PN-ABJ-518
ISN 73910

Office of Rural Development
Report No. 30

Irrigation Sector Assessment

September 1989

Irrigation Sector Assessment: Guatemala

September 1989

936-5315

Prepared for the U. S. Agency for International Development under Indefinite Quantity Contract Number PDC-5315-I-18-8101-00.

James Wolf
Julio Sandoval V.
Juan Gonzalez
Victor Hugo Gonzalez
Jeffery Jones
Carlos Munoz
Loren Parks
Sergio Ruano
Carlos Spiegler C.
Liza Vielman
Gene Wilken
Aaron Zazueta

ACKNOWLEDGMENTS

The Guatemala Irrigation Sector Assessment was carried out by a team composed of local and foreign consultants: Peg Clement, Juan Gonzalez, Victor Hugo Gonzalez, Jeffrey Jones, Carlos Munoz, Loren Parks, Sergio Ruano, Julio Sandoval, Carlos Spiegler, Liza Vielman, Gene Wilken, James Wolf, and Aaron Zazueta.

The team would like to thank the staff of the various Government agencies and private individuals for sharing their time and insights with us. In particular we wish to thank Mario Aragon, USAID Project Officer; Cesar Cisneros, Coordinator of DIGESA's National Irrigation Program; Ouzi David, advisor to DIRYA; and Oscar Gonzalez, advisor to DIRYA, for their valuable contributions to this report.

Lastly, we are grateful to USAID/Guatemala for providing the financial support for this undertaking.

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY xiii

CHAPTER ONE

INTRODUCTION 1

PURPOSE OF ASSIGNMENT 1
METHODOLOGY 1
REPORT ORGANIZATION 2

CHAPTER TWO

OVERVIEW 3

HISTORICAL BACKGROUND 3
REGIONAL ENVIRONMENTS 4
Physical Environments 4
Social Environment 5
TYPES OF IRRIGATION SYSTEMS 5
OBJECTIVES OF IRRIGATION 8
THE ROLE OF IRRIGATION IN THE AGRICULTURAL SECTOR 8
Government Irrigation Policy 9
USAID Policy 10

CHAPTER THREE

THE PRIVATE SECTOR 11

SUMMARY 11
PRIVATE SECTOR ACTIVITIES 11
PRIVATE SECTOR PERFORMANCE 13
Growth in Irrigated Land 13
Growth in Marketing Intermediaries 14
Management 15
CONSTRAINTS TO PRIVATE SECTOR EXPANSION 15
Credit 15
Technical Knowledge 15
Energy Cost 16
Agricultural Product Markets 16
Import Duties 16
THE ROLE OF GOVERNMENT IN THE PRIVATE SECTOR 17
CONCLUSIONS 18

CHAPTER FOUR

THE PUBLIC SECTOR 19

SUMMARY 19
PUBLIC SECTOR ACTIVITIES 19
UNDERUTILIZATION OF PUBLIC IRRIGATION SYSTEMS 20
Definitions of Characteristics of Public Irrigation Units 20
Analysis 22
PUBLIC SECTOR PERFORMANCE 24
Management 24
Budget 24
O&M Expenditures 24
Water Charges and Cost Recovery 26
Labor Generation 28
TRANSFER OF PUBLIC SYSTEMS TO USERS 29
The Model 29
The Process 29
Studies 30
CONCLUSIONS 30

CHAPTER FIVE

THE PUBLIC-ASSISTED SECTOR 33

SUMMARY 33
MINIRIEGO 33
Background 33
Impacts 34
Management 36
Technical Assistance 37
Loans 37
Keys to Success 37
GROUNDWATER MINIRIEGO 37
CONCLUSIONS 39

CHAPTER SIX

GOVERNMENT IRRIGATION INSTITUTIONS 41

SUMMARY 41
INSTITUTIONAL EVOLUTION 41
ORGANIZATION 42
DIGESA'S HUMAN RESOURCES 42
Number of Employees 42
Impact of Donor Programs 42
Technical versus Administrative Capacity 43
Education and Training 44
BUDGET 44
DECENTRALIZATION 45
COORDINATION 46
STRATEGIC PLANNING AND EVALUATION OF ONGOING PROJECTS . . . 47
CONCLUSIONS 47

CHAPTER SEVEN

FUNDING SOURCES FOR IRRIGATION DEVELOPMENT 49

SUMMARY 49
FOREIGN LOANS AND GRANTS 49
PARTICIPATION OF PRIVATE BANKS IN LENDING
FOREIGN DONOR FUNDS 50
CONCLUSIONS 51

CHAPTER EIGHT

THE LEGAL FRAMEWORK 53

SUMMARY 53
WATER LEGISLATION 53
The Multiplicity of Laws and Institutions 53
The Present Water Law Proposal 54
Water Law Enforcement 55
LAND OWNERSHIP 55
Land Tenure Law 56
Land Titling 56
CONCLUSIONS 57

CHAPTER NINE

RURAL ORGANIZATION FOR IRRIGATION 59

SUMMARY 59
ADVANTAGES OF WATER USER PARTICIPATION 59
GOVERNMENT ACTION AND WATER USER GROUPS 60
THE GOVERNMENT'S IRRIGATION UNIT TRANSFER PROJECT 60
STRATEGIES FOR EFFECTIVE WATER USER GROUP FORMATION 61
CONCLUSIONS 62

CHAPTER TEN

INSTITUTIONAL SUPPORT SYSTEMS 63

SUMMARY 63
CREDIT 63
AGRICULTURAL RESEARCH 64
TECHNICAL ASSISTANCE 64
AGRICULTURAL PRODUCTION INPUTS 65
MARKETING 66
CONCLUSIONS 67

CHAPTER ELEVEN

IRRIGATION AND NATURAL RESOURCES MANAGEMENT . . . 69

SUMMARY . . . 69
A HOLISTIC VIEW . . . 69
SUSTAINABILITY . . . 70
Definition . . . 70
Project Sustainability . . . 71
Institutional Sustainability . . . 71
Social Sustainability . . . 71
Economic Sustainability . . . 71
Environmental Sustainability . . . 72
Verifiable Indicators of Sustainability . . . 73
MASTER PLANNING . . . 73
IRRIGATION MASTER PLANNING AND NATURAL RESOURCES SUSTAINABILITY . . . 74
CONCLUSIONS . . . 74

CHAPTER TWELVE

INFORMATION REQUIREMENTS FOR IRRIGATION . . . 76

SUMMARY . . . 76
INFORMATION USERS AND DIMENSIONS . . . 76
PLANNING INFORMATION . . . 76
MANAGEMENT INFORMATION . . . 77
CROP PRODUCTION AND MARKETING INFORMATION . . . 78
CONCLUSIONS . . . 78

CHAPTER THIRTEEN

SUMMARY OF RECOMMENDATIONS . . . 81

ALL SECTORS . . . 81
Master Planning for Irrigation . . . 81
Regulatory Enforcement . . . 81
Cost Recovery . . . 82
Institutional Capacity Strengthening . . . 82
Policy . . . 82
Market Information . . . 83
PRIVATE SECTOR . . . 83
PUBLIC SECTOR . . . 83
Transfer of Public Systems to Users . . . 83
Performance of Existing Public Units . . . 84
New Public Irrigation Systems . . . 85
Water User Participation . . . 85
Construction . . . 85
Operations and Maintenance . . . 85
PUBLIC-ASSISTED SECTOR . . . 86

ANNEX 1: WATER RESOURCES 1-1

ANNEX 2: CONSTRUCTION ADEQUACY OF PUBLIC IRRIGATION SYSTEMS 2-1

ANNEX 3: PROJECT APPRAISAL CRITERIA 3-1

APPENDIX 1: BIBLIOGRAPHY 1-1

APPENDIX 2: SCOPE OF WORK 2-2

APPENDIX 3: TEAM MEMBERS 3-1

APPENDIX 4: WORK SCHEDULE 4-1

APPENDIX 5: LIST OF PEOPLE CONTACTED 5-1

LIST OF TABLES AND FIGURES

Table		Page
1	Classification Characteristics for Irrigation Systems	6
2	Characteristics of Guatemalan Irrigation Systems	7
3	Private Firms Involved in Irrigation Sales, Service, and Manufacturing	12
4	Technical Assistance Firms	12
5	Estimates of Irrigated Land	13
6	Import Duties on Selected Irrigation Supplies and Equipment	17
7	Characteristics of Public Irrigation Units	21
8	Public Irrigation Units - Design, Irrigable, and Harvested Areas	23
9	Parcel Size versus Cropping Intensity	24
10	Water User Fees (1989) for Public Irrigation Units	28
11	Estimated Employment Creation in Public Irrigation Systems: 1988	29
12	Estimated Increment in Value of Production Due to Minriego: 1988	35
13	Estimated Employment Creation in Public-Assisted Systems: 1988	36
14	Status of BANDESA Loans for Minriego: 31 July 1989	38
15	DIGESA Staffing Levels	43
16	1988 DIGESA Budget	45
17	Sources of Funds for Public and Public-Assisted Irrigation Development	50

Figure		
1	Public Irrigation Units: Schematic	22
2	Nominal versus Real DIGESA Budget Allocations: 1976 - 1988	25

LIST OF ACRONYMS

BANDESA	Banco Nacional de Desarrollo Agricola
BCR	Benefit-Cost Ratio
BID	Inter-American Development Bank (Banco Interamericano de Desarrollo)
CAPCO	Central American Produce Company
CEPAL	Comision Economica Para America Latina
CI	Cropping Intensity
COGAAT	Cooperacion del Gobierno de Alemania
CONAMA	Comision Nacional del Medio Ambiente
COREDA	Comite Regional de Desarrollo Agricola
COSUREDA	Comite Sub-regional de Desarrollo Agricola
DGC	Direccion General de Caminos
DRH	Departmento de Recursos Hydraulicos
DIGEBOS	Direccion General de Bosques y Vida Silvestre
DIGERENARE	Direccion General de Recursos Naturales Renovables
DIGESA	Direccion General de Servicios Agricolas
DIGESEPE	Direccion General de Servicios Pecuarios
DIRYA	Direccion Tecnica de Riego y Avenemiento
DIRENARE	Direccion de Recursos Naturales Renovables
EEC	European Economic Community
GOG	Government of Guatemala
HAD	Highlands Agricultural Development Project
ICAITI	Instituto Centroamericano de Investigacion y Tecnologia Industrial
ICATA	Instituto de Ciencias Ambientales y Tecnologia Agricola
ICTA	Instituto de Ciencia y Tecnologia Agricola
INACOP	Instituto Nacional de Cooperativas
INAFOR	Instituto Nacional Forestal
INDE	Instituto Nacional de Electrificacion
INDECA	Instituto Nacional de Comercializacion Agricola
INDERENA	Instituto de Recursos Naturales y del Ambiente
INSIVUMEH	Instituto de Sismologia, Vulcanologia, Meteorologia, e Hidrologia
INTA	Instituto Nacional de Transformacion Agraria
IPM	Integrated Pest Management
IRENAT	Instituto de Recursos Naturales
IRR	Internal Rate of Return
ISNAR	International Service for National Agricultural Research
ITA	Instituto Tecnico de Agricultura
JICA	Japanese International Cooperation Agency
MAGA	Ministerio de Agricultura, Ganadaria, y Alimentacion
NGO	Non-Governmental Organization
NIA	National Irrigation Association (Philippines)
O&M	Operations and Maintenance

PNUD	United Nations Development Program (UNDP)
PRODAC	Programa de Desarrollo Agricola y Comercializacion
PROLAC	Planta Procesadora de Productos Lacteos de Asuncion
PROGETTAPS	Programa de Generacion y Transferencia de Tecnologia Agricola y Produccion de Semillas
PVC	Poly Vinyl Chloride (a plastic)
PVO	Private Voluntary Organization
Q	Quetzal (August 1989: $US 1.00 = Q2.70)
USDA	U.S. Department of Agriculture
USAID	U.S. Agency for International Development (also AID)
USPADA	Unidad Sectorial de Planificacion Agropecuaria y de Alimentacion

EXECUTIVE SUMMARY

Introduction

Over a period of five weeks in mid-1989, a team of local and foreign consultants sponsored by USAID carried out an assessment of public and private irrigation initiatives in Guatemala and visited principal areas where irrigation is practiced. The team's objectives were 1) to provide an overview of the irrigation sub-sector as a basis to help formulate future approaches to be detailed in an irrigation master plan; and 2) to identify approaches and organizational structures that support

- Improved and sustained performance from existing irrigation investments;
- An expanded irrigation sub-sector in the country; and
- Increased private sector involvement in system management.

This report provides an overview of irrigation in Guatemala and recommends various approaches that are supportive of irrigation's expansion to new areas and of improvements in existing irrigation. One of the team's most important conclusions was that an irrigation master plan should be prepared to help prioritize and orient necessary change.

Private, Public, and Public-Assisted Systems

This study proposes a new framework for viewing Guatemalan irrigation. Traditionally, systems have been categorized into medium (mediano), small (mini), and private irrigation. This categorization responds to donor-driven project labels but fails to communicate essential differences between irrigation systems or combinations of systems. Moreover, there is much overlap in terms of size and other characteristics. The team instead proposes a characterization by ownership and public assistance criteria: private, public, and public-assisted. It is a characterization which is simple to understand, which can accommodate future projects of many kinds, and which is donor-independent.

Private systems, which serve somewhere between 80,000 and 150,000 hectares, have no public sector involvement. They are designed, constructed, operated, maintained, financed and owned privately. Private systems can be divided into two classes: 1) small-scale and communal systems whose production orientation is generally toward subsistence and local markets; and 2) enterprises of any size with commercial production orientation. The principal growth in irrigated land appears to be occurring on large holdings that produce traditional export crops such as sugar and bananas.

The principal constraints to irrigation expansion in the private sector are credit for small- and medium-scale producers, and lack of knowledge about irrigation management. To address these constraints, the assessment team recommends:

- **The creation of an irrigation investment fund** to provide medium- and long-term credit for purchase of private irrigation systems;
- **A provision of incentives for private bank participation** in making loans for irrigation; and

- **Improvements in the quality and quantity of irrigation management education and extension.**

Public systems are developed, owned, and managed by the Government. Through Guatemala's agency DIGESA, the Government provides O&M and administrative services in 26 public irrigation units that serve some 2,800 water users and cover about 15,000 hectares. Public sector planning, financing, design, and construction functions have generally been handled adequately. And, investment in public units has generated large increases in employment, production, and incomes.

However, lands and invested capital in public units are grossly underutilized. The Government's management of the public irrigation sub-sector has been poor; this has caused economic stagnancy and a large financial drain on the Government. In this domain, the team has one major recommendation:

- **Public planning, financing, design, and construction should continue.** Among other considerations, construction should be targeted for locations where parcel size is small and where land title is clearly held. Potential irrigation systems where average land holdings are small represent a better investment opportunity than construction of irrigation systems where parcels are larger.

(Recommendations concerning other aspects of public systems -- transfer to users, institutional strengthening, and performance -- are provided below as separate discussion points.)

Public-assisted systems are those that are privately owned but publicly financed. Public-assisted irrigation serves about 2,000 hectares and 6,000 farmers located in 250 projects mostly in the Highlands. When compared with investment in public irrigation, public-assisted projects are excellent investments. Capital costs are about one-third the cost of public systems. Whereas O&M of public systems is a significant financial burden to the Government, O&M costs of public-assisted projects are fully borne by individuals benefitted. In the short span of three to five years, *miniriego* projects have resulted in the conversion of *milpa* farmers to successful small-scale entrepreneurs who produce irrigated vegetables.

Although projects have been functioning less than two years, groundwater *miniriego* has to date encountered a high number of idle investments. The implementation process has two sets of conflicting criteria: a need to centralize contracting and control of well drilling, and a need to regionalize site selection and farmer organization. To offset these constraints, the team has proposed the following recommendations for the public-assisted sector:

- **Continue support to public-assisted irrigation systems;**

- **Provide technical assistance in irrigation management and crop production as** part of the *miniriego* package;

- **Strengthen DIGESA's ability to provide water management technical** assistance. Training programs for irrigation personnel should be instituted to address both staff technical capability in water management, and the development of skills necessary to help organize and to work with water user groups; and

- **Strengthen communications and coordination** between regional and central DIGESA offices for implementation of groundwater *miniriego* projects.

Transfer of Public Units to Users

The government is an inefficient and financially distressed manager of irrigation systems. Improvement is unlikely under the current development/ownership/management model. The team concludes that public ownership and management should cease; and transfer of public irrigation units to water users is recommended. Government responsibility would revert to that of a planner and regulator of water resources. It would also continue as owner and manager of the principal water source (dam or river diversion). The Government would wholesale water to water districts, public entities formed by water users. Districts would then retail water to users.

The report offers the following guidelines for transfer of public systems to users:

- **The Finance Ministry should insist that MAGA turn over ownership and management** of each public irrigation unit to users on an agreed upon date. At the same time, the Finance Ministry must allocate the necessary funds to facilitate the transfer process;

- **A group consisting of representatives of the Government and the private sector should be formed to plan transfer.** The group would establish plans and a timetable for transfer of each unit based on engineering feasibility studies to detail unit-specific requirements for transfer, financial feasibility studies to determine management options and water costs for the newly-created irrigation districts, and social feasibility studies to address the problem of water user unwillingness to accept transfer;

- **DIGESA or another institution should acquire the institutional capacity to communicate with, organize, and train user groups** so that they can assume management responsibilities;

- **The Government must demonstrate commitment to enforce water laws** so that all water users in newly-formed districts have equitable access to irrigation; and

- **Transfer plans must be developed now** for the three projects contemplated for construction under BID II.

Institutional Capacity Strengthening

The transfer of responsibility for public systems to users will result in a smaller, better trained government cadre that would have responsibilities in master planning for irrigation design, construction, O&M of major facilities, regulation of water resources, and for technical assistance (extension) to irrigation systems. All but the extension function could be carried out by a DIRYA-type organization. The Government's institutional capacity for these activities should be strengthened through a series of related measures. The team recommends the following:

- **The quality and quantity of irrigation management education and extension should be improved.** Improved technical knowledge of irrigation is needed in both private and public sectors. Distinctive training can and should be developed at four levels: 1) farmers, 2) extension agents and trainers, 3) irrigation system operators and managers, and 4) irrigation policy makers;

- **Irrigation agencies should prepare long-term programs which address capacity building objectives.** Institutions involved in future irrigation planning must develop their own programs and be assured adequate budgets. The programs should be such that donors such as USAID, BID, and others could support aspects of institutional development as well as make loans/grants for specific irrigation projects;

- **A planning cell should be created and charged with strategic planning for the public irrigation sub-sector.** Once goals are established, communicated, and mutually agreed upon by managers and authorities (the Government or water user organizations), the performance of the unit should be monitored and measured against the goal; and

- **Institutions must attain the capacity to enforce existing regulations.** Increased staffing and budgets are required to permit regulation. The Government has the power but not the ability to enforce the laws regarding, for example, water offtakes and head-tail inequities in irrigation supplies.

Performance of Public Irrigation Units

The goal of transfer of public irrigation projects to users does not relieve the Government from the pressing need to improve performance of the irrigation sub-sector. Certain initial steps would have to be taken by the Government: evaluations of the 26 units, analysis of constraints, plans to provide funding for programs in existing units, preparation of annual plans and goals to enable units to increase cropping intensities. The team reached consensus on the following recommendations concerning performance improvements:

Operations and Maintenance

- **Conduct a study of the real costs of O&M.** Although the cost study should be done by the Government, results of the study would help establish O&M costs for transferred units. The Government would then have a firm basis on which to establish budget allocations;

- **Make water measurements at key locations in all irrigation projects** to facilitate irrigation system operations. Install staff gauges in rated sections of canals. Construct wells with instrument access points so that water levels and discharge can be determined. Initiate programs to monitor well output; and

- **Prepare O&M manuals** as a means to help improve unit management. Manuals should cover operations, maintenance, financial management/reporting, and water user organization.

Cost Recovery

- **Require irrigation systems to self finance operations and maintenance.** Costs for unit O&M should be fully recovered from water users. Funds collected should be earmarked in their entirety for use by the unit. Extraordinary costs (major rehabilitation or repair) would initially (prior to transfer) be the Government's responsibility.

New Public-Financed Systems

- **Ensure that the transition to user-management be a part of the planning for** every new irrigation scheme contemplated for construction by the public sector;

- **Insist that every new project be accompanied by a campaign to grant clear land titles;** and

- **Implement pilot irrigation projects in advance of major construction** to expose individuals new to irrigation to irrigation techniques. This is a recommendation to create small-scale pilot projects to serve as demonstrations in new schemes

to reduce the time required for farmers to make productive use of irrigation systems.

Water User Participation

- **Involve water users in planning, design, construction, and operation of irrigation systems.** The Government should take the initiative to communicate with potential users and to solicit their early involvement in the planning stages of every irrigation project. Users should also be employed to help construct the systems. At government insistence, users should participate in the planning for the transfer initiative.

Master Planning

The assessment team firmly believes that the planning process itself is as important an output as the generated plans. Therefore, the team recommends that an **irrigation master plan** be developed. Sustainability considerations should be an integral part of the irrigation master plan. Environmental, socioeconomic, and project (physical) sustainability issues in both the public and private sectors all must be addressed. Furthermore, the plan must consider

- Irrigation in the context of management of all natural resources -- water, soils, forests, watersheds;
- Impacts upon upstream and downstream water users as well as those in the project areas; and
- Intersectoral uses of water resources.

The team also recommends implementation of a **systematic project appraisal methodology.** Systematic project appraisal is not currently applied to differentiate between projects proposed for implementation. Both economic and social factors need to be considered in cost and benefit analysis. A series of project appraisal criteria should be prepared and used to evaluate new projects. The Government should make the commitment to follow appraisal review procedures.

CHAPTER ONE

INTRODUCTION

PURPOSE OF ASSIGNMENT

The purpose of the Irrigation Sector Assessment is to present an overview of the irrigation sub-sector in Guatemala that can be used to help formulate approaches for an irrigation master plan. The Assessment considers past and present irrigation sub-sector performance, as well as Government and donor policies. It provides additional information about the sub-sector and it identifies approaches, organizational structures, and policies that support the following:

- Improved performance from irrigation investments;
- Sustained performance from irrigation investments;
- An expanded irrigation sub-sector in the country; and
- Increased private sector involvement in system ownership and management.

The team was not asked to evaluate irrigation versus other types of investments in agriculture (such as investments in rainfed production, fertilizer purchases, marketing and processing, or institutional capacity development and training); however, the team suggests that these options be examined.

METHODOLOGY

USAID contracted two groups to carry out the Irrigation Sector Assessment: a six-person expatriate group, and a seven-person Guatemalan group. The two groups worked together as a single team throughout the assignment (June through September of 1989).

Following a team orientation and planning meeting in Guatemala City, the team travelled to all of the country's principal irrigation regions. The team employed rapid rural appraisal (*sondeo*) techniques, such as

- 2-4 person multidisciplinary teams in interviews;
- Daily changes team in composition; and
- Daily meetings to discuss observations, findings, and hypotheses.

Prior to the report writing phase, the team met to outline the work and to obtain consensus on principal findings, constraints/problems, and recommendations.

REPORT ORGANIZATION

This report is organized into 13 chapters. The busy reader may wish to review only the Executive Summary and Chapter Thirteen -- Summary of Recommendations. An introduction and background to the irrigation sub-sector is contained in Chapter Two. This chapter also proposes a typology for irrigation, a format used throughout this report. Chapters Three to Five cover the three types of irrigation: private, public, and public-assisted. Chapters Six to Twelve cover timely and important themes related to the irrigation sub-sector in Guatemala: Institutions, Funding Sources, The Legal Framework, Rural Organization, Support Systems, Natural Resources Management, and Information.

The Annexes cover water resources, comments on construction adequacy, and suggestions for project evaluation. The several Appendices contain a bibliography of more than 175 irrigation references of which 150 are specific to Guatemala; the scope of work for this assignment; names of the team members; a field work schedule; and a list of persons contacted.

CHAPTER TWO

OVERVIEW

HISTORICAL BACKGROUND

Irrigation in Guatemala can be traced to pre-Conquest Indian plantings in areas of Rabinal and Cubulco. During the period of Spanish colonization, an estimated 1,650 hectares of sugar cane, vegetables, vineyards, and fruit were grown under irrigation in Jalapa, Zacapa, El Progreso, Chiquimula, Santa Rosa, and Baja Verapaz. The indigenous populations mastered principles of hydraulic engineering and irrigation technology in ways only now being understood and appreciated. Colonial introductions reflected centuries of irrigation experience in Spain and North Africa. In the highlands, indigenous groups continue traditional, resource-conserving irrigation practices, some of which are centuries old. These precedents merit attention because they help form the environmental, social, and technical bases on which future irrigation development will grow.

In the hundred years following independence, 1821-1920, it is estimated that 2,200 hectares were irrigated, principally in the Motagua Valley for sugar cane. Irrigation increased in importance after 1920, a date that marks the entry of the transnational banana companies into the country. These companies brought approximately 22,000 hectares into production. At the same time, irrigated production of pasture, rubber, coffee, cotton, and citrus also began. Major irrigated areas were found on the South Coast and to a lesser extent in Izabal and the Highlands.

In 1957, the Ministry of Agriculture (now MAGA) began a program of public irrigation systems. Construction began in 1964 and to date has resulted in bringing irrigation to approximately 17,000 hectares in 26 publicly managed irrigation systems. Construction of public irrigation systems initially was concentrated in the Motagua Valley where rainfall is deficient. The Inter-American Development Bank (BID) was the main source of funds, and the policy was oriented mainly to economic goals. These projects vary in size, from 30 to 2,600 hectares, but share common characteristics of being constructed, owned, and managed by the Government with a minimum of user involvement.

In the early 1970s, Government policy focused on irrigation based on social goals. The agrarian reform settlements of Nica and La Blanca on the Pacific Coast were targeted for irrigation. As a result, parcel sizes and economic conditions of users are more homogeneous than in the first phase, but they share the characteristic of irrigation system ownership and management by the Direccion General de Servicios Agricolas (DIGESA). The top-down implementation of the public systems led producers to assume that these were government services over which they had no control, despite project plans to the contrary. This assumption evolved into a perception that irrigation is a public service for which the government is responsible much as education is assumed to be paid for out of the public treasury for the benefit of the entire nation.

Introduction of the public-assisted *miniriego* concept was an outgrowth of USAID funding objectives implemented in several projects from 1978 to the present time. *Miniriego* changed the pattern of design and financing, requiring formation of farmer organizations and specific, legally sanctioned financial commitments as prerequisites to construction. Repayment grace periods and interest rates were made explicit. In contrast to public systems, farmers own and operate their own systems.

REGIONAL ENVIRONMENTS

Irrigation is considered in three regional environments. Divisions are subjective, representing compromises between physical, cultural, and administrative divisions of the country. These environments are used not as a strict framework for irrigation planning, but rather as a convenient grouping for reviewing of past irrigation activities and options for future development. Parts or all of the following 19 Guatemalan departments are included in these regions:

East	Highlands	South Coast
Baja Verapaz	Chimaltenango	Escuintla
Chiquimula	Guatemala	Retalhuleu
El Progreso	Huehuetenango	Santa Rosa
Jalapa	Quezaltenango	Suchitepequez
Jutiapa	Quiche	
Zacapa	Sacatepequez	
	San Marcos	
	Solola	
	Totonicapan	

Missing are the departments of Alta Verapaz, where there is no need for irrigation; Izabal, where the need is sporadic; and Peten, where the need is both sporadic and the sources of water difficult to access -- there has been relatively little agricultural development in Peten.

Physical Environments

The plethora of criteria for classification complicates the problem of regionalization. In the physical environment alone, climate, soils, topography, and water resources (Annex 1) are all critical factors for irrigation planning, design, and management. Climate, soils, and topography are discussed below.

Climate

The East is the driest of the three regions with potential evapotranspiration (PET) in excess of precipitation in all months at some weather stations. Year-round production is constrained by the region's aridity. Consequently, the economic impact of irrigation is higher in the East than anywhere else in the country.

Topography exercises control over the climate of the Highlands Region. Cool temperatures and lower evapotranspiration rates prevail, largely a result of altitude. Although annual rainfall is considerably higher in the Highlands than in the East, only a single cropping season is possible without irrigation because of the six-month dry season.

Rainfall is higher in the South Coast than in either the East or the Highlands. Nevertheless, a pronounced dry season from November to March/April places a strong seasonal constraint on agricultural activities.

Temperatures in the three regions do not impose constraints upon year-round crop production under irrigation; consequently, year-round production is possible using irrigation.

Topography and Soils

The three regions vary considerably with respect to landforms, hydrology, and soils. The Eastern region is dominated by river valleys -- most importantly, the Motagua and its tributaries. Upland areas display the dissection that characterizes regions with sparse rainfall and vegetation. The erodibility of upland soils poses a management challenge to irrigation projects, and emphasizes the need to include whole watersheds in project planning.

Highland areas are characterized by hilly topography and broad plains. Slopes can be managed with slope-modifying techniques such as terraces, and with careful hand- or sprinkler-irrigation. The volcanic soils are fertile, but in many cases are highly erodible and have little water storage capacity.

The South Coast is a region of plains dissected by streams. Near the escarpment, alluvial volcanic soils are moderately to highly erodible, and the upland portions are deeply incised (USAID: ASR 1987). Water holding capacity of the soils is apt to be variable because many of the lands are formed upon old stream beds. Land leveling, sediment management, and drainage are necessary components of irrigation plans and designs in this region.

Social Environment

Guatemala has a total population of nearly nine million (mid-1989). If the present annual growth rate of approximately three percent remains constant, the population will reach 12 million by the year 2000 and will double in 23 years. More than half the population is illiterate. The economically active population is about 32 percent of the total, or 2.9 million. The primary sectors (agriculture, forestry, and fishery) account for 56 percent of the total.

Forty-five percent of the Guatemalan population is composed of ethnically indigenous members of 23 Indian tribes with distinctive languages and different cultures. In the East and the South Coast, the indigenous population is relatively small, at 23 percent and 24 percent respectively. In the Highlands, however, 48 percent of the population is indigenous, and in the departments of Solola and Totonicapan the percentages are 94 and 97 percent. Ethnic differences and a history of mistrust and misunderstanding with the Ladino Guatemalans can create significant problems in communication, and, significant to this study, the Government's ability to encourage farmer water user organizations.

TYPES OF IRRIGATION SYSTEMS

Guatemalan irrigation systems are classified in this report by ownership and public assistance criteria. Suggested categories are private, public, and public-assisted. The proposed classification represents a departure from current categorization, which is donor-driven. For example, *mediano* (medium-size) systems were BID-sponsored projects, and *miniriego* systems were sponsored by USAID. The problem with the old labels is that they 1) fail to accurately communicate essential differences between irrigation system types; 2) fail to accommodate new projects with different combinations of characteristics; and 3) overlap in terms of size and other characteristics. The advantages of the proposed new classification are 1) its simplicity, 2) its flexibility to accommodate future projects of many kinds, and 3) its independence from donors. Note that a given system can change classifications. For example, if a public system is converted to total private ownership and control, it would be reclassified as private; if the conversion involves continued government subsidy, it would be reclassified as public-assisted.

Private systems have no public sector involvement. They are designed, constructed, operated, maintained, financed, and owned privately. Private systems can be divided into two classes: 1) small-scale and communal systems whose production orientation is generally toward subsistence and local markets, and 2) small- to large-scale enterprises with commercial production orientation. Among the former are many private individuals operating on their own, such as groups observed in Panajachel, Pachoj (Zunil), and San Matias (Jutiapa), and groups incorporated into municipal functions at Almolonga, Teculutan, and Usumatlan. Commercial systems can be of any size. Traditionally these were located on the South Coast, created for sugar cane, pasture, or banana production. These systems may cover thousands of hectares, and are usually associated with a single crop. Of recent importance are commercial operations in the Highlands. These can range in size from five hectares upwards. Most are devoted to production of non-traditional crops.

Public systems are owned and operated by the Government. At present there are 26 public systems operated and maintained by DIGESA, and supported financially by the Government. Currently planned projects by the European Economic Community (EEC) and the Japanese International Cooperation Agency (JICA) fall into this category.

Public-assisted systems are privately owned but publicly financed. Systems in this category were created with impetus and assistance from government, which included more than financing. An example is the *miniriego* project funded by USAID and implemented by DIGESA and BANDESA. DIGESA designs the system, helps with construction, teaches water users how to operate and maintain the system, and then gradually withdraws involvement. Financing at concessional rates continues until the system is paid off. This model is also used in the USAID-financed Emergency Fund which promotes small-scale irrigation using groundwater.

Classification and characteristics of the systems are summarized in Tables 1 and 2. As indicated in Table 2, almost 90 percent of all irrigable land is in private systems, just under ten percent in public systems, and one percent in public-assisted systems.

TABLE 1

CLASSIFICATION CHARACTERISTICS FOR IRRIGATION SYSTEMS

Characteristics	Private	Public-Assisted	Public
Land Ownership	private	private	private
System Ownership	private	private	public
System Design	private	public	public/contract
System Construction	private	public/private	public/contract
System Management	private	private	public
Financing	private	public	public

TABLE 2

CHARACTERISTICS OF GUATEMALAN IRRIGATION SYSTEMS

	Public-Assisted	Public	--------- Private --------- Small-scale or communal; subsistence or local markets	Commercial
Popular names	*Miniriego*	*Mediano*	na	na
Locations	Highlands/ East	All country	All country	South Coast North Coast
Irrigable area (ha)	2,000	15,000	83,000 to 155,000	
System size (ha)	1-50	30-2,600	less than 500	5 or more
Plot size	less than 1 (av 1/3)	up to 126 (av 5.4)	less than 500	5 or more
Number users	6,000	2,800	--	--
Technology	Closed conduit pipe systems	Gravity/pump open conduit	All	All
Financing	BANDESA/AID	BID/Govt/EEC	Private and Commercial	
Construction costs (Q/ha)	2,700 (1987)	8,800 (1989) (BID II)	8500 to 10,000+ (1989)	
O & M	Users	DIGESA/mixed	Owners	Users/ Employees
O&M Costs (Q/ha/year) (1986)	minor	217	--- 100 to 300 --- -- 135	
Land tenure	Variable	Variable	Variable	Titled
Producers	Owners/renters	Owners/renters/ mediantes	Owners/ renters	Owners/ renters

OBJECTIVES OF IRRIGATION

Based on various documents and discussions, the assessment team has delineated a set of objectives for Guatemala's irrigated agricultural sector. These are summarized as follows:

- **Objective 1: Achieve food security.** Irrigated agriculture is essential to expand production of basic commodities (e.g., maize, beans, rice, sugar). The ability to irrigate promotes crop diversification and year-round production of vegetables and nutritionally attractive foods that will make their way into local markets and diets.

