3. How	Wet	450	450	5.0	671	327	344	180	180	1.8	97	62	35	309
	Dry	-	450	5.0	671	327	344	-	31	1.1	10	10	0	344
	Annual	-	900	-	1,342	654	688	-	211	-	107	72	35	653
4. Susuwa	Wet	2,920	2,920	5.0	4,351	2,123	2,228	890	890	1.8	477	304	173	2,055
	Dry	-	2,920	5.0	4,351	2,123	2,228	-	151	1.1	49	47	2	2,226
	Annual	-	5,840	-	8,702	4,246	4,456	-	1,041	-	526	351	175	4,281
Total		5,100	10,200	-	15,200	7,416	7,784	2,460	2,878	-	1,456	973	483	7,301

Note:
(1):Annual Cultivated Area x Unit Yield x Rp.298,000/ton
(2):Annual Cultivated Area x Rp.726,980/ton
(3):(1) - (2)
(4):Annual Cultivated Area x Unit Yield x Rp.298,000/ton
(5):Wet Season Cultivated Area x Rp.341,982/ton, Dry Season Cultivated Area x Rp.314,556/ton
(6):(1) - (2)
(7):(3) - (6)

Table 5.4 ECONOMIC COST AND BENEFIT FLOW

(MEZAWA/HOW IRRIGATION PROJECT)

(Unit : MILLION RP.)

Year in Order	Year	Costs			Gross Benefit (B)
		Const-ruction	OMR	Total (C)	
1	1992	3,635	0	3,635	0
2	1993	13,194	0	13,194	0
3	1994	13,194	0	13,194	0
4	1995	15,833	100	15,933	1,031
5	1996	10,555	121	10,677	2,437
6	1997	0	306	306	5,943
7	1998	0	528	528	6,626
8	1999	0	528	528	6,995
9	2000	0	528	528	7,166
10	2001	0	528	528	7,258
11	2002	0	528	528	7,301
12	2003	0	528	528	7,301
13	2004	0	528	528	7,301
14	2005	0	528	528	7,301
15	2006	0	528	528	7,301
16	2007	0	528	528	7,301
17	2008	0	528	528	7,301
18	2009	0	528	528	7,301
19	2010	0	528	528	7,301
20	2011	0	528	528	7,301
21	2012	0	528	528	7,301
22	2013	0	528	528	7,301
23	2014	0	626	626	7,301
24	2015	0	1,126	1,126	7,301
25	2016	0	1,028	1,028	7,301
26	2017	0	528	528	7,301
27	2018	0	528	528	7,301
28	2019	0	528	528	7,301
29	2020	0	528	528	7,301
30	2021	0	528	528	7,301
31	2022	0	528	528	7,301
32	2023	0	528	528	7,301
33	2024	0	528	528	7,301
34	2025	0	528	528	7,301
35	2026	0	678	678	7,301
36	2027	0	528	528	7,301
37	2028	0	528	528	7,301
38	2029	0	528	528	7,301
39	2030	0	528	528	7,301
40	2031	0	528	528	7,301
41	2032	0	528	528	7,301
42	2033	0	528	528	7,301
43	2034	0	626	626	7,301
44	2035	0	1,126	1,126	7,301
45	2036	0	1,028	1,028	7,301
46	2037	0	528	528	7,301
47	2038	0	528	528	7,301
48	2039	0	528	528	7,301
49	2040	0	528	528	7,301
50	2041	0	528	528	7,301

Table 5.5 IMPACT EVALUATION OF THE PROJECT ACTIVITIES

Environmental Matrix/Impacts	PRE-CONSTRUCTION				CONSTRUCTION STAGE								OPERATION AND MAINTENANCE			
	Survey Area	Area marking	Land release	Removal of people	Mobilization of materials and heavy equipment	Mobilization of man power	Opening and cleaning land	Construction of access road	Construction of weir	Excavation and transportation of materials	Construction of drainage ditches	Construction and operation of base camp	Operation of weir	Agricultural extensification	Agricultural intensification	Water management
I. PHYSICO-CHEMICAL																
Climate/noise					(-)a		(-)a									
Physiography/geology																
Hydrology							(-)a		(-)a		(-)a		(-)a	(-)a	(-)a	
Water quality(river)						(-)a	(-)a	(-)a	(-)a	(-)a	(-)a	(-)a	(-)a	(-)a	(-)a	(-)a
Water quality(well)						(-)a	(-)a					(-)a				
Soil and land use			(+)a		(-)a		(-)a	(-)a	(-)a	(-)a	(-)a			(+)b	(+)b	
II. BIOLOGY																
Flora	(-)a	(-)a					(-)a	(-)a	(-)a		(-)a			(-)a	(-)a	
Fauna						(-)a	(-)a							(-)a	(-)a	
Aquatic biota						(-)a	(-)a				(-)a	(-)a		(-)a	(-)a	
III. SOCIO-ECONOMY																
Income level	(+)b		(+)b			(+)c	(+)c	(+)c	(+)b	(+)b	(+)b	(+)b		(+)d	(+)d	
Labor absorption	(+)b					(+)c	(+)b	(+)d	(+)b	(+)b	(+)b	(+)b		(+)d	(+)d	
Perception of local people	(+)b	(+)c	(+)d	(+)b	(+)c	(+)c	(+)d	(+)c	(+)b	(+)b	(+)c	(+)c		(+)d	(+)d	(+)c
Transportation					(-)a	(+)c		(+)c		(-)a		(+)c				
Social problems/conflicts			(-)b	(-)b		(-)a	(+)b	(-)a			(-)a	(-)a		(-)a	(-)a	(-)a
Housing														(+)b	(+)b	
Socio-cultural organization						(+)b						(+)b		(+)b	(+)b	
Formal/non-formal institution			(+)c	(+)b		(+)b	(+)b				(+)b	(+)b		(+)b	(+)b	(+)b

Note:
a:not so important
b=important enough
c=important
d=more important
e=most important
- =negative impact
+ =positive impact

TABLE 5.6 PROPOSED SOLUTION FOR NEGATIVE IMPACT OF THE MEZAWA/HOW IRRIGATION PROJECT

Predicted Negative Impacts by the Project	Environmental Category	Objective Aspects	Implementation Stage of the Project	Reason of occure	Evaluation Class	Proposed Solution (implementation of project activity)	Environment management and monitoring
1. Social conflicts	Socio-cultural/ economy	Local people	Pre-construction	Land release	(-b)	Land cadastral survey, Clarification of boundary	guidance of project target for local people land holding size survey
				Removal of people	(-b)	Adequate compensation	resettlement plan
			Construction	Mobilization of labor	(-a)	Settlement of project worker in the particular location	proper management of project worker
2. Disappearence of biological resources	Biology	Fauna/ Flora	Pre-construction	Site survey	(-a)	Prohibition of fauna/flora catching	supervision of construction works
			Construction	Opening & Clearing land	(-a)	Confirmation of existence of conservancy resources	site observation
				Construction of related facilities	(-a)	Regulation of construction performances	supervision of construction works
3. Increase of noise level	Physical impacts	Noise	Construction	Mobilization of materials and heavy equipments	(-a)	Regulation of motor speed	supervision of construction works
				Construction of weir/canal/access roads	(-a)	Regulation of operation hour/time	supervision of construction works
				Opening & clearing land	(-a)	Regulation of performances	supervision of construction works
4. Deteriolation of water quality	Physico-chemical impacts	River water	Construction	Mobilization of heavy equipments	(-a)	Decision of proper site for installation of heavy equipments	check of water turbidity
				Opening & clearing land	(-a)	Regulation of land clearing works	check of water quality
				Construction of weir	(-a)	Decision of adequate weir site	check of river turbidity/flow
				Construction of irrigation facilities	(-a)	Regulation of drainage water quality	check of water quality
			O & M stage	Utilization of Farm inputs	(-a)	Proper farming practices Regulation of agro-chemical application	check of water quality
		Well water	Construction	Operation of base camp	(-a)	Regulation of drainage water quality/proper drainage	check of water quality
				Mobilization of man power	(-a)	Regulation of drainage water quality/proper drainage	check of water quality
			O & M stage	Utilization of fertilizer and agro-chemicals	(-a)	Proper farming practices Regulation of agro-chemical application Protection of well water from chemicals	check of water quality and health
5. Land slide/erosion	Physical impact	Slope stability	Construction	Mobilization of heavy equipments	(-a)	Regulation of load weight/ motor speed	check of river water turbidity
		Soil erosion	Construction	Opening and clearing land	(-a)	Proper land use plan regulation of land clearing works Re-forestation/re-vegetation	check of river water turbidity
				Construction of irrigation facilities	(-a)	Regulation of excavation works, proper work schedule based on the weather condition	check of river water turbidity
6. Sedimentation	Physical impact	River water	Construction	Construction of weir	(-a)	Proper site decision of weir	check of sedimentation
				Opening and clearing land	(-a)	Soil conservation/re-vegetation along river	check of sedimentation
7. Change in river flow	Physical impact	River flow	Construction	Construction of weir	(-a)	Inform construction schedule for water user in down stream area	Observation of river flow
	Socio-cultural/ economy	Farmer	O & M stage	Increase of Cropping Intensity	(-a)	Adequate water management system planned irrigation water utilization	Observation of river flow
8. Unstable water supply	Socio-cultural/ economy	people in downstream	Construction	Construction of weir	(-a)	Minimization of fluctuation of river discharge by proper design of weir	Observation of river flow

