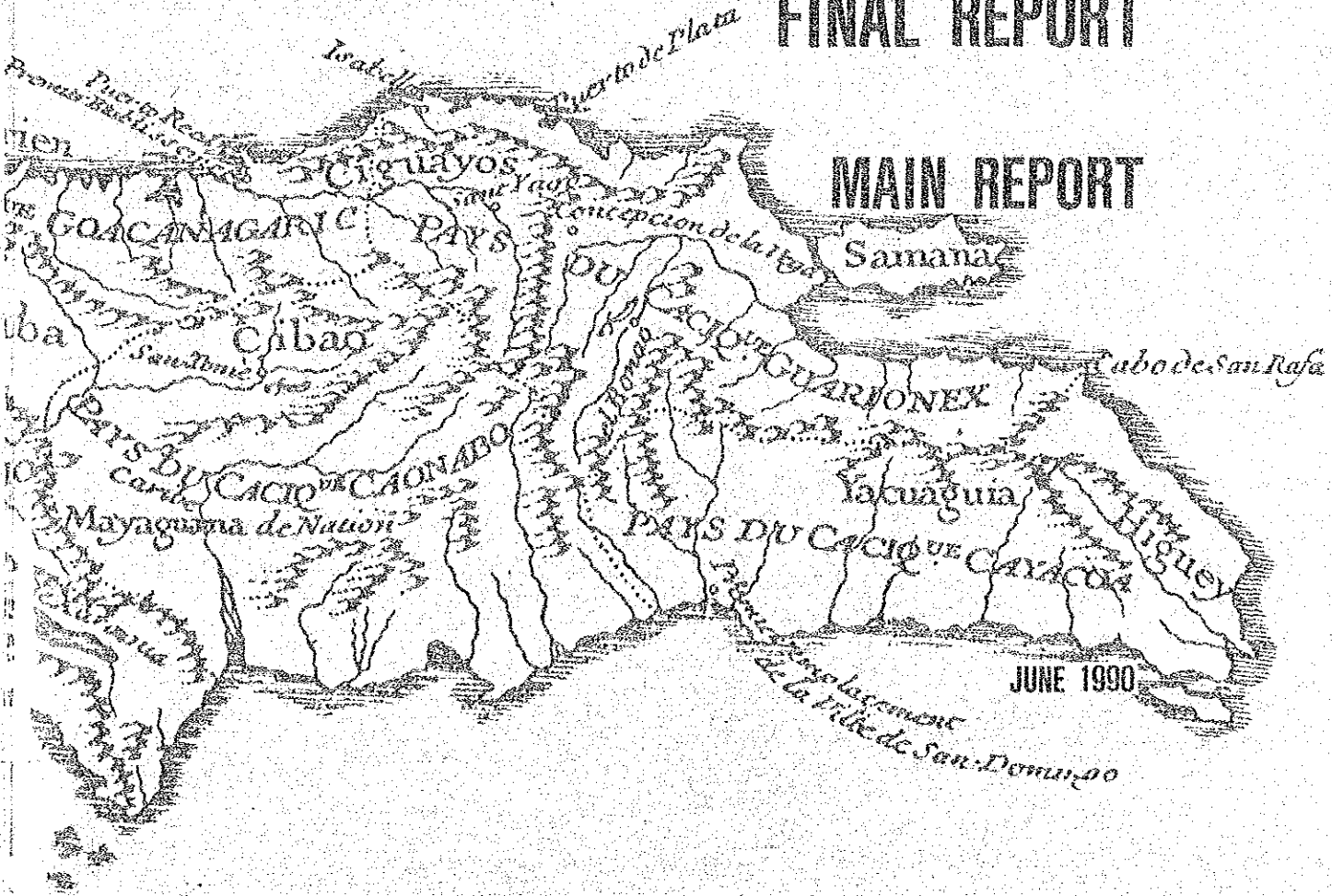
No. 3

THE DOMINICAN REPUBLIC
INSTITUTO NACIONAL DE RECURSOS HIDRAULICOS

FEASIBILITY STUDY ON THE CONSTANZA VALLEY IRRIGATION PROJECT FINAL REPORT

MAIN REPORT



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PREFACE

In response to a request from the Government of the Dominican Republic, the Japanese Government decided to conduct a survey on the Constanza Valley Irrigation Project and has entrusted the survey to Japan International Cooperation Agency (JICA).

JICA sent to the Dominican Republic a survey team headed by Mr. Saburo Nakanishi, Pacific Consultants International, three times from August 28, 1989 to March 31, 1990.

The team held discussions with the officials concerned of the Government of the Dominican Republic and conducted a field survey in the Constanza Valley. After the team returned to Japan, further studies were made and the present report was prepared.

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

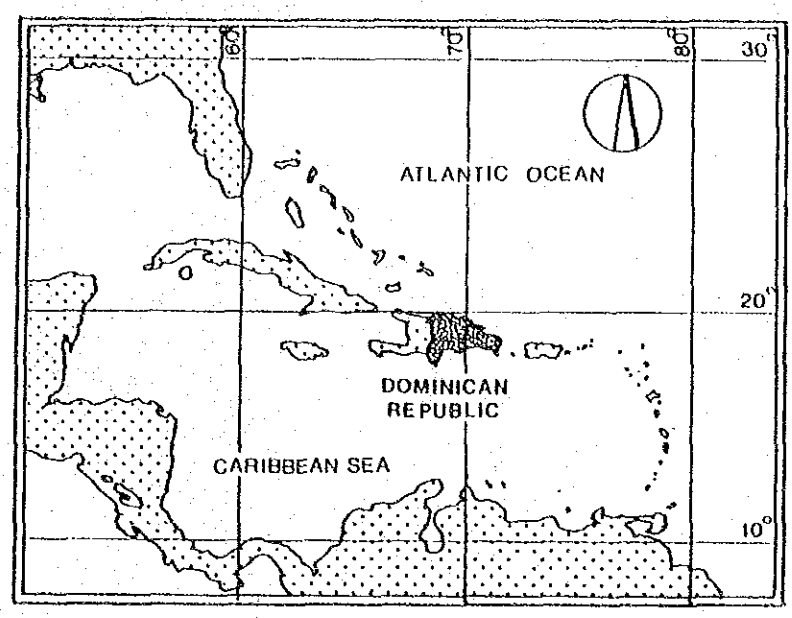
I wish to express my deep appreciation to the officials concerned of the Government of the Dominican Republic for their close cooperation extended to the team.