- **Objective 2: Earn foreign exchange by increasing exports.** Irrigation is the basis for expanding exports of non-traditional crops. Without irrigation it would be impossible to produce vegetables and fruits that meet the quality standards of international markets. Further, irrigation is essential to retain Guatemala's portion of the highly competitive US market for off-season vegetable crops.

- **Objective 3: Increase value-added in agriculture.** Irrigation allows greater diversity of products and permits additional opportunities for food processing and packaging. Processing further increases the value added of irrigated production.

- **Objective 4: Increase employment.** Irrigation provides jobs in agriculture and agro-industry, and has multiplier effects in the general economy. Many of the jobs are year-round instead of seasonal. Therefore, irrigation can have the positive social impact of reducing out-migration.

- **Objective 5: Create wealth.** Irrigation generates increased production and therefore increased rural incomes.

- **Objective 6: Improve income distribution.** Irrigation has proven to be a technology adoptable by poorer farmers. Irrigation is a means by which poorer individuals can increase their incomes. Irrigation also affords employment opportunities for economically disadvantaged individuals.

- **Objective 7: Implement comprehensive renewable natural resources management.** Irrigation is a catalyst for resource management in general, including management of watersheds, forests, soils, and water resources.

THE ROLE OF IRRIGATION IN THE AGRICULTURAL SECTOR

Guatemala's agricultural sector accounts for about 25 percent of the gross domestic product. Primary and secondary agricultural products account for about 70 percent of total export earnings. Agriculture employs almost 60 percent of the work force. Consequently, agricultural production trends have a marked influence on the economy of the country. Of approximately 4.55 million arable hectares, 3.15 million hectares are under cultivation, or about 30 percent of the country's land area. Irrigation is practiced on over 150,000 hectares, or four percent of the cultivated area. The additional area with irrigation potential is estimated at 300,000 to 500,000 hectares. The quantitative importance of irrigation to Guatemala's agricultural sector is unknown.

Most irrigated land is used for traditional export crops -- in particular, sugarcane and bananas. Of increasing importance in area, but particularly in value of earnings, are areas devoted to such non-traditional export crops as vegetables, flowers, tobacco, and ornamentals.

In recent years, Guatemala has increased its exports of non-traditional crops. An increasing proportion of these are grown under irrigation. Guatemala competes closely with other Latin and Caribbean countries for its share of the US market. Because competition is keen, and markets demand steady supplies of high-quality produce, the Guatemalan economy is more and more geared to production under irrigation. Irrigation therefore is necessary to ensure that Guatemala retains or increases its share of international markets.

Government Irrigation Policy

The Government of Guatemala (GOG) gives high priority to its agriculture sector and to irrigation in the five-year National Development Plan (1988-92). A 16-point action plan is given in its "Bases y Estrategias Generales del Sector Agropecuario, 1987." The Government makes the commitment to undertake the following:

- Prepare a master plan for water resources;
- Raise the national consciousness level regarding the need for efficient use of water resources;
- Formulate a comprehensive water law;
- Study and implement projects on the basis of hydrographic (watershed) units;
- Conduct studies and implement projects to improve the use of surface and groundwater resources;
- Accelerate studies and construction of projects on international rivers;
- Conduct studies on groundwater resources in the Highlands;
- Solicit funds for the formulation of new irrigation projects;
- Prepare projects for infrastructure improvement in existing irrigation systems;
- Seek imposition of preferential electricity tariffs in public units that use electrical pumps;
- Promote the establishment of multipurpose user groups;
- Involve water users, from the outset, in planning, construction, and management of irrigation works;
- Analyze each public irrigation unit to seek ways in which an increased proportion of O&M funds can be generated by users;
- Make a gradual transfer of public irrigation units to user groups;
- Provide funding so that the infrastructure in public systems is fully operational when transfer is made; and
- Support an expansion of public-assisted irrigation.

USAID Policy

In agricultural development, USAID/Guatemala has generally focused on programs and projects in institution building, crop diversification, soil conservation, small-scale irrigation, rural cooperatives and credit, and rural marketing (USAID 1989a). Since irrigation necessarily complements all of these areas, it is consistent with USAID and GOG policies. The special needs of irrigation management have strengthened institutions in both the private and public sectors, including indigenous groups at the community level. Irrigation not only permits, but demands crop diversification and market orientation. The switch to market crops induced by irrigation also generates a strong demand for credit, supplied so far by private marketing and export companies as well by BANDESA. Thus, USAID's role in supporting irrigation for small-scale farmers can be seen as entirely consistent and complementary to long-term objectives.

CHAPTER THREE

THE PRIVATE SECTOR

SUMMARY

The private sector is the most powerful force in irrigation development in Guatemala. It accounts for approximately 90 percent of all irrigated land in the country, and its share is growing. Indirect indicators suggest that the amount of irrigated land is increasing rapidly. However, increases appear to be heavily concentrated on large landholdings that produce such traditional export crops as sugar and bananas.

Private sector vendors of irrigation equipment and services are available and capable of handling virtually all on-farm system design and construction needs. They report some difficulty finding qualified personnel in irrigation because domestic educational institutions have very limited irrigation curricula. This knowledge deficiency is even more pronounced among farmers, who often lack understanding of production technology with irrigation. From this constraint emanates a recommendation for a program of education and training in irrigation management.

The principal constraint to irrigation development, however, is the lack of medium- and long-term credit. Few suppliers will provide credit, and the private banking system is not inclined to take the risks. As one equipment vendor put it, "We sell to enterprises, not to farmers." This serves to emphasize the concentration of investment activity among large producers. Although the assessment team believes the Government should act as a facilitator for the private sector, there is need for intervention to mitigate the credit constraint. Establishment of an irrigation loan fund administered by BANDESA and private banks is recommended. With credit for investment in irrigation, many more small- and medium-scale farmers will be able to exploit the growing market demand for irrigated produce.

Government policies with respect to private sector irrigation have been essentially benign. Although some recommendations are made elsewhere in this study to involve the Government in resource protection, information collection and dissemination, regulation of major water sources, and registration of offtakes, it is important that the Government not invoke policies that could impede private sector growth.

PRIVATE SECTOR ACTIVITIES

Private sector firms are involved in all phases of irrigation development, including system design, construction, maintenance, financing, and manufacturing. A complete inventory of firms involved in irrigation is unavailable, but a sample of principal firms and their activities is shown in Table 3.

TABLE 3

PRIVATE FIRMS INVOLVED IN IRRIGATION SALES, SERVICE, AND MANUFACTURING

	Sales	System Design	Technical Assistance O&M	System Installation	Credit
CORSEPRA		X	X	X	
Equiagro	X	X	X	X	
Femco	X	X	X	X	
Hidromex	X	X	X	X	
Hydrosistemas	X	X	X	X	
Hardie Irrigation	X	X	X	X	
Hidrosa	X	X	X	X	
Polymer[1]	X				
Ravit	X	X	X	X	
Riego Vinil[1]	X	X	X	X	X
Riegos del Sur[2]	X	X	X	X	
Sistemas de Riego	X	X	X		
SURSA	X	X	X	X	
Tecni Riegos	X	X	X	X	
TECUN	X	X	X		

[1] PVC pipe sales.

[2] Credit limited to 50 percent of cost for a period of six months.

Private sector marketing firms have benefitted farmers by purchasing fruits and vegetables for domestic and export markets, and by providing technical assistance directly to farmers. Irrigation is a critical factor in this production/marketing partnership because it facilitates control of production timing and product quality. Some firms which provide technical assistance are listed below. Most of these firms contract with farmers located in public sector irrigation units.

TABLE 4

TECHNICAL ASSISTANCE FIRMS

Firm	Produce
ALCOSA	Vegetables
ANACAFE	Coffee
ASAZGUA	Sugar Cane
Case Export	Tobacco
CAPCO	Melons
Chiquita	Melons
Tabacalera Centramericana	Tobacco
Tabacalera Nacional	Tobacco
Tabacalera Maya	Tobacco
Verdufrex	Vegetables

Private sector support in marketing and technical assistance is vital to further development of irrigated agriculture. Irrigation not only encourages transition from rainfed traditional crops such as corn and beans to higher value, non-traditional crops such as vegetables, melons, and tobacco, but it also requires the transition to help pay for irrigation systems. Successful transition requires a market for the higher value crops, which is what marketing firms provide.

But they have provided much more than a market in most cases; they have also 1) provided technical assistance in production, 2) organized farmers to produce specified quantities at specified times, 3) provided production credit, 4) reduced market risk to farmers by specifying contract prices in advance of production, and 5) provided the service of farmgate produce collection. In several cases, tobacco companies have leased land, divided it into parcels of manageable size, and subleased to farmers.

In effect, these marketing firms have achieved vertical integration of the production/marketing system under the most difficult of circumstances: small, geographically-dispersed farms, and capital-poor farmers who are often technologically deficient in the production of export crops. On balance, it appears that this is a market-driven partnership that serves both parties. Furthermore, it is an activity that cannot be efficiently duplicated by the Government.

PRIVATE SECTOR PERFORMANCE

The social and economic impacts of private sector irrigation cannot be quantified due to a lack of information. To estimate crop production, income, and employment gains it is necessary to know how many hectares are planted with each crop, and the approximate production and yield differences with and without irrigation. Until an inventory of irrigated land is conducted, the magnitude of impacts will remain unknown.

Interviews with purveyors of irrigation supplies and services indicate significant growth in demand for irrigation during the past five years. Growth in the volume of products and number of farmers covered by agricultural marketing intermediaries is also believed to be strong, but little evidence has been obtained. These are discussed in turn below.

Growth in Irrigated Land

The amount of land under irrigation in the private sector is unknown, although crude estimates have been made by the following sources.

TABLE 5

ESTIMATES OF IRRIGATED LAND

Source	Year	Hectares
DIRYA	1989	155,000
CEPAL		110,000
World Bank		110,000
Inter-American Development Bank	1987	85,000

The private irrigation sub-sector includes 1) enterprises with commercial, often export, orientation, including large sugar estates and small farms (such as a five-hectare operation producing irrigated strawberries for export); and 2) small-scale and communal systems (for example, San Matias) with production under irrigation but with principal emphasis on subsistence or local markets.

Assuming 155,000 hectares, about 90 percent of all irrigated land in Guatemala is owned and controlled by the private sector. The private sector share is increasing because public sector development is stalled and public-assisted development is minor. Since direct measurement of irrigation growth by the assessment team was not possible, evidence from some of the most prominent purveyors of irrigation supplies and services is used as a proxy.

Interviews with selected irrigation supply firms suggest across the board a strong growth in demand for new irrigation systems. For example, the irrigation division of one of the largest firms has grown from five employees to more than 20 in the past five years; sales in 1988 were approximately 50 percent greater than in 1987. This firm also reports that about 80 percent of sales are associated with new irrigation development, and 20 percent to system rehabilitation and repair. Similar rates of growth with a focus on new systems are suggested by other firms.

However, in terms of land area a large proportion of irrigation development is in traditional export crops in the South Coast area. An enterprise engaged in the design and installation of new irrigation systems reports that of nearly 40 projects completed or underway in 1989, a fourth of the projects comprising 90 percent of the newly irrigated area is devoted to bananas or sugar cane.

A complete accounting of business done by Guatemalan irrigation supply and service companies would not reveal the true extent of the increase in irrigated land or its concentration in plantation crops because some large farming enterprises import irrigation equipment directly and install it themselves, bypassing local firms. Additionally, some enterprises construct all-gravity systems themselves, and make no significant purchases of materials identified as irrigation specific.

Development of groundwater irrigation systems appears to be occurring at a slower pace than surface water systems because of the capital cost of wells and pumps, and because of the high cost of energy. One of the largest well-drilling firms in Guatemala reports steady business, but nowhere near the rates of growth associated with gravity systems.

Growth in Marketing Intermediaries

Agricultural marketing firms have stimulated demand for irrigation, but their aggregate impact is unknown. Although attention has been focused on high-value export crops such as broccoli, cauliflower, melons, and tobacco destined for the United States, trade is also brisk in other products and markets. In the Salama Valley, for example, irrigated sweet corn is being grown for canning and shipment to Costa Rica. Marketing intermediaries have also fostered exports of plantains to Mexico, and vegetables to Honduras and El Salvador, part of which comes from irrigated land.

Although the impact of marketing firms on agricultural production and investment in irrigation is not known, it is apparent that the firms' importance is growing and that they must draw upon production from irrigated land. In general, demand for export-quality products exceeds supply; CAPCO reports that it needs more produce to utilize its processing and shipping capacity, but is unable to purchase more. Further, irrigation development can therefore be viewed as necessary to support increased production and export trade.

Management

The assessment team was unable to evaluate irrigation management directly because field visits occurred during the wet season when little irrigation was underway. Opinions gathered from persons knowledgeable about irrigation in Guatemala suggest that system management is variable on large-scale farms concentrating on traditional export crops such as sugar cane, bananas, and irrigated pasture for export cattle. Certain smaller private operations harvest up to three or four crops per year of lettuce and celery under irrigation -- evidence of excellent management. It cannot, however, be assumed that the private sector is a model of good management.

Small-scale, communal systems are reportedly managed adequately, but there is great variation among them. Furthermore, some private irrigation units experience conflict when there is competition for scarce water, when members do not volunteer sufficient time for system maintenance, and when money must be raised for repairs.

The San Matias Irrigation District in Southeastern Guatemala is an example of a cost-efficient, private irrigation system. Approximately 600 hectares of land are irrigated with a river-fed gravity system. More than 400 water users contribute their time to clean canals and rebuild the system headworks annually. One local person called a *juez de agua* is employed to make all water allocations during the irrigation season. Water users pay only Q0.70 per harvest per hectare for the service.

CONSTRAINTS TO PRIVATE SECTOR EXPANSION

Constraints to private sector irrigation development are discussed in this section and include a lack of long-term credit for investment in irrigation systems, insufficient technical knowledge on the part of both farmers and consulting technicians, the high cost of energy for pumping, volatile product prices, and to a lesser extent, import duties on irrigation equipment.

Credit

The principal constraint to irrigation development, according to farmers and purveyors of irrigation equipment and services interviewed by the team, is credit. Farmers cannot get medium-term (2-5 year) or long-term (6+ years) financing to invest in irrigation systems because funds are in short supply, commercial banks (e.g., BANDESA) will not take the risk, or farmers cannot meet collateral requirements. Lack of credit acts as a particular disincentive to farmers with small land holdings, with the result that private sector irrigation expansion is concentrated on large farm enterprises that export their products. When foreign-sponsored credit becomes available at concessional rates, it is quickly exhausted because collateral requirements are typically less than commercial banks, and because the real rate of interest is low or even negative. The USAID-sponsored *miniriego* project, which has concessional interest rates, a no-payment period of two years, and long-term repayment period, has generated more demand for project money than is available. A new BID loan (BID #817/SF-GU), which will provide medium and long-term credit for agriculture, is imminent. BID charges the Government of Guatemala two percent interest, but the rate that will be charged to the farmers will probably be the market rate as in the past (see Chapter Seven).

Technical Knowledge

Purveyors of irrigation equipment and design services contend that demand for irrigation is constrained by farmers' ignorance of the potential benefits of irrigation, and

of irrigation technology. Furthermore, few technicians have sufficient training and experience in irrigation to teach farmers. The firms interviewed report difficulty finding qualified personnel, and contend that the agronomy curricula offered in the universities are deficient in irrigation. Cross-training and exchanges between private and public sector individuals working in irrigation could be beneficial to both.

Energy Cost

The high cost of electricity and petroleum-based energy constrains irrigation development because pumps are required in many systems. The cost of system operation is particularly high if groundwater is pumped. The lack of electrical power lines in rural areas also severely constrains the use of pumps because new users must pay the installation cost.

Agricultural Product Markets

Market price variability for the products of irrigated agriculture is viewed by producers as a major constraint to expansion of irrigated area. The problem is particularly acute for small farmers who do not have sales contracts with intermediaries, or who have insufficient land to achieve economies of scale or to diversify production. Producers of perishable products such as fruits and vegetables are also particularly susceptible to market risk because storage for price speculation is impossible. However, irrigated area is increasing, which suggests that prices are temporarily favorable for enterprises with crops such as sugar and bananas, with irrigated pasture for beef production and export, and for other export crops such as vegetables, tobacco, and melons.

Market access is also considered a principal constraint to irrigation development -- and particularly for small farmers. Poor roads, infrequent public transportation, and long distances from farm to market inhibit the ability of the farmer to move products in a timely and inexpensive manner. For example, farms in Nica are accessible only by four-wheel drive vehicle; during the wet season those vehicles often cannot enter.

The problem of small farms and market access is endemic to the countries of Latin America. Small production volumes simply do not justify or enable purchase of a truck, causing dependence on marketing intermediaries. Intermediaries have high average unit marketing costs (and alleged high profits), forcing farmgate prices to low levels. This problem has been particularly acute for some USAID-financed *miniriego* projects located far from market centers.

Import Duties

Import duties on most foreign produced irrigation supplies and equipment are less than 10 percent. While this adds cost for purchase of on-farm irrigation systems, import duties are not onerous (Table 6). Among the components listed in the Table, only PVC pipe is manufactured in Guatemala, hence local industry protection explains the higher tariff.

Importers of irrigation equipment indicate that the product categories used by Guatemalan customs are very broad, resulting in higher duties than they believe should be charged in some instances. (One importer objected to having to pay 19 percent duty on a mobile well-drilling rig because the rig had wheels and a driver's cab. The duty rate for heavy machinery -- the category the importer claims -- is nine percent.)

TABLE 6

IMPORT DUTIES ON SELECTED IRRIGATION SUPPLIES AND EQUIPMENT

Item	Import Duty in percentage (on CIF value)
Complete irrigation system	9
Components:	
Sprinkler heads	39
Drip irrigation components	39
PVC pipe and accessories	54
Aluminum pipe and accessories less than 50mm diameter	24
Steel pipe	9
Filters	9
Drilling rig	9
Drilling rig on truck	19
Electrical cable made of silicon, magnesium, copper, aluminum, or manganese, not exceeding 5,000 volts capacity	54
Electrical cable (all other)	
Pumps and electrical motors	9

Source: Direccion General de Aduanas

The rate structure discriminates against Guatemalan entrepreneurs who might import components and assemble irrigation systems in Guatemala because the rate on complete systems is relatively low at nine percent. According to the customs authority, a complete system is identified as a group of components on a single sales invoice, which encourages importers to purchase everything from one source instead of shopping for the best prices among different suppliers. Importers have discovered ways to qualify for the lower tariff by grouping needed items on one invoice, even though they might be technically incompatible or unrelated. In general, the complaints among importers are subjectivity, inconsistency, and inequity in the application of tariffs.

THE ROLE OF GOVERNMENT IN THE PRIVATE SECTOR

Evaluation of the relationship between public and private sectors in irrigation development necessarily requires a frame of reference for making judgments. That frame of reference is a vision of what the role of the public sector ought to be in agricultural development in general -- not merely the subset of irrigation development. Westerners usually maintain that the role of the public sector is to facilitate the private sector by providing public goods and services, mitigating constraints on development, and preventing abuse of producers and consumers in a capitalistic system. The public sector role excludes ownership or control of agricultural production and distribution unless extenuating circumstances so warrant -- as in private sector monopoly.

Irrigation development has some characteristics common to any agricultural environment. General characteristics include 1) high initial capital cost, 2) subsequent

long-term financing, and 3) organization of irrigation system O&M. These characteristics typically justify public sector intervention because the private sector is unable, unwilling, or prohibited by law from undertaking development of water resources.

Some characteristics specific to Guatemala also suggest a need for public sector intervention that would not be required in a more advanced, commercial agriculture: 1) farmer ignorance of irrigation technology, 2) low farmer incomes, 3) prevalence of subsistence crops, 4) disarticulation with commercial markets, and 5) the difficulty of organizing small-scale farmers to share irrigation system water, costs, and maintenance responsibilities. Clearly, many farmers in Guatemala do not fit this model; a dualistic agricultural economy prevails in which commercial farms use modern irrigation technology adjacent to those who haul water to fields in barrels. Although public sector intervention can be justified for both extremes of the dualistic system to increase national production and exports, the greater development challenge is the traditional sector which lacks resources and opportunities for improvement.

CONCLUSIONS

Based upon evidence from business activity registered by selected purveyors of irrigation equipment and services, the private irrigation sub-sector is growing rapidly. Growth is powered by increased demand for Guatemalan produce for export. The principal growth in irrigated land area appears to be occurring on large holdings that produce traditional export crops such as sugar and bananas. There has also been significant growth in irrigated fruit and vegetable exports via marketing intermediaries who provide small-scale producers with contracts for produce, technical assistance and credit -- services the Government cannot adequately provide.

The principal constraint to irrigation expansion is credit for small- and medium-scale producers. Financial institutions other than BANDESA are unwilling to take the risks associated with medium- and long-term investments in agriculture, even with foreign donor backing. A general lack of knowledge about irrigation management remains a constraint to increased production from existing irrigation. Cross-training and exchanges between private and public sector individuals working in irrigation could be beneficial to both. Additional constraints include volatile market prices for fresh produce and lack of market access for some producers.

CHAPTER FOUR

THE PUBLIC SECTOR

SUMMARY

The Government owns and operates 26 public irrigation units that serve some 2,800 water users and that cover about 15,000 hectares. Through DIGESA, the Government provides O&M and administrative services. The performance of Guatemala's public irrigation sub-sector has been poor, as is illustrated here and discussed in this chapter:

- In most public systems, less than one crop a year is grown even though designs should permit double cropping;
- Public systems are underutilized and lands lay idle: only one hectare in two can be irrigated;
- Absentee land ownership and large parcel size discourages investment in on-farm irrigation improvements and full use of irrigable land; and
- Less than 15 percent of O&M costs are recovered from farmers and the Government is unable to provide the difference, with the result that the physical infrastructure will deteriorate.

The process should begin to transfer public units to users. But, given the conditions mentioned above, water users decline to accept system transfer because they do not want to lose their subsidies.

A wholesaler/retailer model is proposed, one in which the Government sells water wholesale to districts that are to be owned and operated by farmers. Farmers employ district management. All costs for operating the district are paid for out of water sales. Guidelines to effect transfer are suggested; one crucial prerequisite is that water users participate in planning the transfer.

PUBLIC SECTOR ACTIVITIES

The public sector provides a spectrum of services in support of farmers who irrigate their land. By sponsoring agency services include: financing of private sector systems (BANDESA); planning, design, and construction (DIRYA); agricultural extension, O&M, and statistical reporting (DIGESA); and research (ICTA). This chapter focuses on DIGESA's management of the public irrigation systems.

From 1964 through 1969 the Government constructed irrigation systems using national funds. In 1969 the Department of Hydraulic Resources was made responsible for execution of a BID loan involving construction of irrigation systems. From 1970 until the time BID's program ended in 1975, the agency had built and was operating 20 irrigation projects across the nation, had one of the largest budgets and staff in MAGA, and had developed a well-trained team of irrigation specialists (DIGESA, 1976: 44-46. Between 1976 and 1984 the Government continued irrigation system construction, although at a slower pace. By 1984, 26 systems had been completed. At present, 25 remain under public management (DIGESA), and one is in the process of transfer to a user group.

Table 7 presents data on construction costs for the various units. Many of these data are old and have little relevance today. A better measure of 1989 irrigation system construction costs may be obtained from the cost estimates for the three projects to be included in the BID II loan package -- Alta Mongoy, Caballo Blanco, and Cuyuta. Average construction costs were based on an estimate of Q8,837/hectare ($3,156/hectare). Development costs of this magnitude are able to be borne only by the public sector. Therefore, the planning and construction of major irrigation works will remain a responsibility of the Government.

Even though the Government has played in the past and will continue to play the key role in major system planning and construction, Government ownership and management of irrigation systems is subject to examination. In some parts of the world national governments plan and construct the systems and successfully continue to manage them. But in other countries, where user management has proven effective and efficient, and where Government costs to run the irrigation sub-sector have been too costly, Government participation stops with development of the water resource. Ownership and management of systems are turned over to users who form water districts or communal irrigation systems to manage the irrigation facilities. This is called a wholesaler/retailer model because the Government sells water at wholesale rates to user-managed districts and then districts retail water to users.

UNDERUTILIZATION OF PUBLIC IRRIGATION SYSTEMS

The degree of utilization of irrigation systems can be determined in at least five ways: 1) First is the notion of investment utilization. Guatemala has invested in irrigation infrastructure but the capital investment is underutilized. Examples are common in the public irrigation sub-sector and also in the Highlands where wells have been installed but are not currently being used. 2) A second index might be called economic or productivity. Where irrigation is installed and the land is still used for *milpa* instead of for production of a crop offering higher economic returns, the irrigation system is economically underutilized. 3) Water utilization, or efficiency, is commonly used to judge beneficial use of the resource. 4) Another determining index is social utilization, which could be measured by comparing the number of persons who receive water versus the potential number of water users. 5) Lastly, area utilization can be used to analyze the performance of irrigation systems. Cropping intensity (CI) is the commonly used parameter.

Definitions of Characteristics of Public Irrigation Units

The following pages contain several Tables and Figures provided to illustrate the characteristics of public irrigation units. The following key terms are employed:

Cropping Intensity, CI, is the ratio of harvested area to design area. Normally expressed as a percentage, it represents the intensity with which land is used. A cropping intensity of 100 percent would indicate that, on the average, each hectare in an irrigation system is harvested once annually.

Project is the gross design area of a project including roads, buildings, canals, and land, some of which can be irrigated.

Design is the farmable area dominated by canals or other irrigation infrastructure. In Guatemala, by convention, this is 85 percent of the project area.

TABLE 7

CHARACTERISTICS OF PUBLIC IRRIGATION UNITS

Unit	Cost (Q '000s)	Completed (year)	Project	--H E C T A R E S-- Design	Irrigable	Harvested
Asuncion Mita	723.40	1965	1000	850	545	760
Atescatempa	341.35	1972	300	256	123	287
Cabanas	1027.21	1972	1400	1190	567	1340
Canilla	360.50	1978	400	340		
Catarina	1036.61	1974	1500	1285	423	511
El Guayabal	918.00	1975	1500	1275	464	754
El Progreso	117.01	1972	150	128	97	161
El Rancho	700.90	1975	895	760	440	1204
El Tempisque	269.52	1972	517	431	101	159
La Blanca	1943.89	1975	1800	1530		
La Fragua	3232.40	1970	2600	2210	1411	1610
Laguna El Hoy	305.17	1971	450	382	310	684
La Palma	125.00	1973	150	128		
Las Canoas	43.60	1966	65	55		
Llano de Morales			100	85*		
Llano de Piedras	1360.60	1975	1700	1445	369	918
Nica	653.67	1973	700	595	382	692
Oaxaca	386.50	1974	423	360		
Palo Amontonado	42.00	1965	60	50		
Rincon de la Paja	14.50	1968	30	27		
Sacapulas	612.23	1984	300	255		
San Cristobal Ac.	185.07	1971	250	212	220	267
San Jeronimo	1347.78	1967	1200	1020		
Sansirisay	41.90	1969	105	90		
Tulumajillo	55.00	1980	30	27		
Xibalbay	144.50	1978	100	85		
TOTALS			17,725	15,079		

*estimates

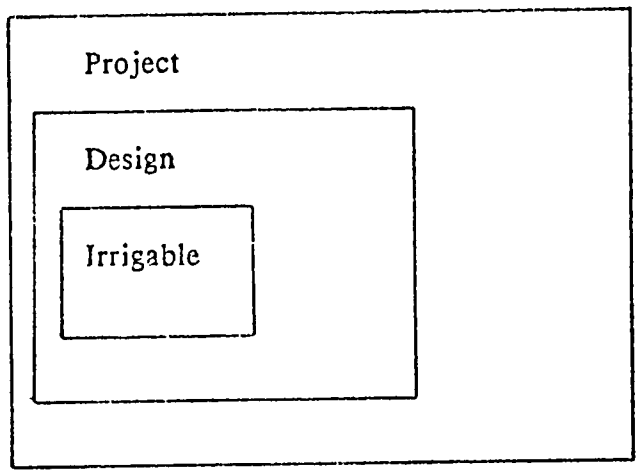
Irrigable is the area dominated by canals or other irrigation infrastructure and which can be irrigated. No accurate data for irrigable area have been compiled for Guatemalan irrigation systems. Data shown in Table 7 for irrigable area were compiled by the team from various years of record between 1979 and 1988. The actual irrigable area may be somewhat larger than that indicated (some farmers may decline to irrigate, or there may be insufficient water available), but no means exist for verifying this.

Harvested is the maximum area reported as harvested in any year.

The relationship between these definitions is shown in Figure 1.

FIGURE 1

PUBLIC IRRIGATION UNITS: SCHEMATIC



Analysis

Land lays idle in public irrigation units. CI varies from 36 to 179 percent with larger units (La Fragua, El Guayabal, and Catarina) in the range 38 to 73 percent. Whereas a frequent justification for irrigation is that it permits double cropping, on the average less than one crop per year is harvested from the public systems. Data from 13 systems are summarized in Table 8. Reasons for irrigation system under-utilization can be separated into three broad categories: socioeconomic and legal, engineering, and system management.

Socioeconomic and Legal: Parcel size has a direct influence on CI. Those systems having more than 80 percent of users with parcels fewer than six hectares had the highest cropping intensities (El Progreso, El Rancho, and Laguna El Hoyo). The two systems with the largest land holdings, El Guayabal and El Tempisque, showed the greatest degree of underutilization (see Table 9 below). Farmers with small parcels must use their land intensively to feed their families; therefore, the irrigation infrastructure is used more fully. The conclusion is that irrigation system utilization is higher if parcels are smaller.

Landowners within irrigation units received windfall economic gains when irrigation arrived. The team's inquiries revealed that land values and rents increased between five and nine times, depending on the quality and location of land. As a consequence, landowners have found it very good business to rent land to those willing to produce and use the proceeds in other, less risky ventures. The proportion of absentee landlords approaches three-fourths in some irrigation units in the East. This is important because neither lessors nor lessees are willing to invest in on-farm irrigation improvements.

TABLE 8

PUBLIC IRRIGATION UNITS - DESIGN, IRRIGABLE, AND HARVESTED AREAS

Unit	Area (hectares) Design	Irrigable	Harvest	CI %	Irrig. Design %	Harvest Irrigable %
Asuncion Mita	850	545	760	89	64	139
Atescatempa	256	123	287	112	48	233
Cabanas	1190	567	1340	113	48	236
Catarina	1285	423	511	38	33	121
El Guayabal	1275	464	754	59	36	163
El Progreso	128	97	161	126	76	166
El Rancho	760	440	1204	158	58	274
El Tempisque	439	101	159	36	23	157
La Fragua	2210	1417	1610	73	64	114
Laguna El Hoyo	382	310	681	179	81	221
Llano de Piedra	1445	369	918	64	26	249
Nica	595	382	692	116	64	181
San Cristobal	250	220	267	107	88	121

TABLE 9

PARCEL SIZE VERSUS CROPPING INTENSITY

Unit	Parcel Size (hectares) (percent of farmers) < 6	< 2	< 44	> 44	Cropping Intensity
Atescatempa	80	13	5	2	112
Cabanas	72	23	3	2	113
Catarina	78	15	5	2	38
El Guayabal	62	25	11	3	59
El Progreso	84	8	--	8	126
El Rancho	80	14	4	2	158
El Tempisque	25	42	--	33	36
Laguna El Hoyo	82	9	7	2	179
Nica	88	8	--	4	116
San Cristobal	85	12	2	1	107

Engineering: Engineering defects limit full utilization of irrigation facilities. For every two hectares "designed," only one is irrigable. Irrigable hectarage as a percentage of design is always less than 100 percent, and sometimes as low as 23 percent (Table 8). The difference between irrigable and design hectarage is in large part a measure of a unit's underutilization due to engineering defects, for example, lack of secondary or tertiary canals, tertiary canals unable to serve parcels, or lack of leveling. A difference between irrigable and design hectarage represents a substantial investment opportunity. If the difference is due to engineering defects at the secondary or tertiary level, and if the system has adequate design flow capability at the headworks, then with relatively small additional investment the country can more fully exploit existing systems. Therefore, investment in engineering works in existing systems is suggested as an attractive alternative to, or in addition to, investment in new systems.

Management: Management deficiencies also contribute to the degree of system underutilization. For example, certain systems such as La Fragua are unable to deliver designed amounts of water because of failure to provide adequate funding for O&M which has resulted in a need for major rehabilitation. For systems to be more completely used, funding for O&M must be adequate.

PUBLIC SECTOR PERFORMANCE

Management

The Government's performance as owner and manager of irrigation systems in Guatemala has been poor. Public sector irrigation units have been victims of managerial difficulty related to chain of command and responsibility since regionalization in 1976. Reorganization resulted in competition between DIRYA and DIGESA for a dwindling budget. A consequence is that O&M needs of irrigation units often are not met. Drastic cuts in budget and staff have prevented DIRYA from adequately implementing and monitoring technical assistance programs (USPADA 1986:37). Inadequate funds, inexperienced local staff, utilization of irrigation funds for other projects in the regional offices, lack of timely supply of materials and services, and technical assistance are all factors that have contributed to the growing deterioration of hydraulic works and pumping equipment (USPADA 1986:39-40). This situation has greatly affected operation and management practices in irrigation units. DIGESA unit managers find themselves essentially in a caretaker mode, unable to improve or adequately maintain the systems for which they are responsible.

Budget

Due to continued budget problems, the Government has systematically curtailed funding allocations for the units. Although nominal funding increased 190 percent from 1976 through 1988, real funding in 1976 Quetzales declined by about half -- from Q854,000 to Q451,000 per year (see Figure 2). Lack of funds has resulted in insufficient maintenance and consequent deterioration of the systems.

Payroll payments represent a high percentage of DIGESA's expenditures. Within the payroll category, there is a very high ratio of administrative to technical staff (see Chapter Six). Based on DIRYA data for 1986 from all DIGESA-managed units, salaries and bonuses accounted for 71 percent of budgets, electricity and fuel for pumps (17 percent), and materials, supplies and services (12 percent). Obviously, O&M functions are carried out using labor-intensive methods. An irrigation unit manager has little discretionary use of funds for operations and minor repairs.