Table 5.7 PROJECT COST OF MEZAWA/HOW IRRIGATION PROJECT

	Cost Item	Mezawa			Mola			How			Susuwa			Total		
		F/C (1,000US$)	L/C (Rp.mill.)	Total (Rp.mill.)	F/C (1,000US$)	L/C (Rp.mill.)	Total (Rp.mill.)	F/C (1,000US$)	L/C (Rp.mill.)	Total (Rp.mill.)	F/C (1,000US$)	L/C (Rp.mill.)	Total (Rp.mill.)	F/C (1,000 US$)	L/C (Rp.million)	Total (Rp.million)
I	**Detailed Design**	27	88	139	147	418	690	89	200	365	682	1,511	2,773	946	2,217	3,968
II	**Land Acquisition**	0	120	120	0	790	790	0	260	260	0	1,500	1,500	0	2,670	2,670
III	**Construciton Cost**															
1	Direct Construction Cost															
	1) General Items	36	115	181	191	542	896	67	169	292	559	1,375	2,409	852	2,201	3,778
	2) Intake Weir	74	262	399	170	561	875	108	372	572	205	726	1,105	557	1,921	2,950
	3) Irrigation Canals	155	460	747	1,256	3,531	5,854	376	963	1,659	4,067	9,712	17,237	5,854	14,666	25,497
	4) Drainage Canals	40	188	262	111	434	639	43	49	128	255	921	1,393	449	1,592	2,422
	5) Farm Roads	34	87	149	103	110	301	26	28	75	288	561	1,093	450	786	1,619
	6) On-farm Development	52	151	248	274	787	1,294	114	279	490	772	1,833	3,260	1,212	3,050	5,292
	7) IACC													6	37	48
	Sub Total	391	1,264	1,986	2,105	5,965	9,858	733	1,859	3,215	6,146	15,128	26,497	9,380	24,252	41,605
2	Contingencies															
	1) Physical Contingency (15%)	59	190	298	316	895	1,479	110	279	482	922	2,269	3,975	1,407	3,638	6,241
	2) Price Contingency															
	Sub Total	59	190	298	316	895	1,479	110	279	482	922	2,269	3,975	1,407	3,638	6,241
3	Total for Item 1&2	449	1,453	2,284	2,420	6,860	11,337	843	2,138	3,698	7,067	17,397	30,472	10,787	27,890	47,846
4	Tax on Civil Works, VAT (10%)	45	145	228	242	686	1,134	84	214	370	707	1,740	3,047	1,079	2,789	4,785
	Total for Item III	494	1,598	2,512	2,662	7,546	12,471	927	2,352	4,067	7,774	19,137	33,519	11,866	30,679	52,631
IV	**O&M Equipment**	49	2	93	255	12	484	79	4	150	514	23	974	897	41	1,700
V	**Engineering Services**	39	126	199	210	596	986	73	186	322	615	1,513	2,650	938	2,425	4,161
VI	**Administration Cost**	12	38	60	63	179	296	22	56	96	184	454	795	281	728	1,248
VII	**Training Program**	0	14	14	0	71	71	0	22	22	0	143	143	0	250	250
	GRAND TOTAL	621	1,987	3,137	3,338	9,612	15,787	1,191	3,079	5,283	9,769	24,281	42,354	14,928	39,010	66,628

Table 5.8 PRINCIPAL FEATURES OF ALTERNATIVE DEVELOPMENT PLAN

	Description	Mezawa System	Mola System	How System
1	Net irrigable area	280 ha	1,450 ha	450 ha
2	Water Source	Mezawa river	Mola river	How river
3	Project Works			
	1) Diversion weir	Fixed weir (with Intake & Sand settling basin, Intake) discharge Q=0.412m3/s)	Fixed weir (with Intake & Sand settling basin, Intake) discharge Q=2.132m3/s)	Fixed weir (with Intake & Sand settling basin, Intake) discharge Q=0.662m3/s)
	2) Main & secondary canals (Open canal with masonry lining)	5.3 km in total	32.2 km in total	8.5 km in total
	3) Drainage canal (Rehabilitation of existing rivers/streams)	4 km in total	39.8 km in total	5 km in total
	4) Farm road network	6.8 km in total (Rehabilitation 5 km, New 1.8km)	42 km in total (Rehabilitation 10 km New 32 km)	11 km in total (Rehabilitation 8.5 km, New 2.5 km)
	5) On-farm facilities	280 ha (50 ha newly developed)	1,450 ha (300 ha newly developed)	450 ha (270 ha newly developed)

Table 5.9 PROJECT COST FOR ALTERNATIVE DEVELOPMENT PROJECT

	Cost Item	Mezawa			Mola			How			Combined Project		
		F/C (1,000US$)	L/C (Rp.mill.)	Total (Rp.mill.)	F/C (1,000US$)	L/C (Rp.mill.)	Total (Rp.mill.)	F/C (1,000US$)	L/C (Rp.mill.)	Total (Rp.mill.)	F/C (1,000 US$)	L/C (Rp.million)	Total (Rp.million)
I	**Detailed Design**	**29**	**93**	**147**	**106**	**321**	**517**	**89**	**200**	**365**	**224**	**614**	**1,029**
II	**Land Acquisition**	**0**	**140**	**140**	**0**	**550**	**550**	**0**	**260**	**260**	**0**	**950**	**950**
III	**Construciton Cost**												
	1. Direct Construction Cost												
	1) General Items	38	121	191	138	417	672	67	169	293	243	707	1,156
	2) Intake Weir	74	262	399	170	561	875	108	372	572	351	1,196	1,846
	3) Irrigation Canals	174	523	845	531	1,687	2,670	376	963	1,659	1,081	3,173	5,174
	4) Drainage Canals	40	188	262	256	972	1,446	43	49	129	339	1,210	1,837
	5) Farm Roads	36	89	156	145	156	424	26	28	76	207	273	656
	6) On-farm Development	52	151	248	277	791	1,303	114	279	490	443	1,221	2,041
	7) IACC										6	37	48
	Sub Total	414	1,336	2,102	1,517	4,584	7,390	733	1,859	3,215	2,671	7,816	12,758
	2. Contingencies												
	1) Physical Contingency (15%)	62	200	315	228	688	1,109	110	279	482	401	1,172	1,914
	Sub Total	62	200	315	228	688	1,109	110	279	482	401	1,172	1,914
	3. Total for Item 1&2	476	1,536	2,417	1,744	5,271	8,499	843	2,138	3,697	3,072	8,989	14,671
	4. Tax on Civil Works, VAT (10%)	48	154	242	174	527	850	84	214	370	307	899	1,467
	Total for Item III	**524**	**1,689**	**2,658**	**1,919**	**5,799**	**9,349**	**927**	**2,352**	**4,067**	**3,379**	**9,888**	**16,138**
IV	**O&M Equipment**	**85**	**4**	**161**	**440**	**20**	**834**	**79**	**4**	**150**	**604**	**28**	**1,145**
V	**Engineering Services**	**41**	**134**	**210**	**152**	**458**	**739**	**73**	**186**	**322**	**267**	**782**	**1,276**
VI	**Administration Cost**	**12**	**40**	**63**	**46**	**138**	**222**	**22**	**56**	**96**	**80**	**234**	**383**
VII	**Training Program**	**0**	**13**	**13**	**0**	**72**	**72**	**0**	**22**	**22**	**0**	**107**	**107**
	GRAND TOTAL	**692**	**2,114**	**3,393**	**2,662**	**7,357**	**12,283**	**1,191**	**3,079**	**5,283**	**4,554**	**12,603**	**21,028**

Table5.10 ECONOMIC COST AND BENEFIT FLOW

(Alternative : Mezawa System)

(Unit : MILLION RP.)