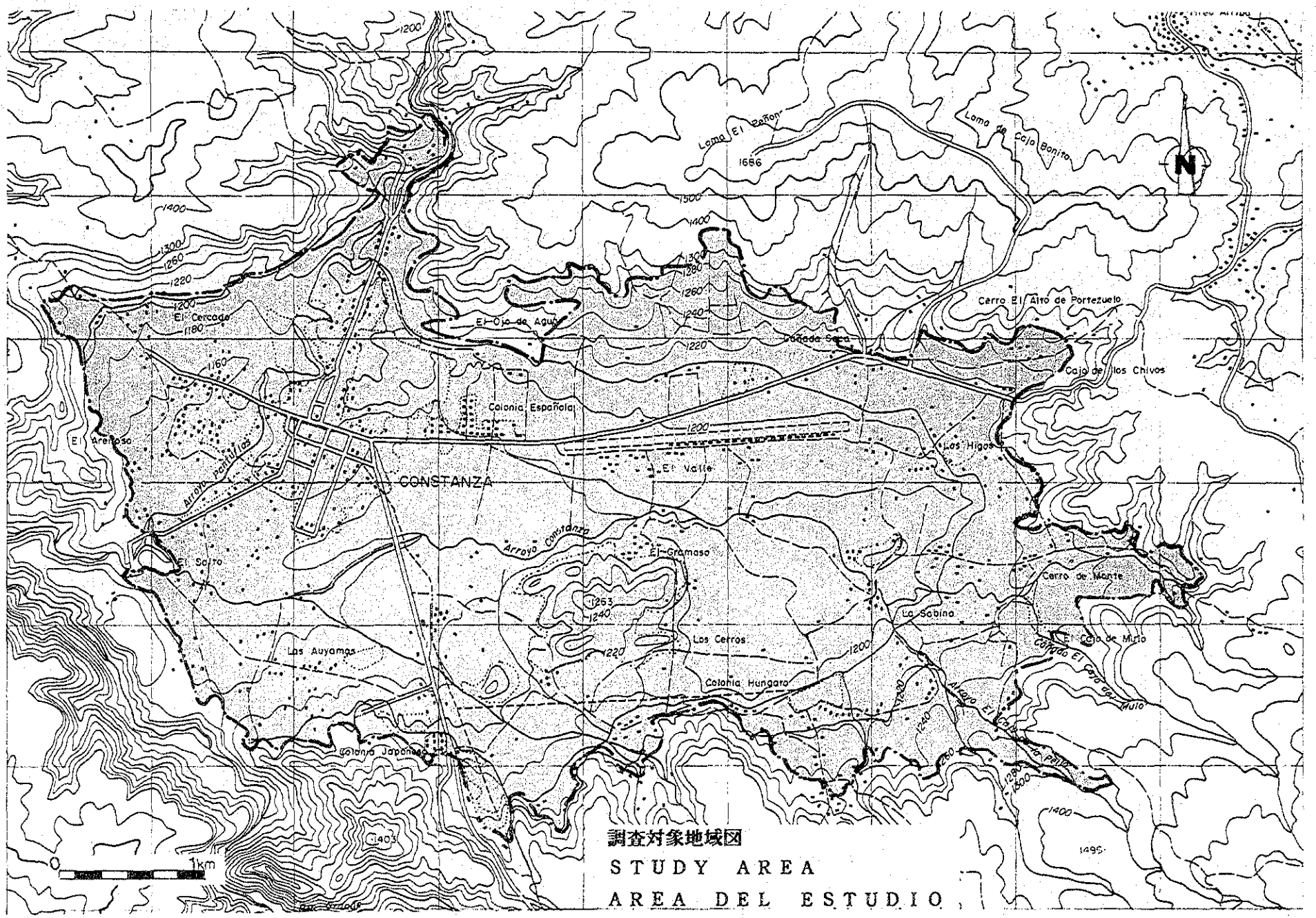
June, 1990

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

LOCATION MAP



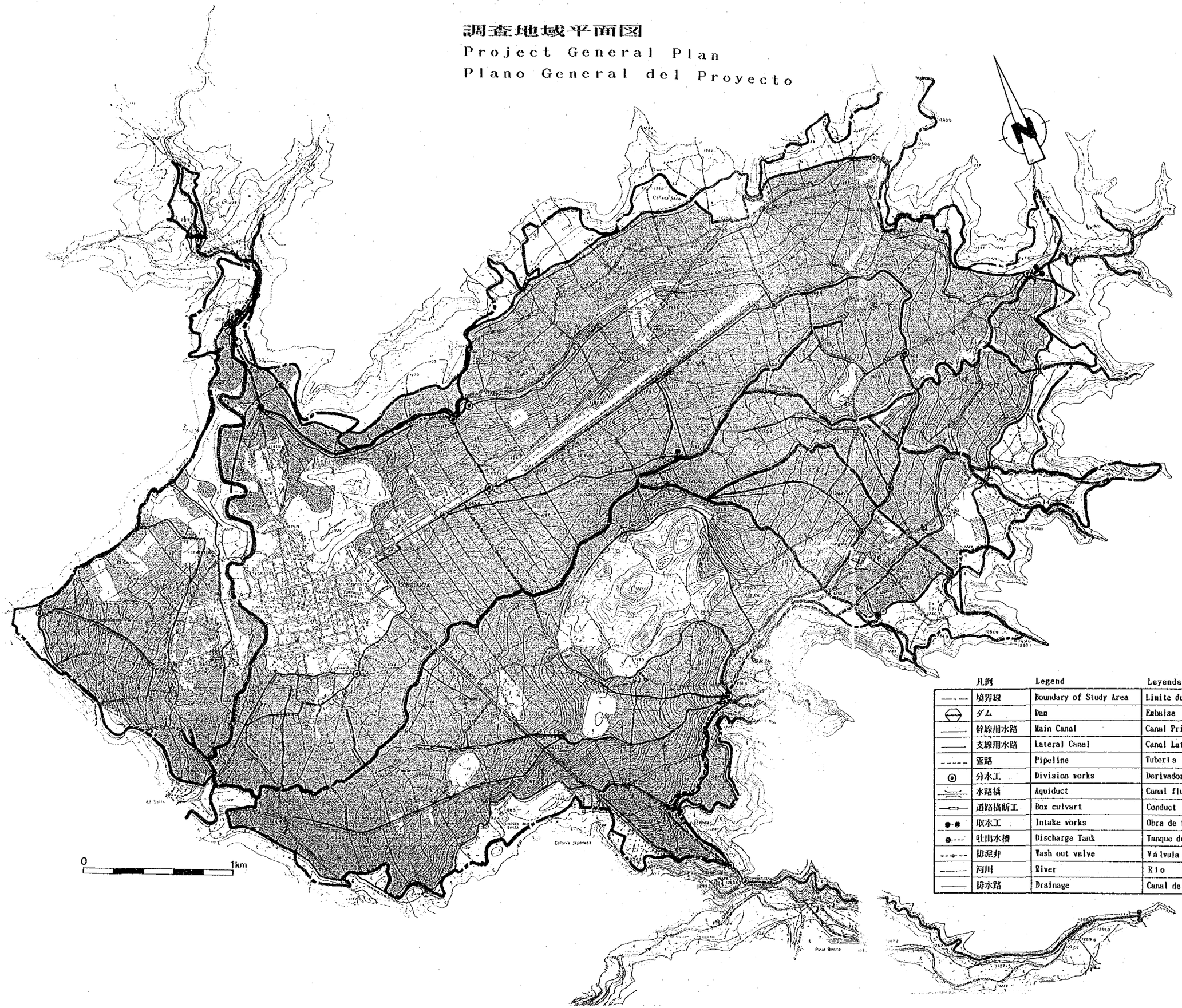


調査対象地域図

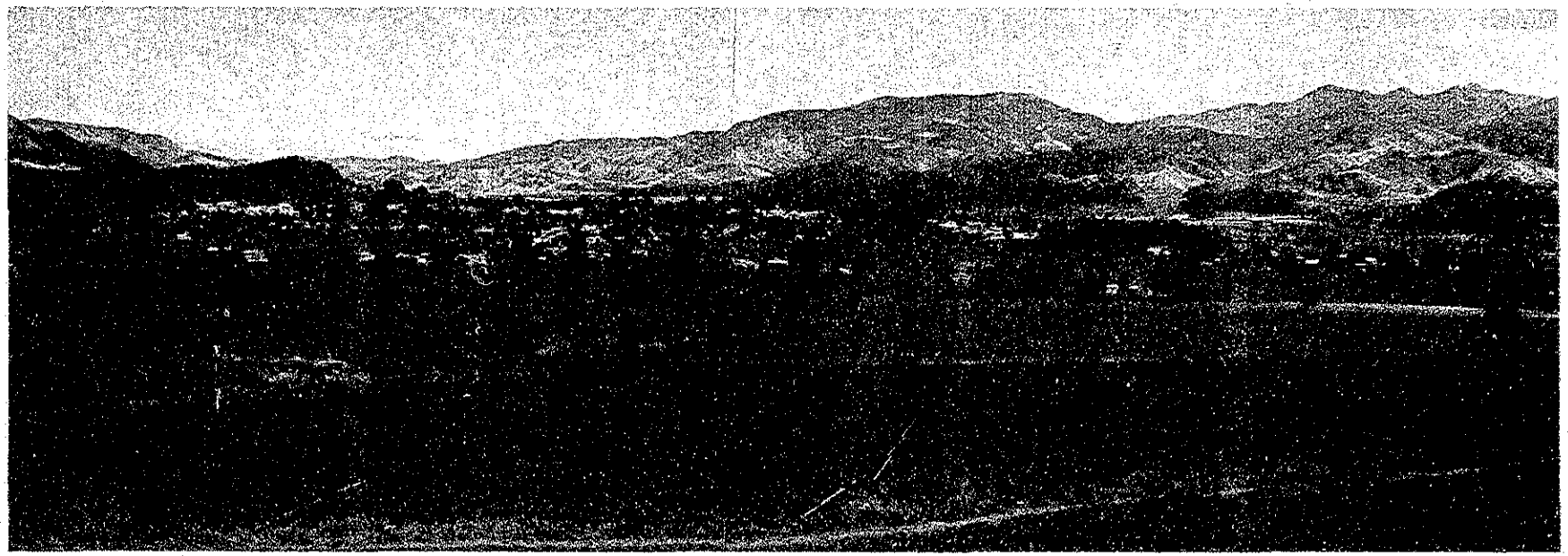
STUDY AREA

AREA DEL ESTUDIO

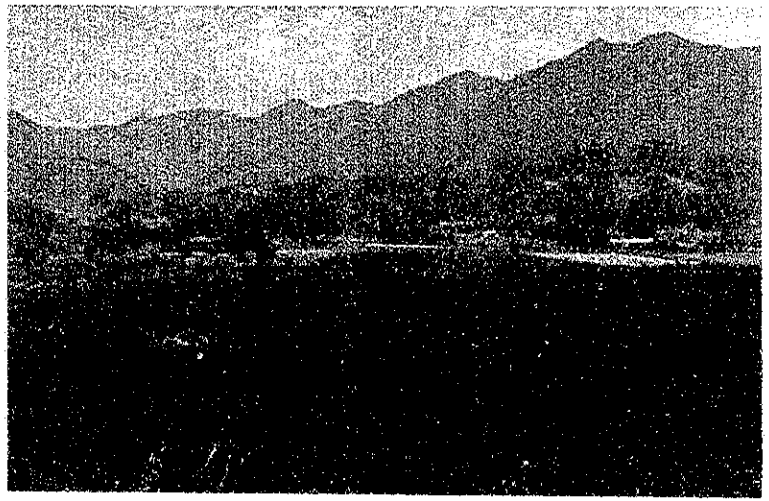
調査地域平面図
Project General Plan
Plano General del Proyecto