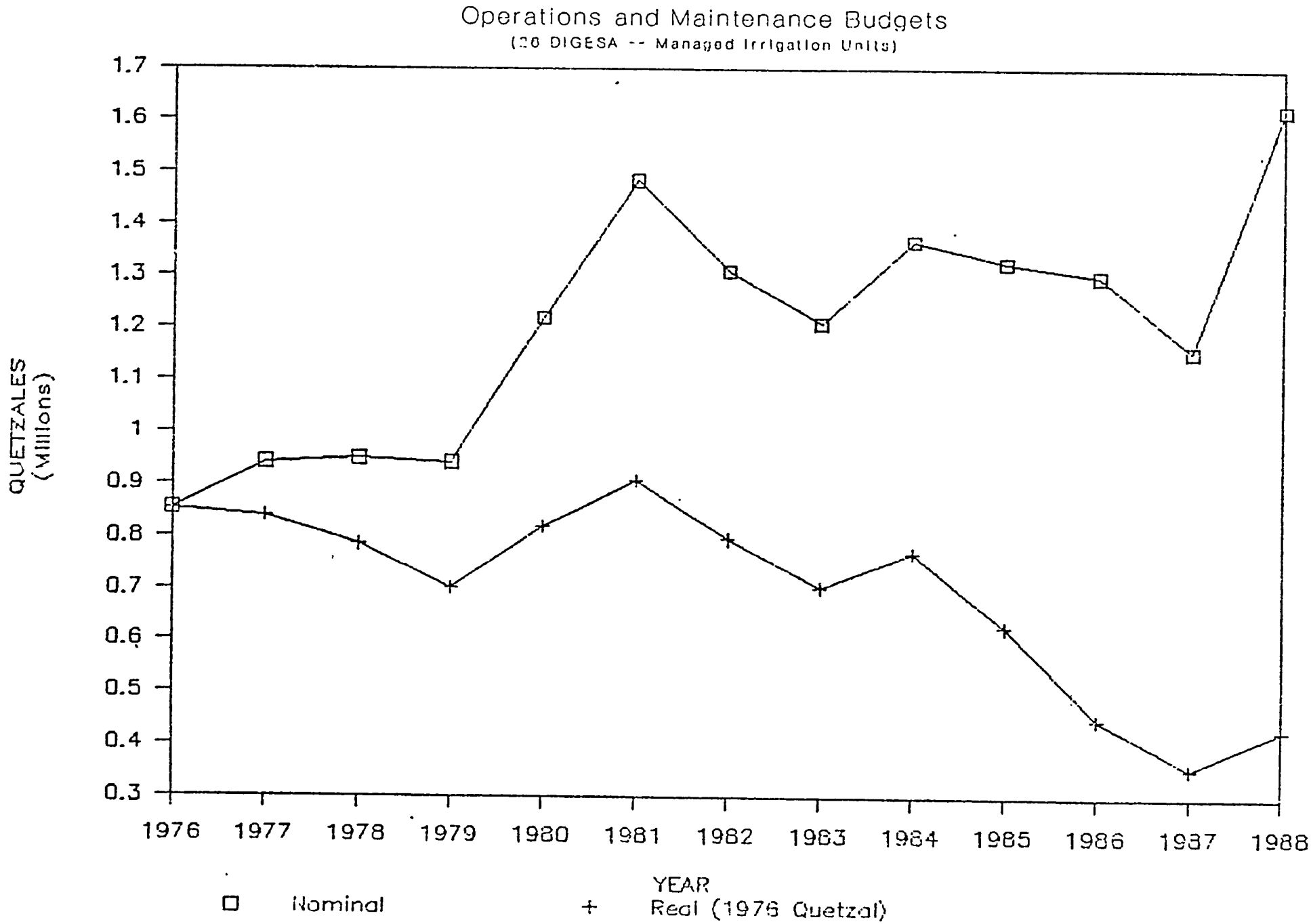
Budgets for O&M are met in the following ways:

- Assigned Budgets: The stable portion of a unit's budget, assigned funds account for approximately 40 percent of O&M costs, not including "extraordinary costs." As reported by DIRYA, assigned budgets do not include bonuses;

- Earmarked Funds (*privativos*): A portion of the O&M fees collected are termed *privativos* and supposedly earmarked for use in the irrigation unit where the fees were generated. According to unit managers interviewed, these funds are not normally made available to the unit; and

- Extraordinary Funding: Funding is made available to meet major repairs. For units that rely on pumping, the Government also meets electricity costs through budget transfers directly to INDE.

FIGURE 2
NOMINAL VERSUS REAL DIGESA BUDGET ALLOCATIONS: 1976-1988



O&M Expenditures

Irrigation units are heavily subsidized in both capital costs and O&M. Using DIRYA data for 1986, the average annual expenditure on O&M was calculated to be Q217 per hectare ($80/hectare). However, DIRYA cost data do not include "extraordinary" costs for 1) rehabilitation; 2) major repairs ("deferred maintenance" -- for example, significant costs are currently being incurred for repairs to La Fragua's main canal bridging a stream bed); 3) extraordinary repairs as was required in several irrigation units due to storm damage in 1982; and 4) special contributions to meet electricity costs. For example, irrigation units such as Llanos de Piedra commonly receive extra funds to pay pumping costs. The team was unable to obtain data on the magnitude of the "extraordinary" components of O&M.

Government O&M expenditures of Q217 per hectare per year (in 1986) could be compared to private sector expenditures if more information were available concerning allocation of fixed and variable costs, and if Government expenditures on statistical reporting and other activities could be separated from total O&M expenditures. As a frame of reference, however, Pantaleon Sugar Central spent approximately Q135 per hectare in 1986 for O&M on the gravity portion of its irrigation system. The private sector typically employs a limited number of trained staff, but has provided them with the equipment and vehicles necessary for efficient O&M functions. In contrast, the public sector relies entirely on a large labor force with relatively little investment in training, equipment, or materials.

Water Charges and Cost Recovery

Water user fees are levied on irrigable land located in public irrigation systems. Fees are based on two concepts:

- *Compensacion*, a fixed annual fee charged to partially recover irrigation system capital costs (60 percent is the targeted figure). *Compensacion* is calculated as follows:

$$\frac{\text{(cost of the irrigation facilities) x (0.60)}}{\text{(40 years) x (design area benefitted)}}$$

  Assessments are based on irrigable area, not design area. Therefore, actual recovery via *compensacion* will not meet the targeted 60 percent. Nor is any attempt made to recover interest charges associated with capital costs. Payment of *compensacion* does not convey any right of ownership to water users.

- *Operacion*, a fee that covers a portion of O&M costs incurred by the irrigation unit. It is revised annually based upon the previous year's O&M cost in each irrigation unit and is established by decree. Fees are based on cropped area. A farmer harvesting two crops per year (for example, corn followed by tobacco) must pay two fees for *operacion*. A farmer who, on the other hand, harvests a single crop pays one *operacion* fee even if it is a permanent crop that occupies the land for 12 months (e.g., pasture, plantains). Thus, the *operacion* concept fails to take into consideration the amount of water delivered.

Rules governing water user fees were first proscribed in Government Act 11-80 published in the Diario de Centro America on June 10, 1980. Rules have been modified in succeeding years. The first year in which user fees were to be collected was 1981; however, due to user opposition, the decree was annulled and no fees were collected until 1984.

Water fees are currently collected in all DIGESA units. According to DIGESA, receipts in 1988 and 1989 covered approximately 15 percent of O&M costs (excluding extraordinary costs) associated with irrigation unit operations. User fees for 1989 are shown in Table 10.

Farmers with water rights pay their fees at the *Receptoria Fiscal* of the Direccion General de Rentas Internas of the Ministry of Finance. In return they receive two receipts or *orden de pago* corresponding to *compensacion* and *operacion* which they deliver to DIGESA as proof of payment. DIGESA is then obliged to deliver water for one crop to the individual in accordance with irrigation unit operational procedures.

By law, *compensacion* is to be paid annually whether the individual takes water or not. *Operacion* is paid only if the user takes water. The compensation payment is to be paid once annually; additional crops grown during the year require payment only of the operation fee. In practice, nobody pays either of the two types of fees if no water is taken. Irrigation units do not enforce the requirement to pay because in many cases they cannot deliver the water. There are situations when individuals want to pay and receive water but payments are not accepted because of inability of the unit to meet its water delivery obligations.

TABLE 10

WATER USER FEES (1989) FOR PUBLIC IRRIGATION UNITS

Unit	*Compensacion* (Q/Manzana/year)	*Operacion* (Q/Crop/Manzana)[1]
Asuncion Mita	14.66	24
Atescatempa	41.30	24
Cabanas	14.91	36
Canilla	32.38	24
Catarina	14.88	24
El Guayabal	13.40	36
El Progreso	11.26	36
El Rancho	14.43	24
El Tempisque	12.11	24
La Blanca	21.37	24
La Fragua	22.06	24
Laguna El Hoyo	7.76	72
La Palma	17.05	24
Las Canoas	19.24	72
Llano de Morales	25.00	24
Llano Piedras	9.76	72
Nica	12.26	24
Oaxaca	18.41	24
Palo Amontonado	16.58	-
Rincon de la Paja	9.89	72
Sacapulas	25.00	24
San Cristobal	14.77	36
San Jeronimo	22.47	24
Sansirisay	8.27	72
Tulumajillo	33.00	-
Xibalbay	19.02	-

[1] One manzana is 0.7 hectares.

Although conceptual distinction is made between the fees when paid, the Ministry of Finance makes no such distinction. Government accounting procedures do not permit a separate accounting for the two types of fees. Fees paid under either concept are combined and sent to the national treasury.

Labor Generation

It is estimated that irrigation has increased direct employment in the public units by approximately 690,000 labor days per year (Table 11). Since one of the objectives of irrigation is employment generation, public units contribute to that objective. However, there is an estimated potential for three to five times as much labor generation from public units.

TABLE 11

ESTIMATED EMPLOYMENT CREATION IN PUBLIC IRRIGATION SYSTEMS: 1988

		Labor Days Per Year		
Crop	Irrigated Hectares	Without Irrigation	With Irrigation	Difference
Corn	43	21,570	45,297	23,727
Beans[1]	66	4,686	5,742	1,056
Rice	3	267	295	28
Sorghum[1]	41	2,754	3,411	658
Tomato	288	0	65,732	65,732
Onions	23	0	8,663	8,663
Guisquil[1]	26	2,548	3,640	1,092
Cucumber[1]	50	0	8,082	8,082
Melon	480	0	131,067	131,067
Chili	33	0	8,838	8,838
Watermelon	92	0	22,671	22,671
Okra[1]	79	0	21,772	21,772
Broccoli	6	1,068	1,692	624
Plantains	318	36,547	40,678	4,131
Citrus	56	3,108	3,663	555
Other fruit	46	2,582	3,043	461
Tobacco	914	0	386,664	386,664
Peanuts[1]	4	285	319	34
Soybeans	11	840	1,445	605
Cocoa	29	2,465	2,668	203
Pasture	367	11,757	16,166	4,409
Total	3,364	90,476	781,548	691,072

Sources: BANDESA, "Costos e Ingresos de Produccion," 1984. DIRYA, "Cuadros de Superficie Regada del 225 al 236, 1989."

[1] Only one crop per year is produced, with or without irrigation.

Assumptions:

1. Irrigated permanent crops (plantains, citrus, cacao, pasture) yield 1.5 harvests annually with irrigation, and 1.0 harvests without.

2. Labor requirements for permanent crops are taken from a year of full production in the life cycle of the crop.

3. Irrigated land area shown for each crop is the maximum for the year.

TRANSFER OF PUBLIC SYSTEMS TO USERS

The Model

Judged by public system performance, and its potential, the team has concluded that the Government is an inefficient and financially distressed manager of irrigation systems. Improvement is unlikely under the current model of government ownership, control, and subsidy. Consequently, transfer of irrigation system ownership and control to landowners and/or water users is recommended. This option was proposed by the Government (MAGA, 1987, pp. 43-45). However, government proposals suggest nothing about change of ownership -- only transfer of management responsibility.

The development/ownership/management model should be changed from one of total government responsibility to one in which the Government would develop the water resource and would continue as owner and manager of the principal water source (dam, or river diversion). It would sell water wholesale to water districts, a public entity formed by water users. Districts would retail water to users. The cost of district operations (purchase price of wholesale water, plus costs to operate and maintain the district) would be borne by users. Government policy would determine to what extent the wholesale price of water would be subsidized.

Transfer of public irrigation systems to the private sector has precedence. For example, in the Philippines, smaller public systems operated by the National Irrigation Administration (NIA) were transferred to communal management. The impetus for transfer was a mandate from the Finance Ministry which required NIA to balance its books. The Guatemalan Finance Ministry should establish a similar requirement for MAGA, because it is doubtful that MAGA/DIGESA will carry out transfer on its own volition without both a dictum and a timetable.

The Process

Guidelines for transfer of public systems to users are provided below:

- The Finance Ministry should insist that MAGA balance its books on or before an agreed-upon date. At the same time, the Finance Ministry must allocate the necessary funds to facilitate the transfer process. If one allows an estimated Q1400 per hectare for transfer, the cost of the transfer initiative could be on the order of Q24 million.

- A group should be formed to plan transfer. The group must include representatives of the Government and the private sector. The group would:

  -- Prepare plans for transfer;

  -- Establish programs to inform users of transfer initiatives;

-- Establish priorities for transfer among units;

-- Take steps so that DIGESA, or another institution, acquire the institutional capacity to communicate with, organize, and train user groups;

-- Call upon the Government to demonstrate commitment to enforce water laws so that all water users in newly-formed districts have equitable access to irrigation; and

-- Develop transfer plans now for the three projects contemplated for construction under BID II.

Studies

With participation from local water users, studies would be made of conditions prevalent in each public irrigation unit. These would include the following:

- Engineering feasibility studies would be carried out to detail unit-specific requirements for transfer, to determine what repairs and renovations must be completed prior to transfer, and to detail the cost implications. Unit rehabilitation would be contracted and completed prior to transfer;

- Financial feasibility studies would be conducted for each public unit to determine management options and water costs for the newly-created irrigation districts; and

- Social feasibility studies would be undertaken to address the matter of water user unwillingness to accept transfer.

CONCLUSIONS

Because of the costs and complexity involved in developing water resources for major irrigation systems, the Government has a key role to play in planning and constructing the systems. Public construction should continue. Among other considerations, construction should be targeted for locations where parcel size is small and where land title is clear. The extent of underutilization is related to the size of land holding. Systems in which parcels are largest have the greatest extent of idle lands. Conversely, cropping intensity is highest in systems where parcels are smallest. Potential irrigation systems where average land holdings are small represent a better investment opportunity than construction of irrigation systems where parcels are larger.

Public management has been poor and should cease. Investment in public units has generated large increases in employment, production, and incomes, but lands and invested capital are left idle. Cropping intensities in the largest irrigation systems are in the range of 38 to 73 percent. Instead of two crops per year with irrigation, farmers in public systems harvest less than one crop per year. Many canal systems were never completed or lack engineering works. The team estimated that for every two hectares dominated by principal or secondary canals, only one can be irrigated. This represents an attractive investment opportunity ("fix-up") which should be compared to investment in new systems.

The cost of water is highly subsidized in public irrigation systems. Only 15 percent of O&M costs are recovered from farmers. Cheap water induces inefficient use. Those who use irrigation water often over-irrigate and waste water because they pay a low fixed cost. Inefficient use contributes to low production and productivity, which results in low financial returns per unit of land. Low financial returns inhibit farmers' ability to pay more for water, and there is resistance to paying anything at

all because of a history of free water. Pressure from landowners prevents the Government from increasing water charges, which, in the face of operating cost inflation, increases the government deficit. The Government responds by holding funding for O&M to nominal increases, which analyzed over the long term have declined in real terms to levels that cannot sustain the systems.

Systems deteriorate to such an extent that water delivery capacity is actually diminished in some cases. Attempts to get farmers to take over the systems fail because the majority (those receiving sufficient water) don't want to lose their subsidies. Farmers argue that they can't afford to pay full costs because their profits (i.e., productivity) are low. And so arises a cycle of economic stagnancy: cheap water, low production and productivity, low profits, government inability and unwillingness to properly maintain the systems, reduced delivery capacity, and lower production. Furthermore, landowners who have water but are unable or unwilling to farm discover that they can earn a satisfactory, low risk financial return by renting their land to farmers who can make a profit -- even including the rental payment. Since sharecroppers typically secure one-year land rental contracts, there is no incentive for them or the landowners to invest in on-farm irrigation improvements.

Economic stagnancy as well as financial drain can best be addressed by the orderly transfer of public units to water users. MAGA/DIGESA should be directed to 1) bring irrigation units up to engineering standard; 2) help prepare water users to assume responsibility for management of systems; and 3) transfer public units by a certain date.

CHAPTER FIVE

THE PUBLIC-ASSISTED SECTOR

SUMMARY

Public-assisted systems are small-scale systems (*miniriego*) that are designed, constructed, and financed by the Government, but which are owned, operated, and maintained by water users. *Miniriego* projects are funded by USAID and are very popular among Highland farmers.

Performance of *miniriego* has been financially and socially beneficial to farm families, but the number of beneficiaries remains relatively small on a national basis. The assessment team estimated that the 2,000 hectares developed through 1988 generate annual incremental production valued at Q5.1 million, and 250,000 days of employment. Approximately 6,000 farm families have benefitted from the 250 projects constructed to date.

Lack of technical assistance after construction is a principal constraint on success of *miniriego* projects.

There are idle investments resulting from the groundwater *miniriego* projects. Only eight of 48 wells constructed over the past two years are being used. Government technicians have failed to properly assess demand for the water, to organize the potential beneficiaries, or to conduct financial feasibility analyses. However, it is too early to judge success or failure of the groundwater *miniriego* projects.

MINIRIEGO

Background

Through 1988, over 250 *miniriego* projects have been constructed on about 2,000 hectares. These serve an estimated 6,000 water users. A typical *miniriego* project has the following characteristics:

- The project is located in the Highlands or in the East;
- The water source is a small stream or spring;
- Water is diverted and transported to farmers fields through PVC pipe, and gravity provides the pressure head; and
- Farm outlets are risers (hose bibs) to which farmers attach rubber hoses and portable sprinkler heads.

Construction costs are on the order of Q2,700 per hectare (LeBaron, 1987). This may be compared with 1989 public system costs (BID II) which are on the order of Q8,800 per hectare. The capital costs of *miniriego* systems are one-third that of public systems; O&M costs for *miniriego* are nominal (less than Q10 per hectare per year) and entirely borne by farmers.

Previous Page Blank

The first *miniriego* project was completed in 1978 as a USAID/GOG project in which USAID financed capital investments and the GOG covered implementation costs. What began as a donor-specific project has evolved into a generic type of irrigation development with various funding sources, including farmers' own funds.

Miniriego is implemented by DIGESA though its regional offices in collaboration with BANDESA. DIGESA staff identify and design projects, supervise construction of the water systems, and prepare and help organize user groups; BANDESA makes loans to farmers. The key features that make this collaboration successful are that

- USAID has earmarked loan funds to be used specifically for *miniriego*;
- There is clear definition of the roles of the agencies and the individuals within each agency;
- DIGESA and BANDESA staff plan activities together, establishing annual objectives regarding number of systems to be installed; and
- DIGESA staff keep BANDESA staff informed about progress made in organizing user groups.

Impacts

Based on DIGESA records, *miniriego* appears to have resulted in annual production increases valued at more than Q5.2 million (Table 12). Annual estimated creation in employment is on the order of 250,000 labor days per year (Table 13). These estimates assume that one extra vegetable crop is produced on irrigated land; no allowance is made for additional harvests or yield increases from supplemental irrigation during the wet season.

The evaluation of the USAID project carried out by LeBaron, et al (1987) indicates that the internal rates of return realized by a sample of *miniriego* systems were favorable. Their analysis concludes that *miniriego* has been economically successful for the participants. An important social benefit is also derived by providing more employment at home, thus mitigating the need for seasonal migration.

One of the strongest visual impacts is to observe television sets and cars or trucks now owned by small farmers who, through *miniriego*, have made the transition to irrigated farming. That the transformation from small farmer to private entrepreneur has occurred in less than ten years makes it all the more remarkable.

TABLE 12

ESTIMATED INCREMENT IN VALUE OF PRODUCTION
DUE TO MINIRIEGO: 1988

Gross Sales: Thousands of Quetzales

(Second Crop Only)

Department	Irrigated Hectares	Without Irrigation	With Irrigation	Difference
Guatemala	137.7	248.5	521.0	272.5
Alta Verapaz	13.6	0	13.0	13.0
Baja Verapaz	63.0	0	187.7	187.7
Zacapa	16.4	0	51.4	51.4
Chiquimula	80.2	0	288.9	288.9
El Progreso	51.9	0	175.8	175.8
Santa Rosa	11.4	0	54.8	54.8
Jutiapa	15.2	0	57.4	57.4
Jalapa	0.4	0	1.7	1.7
Sacatepequez	96.1	32.4	665.1	632.7
Chimaltenango	124.0	55.8	776.4	720.6
Quetzaltenango	180.0	150.9	619.8	468.9
San Marcos	494.2	400.4	1,593.9	1,193.5
Suchitepequez	15.4	0	29.6	29.6
Retalhuleu	6.0	0	11.5	11.5
Solola	26.2	60.6	102.2	41.6
Totonicapan	29.6	54.1	110.8	56.7
Huehuetenango	483.8	2,141.1	2,897.7	756.6
El Quiche	157.5	594.7	849.1	254.4
Total	2,002.6	3,738.5	9,007.8	5,269.3

TABLE 13

ESTIMATED EMPLOYMENT CREATION IN PUBLIC-ASSISTED SYSTEMS: 1988

Labor Days Per Year

Department	Without Irrigation	With Irrigation	(Second Crop Only) Difference
Guatemala	13,300	23,700	10,400
Alta Verapaz	0	1,800	1,800
Baja Verapaz	0	15,600	15,600
Zacapa	0	3,300	3,300
Chiquimula	0	18,600	18,600
El Progreso	0	14,400	14,400
Santa Rosa	0	2,600	2,600
Jutiapa	0	3,200	3,200
Jalapa	0	100	100
Sacatepequez	2,400	28,500	26,100
Chimaltenango	4,100	32,600	28,500
Quetzaltenango	9,200	33,700	24,500
San Marcos	31,100	102,600	71,500
Suchitepequez	0	1,800	1,800
Retalhuleu	0	700	700
Solola	5,000	6,500	1,500
Totonicapan	4,900	7,200	2,300
Huehuetenango	136,500	154,700	18,200
El Quiche	50,800	56,100	5,300
Total	257,300	507,700	250,400

Management

Public-assisted irrigation systems are those in which the Government plays the role of a facilitator by providing loan, design, and construction assistance. Once constructed and paid for, the Government withdraws and irrigation systems are then owned, operated, and maintained by water users. Conceptually, this is similar to the wholesaler/retailer model suggested for public systems (see Chapter Four).

Even though *miniriego* has introduced some of DIGESA's personnel to planning and monitoring systems, the impact on adoption of these methods has not extended beyond those working directly in *miniriego* projects. Furthermore, planning and monitoring efficiency and the availability of donor funds for *miniriego* has introduced bias in the allocation of resources within DIGESA in such a way that funds and staff are absorbed disproportionately by these projects, leaving other areas unattended. These issues are covered in Chapter Six.

Site evaluation techniques are in need of improvement. Instances of financial difficulty due to isolation from markets for irrigated produce were mentioned in several interviews, and confirmed by DIGESA technicians. In general, market analysis is a weak point in site evaluation. Inquiries revealed that DIGESA does not have a set of evaluation criteria that can be systematically applied to potential sites.

Technical Assistance

Many *miniriego* farmers are in transition from rainfed *milpa* (corn and beans), to irrigated vegetable production. Most have not yet had sufficient time to master irrigated vegetable production, which can be more remunerative but also technologically more demanding. Experience elsewhere has shown that it takes many years to make the transition successful. However, the change-over is occurring very rapidly.

Project benefits can even be accelerated further if farmers new to irrigation are given technical assistance as part of the project package. This is not commonly done. Lack of follow-on technical assistance is considered the biggest failing in the *miniriego* program. One of the reasons that technical assistance is not given is that DIGESA agents themselves lack the experience with water management and with irrigated vegetable production.

Early in the initiation of the *miniriego* program there was an *escuela movil* (mobile school) where farmers having early success with *miniriego* visited farmers being introduced to *miniriego* for the first time. This type of technical assistance could be started again. For a new water management mobile school, it would be useful to bring together successful farmers and DIGESA agents to provide the technical assistance, and to carry out training of trainers courses.

Loans

Demand for funds exceeds supply, indicating potential for project expansion. During the 1980s farmer demand for *miniriego* exceeded the allotment of USAID funds, so BANDESA has channeled other funds into *miniriego*. More than 150 *miniriego* projects are currently financed by BANDESA. Of Q4.3 million loaned, only Q215,000 (5 percent) is delinquent (see Table 14). This delinquency rate is low for small farms, and should not be considered detrimental to the success of *miniriego*. BANDESA officials do not express great concern over the delinquency because much of the amount in arrears is expected to be collected eventually.

Keys to Success

The critical elements for success of *miniriego* are:

- Farmer interest;
- Adequate water supply developed at low cost;
- Market opportunity; and
- An organized community of participants. The most successful sites have learned to coordinate their production and to sell to a single intermediary who sometimes provides technical assistance. In other terms, vertical integration of producer and wholesaler works to the advantage of both.

GROUNDWATER MINIRIEGO

Groundwater *miniriego* first installed systems in late 1988. Systems differ from previous miniriego projects in that the water source is groundwater. When compared with *miniriego*, this requires additional investigations about aquifer conditions and additional costs due to well construction and pumping charges. Farmers interested in

groundwater *miniriego* must be informed about the additional investments required to defray drilling and pumping equipment.

Miniriego projects that use groundwater have experienced coordination problems and limited impact. The project led to two problems -- one from the point of view of the donor agency (USAID), and the other from the regional DIGESA staff implementing the program. From the standpoint of the donor, there was need to establish a quick and efficient mechanism to administer funds for drilling and pumping equipment. USAID believed that MAGA lacked the technical capacity to manage a well drilling program, and that channeling funds through the Finance Ministry would be time consuming and inefficient. The strategy was to establish the office of the National Coordinator of Irrigation financed by USAID that would manage loan funds while an arrangement was made with CATIE for administration of the funds. This office has been quite successful in finding water; of 50 wells drilled only two have not produced sufficient water for irrigation. Nonetheless, of these 48 wells only eight are used; the rest have been ignored due to user dissatisfaction or apathy.

To understand why such a small number of wells is used, it is important to understand the problem from the perspective of regional DIGESA staff. They repeatedly mentioned that wells are not necessarily drilled where there are users, but rather where the chances of finding water are the greatest. Consequently, regional staff sometimes find themselves with wells in areas where people are not interested. This is denied by persons in the National Coordinator's office which reports that well location is based first upon user interest. Projects would appear to benefit from increased communications and coordination between regional and central DIGESA offices. Leadership for site selection and farmer organization should originate with the regional offices. It is important to realize here that groundwater *miniriego* dates from 1988; it is considered far too early to judge success or failure of the project.

Another problem is that when farmers realized the debt they would incur, they often reconsidered their commitment. Extension agents often lack sufficient training in community organization to train farmers to analyze their options before wells are drilled. Furthermore, this type of project, more so than the average *miniriego* system, typically requires more farmers to make the project economically feasible.

TABLE 14

STATUS OF BANDESA LOANS FOR MINIRIEGO: 31 JULY 1989[1]

Region	No. of Projects	Amount Loaned	Amount Delinquent	% Delinquent
Guatemala	5	Q 122,098	Q 22,748	18.6
Zacapa, Chiquimula	?	351,048	1,934	0.6
Jutiapa, Santa Rosa	6	193,866	1,541	0.8
Antigua, Chimaltenango	30	876,585	60,753	6.9
Quetzaltenango, Totonicapan, Solola, San Marcos	75	2,111,976	70,514	3.3
Quiche, Huehuetenango	32	662,496	58,144	8.8
Total	148	Q4,318,072	215,634	5.0

[1] Source: BANDESA. Loans cover materials purchases only.

CONCLUSIONS

When compared with investment in public irrigation, public-assisted projects are excellent investments. Capital costs are about one-third the cost of public systems. Whereas O&M of public systems is a significant financial burden to the Government, O&M costs of public-assisted projects are fully borne by the beneficiaries themselves.

In the short span of three to five years, *miniriego* projects have resulted in the conversion of *milpa* farmers to successful small-scale entrepreneurs who produce irrigated vegetables. By any standards, this transformation has been very rapid. Even so, increased technical assistance after construction would further accelerate the success of *miniriego* projects.

Although projects have been functioning for fewer than two years, groundwater *miniriego* has a high risk of resulting in idle investments. The implementation process has two sets of conflicting criteria: a need to centralize contracting and control of well drilling; and a need to regionalize site selection and farmer organization. Increased communications and coordination between central and regional DIGESA offices is suggested.

CHAPTER SIX

GOVERNMENT IRRIGATION INSTITUTIONS

SUMMARY

The Ministry of Agriculture, now MAGA, is the ministry in charge of public irrigation systems. Within MAGA, DIGESA manages 26 public irrigation units and helps support public-assisted projects. DIGESA irrigation management is exercised through regional offices. Irrigation units are clustered in five Districts. Technical support for irrigation planning and engineering is centralized, provided by DIRYA offices in Guatemala City.

DIGESA is heavily dependent (over 90 percent) upon foreign donor support for its irrigation budget. Since donor funding in irrigation is primarily directed to new construction, DIGESA's programs favor construction at the expense of O&M. A result is that the public irrigation sub-sector has lost priority. With funding so donor-driven, the agency has reacted to funding opportunities rather than responding with its own agenda or strategic plan to guide the institution. DIGESA staff would benefit from education and training programs related to irrigation management. The agency gives priority to agricultural extension rather than to irrigation, and is overstaffed in administration and understaffed in qualified technicians. Decentralization of DIGESA has a positive impact on implementation of the *miniriego* project.

INSTITUTIONAL EVOLUTION

Dating from 1945, MAGA has officially been in charge of irrigation-related activities. Within MAGA, the Direccion General de Colonizacion y Tierras was the first public agency with irrigation responsibility and was charged with promoting land development using irrigation. In 1957, the Department of Hydraulic Resources (DRH) was created to plan, develop, and protect agricultural water resources. In 1965 the General Directorate of Natural Renewable Resources (DIGERENARE) was created to plan, develop, and promote the utilization of renewable natural resources. This was important because DIGERENARE was the first government agency charged with integrated management of renewable natural resources. In 1969 DIGERENARE was made responsible for execution of a loan from BID for construction of irrigation public works. This led to a major reorganization and expansion of the agency from 1969 to 1975 (DIGESA, 1976). By the time BID's program ended in 1975, the agency had built and was operating 20 irrigation units across the nation, had one of the largest budgets and staff in MAGA, and had developed a well-trained team of irrigation specialists (DIGESA, 1976).

Beginning in 1970, a series of MAGA reorganizations placed DIGERENARE under DIGESA and transferred functions and resources from DIGERENARE to other agencies. In 1982, DIGERENARE became the Direccion de Riego y Avenamiento (DIRYA). This change was accompanied by large budget and staff reductions which have severely limited the agency's capacity to fulfill its functions, have prevented DIRYA from properly monitoring national water resources, and have inhibited the agency from providing effective technical support to irrigation units (USPADA, 1986).

These institutional changes were largely the result of two factors. First there was a policy shift that reduced priority on irrigation infrastructure and emphasized

agricultural services other than irrigation. The second factor was the economic burden that the agency imposed on the GOG once BID's irrigation program ended. Not having access to funds for the construction of irrigation works, the GOG no longer needed an agency for these purposes.

The dissolution of DIGERENARE had three long-term consequences for the public irrigation sub-sector. One is that the functions related to irrigation were divided and placed under the administration of agencies that had objectives other than irrigation. Consequently, public irrigation was relegated to a low priority within MAGA and irrigation was unable to compete for funds. This has been an important factor leading to the deterioration of public irrigation works in Guatemala (USPADA, 1986). The second consequence is that by dissolving DIGERENARE, the GOG lost its agency charged with coordinating the use of renewable natural resources. This important function was allocated among other agencies within MAGA that acquired autonomy at the cost of coordination in planning and implementation. The third consequence is loss of institutional capabilities created by BID's project. Given budgetary restrictions and the greatly reduced size of the construction portfolio, DIRYA's cadre of highly trained irrigation specialists left the agency.

ORGANIZATION

MAGA is organized into eight institutions: DIGESA (irrigation and agricultural extension), BANDESA (credit), DIGEBOS (forestry), DIGESEPE (livestock extension), ICTA (research), INDECA (price stabilization), INTA (land reform), and PROLAC (milk processing).

DIGESA is responsible for irrigation, but it also has responsibilities beyond the irrigation sub-sector, particularly in technology transfer (agricultural extension). Approximately 30 percent of DIGESA's budget is devoted to irrigation, and the remaining 70 percent to agricultural extension and other services.

DIGESA's main irrigation functions are to 1) operate and maintain 26 public irrigation and drainage units (projects); 2) implement the *miniriego* project; and 3) provide irrigation design and specialized engineering services through DIRYA. The first two functions are decentralized and carried out in various regions of the country. DIRYA works throughout the country but is headquartered in Guatemala City. DIRYA also has regulatory responsibilities for private irrigation development.

DIGESA'S HUMAN RESOURCES

Number of Employees

Since 1985, DIGESA has reduced staff by 20 percent due to lack of funds (Table 15). Every new job vacancy has been cancelled and, except for externally funded projects, no new positions have been created. Among all the units and directorates, DIRYA has been the most affected; DIRYA's permanent staff has been cut by 54 percent. This is indicative of the lack of importance given irrigation by DIGESA. It is clear that public sector irrigation has lost priority.

Impact of Donor Programs

Donor programs have a "see-saw" effect upon Government institutions. Upon completion of BID's first irrigation program, numerous trained staff left DIRYA because donor funding ceased. The *miniriego* project was introduced in the late 1970s and

resulted in a large increase in budget and human resources for DIGESA. When *miniriego* terminates, we may expect a sharp cutback in staff numbers and DIGESA programs will probably occur.

TABLE 15

DIGESA STAFFING LEVELS
1985-1988

Office	1985	1986	1987	1988
General Administration	148	111	104	242
Plant Production Dir.	113	115	112	44
Plant Protection Dir.	61	61	61	93
DIRYA	469	884	512	215
Administrative Unit	84	80	81	73
Programming Unit	64	64	64	64
Regional Offices	3572	4026	3387	2861
Total	4511	5341	4321	3592

Sources: 85-87, BID 1987 Informe de Proyecto, Segundo Programa de Riego y Drenaje, p. 47; and DIGESA's Programming Unit 1988.

Construction, and not institution building, has been the primary objective of BID and USAID programs to date. Future donor programs should consider ways to more successfully integrate institutional capacity development within the Government institutions concerned with irrigation. If the effort is planned correctly, the proposed irrigation master plan offers an opportunity for integrating long-term planning with institutional capacity development.

Technical versus Administrative Capacity

DIGESA's ratio of administrative to technical staff of 2:3 is excessive, indicative of an administratively rich, technically weak, and inefficient organization. The International Service for National Agricultural Research (ISNAR), a member organization of the Consultative Group for International Agricultural Research, cites a ratio of at least 1:4 (administrative to technical staff) as appropriate for an extension-type organization. This suggests an opportunity to review DIGESA's administrative staff functions and to reassign staff to technical areas where they are needed or gradually reduce administrative staff.