Year in Order	Year	Costs			Gross Benefit (B)
		Const-ruction	OMR	Total (C)	
1	1992	132	0	132	0
2	1993	681	0	681	0
3	1994	2,044	0	2,044	0
4	1995	0	5	5	282
5	1996	0	6	6	329
6	1997	0	16	16	353
7	1998	0	27	27	365
8	1999	0	27	27	376
9	2000	0	27	27	376
10	2001	0	27	27	376
11	2002	0	27	27	376
12	2003	0	27	27	376
13	2004	0	27	27	376
14	2005	0	27	27	376
15	2006	0	27	27	376
16	2007	0	27	27	376
17	2008	0	27	27	376
18	2009	0	27	27	376
19	2010	0	27	27	376
20	2011	0	27	27	376
21	2012	0	27	27	376
22	2013	0	27	27	376
23	2014	0	35	35	376
24	2015	0	54	54	376
25	2016	0	55	55	376
26	2017	0	27	27	376
27	2018	0	27	27	376
28	2019	0	27	27	376
29	2020	0	27	27	376
30	2021	0	27	27	376
31	2022	0	27	27	376
32	2023	0	27	27	376
33	2024	0	27	27	376
34	2025	0	27	27	376
35	2026	0	37	37	376
36	2027	0	27	27	376
37	2028	0	27	27	376
38	2029	0	27	27	376
39	2030	0	27	27	376
40	2031	0	27	27	376
41	2032	0	27	27	376
42	2033	0	27	27	376
43	2034	0	35	35	376
44	2035	0	54	54	376
45	2036	0	55	55	376
46	2037	0	27	27	376
47	2038	0	27	27	376
48	2039	0	27	27	376
49	2040	0	27	27	376
50	2041	0	27	27	376

Table 5.11 ECONOMIC COST AND BENEFIT FLOW
(Alternative : Mola System)

(Unit : MILLION RP.)

Year in Order	Year	Costs			Gross Benefit (B)
		Const-ruction	OMR	Total (C)	
1	1992	468	0	468	0
2	1993	2,485	0	2,485	0
3	1994	7,454	0	7,454	0
4	1995	0	19	19	747
5	1996	0	23	23	1,618
6	1997	0	58	58	1,807
7	1998	0	99	99	1,901
8	1999	0	99	99	1,961
9	2000	0	99	99	1,991
10	2001	0	99	99	1,991
11	2002	0	99	99	1,991
12	2003	0	99	99	1,991
13	2004	0	99	99	1,991
14	2005	0	99	99	1,991
15	2006	0	99	99	1,991
16	2007	0	99	99	1,991
17	2008	0	99	99	1,991
18	2009	0	99	99	1,991
19	2010	0	99	99	1,991
20	2011	0	99	99	1,991
21	2012	0	99	99	1,991
22	2013	0	99	99	1,991
23	2014	0	140	140	1,991
24	2015	0	286	286	1,991
25	2016	0	246	246	1,991
26	2017	0	99	99	1,991
27	2018	0	99	99	1,991
28	2019	0	99	99	1,991
29	2020	0	99	99	1,991
30	2021	0	99	99	1,991
31	2022	0	99	99	1,991
32	2023	0	99	99	1,991
33	2024	0	99	99	1,991
34	2025	0	99	99	1,991
35	2026	0	149	149	1,991
36	2027	0	99	99	1,991
37	2028	0	99	99	1,991
38	2029	0	99	99	1,991
39	2030	0	99	99	1,991
40	2031	0	99	99	1,991
41	2032	0	99	99	1,991
42	2033	0	99	99	1,991
43	2034	0	140	140	1,991
44	2035	0	286	286	1,991
45	2036	0	246	246	1,991
46	2037	0	99	99	1,991
47	2038	0	99	99	1,991
48	2039	0	99	99	1,991
49	2040	0	99	99	1,991
50	2041	0	99	99	1,991

Table 5.12 ECONOMIC COST AND BENEFIT FLOW
(Alternative: How System)

(Unit : MILLION RP.)

Year in Order	Year	Costs			Gross Benefit (B)
		Const-ruction	OMR	Total (C)	
1	1992	335	0	335	0
2	1993	1,037	0	1,037	0
3	1994	3,112	0	3,112	0
4	1995	0	8	8	490
5	1996	0	10	10	571
6	1997	0	24	24	614
7	1998	0	41	41	633
8	1999	0	41	41	646
9	2000	0	41	41	653
10	2001	0	41	41	653
11	2002	0	41	41	653
12	2003	0	41	41	653
13	2004	0	41	41	653
14	2005	0	41	41	653
15	2006	0	41	41	653
16	2007	0	41	41	653
17	2008	0	41	41	653
18	2009	0	41	41	653
19	2010	0	41	41	653
20	2011	0	41	41	653
21	2012	0	41	41	653
22	2013	0	41	41	653
23	2014	0	49	49	653
24	2015	0	93	93	653
25	2016	0	85	85	653
26	2017	0	41	41	653
27	2018	0	41	41	653
28	2019	0	41	41	653
29	2020	0	41	41	653
30	2021	0	41	41	653
31	2022	0	41	41	653
32	2023	0	41	41	653
33	2024	0	41	41	653
34	2025	0	41	41	653
35	2026	0	54	54	653
36	2027	0	41	41	653
37	2028	0	41	41	653
38	2029	0	41	41	653
39	2030	0	41	41	653
40	2031	0	41	41	653
41	2032	0	41	41	653
42	2033	0	41	41	653
43	2034	0	49	49	653
44	2035	0	93	93	653
45	2036	0	85	85	653
46	2037	0	41	41	653
47	2038	0	41	41	653
48	2039	0	41	41	653
49	2040	0	41	41	653
50	2041	0	41	41	653

Table 5.13 ECONOMIC COST AND BENEFIT FLOW
(Alternative : Combined System)

(Unit : MILLION RP.)

Year in Order	Year	Costs			Gross Benefit (B)
		Const-ruction	O&M	Total (C)	
1	1992	936	0	936	0
2	1993	4,217	0	4,217	0
3	1994	12,652	0	12,652	0
4	1995	0	32	32	1,519
5	1996	0	39	39	2,518
6	1997	0	98	98	2,774
7	1998	0	169	169	2,899
8	1999	0	169	169	2,983
9	2000	0	169	169	3,020
10	2001	0	169	169	3,020
11	2002	0	169	169	3,020
12	2003	0	169	169	3,020
13	2004	0	169	169	3,020
14	2005	0	169	169	3,020
15	2006	0	169	169	3,020
16	2007	0	169	169	3,020
17	2008	0	169	169	3,020
18	2009	0	169	169	3,020
19	2010	0	169	169	3,020
20	2011	0	169	169	3,020
21	2012	0	169	169	3,020
22	2013	0	169	169	3,020
23	2014	0	209	209	3,020
24	2015	0	422	422	3,020
25	2016	0	382	382	3,020
26	2017	0	169	169	3,020
27	2018	0	169	169	3,020
28	2019	0	169	169	3,020
29	2020	0	169	169	3,020
30	2021	0	169	169	3,020
31	2022	0	169	169	3,020
32	2023	0	169	169	3,020
33	2024	0	169	169	3,020
34	2025	0	169	169	3,020
35	2026	0	233	233	3,020
36	2027	0	169	169	3,020
37	2028	0	169	169	3,020
38	2029	0	169	169	3,020
39	2030	0	169	169	3,020
40	2031	0	169	169	3,020
41	2032	0	169	169	3,020
42	2033	0	169	169	3,020
43	2034	0	209	209	3,020
44	2035	0	422	422	3,020
45	2036	0	382	382	3,020
46	2037	0	169	169	3,020
47	2038	0	169	169	3,020
48	2039	0	169	169	3,020
49	2040	0	169	169	3,020
50	2041	0	169	169	3,020

The Feasibility Study on
The Nias Island Irrigation Agricultural Development Project