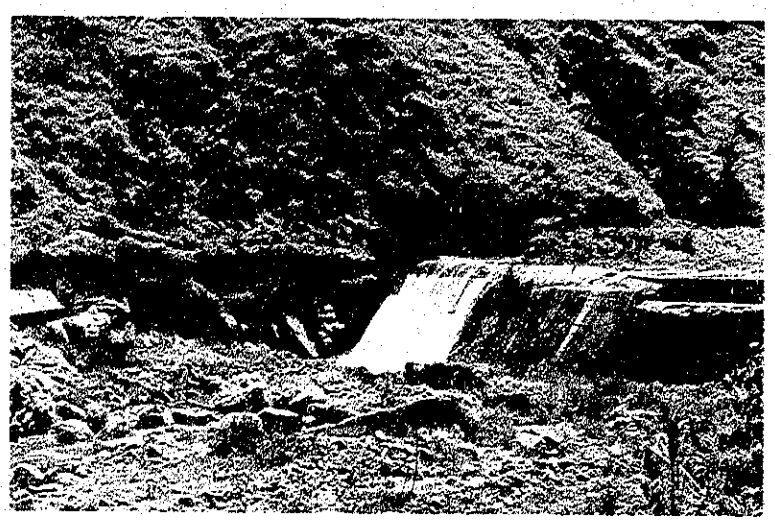
凡例	Legend	Leyenda
境界線	Boundary of Study Area	Limite de Area del Estudio
ダム	Dam	Embalse
幹線用水路	Main Canal	Canal Principal
支線用水路	Lateral Canal	Canal Lateral
管路	Pipeline	Tubería
分水工	Division works	Derivadora
水路橋	Aquiduct	Canal fluwen
道路横断工	Box culvart	Conduct
取水工	Intake works	Obra de tona
吐出水槽	Discharge Tank	Tanque de descarga
排泥弁	Wash out valve	Válvula de deslave
河川	River	Río
排水路	Drainage	Canal de drenaje



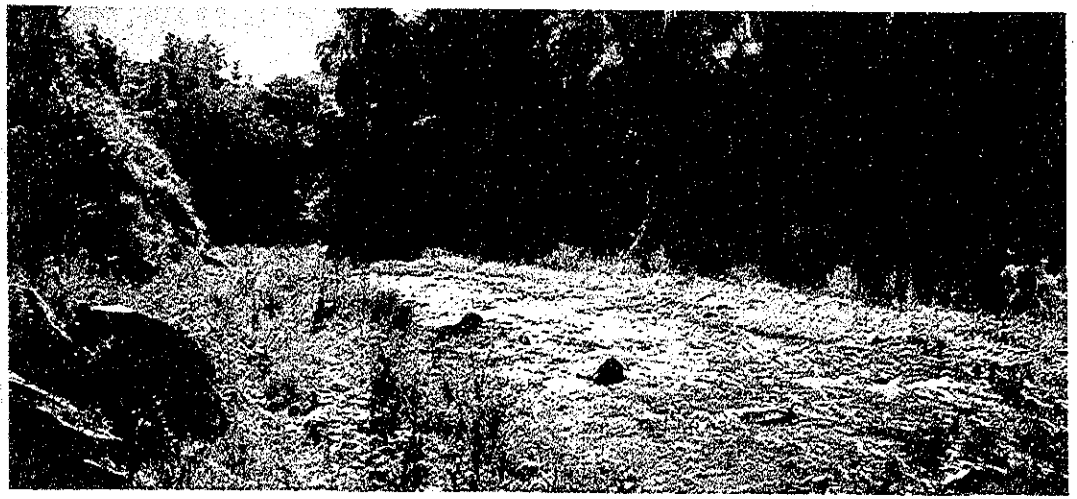
Constanza Valley



Upland field of vegetables



Deteriorated head works in the Rio Grande



Proposed site of the new head works in the Rio Grande

Proposed site of the Pantuflas dam

SUMMARY AND RECOMMENDATION

SUMMARY AND RECOMMENDATION

1. Introduction

This Report describes and explains results of the Feasibility Study on the Constanza Valley Irrigation Project in the Dominican Republic.

The Report consists of the Main Report in Volume I and the Annex in Volume I, II.

2. Background of the Study

2.1 Agriculture is the basic economical industry of the Dominican Republic. The Government of Dominican Republic gives high priority to the agricultural sector in line with National Development Plan (1987 - 1990). The Government promotes irrigation agriculture and exports non-traditional goods in particular, as one of the significant agricultural development programs.

And as a part of the irrigation agriculture program, the Constanza Valley Irrigation Project is given the highest priority and a request for the feasibility study of the Project was submitted by the Government of Dominican Republic to the Government of Japan in May, 1987.

In compliance with the request, the Government of Japan despatched a pre-study team to Dominican Republic in advance of the feasibility study on November, 1988 and concluded on the Scope of Work (S/W) through the discussion between the pre-study team and the Government of Dominican Republic.

As a result, the Feasibility Study (the Study) was started in August, 1989.

2.2 The objectives of the Study is to form the water resource development plan which is pertinent in technical, economical,

financial, and social aspects in order to promote the agricultural development in Constanza area, La Vega Province, located in the central of the Dominican Republic.

3. Brief Description of the Study Area

3.1 The Study area is Constanza Valley area situated about 140 km north-west of the capital. The area is located in the middle of the Republic and surrounded by mountains with their height ranging from 1,400m to 1,700m. The elevation of the Valley is from 1,140m to 1,300m. The whole area of the Valley is about 2,340ha and the Study area is about 2,140ha.

3.2 The population in the Valley is 29,200 and the number of families is 4,859. More than half of the head of family is engaged in agriculture, cultivating garlic, potato, onion, beans and vegetables.

3.3 The Arroyo Constanza flows from east to west on the middle of the Valley, and joins with branches of Pantuflas, Palero, etc. before flowing out of the west of the Valley.

3.4 The Valley is divided into two parts, one is a farm land which has a gentle slope of 2 - 3% from 1,160 to 1,260m and the other is the mountainous area with steep slopes.

3.5 The bed rock in the Study area is composed by the andesitic pyroclastic rock, andesitic lave, the sedimentary rock and tonalite in the cretaceous. Quarternary sediment in the Study area is composed of gravel, sand and clay, about 10m to 40m deep, and forms the water-bearing layer in the Valley.

3.6 Annual precipitation is about 1,000mm. Monthly rainfall amount varies more than 100mm in May/June and September/October, and less than 50mm from January to March. Therefore, the division of wet and dry season is unclear. Annual mean temperature is about 18°C.

3.7 The month with monthly rainfall higher than the monthly evaporation is May, August and September only. The shortage of irrigation water occurs throughout the year. The government of the Dominican Republic constructed the head works about 40 years ago in the Rio Grande which flows out of the southern part outside the Valley and distribute water from the head works to the Valley in order to secure irrigation water. However the shortage of irrigation water has been more remarkable recently because of the deterioration of the irrigation facilities and the enlargement of arable land area after their construction.

3.8 The catchment area related with the study area is classified into two areas, as the area inside the study area and the area outside the study area.
The inside catchment area is composed of Arroyo Constanza catchment area and Arroyo Pantuflas catchment area and the outside catchment area is composed of Rio Grande catchment area.

3.9 The water is taken from the Arroyo Pantuflas and irrigate 166ha of arable land in the Arroyo Pantuflas catchment area. The Arroyo Constanza catchment area is composed of the Arroyo Palero and other small rivers. The water of small rivers except for the Arroyo Palero percolate into the sub surface at upstream and appears near the Arroyo Constanza. The water of the Arroyo Constanza is utilized only to irrigate 164ha of arable land through the Canal Abud. 64% of the irrigation water in the Valley is the water taken and conducted from the Rio Grande. The water from the Rio Grande irrigates 1,063ha of arable land through the Canal Constanza and Canal Lateral Constanza.

3.10 The other 267ha of arable land is irrigated by rainfall or groundwater. However the further development of the groundwater resource seems hard since the aquifer stratum is thin.

3.11 Regarding the soil, Mollisols and Inceptisols which are suitable for farming are extensively distributed in the Valley. Mollisols are distributed in 80% of the arable lands. The whole of arable

lands in the study area belongs to classes I to III under the USDA classification and is suitable for crop cultivation.

3.12 The area of arable crops are 1,660ha which comes approximately to 77% of the 2,140ha of the study area. Farmers with the land holding size of less than 5ha occupies approximately 90%. The number of farmers with the land holding size of less than 1ha is approximately 70% of them. Small scale farmers is the exceeding majority of the total farmers in the study area.

3.13 The farmers grow garlic, potato, kidney bean, onion, vegetables, etc. except seven farmers growing flowers such as chrysanthemum, rose and carnation under vinyl houses.

3.14 The potato is grown by 60% of farmers, garlic and vegetables by 54%, kidney bean and onion by 20 to 25% in the study area. The garlic is grown from November to April and most crops in the season is garlic. The rate of cropping area against the arable lands is 214% and the double cropping is followed under the limitation of irrigation water.

3.15 As fruit growing, apple and grape are under trials in the Valley and their production is small. Animal raising in the Valley is also small. Farmers keep chickens and a few pigs around their houses. A few farmers in the Valley keep cattle on the slope of mountains.

3.16 As intensive agriculture, mainly vegetable cultivation is followed in the Valley, the pests and diseases are remarkable. The pesticides are used as the countermeasures, but the pesticide residues are pointed out. Only a little organic matter is supplied to the soil and the countermeasure to keep the soil fertility should be established.