Education and Training

DIGESA staff lack education and training related to irrigation management. Only three percent of DIGESA staff hold a university degree. Approximately 65 university-trained agronomists lead extension programs in the field. Of these, none have earned degrees in irrigation or soil and water management. Neither these individuals, nor non-university professionals who work in extension, receive any on-the-job or formal training in water management. Consequently, technical staff ability to diagnose irrigation-related problems and to convey irrigation-related messages is very weak. Neither do staff receive any training in community organization or management -- skills invaluable for helping make water users better able to eventually manage irrigation units.

Within DIRYA, approximately 15 percent of the staff are degree-holders. More than half are agronomists and one-quarter are civil engineers.

DIGESA and DIRYA have been unable to plan for and execute capacity building programs of long-term benefit to the institutions. One of the reasons is that there is heavy reliance on external project funding (as described below) which has in the past been oriented to construction and not to programs that help the institutions train and retain staff. Future USAID and BID projects should consider the advantages of support for institutional capacity development.

BUDGET

DIGESA is heavily dependent on foreign donors for its operating budget; donors provided 76 percent of the funds in 1988. Within the irrigation portion of DIGESA's budget, external project funding is on the order of 94 percent (Table 16). Between 70 and 80 percent of DIGESA's budget goes for salaries and bonuses.

Project funding favors new construction at the expense of O&M. More than half of DIGESA's budget for irrigation goes for public-assisted *miniriego* projects, which is three times as much as is being spent for management of all the public systems (largely O&M). Funding for *miniriego* has introduced bias in the allocation of resources within DIGESA in such a way that funds and staff are absorbed disproportionately by *miniriego*, leaving other areas unattended.

Given scarce funding geared to donor-driven projects, O&M needs of irrigation units are not met. Drastic cuts in budget and staff prevent DIRYA from adequately implementing and monitoring technical assistance programs (USPADA, 1986:37). Inadequate funds, poorly trained staff, utilization of irrigation funds for other projects in the regional offices, lack of timely supply of materials and technical assistance are factors that contributed to the growing deterioration of hydraulic works (USPADA, 1986: 39-40). Budgetary shortfalls have directly contributed to public unit underutilization.

TABLE 16

1988 DIGESA BUDGET

	Quetzales		%
DIGESA TOTAL	27,195,800		100
LOCAL FUNDS (Total DIGESA)	6,524,500		24
EXTERNAL FUNDS	20,671,300		76
IRRIGATION PORTION SUBTOTAL	8,241,600		30
		Local Funds %	External Funds %
DIRYA[1]	2,059,546	7	93
UNIDADES MEDIANO RIEGO[2]	1,556,457	8	92
MINIRIEGO[3]	4,625,613	5	95

1 Source: DIRYA's Programming Unit
2 Source: DIGESA'S Programming Unit
3 Source: Miniriego Program

DECENTRALIZATION

Decentralization of DIGESA responsibilities has had mixed results. Irrigation units were reorganized and first placed under the administration of regional DIGESA offices in 1976. Reorganization established two chains of command to which irrigation unit managers must respond. Irrigation unit managers report regionally but turn to DIRYA in Guatemala City for resolution of technical irrigation problems because planning and design expertise in the regions is comparatively weak. Given distances involved and a need to maintain a critical mass of specialized engineering expertise, the concentration of technical experts in Guatemala City is the preferred solution.

Presently, 80 percent of DIGESA's staff are posted in the various regions, and 20 percent are assigned to central offices in Guatemala City. As is typical of any engineering planning and design organization, new planning, design, and construction takes priority over rehabilitation and O&M. Although regional DIGESA offices have control over irrigation unit budgets, they are primarily concerned with agricultural extension unrelated to irrigation. Consequently, they too view irrigation unit O&M as a low priority task. Given current priorities, the O&M of public irrigation units is unlikely to be enhanced by decentralization.

Preparation of O&M manuals can be suggested as a means to improve unit management. Manuals might cover operations, maintenance, financial management/reporting, and water user organization. The manuals would be of utility to unit managers and

to regional and central DIGESA offices for they would provide a framework for standardized reporting of information.

Decentralization has been of benefit to implementation of the *miniriego* project because regionally-based DIGESA staff are in close contact with farmers who benefit from the project. The public-assisted groundwater *miniriego* project has experienced serious problems due to decentralization and lack of coordination. For the project, USAID sought to streamline the implementation mechanism. The solution was to establish, within DIGESA's central organization, the office of the National Coordinator of Irrigation. Paid for by USAID, this office has been efficient in carrying out a well drilling program. But, to date, only eight of 50 wells are being used. In part, this is a problem due to center-periphery relations.

Conventional wisdom is that development of groundwater resources is a highly technical skill, and one better left to a specialized agency rather than to regional offices. Indeed, technical success in finding water and developing wells has been high. But regional offices hold the key to help determine where farmer interest in irrigation is greatest. Many wells were drilled where community interest was not strong. Thus, well use for irrigation has been low. And in many cases, regional DIGESA offices have not been interested in the organization and promotion of local groups. In short, DIGESA's regional offices have little interest in groundwater *miniriego* because it may be perceived as a top-down approach controlled from Guatemala City. Increased communication and coordination between the office of the National Coordinator of Irrigation and the regional DIGESA offices is suggested.

COORDINATION

Regionalization of DIGESA established organizational structures to facilitate regional planning and coordination. Nonetheless, planning and coordination have not taken place. At the regional and sub-regional levels, the planning and coordinating units are COREDA and COSUREDA which hold periodic meetings but which have not been able to develop effective coordination mechanisms. In some cases, inter-institutional coordination is poor. Take for example the irrigation project proposed for Montufar, a settlement scheme managed by INTA. Although the project has been in planning for years, it was not until August 1989 that DIRYA staff contacted INTA about the project. Nor have farmers in the project area been consulted about the proposed scheme.

Coordination between DIGESA and DIRYA can also be improved. Although DIRYA is part of DIGESA, it is poorly integrated. Both agencies do independent planning. DIRYA has could have a role in many irrigation-related DIGESA activities -- for example, *miniriego*.

Regulation, coordination, and protection of water resources and river basins is shared by MAGA and INDE, but they do not coordinate activities. This has contributed to a lack of integrated river basin planning, a situation which could be rectified through coordinated master planning.

Programs in which evidence of effective planning and coordination are *miniriego* projects and PROGETTAPS. The *miniriego* project has benefitted from USAID insistence on coordination between DIGESA and BANDESA. USAID's funding package for *miniriego* contains funding for both institutions. It is important to note that although DIRYA has the engineering expertise for irrigation within DIGESA, they have no planning or design role in the *miniriego* project. DIRYA's involvement can be recommended to provide technical expertise, and to help stem the outflow of trained Government staff which has been happening in recent years.

PROGETTAPS is a successful example of a small-farmer technology transfer program implemented with collaboration among DIGESA, ICTA, and DIGESEPE. This program disseminates technological innovations among small farmers at low cost. Importantly, PROGETTAPS is assisting DIGESA in adopting methods for project planning and monitoring which could be adapted for implementation in public-managed irrigation units.

STRATEGIC PLANNING AND EVALUATION OF ONGOING PROJECTS

DIGESA lacks strategic planning capability for the public sector. Although the team has recommended transfer of public units to user ownership and management, if transfer is delayed, DIGESA/DIRYA would benefit from creation of a planning cell charged with strategic planning for public units and with monitoring and evaluation of results. During interviews, none of the individuals responsible for management of the public irrigation units could articulate agency plans for the irrigation unit they manage. According to a study conducted by DIRYA in 1984, 50 percent of the irrigation units did not have activity plans for the year (USPADA, 1986:41). Thus neither the managers nor DIGESA have any means to monitor or evaluate activities.

Until now there has been no systematic way to gauge performance of irrigation units (public- or user-managed). Managers have no goals for the units they manage. Once goals are established, communicated, and mutually agreed upon by managers and authorities (the Government or water user organizations), the performance of the unit should be monitored and measured against the goal. Corrective measure should be outlined where performance falls short of goals.

One simple way to gauge performance can be suggested. DIGESA controls the irrigation water supply. Each irrigation unit could commit, via annual plans, to the delivery of a certain amount of water within the unit. This in turn implies adequate funding for O&M and for technical assistance. Evaluation of water delivered versus that stipulated in the annual plan is a measure of a system's hydraulic performance.

Other potential evaluation criteria for DIGESA are more difficult. A public agency has no means to achieve crop production targets, areas planted, or cropping intensities. However, unlike many countries, Guatemala has the advantage that irrigation and agriculture are in the same ministry. For that reason alone, there may be some possibility to use production as a means to gauge irrigation system performance. This requires further investigation.

CONCLUSIONS

According to budget allocation, DIGESA's primary function is agricultural extension -- not irrigation planning or management. The irrigation portion of DIGESA's budget is heavily dependent upon donor funding, which is traditionally directed to new construction, rather than to O&M of older systems. In the past decade, donors have contributed to the Government to help build farmer-owned and operated systems (e.g., the *miniriego* project). Lacking government funds of its own, O&M for existing public irrigation units has been relegated low priority. Deterioration and underutilization of existing units has resulted, which in turn is unlikely to inspire foreign donors to contribute to rehabilitation or O&M. Further, the Government has been unwilling to take the necessary steps to transfer ownership and responsibility of the units to water users to help curb the heavy subsidies that drain DIGESA's budget.

Lack of funds and strategic planning by DIGESA has created an organization that must necessarily respond to donor wishes or severely reduce its personnel and activities. Simultaneously, DIGESA has let its institutional capacity and efficiency diminish by maintaining a high ratio of administrative-to-technical staff. If donor-dependence continues, DIGESA should press for allocation of part of the funds for institution-building such as personnel training in irrigation management.

Decentralization of DIGESA has benefitted implementation of the *miniriego* project, but it has not been as effective to date in meeting the objectives of the groundwater development portion of USAID's Emergency Fund project or the public sector irrigation units. Regional offices lack individuals with planning experience so supervision and approval by DIGESA's central offices are required.

Coordination between DIGESA and DIRYA could be improved through joint instead of independent planning, and through cooperation on projects such as *miniriego*.

CHAPTER SEVEN

FUNDING SOURCES FOR IRRIGATION DEVELOPMENT

SUMMARY

Since 1969 the Government of Guatemala and foreign donors have invested in irrigation infrastructure with mixed results. The BID and GOG projects of the 1970s focused on public owned and operated irrigation systems; they did not achieve predicted benefits due to poor planning and implementation. The USAID-funded *miniriego* projects of the 1980s utilized Government as a facilitator of farmer owned and operated irrigation systems; this method yielded positive economic benefits to farmers and to the country (LeBaron et al, 1987). Future investments by Government or foreign donors should require that irrigation systems be owned and managed by users.

Sources of funds used by the private sector for irrigation investments are unknown. Few private banks will lend for that purpose. Private banks interviewed for this assessment indicated little interest in lending BID funds intended for private sector agriculture because the financial incentives are insufficient. An effort should be made to improve incentives and to involve private banks to a greater extent in lending for irrigation development.

Foreign donor assistance is required to help develop irrigation; new donors such as the EEC are already providing assistance. It is recommended that the GOG have good projects designed and ready for funding. Investment suggestions are presented in Chapter Thirteen.

FOREIGN LOANS AND GRANTS

Loans and grants with a specific irrigation component began in 1969 with BID funds (Table 17). BID continued assistance through the 1970s, but no other donors were active. BID showed early and continued willingness to loan for irrigation development, but project planning, feasibility analyses, and implementation were poorly done. The economic performance of all public irrigation systems constructed with BID/GOG funds has fallen far short of expectations (see Chapter Four).

In the 1980s, USAID became actively interested in irrigation, but took a different approach to investment in irrigation infrastructure by promoting small systems (*miniriego*) owned and operated by farmers. In effect, the Government's role has been limited to that of a facilitator for public-assisted systems, with concessionary financing provided to owner and operator groups. Considering the poor experience with Government owned and controlled irrigation systems (see Chapter Four), USAID's strategy has been appropriate. Furthermore, evaluations of the *miniriego* projects have been generally favorable (see Chapter Five).

Several new projects or loans with an irrigation component are recently underway or are in the planning stage. In 1989 the EEC and the Government began a 1,400-hectare socioeconomic development project on the South Coast near Tiquisate called "El Arisco." Approximately six million Quetzales is allocated to construction of an irrigation system. BID is considering new loans for irrigation development, and other international donors such as the Japanese (JICA) are reportedly interested in funding irrigation.

TABLE 17

SOURCES OF FUNDS FOR PUBLIC AND PUBLIC-ASSISTED IRRIGATION DEVELOPMENT[1]

Source	Loan or Grant Number	Initial Year	Total Amount (Q 000)	Amount Devoted to Irrigation (Q 000)
Foreign Loans				
USAID	T-026	1980	13,000	500
USAID	T-034	1982	5,500	1,035
USAID	T-037	1986	30,343	4,848
BID	162/SF-GU	1969	5,952	5,952
BID	630/SF-GU	(2)		171,083
BID	817/SF-GU	(3)	29,680	29,680
Foreign Grants				
USAID	T-037	1986		4,050
EEC	"El Arisco"	1989	unknown	6,000
Guatemalan Government Matching Funds				
Government	T-037	1986		5,748
Government	162/SF-GU	1969		6,448
Government	817/SF-GU	(2)		10,080

1 The Quetzal amounts shown cannot be directly compared across years because of domestic inflation and changes in the exchange rate.

2 This BID loan was for agriculture in general, but demand for USAID *miniriego* funds exceeded supply so BANDESA channeled BID funds to *miniriego* under the same loan terms and conditions. The interest rate of 10 percent is a subsidized rate.

3 Pending.

The Government does not have funds to invest in new irrigation infrastructure now or in the near future, much less to support O&M in public irrigation units. Willingness to invest government money is only likely to occur in conjunction with foreign donor contributions on concessional terms.

PARTICIPATION OF PRIVATE BANKS IN LENDING FOREIGN DONOR FUNDS

BANDESA is a logical conduit for some foreign donor money, but it cannot be expected to be the only one. The private banking system is often expected to participate in disbursement of foreign donor funds by providing the incentive of a point spread in the interest rate. For example, banks borrow funds at 12 percent and lend at 16 percent. It is often the case, however, that banks do not view the point

spread offered as lucrative enough to pay for loan promotion, personnel training, and the risk of default. To determine the status of a typical BID line of credit, the assessment team investigated BID loan 529/OC-GU (which is for agriculture in general) including investment in irrigation infrastructure.

Representatives from six private banks plus the Central Bank were interviewed to determine the extent of loan activity for private sector irrigation infrastructure and agriculture in general: Banco Inmobilario, Banco Agricola Mercantil, Banco del Cafe, Banco del Agro, Banco de la Construccion, Banco de Occidente, and the Banco de Guatemala (Central Bank). In particular, inquiries were made about the BID line of credit for agriculture at a market interest rate of 16 percent to borrowers. However, loans from this source carry a subsidy of four percent because borrowers are exempt from a three percent government tax on the loan amount and a one percent attorney fee that usually are required. The team's findings are as follows:

- None of the six banks had made irrigation loans;
- The four percent point spread authorized for banks that loan BID funds is low given that most banks can earn more on other loan operations. Banks that have not made loans from the BID fund consider the point spread inadequate;
- Some of the banks have made agricultural loans (not irrigation) from the BID fund because they see an opportunity to expand their portfolios at low marginal cost. However, only one of the six banks aggressively promotes BID loans; and
- Potential borrowers are not motivated to borrow BID money because of the lengthy approval process. Approval of all loans must be made by the Banco de Guatemala, a process said to take three to four months. Approval processes are lengthy because lending banks do not want to incur the expense of doing the financial analysis; they merely check the collateral and forward the loan to the Banco de Guatemala who then must do the analysis.

CONCLUSIONS

The main donors for irrigation in Guatemala are BID and USAID. Other donors showing recent interest are the EEC and JICA. *Miniriego* projects generate a demand for irrigation development funds that exceeds supply. The Government should seek more foreign donor funds to help fund irrigation investments. Water user ownership and management of irrigation systems should be a prerequisite for investment funding.

Domestic and foreign sources do not begin to meet the great demand for irrigation development funds. Some donor funds ostensibly available through private banks are slow to move because incentives are inadequate to induce banks to lend. Private banks should be induced to participate in lending their own funds as well as those of foreign donors in order to meet demand. Finally, the loan process associated with foreign donor funds is cumbersome; this, too, discourages borrowing.

CHAPTER EIGHT

THE LEGAL FRAMEWORK

SUMMARY

Water laws are scattered among various sources. These are to be embodied in a comprehensive water law that was recently prepared and presented to the Government. Present and proposed laws give adequate legal coverage. But in addition to legal coverage, the Government must have the budget, staff, and commitment to fully enforce the regulations.

Land tenure legislation provides private property guarantees that are a safe environment for investments in irrigation expansion among farmers with titles to their land. Individuals without title to the lands they farm are unlikely to invest in irrigation improvements. Therefore, any public or public-assisted irrigation project should be accompanied with a land titling project. Larger land holdings in irrigation systems tend to be underutilized relative to smaller land holdings.

WATER LEGISLATION

Guatemala has many laws that regulate use of water resources and property related to irrigation. These laws are scattered in the National Constitution, and among a number of codes, decrees, and rulings. While laws do exist, Guatemala lacks effective authority to implement national water policy and to control the development of water resources. In March of 1989, a comprehensive Water Law Proposal was sent from INSIVUMEH to the Presidency. The proposal seeks to unify water legislation in one document. However, the current version of the proposal has not defined the authority that will be charged with management of water resources, a problem currently being addressed by a task force.

The Multiplicity of Laws and Institutions

Water legislation is scattered in a number of laws, codes, and decrees that regulate multisectoral use of the resource. The National Constitution of 1985 gives the state the responsibility to protect and develop water and other renewable resources, and to ensure their efficient use. Under the Constitution, all waters are public. The state can grant use of public waters to private parties.

The Civil Code defines private waters as rainfall on private property that does not flow outside the property; springs and lakes that originate on one property and that do not flow out of the property; and underground waters extracted by artificial means on private properties. The Code regulates capture and conduct of private waters used, for example, by communities for domestic purposes. The Agrarian Transformation Law regulates public and private waters and their use in settlement or colonization areas. The Municipal Code grants municipalities rights to establish, operate, and charge for public water services. The Mining Code establishes restrictions and sanctions on the misuse of water for mining. The Forestry Law places in reserve all lands that have a gradient higher that 15 percent near creeks and springs.

Previous Page Blank

Private irrigation and drainage projects are regulated by several pieces of legislation: the Civil Code; the Ley de Servidumbres Forzosas (Law No.40-72); and by Ruling 102-70 which states that individuals taking water from public waterways must register their claims with DIRYA. DIRYA currently maintains a registry containing 300 claims, which is considered to be only a small fraction of the total number of individuals taking water from public waterways.

Public irrigation projects are regulated by The Irrigation Ruling and the Ruling for Operation, Conservation, and Administration of Irrigation Districts which vests MAGA with legal responsibility for construction, operation, and conservation of public irrigation projects. The Ruling specifies procedures for the management of irrigation units and specifies the role of water user organizations vis-a-vis the Government.

Similar multiplicity and overlap exists regarding institutional mandates and the regulation of water resources. One example exists between MAGA, INDE, and the National Environmental Commission (CONAMA). MAGA is responsible for controlling and protecting water, soil, and other resources associated with agricultural activities. INDE has parallel responsibility for ensuring the rational use of natural resources associated with power development and for conserving and protecting hydraulic resources. The law that created CONAMA requires environmental impact studies before construction of irrigation works and makes CONAMA responsible for the monitoring of studies.

Multiplicity in institutional mandates has hindered coordinated planning for the development of water resources. The lack of universal criteria to establish priorities among water uses and the absence of a single regulatory agency have resulted in indiscriminate and anarchical use of water (INSIVUMEH, 1989:18). Private individuals have dammed streams and taken waters from downstream users, resulting in water-right conflicts (USPADA, 1986:109).

The Present Water Law Proposal

Given the present legal complexity and the increased recognition of a need to regulate and control water resources, an inter-institutional commission was formed with a mandate to draft a National Water Law proposal. The proposal was presented to the President in March of 1989. The proposed law is based on the assumption that public waters and irrigation facilities built with public funds, or constructed on public lands, should be regulated and protected by the Government. The proposed law is rooted in the principle that social interests of the community must be protected by the Government. Nonetheless, the proposed law makes provisions for the concession of rights to public water to private parties, and establishes procedures and mechanisms for this purpose.

In an important departure from the Civil Code, the proposed law defines groundwater as public and it proposes that the Government should monitor and control its development. Certain individuals in the private sector perceive this as regulatory (which it is), and a potential threat to the autonomy of individuals to develop groundwater for irrigation purposes.

The proposed law would establish criteria for a hierarchy of water uses. In order of priority these are: 1) domestic supply; 2) agriculture; 3) energy; 4) industrial; 5) mining; 6) recreation; and finally, 7) other uses. It mandates the monitoring of water resources and the registration and monitoring of public water uses, and makes provisions to control, promote, and monitor the rational and efficient use of surface and groundwater. The proposed law would regulate and control both use and conservation of public waters and waterways. It would also regulate the construction and operation of existing or proposed structures (for example irrigation headworks) located on public waterways. It consolidates previous laws regarding the construction, operation, and management of public irrigation systems.

Portions of the proposed law deal with recovery of capital costs of public irrigation investments, with O&M costs of public works though user fees, and with the promotion of water user organizations. It establishes the right of the state to expropriate and revoke water concessions in the public interest. At the same time, it identifies legal channels for grievances with state actions.

The proposed law is comprehensive, consolidating broad water legislation in a single act. If and when it is approved by congress it would replace previous water laws, thus providing a unified framework for water policy implementation. It might help resolve many of the water problems mentioned above. However, the proposed law is not clear as to which institution has authority for implementation of the law. Given a history of institutional coordination problems, it is crucial that the law clearly define the entity responsible for its implementation. A task force is currently working on this issue and will make a recommendation to the Government.

Water Law Enforcement

A Water Commission was established as an authority to enforce existing water laws. But to date, the Government lacks the means and commitment to fully enforce the existing water laws. For example, all offtakes of public waters should be registered with DIRYA, but the agency lacks the means (staff and budget resources) to adequately carry out this function (see Chapter Six). Through its operation of public systems, the Government has the obligation to make equitable water distribution to all portions of an irrigation unit. In practice, the distribution is not always equitable. For example, tail-end farmers in Llanos de Piedra receive less than their fair share of the irrigation water. Farmers in the tail portion of the El Rancho system (Lo de China) never receive irrigation water. Unit operating staff lack both the means to measure the water and the commitment to enforce an equitable distribution.

In the near future the Government will be charged with groundwater regulation. As in other countries, they may also have responsibility to ensure that irrigation return flows (tail-water) meet certain quality standards. Without both the means and the commitment to apply and enforce present and future water law, the Government's regulatory function exists only on paper.

LAND OWNERSHIP

Because most medium- and large-scale farmers have clear title to their land, land tenure uncertainty does not represent a constraint to investment in irrigation. For the many small farmers who lack permanent title to their land, ownership uncertainty is a disincentive to investment in irrigation and irrigation-related improvements.

Full utilization of land and water resources is encouraged where irrigated holdings are small (for example, in San Jeronimo, Laguna del Hoyo, or Xilbalbay), and owners must use the irrigation resources to the maximum for their economic livelihood. In contrast, irrigation systems tend to be underutilized in project areas where land holdings are large -- for example, La Fragua or Asuncion Mita. Large differences in the sizes of land holdings in an irrigation system is a formula for concentration of power (water). This could become a problem once transfer occurs from public-management to user-management unless safeguards are established and the law is enforced.

Land Tenure Law

The National Constitution guarantees individuals the right to own property. Expropriation procedures are lengthy and complex. Further, the Government must pay full market value for lands taken. As a result, uncertainty about retention of lands is not an issue, and private individuals do not perceive land ownership uncertainty as a disincentive to irrigation investment. Under secure conditions of land tenure, private farmers and large corporations have invested in irrigation systems in the South Coast and elsewhere.

Under the Agrarian Transformation Law, Decree 1551, the Government created colonization or settlement schemes, and sold the right to use public land to landless individuals. Schemes are administered by INTA. Land size has varied from 5 to 20 hectares. Schemes such as La Blanca and Nica are colonization schemes that were targets of medium-scale irrigation projects during the 1970s. An irrigation project is currently under discussion for Montufar, another settlement scheme. The law stipulates that settlers can use and inherit land, but it prohibits selling parcels. "Right-to-use" appears to be a sufficient guarantee such that farmers are willing to make investments in irrigation. For example, one individual farming 20 hectares in La Blanca invested Q3000 to raise the canal banks so that water could be delivered to his land.

Land Titling

Land ownership in Guatemala is one of the most unevenly distributed in Latin America. In 1979, farmers holding fewer than 3.5 hectares represented 78 percent of the farming population, but held only 10 percent of the agricultural land in the country. On the other extreme, farmers holding 450 hectares or more represented one percent of the farm population, but held 34 percent of the land under cultivation. Much of the best agricultural lands in the nation in South Coast are owned by large farmers (Hought et al, 1982:1,7). Land distribution problems are most intense in the Highlands where population pressure has resulted in excessive land fragmentation into *minifundio*, where problems of titling and indirect tenancy are common. About 30 percent of the land holdings are held by farmers without land title. These farmers know that, without title, they could be forced from their lands (Hought et al, 1982:8). Therefore, many are reluctant to invest in irrigation or other permanent improvements. In contrast, small farmers with clear titles to their lands are more likely to be receptive to irrigation investment.

Indirect land tenancy systems, renting of lands, for example, is also a disincentive to irrigation investments. Many landowners in the East find renting their land more attractive and less risky than cultivating it. Under this condition landlords do not find it attractive to improve on-farm irrigation systems and tenants have no incentive to invest in improvements to rented land.

During field visits, the team observed that public irrigation units characterized by large land holdings (exceeding ten hectares) tend to be underutilized, left fallow, or used for pasture. In units where land holdings are smaller and more equally distributed, land and water resources are fully used -- for example, the private system at San Matias, or public systems at Atescatempa, El Rancho, San Jeronimo, Laguna El Hoyo, or Xilbalbay (see Chapter Four for a more complete analysis).

If the Government decides to transfer public irrigation systems to user-managed systems, special attention will have to be given to the development of user groups that represent the interest of all farmers. This will be particularly important in systems where land distribution is unequal and where the potential exists for concentration of water rights in the hands of larger landholders. One positive aspect of public management is that the Government is regarded as neutral in its allocation of water and generally fair in enforcement of the law.

CONCLUSIONS

Water law is in place or proposed, but the Government lacks the means and commitment to fully enforce the law. Land title uncertainty acts as a disincentive to private irrigation investment. Conversely, individuals with clear title to their land are more willing to make irrigation investments than are individuals without clear title. More complete and efficient utilization of an irrigation system will be enhanced if differences in size of land holdings are small.

CHAPTER NINE

RURAL ORGANIZATION FOR IRRIGATION

SUMMARY

Water user groups can bring social and financial benefits to users and economic benefits to the nation because, if user groups assume O&M responsibilities, government subsidies to irrigation units can be reduced. In Guatemala, organization of water users has been ineffective, which has contributed to poor performance of public irrigation systems. Participation by beneficiaries should begin at the planning stage, well before an irrigation system is constructed. A strategy of early user participation helps build groups who are more likely to fully use and eventually manage new systems.

Formation of water user groups can be facilitated by 1) adoption of government policy which is "pro" user group; 2) increased communication between concerned national agencies and potential water users; 3) involvement of users at all stages of design and implementation; and 4) training of officers in community organization techniques.

ADVANTAGES OF WATER USER PARTICIPATION

Public sector irrigation systems are characterized by government ownership, management, and subsidies which leave little incentive for users to organize or participate (see Chapter Four). This is a result of a top-down planning approach in lieu of a bottom-up participatory approach. In the former, the focus is primarily on hardware, or the physical works. Participatory approaches give more emphasis to organization and management of people.

Participation of potential water users should be sought before an irrigation project is fully planned. Indeed, farmers should be the ones requesting an irrigation project. Farmers have knowledge of soils, topographic problems, the tendency for flooding, and other local conditions that can be of great use to planners. Farmers can participate in the construction phase which both gives them additional incomes and establishes a direct linkage between their actions and the irrigation system. This becomes a mechanism to establish ownership for the system; that is, it becomes their system and not the Government's.

After construction, farmers should participate in system O&M through water user groups. If water user groups can assume economic responsibility for O&M functions, the Government is relieved of this responsibility. Water users can either do the work themselves or hire others to provide the services. Since system operators would receive their pay from and be responsible to users (and not the Government), one might expect water management responsiveness and efficiency to improve, and costs to be lowered. Additional rationale for user participation in irrigation can be found in Coward (1984) and in Cernea (1985).

Previous Page Blank

GOVERNMENT ACTION AND WATER USER GROUPS

The formation of water user groups in the Guatemalan public sector has been a failure. In the 26 public irrigation projects only one has a formal water user association. Why haven't associations formed? Because the Government provides the services (O&M) that would otherwise be accomplished by local management. Water user groups have suffered from a lack of positive responsibilities, so participation of users in water organizations is, at best, a symbolic gesture.

Development of water user groups has been identified as a major priority for irrigation projects (DIGESA, 1984). However, attempts to win increased responsibility for user groups have not encountered full support within DIGESA or DIRYA. In two cases, functioning user groups disintegrated through manipulation by public officials. In the first, a popular leader of an older user group was replaced by a local politician against its wishes; motivation for the replacement was not clear, but the group disintegrated afterward. In another case, government officials trumped up a case against a group and it too dissolved. The message that water user groups can be positive instruments of government policy has not permeated the bureaucracy. Unless DIGESA clearly articulates and demonstrates that it is "pro" water user groups, we cannot expect them to take hold.

The beneficiaries of nearly all public systems participate in maintenance. They are less inclined (or not permitted) to participate operationally. Water users are not integrated into the decision-making structure of public irrigation units. Unit managers tend to view user groups as conduits for communication (from managers to users), and as sources of reserve labor. Authority rests with the Government, and functional groups are discouraged. From a user perspective, farmers are reluctant to participate either organizationally or financially when they have little control over management of irrigation systems. Experience in *miniriego* seems to confirm this observation: poor farmers have taken on sizeable loans for irrigation infrastructure when it is clear they have control over the system.

The pattern of farmer contributions to irrigation costs seems to reflect farmer discontent with their exclusion from management. Water users have contributed material, cash, and labor to emergency repair and maintenance activities in water units; specific cases were reported in La Fragua, San Jeronimo, La Palma, and El Rancho. Nevertheless, farmers were unanimous in their resistance to increases in water fees.

Farmer disinterest in contributing to operations in the unit also reflects their perception of administrative efficiency. One may compare the communal system at San Matias with the nearby DIGESA unit at Asuncion Mita. San Matias irrigates 600 hectares, and employs one full-time person in irrigation operations. System users perform required maintenance. Asuncion Mita irrigates 450 hectares with 36 full-time employees working in O&M and administration. Farmers perceive public irrigation units to be over-staffed by as much as 200 percent. Refusal to pay more water charges can be interpreted in part as a protest against inefficient administration. When funds or materials are being employed for unit O&M, farmers lend their support.

THE GOVERNMENT'S IRRIGATION UNIT TRANSFER PROJECT

Since 1982, MAGA regulations have required the transfer of irrigation units to users. To date (1989), only three units have been transferred, and only one of those to a water user association. The limited performance of the Transfer Project reflects problems of organization and commitment.

The Transfer Project envisions a three-stage process beginning with government control and ending with user control, with an intermediary stage of "Shared Administration." During the period of shared administration, costs of the irrigation system and its personnel are borne jointly; the Government's contribution decreases with complete transfer. However, the Project does not propose to transfer ownership of projects to users.

The transfer strategy proposes to eliminate most of the paid positions within the irrigation unit, maintaining only a few key personnel, such as the unit chief, the secretary, the canal managers, and possibly the extensionist. This will significantly cut operational costs, since most units have 20 to 30 employees. Maintenance activities will be carried out through user labor. The Transfer Project paper suggests that costs of O&M will be eventually assumed by user groups, although it is not clear whether all positions will be eliminated, and if not, if the Government will bear any costs. Given the mutual desire of both the Government and the users to see each other bear the costs of the irrigation systems, this may in fact be a strategic vagueness, rather than an oversight, to expedite current activities of group formation. Furthermore, failure to give users propriety interest in the system for which they are asked to accept management responsibility might evoke suspicion and distrust of government intentions.

The formula of increased administrative and economic responsibility for users has been presented to the users of several irrigation units, including Oaxaca, San Jeronimo and Nica, and in all but one case has been rejected. Users recognize the high level of government subsidy, and do not want to assume financial responsibility for services. Between the financial obligations and the potential for intra-community conflict, producers find strong reasons for rejecting transfer of responsibilities.

Only the irrigation unit of Xibalbay has begun the process of transfer; it is now in the phase of shared administration. Two other irrigation units have been transferred, but the process has differed from that proposed by the Project. The irrigation unit of Xuachic, near the town of Sololá, was transferred to users by executive fiat (by the vice-president of the Republic) without paying attention to the prerequisites established by the Transfer Project. In another case, an irrigation system was transferred to the municipal authority of Usumatlan.

A pilot project is currently planned in which three districts in the eastern part of the country will be transferred: Tulumajillo, Palo Amontonado, and Santa Catarina. In Santa Catarina, a farmer union has been very active, and plans are under way to authorize the transfer of the irrigation system to that group instead of to the (non-functioning) water user group. The three projects transferred to date, and the three contemplated in the immediate future, are all small systems, of fewer than 100 hectares each.

A transfer manual to guide and promote transfer could be prepared for each irrigation unit. It should be prepared by the Government with assistance from water users affected by transfer.

STRATEGIES FOR EFFECTIVE WATER USER GROUP FORMATION

Interest in receiving irrigation water is the *sine qua non* for group formation. There are several underutilized systems in Guatemala where interest in irrigation is minimal. As a result of lack of interest, one cannot expect a functional water user organization to evolve. Second, even if there is interest in irrigation, individuals must have a reason to organize. Without a valid reason, such as improved maintenance, channel construction, marketing irrigated vegetables, or even protests against bureaucratic inefficiency or high water charges, groups will not be viable in the long term.

As a general rule, user participation must be solicited (or be self-generated) at the project planning stage even before the system is constructed. User involvement at all stages of irrigation development, planning, construction, and O&M, will provide a platform for user group formation. Since the Government controls the stages in public-financed irrigation systems, it must communicate irrigation initiatives to farmers and actively seek their involvement early in the process.

Impressive organizational strides have been made in *miniriego* projects which are a model for further developments in the public, public-assisted, and private sectors. Although it has not always been necessary, the establishment of a legal corporate identity (*personeria juridica*) for *miniriego* groups, along with ownership of the systems, has provided a strong basis for further organization. Groups formed initially as a conduit for irrigation system construction loans were transformed into more general community action groups, with social as well as economic functions. A valuable objective of a future users' group support institution could be to build on the accounting and financial management experience of the *miniriego* loan groups for future local credit union functions. Or, a water user group could assume lateral economic functions, such as purchase of agricultural inputs or coordination in the production and sale of products.