Vol. I
MAIN REPORT

FIGURES

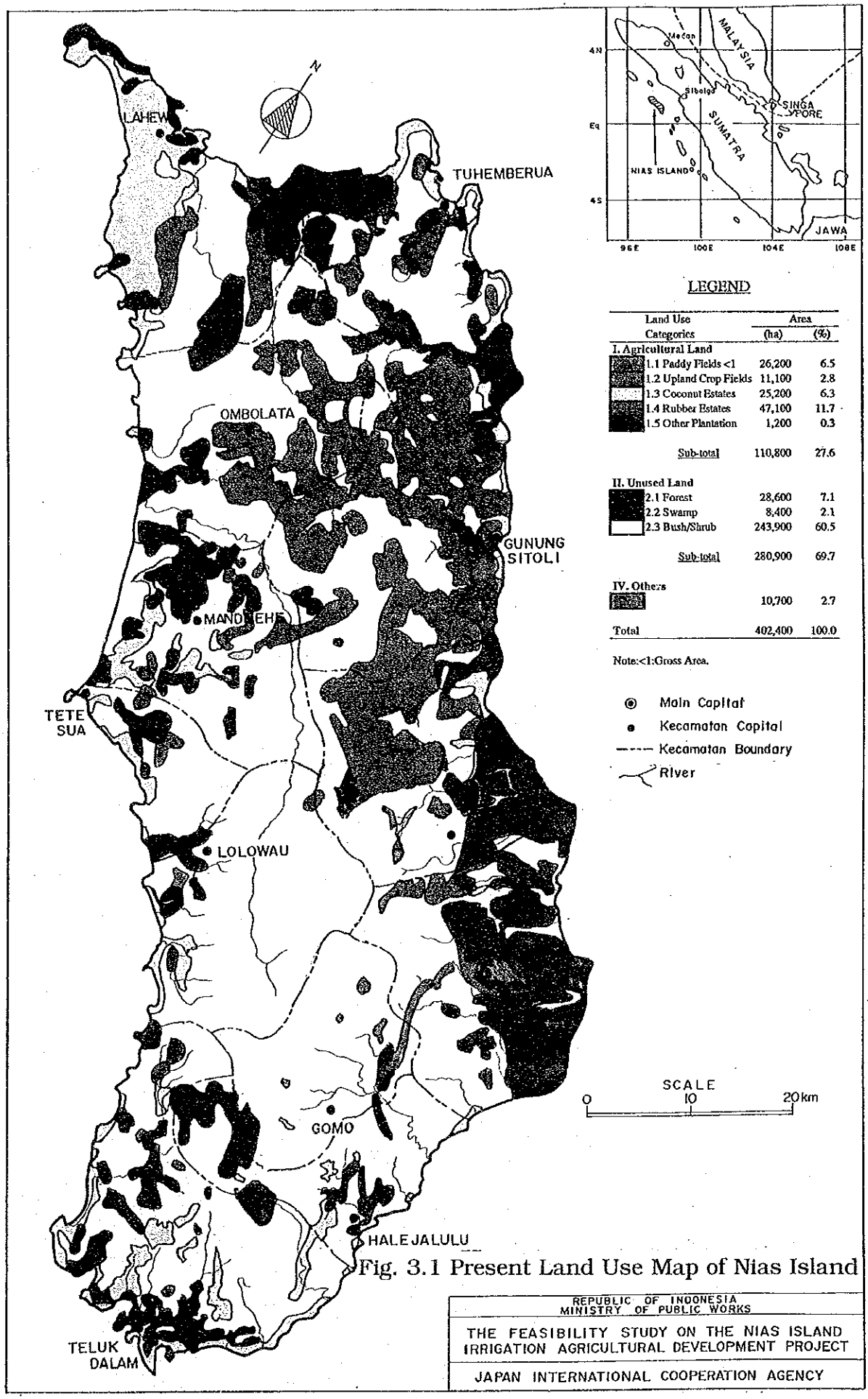

Fig. 3.1 Present Land Use Map of Nias Island

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THE FEASIBILITY STUDY ON THE NIAS ISLAND IRRIGATION AGRICULTURAL DEVELOPMENT PROJECT

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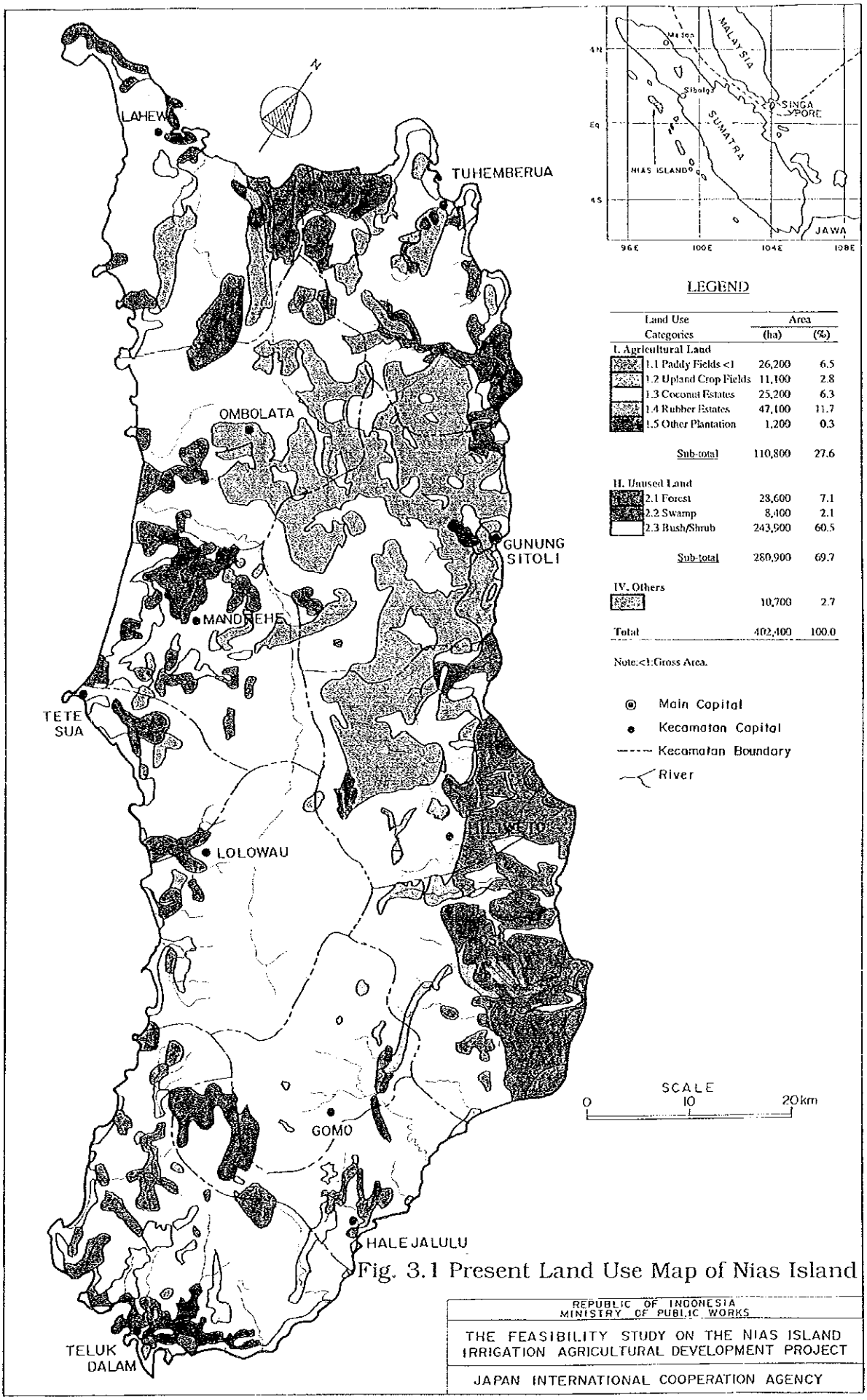