3.17 The Horticultural Experiment Station in the Valley is well organized and staffs have been working hard, but they may be improved with more staffs, more facilities and more budget.

3.18 Most of the products are sold to market through a middle man and shipped to Santo Domingo and Santiago.

4. Project Plan

4.1.1 Objectives and Basic Policy of the Project

In order to solve the irrigation water shortage problem which limits the amount of the agricultural production, water resources development and improvement of irrigation facilities are planned. The project aims to establish agricultural development plan through the following aspects.

- To be able to practice the whole-year-cultivation
- Improvement of farming management and increase of farm income
- Increase of the cropping rate
- Stable supply of vegetables to urban area
- Increase of employment opportunity

4.1.2 Basic Policy

The basic policy is focused on the following items:

- The plan should be based on the National development plan
- The plan should not have any bad influence on other projects
- Full utilization of water resources and guarantee of water supply
- Effective utilization of the existing irrigation facilities
- Upbringing of operation and maintenance association organized by beneficiaries
- Guarantee of the stable agricultural management condition
- Selection of appropriate crop which the farmer can cultivate by their present techniques
- Absorbing excess labor and creating new employment opportunities.
- Priority of economic benefit

4.2 Basic Concept for Development

4.2.1 Benefit Area

In the development plan, the benefit area should be not less than the present benefit area of 1,275ha in the 1,660ha of arable lands. The new benefit area whose altitude is higher than the present one should be advantageous economically considering the geographical conditions.

4.2.2 Water Resource Plan

The possibility of the development was studied regarding the following water resources.

- Water resource in the Valley
- Water resource outside the Valley
- Groundwater resource

As the result of the study, it is decided that new head works will be constructed at 300m upstream of the existing head works in the Rio Grande and water is distributed from the head works to the Valley in wet season. It is advantageous technically and economically to construct Pantuflas dam with approximately 1,000,000 ton of storage capacity at the Arroyo Pantuflas and utilize the water from the dam and the Rio Grande in dry season.

The development of groundwater resource is excluded from the development, since it is anticipated that the development may influence on the hydropower station which is now under construction at the western area of the Valley.

4.2.3 Water Distribution Plan

The following three plans for water distribution were evaluated

- Existing canal rehabilitation plan
- Open canal construction plan
- Pipeline plan

As the result of the comparison study, it is considered that the construction cost of the pipeline plan is the most expensive and concluded as uneconomical. Regarding the existing canal rehabilitation plan and open canal construction plan, the former plan is advantageous in the cost per unit area though the benefit area is the same as the present one. The latter plan is a little costly in the expense per unit area, but it includes the effect accompanying with the enlargement of irrigation area by considering benefit produced newly. Hence the open canal construction plan is justified as the most appropriate plan for the Constanza Valley irrigation plan.

4.2.4 Benefit Area

From the result mentioned above, the arable land of 1,510ha with an altitude of less than 1,240m are determined the benefit area. The benefit area increases by 18.4% of the present one.

4.3 Development Plan

4.3.1 Agricultural Development Plan

(1) Agricultural Improvement Plan

In the main report, the agricultural improvement plans are proposed as short-term plan and long-term plan. The main countermeasures are summarized below.

1) Countermeasures for soil fertility

Supply of organic matter and cultivation along contour line in slopy area.

2) Improvement of seed and seedling

Periodic renewal of seed and seedling is to be done. Experiment, multiplication and distribution of seed and seedling should be arranged.

3) Improvement of cropping pattern

Establishment of crop rotation and introduction of graminae.

4) Control of pests and diseases

Mode of pests and diseases, survey of damaged condition by pests and diseases, clarification of characteristics by pesticides and establishment of guidance system of its suitable utilization and experiment system.

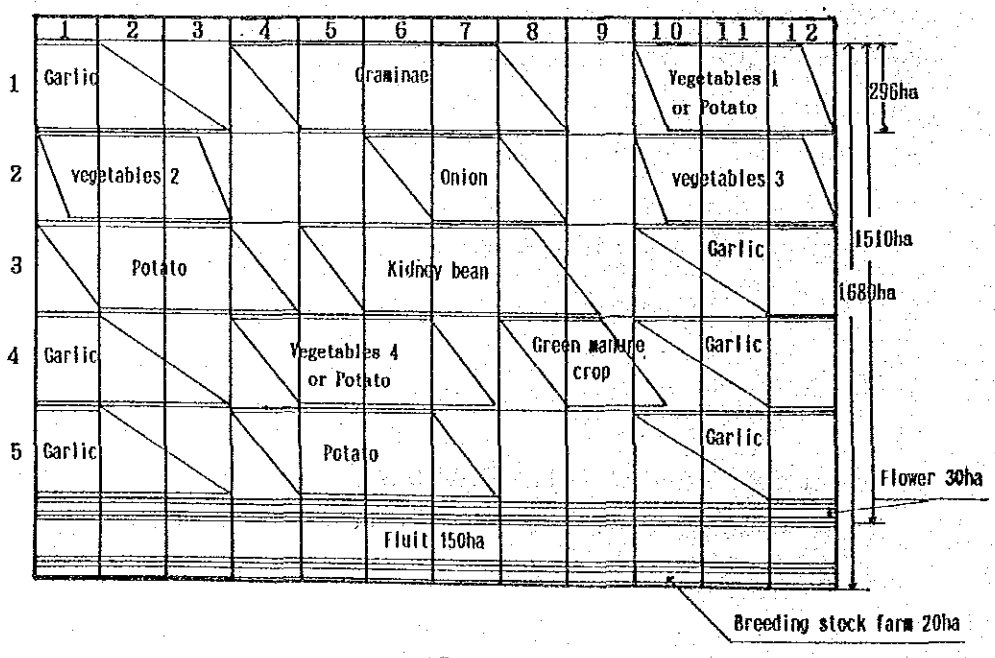
(2) Agricultural Production Plan

1) Cropping Plan

The following are the basic ideas to plan cropping.

a. Crop rotation as one cycle for 5 years
b. To avoid a continuous cropping of the same family
c. To introduce graminae as a cleaning crop
d. To intorduce green manure crops and plow them into the soil
e. To increase the cropping rate

Cropping pattern is planned based on the above ideas as shown below.



2) Agricultural production plan

The cropping rate will increase to 240% and 214ha of cultivated area is enlarged comparing to the present condition according to the cropping plan. The harvest per unit area is 1.2 - 1.4 times of the present one due to the technical improvement effect such as increase of income by stable supply of irrigation water throughout the year, improvement of fertilization, suitable control of pests and diseases, periodic renewal of seeds and seedlings. The estimated production volumes are shown in the following Table.

Planned Production

Unit:ton

Crop	Present	Without Project	With Project
Garlic	5,133	5,664	7,193
Potato	17,702	19,462	20,868
Kidney bean	461	503	385
Onion	3,553	3,912	3,878
Lettuce	4,567	5,033	4,277
Carrot	4,564	5,012	4,292
Beet	4,724	5,189	4,423
Other vegetables	3,692	4,054	3,720
Export vegetables	-	-	5,240
Graminae	-	-	2,368

The benefit by agricultural production is shown below. The balance of total income between "with project" and "without project" is RD$ 24,120,000.00 which is the benefit by the project.

Gross Profit, Cost and Net Profit

Unit: RD$1,000

	Gross Profit	Cost	Net Profit
(1) Present	157,438	74,169	83,269
(2) Without	173,351	88,487	84,864
(3) With	204,109	95,124	108,985
(3) - (2)	30,758	6,637	24,121

(3) Agricultural Management Plan

After the project execution, the gross benefit of farmers becomes 1.3 - 1.4 times, farmer's net income will increase by 1.4 - 2.0 times and farmer's economic surplus will increase by 1.4 - 2.3 times.

(4) Farmer's Organization and Products Circulation Plan

The agricultural development union unifying water control union in the Valley (refer to the organization chart) should be organized and the activities by beneficiaries should be increased. The activities of common sales and common purchase should be promoted and the system of direct transportation to markets should be developed.

(5) Establishment of agricultural support system

Horticulture Experiment and agricultural extension system should be proposed.

4.3.2 Irrigation Facilities Arrangement Plan

(1) Facilities Plan

Irrigation facilities such as dam, head works and canals, are designed.

1) Dam

The central core type rockfill dam is planned at the upstream of the Arroyo Pantuflas. The dimensions of the dam are as follows.

Height of dam	:	30m
Length of crest	:	162m
Dam volume	:	214,000m^3
Available storage capacity	:	980,000m^3
Total storage capacity	:	1,050,000m^3

2) Head works and head race

The mountain stream diversion works is to be constructed at 310m upstream of the existing head works at the Rio Grande. The design discharge is 1.0m^3/s.

The deteriorated portion of the existing head works are to be rehabilitated. A new head race to conduct water taken at the stream diversion works to the existing head race is to be constructed at the right bank of the Rio Grande. Its inside dimension is 1.0m x 1.0m.

3) Canal

a. Canal Nueva Constanza is to be constructed at 1,240m A.S.L. Its water resource is the Rio Grande. Its length is approximately 26km and its irrigating area is 469ha.

b. Canal Constanza which is the existing main canal is to be rehabilitated. Its irrigated area is 884ha. The water resource is the Rio Grande, but half area of the benefit area is irrigated by Pantuflas dam water resource in dry season.

c. Canal Pantuflas is to be rehabilitated and partially constructed. Its water resource is the Rio Grande, but water is supplemented from the Pantuflas dam in dry season. Its irrigation area is 157ha.