Personeria juridica is only possible for associations or cooperatives. Thus, a simple water user group cannot be incorporated. This is important because, among other things, it can ease group access to credit. It might be useful if model by-laws for user groups and associations were prepared and disseminated to perspective groups in process of formation.

Training programs for government irrigation personnel can also facilitate water user group formation. Special training is required for DIGESA extension agents to permit skills development and the commitment to both help form and work with user group's. Sri Lanka's Irrigation Department now employs Institutional Organizers to facilitate water user group formation; DIGESA could do the same. Training for irrigation personnel should include preparation in communications, group motivation, organizational structure and management, cooperative finance, and legal and financial regulations. Strengthening of these capabilities on the part of government agents, together with government commitment that is "pro" organization, and a program that actively helps farmers organize, will facilitate formation of water user groups.

CONCLUSIONS

Farmers successfully organize themselves to take advantage of public-assisted irrigation opportunities and to own and manage private communal systems. However, in the public systems, farmers have failed to organize because they see no need to do so. The O&M services for which they would organize are provided by the Government at highly subsidized rates. In most systems, water users have resisted accepting responsibility for system management because they recognize the extent of government subsidies. Anomalously, the Government has not been fully committed to fostering local water user organization. If the Government proceeds with transfer of irrigation units to farmers, they will have little choice but to organize. The Government should take a "pro" user group stance, and provide training programs for Government personnel to facilitate user group formation.

For effective irrigation development and management, participation by beneficiaries should begin at the planning stage, well before an irrigation system is constructed. User involvement will be beneficial during design, construction, and O&M; farmers should also help plan the transfer of public units to themselves. Preparation of a transfer manual is recommended.

CHAPTER TEN

INSTITUTIONAL SUPPORT SYSTEMS

SUMMARY

Five types of institutional support services -- credit, agricultural research, technical assistance, agricultural production inputs, and marketing -- are reviewed in this chapter to determine their adequacy to support expansion of Guatemala's irrigation sub-sector. In general, the availability of research technologies and agricultural inputs is very good. Market opportunities are continuing to stimulate growth of irrigation. Lack of credit is a problem for most individuals to invest in on-farm irrigation systems. Lack of technical assistance is a principal constraining factor limiting farmer acceptance of irrigation and slowing their productive use of irrigation technology.

CREDIT

Credit is a severe limitation for private sector purchase of on-farm irrigation equipment (see Chapter Three). The following discussion concerns use of production credit by farmers using irrigation.

Three basic channels for credit are banks, private lenders, and private franchises. Although commercial banks lend for agriculture, they find it unprofitable to deal in loans less than Q10,000, so they are not active in the irrigation sub-sector. As a state development institution, BANDESA lends smaller amounts, and provides subsidized credit (10 percent annually, as opposed to 16 percent in commercial banks [September 1989]) to farmers. BANDESA requires a set of prerequisites which, while designed to address special needs of low income producers, involves significant bureaucratic hurdles for new borrowers or those with suspect credit histories. Loan processing is expedited considerably for good credit users having past experience with BANDESA. BANDESA credit can be channeled indirectly, where a single farmer will take out a large loan, and then onlend to others who do not meet BANDESA requirements. This has occurred in financing for *miniriego* projects.

Private individuals are also prominent sources of credit; interest rates can be up to 36 percent annually. The difference in the cost of credit through bank channels as opposed to private individuals is due to risk and to transaction costs. The time and money farmers must devote to satisfying bank prerequisites significantly raise the real cost of loans above the stated annual interest rate.

Private marketing companies (especially tobacco and melon companies) execute franchising arrangements involving provision of credit with some farmers. Some provide credit for unrestricted use; others provide inputs directly. Market interest rates can be assessed against inputs or funds loaned to farmers. Producers are appreciative of credit provided through private franchise arrangements because the crop is used as collateral, and no bureaucratic processing is required. In the El Rancho-Jicaro irrigation unit, 53.3 percent of farmers received credit from companies for tobacco and chile production (MAGA-BID 1984; p. 26). In Nica, the number of water users in the unit dropped from 162 to fewer than 10 users with the institution of water payments in 1981; the head of the unit attributes the return of the 121 current users to their use of credit provided by tobacco companies. Private credit is restricted to the limited group of producers included in each years franchising arrangement.

Although BANDESA has limited funds to lend, this does not seem to be the major factor limiting the use of BANDESA funds for production credit. In the three irrigation units of La Fragua, only four loans were processed in the first six months of 1989 for a total of Q34,900. BANDESA officials recognize that there is only a slight unfilled demand for BANDESA credit due to the presence of the franchising arrangements.

A general hierarchy of preference for credit can be identified for farmers. Most preferred is the private franchise. If franchise arrangements are not available, BANDESA is the next preferred alternative, followed by loans from private individuals.

AGRICULTURAL RESEARCH

ICTA is responsible for conducting agricultural research. Among all the public institutions contacted, ICTA was the only one that showed a clear set of objectives and defined working plans for the future, including a formal research plan for the period 1988-1992. The plan does not contain a strong focus on research for irrigated areas. ICTA's directors are aware of this fact but without additional funding they do not wish to commit resources to irrigation-related research.

Nevertheless, ICTA has already had an important impact on the irrigation sub-sector. ICTA released the varieties of melon for export, tomatoes that are being grown in La Fragua and other eastern districts, ICTA B-1 maize commonly grown in public irrigation units, and potato varieties currently grown in *miniriego* schemes. Varietal development has been complemented by post-harvest techniques and cottage-level seed technologies commonly used in *miniriego* areas.

Despite current financial limitations, ICTA is taking some actions for future support of irrigation -- one technician is doing graduate work in irrigation; the former soil support division has become the soil and water division; in the irrigation projects of Cuyuta and Asunción Mita some specialized work has begun; and, farm research teams are doing more work in *miniriego* projects focusing on vegetable crops.

TECHNICAL ASSISTANCE

Technical assistance services are available from several sources, the most prominent being private companies either within franchising arrangements or through input salesmen. The contractual basis for franchising includes the production of crops to specifications that company extensionists are expected to regulate. Company extensionists make periodic visits to check crop quality and to make recommendations. Both franchisers and input salesmen concentrate their efforts on the public irrigation units because of the market opportunities presented by irrigated crops.

Private companies providing technical assistance have achieved a high level of penetration in the irrigation sub-sector. This service is noteworthy because it requires no public expenditure, and in many cases resolves collateral problems of input acquisition, credit, and marketing.

Agricultural extension services are provided to farmers through DIGESA technicians. However, DIGESA does not serve farmers in public irrigation units on the assumption that these are reasonably successful farmers, and that others are more in need of extension services. DIGESA lacks sufficient personnel to serve all groups.

Efforts are underway to improve the quality of extension services within the public sector through the PROGETTAPS program. This BID-financed program facilitates transfer of ICTA information through DIGESA and DIGESEPE using a hierarchy of agricultural representatives and local farmers as agents of technical assistance. The model links a researcher with three extensionists, who are then linked to 15-20 agricultural representatives, each of whom is linked to 15-20 producers, resulting in an audience of some 600 producers for technical information for each researcher. The methodology involves the use of technology transfer (demonstration) parcels in farm communities, managed by the farmers themselves, and is thought to have had an impact on some 90,000 producers in the three-year life of the project.

Public-assisted projects fare better than public projects in receipt of technical assistance. DIGESA extension agents are active in *miniriego* projects in the process of motivating group formation and the installation of the new irrigation systems. Some *miniriego* projects are included in the PROGETTAPS program. One of the most innovative extension technologies for water management took place some years ago in the *miniriego* projects near San Marcos. A mobile water management school was organized by staff from Utah State University. *Miniriego* farmers with experience in water management took their experience to other farmers who were being introduced to irrigation for the first time. This could be a model for water management extension. If DIGESA personnel participated along with farmers with experience in irrigation, there could be benefits both to the farming community and to the extension personnel.

Most of the extension information provided by public or private extension agents concerns agronomic matters; irrigation and water management messages are not commonly conveyed. Few extension agents have themselves received any training in water management. Consequently, provision of irrigation-related technical assistance to farmers will first require training of extension personnel. Three types of training are needed: 1) training in specific aspects of water management; 2) methods to effectively communicate messages to water users; and 3) ways to facilitate organization of water users.

Besides training for extension agents, training in irrigation management should also be directed to 1) water users -- for example through PROGETTAPS-type outreach; 2) unit managers (public or user-managed systems) who could benefit from training in irrigation O&M, and from management in general; and 3) policy makers who will be called upon to deal with broader aspects of irrigation planning and development which will be of increased importance as the sector expands. Particularly for unit managers and extension agents, there is some value in a uniform training program that provides a common basis for reporting.

AGRICULTURAL PRODUCTION INPUTS

Inputs are generally available through either commercial outlets or through franchisers, and do not seem to constitute a limitation to the expansion of production in the irrigation sub-sector. Producers, even within some franchising arrangements, have a choice of sources, and are aware of cost tradeoffs (e.g., lower purchase prices versus free delivery). The team did not encounter any complaints regarding supply of seed, fertilizers, or agrochemicals.

MARKETING

Marketing is a crucial link in the use of irrigated land. Irrigation provides high cost opportunities for increasing income, due both to the cost of the irrigation equipment and to the increased levels of investment in production technology (e.g., agrochemicals and improved seed varieties). The process of change for farmers involves shifting from a primary reliance on basic grain market to the more volatile fresh vegetable market to realize added income. Risk-averse peasants find such change difficult, and they may be easily driven from the market by short-term marketing setbacks.

Three channels for marketing exist, although only two have had major impact on irrigation areas. The most important channel is the open market. Intermediaries appear at the farm gate to bid on maturing crops, or at the time of harvest. Within this open market channel can be included the "terminal" in Guatemala City; farmers contract with a trucker to transport produce to the city, where the farmer sells in the wholesale market. The open market also feeds into a regional market. Truckers from Mexico and El Salvador make purchases in Almolonga and Guatemala City.

A second channel for marketing is through franchising arrangements with exporters or processors. Product sales contracts are pre-established, although prices may be specified only within a range. This arrangement is also known as "contract farming." In the highlands private companies purchase a large percentage of irrigated crops introduced for export, such as cauliflower, broccoli, asparagus, and snow peas. In El Rancho-Jicaro, 96 percent of producers sold tobacco to tobacco companies (MAGA-BID 1984; p. 26); other companies purchase melons, okra, and tomato. At present, there is evidence of unfilled demand for products of irrigated lands through export franchising arrangements. CAPCO, in La Fragua, can pack and ship melon production from 1,050 hectares but in 1988, they purchased produce from only 225 hectares and in 1989 contracts cover only 345 hectares. CAPCO technicians report that they could not find enough producers who were good managers and who had soil and water conditions required for melon production.

Of least importance is the national marketing service managed through INDECA and PRODAC. Government-run centers seek to reduce the price markups of middlemen, to improve market price stability, and to stabilize supply of agricultural products. INDECA has primarily focused on basic grains, and is thought by some to be extremely unlikely to provide a competitive service. PRODAC, which deals with diversification and marketing, is too new to see any important impact or contribution.

Participation in vegetable production and marketing programs has significant positive impacts on both agricultural technology and farmer standards of living (von Braun, 1987, Kusterer, et al 1981). Farmers adopt new crops and new production technologies in response to the demands of the new markets, reducing the amount of land dedicated to basic grains. Members of the Cuatro Pinos cooperative who had specialized in vegetable crop production for export were more self sufficient than non-members of the cooperative, due to the use of higher yielding (and more capital intensive) technologies. Even though increased vegetable production left less land for maize production, improved maize technology permitted total family maize production to increase. The motivation of food security in part reflects insecurity of markets, as well as the generalized pattern for farmers to prefer to rely on their own subsistence production in spite of extra costs that strategy might incur (von Braun, 1987).

Farmers in the Highlands understand national and regional markets. Annual price cycles are recognized and production strategies are designed to take advantage of periods of high prices. For example, farmers in Solola recognize the special volatility of the December onion market, where price levels depend on supply being adversely affected by excessive moisture in certain onion production areas. Farmers do not necessarily

avoid the December market, but recognize it as a period with potential for significant gain as well as loss.

Franchising arrangements that guarantee prices are well received by farmers, even in preference to crops with higher potential profits in the open market. Annual market price cycles do not play as important a role in the dry eastern part of the country. Its relatively stable climate is more conducive to year-round production. Therefore, price swings for products of the eastern region, such as melon and tomato, are not as pronounced as for products that must be grown under climatic conditions of the Highlands.

Annual market price fluctuations do not seem to have been considered in previous irrigation planning. The market survey for the second phase of the BID loans cites only annual crop prices, and concludes that there is ample market capacity to absorb increased production for most products (DIRYA, 1984). Crop marketing and production information needs are discussed in Chapter Twelve.

CONCLUSIONS

Guatemalan farmers using irrigation draw upon support services provided by the public and private sectors. Research technologies and agricultural inputs are readily available and do not act as constraints to expansion of irrigated hectarage. For many non-traditional irrigated export crops, market potential still exists. Consequently, market opportunities are helping stimulate growth of the irrigation sub-sector. However, to some, market price volatility remains a deterrent to investment in irrigation. Credit for purchase of on-farm irrigation equipment is a constraint; production credit is less of a limitation.

Lack of technical assistance slows farmer adoption of irrigation. Producers new to irrigation (e.g., farmers beginning to use *miniriego* projects), would benefit from increased technical assistance. Farmers in public irrigation units do not normally receive technical assistance from DIGESA, because the agency assumes that they are better off than farmers outside of irrigation units, and because DIGESA lacks staff and budget to serve both groups. Extension services are mostly concerned with agronomic messages; water management information is rarely conveyed. Extension agents would profit from specialized training in water management.

CHAPTER ELEVEN

IRRIGATION AND NATURAL RESOURCES MANAGEMENT

SUMMARY

Sustainability is defined as the ability of an agroecosystem to produce at ever higher levels without deterioration of the resource base. Contributions to sustainability include social, economic, and environmental factors. Verifiable indicators are proposed to monitor changes in irrigation system sustainability. Master planning for irrigation must consider the entire resource base and impacts in irrigated areas, watersheds, and downstream areas. Of equal importance to the resulting prioritized plans is the master planning process itself, which is an institutional strengthening effort.

A HOLISTIC VIEW

Of the man-made changes to the natural resource environment, none has greater impact than irrigation. In sub-humid regions supplemental irrigation reduces risk from delayed or scanty rains, in semi-arid areas it supports additional crop cycles and varieties, and in arid regions irrigation creates cultivation possibilities where none before existed. Because of its impact on land prices, yields, and crop values, irrigation has equally profound implications with respect to the economic and social environments.

But irrigation also has the potential for negative impacts. Waterlogging, salinity, erosion, and silting in improperly designed or managed irrigation systems can lower the agricultural potential of a region, and simultaneously the economic and social bases. Irrigation systems collect and concentrate toxic agricultural chemicals such as pesticides and herbicides. Waterborne seeds accelerate the spread of noxious weeds. But even if negative environmental impacts are avoided, the conversion of subsistence or marginal rainfed farming systems to highly specialized, commercialized irrigation agriculture triggers economic and social forces that can adversely affect small-scale, resource-poor farmers.

In addition to management of water, physical and economic aspects of irrigation inevitably affect management of other natural and agricultural resources. For example, increased land values justify the investments in topographic controls, such as land leveling or terracing, that are required by irrigation. Slope adjustments in turn facilitate soil management, while the greater value and diversity of irrigated crops make it economically feasible. In short, irrigation does not stand alone but stimulates a complex of activities that convert low-input farming into systems wherein many of the agricultural resources are intensively managed.

These interactions create quite different conditions for farmer decision-making. Enhanced land values and crop opportunities are strong incentives to commercialize. Markets demand specific varieties and quality standards that require farmers to intensify all forms of resource management. Although increased inputs reduce dependence on natural soil and climate conditions, they come at substantial cost and, coupled with fluctuating market prices, place farmers in considerable economic jeopardy. In a real sense, irrigation farmers substitute market risks for environmental risks, minimizing natural hazards such as drought and soil infertility, but at the cost of increased market vulnerability.

Previous Page Blank

As a general rule the greater the moisture deficit (evapotranspiration in excess of effective precipitation and available soil moisture), the greater the benefits from investment in irrigation. But irrigation is a technology and thus, is not an end in itself, but a means to an end. Benefits are socially defined, and irrigation is simply one way of achieving them. Before benefits can be counted, goals must be identified. For example, increased production becomes a goal only when its utility is defined, such as increasing national nutritional levels or generating foreign exchange.

From this perspective the whole natural resource and socioeconomic environments must enter into master planning and must be considered in the evaluation of locations most suitable for irrigation systems. Water supplies, including total amounts and costs of exploiting them, must be considered. If social goals, such as increasing farm incomes or targeting specific disadvantaged groups, are dominant goals then environmental factors may become secondary in importance in the selection of project sites.

SUSTAINABILITY

Definition

A sustainable system can be defined as

> . . . a system that over the long term a) enhances environmental quality and the resource base on which agriculture depends; b) provides for basic human food and fiber needs (here we add the notion of production substantially above present levels)[1], c) is economically viable; and d) enhances the quality of life for farmers and society as a whole. (American Society of Agronomy (ISA 1989).

In addition to environmental stability, this definition includes economic and social elements. To this list one can add system sustainability to include engineering works, dams, canals, and so on which are subject to deterioration and thus could threaten the sustainability of a project.

Because it would be meaningless to speak of short-term sustainability, one must assume that it is unbounded in time, and in fact, no limit has ever been suggested. The concept of sustainability is one of carefully managed resources that will support continuing and even expanding production from an agroecosystem indefinitely (Hopper 1987).

Although the desirable qualities of natural resources (e.g., soil fertility, water quality) may remain constant, social systems that sustain resource management will evolve into entirely new forms, just as they have in the past. Thus, deterioration of socioeconomic factors is not conclusive evidence of deterioration of sustainability. In fact, inflexible socioeconomic institutions could be considered as negative elements.

One popular view considers systems more sustainable if fewer externally supplied inputs (e.g., chemicals, fertilizers, fossil fuels) are used. This assessment is largely based on the experience of developed countries with chemical toxicity in soils and water systems (Carter 1989). Increased reliance on irrigation brings with it a high-tech/high

---

[1] Due mostly to population growth, land available per person for agricultural uses in Guatemala decreased by almost 40 percent, from 1.82 to 1.11 hectares during the period 1964-1982 (Ag. Sector Review 1987, Table 9). The country's population is projected to nearly double in the next 30 years, from the present (mid-1989) level of 8.9 million to 17.6 million by 2020 (Pop. Reference Bureau 1989).

yielding agriculture, which is dependent upon externally supplied chemical inputs. This is illustrative of one of the dilemmas that Guatemala may face as it moves more into irrigation. It also underscores the fundamental conflict between production and protection inherent in the definition of sustainability (Wilken 1989).

Project Sustainability

The majority of the public irrigation systems in Guatemala have a lifespan of only 10 to 20 years. Unlike older systems in many countries, systems in Guatemala have not yet undergone major rehabilitation. This becomes a necessity when, because of under-funding for O&M, deferred maintenance accumulates and the system no longer is able to meet design water deliveries.

It is difficult to gauge sustainability of engineering works from a snapshot. In general, maintenance appears to be acceptable. But this may be an illusion.

Over the last 13 years, real funding for O&M has taken a precipitous downturn (see Figure 2 in Chapter Four.) Whereas assigned budgets for DIGESA-managed irrigation units doubled in the period 1976 to 1988, real budgets (expressed in 1988 Quetzales), have been halved. If this trend continues, the physical irrigation facilities cannot be sustained. They will deteriorate to the point that water deliveries will be interrupted and agricultural production affected.

Institutional Sustainability

Institutions that maintain irrigation systems must also sustain their viability. For example, a government institution charged with public system O&M must itself be relatively free from political whim and must receive funding that resists inflation. This is an unlikely scenario. Project sustainability might be more assured if irrigation units are liberated from dependency on government management, and instead are placed in the hands of users who benefit from resource conservation or lose from resource deterioration. This is yet another argument supporting transfer of public irrigation systems to the private sector.

Social Sustainability

A positive impact of irrigation investment has been to diminish the out-migration of labor. This occurs in Highland systems and elsewhere where *miniriego* has introduced year-round cropping.

Potentially negative social impacts of irrigation remain unknown. Elsewhere the differential land values and production potentials created by irrigation have been socially disruptive. The almost instant, dramatic differentiation of wealth between those with and those without irrigation is jarring to formerly egalitarian communities. *Miniriego* projects have this potential for social disruption. Differences of scale also are exacerbated since commercialization and intensification of agriculture require higher levels of inputs (water, fertilizers, pesticides) and production and market knowledge which may work to the disadvantage of small land holders. If government policy is to maintain a viable class of small-scale farmers, facilitating and legal steps should be taken to offset the potentially disruptive impacts of irrigation.

Economic Sustainability

Sustainability is dependent on economic viability and organizational stability of irrigated agroecosystems. Unless operations are profitable, agriculturists will be unwilling

and unable to maintain environmental defenses. In addition, dramatic changes in technology, land values, market orientation, and income levels impact heavily on economic relationships and social organizations, which also are essential to rational resource use and environmental protection.

The large national and export produce companies operating in the Eastern Region insist on careful soil and water management to meet international standards, and offer technical and financial assistance to make them possible. Relatively assured markets and prices remove much of the risk from farming. In turn, farmers have demonstrated considerable flexibility by mastering cultivation techniques for a range of crops (crop diversity), and by choosing between market-related (as contrasted to environment-related) trade-offs such as higher- or lower-price crops. These skills are positive in terms of economic stability.

Longer-term sustainability trends in the Eastern Region are difficult to predict. Despite farmer flexibility and skills, dependence on foreign markets is inherently risky. Should demand for vegetables or melons diminish, farmers would be hard pressed to continue resource management at present levels. In such a case, the system could degenerate. Continuing market analyses of such factors as domestic and international demand, and potential competitive producers would at least give the region advance warning of possible market declines. Developing alternative local and international outlets, matching market diversity with production diversity, would be an even stronger step.

Similarly, it is difficult to anticipate the effects of a growing disparity between well-to-do land owners and large operators, and those with only small plots or no land at all. During the period 1950-1979 the percentage of farmers nationwide with less than 3.5 hectares increased from 76.2 to 78.4 percent (Ag. Sector Review 1987: Table 6). Windfail capital gains and economies of scale benefit those with more land and resources. Concentration of land in the hands of the most efficient producers may result in maximum production. But growing populations of subviable farmers and landless swell emigration streams and create political instability. Thus disparity of land holdings and access to satisfactory income streams are considered negative impacts that impede progress toward sustainability.

In the Highlands, irrigation has brought crop diversity and increased income to many farmers. On the other hand, small-scale farmers living in settlement schemes find it difficult to develop viable crop alternatives in the warmer South Coast Region. The South Coast does not have the environmental advantages enjoyed by either the East or the Highlands and thus lacks market diversity.

Environmental Sustainability

The Motagua Basin is geomorphically unstable. Other than assuring the engineering integrity of structures, little can be done to diminish the effects of earth movements and sediment transport. For example, canal siltation is common in the La Fragua irrigation unit. The Highlands are also geologically unstable, and contain some of the most precipitous landscapes farmed anywhere in the Western Hemisphere. But agriculture has adapted to this problematic environment; the few fertile valleys are intensively farmed, steep slopes are terraced, and tiny plots are carefully irrigated by furrow, splash, or in some cases sprinkler or even drip systems. A long history of small-scale farming and irrigation suggests that these well-managed systems are sustainable.

In general, there appear to have been few negative environmental impacts from government-sponsored irrigation projects to date. For example, there is little evidence of widespread waterlogging or salinization, perhaps because the scale of government projects has been small. Heavy chemical inputs associated with production for export markets constitute a potential threat. Almost 90 percent of all irrigated land is in

private systems. Thus, the main body of experience regarding irrigation's impact on the environment stems from the private sector, but this experience is poorly documented.

Verifiable Indicators of Sustainability

Sustainability is the result of many environmental, economic, and social factors interacting over long periods of time. It is less a characteristic to be measured than a tendency to be monitored. Agroecosystems become more or less sustainable. Conditions at any one time are less important than the direction of change, and monitoring is the critical activity.

Many factors can be monitored. What is needed are indicators that will remain constant over time and are relatively free of measurement error and interpretation. These qualities coupled with uncertain support for data gathering suggest that monitoring programs should depend only on minimum necessary data, preferably of elements already measured for other purposes. From what is perhaps a limitless list of possibilities, the team suggests only 12 indicators divided into three groups: environmental, socioeconomic, and irrigation systems indicators.

Environmental indicators:
- Groundwater levels
- Salinity/soil fertility levels
- Supply stream sediment loads
- Irrigation water quality

Socioeconomic indicators:
- Average farm size
- Crop diversity
- Nutritional status of farm families using irrigation
- Average net income

Irrigation system indicators:
- Total area irrigated
- Amount of water delivered/unit area
- Frequency of rehabilitation
- Maintenance costs/unit area

MASTER PLANNING

Master planning is a tool for those who make decisions; an irrigation master plan helps establish project priorities for irrigation development. The human aspect must receive central consideration as part of the master plan. The plan will deal with the major regions -- East, Highlands, and South Coast -- and with other areas, as required. It will lay out options for surface and groundwater development. It will make suggestions by irrigation type: public, public-assisted, and private. Although it will be a plan formulated by the Government, it must treat irrigation development by private individuals as well as development under government auspices. For this reason alone, it will be useful to obtain the collaboration of non-government professionals, along with those from the Government, and outside consultants, in preparation of the plan.

An irrigation master plan must deal with irrigation in the context of the entire resource environment. Land and soils, watersheds, and forests must all be considered integrally with water as part of the resources mosaic. The plan will deal with increasing Guatemala's productive capacity through irrigation; it must also deal with increasing Guatemala's natural resource protective capacity.

What *isn't* the master plan? It is not a blueprint. It is a process. Although the plan may set out scenarios for 5-, 10- and 20-year horizons, these are options, and it is in the formulation process that the master planning exercise makes its most lasting contribution. The master planning is to be done by a team of local experts, with advice now and then by outsiders, but with responsibility resting with Guatemalan professionals. Over the long term, these are the individuals who will have the responsibilities for implementing master plan recommendations. Thus, the planning process must itself contribute to building institutional and human capacity.

IRRIGATION MASTER PLANNING AND NATURAL RESOURCES SUSTAINABILITY

Introduction of irrigation disturbs ecological stability and may lead to deterioration of the resource base on which agriculture depends. Management for production favors short-term resource use at the expense of long-term, system sustaining environmental practices. Management for production must be matched by management for protection. Government intervention is justified in several areas since market forces are inadequate to stimulate private conservation efforts.

The irrigation master plan should establish short- and long-term management goals and activities for conservation and sustainability of irrigated agro-systems. The plan would

- Identify main threats to sustainability by irrigation development;
- Incorporate environmental defense strategies in irrigation project planning and design;
- Develop procedures for identifying likely sites for irrigation development that include environmental, and socioeconomic sustainability factors;
- Establish criteria for evaluating environmental sustainability of irrigation developments including those affecting entire watersheds; and
- Suggest necessary government interventions to maintain or enhance irrigated agroecosystem sustainability.

The sustainability of irrigation systems depends on stability and management in all parts of a hydrologic unit. But benefits of irrigation projects are not distributed evenly across the unit. Those who benefit less or even lose from irrigation development will be less inclined to contribute. Members of the watershed community must be included in project planning and design, and benefits must be identified or instituted for all parties to ensure participation in sustainability efforts. Agriculturalists in areas downstream from the irrigation project area will also be affected by the irrigation scheme. Thus, the master plan should seek ways to incorporate upstream and downstream organizational and managerial linkages in overall irrigation system planning and programs.

CONCLUSIONS

Irrigation planning should include a resource protection component because irrigation has pronounced impacts upon project areas and surroundings. To gauge impacts, sustainability indicators should be monitored over time using environmental, socioeconomic,

and irrigation system indicators. To date, there have been few negative environmental impacts from irrigation. Economic sustainability seems positive; however, this depends upon continued market demand for irrigated produce. Sustainability of public sector irrigation units appears doubtful because real funding for O&M has halved over the past 13 years.

The proposed irrigation master plan should establish goals and activities to ensure that sustainability issues are included. Guatemalan professionals should take leadership roles in preparing an irrigation master plan because elaboration of the plan is a means of building institutional capacity.

CHAPTER TWELVE

INFORMATION REQUIREMENTS FOR IRRIGATION

SUMMARY

Informational needs for irrigation are in planning, management, crop production, and marketing. Planning information is needed to evaluate new projects or policy alternatives. Management information is necessary to operate irrigation systems, and to evaluate their performance. Management information can also be used as an input to the planning cycle. Crop production and marketing information are important for farmer decision-making. The discussion in this chapter focuses on information gaps for irrigation; it does not attempt to present a comprehensive analysis of all informational requirements.

INFORMATION USERS AND DIMENSIONS

Major users of irrigation information are system managers and farmers. It is important to recognize who will use the information so that the trap of data gathering becoming an end in itself can be avoided. Data gathering should be user-driven, where users are in a position to evaluate information for relevance and accuracy. Data evaluation procedures should incorporate methods for eliminating data collection that is not of value.

Data has three critical dimensions: quality, timeliness, and geographical coverage. The definition of quality and timeliness depends on each specific type of data. Quality of economic performance data must be ensured by collection and verification techniques to realistically reflect costs and incomes of farmers; market information must be current to be useful to producers. Appropriate geographical coverage likewise varies, depending on the recommendation domain of interest. Market information requires a focus on market centers, while precipitation data might require a more widespread, geographically homogeneous coverage.

PLANNING INFORMATION

The most deficient irrigation planning data in Guatemala are stream hydrology, sediment load, groundwater availability and depth, and water quality. It is necessary to accumulate and process stream hydrology time series data as a basis for planning new systems. The focus should be on extreme events, both low flows and floods. A long-term hydrologic record is required for flood forecasting and spillway design. Sediment load is an essential design factor for exclusion works for systems drawing from the Motagua River. Measurement of sediment load is taken for the Rio Grande and the Motagua River systems. These systems face continual problems due to sediment load. Other irrigation systems lack similar information.

Groundwater characteristics are essential for locating well-based irrigation systems and for monitoring irrigation's impact upon the environment. Given the steady growth in groundwater pumping, there might be a time when over-exploitation of aquifers occur. But, as indicated in Annex 2, no provision has been made to monitor groundwater levels. Water quality is particularly important for any scheme dependent upon groundwater.

As irrigation becomes more widespread, the need for water monitoring becomes more acute. Determinations must be made of water allocations between competing uses. The impact of irrigation outside the system must also be determined. The problem is that no one knows just how much water is actually being withdrawn from the rivers, and thus what impact additional irrigation works might have. By law, all water offtakes are to be registered. DIRYA has the registry responsibility but it lacks the resources to maintain the registry and to monitor water offtakes in the field. DIRYA's capacity to implement monitoring is limited by staff and funds. Only three persons are charged with inspecting and confirming water offtake claims. In addition, Guatemala has not yet found a way to enforce compliance with the registry requirement.

Although not deficient to the same degree as the items mentioned above, the team found that analysis of cadastral information is essential for irrigation system planning. Irrigation systems located where parcel size is small show the highest degree of utilization (see Chapter Four). Farmers will invest in on-farm irrigation systems, but only if they have clear titles to their land (see Chapter Eight).

MANAGEMENT INFORMATION

Evaluation of irrigation system performance requires flow data and institutional performance information. The amount of water in canals is the fundamental basis for system operations. Water quantities must be known at many points in the system to guarantee that proper amounts reach users. No irrigation systems visited during this study had functioning water gauges. The only district that regularly measures flow is La Fragua. DIRYA has developed technical manuals for water measurement, but lacks the staff and funds to regularly conduct these activities. Nor should they do so, for this needs to be a daily activity carried out by the local irrigation unit. Simply painting a meter stick on the side of a rated-section of a canal would permit operators to make decisions and would allow farmers to know if deliveries are as prescribed.

Distinction is made between irrigation system performance that requires flow measurements (liters/second) and parameters of system performance -- for example, how much water is delivered (hectares-meters per year). The amount of water delivered can be compared with design to give a measure of a system's hydraulic performance. No such measurements are currently taken for Guatemalan irrigation systems.

Measures of financial performance of DIGESA irrigation units are available, but they generally are of no value. O&M costs associated with public irrigation systems are reported by DIRYA as annual budget allocations to each unit, but allocations do not include worker bonuses which are the same order of magnitude as salaries. Analyses conducted by DIRYA for 1986 and 1987 of the "real" O&M costs showed these to be double the reported costs because of the failure to include bonuses. Further, no reporting is made for emergency repairs or major rehabilitation which also must be included to obtain a complete picture of an irrigation unit's financial performance. It is necessary to develop accurate collection and reporting techniques, and consistent and accurate analysis of system performance data.

O&M charges should be developed based upon all system costs. Breakdowns of operational costs into salaries (and bonuses), supplies, services, materials, and repairs should be made available to system managers and users. Farmers commonly assume that irrigation units are administratively over-staffed, making systems uneconomical, and they have brought their concerns to the attention of DIGESA. The proposed transfer of system ownership and management to users might be facilitated if O&M costs were disaggregated and if users knew precisely which costs they would bear after transfer. But without cost accounting they do not know; and DIGESA managers are unable to tell them. Cost accounting is absolutely essential to the process of better management.

These same data could be used by DIGESA as a measure of system performance, and for their own management decision-making.

As described in Chapter Four, water charges contain components of *compensacion* and *operacion*. Fees are paid to the central treasury but no accounting is made to separate the two components. The problem here is not a lack of data, but a deficiency in the way data are managed and analyzed.

CROP PRODUCTION AND MARKETING INFORMATION

Farmers use information about prices and areas planted to help make production and marketing decisions. Accurate and timely information helps them to plan what and when to plant, and when and where to sell. While producers understand the annual swings in market prices, they often negotiate at a disadvantage with intermediaries because they lack day-to-day market information.

Principal data required are market prices. A limited number of markets in Guatemala dominate price determination throughout the country: Guatemala City, Quetzaltenango, and Almolonga. INDECA collects market prices for major centers and disseminates them on a weekly basis, focusing on basic grains. The Direccion General de Estadistica collects price data, although these tend to be published as annual or periodic summaries. There is a need to improve the quality and timeliness of some of the information gathered.

Improved information regarding area planted to specific crops will help farmers and intermediaries gauge markets much earlier. DIGESA technicians currently obtain production area information as part of their extension data gathering. Dissemination of this information would provide farmers with production forecasting raw data. Weekly publication or announcement of areas sown could be developed from DIGESA extension agents' files,. or possibly from less direct sources of information, such as (potato) seed sales. Several existing data sets can be compiled and analyzed to begin a national market information service.