Fig. 3.1 Present Land Use Map of Nias Island

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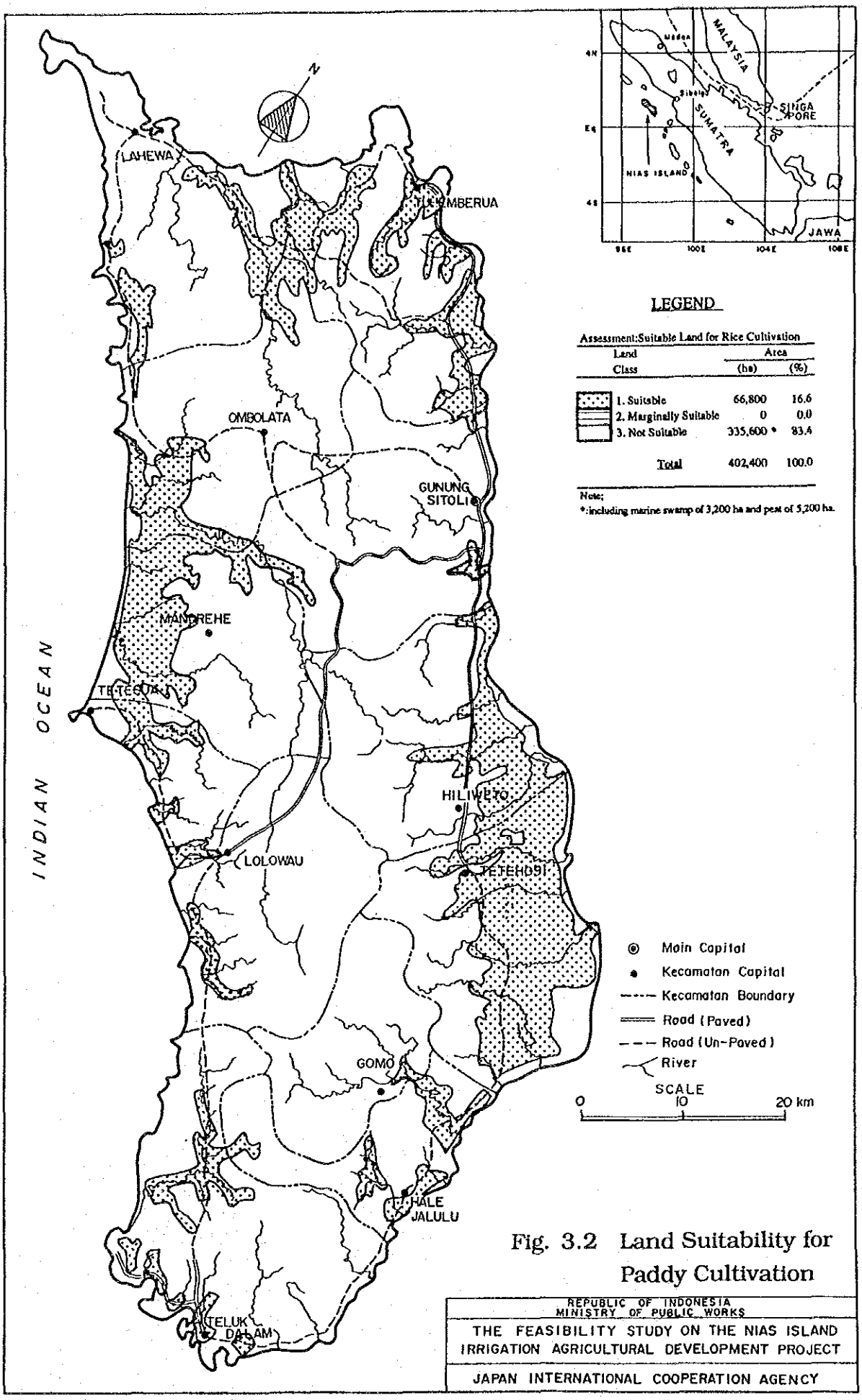

Fig. 3.2 Land Suitability for Paddy Cultivation

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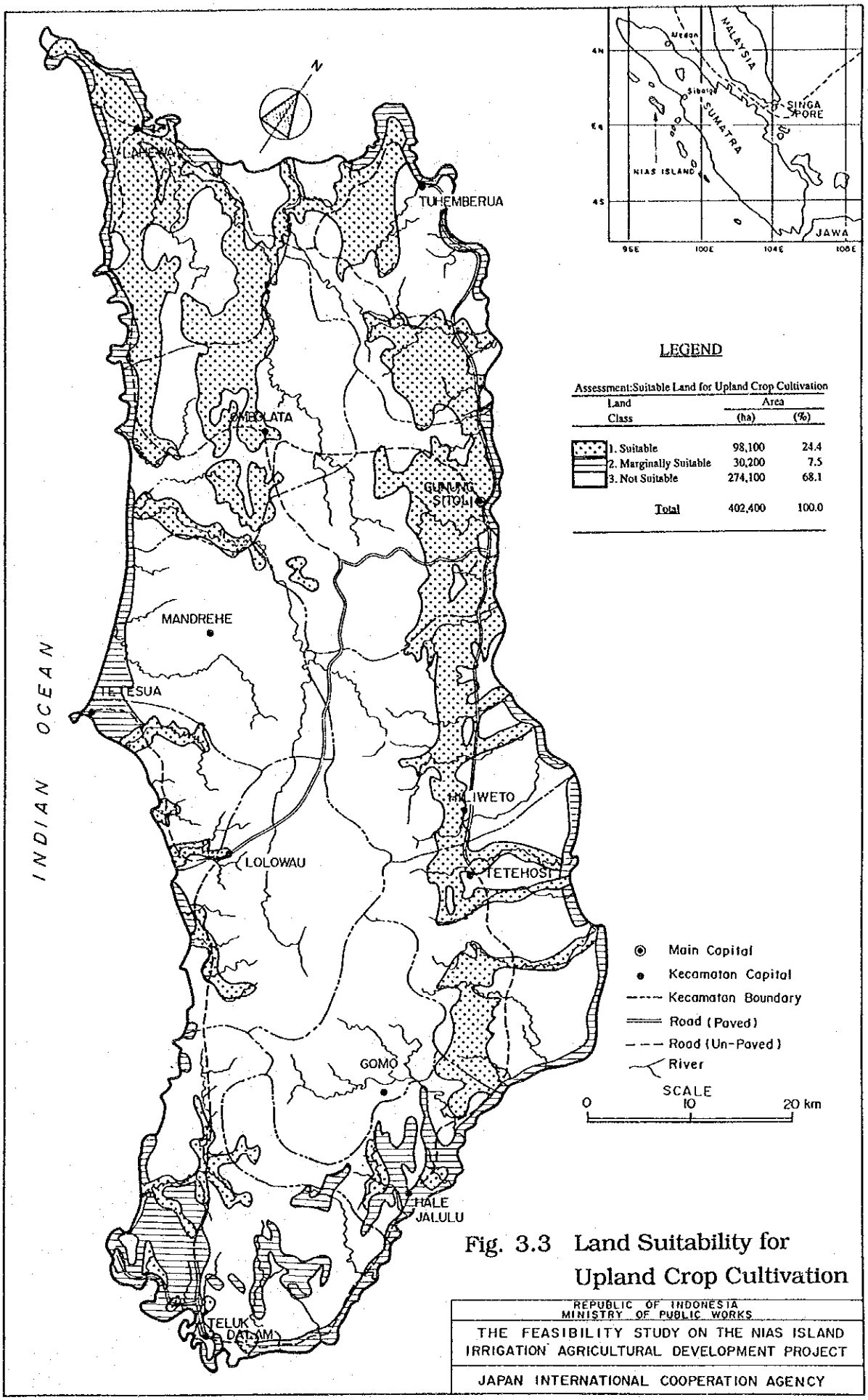

Fig. 3.3 Land Suitability for Upland Crop Cultivation

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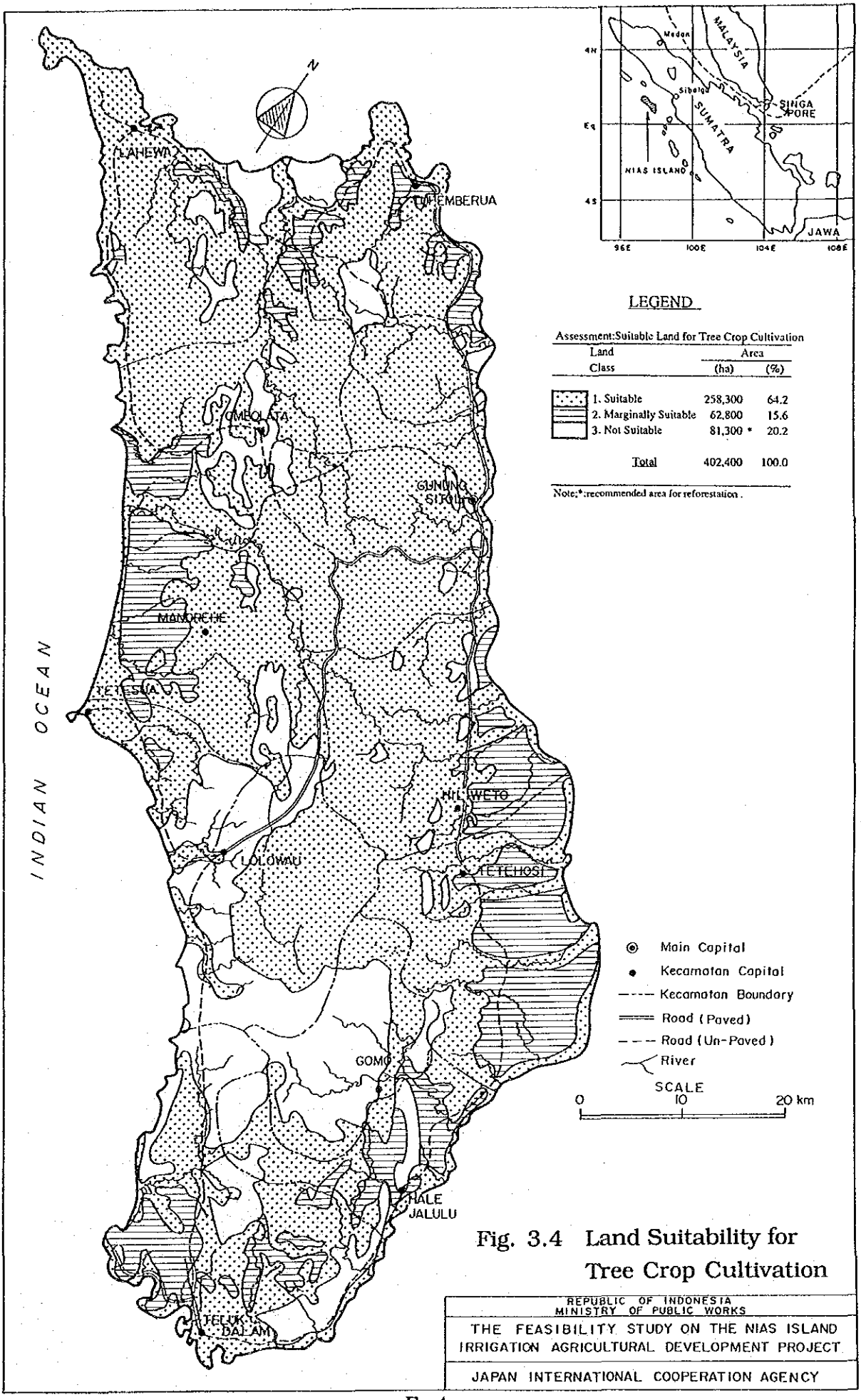