4) The period of the project execution is 36 months composing of 12 months of detailed design period and 24 months of construction period.

(2) Irrigation Plan

Sprinkler irrigation is planned to be applied. The irrigation is planned such that the water volume per one time is 33mm, the irrigation interval is 12 days and one rotation block is 12ha.

4.4 Project Cost

Total project cost is RD$105,774,000.00 as shown in the following table. The local currency portion is RD$46,155,000.00 and the foreign currency is RD$59,619,000.00. The local and foreign currency excluding supplementary cost are RD$30,025,000.00 and RD$53,959,000.00 respectively. The proportion of the local and foreign currency portions are approximately 36% and 64% respectively.

Details of Project Cost

(Unit: thousand RD$)

Item	Foreign Currency	Local Currency	Total
1. Civil Engineering Works			
1-1. Preparatory Works	1,917	1,258	3,175
1-2. Dam	23,567	12,471	36,038
1-3. Dimension System	828	1,017	1,845
1-4. Canal System	13,950	11,671	25,671
Sub Total	40,262	26,417	66,679
2. Project Facilities	100	300	400
3. Project Administration	-	360	360
4. Pre-engineering	557	27	584
5. Consulting Services	9,014	279	9,293
Sub Total	49,933	27,383	77,316
6. Physical Contingency	4,026	2,642	6,668
Sub Total	53,959	30,025	83,984
7. Price Escalation	5,660	16,130	21,790
Grand Total	59,619	46,155	105,774

5. Project Implementation Plan and Operation and Maintenance Plan

5.1 Project Implementation System

INDRHI serves as the organization in charge. In view of the project oriented to agricultural development, INDRHI is expected to keep close interrelation with SEA, IAD. In addition, the local government of La Vega and Municipality of Constanza should give proper guidance to farmers to cope with project.

5.2 Operation and Maintenance Plan

Agricultural Development Union is to be established in the Valley and operation and maintenance of this sytem is to be trusted to the union. INDRHI will have the role of advisory organization. Operation and Maintenance of dam, head works and head race is to be executed by beneficiaries under the direction of the union. Operation and Maintenance of each canal is managed by each irrigation association.

5.3 Operation and Maintenance Cost

The annual operation and maintenance cost for the project would amount to about RD$733,000.00. These cost should be shared by the beneficiaries.

5.4 Consulting Services

Consultants provide technical services on contract basis with the project implementation organization, consulting services consist of all services for the period of the pre-engineering and detail design, evaluation of tender, and supervisory services during the construction work term such as technical control, process control, and safety control.

6. Project Evaluation

6.1 The project life of the development plan is 50 years including preparation and construction work period.

6.2 The quantifiable project benefit is increase of agricultural production. Annual project benefit at the time of accomplishment of proposed production is estimated as approximately RD$24,120,000.00.

6.3 Summary of economic and financial evaluation of the project is shown below. It is judged that implementation of the project is economically valid and financially sound.

	Internal Rate of Return	Discount Rate 12%	
		Net Present Value	Benefit-Cost Ratio
Economic Evaluation	15.17%	35,183 RD$1000	1.37
Financial Evaluation	13.24%	13,463	1.14

6.4 If foreign fund will be provided by the international finance organization to cover mainly the foreign currency portion of the project cost and amortization of loan will be payed by beneficiaries, which can be compensated by the economic surplus of beneficiaries.

6.5 Project effect of the development plan is not only direct quantificable benefit but indirect unquantificable benefit such as socio-economic effect which are shown in the following aspects.

- Contribution of National Development Plan
- Stable supply of vegetables to urban area
- Expansion of exportation by vegetables (acquisition of foreign exchange)
- Increase of employment opportunity
- Improvement of living standard
- Economic stimulation of local commercial activities

7. Conclusion

Implementaion of the project is judged as valid technically as a result of economical and financial evaluation. In addition, socio-economic impact evaluated from unquantitiable benefit is also judged as sufficiently expectable.

8. Recommendation

8.1 Early Implementation of the Project

It is recommended that the project shall be implemented promptly considering economical and social effect in the project area and the Dominican Republic, which will be realized by the implementation of the project.

8.2 Construction works

In order to carry out the construction works, the following points shall be taken into consideration.

(1) Land acquisition should be facilitated as well as the other similar project, discussing thoroughly with the land holders of the construction area before the works start.

(2) A proper measure is proposed to be taken for the loss of farmer's economy which may be caused because of irrigation stoppage by the construction.

(3) It is proposed that farmers in the project area are given advantage to work for the construction as a laborer.

8.3 Maintenance Organization

(1) It is necessary that the beneficiaries establish a maintenance organization of themselves under the guidance of INDRHI.

(2) For that purpose, it is necessary to establish Agricultural Development Union which carries out practically the maintenance of irrigation facilities and activities of agricultural production.

(3) It is necessary to guide the Agricultural Development Union to maintain the dam and head works which are the basic facilities under the direction of INDRHI and Irrigation Union of beneficiaries to maintain the irrigation canals.

(4) All operation and maintenance cost and cost of the sprinkler irrigtion are planned to be borne by the farmers. However the total cost is estimated to be 10 times more than the present cost. Hence, in order to avoid the sudden increase of farmer's burden, it is necessary to study the step by step financial support by the government.

8.4 Agricultural Development Measures

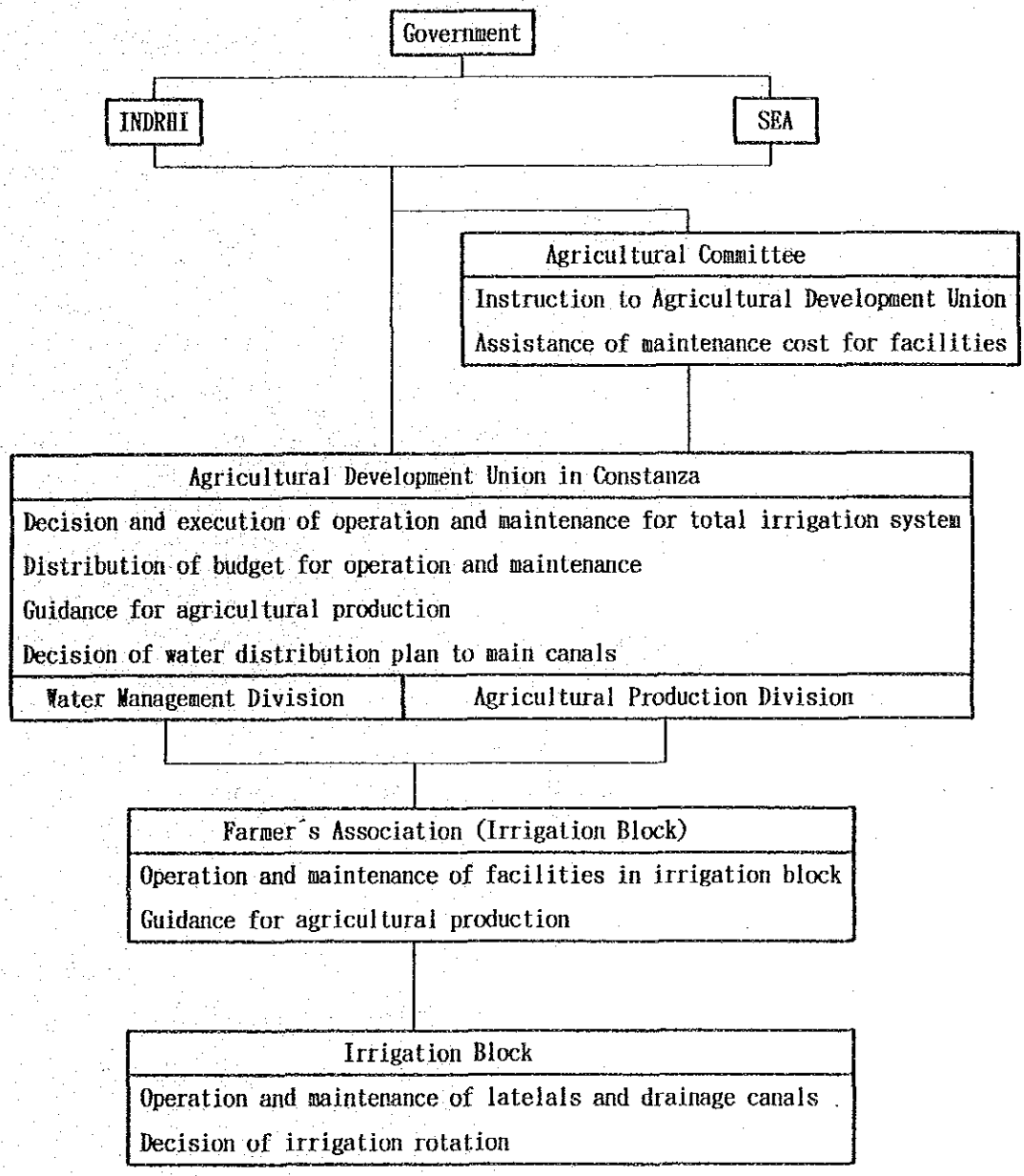
(1) It is necessary to organize the Farming Committee to disseminate farmers national agricultural policies and the Agricultural Development Union to promote a self-reliant production activities by farmers themselves.