Information currently collected is not utilized because it is not disseminated in a timely fashion. Production and marketing information should be disseminated through a data distribution network. More general distribution of this information or its daily broadcast by radio, as is done in many countries, would significantly improve the availability of market information to farmers.

CONCLUSIONS

The most deficient irrigation planning data are stream hydrology covering extreme events, and aquifer characteristics. No one yet knows how much water is being withdrawn for irrigation from surface and groundwater sources. As irrigation becomes more widespread, such information becomes essential to help ration water among competing uses. Although DIRYA has registry responsibility for monitoring water offtakes, it has insufficient budget and staff to carry out this function.

Irrigation system operations are greatly enhanced if canal operators can determine flow in canals. However no water measurements are taken in Guatemalan irrigation units. Nor are there provisions to monitor output from wells constructed with public assistance.

O&M costs as commonly reported do not include bonuses that are of the same magnitude as salaries. True costs are further under-reported because emergency repairs

and rehabilitation work are not reported or analyzed. Without these data, proper financial management of irrigation units is impossible.

Farmers and intermediaries would benefit from daily reporting by radio of prices for principal irrigated crops. Information gathered by DIGESA statisticians and extension agents regarding areas planted to principal crops can, if translated into production forecasts, be used by farmers making planting decisions.

CHAPTER THIRTEEN

SUMMARY OF RECOMMENDATIONS

This chapter brings together in one place the recommendations made throughout the report. Recommendations are grouped under major headings; references are made to chapters where additional discussion is provided. In addition, for each recommendation, a brief rationale or justification is given. Quite intentionally, the rationale or justification falls far short of an action plan to implement the recommendation. Action plans are outside the scope of work of the consultants' assignment; and, if left to the Government to devise, they stand a better chance of implementation.

ALL SECTORS

Master Planning for Irrigation

Develop an irrigation master plan to consider both the public and private sectors and irrigation planning (Chapter Eleven). The plan should consider both short-term (next 5 years), mid-term, and long-range (25-year) planning. An irrigation master plan also must consider

- Irrigation in the context of management of all natural resources: water, soils, forests, watersheds;
- Impacts upon upstream and downstream water users as well as those in the project areas; and
- Intersectoral uses of water resources.

Make sustainability considerations an integral part of the irrigation master plan. (Chapter Eleven). Environmental, socioeconomic, and project (physical) sustainability issues all must be addressed. Establish a limited number of key verifiable indicators of sustainability and monitor these.

Implement a systematic project appraisal methodology (Annex 3). Systematic project appraisal is not currently applied to differentiate between projects proposed for implementation. Both economic and social factors need to be considered in cost and benefit analysis. A series of project appraisal criteria should be prepared and used to evaluate new projects. The Government should make the commitment to follow appraisal review procedures.

Regulatory Enforcement

Strengthen the capacity of institutions to enforce existing regulations (Chapters Eight and Twelve). The Government has the power but not the ability to enforce the laws regarding, for example, regulation of water offtakes and head-tail inequities in irrigation supplies. Increased staffing and budgets are required to permit regulation. Work is currently proceeding on developing an improved legal framework.

Previous Page Blank

Cost Recovery

Require irrigation systems to self finance operations and maintenance (Chapters Four and Seven). Costs for unit O&M should be fully recovered from water users. Funds collected should be earmarked in their entirety for use by the unit. Extraordinary costs (major rehabilitation or repair) would initially (prior to transfer) be a responsibility of the Government.

The operating unit (Government or user organization) must take steps to recover charges on an annual basis from all land holders whose lands can be irrigated. The legal basis for this is already in place and charges should be levied and collected whether or not one elects to take the water. Higher charges are a means to encourage more widespread utilization of land in irrigation projects (Chapter Four).

Institutional Capacity Strengthening

Improve government institutional capacity for irrigation planning, design, implementation, and regulation (Chapter Six). Government agencies in irrigation are underfunded and inefficient. Transfer of responsibility for public systems to users will result in a smaller, better trained Government cadre with responsibilities in master planning for irrigation, design, construction supervision, O&M of major facilities, regulation of water resources, and for technical assistance (extension) in irrigation systems. All but the extension function could be carried out by a DIRYA-type organization. Government service should be made more attractive through opportunities for advanced training and for travel.

Prepare long-term programs that address capacity-building objectives (Chapter Six). Institutions involved in future irrigation planning must develop their own programs and be assured adequate budgets so that programs can be implemented. DIGESA programs are almost entirely donor-driven. Donors such as USAID, BID, and others could support aspects of institutional development as well as make loans/grants for specific irrigation projects.

Improve the quality and quantity of irrigation management education and extension (Chapter Three). Improved technical knowledge of irrigation is needed in both the private and public sectors. Distinctive training can and should be developed at four levels: 1) farmers; 2) extension agents and trainers; 3) irrigation system operators and managers; and 4) irrigation policy makers. Cross-training and exchanges between private and public sector individuals working in irrigation could be beneficial to both. Donors are likely, for example, to express interest in irrigation training while establishing a water management training center. Or, resources could be directed to the universities or to other public and private organizations willing to strengthen training in irrigation.

Policy

Examine the possibilities for preferential electricity tariffs for irrigation pumping (Chapter Three). Many countries establish preferential electricity tariffs for agricultural users. The Government is already committed to an examination of preferential tariffs; this examination must consider not only the impact upon the irrigation system, but also impacts across other sectors.

Examine the implications of a revision of import duties on irrigation supplies (Chapter Three). Import tariffs contribute to the high costs of on-farm irrigation systems. Costs can be decreased somewhat if tariffs are reduced or eliminated. This is a means to spur expansion of the private sector. The private firms that provide irrigation supplies could prepare a list of items for which they seek lowered import

duties. An analysis of this option must also consider its impact upon domestic manufacture of irrigation supplies.

Examine the options for implementation of realistic regulatory controls on a) water resource offtakes; b) groundwater usage; c) water quality standards for return water flows; and d) water distribution equity in irrigation systems (Chapters Four, Six, Eight, and Eleven). Guatemala has or will have laws in place to permit water development with consideration given to each of these regulatory needs; however, it does not have an ability to enforce existing regulations. The recommendation here is to examine options that are conducive to more widespread and uniform enforcement of the regulations.

Market Information

Provide information on market prices and crop areas (Chapter Twelve). Particularly for non-traditional irrigated crops, information regarding prices and areas planted is lacking. Analysis and dissemination of such information would facilitate farmer decision-making. It would also stimulate more widespread utilization of systems and could increase overall production.

PRIVATE SECTOR

Create an irrigation investment fund to provide medium- and long-term credit for private irrigation systems (Chapter Three). Access to credit has been identified as a major constraint to expansion of the private irrigation sub-sector. Except for the largest producers, private individuals cannot get sufficient medium- and long-term financing for irrigation infrastructure either because funds are in short supply (e.g., BANDESA), commercial banks will not take the risk (Chapter Seven), or farmers cannot meet collateral requirements. A program for user groups (small- and medium-size farms) could be developed. Funding could be sought from donors for this purpose.

Provide incentives for private bank participation in making loans for irrigation (Chapter Seven). Private banks have been disinclined to make long-term loans for irrigation. A portion of low-cost donor funds earmarked for irrigation could be reserved for management by private banks as a means to gain their participation in lending for irrigation. Alternatives to be explored include greater point spreads, risk sharing, and loans guaranteed by the Government.

PUBLIC SECTOR

Transfer of Public Systems to Users

Transfer responsibility for irrigation system ownership and O&M to users (Chapter Four). The Government has been unable to sustain operating subsidies; consequently, public irrigation systems are greatly underutilized. In a wholesaler/retailer model, user groups would formulate irrigation districts. Districts would purchase water at wholesale rates and make retail water sales to farmers, with wholesale prices being defined by government policy. The retail price would cover wholesale costs and full O&M costs associated with district management. The Government would maintain control of the water sources and major irrigation facilities such as barrages and headworks. Districts would own, operate, and maintain canals and minor structures.

The Finance Ministry must both apply pressure and provide funds for transfer and must also require DIGESA to balance its books. Without both a dictum and a timetable, it is unlikely that DIGESA will initiate transfer of its own volition (Chapter Four). The Finance Ministry must provide the necessary funds to cover the transfer process.

The Government should take the following steps to facilitate transfer:

- Analyze conditions prevalent in each irrigation unit to establish a timetable for transfer, with participation from local water users;
- Prepare a manual covering transfer for each of the existing units with cooperation from users (Chapter Nine);
- Re-define how much of the irrigation capital costs it will seek to recover on both old and new projects;
- Establish programs to inform users of transfer initiatives;
- Provide organizational assistance and training for Government institutions leading to organization of water users to manage districts;
- Upgrade the facilities to fully functional status prior to transfer;
- Demonstrate commitment to enforce water laws so that rights of small farmers, and those located in tail reaches of systems, have access to an equitable share of the irrigation resource (Chapter Eight); and
- Develop transfer plans now for the three projects planned for construction under BID II.

Performance of Existing Public Units

Develop a plan to improve performance of existing public sector irrigation systems (Chapter Four). The goal of transfer of public irrigation projects to users does not relieve Government from the pressing need to improve performance from the sub-sector. The following several steps can be envisaged; these steps would initially be taken by the Government and the same procedural steps would apply once units have been transferred to user management:

- Conduct evaluations of each of the 26 units to determine 1) which of the units are functioning most closely to expectations, 2) why, and 3) the technical, economic, and organizational constraints impeding proper functioning of the majority of the systems;
- Determine ways in which key elements of well-functioning units can be employed in other systems;
- Provide funding for plans and programs in existing, as opposed to new units; this should take precedence over new construction; and
- Prepare annual plans and programs to enable units to increase cropping intensities, and establish annual goals for management of the unit.

Create a planning cell responsible both for strategic planning and for the performance of the public irrigation sub-sector (Chapter Six). Once goals are established, communicated, and mutually agreed upon by managers and authorities (the Government

or water user organizations), the performance of the unit should be monitored and measured against the goal. Corrective measures should be outlined where performance falls short of goals (Chapter Six).

Prepare O&M manuals to improve unit management (Chapter Six). Manuals should cover operations, maintenance, financial management and reporting, and water user organization. The manuals would be useful to unit managers and to regional and central DIGESA offices by providing a framework for standardized reporting of information (Chapter Six).

New Public Irrigation Systems

Insist that the transition to user-management be a part of the planning (Chapter Four). Every new irrigation scheme contemplated for construction by the public sector should incorporate this policy.

Conduct a campaign for every new project to grant clear land titles (Chapters Eight and Twelve).

Implement pilot irrigation projects in advance of major construction to expose uninitiated individuals to irrigation techniques (Chapter Four). It takes considerable time to make the transition from rainfed to successful irrigated farming; small-scale pilot projects would serve as demonstrations in new schemes to reduce the time required to make fully productive use of irrigation systems.

Water User Participation

Involve water users in the planning, design, construction, and operation of irrigation systems (Chapter Nine). Lack of user involvement is most readily apparent today from the early results of the groundwater *miniriego* projects. The Government should take the initiative to communicate with potential users and to solicit their early involvement in the planning stages and in the transfer processes of every irrigation project.

Construction

Ensure that there is sufficient time between design and construction phases (Annex 2). The final design phase must precede, not be carried out simultaneous to, construction. Users should be involved in planning these timetables; they should also be employed to help construct the systems.

Operations and Maintenance

Conduct a study of the real costs of O&M (Chapter Four). Without a careful study of O&M needs, the Government has no firm basis on which to establish budget allocations. DIRYA's reporting of O&M allocations is either inaccurate or incomplete. It is clear that while nominal allocations for O&M have increased, real allocations have declined. Although the Government should carry out the cost study, its results would help establish O&M costs for transferred units.

Make water measurements at key locations in all irrigation projects in order to facilitate irrigation system operations (Chapter Twelve). Install staff gauges in rated sections of canals and instrument wells with access points to determine water levels and discharge, and initiate programs to monitor well output. Knowledge about water levels is needed to assess aquifer sustainability. Discharge characteristics must be known so that timely maintenance can be performed. (Note that this is not a recommendation

designed to permit accurate calculation of amount of water delivered. Volumetric water deliveries, and water charges based directly on volumes are not recommended as this is administratively difficult and very costly to implement).

PUBLIC-ASSISTED SECTOR

Continue support to public-assisted irrigation systems (Chapter Five). Performance of *miniriego* projects generally has been financially and socially beneficial to farmers. The Government's role should be limited in the future to provision of credit and technical assistance. The Government should turn over design responsibility for future *miniriego* projects to private sector engineering firms whose costs would be met by users.

Provide technical assistance in irrigation management and crop production as part of the *miniriego* package (Chapter Five). Project benefits can be accelerated if farmers new to irrigation are given technical assistance.

Strengthen DIGESA's ability to provide water management technical assistance (Chapters Three, Five, Nine, and Ten). Training programs for irrigation personnel should address both staff technical capability in water management, and the development of skills necessary to help organize water user groups. Universities might add water management to their course offerings and a long-term relationship with a foreign university to provide assistance in irrigation education can be suggested. Alternatively, DIGESA could develop a water management training center. This might be attractive for donor participation. A third option would be the development of an *escuela movil* to be concerned with water management extension.

Strengthen communications and coordination between regional and central DIGESA offices for implementation of groundwater *miniriego* projects (Chapters Five and Six). Project effectiveness could be improved if regions take initial leadership in user organization and site selection, and then seek technical support from the central DIGESA office for groundwater surveys and well construction.

APPENDIX 1

BIBLIOGRAPHY

APPENDIX 1

BIBLIOGRAPHY

AGUAYO, H.
1984. Especificaciones Varias, Consultoria de Obras Hidraulicas de Regadio. Gobierno de Guatemala-BID, Guatemala.

ALVARADO, E. AND F. ALVARADO.
1981. La Agricultura en Guatemala. Camara del Agro, Asociacion de Amigos del Pais.

ALVAREZ, T., et al.
1977. Proyecto de Miniriego y Conservacion de Suelos DIRENARE, Mimeo. Guatemala.

AQUINO, O.
1985. Una Estrategia de Planificacion y Organizacion Institucional para el Desarrollo de los Recursos Naturales Renovables en Guatemala. Universidad de San Carlos.

ARLEDGE, J.
1987. Evaluation of Irrigation/Soil Terracing Activities, Especially the Relationship Between BANDESA and DIGESA, for Project Loans T-034 and T-037. USAID, Guatemala.

ASMON, I. et al.
1987. Small Farmer Diversification Systems Project. Final Evaluation.

BANCO DE GUATEMALA.
1987. Boletin Estadistico Enero-Marzo 1987. Guatemala.

1988. Estadisticas de Productos Pecuarios. Guatemala.

1988. Estadisticas de Productos Agricolas, Periodo 72-89.

BANCO INTERAMERICANO DESARROLLO/GUATEMALA.
1987. Informe de Proyecto, Segundo Programa de Riego y Drenaje. Guatemala.

BAZOBERRY, A.
1984. Fortalecimiento Institucional y Preparacion del Programa de Riego II. Gobierno de Guatemala-BID, Guatemala.

BOTTRALL, A.
1981. Comparative Study of the Management and Organization of Irrigation Projects. World Bank Staff Working Paper No. 458.

BOVAY ENGINEERS INC./URRUELA & SITTENFELD Y CIA. LTDA.
1975. Estudio de Prefactibilidad Para un Plan Maestro de los Recursos Naturales Renovables de Guatemala. Tomo III, Agua. Guatemala: Consejo Nacional de Planificacion Economica, Programa de Estudios de Factibilidad AID 520-L-016.

CANADIAN AGENCY FOR INTERNATIONAL DEVELOPMENT.
1965. Tenencia de la Tierra y Desarrollo Socioeconomico del Sector Agricola, Guatemala. Union Panamericana, Washington, D.C.

CARTER, H. O.
1989. Agricultural Sustainability: An Overview and Research Assessment. California Agriculture, May/June, pp. 16-18, 37.

CASSASCO, J. et al.
1982. Evaluation of Loan 520-T-026 (Terracing, Irrigation and Rural Access Road). USAID, Guatemala.

CATIE.
1987. Seminario Taller: Priorizacion de Cuencas. Guatemala.

CERNEA, M.
1985. Putting People First. New York. Oxford University Press.

CHAMBERS, R. AND I. CARRUTHERS.
1986. Rapid Appraisal to Improve Canal Irrigation Performance: Experience and Options. IIMI Research Paper 3.

CIPPC-ECOTECNIA.
1988. Evaluacion Ambiental del Proyecto de Desarrollo Agricola del Altiplano, Guatemala.

CISNEROS, C.
1986. Uso y Manejo del Agua en Sistemas de Miniriego. EAT, Guatemala.

COLEGIO DE ABOGADOS Y NOTARIOS.
1987. Constitucion Politica de la Republica de Guatemala y Codigo de Etica Profesional Colegio de Abogados Universidad de San Carlos.

COMISION MEXICO-GUATEMALA.
1987. Atlas Fisico de las Cuencas de los Rios Internacionales entre Mexico y Guatemala.

COWARD, W.
1984. Technical and Social Change in Currently Irrigated Regions: Rules Roles and Rehabilitation.

--------.
1984. Improving Policies and Programs for the Development of Small-Scale Irrigation Systems. Cornell University.

CROSSON, P.
1987. Soil Conservation and Small Watershed Development. In Davis, T.J., and I.A. Schirmer (eds.) 1987. Sustainability Issues in Agricultural Development: Proceedings of the Seventh Agriculture Sector Sysposium, pp. 182-189. Washington, D.C.: The World Bank.

DAVID, O.
1989. "Outline" del Plan Maestro del Riego, Drenaje y Conservacion de Suelos.

DESFIL.
1988. Environmental Assessment for the Northern Zone Consolidation Project in Costa Rica.

DGOP.
1965. Inventario para el Proyecto Piloto del Valle de Asuncion Mita.

DIRECCION GENERAL DE ESTADISTICA.
1980. Anuario de Comercio Exterior. Guatemala.

--------.
1984. Censos Nacionales IV Habitacion - IX Poblacion, 1981.

--------.
1983. III Censo Nacional Agropecuario de 1979, Vol I, Numero y Superficies de Fincas y Caracteristicas Principales.

--------.
1983. III Censo Nacional Agropecuario de 1979, Vol. II Cultivos, Produccion Agricola y Forestal. Guatemala.

--------.
1983. III Censo Nacional Agropecuario de 1979, Vol III, Existencia de Animales y Productos Agropecuarios Derivados, Guatemala.

DIRECCION GENERAL DE SERVICIOS AGRICOLAS.
1976. Evaluacion del Programa Nacional de Pequeno y Mediano Riego, Prestamo MA-BID 162/SF-GU. Ministerio de Agricultura, Ganadaria y Alimentacion, Direccion General de Servicios Agricolas. Unidad de Estudios y Proyectos; Guatemala.

--------.
1977. Proyecto de Riego Sacapulas. Guatemala.

--------.
1977. Proyecto de Riego San Pedro Pinula, Jalapa. Guatemala.

--------.
1979. Plan Maestro de Riego y Drenaje. Mimeo. Guatemala.

--------.
1979. Diagnostico de la Region I (Altiplano Occidental), con Fines de Desarrollo Agricola. Guatemala.

--------.
1981. Recursos Hidraulicos. Guatemala.

--------.
1984. Segundo Programa de Riego y Drenaje. Guatemala: Direccion General de Servicios Agricolas, Direccion de Recursos Naturales Renovables.

--------.
1985. Cuardos de Proyectos de Miniriegos en el Altiplano Occidental Guatemala.

DIRECCION DE RECURSOS NATURALES RENOVABLES.
1965. Proyecto de Plan Nacional de Irrigation y Avenamiento, 1965-1974. Guatemala.

--------.
1967. Proyecto de San Cristobal Acasaguastlan. Guatemala.

--------.
1967. Proyecto de el Tempisque. Guatemala.

--------.
1967. Proyecto del Jicaro. Guatemala.

--------. 1968. Programa de Pequeno y Mediano Riego. Guatemala.

--------. 1968. Proyecto de El Progreso. Guatemala.

--------. 1968. Proyecto Argueta, Solola. Guatemala.

--------. 1968. Estudio Agrologico Semidetallado de Suelos para Riego del Proyecto Atescatempa. Guatemala.

--------. 1972. Proyecto de Riego Oaxaca. Guatemala.

--------. 1972. Proyecto de Riego Nica. Guatemala.

--------. 1972. Proyecto de Riego Catarina. Guatemala.

--------. 1972. Proyecto de Riego Tulumajillo. Guatemala.

--------. 1972. Proyecto de Riego Bajo Mongoy. Guatemala.

--------. 1973. Documento Global de Solicitud de Financiamiento para Ejecucion del Segundo Programa Nacional de Riego y Drenaje ante el BID. Guatemala.

--------. 1973. Proyecto La Maquina. Guatemala.

--------. 1974. Proyecto de Riego Llanos de Piedra. Guatemala.

--------. 1975. Proyecto de Riego El Guayabal. Guatemala.

--------. 1976. Proyecto de Riego y Drenaje Montufar. Vol. I. Guatemala.

--------. 1977. Proyecto Canilla. Guatemala.

--------. 1980. Proyecto de Riego y Drenaje Caballo Blanco. Guatemala.

--------. 1980. Estadisticas Agricolas de las Unidades de Riego, Ciclo Agricola 1979-1980. Guatemala.

--------. 1981. Documento Global II. Programa de Riego y Drenaje. Guatemala.

--------.
1981. Anexo Proyecto de Consolidacion II Programa de Riego. Guatemala.

DIRECCION DE RIEGO Y AVENAMIENTO.
1982. Boletin Estadistico Datos de Produccion Mayo 81-Abril 82. Guatemala.

--------.
1982. Curso de Administracion, Operacion y Mantenimiento de Unidades de Riego. DIGESA, Guatemala.

--------.
1982. Proyecto de Irrigacion Valles, Salama-Chicaj. Guatemala.

--------.
1983. Estudio Preliminar de Riego. Chiquimula. Guatemala.

--------.
1983. Boletin Estadistico Datos de Produccion Mayo 82-Abril 83. Guatemala.

--------.
1983. Boletin Estadistico No. 11. Guatemala.

--------.
1984. Boletin Estadistico, Costos de Produccion Agropecuarios Mayo 83-Abril 84. Guatemala.

--------.
1984. Proyecto de Riego Caballo Blanco. Anexo I. Guatemala.

--------.
1984. Proyecto de Riego Cuyuta, Anexo 2. Guatemala.

--------.
1984. Proyecto de Riego y Drenaje Mongoy Anexo 3. Guatemala.

--------.
1984. Proyecto de Consolidacion de la Unidad de Riego Rancho-Jicaro. Guatemala.

--------.
1984. Proyecto de Consolidacion de la Unidad de Riego San Jeronimo. Guatemala.

--------.
1984. Programa de Riego II, Aspectos de Mercado. Guatemala.

--------.
1986. Anteproyecto de la Transferencia de Unidades de Riego Ministerio de Agricultura, Ganadaria y Alimentacion. Guatemala.

--------.
1988. Programa Nacional de Riego, Programa de Trabajo de Componente de Preinversion. Ministerio de Agricultura, Ganadaria y Alimentacion. Guatemala.

--------.
1988. Proyecto Piloto de Pequenos Embalses para Almacenamiento de Agua en el Oriente del Pais. Ministerio de Agricultura Ganadaria y Alimentacion. Guatemala.

--------.
1988. Proyecto Piloto de Aprovechamiento de Agua Subterranea para el Riego en al Altiplano del Pais. Ministerio Agricultura, Ganadaria y Alimentacion. Guatemala.

EASTER, W.
1980. Issues in Irrigation, Planning and Development. University of Minnesota.

ENGELHARDT, T.
1984. Consultoria Parte Agronomica, Programa de Riego II. Gobierno de Guatemala-BID, Guatemala.

ESCUELA FACULTATIVA DE C.C. ECONOMICAS DE OCCIDENTE Y COMITE INTERAMERICANO DE DESARROLLO AGRICOLA.
1971. Tenencia de la Tierra y Desarrollo Socio-Economico del Sector Agricola en Guatemala (2nd ed.). Editorial Universitaria, Guatemala.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
1968. Exito en el Regadio, Planeamiento, Fomento, Ordenacion.

--------.
1972. Irrigation and Drainage Paper, Planning Methodology Seminar. Bucharest.

FOOD AND AGRICULTURE ORGANIZATION/UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT.
1986. Expert Consultation on Irrigation Water Charges, Vol. I, Rome.

FARRINGTON, W. AND G. PORRES.
1964. Proyecto de Irrigacion del Valle de la Fragua. Ministerio de Agricultura, Ganadaria y Alimentacion. Guatemala.

FRENCH, E.
1989. Small Scale Irrigation, Annex IV. USAID/Guatemala.

GIL, N.
1979. Watershed Development, with Special Reference to Soil and Water Conservation. FAO, Rome.

GITTINGER, J.P.
Economic Evaluation of Agricultural Projects, Second Edition, Economic Development Institute of the World Bank, Washington, DC.

GLICK, P.
1967. Ley Nacional de Aguas de la Republica de Guatemala. Mimeo, Guatemala.

GOBIERNO DE GUATEMALA/UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT.
1988. Descripcion del Proyecto de Desarrollo Agricola del Altiplano. AID. Guatemala.

GONZALEZ, O.
1974. Estimacion de Requerimientos de Riego en Guatemala. Chapingo, Mexico

--------.
1988. Programa Nacional de Riego, Objetivos, Estrategias y Politicas. PNUD-OSP-FAO. Mimeo. Guatemala.

HARGREAVES, G.H. AND Z.A. SAMANI.
1986. Meteorological Records for Guatemala. World Water for Agriculture. II/USU.

----------.
1986. World Water for Agriculture: Precipitation Management. Washington, D.C.: USAID, Bureau for Science and Technology.

HARRINGTON, L. AND R. TRIPP.
1984. Dominios de Recomendacion, un Marco de Referencia para la Investigacion en Fincas. CIMMYT, Mexico.

HILDEBRAND, P. AND S. RUANO.
1982. El Sondeo, una Metodologia Multidisciplinaria de Caracterizacion de Sistemas de Cultivo Desarrollado por el ICTA. Guatemala.

--------.
1982. The "Sondeo." A Multidisciplinary Methodology for Farm Description and Analysis, Developed for ICTA. Guatemala.

HONADLE, G.
1982. Rapid Reconnaissance for Development Administration: Mapping and Moulding Organizational Landscapes. World Development.

HOPPER, W.D.
1987. Sustainability, Policies, Natural Resources, and Institutions in Davis, T.J., and I.A. Schirmer (eds). Sustainability Issues in Agricultural Development: Proceedings of the Seventh Agriculture Sector Symposium. Washington, D.C.: The World Bank.

HORST, O.H.
1987. Commercialization of Traditional Agriculture in Highland Guatemala and Ecuador. Revista Geografica No. 106, July-December, pp. 5-17.

HOUGH, RICHARD, et al.
1982. Land and Labor in Guatemala: An Assessment. Development Associates/AID; Washington D.C.

IIED.
1988. Rapid Rural Appraisal Notes. Sustainable Agriculture Programme.

INSTITUTE FOR SUSTAINABLE AGRICULTURE (ISA).
1989. Sustainable Agriculture News. 3(2). Greenbelt, Maryland

INSTITUTO DE CIENCIA Y TECNOLOGIA AGRICOLA.
1988. Plan de Investigacions Agropecuarias 1988-1992. ICTA, Guatemala.

INSTITUTO NACIONAL DE SISMOLOGIA, VULCANOLOGIA, METEOROLOGIA, E HYDROLOGIA.
1975. Boletin Hidrologico No. 6, 1974-1975. Guatemala.

--------.
1980. Boletin Hidrologico No. 11. Guatemala.

--------.
1981. Boletin Hidrologico No. 12. Guatemala.

--------.
1989. Datos Meteorologicos de las Cabeceras Departamentales. Guatemala: Instituto Nacional de Sismologia, Vulcanologia, Metereologia e Hidrologia.

JICA.
1988. Feasibility Study on the Monjas Irrigation Project, Vol. I. Main Report. Guatemala.

--------.
1988. Feasibility Study on the Monjas Irrigation Project, Vol. II. Appendix. Guatemala.

JOHNSON, T.D.
1973. Analisis de Actividades Necesarias para la Produccion de 11 Especies Horticolas (Hortalizas) Guatemala: Ministerio de Agricultura, Sector Publico Agricola CETEFOR. Mimeo.

JONES, J. et al.
1987. Guatemala Highlands Agricultural Development Project - Mid-Term Evaluation.

KENNEDY, R. et al.
1984. Supply of and Demand for Agricultural Land in Guatemala. USAID. Guatemala.

KORTEN, F.
1981. Building National Capacity to Develop Water's Associations: Experience from the Philippines. World Bank Sociological Workshop.

KUSTERER, K.C., M.R. ESTRADA DE BATRES, AND J. XUYA CUXIL.
1981. The Social Impact of Agribusiness: A Case Study of ALCOSA in Guatemala. Washington, D.C.: USAID Bureau for Latin America and the Caribbean, AID Evaluation Special Study No. 4.

LEBARON, A.D., T. TENNEY, B.D. SMITH, B.L. EMBRY, AND S. TENNEY.
1987. Experience with Small-Scale Sprinkler System Development in Guatemala: An Evaluation of Program Benefits. Logan: Utah State University, Agricultural and Irrigation Engineering Department/Economics Departament.

LOWDERMILK, M. et al.
1983. Diagnostic Analysis in Irrigation Systems. Vol. I: Concepts & Methodology. Colorado State University.

LUQUE, J.
1980. Proyectos Agricolas de Riego. Argentina.

MACKENZIE, J. AND A. TAMBE.
1988. Analysis of Survey Data From the USAID-Guatemala Western Highlands Small Farmer Diversification Systems Project. University of Delaware, United States.

MARTINEZ, E. R.
1984. Diagnostico del Funcionamiento de las Unidades de Riego. La Fragua, Llanos de Piedra, El Guayabal, Cabanas, Oaxaca y la Palma del Distrito No.7, Zacapa. Tesis de Ing. Agronomo. Facultad de Agronomia. USAC, Guatemala.

MATHEWSON, K.
1984. Irrigation and Horticulture in Highland Guatemala: The Tablon System of Panajachel. Boulder: Westview Press.

McCRACKEN, J. et al.
1987. An Introduction to Rapid Rural Appraisal for Agricultural Development.

MERRILL, W.C., L.B. FLETCHER, AND M. S. HANRAHAN.
1971. Vegetable Production and Marketing in Guatemala. Mimeo. U.S. Agency for International Development, Guatemalan.

MINISTERIO DE AGRICULTURA.
1977. Subprograma Mejoramiento de los Recursos de la Tierra, Miniriego y Conservacion de Suelos. Guatemala.

MINISTERIO DE AGRICULTURA/BANCO INTERAMERICANO DESAROLLO.
1976. Evaluacion del Programa Nacional de Pequeno y Mediano Riego. Guatemala.

MINISTERIO DE AGRICULTURA, GANADARIA Y ALIMENTACION.
1981. Segundo Programa de Riego y Drenaje. Guatemala: Direccion General de Servicios Agricolas, Direccion de Recursos Naturales Renovables.

--------.
1987. Bases y Estrategia Generales del Sector Agropecuaro en el Primer Gobierno Democrata Christiano de Guatemala.

--------.
1987. Programas y Proyectos Prioritarios del Sector Publico Agropecuario y de Alimentacion. Guatemala.

MINISTERIO DE AGRICULTURA, GANADARIS Y ALIMENTACION/UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT.
1987. Impact of Project 520-T-0255: An Exploratory Sondeo (Small Farmers Diversification Project). Guatemala.

NACIONES UNIDAS.
1976. La Demanda de Agua: Procedimientos y Metodologias Para Proyectar las Demandas de Aguas en el Contexto de la Planificacion Regional y Nacional. New York.

OEHLER, K. (ed.)
1971. Los Minifundios en Guatemala. Guatemala: IDESAC.

OFFICE OF TECHNOLOGY ASSSESSMENT (OTA).
1988. Enhancing Agriculture in Africa: A Role for U.S. Development Assistance. Washington, D.C.: Congress of the United States.

ORTIZ, R.
1989. "Guia de Califacacion de los Criterios para la Seleccion y/o Priorizacion de Areas con Proyectos de Riego," DIGESA, Guatemala.

OVALLE, J.A.
1986. Diagnostico Sobre la Eficiencia de Riego en la Unidad Catarina, San Marcos. Tesis de Ing. Agronomo. Facultad de Agronomia. USAC, Guatemala.

POVOA, A. F. R.
1988. Manual for Dryland and Irrigated Crop Production: Monthly Climatic Data Tables for Latin America. Logan: Utah State University, International Irrigation Center.

RAFAEL LANDIVAR UNIVERSITY.
1984. Environmental Profile of Guatemala. Guatemala: Institute of Environmental Sciences and Agricultural Technology (ICATA) and USAID.

RAMIREZ, G.A.
1986. Diagnostico de la Eficiencia de Funcionamiento de la Unidad de Riego Nica, Malacatan, San Marcos. Tesis de Ing. Agronomo. Facultad de Agronomia, USAC, Guatemala.

REPETTO, R.
1987. In Davis, T.J., and I.A. Schirmer (eds). Sustainability Issues in Agricultural Development: Proceedings of the Seventh Agriculture Sector Symposium. The World Bank, Washington, D.C.

POPULATION REFERENCE BUREAU.
1989. Population Data Sheet, Washington D.C.

ROSALES PADILLA, J.L.
1967. Evaluacion de Sequias en la Republica de Guatemala con base en datos de precipitacion mensual. Guatemala. Instituto Geografico Nacional.

RUANO, S. AND S. CALDERON.
1982. Tecnicas Basicas de Entrevista al Realizar Investigacion Sobre Sistemas de Cultivo. ICTA. Guatemala.

RUANO, S.
1989. El Sondeo: Actualizacion de su Metodologia para Caracterizar Sistemas Agropecuarios de Produccion. RISPAL, Costa Rica.

SAMAYOA, M.
1980. Evaluacion del Proyecto de Miniriego y Conservacion de Suelos Santa Rita. USPA, Guatemala.

SANCHEZ, M.
1980. Calculo y Evaluacion de Proyectos de Miniriego Universidad de San Carlos, Guatemala.

SCHMID, LESTER.
1973. El papel de la mano de obra migratoria en el desarrollo economico de Guatemala. Guatemala, Universidad de San Carlos, Instituto de Investigaciones Economicas.

SECRETARIA GENERAL DE PLANIFICACION.
1981. Mapa de Cobertura y Uso Actual de la Tierra. Guatemala.

--------.
1985. Lineamientos de Politica para el Desarrollo Agricola del Altiplano Occidental. Guatemala.

SIMONS, C.
1956. Descripcion de los Suelos que Aparecen en la Carta Agrologica de Reconocimiento de la Republica. Guatemala.