Fig. 3.4 Land Suitability for Tree Crop Cultivation

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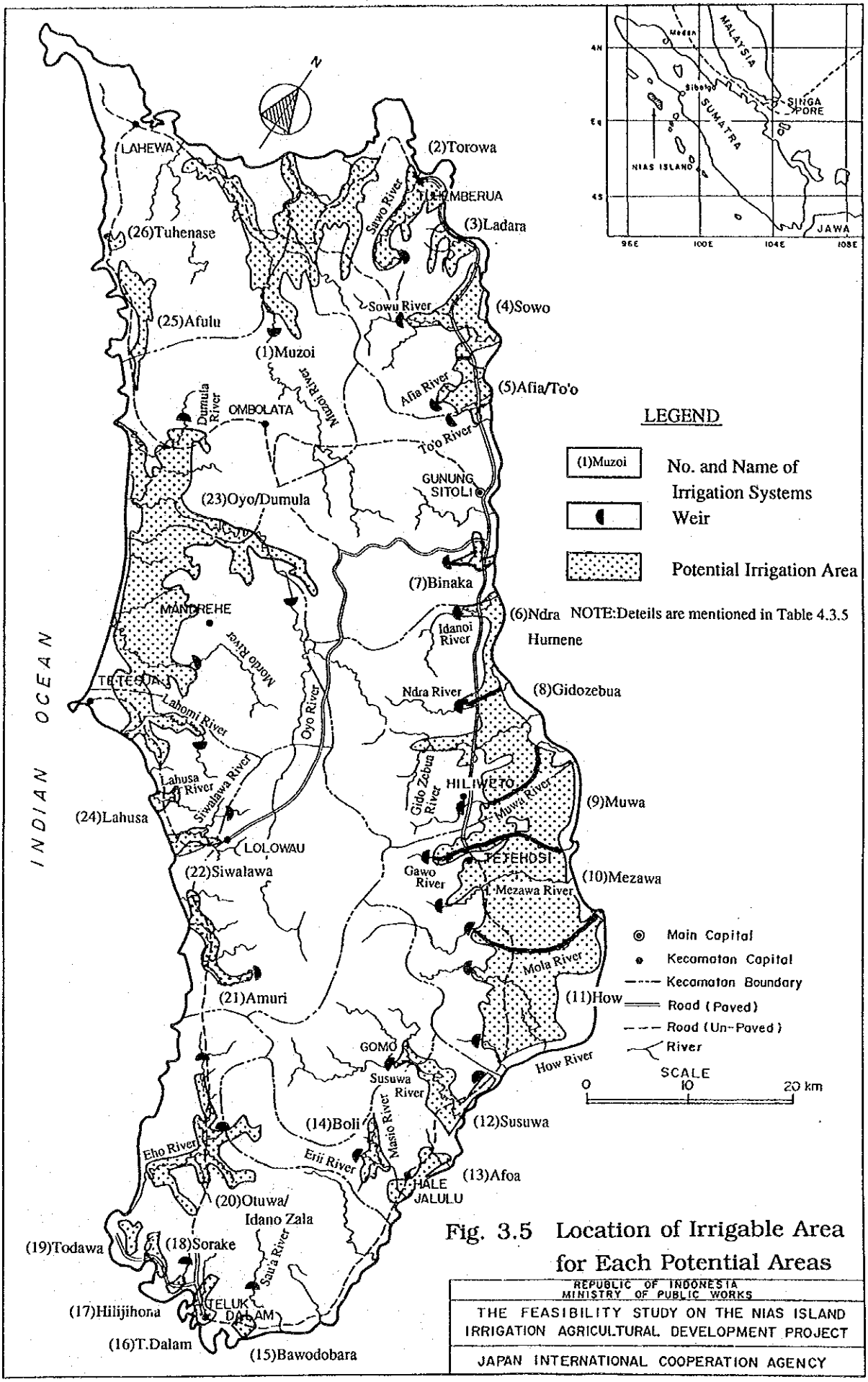

Fig. 3.5 Location of Irrigable Area for Each Potential Areas

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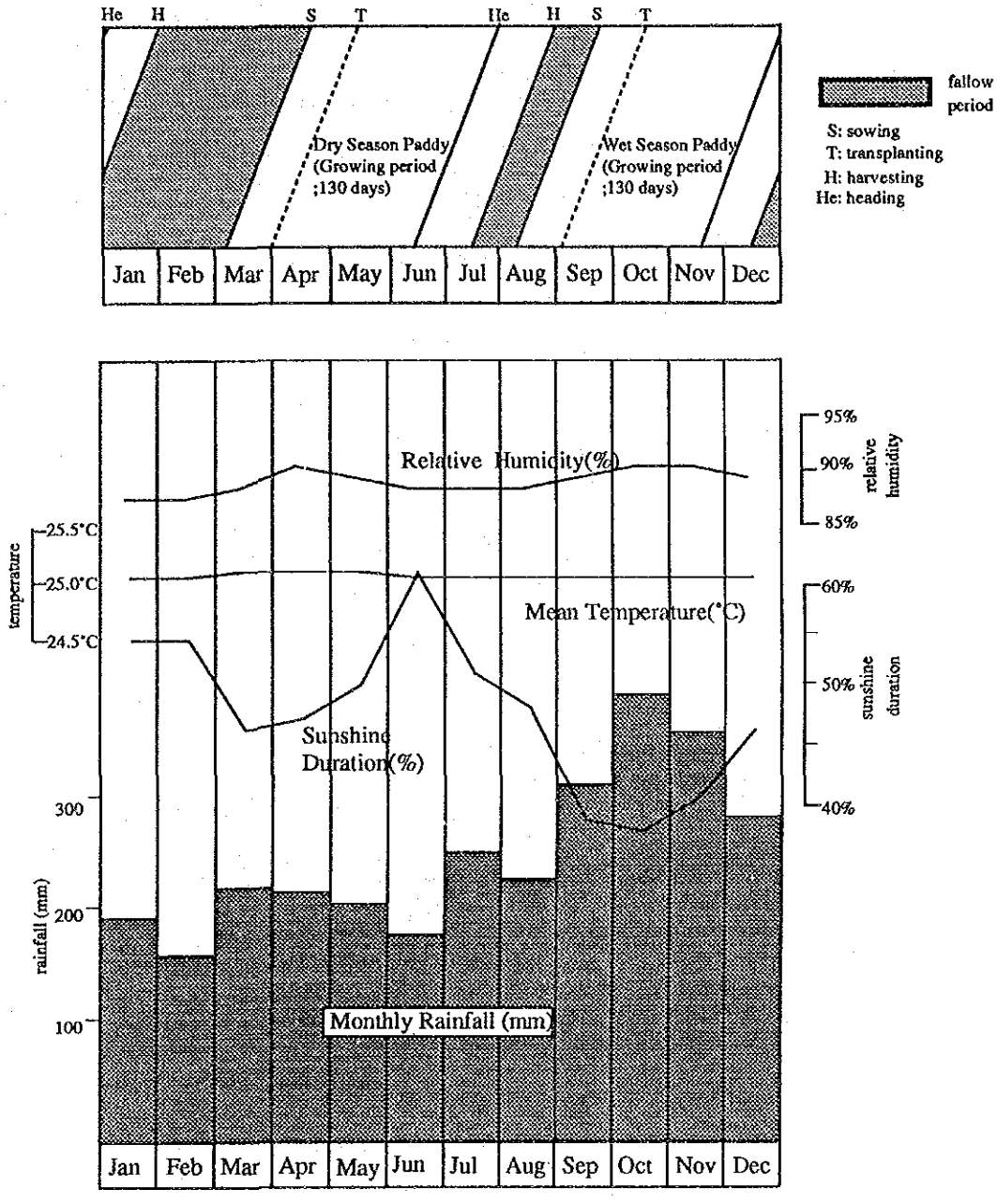