(2) It is necessary to guide farmers production activities and promote cooperative sales and purchase of the output and input materials by organizing Agricultural Production Division in the Agricultural Development Union.

(3) It is necessary to intensify the organization of Horticultural Experiment Station and develop practical techniques such as selection of proper varieties, inspection and distribution of excellent seeds, fertilizer management, selection of pesticides, proper countermeasure to pests and diseases, etc.

(4) It is necessary to intensify the agricultural extension system and give a proper guidance to farmers.

Organization Chart of Agricultural Production and Water Management



CONTENTS OF MAIN REPORT

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF TERMS AND ABBREVIATIONS

Organizations

B.A	:	Banco Agricola
C.D.E	:	Corporacion Dominicana de Electricidad
CEDOPEX	:	Centro Dominicano de Promocion de Exportacion
EIRR	:	Economic Internal Rate of Return
ENPV	:	Economic Net Present Value
FAO	:	Food Agriculture Organization of the United Nations
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
IAD	:	Instituto Agrario Dominicano
INDRHI	:	Instituto Nacional de Recursos Hidraulicos
INESPRE	:	Instituto de Estabilizacion de Precios
IRR	:	Internal Rate of Return
JICA	:	Japan International Cooperation Agency
NPV	:	Net Present Value
ONAPLAN	:	Oficina Nacional de Planificacion
pH	:	Hydrogen-ion Concentration
SEA	:	Secretaria de Estado de Agricultura
SEOPEC	:	Secretaria de Estado de Obras Publicas y Comunicacion

Length

cm	:	centimeter
m	:	meter
km	:	kilometer

Area, Volume and Weight

m^2	:	square meter
km^2	:	square kilometer
ha	:	hectare
tas	:	tarea = 0.0625 ha
ℓ	:	liter
G	:	galon = 3.75ℓ
m^3	:	cubic meter

g	:	gram
kg	:	kilogram
t	:	ton
lb	:	pound = 453.6 g
qq	:	quintal = 100 lb = 45.36 kg

Electric Measures

KW	:	kilowatt
KVA	:	kilovolt-ampere
GWH	:	gigawatt-hour (10^9 WH)

Currency

US $	:	United States Dollar
RD $	:	Dominican Peso
¥	:	Japanese Yen

Others

m/s, m/sec	:	meter per second
m3/s, m3/sec	:	cubic meter per second
t/ha, ton/ha	:	ton per hectare
m^3/km^2	:	cubic meter per square kilometer
mm/day	:	milimeter per day
ℓ/s, ℓ/sec	:	liter per second
qq/tas	:	quintal per tarea
℃	:	degrees in centigrate
A.S.L.	:	above sea level
EL, GL	:	elevation
%	:	percent
No.	:	number

Study Team Members and Counterpart Personnel

Speciality and Assignment	Name	Counterpart
Team Leader (Coordination and Management)	Mr. Saburo NAKANISHI	Mr. Jose Tiburcio Mrs. Lisette Gomez
Deputy Leader (Irrigation and Drainage)	Mr. Yutaka SHIONO	Mr. Reynaldo Gomez
Meteorology and Hydrology	Mr. Masayuki HONJO	Mr. Jose Saint Hilaire
Groundwater	Mr. Keizo SANO	Mr. Hector Rodriguez
Water resources	Mr. Minoru YAHATA	Mr. Eddy Pujols
Facilities/Survey	Mr. Kenichi YAMAKAWA	Mr. Jose Mendez
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CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

In the Dominican Republic, agriculture and animal husbandry play an important role as the key industries of the domestic economy accounting for 19.8% of gross domestic product (GDP) and 27% of the population engaged in economic activities and agricultural products contribute 70% of the total exportation. Hence the production trend of these industrial sectors has serious influence on the economy and the society of the Dominican Republic.
However, the index of agricultural production has decreased in these years. Especially the international balance of payments of the Dominican Republic is stagnated due to low international price of commodities i.e. sugar, coffee, cacao, etc. and the curtailment of the sugar export quota to U.S.A.

For this reason, the government of the Dominican Republic gives priority to the agricultural sector in the National Development Plan (1987-1990) and focus towards the following target.

1. Increase of agricultural production through the enlargement of arable land and irrigated area
2. Augment of agricultural export, especially the non-traditional goods.

With this background, the government of the Dominican Republic recognizes the "Constanza valley irrigation project" (hereinafter referred to as "the project") as a part of the irrigation expansion project. In Constanza valley, the irrigation and drainage system with the head works was built about 40 years ago. However, shortage of water because of the enlargement of arable land and superannuation of the irrigation facilities, has serious influence on the agricultural production. Therefore the government of the Dominican Republic requested the Government of Japan for the technical cooperation of the study of the said project in May, 1987. In compliance with the request, the Government of Japan through the

Japan International Cooperation Agency (JICA) dispatched a preliminary survey team to the Dominican Republic in November, 1988 prior to the full-fledged study, and concluded the agreement on the Scope of Work (S/W) for the full-fledged study with the Government of the Dominican Republic through discussion. As a result, the Feasibility Study has started in August, 1989.

1.2 Scope of Work for the Study

The scope of work for the Study made and agreed upon by the Governments of Japan and the Dominican Republic are summarized as follows :

- Preliminary design of irrigation/drainage facilities
- Implementation schedule of the project
- Estimation of cost and benefit of the project
- Evaluation of the project

1.3 Description of the Study

1.3.1 Objectives of the study

The main objective of the study is to review the technical, economical and socioeconomical validity of the irrigation project in Constanza area, in La Vega province situated at the central of the Dominican Republic, through the feasibility study of the irrigation project for promoting the agricultural development.

The objectives of the study are briefly summarized below :

- To investigate land and water resources in the study area and to examine their development possibilities.
- To formulate an irrigation development project, to establish an optimum development area and plans, and to verify its technical, economic and financial feasibility.
- To provide on-the-job training and transfer of technology to the Dominican counterpart personnel during the course of the study.

1.3.2 Outline of the Study

The study is conducted in two phases, each of which comprises of field works in the Dominican Republic and the home office works in Japan.

(1) Phase I Study

Phase I Study is divided into two components :

1) Field Works (Aug. 1989 - Oct. 1989)

The field works was carried out mainly aiming at collecting fundamental data and information about the agricultural development plan. Its breakdowns are as follows.

a. Field survey and collection of data and information necessary for the study (climate, hydrology, irrigation and drainage, land use, soils, geology, agriculture and agro-economy).
b. Preparation of the Progress Report (I).

2) Home Office Works (Nov. 1989 - Dec. 1989)

Based on the data and information collected in the course of field work, the home office study was carried out focusing on the following items.

a. Review and analysis of the data and information collected during the field survey.
b. Formulation of the basic development concepts, and
c. Preparation of the Interim Report.

(2) Phase II Study

1) Field Works (Dec. 1989 - Jan. 1990)

The interim Report comprising of the basic development concepts was presented to the Government of the Dominican Republic for review and discussion. After an agreement on the contents of the Interim Report between the relevant parties, the following studies were carried out so as to supplement the Phase I Study.

a. Collection of necessary data and information (irrigation and drainage, soils, land use, facilities plan, implementation plan, cost estimation, farming plan, agro-economy and socio-economy) required to formulate the development plan.
b. Review of the basic development concepts and formulation of alternatives for the development area and water resources development plan.
c. Preparation of the Progress Report (II).

2) Home Office Works (Jan. 1990 - Mar. 1990)

By means of review and analysis of the data and information collected in the course of Phases I and II field works together with agreements between the Study Team and relevant Dominican authorities, a farming plan, irrigation plan, facilities plan and estimation of the costs and benefits of the project have been prepared to make economic, financial and social evaluations of the Project; specific recommendations for the implementation and development of the Project have also been presented.

The results of the Study are summarized in the following reports :

1. Main Report (English, Spanish and Japanese)
2. Annex (I) (English) : Supplemental data of main report
3. Annex (II) (English): Drawings

CHAPTER 2 SOCIO-ECONOMIC BACKGROUND

CHAPTER 2 SOCIO-ECONOMICAL BACKGROUND

2.1 Geography and Population

The Dominican Republic is situated in lat. 17°36'N- 19°56' N and long. 68°19'W- 72°01' W, and occupies the eastern two-thirds of the Island of Hispaniola which is situated at the center of archipelago of Antillas and in the west, it is flanked by the Republic of Haiti. The Dominican Republic covers an area of 48,442 km^2, extending for about 265 km from north to south, about 390 km from east to west and about 388 km of boundary line with the Republic of Haiti. The political system of the Dominican Republic is of Constitutional republic type i.e. the separation of three powers (administration, legislation and judicature). The President, Vice-president of the Dominican Republic and the members of National Congress are selected by a national referendum.

In terms of regional administration, the Dominican Republic is divided into one National District and 29 provinces which are composed of 136 local municipalities (Municipio).

The Dominican Republic has a population of 5,648 thousand and the population density in national average is 116.6 persons/km^2.

The estimated population will be 7,169 thousand in 1990, 7,915 thousand in 1995 and 8,620 thousand in 2000.
Comparing with the census of 1970, the urban population increased extremely from 39.7% to 52% of the total population, which clearly implies the emigration of rural people to the cities.