SIMMONS, C.S., J. M. TARANO, AND J.H. PINTO.
1959. Clasificacion de reconocimiento de los suelos de la Republica de Guatemala. La Aurora: Ministerio de Agricultura Instituto Agropecuario Nacional.

SMITH, G.
1980. The Social, Cultural and Political Dimensions of Rural Development in Guatemala: Hypothesis and Suggested Directions for Action. SEGEPLAN, Guatemala.

--------. 1983. Abbreviated Economic Analysis of the Small Farmer Developme Guatemala.

--------. 1987. Anexo F(7) Analisis Tecnico-Recursos Naturales. USAID. Guatemala

TILLMAN, R. 1981. Environmental Guidelines for Irrigation. USMEP-AID, New York.

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT. 1974. Research Needs for On-Farm Water Management. Utah.

--------. 1977. Proyecto de Miniriego y Conservacion de Suelos. Ministerio de Agricultura, Ganadaria y Alimentacion, Guatemala.

--------. 1981. The Social Impact of Agribusiness: A Case Study of ALCOSA in Guatemala.

--------. 1986. Importer's Guide To Non-Traditional Agricultural Products From Guatemala.

--------. 1987. Agriculture Sector Review.

--------. 1987. Informe del Grupo de Trabajo de La Mision Agricola para Guatemala.

--------. 1988. Desarrollo Agricola del Altiplano. USAID, Guatemala.

--------. 1988. Environment and Natural Resources: USAID Policy Paper. Washington, D.C.: Bureau for Program and Policy Coordination.

--------. 1988. Guatemala Agriculture Sector Development Strategy.

--------. 1988. Project Amendment Phase II, Highlands Agricultural Development.

--------. 1989-90. Action Plan. Guatemala.

--------. 1989. Cuadros: Proyectos Construidos con Financiamiento AID, Mediano Riego y Miniriego.

--------. 1989. Forty Years in the Altiplano; a Cross-Cutting Evaluation of USAID-Financed Assistance in Guatemala's Altiplano (from the 1940s to the present) (3 Vols.) Guatemala: USAID.

--------. 1989. Program Assistance Approval Document (PAAD). Guatemala.

- 92

UNIDAD SECTORIAL DE PLANTIFICATION AGROPECUARIA Y DE ALIMENTACION.
1987. Resumen de las Conclusiones y Recomendaciones del Grupo de Seguimiento de las Actividades de los Representates Agricolas. Ministerio de Agricultura, Ganadaria Alimentacion, Guatemala.

USPADA/PIND/FAO.
1986. Situacion y Perspectivas del Riego en Guatemala. Ministerio de Agricultura, Ganadaria y Alimentacion.

--------.
1987. Capacidad Productiva de la Tierra por Municipios y por Regiones. Ministerio de Agricultura, Ganadaria y Alimentacion. Guatemala.

VON BRAUN, J. et al.
1987. Non-Traditonal Export Crops in Traditional Smallholder Agriculture. Effects on Production, Consumption, and Nutrition in Guatemala.

VON BRAUN, J.D. HOTCHKISSS, AND M. IMMINK.
1987. Non-Traditional Export Crops in Traditional Small Holder Agriculture: Effects on Production, Consumption, and Nutrition in Guatemala. Guatemala: International Food Policy Research Institute and the Institute for Nutrition in Central America and Panama (INCAP).

WILKEN, G.C.
1987. Good Farmers: Traditional Agricultural Resource Management in Mexico and Central America. Berkeley: University of California Press.

--------.
1989. Implementing BIFAD Strategy on Sustainable Agriculture: Perspective of the Universities. Fort Collins: BIFAD/USAID Title XII Regional Seminar.

WING, H.
1988. USAID/GUATEMALA Agriculture Sector Development Strategy (1988-1992).

WORLD BANK.
1981. Comparative Study of the Management and Organization of Irrigation Projects. Washington, D.C.: World Bank Working Paper No. 458.

--------.
1987. Sustainability Issues in Agricultural Development. Procedings of the Seventh Agriculture Sector Symposium.

APPENDIX 2

SCOPE OF WORK

APPENDIX 2

SCOPE OF WORK

IRRIGATION SECTOR ASSESSMENT

PURPOSE

Conduct an irrigation sector assessment which will form part of the basis for the later development of an irrigation master plan.

OBJECTIVES

1. Obtain an overview of the sub-sector, based on successes and failures, as a basis to help formulate future approaches. The assessment will consider past and present irrigation sub-sector performance, and will include data collection, analysis, and evaluation of the various forms of irrigation that are practiced in diverse regions of the country.

2. Identify approaches, strategies, and organizational structures that support

- Improved performance from irrigation investments;
- Sustained performance from irrigation investments;
- An expanded irrigation sub-sector in the country; and
- Increased private sector involvement in system management.

COMPONENTS OF THE ASSESSMENT

The assessment will include analyses of certain major themes/issues which affect the irrigation sub-sector. These will include the following:

1. Irrigation's Impact

Is investment in irrigation a correct course for the GOG? If so, what types of irrigation should be promoted and in which regions? What are the intended impacts desired from irrigation in Guatemala? Has irrigation produced the desired impacts upon (a) the country and (b) the farmer? What is the impact of the various forms of irrigation on production and income? What is its impact upon secondary parameters (health, diet, employment)? What can be done to improve the impact of existing and proposed irrigation systems?

2. Water Resource Availability for Irrigation

Is information available regarding water resource adequacy for irrigation? If so, what is the potential availability of surface and groundwater sources in the major hydrologic units? What is the availability of water in relation to seasonal demand? What are the potential conflicts in use between sectors? Are there potential conflicts in water allocation between nations? What operational systems are used to allocate water amongst users? What is the efficiency of water use? Is efficiency a valid concern? Is water quality a current issue?

3. Sustainability

What has been the impact of irrigation development upon the various sustainability concerns: (a) the environment; (b) the project -- production and incomes from irrigation projects; (c) a system of "sustainable agriculture"; (d) demographic/social stability? What type of planning for irrigation is required to adequately address sustainability concerns? How should a master plan for irrigation incorporate an irrigation strategy in the context of a natural resource strategy?

4. Public - Private Sector Relationships

What can we learn from private initiatives in irrigation that can be incorporated into GOG-financed projects? How can GOG projects be designed such that private participation is encouraged and so that a dependency is not created? Is there scope for transfer (turnover) of O&M responsibilities in medium-sized irrigation projects to the private sector? How can the GOG best stimulate private investment in irrigation in new areas?

5. Financing

Is there ample interest on the part of donors for investment in Guatemala's irrigation sub-sector? Which policies pursued by donors in relation to Guatemala's irrigation sub-sector have proved the most beneficial? What are the ground rules for prioritization of irrigation projects? Is there credit available to stimulate growth in the irrigation sub-sector? Are policies targeted to recover investments? Is there a GOG policy to address cost recovery from GOG-financed irrigation projects? To what extent is cost recovery obtained?

6. Institutions

Is there sufficient allocation of human resources to permit adequate planning for and more widespread exploitation and development of public sector irrigation projects? Is USAID financial support for certain positions within the GOG supportive of growth of those institutions? What can be done to strengthen government institutions (training, incentives for personnel, budget, institutional reorganization)? What options exist for central versus regional management of irrigation projects? Or, should the GOG get out of the irrigation "business?" What are the roles of PVOs/NGOs in irrigation in Guatemala?

7. Rural Organizations

Do WUAs exist? What tasks are done by WUAs in medium-sized and small-scale irrigation developments? Have WUAs or cooperatives been involved in irrigation system construction, O&M, marketing, agricultural extension? Are there rural organizations active in ag production and in produce marketing? Is lack of rural organization a constraint to more complete irrigation system utilization? If so, how can rural organization be strengthened? What is the relationship between rural organizations, regional organizations, and central GOG institutions?

8. Support Systems

Are rural support systems adequate to permit full development (and expansion) of the irrigation sub-sector? Which support systems (credit, research and extension, marketing, complementary ag inputs (seed, fertilizer, equipment, pesticides), processing, are the most constraining? What can the GOG do to stimulate private sector institutions which provide critical support to irrigation?

102

SCHEDULE

The assessment will be carried out over a period of 15 weeks from June 15, 1989 until September 30, 1989. In so far as possible, the work plan will be based upon the following schedule:

Weeks	Dates	Principal Activities
1 - 2	June 15 - July 1	Objectives, Work Plan, Logistics
3	July 2 - 8	Data Collection, Organization
4	July 9 - 15	Integrate Team, Introduce RRA
5 - 8	July 16 - Aug 12	Field Visits, Preliminary Findings
9 - 10	Aug 13 - 26	Data Collection, Analysis
11 - 13	Aug 27 - Sept 16	Final Report
14 - 15	Sept 17 - 30	Translation

REPORTS/DELIVERABLES

1. Detailed work plan (end of week 2).
2. Draft of preliminary findings shared with GOG and USAID for their review (end of week 7). Within 3 working days after presenting preliminary findings, the team will have review sessions with the GOG and USAID.
3. Draft of final report (5 copies in English) shared with GOG and USAID for their review (week 12). Within three working days after presenting the draft final report, the team will have review sessions with the GOG and USAID.
4. Ten (10) copies of final report (in English) submitted to Mission (week 13).

June 28, 1989

SCHEDULE

The assessment will be carried out over a period of 15 weeks from June 15, 1989 until September 30, 1989. In so far as possible, the work plan will be based upon the following schedule:

Weeks	Dates	Principal Activities
1 - 2	June 15 - July 1	Objectives, Work Plan, Logistics
3	July 2 - 8	Data Collection, Organization
4	July 9 - 15	Integrate Team, Introduce RRA
5 - 8	July 16 - Aug 12	Field Visits, Preliminary Findings
9 - 10	Aug 13 - 26	Data Collection, Analysis
11 - 13	Aug 27 - Sept 16	Final Report
14 - 15	Sept 17 - 30	Translation

REPORTS/DELIVERABLES

1. Detailed work plan (end of week 2).
2. Draft of preliminary findings shared with GOG and USAID for their review (end of week 7). Within 3 working days after presenting preliminary findings, the team will have review sessions with the GOG and USAID.
3. Draft of final report (5 copies in English) shared with GOG and USAID for their review (week 12). Within three working days after presenting the draft final report, the team will have review sessions with the GOG and USAID.
4. Ten (10) copies of final report (in English) submitte ' to Mission (week 13).

June 28, 1989

104

APPENDIX 3

TEAM MEMBERS

APPENDIX 3

TEAM MEMBERS

External Consultants/DAI

Ms. Peg Clement, Trainer
Dr. Jeffrey R. Jones, Social Scientist/Rural Organizations
Dr. Loren Parks, Agricultural Economist
Dr. Gene C. Wilken, Agroecologist
Dr. James M. Wolf, Irrigation Engineer and Team Leader
Dr. Aaron E. Zazueta, Social Scientist/Institutional Development

National Consultants/SWSASEPRA

Ing. Juan Gonzalez, Agroecologist/Natural Resource Management
Ing. Victor Hugo Gonzalez W., Hydraulic Engineer
Dr. Carlos Munoz, Hydrogeologist
Dr. Sergio Ruano, Sociologist/Institutional Development
Ing. Julio Sandoval V., Irrigation Specialist and Team Leader
Ing. Carlos Spiegler C., Agricultural Economist
Lic. Liza Vielman, Anthropologist/Rural Organizations

APPENDIX 4

WORK SCHEDULE

APPENDIX 4

WORK SCHEDULE

Week/Date	Locations and Actions
June 20-30	**Guatemala**
	Interact with Mission, GOG and others regarding assignment; make modifications to Scope of Work; develop detailed work schedule; liaise with local team; make logistical arrangements.
July 10-17	**Guatemala**
11 Tuesday:	Team Planning Meeting: Overview; work plan (general); individual Scopes of Work; responsibilities for the various themes; team integration.
12 Wednesday:	Theme responsibilities continued; final document; introduction to Rapid Rural Appraisal (*Sondeo*).
13 Thursday:	*Sondeo* continued; the detailed work plan; reference materials.
14 Friday:	Literature review; meet with USAID and GOG officials.
15 Saturday:	Review literature.
July 17-22	**Progreso, Baja Verapaz, Zacapa, Chiquimula, Regional Offices**
17 Monday:	
Group 1:	El Progreso (Km 75)
Group 2:	El Rancho (Km 84)
Group 3:	San Cristobal, Teculutan, Usumatlan (Km 101)
Group 4:	Cabanas (Km 100)
Night:	Hotel Longarone, Teculutan
18 Tuesday:	Zacapa
Group 1:	El Guayabal
Group 2:	La Fragua
Group 3:	Llanos de Piedra
Group 4:	Riego Privado Vegas Rio Motagua (La Palma, Oaxaca)
Night:	Hotel Longarone, Teculutan
19 Wednesday	
Group 1:	San Jorge (Llanos de Piedra)
Group 2:	Zacapa - DIGESA, BANDESA; Miniriego San Juan de Hermita
Group 3:	DIGESA La Fragua, ICTA, CAPCO
Group 4:	Area de Teculutan (Rio Hondo, others)
Night:	Hotel Longarone, Teculutan
20 Thursday:	Chiquimula and Baja Verapaz
Group 1:	Chiquimula Miniriego Las Ceibitas
Group 2:	Chiquimula Miniriego Ipala (El Obraje)
Night:	Hotel Longarone, Teculutan
Group 3:	Salama - DIGESA, San Jeronimo, dryland farms
Group 4:	Salama - DIGESA, San Jeronimo
Night:	Salama, Hotel Teculutan

21 Friday: Baja Verapaz
Group 1: Guatemala
Group 2: Riego Privado
Group 3: Guatemala
Group 4: Guatemala
Night: Guatemala Hotel Casa Grande
22 Saturday: Guatemala; Chichicastenango, Mayan Inn
23 Sunday: Chichicastenango, Mayan Inn

July 24-30 Solola, Totonicapan, Quetzaltenango, San Marcos, Regional Offices

24 Monday:
Group 1: Patzun
Group 2: DIGESA - Antigua, Cuatro Pinos, Santa Maria Cauque
Group 3: La Alameda (3 wells)
Group 4: La Fuerza, Chirijuya
Night: Panajachel - Hotel Monterrey
25 Tuesday:
Group 1: DIGESA - Solola, Xibalbay, Chaquija, Nahuala, private projects
Group 2: DIGESA Totonicapan, Chuixchiman, Nimasac
Group 3: Quetzaltenango Miniriego Centro Mam
Group 4: DIGESA Quetzaltenango, Solola - Comunidad los Cipreces Xacajax
Night: Quetzaltenango - Hotel del Campo
26 Wednesday: Miniriego
Group 1: San Marcos: San Andres Chapil, Santa Rita
Group 2: San Martin Chiquito
Group 3: Momostenango: Xequemeyac
Group 4: Zunil: Chacap, Chuimucubal-Cholcaja, Pachoj; Almolonga
Night: Quetzaltenango - Hotel del Campo
27 Thursday: La Costa
Group 1: Santa Catarina
Group 2: Nica
Group 3: La Blanca
Group 4: Caballo Blanco
Night: Retalhuleu - Hotel Siboney
28 Friday:
Group 1: Riego Privado Cuyotenango - Tulate
Group 2: Riego Privado Retalhuleu
Group 3: Tiquisate: Proyecto Boca Costa - El Arisco (EEC)
Group 4: Tiquisate: Proyecto Boca Costa - El Arisco (EEC)
Night: Guatemala
29 Saturday: Guatemala
30 Sunday: Guatemala

July 31-August 4 Guatemala

31 Monday: Meeting with USAID and GOG
1 Tuesday: Guatemala Interviews and Report Writing
2 Wednesday: Guatemala " "
3 Thursday: Guatemala " "
4 Friday: Guatemala " "
5 Saturday: Guatemala " "
6 Sunday: Guatemala " "

August 7-10	**Guatemala**
7 Monday:	
Group 1:	Jalapa: Laguna del Hoyo, Monjas
Group 2:	Ciudad Pedro de Alvorado: Proyecto Montufar
Group 3:	Jutiapa: Asuncion Mita, Distrito de Riego San Matias (Private), Laguna de Retuna
8 Tuesday:	Guatemala Interviews and Report Writing
9 Wednesday:	Guatemala Meeting with USAID and GOG
10 Thursday:	Guatemala Report Writing
11 Friday:	Foreign Team Departs

APPENDIX 5

LIST OF PEOPLE CONTACTED

APPENDIX 5

LIST OF PEOPLE CONTACTED

By Name, Position, Institution, Town, Department (State)

Archila, Anibal. Director, DIGESA Irrigation Unit, Cabanas, Zacapa
Aragon Paez, Carlos Humberto. Mayor, Teculutan, Zacapa
Aruche, Justo. Vice-President, Farmers Association El Arisco, Tiquisate, Mazatenango
Azucena Lopez, Alma. DIGESA, Monjas, Jutiapa

Benavente, Miguel Angel. Regional Head, DIGESA, Patzun, Chimaltenango
Brenner, Randolph. Tubovinil, Guatemala City

Calderon, Roberto. Director, DIGESA Irrigation District, La Fragua, Zacapa
Carias, Sergio Mauricio. Student, San Carlos University at Miniriego "El Esfuerzo, Chirijuyu, Chimaltenango
Cartagena, Byron. DIGESA Irrigation Unit, La Blanca, San Marcos
Cartagena, Julio. DIGESA Irrigation Unit, La Blanca, San Marcos
Casados, Jaime Leonel. Chief, Irrigation Unit, Xibalbay DIGESA, Solola
Casoli, Alvaro. Field Technician, ALCOSA, Zacapa
Castellanos, Hugo. DIGESA, Guatemala City
Castillo, Rolando. Credit Manager, Banco de la Construccion, Guatemala City
Chacon, Juan Jose. Assistant Chief, DIGESA Irrigation Unit, La Palma, Zacapa
Choy, Maximiliano Pablo. President, Miniriego Users Group, Chakiya, Solola
Cisneros, Cesar. Coordinator, National Irrigation Plan DIGESA, Guatemala City
Coban, Juan Enrique. Assistant Manager for Credit, Banco Inmobiliario, Guatemala City
Cojulun, Ricardo. Irrigation Unit Chief, DIGESA, San Jeronimo, Baja Verapaz
Contreras, Byron. Dept. of Policy and Sector Programs, USPADA, Guatemala City
Conzo, Alvaro. Field Technician, TACASA, Zacapa
Cortes, Julio Cesar. Director, DIGESA Irrigation Unit, La Palma, Zacapa
Cruz, Alejandro. Tecun S.A. Agroquimicos, Retalhuleu
Cruz, Edgar. DIGESA Irrigation Unit, Llanos de Piedra, Zacapa
Cuc, Santiago. President, Water Users' Committee, Xibalbay, Solola
Curley, Marco Antonio. DIRYA, Guatemala City

Dauber, Otto. President, Daho Pozos S.A., Guatemala City
David, Ouzi. Advisor for Planning, DIRYA, Guatemala City
de Higueros, Julia. Credit Department, Banco de Occidente, Guatemala City
de Leon, Martin. DIGESA La Blanca, San Marcos
de Paz Mejia, Hector. DIGESA Irrigation Unit, Llano de Piedra, Zacapa
de Sarti, Ana Eugenia. DIGESA, Guatemala City
Diaz Duran, Ricardo. Ingenio Santa Ana, Guatemala City
Duarte, Rodolfo. Interim Chief, Irrigation Unit, Nica, San Marcos
Duran, Reinaldo. Production Manager, CAPCO, Zacapa

Echeverria, Ing. SISCO Construction Company El Arisco, Tiquisate, Suchitepquez

Fernandez, Alvaro. Director of Financial Planning, Banco de Guatemala, Guatemala City
Font, Francisco. Farmer, Private Sector, Retalhuleu
Fuentes, Gustavo. President, Water Users' Committee, San Andres Chapil, San Marcos

Gallardo, Fredy. Unidad de Riego DIGESA, Cabanas, Zacapa
Galdamez Oliver Hugo. Director, DIGESA Irrigation Unit, La Fragua, Zacapa
Garcia, Carlos. Daho Pozos S.A., Guatemala City

Garcia, German. Project Head, Proyecto Miniriego, Quetzaltenango
Giron, Juan. Estadistico, DIGESA Irrigation Unit, La Fragua, Zacapa
Gonzalez, Margarito. President, Water Users' Committee, Santa Rita, San Marcos
Gonzalez, Oscar. Advisor for Planning, DIRYA, Guatemala City
Gordillo, Luis Felipe. Head, Irrigation Transfer Project DIRYA, Guatemala City
Granados, Misael. Supervisor, Region III BANDESA, Zacapa, Zacapa

Ixtabalan, Abednego. Unit Chief, DIGESA, Catarina, San Marcos

Jordan, R. President, Water Users' Committee Oaxaca, Gualana,. Zacapa

Lau, Mario. Hidrotecnia S.A., Guatemala City
Linares, Byron. Perito Agronomo, Field Technician, Productos Frescos, Llanos de Piedra, Zacapa
Lopez, Jose. DIGESA Statistician, Cabanas, Zacapa
Lopez, Juan. President, Water Users' Committee, Llanos del Pinal, Quetzaltenango
Lorenzo, Bernardo. Agricultural Guide, DIGESA, San Martin Chiquito, Quetzaltenango
Luna, Ing. Production Supervisor, Morales Gonzalez Co. (MOGO), San Jeronimo, Baja Verapaz
Luna, Mario. Riegos del Sur S.A., Guatemala City
Lutin Perez. Elias. Statistician, DIGESA Irrigation Unit, Monjas, Jutiapa

Macal, Roberto. Director of Agricultural Credit, Banco de Guatemala, Guatemala City
Martinez, Hector. Statistician, DIGESA Irrigation Unit, El Progreso, El Progreso
Martinez, Julio Fernandez. Portfolio Director, Banco del Agro, Guatemala City
Mendoza, Basilio. Chief Extensionist, Miniriego Project Chakiya, Solola
Meneses, Adlai. National Coordinator PROGETTAPS, Guatemala City
Morales, Byron. Field Technician, Tabacalera Maya, Zacapa
Morales, Jorge. DIGESA, Quetzaltenango
Morales, Vicente. President, Cooperative Oversight Committee, La Fragua, Zacapa
Moscoso, Baltazar. Director, ICTA Regional Office, Zacapa
Mota, Roberto. Department Chief of Use and Management DIRYA, Guatemala City

Najarro, Eldin. Secretary, DIGESA Oaxaca, Gualana, Zacapa

Orellana, Conrado. Coordinator, USAID Emergency Fund Projects for DIGESA, Zacapa, Zacapa
Orellana, Rigoberto. Member, Water Users' Committee La Palma, Zacapa
Ortiz, Ramiro. Advisor, PROGETTAPS/HAD, Guatemala City

Paez Vazquez, Alberto. Secretary (DIGESA?), Teculutan, Zacapa
Paz Hernandez, Oscar. Head Canal Manager, DIGESA Irrigation Unit, Llanos de Piedra, Zacapa
Paz, Luis. Unit Chief, DIGESA Irrigation Unit, Oaxaca, Zacapa
Pesa, R. Plant Manager, CAPCO, Zacapa
Perdomo, Roberto. TECUN S.A., Guatemala City
Perez, Marco Tulio. DIGESA Miniriego Project, Chiquimuia
Perussina, Jorge. Ex-Administrator, INTA Settlement, Montufar, Jutiapa
Pornes, Ingrid. Secretary, DIGESA Irrigation Unit, El Progreso, El Progreso

Quinones, Carlos. Farmer, Private Sector, Retalhuleu

Ramirez, William. DIGESA Irrigation Unit, Llano de Piedra, Zacapa
Retana Barrera, Leonel. Secretary, DIGESA Irrigation Unit, Monjas, Jutiapa
Rivera Pomes, Carlos Humberto. Hydrology Section DIRYA, Guatemala City
Rodas Castaneda, Roni. Extensionist, DIGESA, Nahuala, Solola
Rodas, Carlos. Tubo Vinil S.A., Guatemala City
Rodriguez, Efrain. Field Technician, TACASA, Zacapa

Rodriguez, Jorge Luis. Technician, DIGESA, Quetzaltenango
Romero, Hector. Engineering Assistant, DIGESA Irrigation Unit, El Progreso

Sandoval, Celestino. DIGESA Irrigation Unit, Llano de Piedra, Zacapa
Santos, Julian. DIGESA Irrigation Unit, San Marcos
Secaida, Romulo. Assistant Chief, DIGESA Irrigation Unit, El Rancho, El Progreso
Sincal, Pedro. Manager, Kato-ki Cooperative, Patzun, Chimaltenango
Soberanis, Jorge Luis. Regional Coordinator of Miniriego DIGESA, Zacapa, Zacapa
Solorzano, Hector David. Administrator Cooperativa Motagua, Cabanas, Zacapa
Sosa, Guillermo. Field Technician, DIGESA Irrigation Unit, El Guayabal, Zacapa
Soto, Hugo. Economist, ICTA, La Fragua, Zacapa
Souza, Arturo. DIGESA Irrigation Unit, El Guayabal, Zacapa

Tambriz Tambriz, Francisco. President, Miniriego Users' Group Santa Rita Nahuala, Solola
Tanahuve, Feliciano. Head of Maintenance, INCODEPA, Estanzuela, Zacapa
Tarot, Edgar. Chief, Sub-Region IV-2 DIGESA, Jalapa, Jalapa
Toledo, Ricardo. DIGESA Irrigation Unit, La Blanca, San Marcos
Trejo, Alfredo. Ex-Director, DIGESA, Guatemala

Valdez, Mario. DIGESA, Guatemala City
Van der Zel, Humberto. DIRYA/PNUD, Guatemala City
Vargas, Freddy. DIGESA Mini-Riego, Chiquimula
Ventura, Haroldo. Ex-Director, Water Users' Group San Jorge, Llano de Piedra, Zacapa
Villalta, Carlos. Ravit S.A., Guatemala City
Villamar, Juan Enrique. Banco Inmobilario, Guatemala City
Villamar, Tomas. Internal Auditor, Banco del Cafe, Guatemala City

Wegener, Mario Andrino. Office Chief INTA, Montufar Settlement, Ciudad Pedro de Alvarado, Jutiapa

Xuroc, Juan. Agricultural Representative, DIGESA, Totonicapan

Yapur Ovalle, Edwin. Regional Chief, DIGESA, Solola, Solola

Zecena, Ana Eugenia. Supervisor, Home Economics, DIGESA, Jalapa, Jalapa
Orellana, C
Zacapa

ANNEX 1

WATER RESOURCES

ANNEX 1

WATER RESOURCES

Geology

As Figure 1 shows, there are four geologic zones in Guatemala: 1) sedimentary rock formation; 2) crystalline rock formation; 3) volcanic rock formation; and 4) alluvial sediment formation.

Sedimentary Rock Formation or Yucatan Platform and Folded Belt Platform of Chiapas and Guatemala: This unit includes rocks formed in the central and northern region of the Department of Peten. The structures are only slightly affected by regional deformities and constitute a support zone for a broad and thick sequence of folded sedimentary formations moving toward the south. Geographically this unit is composed of the lowlands of the central and northern part of Peten and the folded highland developed through the tallest mountain ranges of the region: The Cuchumatanes, Chama, Santa Cruz, and Mayan Mountains. The folded region forms an extensive convex arch toward the south which extends from Guatemala to the southeast of Mexico.

Crystalline Rock Formation or The Central Range of Guatemala: Three parallel mountainous sierras make up this unit: Cuilco, Chuacus, and Minas. The oldest rocks of the region, mainly crystalline (igneous and metamorphic) of the lower paleozoic period, are found in this range. These formations constitute the crystalline basement of the country.

Volcanic Rock Formation or Pacific Volcanic Belt: This unit includes a thick and complex sequence of tertiary and quaternary volcanic rocks originating and characterized, respectively, by fissure and focused volcanic activity. The belt develops over 200 kilometers from the west northwest to the east southeast, with a width that varies from 40 to 80 kilometers. The Pacific Volcanic Belt forms the Continental Divide.

Alluvial Sediment Formation or The Pacific Coastal Plain: This plain was deposited as a series of great fans by piedmont sediment at the foot of the whole mountain range and on the sides of the volcano cones. Deltaic deposits, alluvial fan cones, and alluvial terraces crossed over one another thousands of years ago. The structure thus formed has a length of approximately 200 and a width ranging from 10 to 60 kilometers.

Morphology

The morphological configuration of the territory plays a significant role in the determination of climate and particularly in the definition of some principal parameters of the hydrological cycle. The great barrier mountains in the central part of the country are the most important morphological aspects in relation to water resources because they define the internal circulation of the masses of humid air and the different meteorological mechanisms that determine the amount of precipitation.

The volcanic belt composes two mountainous barriers -- the southern and the northern. The southern barrier defines the two great watersheds (Figure 2) with surface waters flowing to the Atlantic and the Pacific Oceans. The largest basins in the country are the Chixoy-Usumacinta and the Motagua River Basins. The surface forms of this unit are markedly different: On one side the southern great slopes loom while on the other, there are extensive intermountain valleys. In addition, 33 volcanic cones of altitudes between 4,220 and 2,000 meters cover the unit. Approximately ten important volcanic depressions exist. Lakes and lagoons up to 400 meters deep such as Atitlan, Amatitlan, Ayarza, and Guija have formed within these depressions.

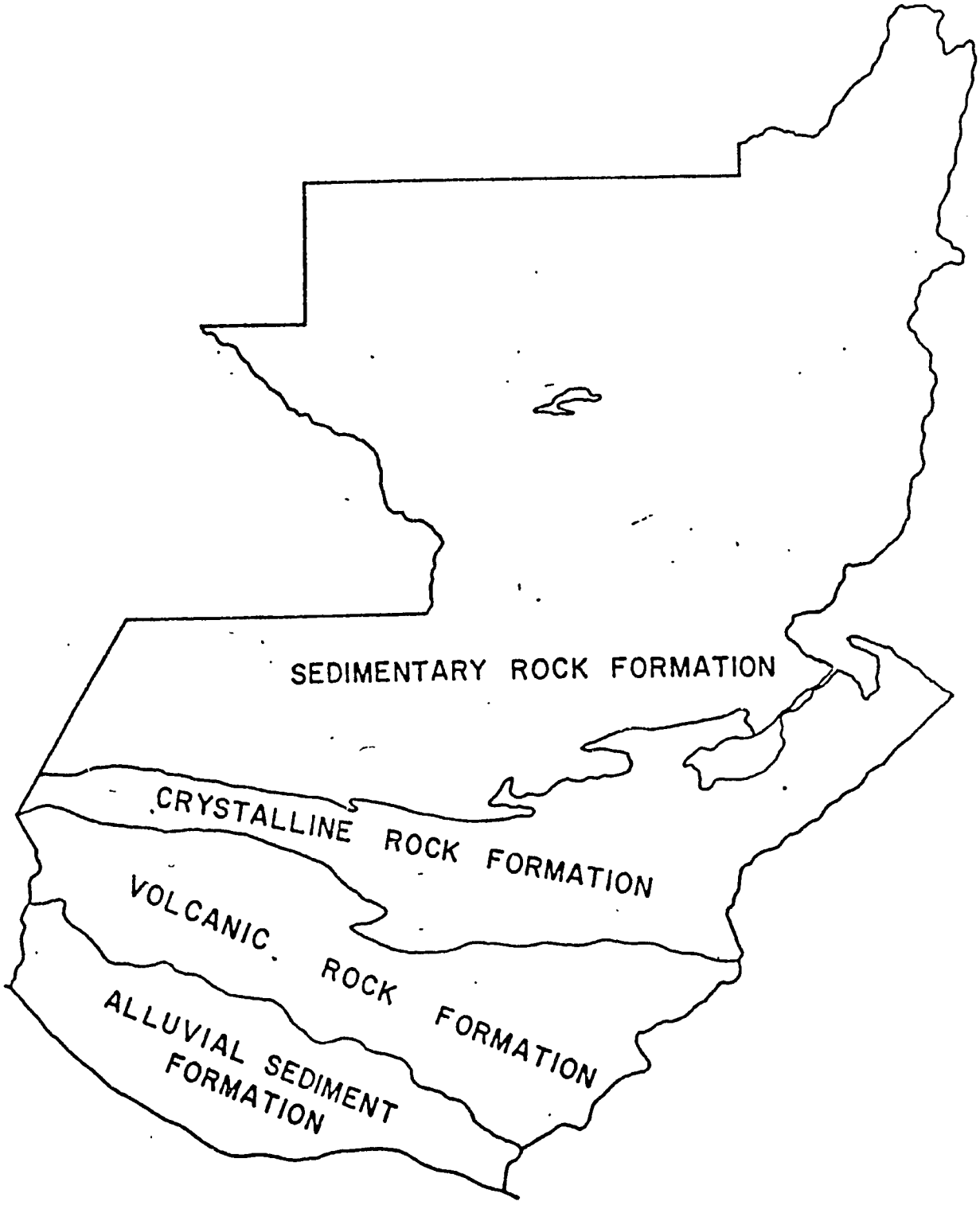


FIG. I

PRINCIPAL ROCK FORMATIONS

LEGEND

1.0. PACIFIC WATERSHED
2.0. CARIBBEAN WATERSHED
3.0. MEXICAN GULF WATERSHED

ATLANTIC WATERSHED

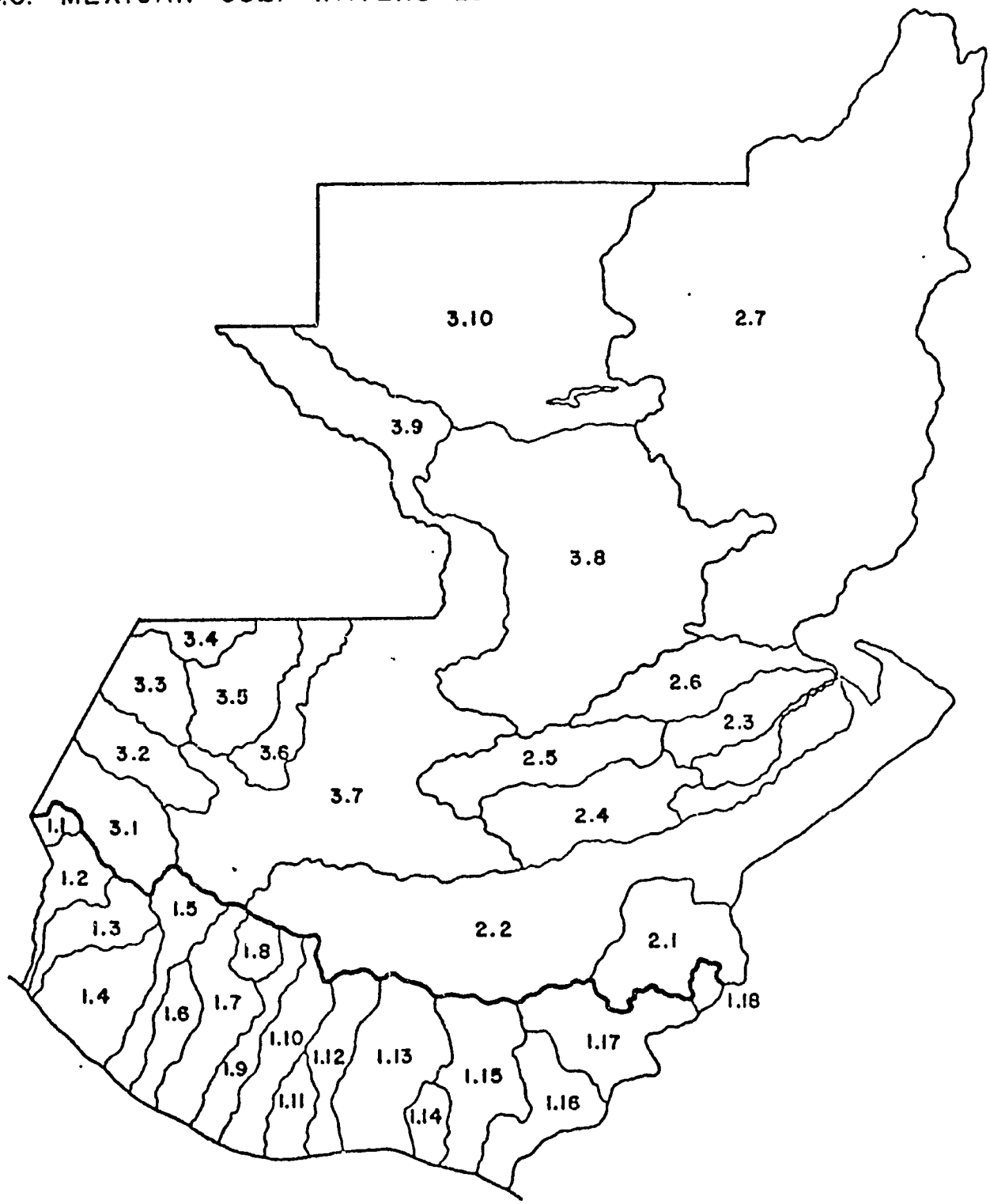


FIG. 2

PRINCIPAL WATERSHEDS AND RIVER BASINS

The northern barrier is formed by various high mountain systems of the Sierra Madre: Los Cuchumatanes, Chama, Santa Cruz, Chuacus, Las Minas, El Mico, etc. The tallest peaks are between 1,300 and 3,800 meters. However their slope toward the north plain is less abrupt at altitudes between 500 and 200 meters and occurs over a more gradual slope. The most important morphological aspects of this barrier are a result of the intense regional tectonic activity. This activity is responsible for the uplifting of important rocky masses such as the Cuchumatanes which has vast plains at an altitude of 3,000 meters. Geohydrological origin has conditioned the formation of at least four broad depressions which are closed to the surface runoff. They include Chajmaic, Candelaria, San Simon, and Icbolay, among others.