Fig. 4.1 Proposed Cropping Pattern of
Nias Island Irrigation Development Plan

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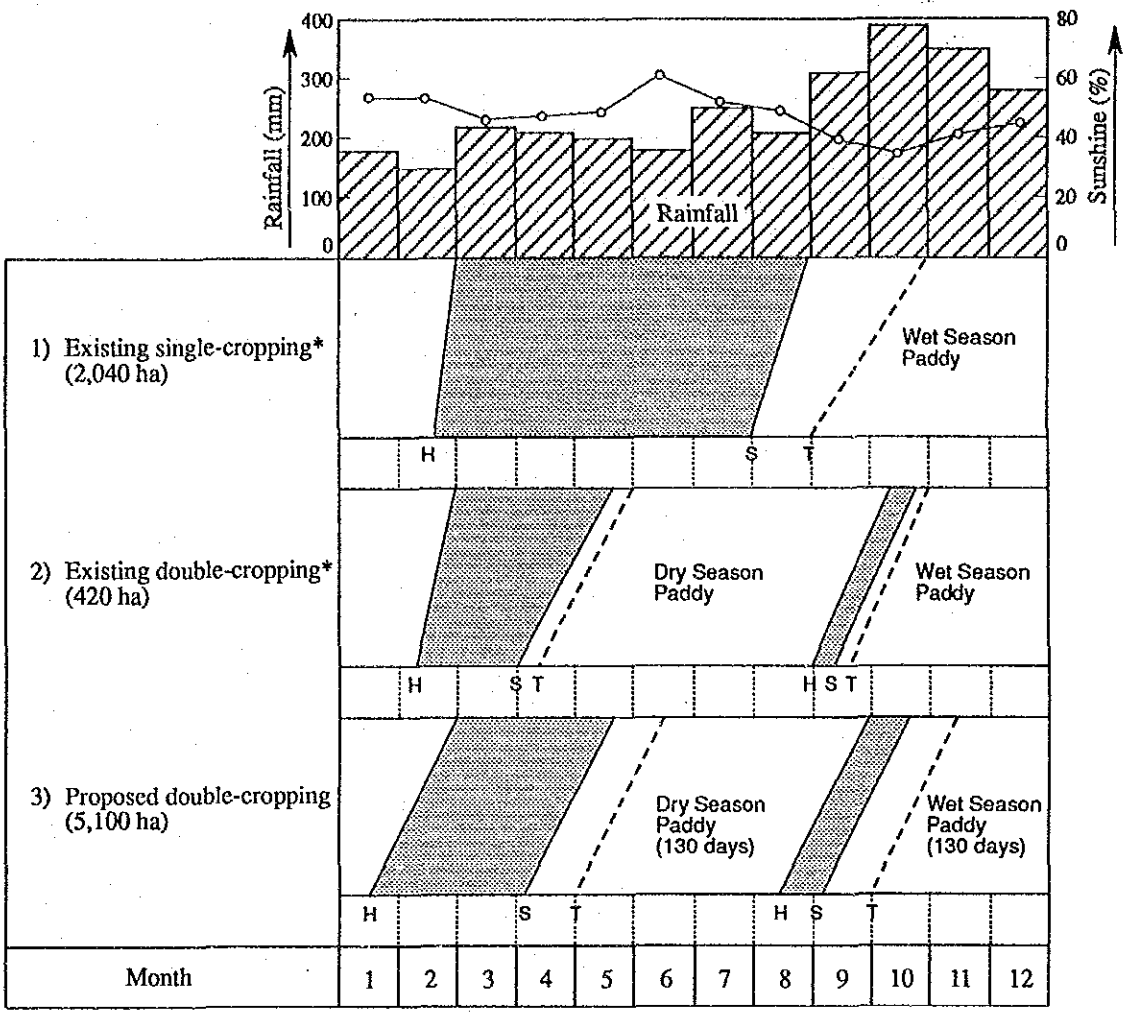

LEGEND

- Rainfall
- Fallow period
- S Sowing
- T Transplanting
- H Harvesting

Remarks

1. Sunshine hours are daily total from 8 A.M. to 4 P.M.
2. Rainfall data at Sitoli Mountain Station is used. (average of 85 years)

* Data Source : Crop cutting survey

Fig. 5.1 EXISTING AND PROPOSED CROPPING PATTERN IN MEZAWA/HOW PROJECT AREA

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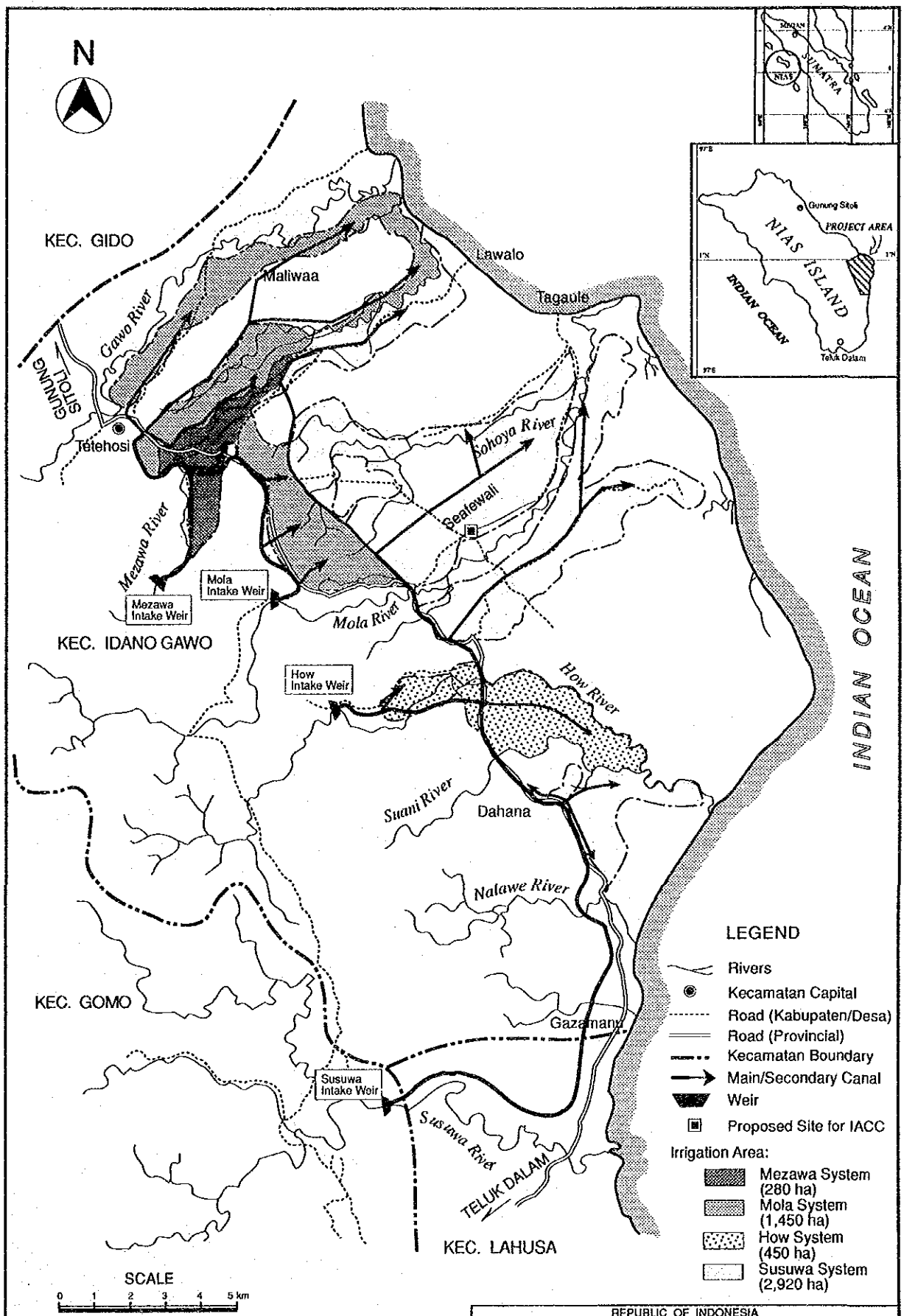