The population working in agriculture sector is about 430 thousand which accounts for about 22% of the population of engaged in economical activities. The rate of unemployement increases and reaches to 18% of the population engaged in economic activities in 1981.

2.2 National Economy and Agriculture

2.2.1 National Economy

(1) Present Conditions

The growth rate of gross domestic product (GDP) from 1982 to 1987 was about 2.3% per annum and its rate is lower than the rate of population increase (2.8%) during the same period. The GDP in 1987 was about RD$19.3 billion (US$5.5 billion) with increased high rate of economic growth of 8.1% compared to the year of 1986, and recovered the declined economic growth of 1984/85. The low economic growth was caused by reduction of sugar products due to the reduced United States quota of sugar sector, the lower price of sugar exportation and the inactivity of ferronickels production. The high growth rate in 1987 was due to the increase of mining sector (24% up from 1986) which improved the production of ferronickel and reproduced bauxite suspending from 1982, and the contruction sector (34% up from 1986) because of construction rush of housing and building with increase of public investments..

(2) Balance of Payments

In the Dominican Republic the balance of payments is continuously worse due to the international trade deficit.

The global balance increased the deficit from US$250 million in 1986 to US$470 million in 1987. The deficit of international trade balance in 1987 increased about US$200 million that of 1986 due to the excess of imports. Tourism sector is growing as the main foreign exchange earner and contribute to improve the balance of total international trade including services.

(3) Foreign Trade

The exportation of the Dominican Republic has been dominated by six traditional products such as sugar, coffee, cacao,tobacco,

ferronickel and doré (alloy of gold and silver), all of which accounts for about 80% of the total export. In 1988, the total export amounts to US$890 million (FOB) and increased by 25% comparing with 1987 due to rise of international price of ferronickel by 2.5 times (US$1,462/M.T to US$2,653/M.T) compared to 1987. Such as this situation, the unstability of international market price has influence on the Dominican economy.

The agricultural products occupy the biggest share of export products and account for about 70% of the total export amount until the year of 1987, however, in 1988 the share decreased to 56% due to high rise of price of ferronickel.

The import amount is more than the export amount from year of 1976 and the balance of foreign trade is continuously in deficit. The main import product is petroleum and refined products which occupy for 20% of the total import amount. Other import products are such as cars, provisions (rice, wheat, vegetable oil, etc) and medicine which occupy less than 6% each of the total import amount. The import quantity of the agricultural products are about 230 thousand ton of wheat, 140 thousand ton of maize, 66 thousand ton of rice and 5 thousand ton of beet.

The exports have a tendency to decrease due to the deduced United States quota and lower international market price of sugar sector, on the other hand the imports is increasing year by year. Especially in years of 1987 and 1988, the import amount was about two times more than the export amount. Under this situation, the external debt has increased yearly and reached US$36.5 billion at the end of 1986.

The biggest country of foreign trade is the U.S.A. which occupy for 65.8% of exportation and 39.5% of importation in 1987.

2.2.2 Agriculture

(1) Agricultural land and scale

According to the national census of 1970 and 1981, the total agricultural land decreased from 2,737 thousand ha to 2,676 thousand ha.The agricultural land occupies 55.25% of the total national land, and amoung this agricultural land 49.3% is cultivated land, 44.7% is pasture land, and 6% is the mountain, forestry and others. The major farmers are the small-scale farmers who own farms of less than 5 ha size which corresponds to about 81.7% of the total farm families and hold only 21% of the total agricultural lands. On the other hand, the large-scale farmers who own more than 50 ha area is only 1.8% of the total farm families and hold 45.5% of the total agricultural lands.

(2) Agricultural Production

Agriculture is the most important sector of the national economy, and its contribution to the GDP has been declined from 23.2% (1970) to 15.5% (1987). And there is a declining tendency in the production of main agricultural products.

The production of sugar was reduced by 4.1% per annum from 1970 (12.2 million ton) to 1987 (8.8 million ton). The area of cultivated land diminished yearly and reached to 230 thousand ha by 1988.

The yearly production of coffee is constant at 130 to 140 thousand tons. Cacao is cultivated over an area of about 90 thousand ha. The number of farm families are about 40 thousand and the small-scale farm families who own less than 5ha corresponds to 72% of total cacao farm families.

The area of cultivated land and production of the non traditional agricultural products (which are mainly for domestic consumption) such as rice, maize, kidney bean, cassava, banana and vegetables, etc. are almost constant.

Table 2.2.2-1 Production of Main Agricultural Products

(Unit: Thousand ton)

Agricultural Product	Year				
	1983	1984	1985	1986	1987
1. Traditional Exportation Products					
-Sugar	11,520	10,995	8,217	8,208	8,772
-Coffee	136	144	144	137	134
-Tobacco	34	28	31	26	29
-Cacao	33	33	35	36	36
2. Domestic Consumption Products					
-Rice	501	507	494	468	514
-Kidney Bean	61	67	48	49	52
-Cassava	99	124	135	143	143
-Potato	23	17	16	16	15
-Onion	15	18	19	20	21
-Garlic	3	3	3	3	3

Source: Monthly Report of Central Bank, Jan. 1989/ Cifras, 1988

2.3 National Development Plan

(1) Background

The present government started on August, 1986 have implemented "The National Development Plan (1987-1990) - Repercussion of Public Investment Program" on September, 1987 under the national economic development policy such as extension of public investment and agriculture sector. Based on the National Development Plan, the government published "Evolution Program of Public Investment and Perspective in 1988" on July, 1988 and "Perspective of Dominican Economy for the Period 1989-1992".

(2) Objectives of the Plan

The basic policy of the National Development Plan is to recover and develop the national economy with the following objectives:

- activation of national economy
- extension of production by public investment
- improvement of social welfare

The short and medium term plans are establised in order to realize the above objectives.

1) Short Term Plan

The main strategies of the short term plan are as follows:

- expansion of internal saving
- deduction of external debt
- extension of GDP per capital by increasing public investment

2) Medium Term Plan

The main stratagies of the medium term plan are as follows:

- constant supply of electricity
- expansion of agricultural products
- expansion of exportation products

The realization of the above stratagies is established by an annual GDP growth rate of 6.3% from 1987 to 1990.

(3) Development Plan in Agricultural Sector

The development plan of new cultivated land is planned as follows:

1. Extension of about 20 thousand ha of cultivated land under irrigation infrastructure project and extension of existing irrigation system up to 150 thousand ha.

2. Liberation land of about 13 thousand ha of sugar plantation area, property of National Council of Sugar, for changing the agricultural crops which will be joined with private sector to promote as exportation products.

CHAPTER 3 PRESENT CONDITIONS OF THE STUDY AREA

CHAPTER 3 BRIEF DESCRIPTION OF THE STUDY AREA

3.1 Location of the Study Area

The study area is Constanza Valley, which is located in latitude 18° 54' north and longitude 70° 45' west, in the middle of the Republic. The study area extends over an area of about 2,140ha out of the total valley area of 2,340ha. The elevation of the study area ranges between 1,140m to 1,300m above the sea level (A.S.L.) and is surrounded by mountains whose heights are about 1,400m to 1,700m A.S.L.

All of the Valley belong to Municipal Constanza of La Vega province. The center of the municipal constanza is located almost at the middle of Valley. The distance from the capital city (Santo Domingo) to Constanza is about 140km connected by national road No. 1 which is the principal road in Dominican Republic.

3.2 Socio-economic Characteristics of the Study Area

3.2.1 Population

According to the census of 1982, the population of Municipal Constanza is 38,524. The detail of the population is as follows:

Male	20,098	52%	Urban area	15,141	39.3%
Female	18,426	48%	Rural area	23,383	60.7%
Total	38,524	100%			100.0%

In accordance with "República Dominicana en Cifras" published by "Oficina Nacional de Estadística" in May, 1989, the population of Municipal Constanza from 1985 to 1988 is as follows:

Year	1985	1986	1987	1988
Population	41,075	41,453	41,816	42,163

The population in the study area of the Valley is 29,200 and the number of families is 4,859 based on the final report of "Estudio Integrados de Recursos Naturales de la Cuenca del Río Grande o del Medio" submitted to the Ministry of Agriculture, in Sept. 1988.

3.2.2 Socio-economic Characteristics

Agriculture is the main industry of the Valley and 58% of the head of family in the study area is engaged in agriculture. The main agricultural products are garlic, potato, onion, beans and vegetables. The scale of commercial activity is small comparing with the agriculture which is the main economic activity in the Valley, and the proportion of the head of the family employed in commercial business is approximately 15% of the total population.

The scale of farm business is comparatively small and the number of small-scale farmers who own less than 1ha correspond to about 60% of the total number of farmers and the farmers who own 1ha to 5ha correspond to only about 30%. More than 90% of the total agricultural production are shipped to the capital of Santo Domingo city and Santiago city.

3.2.3 Social Infrastructure

The main road of access to the Valley is the mountain road Carretera Casabito which is branched from the National Road Route No.1 (Carretera Duarte) at the Capital of Santo Domingo city.

Electricity and water services are supplied to the center and most part of the Valley; however a portion of the higher part of the rural area has no such services. Those who have no water supply services depend on wells or rivers for their domestic water. Facility of water services has been installed in 1953 and administrated by Instituto Nacional de Aguas Potables y Alcantarillado (INAPA). Drainage facilities are very few and not in good condition. At the entrance of Constanza City, there is a public hospital administrated by the Ministry of Health, and there are several clinics in the City.

There are three elementary schools (Escuela Primaria Padre Fantino, Escuela de Palero and Escuela de la Colonia Japonesa), one secondary school (Liceo Gaston Fernando Deligne) and one high school (Colegio Nuestra Señora Del Valle) in the City.

At the center of Constanza City, there are several public offices such as municipality, post office, police station, fire station, banks and military office.

3.3 Natural Features and Characteristics

3.3.1 Topography and Geology

The Constanza Valley is a mountainous basin which is located in the middle of the Dominican Republic. The project area is about 4km wide from north to south and about 8km long from east to west. The farm land has a gentle slope with an undulation of 100m (altitude: from 1160 to 1260m). Arroyo Constanza flows at the middle of the project area from east to west.
The Valley is divided into two parts, one is a farm land at the bottom with 2-3% slope and the other is the montainous area with steep slopes.

The bed rock in the study area is composed of the andesitic pyroclastic rock, andesitic lave, the sedimentary rock and tonalite in the cretaceous.
Andesitic pyroclastic rock is mainly found in the Valley and characterized by its color of red or dark gray.
The sedimentary rock is mainly composed of dark gray colored shale and sand stone lain partly between shale.

Tonalite stratum is mainly distributed in the northern mountain part and a part of the southern mountain. The small Tonalite in the southern side touches with Tireo stratum by faults. Quaternary sediment is composed of gravel, sand and clay, about 10 to 40m deep, and forms the water-bearing layer in the Valley. Quaternary sediment distributed along Río Grande is characterized by greats boulders of 30-50cm in diameter, and is called as Guayabal stratum.

3.3.2 Meteorology

(1) Climatological characteristics of the Constanza Valley

The climatological characteristics of the Constanza Valley are shown in the Fig. 3.3.2-1. The most rainy month is May, covering 18% of the annual rainfall. The dry season is observed during December to March, covering only 13% of the annual rainfall.
The wettest period is May and August to October, covering 57% of the annual rainfall.
The rainy day is observed scarcely during January to March, with 16 days. And in May, the rainy day is observed most frequently, with 15.1 days of mean rainy day. The mean annual temperature is 18.2°C and the mean monthly temperature varies from 16.4°C to 19.5°C. The variation of the mean monthly temperature is small, but the variation of daily difference is very high; minimum and maximum temperature are recorded as -1°C and 35°C respectively.
The relative humidity is generally stable at 76% with a variation of ±3%.
The mounthly evaporation varies from 100mm to 150mm. The high evaporation is recorded in March, July and August. The annual evaporation is 1,466mm and it shows higher value than the annual rainfall.

(2) Annual Rainfall at the Constanza Valley

The rainfall of the area is characterized by the localized distribution of rain influenced by the topographic factor.
The rainfall varies from 700mm to 1,400mm. The mean annual rainfall is 1014.5mm/year.
On the basis of annual rainfall data, the probability of annual rainfall was estimated as follows;

Probability of Annual Rainfall

Return Period	Annual Rainfall
50 years	648mm/year
20 years	705mm/year
10 years	760mm/year
5 years	832mm/year
2 years	987mm/year

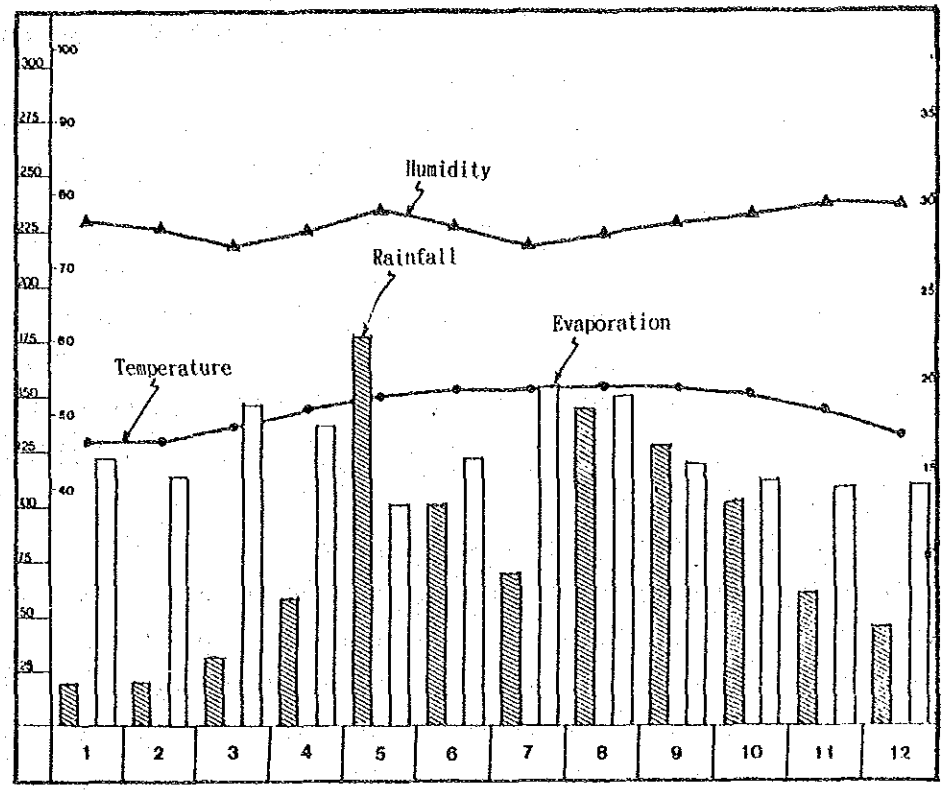

Fig. 3.3.2-1 Climatological Characteristics at the Constanza Valley

3.3.3 Hydrology and Rivers

The catchment area related with the study area is classified into two areas, as the area inside the study area and the area outside the study area.

The inside catchment area is composed of Arroyo Constanza catchment area and Arroyo Pantuflas catchment area.

The outside catchment area is divided into Río Grande catchment area and Pinar Bonito catchment area. The Pinar Bonito catchment area is mainly utilizing as potable water of the Valley.

(1) Arroyo Pantuflas Catchment Area

In the Arroyo Pantuflas, the measurement of discharge data was carried out at the La Cienaguita, Arroyo Arriba and at the Confluence.

On the basis of the discharge observation data at Arroyo Arriba, the mean discharge recorded was $0.079m^3/s$.
The specific discharge rate is calculated as approximately $1.0m^3/s/100km^2$, considering the catchment area at the point as approximately $8km^2$.

(2) Arroyo Constanza Catchment Area

The area of the river basin is $40.55km^2$ (mountainous part: $19.05km^2$, residential and cultivated area: $21.5km^2$). In the Valley, various mountainous rivers flow into the study area, but most of them are formed in temporal stream style, since most of them pass through part of the alluvial fan at higher parts of the area.
It is estimated that most of them are springed up at the lower reach of the Arroyo Constanza. The discharge of the river is increasing at lower parts of the river.
The irrigation water depends on the Río Grande water resource and the utilization of water resource of the river is insignificant, except the intake work of the Arroyo Palero at Cerro de Monte site and the reuse of the drainage water of the Arroyo Constanza by the Canal Abud localized at El Valle site.

(3) Río Grande Catchment Area

The Río Grande which is the main water source of the study area, is originated at the Alto Bandera and flows into the Río Medio, catching the mountainous small river and the Arroyo Constanza near the western parts of the study area.

The intake work is located at 300m upper part of the confluence site of the Arroyo El Gajo de Maíz and its water is introduced to the study area for irrigation. The catchment area at this site covers approximately $42km^2$ with mountainous regions.

(4) Pinar Bonito Catchment Area

The Arroyo Pinar Bonito which is the main water resource for the potable water of the Constanza City has approximately 15km^2 catchment area and flows into the Río Grande at the Pinar Bonito site.

The intake works is located at 2km upper stream of the confluence site and supply to the Constanza City. The catchment area at the intake works site is 12.5km^2 and the estimated discharge is approximately 0.2m^3/s.

(5) River discharge estimation

The river discharge estimation was carried out, on the basis of the Arroyo Pinar Bonito discharge data.

The estimation of the mean monthly discharge at 5 years return period is shown in the Table 3.3.3-1.

Table 3.3.3-1 Mean Monthly Discharge at 5 Year Return Period

Month	Monthly rainfall(mm)	Discharge (m^3/s)			
		Pinar Bonito	Rio Grande	Pantuflas	Palero
1	15.8	0.13	0.33	0.06	0.03
2	24.9	0.15	0.38	0.07	0.03
3	26.6	0.15	0.38	0.07	0.03
4	54.0	0.19	0.51	0.10	0.05
5	152.1	0.33	0.96	0.21	0.10
6	83.9	0.23	0.66	0.14	0.07
7	59.0	0.20	0.53	0.11	0.05
8	125.6	0.29	0.84	0.18	0.08
9	108.1	0.27	0.77	0.17	0.08
10	89.0	0.24	0.67	0.14	0.07
11	52.4	0.19	0.51	0.10	0.05
12	39.9	0.17	0.44	0.09	0.04