Fig. 5.2 GENERAL MAP OF MEZAWA / HOW IRRIGATION PROJECT

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Description	Unit	Q'ty	Year in order 1	2	3	4	5
1. Detailed Design							
2. Construction Work							
(1) Implementation Program							
(2) Budget Arrangement							
(3) Pre-construction Works							
(4) Construction Works							
i) Mezawa Area	ha	280					
ii) Mola Area	ha	1,450					
iii) How Area	ha	450					
iv) Susuwa Area	ha	2,920					
3. Training of Government Staff and Farmers & Operation of Irrigation Agricultural Coordination Center							
4. O&M Works							

NOTE
- Detailed Design
- Pre-construction Works
- Project Works

Fig. 5.3 IMPLEMENTATION SCHEDULE OF MEZAWA/HOW IRRIGATION PROJECT

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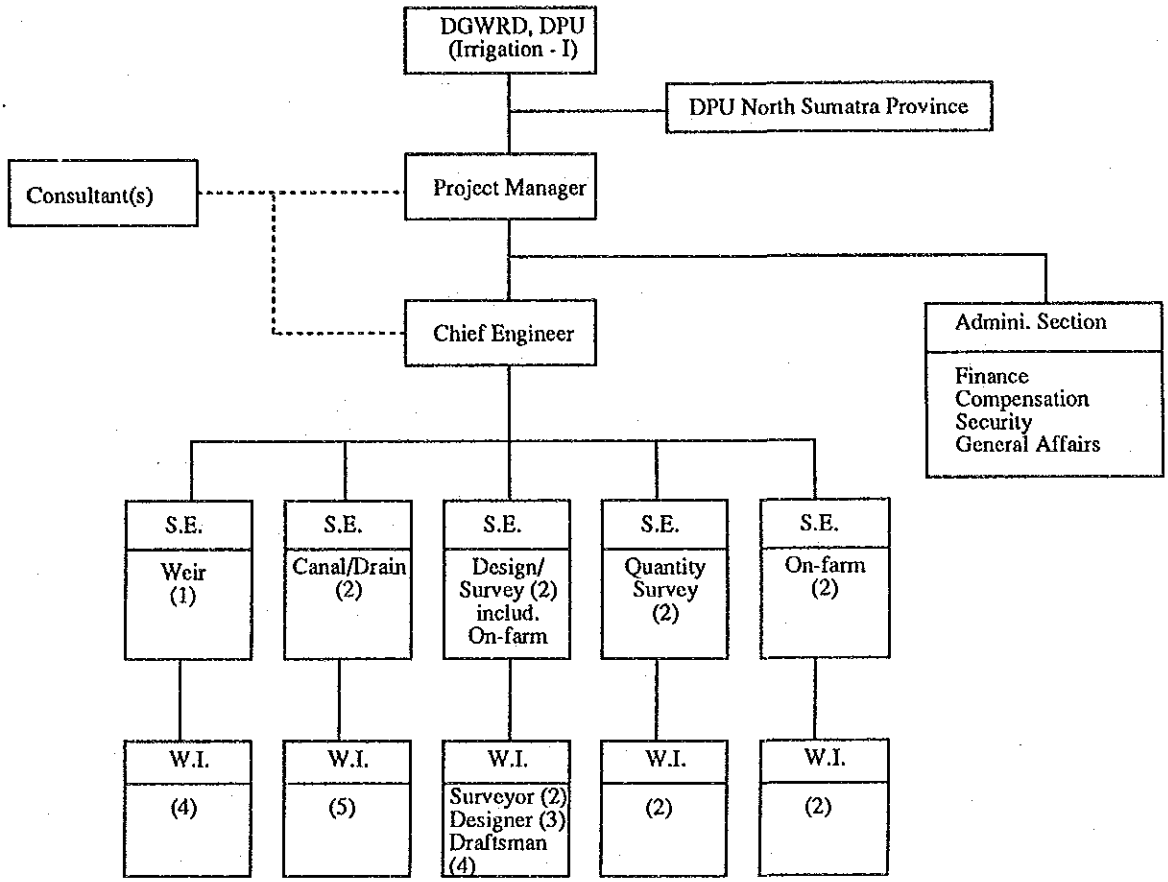

Remarks

S.E. : Site Engineer
W.I. : Work Inspector

Fig. 5.4 Proposed Organization of Project Office

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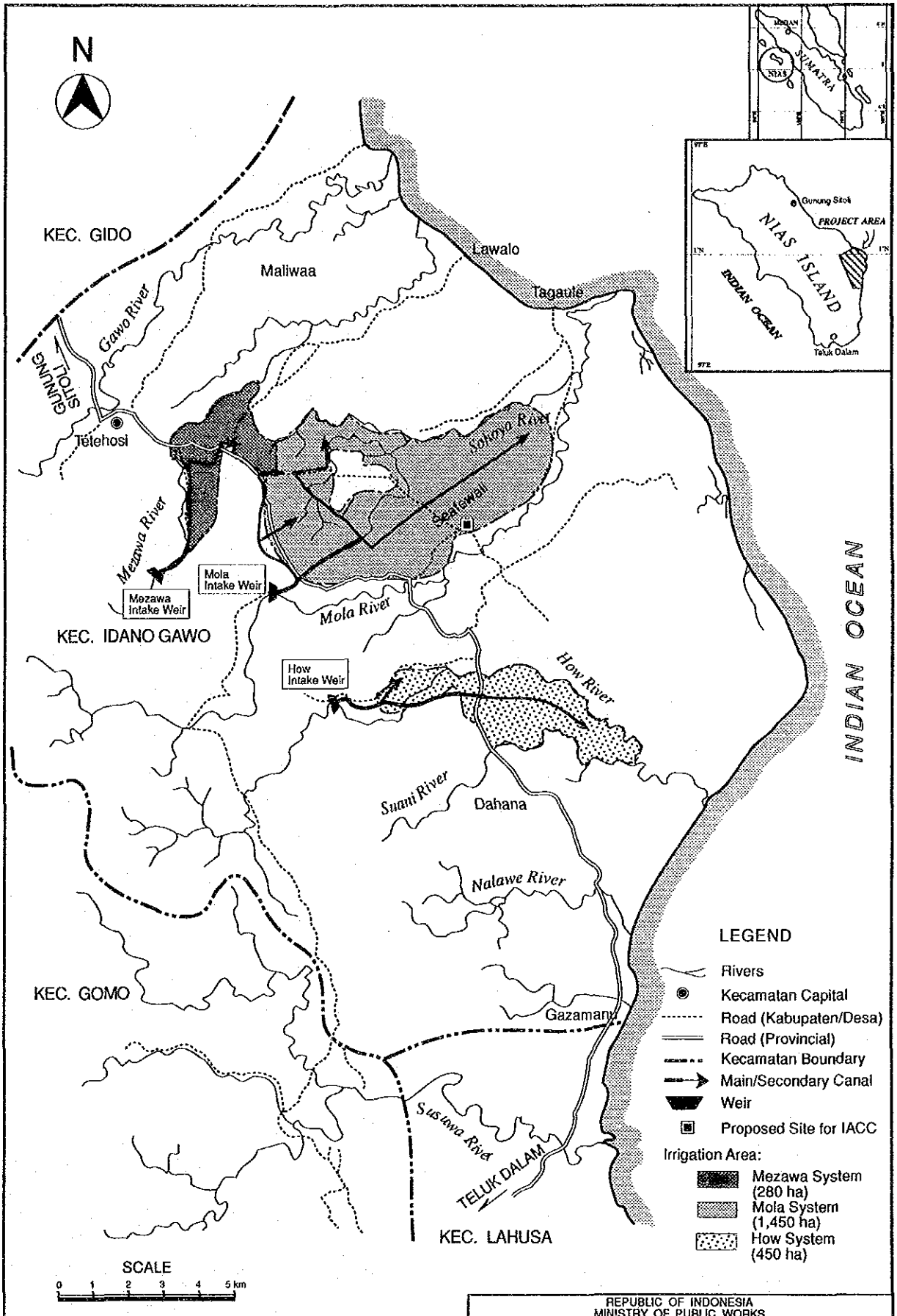

Fig. 5.5 GENERAL MAP OF ALTERNATIVE DEVELOPMENT PROJECT

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