The Motagua River Basin is located between the two mountain barriers described above. It is topographically deep and narrow, and runs for approximately 600 kilometers.

Rainfall

Guatemala is located in a convergence zone of atmospheric disturbance, generated by two tropical cyclone zones, one located northeasterly over the Atlantic Ocean and the Caribbean and the other southeasterly over the Pacific Ocean. The relative proximity of Guatemala to the oceans ensures frequent cyclone activity. An intense attraction of humid air from one of the oceans generates cyclones that produce abundant rainfall when crossing land. Some eight hurricanes and tropical storms from the northeastern Atlantic occur yearly. Cyclones strike the region one or two times a year between May and the middle of December, with the greatest intensity and frequency in September. Hurricanes and tropical storms that originate in the southeast of the Pacific Ocean average 15 times per year, developing between the months of May and November, with greater intensity in September.

The most general criterion for measuring the country's potential water resources involves assessing the mean annual precipitation; in Guatemala, it is approximately 2,210 millimeters. The Atlantic and Pacific Ocean watersheds receive 2,240 and 2,080 millimeters of yearly rainfall respectively. The geographic distribution of the mean annual precipitation is represented on a isohyetal map of the country (Figure 3). It shows that rainfall is generally abundant -- greater than 1,000 millimeters, except in the central region of the country (Middle and High Motagua River Basin and the basins of the Cuilco and Selegua Rivers).

The monthly minimums of mean rainfall register between zero and ten millimeters. The lowest levels occur during January and February in the central part of the Highlands, Cuilco and Selegua basins, the High Chixoy River Basin, the middle and upper Motagua River Basin and in the majority of Pacific basins, with exception of the high and middle basins of the western rivers: Coatan, Suchiate, Naranjo, Ocosito, Samala, Sis, Ican, and Nahualate. During the month of March these values persist only in the Cuilco and Selegua basins, upper Chixoy River Basin, high and middle Motagua River Basin, eastern part of the Maria Linda River Basin and in the Esclavos, Paz and Lempa River Basins.

Rainfall distribution is bi-modal. The monthly maximums occur during June (200-400 millimeters) and September (300-500 millimeters) for the monthly precipitation zones mentioned above. For the rest of the country the maximum June and September values are between 500 and 700 millimeters.

In the high and middle Motagua River Basins and in the basins of the Los Esclavos, Paz and Lempa Rivers, the number of annual rainfall days ranges between 60 and 90. For the rest of the Pacific Ocean basins, from the Maria Linda River toward the west, the number of rainfall days ranges from 120 to 150. For the rest of the country, especially on the mountainous barrier of the north, rain falls between 150 and 210 days yearly.

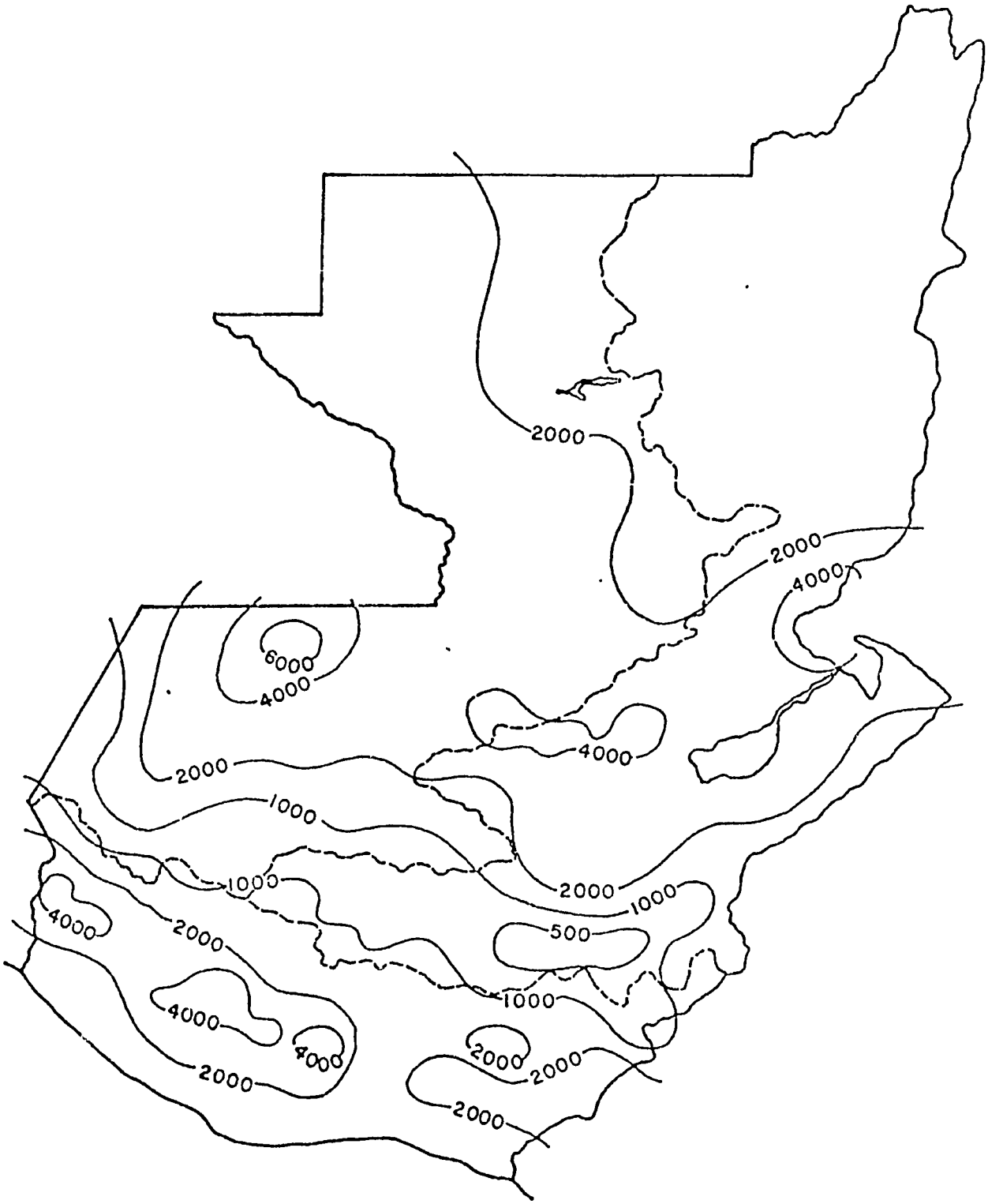


FIG. 3

ISOHYETAL MAP

MEAN ANNUAL PRECIPITATION

MM.

As stated, the source of the rainfall is basically related to cyclonic depressions generated in the Caribbean Sea and the Pacific Ocean. However, due to the topographical configuration of the country and the degree of exposure to the masses of humid air from the Pacific and Atlantic Oceans, other patterns of precipitation exist. The orographic pattern for the middle altitude zones between 500 and 1,000 meters is a result of exposure to the movement of the masses of humid air on the two mountainous barriers of the Pacific and the Atlantic and of the convective for the inter-mountainous valleys.

Generally, the hydrologic year starts with rains in May which continue until October, November, or December, and end with the dry season in April.

Surface Water

Morphologic and geologic characteristics, as well as the recharge resulting from the rainfall, are the principal factors that determine the potential and the circulation system of the surface water resources.

Guatemala has a number of geographically dispersed lakes and lagoons. These bodies of water are located in the northern lowlands, the Pacific coastal belt, as well as within the principal mountain systems at middle and high altitudes. The majority of these bodies of water (more than 90) are located in the northern lowlands, especially within the Department of Peten, as well as on the coastal plain in the eastern and western regions. Among the 24 most important lakes by their volume and surface area, eight are located within the Pacific Volcanic Belt.

The hydrographic system of Guatemala is composed of 35 basins, 18 and 15 of which drain to the Pacific and Atlantic Oceans, respectively (Figure 2 and Table 1). The largest basins drain their waters to the Atlantic Ocean. Among these is the Usumacinta River (with an area of 41,279 square kilometers and a flow in the range of 1,776 m^3/sec.) and the Motagua River (with an area of 15,190 square kilometers and a discharge of about 202 m^3/sec. The basins draining to the Pacific Ocean are relatively small. The surface areas range between 1,064 and 2,759 square kilometers and average flows vary from 9 m^3/sec. to 64 m^3/sec. Guatemalan rivers have a highly variable flow because the river beds are steep and the concentration of rain intense and of short duration. As a result, when the surface extension of these basins is small the variability of flow is greater.

Variability of stream flow can be expressed in a Flow-Duration curve (Figure 4) which shows a high slope. For the Pacific and Atlantic indices of variability, low and high values range between 0.165 and 0.297 and from 0.306 to 0.457, respectively.

Groundwater

Two of the four geologic zones in Guatemala are good groundwater sources. The volcanic zone covers a surface area of approximately 10,000 square kilometers. The volcanic zone is potentially an aquifer with characteristics of permeability and production ranging from acceptable to good. Aquifers are most frequently present in volcanic ash and in the fractured volcanic tufts and lava flows. Typical transmissivity of ash varies from 23 to 750 m^3/day/meter when the saturated zone is between 50 and 200 meters from the surface. Standard transmissivity of volcanic tufts and fractured lava flows is between 500 and 5,000 m^3/day/meter at depths of more than 250 meters.

The South Coast sedimentary formation is the another important hydrogeological unit. According to location, the particle size of the materials fluctuates from very coarse to very fine. Depending on site of the deposit, alluvial formations represent common cases such as alluvial valleys, fans, and deltas. These units are usually highly

FIG. 4
REGIONAL FLOW DURATION CURVE
RATIO Q / Qm. = f (t)

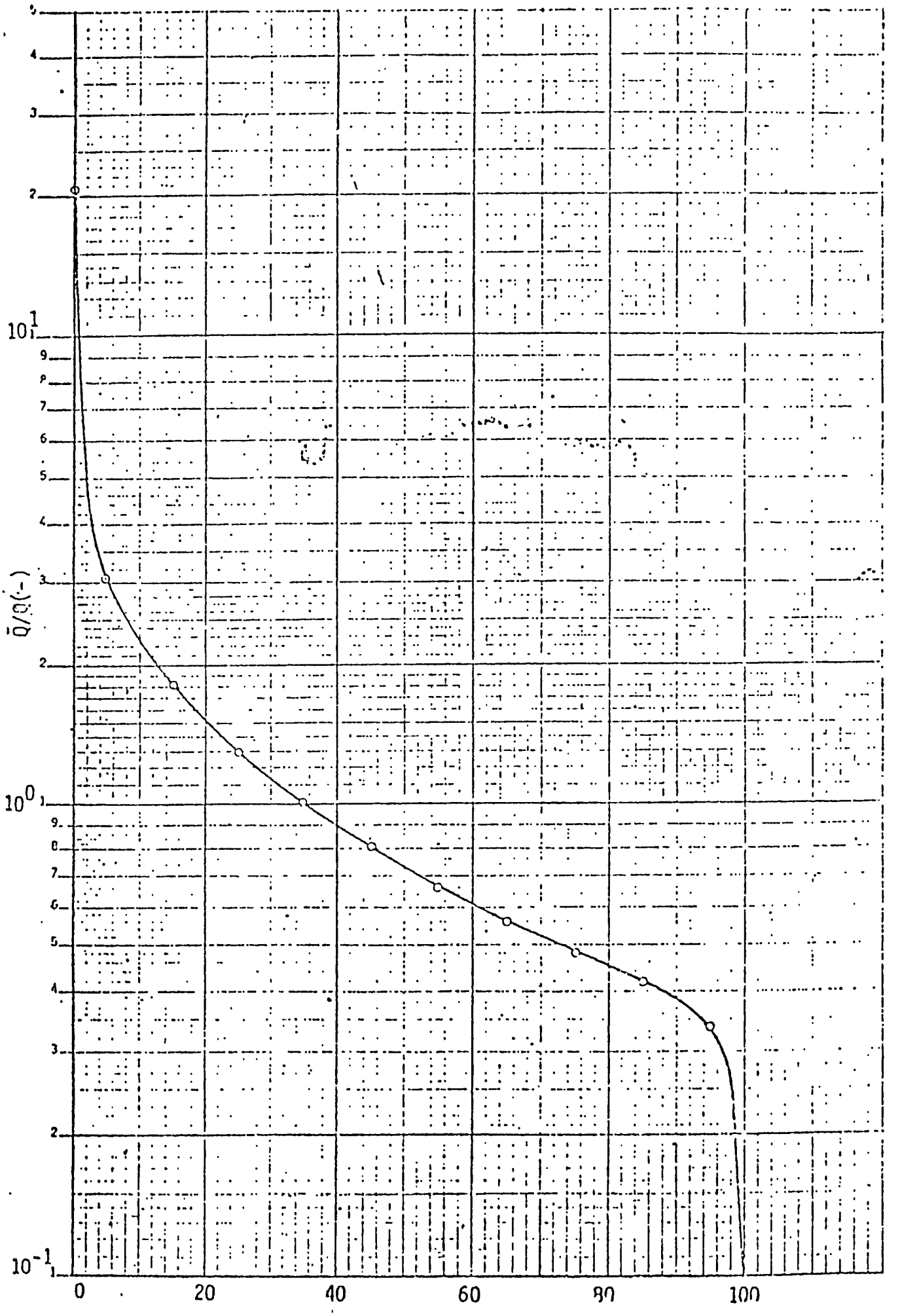


TABLE No.1

RIVER BASINS

1. PACIFIC WATERSHED		2.CARIBBEAN WATERSHED		3.MEXICAN GULF WATERSHED	
1.1	Coatán	2.1	Motagua	3.1	Cuilco
1.2	Suchiate	2.2	Motagua	3.2	Selegua
1.3	Naranjo	2.3	Izabal-Río Dulce	3.3	Nentón
1.4	Ocosito	2.4	Polochic	3.4	Pojom
1.5	Samalá	2.5	Cahabón	3.5	Ixcán
1.6	Sis-Icán	2.6	Sarstún	3.6	Xaclbal
1.7	Nahualate	2.7	Mopán Belice	3.7	Salinas
1.8	Atitlán			3.8	Pasión
1.9	Madre Vieja			3.9	Usumacinta
1.10	Coyolate			3.10	San Pedro
1.11	Acomé				
1.12	Achiguate				
1.13	Maria Linda				
1.14	Paso Hondo				
1.15	Los Esclavos				
1.16	Paz				
1.17	Lempa				
1.18	Lempa				

productive, based on the conditions of recharge which rely on precipitation, lateral inflows and river flow. Within these formations, aquifers exist with water levels located only a few meters below the surface. Transmissivity of these aquifers is approximately 50 m^3/day/meter. The most important alluvial deposits of the country form the great plain of the Pacific Ocean where transmissivity rates of 200 m^3/day/meter are common. There are about 20 important alluvial formations within the volcanic belt. Groundwater is less abundant in the other two zones.

Regime of Water Resources and Seasonal Demand

Water demand increases during the dry season (from November to April). Similarly, during the rainy season, one or two periods of ten days of precipitation deficit are common. For the six month dry period, the demand for irrigation can be met only through supply of surface water from rivers or from groundwater resources.

Stream flows decline rapidly after the rains have ceased. In most principal tributaries the runoff stops in the middle of the dry season. If minimum flow is expressed as a percentage of mean flow, only three basins in the Pacific watershed maintain a sufficiently stable pattern: the Maria Linda, Samala, and Madre Vieja Rivers, where the characteristic low water flows show, respectively, values of 40, 55, and 60 percent of the average flow. For the rest of the basins the average value for the low water flows is 25 percent of the mean flow, ranging between 30 and 35 percent in nine basins of the Pacific watershed and in three basins of the Atlantic watershed.

Low stage discharge can be represented in terms of a ratio, Q95/Qm, expressed as a percentage (see Figure 5) in which Qm is the mean flow and Q95 is the flow characteristic of low stage regime waters. The ratio Q95/Qm ranges between 25 and 30 percent in the Atlantic watershed. In the basins of the Pacific watershed, percentages between 15 and 60 are common.

Low value flow limitations, especially in the Pacific watershed and in the Atlantic basins located in central Guatemala (Motagua, Cuilco, Selegua, and Chixoy), become even more critical, if we consider the topographical aspects of the potential irrigation areas. These are found on the high plains, in inter-mountainous valleys, and on mountainsides. In such cases, irrigation relies on the use of small mountain rivers.

The volcanic belt and the alluvial sediments of the Coastal Pacific zone characterize the most favorable conditions for the safe use of groundwater for irrigation. Low water table levels affect only the low producing shallow aquifers located in middle and high altitudes in the Highlands. The aquifers located on the alluvial sediments of the Pacific Coast and of some rivers such as the Motagua, the High Chixoy, the Villalobos and Michatoya in the Maria Linda Basin, the Quiscab and Panajachel in the Atitlan Closed Basin, have water levels that can drop five meters without changing their level of production.

Water resource availability (surface plus groundwater) is shown in Figure 6. Water availability is relatively low in the zones where agricultural land pressure is very high and vice versa.

Water Quality

The chemical quality of the majority of the rivers in Guatemala is good. The more pressing problem is solids: sediment load is a factor directly affecting performance of many irrigation systems in the country.

Concentrations of dissolved solids and chemicals exist in acceptable amounts for most water sources. Nevertheless, the problem of surface water contamination is becoming serious because of the growth of sewer networks in urban population centers

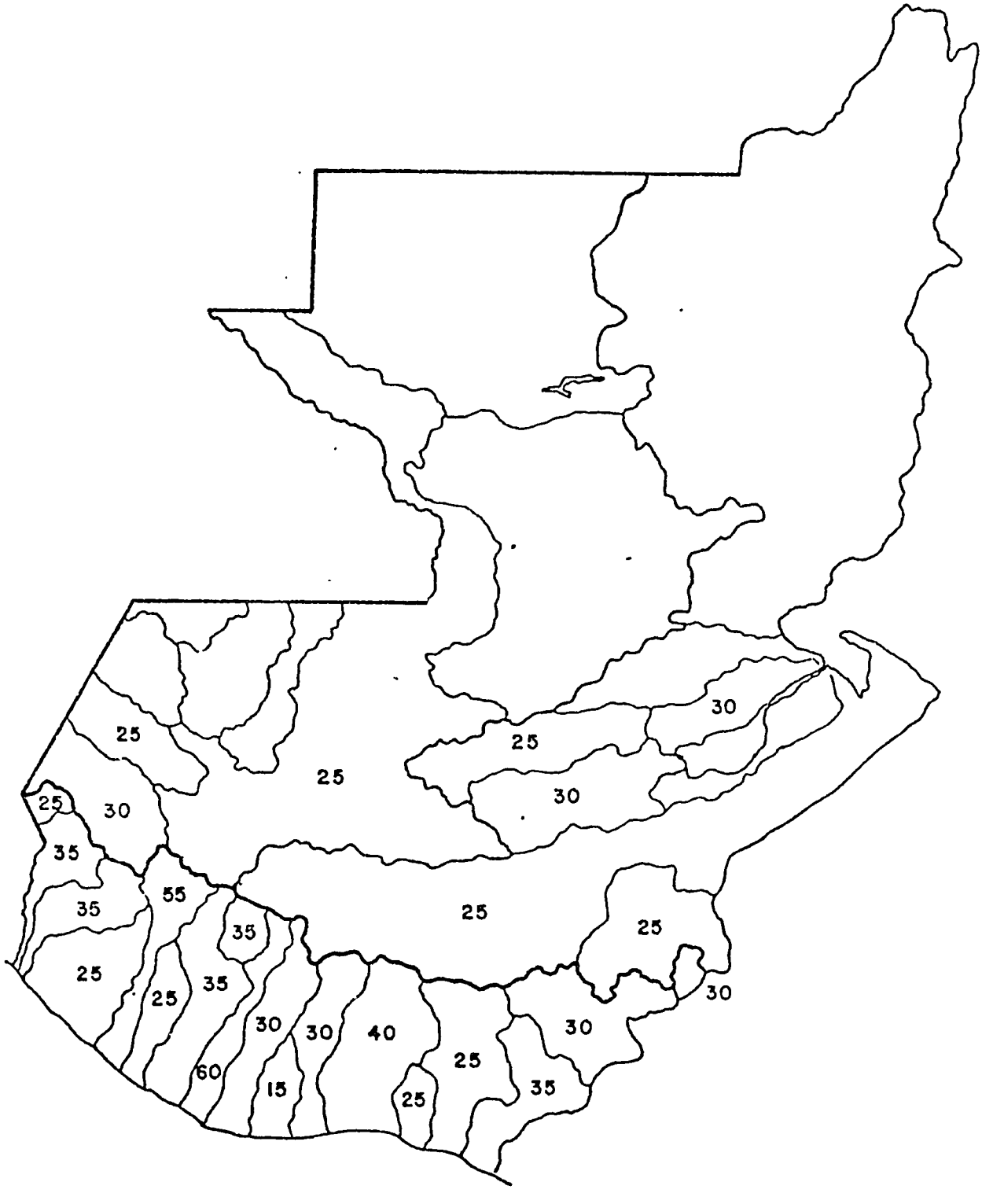


FIG. 5

RATIO $Q_{95}/Qm.$

IN PERCENTAGE

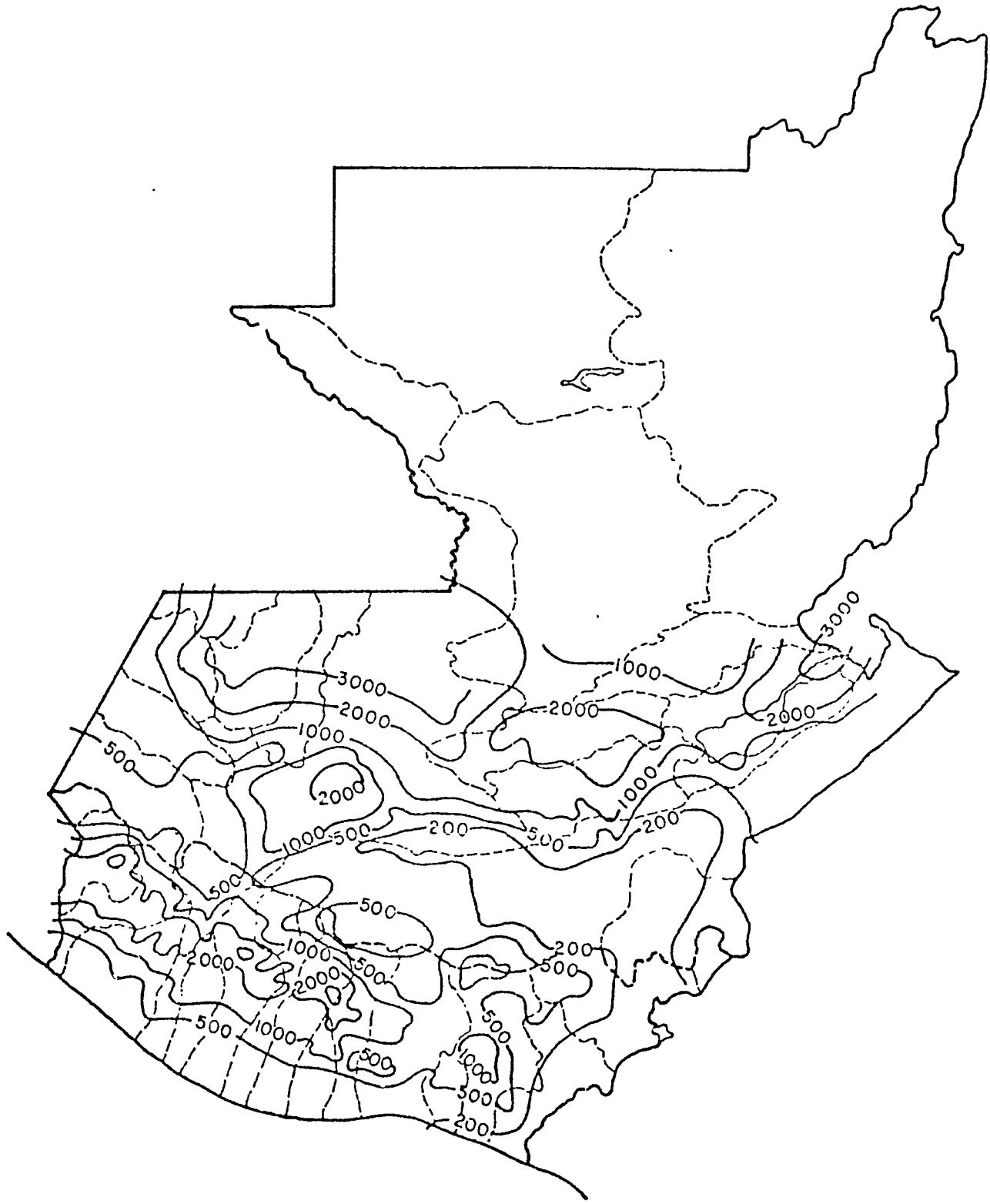


FIG. 6

POTENTIAL TOTAL FLOW

GROUND-WATER AND RUNOFF

MM.

and discharge of untreated sewage into rivers and streams. The greatest concentrations of contamination are found in the rivers close to departmental centers of government and to Guatemala City. Among the most affected of these, the Las Vacas River, receives approximately 90 percent of the domestic and industrial waste water. Likewise, the Villalobos and Michatoya Rivers receives domestic waste water from some outlying areas of Guatemala City, from municipal centers of government, and from industries located in the Maria Linda River Basin.

Inter-Sectoral Conflicts

To date, the priorities of state policies, which carry little continuity between different government administrations, have molded the utilization of water resources. Policy has alternatively favored the agricultural, energy and domestic sectors with different grades of attention over time. Naturally, the tendency in each sector has been to optimize its own benefits in the use of water supply.

As a consequence, the implementation of projects in any sector involves serious conflicts over the availability of water for the remaining sectors. For example, hydroelectric, potable water, and urban sewer projects all restrict the supply of water for those not benefitting from the projects. Inter-sectoral conflicts will continue if water resource management is prey to the agenda of politics. In addition, effective coordination between planning and water resource utilization has not yet occurred.

Information on Water Resources

Although existing data are acceptable for preliminary master planning, detailed planning will require more adequate information about ground and surface waters in the zones suitable for agricultural development.

For at least two decades, the Government has recognized the importance of reliable information about water resources. INSIVUMEH was created to consolidate data gathering activities which had been carried out by more than 30 state offices. However, other public sector institutions (e.g., DIRYA, and INDE) have their own water data information systems.

INSIVUMEH's responsibilities include collecting and processing data, conducting studies and investigations concerning atmospheric and climatic data, surface, and groundwater. It has the responsibility for publishing and publicly transmitting information nationwide. Financial support received from the Government has not been commensurate with INSIVUMEH's growing responsibilities in data collection for which demand in quality, quantity, and coverage is increasing.

INSIVUMEH has produced and published very extensive hydrogeologic information for two regions: the Guatemala City and the Quetzaltenango Valleys. In addition to this, INSIVUMEH has produced many studies within the hydrological field and has in its possession sporadic unpublished data on the hydrogeological characteristics of some regions of the country. Precipitation and temperature data are adequate with sufficient coverage, quality, and chronological constancy. However, data regarding rainfall intensity and other meteorological parameters are inadequate.

Annual hydrological reports contain average daily stream flows and maximum stream flow curves. The coverage of the hydrometric stations includes all the drainage basins of the country, but with interrupted data. In most of the cases continuous records cover only 12 years. Given that the basins do not have sufficient hydrometric stations, and that the spatial distribution of the existing hydrometric stations does not afford good stream flow coverage, information derived from analysis of these data must be carefully evaluated and used with caution.

ANNEX 2

CONSTRUCTION ADEQUACY OF PUBLIC IRRIGATION SYSTEMS

ANNEX 2

CONSTRUCTION ADEQUACY OF PUBLIC IRRIGATION SYSTEMS

OVERVIEW

A typical public-managed project consists of a river diversion, sometimes with sediment removal facilities, and a network of concrete-lined primary and secondary canals. Systems were designed to deliver water to the high points of fields. Except as noted, irrigation facilities in Guatemala generally meet that design criteria. However, due to engineering flaws and management problems, irrigation facilities are not able to deliver design flows on a sustained basis. This has serious negative impact upon the ability of public-managed irrigation systems to generate planned benefits. Principal engineering problems are in sediment removal and in the functioning of headworks facilities.

Public-assisted projects (*miniriego*) consist of a small diversion and intake structure, or a well, with delivery of the water by gravity and sometimes by pumping through a PVC pipe system to individual land holdings. Projects were constructed beginning in 1979 with funding from USAID. Publicly-assisted irrigation projects generally have been well constructed and are well maintained.

In addition, since 1978, USAID has funded more than 185 small-scale *miniriego* projects in the Highlands, Zacapa, and Chiquimula. Other donors such as German Assistance (COGAAT) have funded more than 35 other *miniriego* projects. Design and construction are generally adequate.

Public irrigation projects were constructed beginning in 1962 with local funds and force account labor. Donor funded projects were constructed beginning in the early 1970s with principal support from the Inter-American Development Bank (BID). Early projects such as Llanos de Piedra, El Guayabal, and El Rancho were generally well designed and constructed. Projects selected and constructed in a second phase -- Nica, Catarina, and La Blanca -- were notably poorer in their construction. These projects were prepared in relative haste with final design occurring at the same time as construction. Social organization was also ignored in that the irrigation network was superimposed on existing settlement schemes (Catarina excepted). This had profound impact, for example in La Blanca where settlers refused to cede 40-meter rights-of-way for irrigation canals. As a result, the project cannot now deliver gravity water to all portions of the project area. The second-phase projects were chosen for irrigation not because they were the best projects either economically or from an engineering viewpoint, but because at donor insistence, land tenure was not a problem.

CONSTRUCTION ADEQUACY

Barrage and Headworks

Barrage and headworks problems are common and contribute to a system's inability to deliver design flows. Several headworks were damaged by erosion; others such as the headworks at Catarina were damaged by high water in the river. In 1982, floodwater washed away the headworks of Asuncion Mita, El Tempisque, and Sansirisay. Flood damage can be attributed to design flaws -- that is, to a lack of hydrological record and an inability to plan for 100-year floods. This informational gap needs to be addressed.

Sediment Exclusion

The inability to deal with sediment load is the most important engineering problem encountered. This common problem is evident in systems that offtake from the Rio Grande de Zacapa and from the Motagua River. Accumulation of sediment in the headworks and in the main canal has reduced flow capacity of the entire system and directly affects planting areas in La Fragua, El Guayabal, and Llanos de Piedra. The capacity of pumps at Llanos de Piedra, Cabanas, and San Cristobal is reduced by wear caused by heavy sediment load. It is possible to reduce sediment load through a redesign of the headworks facilities and through the introduction of additional sediment exclusion facilities. However, these solutions are costly and the results are by no means assured.

Canal Network

In general, lined canals are well constructed with no evidence of design flaws or poor quality construction materials. A problem exists in La Blanca where, because of the right-of-way problem mentioned above, design changes resulted in water surface elevations too low to serve certain parcels. In other irrigation systems, certain parcels are not served, but this is because of economic decisions taken during design.

Pumps and Wells

Sediment-laden waters and a lack of preventative maintenance have resulted in pump failures at Palo Amontonado, Cabanas, San Cristobal, and Llanos de Piedra. The issue here is a lack of maintenance rather than poor construction. None of the "Emergency Fund" projects has been in function long enough to detect pump-related problems. However, well performance cannot be measured both because installations lack access points to measure water depth and pump discharge, and no well-performance program is being implemented.

Drainage

At the time of construction of the irrigation facilities, drainage was never considered. Some of the lower portions of La Blanca demonstrate drainage problems because the irrigation canals run cross-slope and impede natural drainage. Portions of La Fragua and Cabanas also have drainage problems.

Accessibility

Access to and within many of the irrigation systems is also a problem. Projects such as Nica and La Palma and the proposed project at Montufar suffer from severe road problems. The case of Canilla is perhaps the worst: To reach the project, one must travel a 53 kilometer dirt road passable only with a four-wheel drive vehicle and only in the dry season. The headworks for Canilla is seven kilometers from the irrigation area and only accessible on foot. Access to the headworks for Catarina is also problematic. Poor access has at least two negative implications for an irrigation project: 1) because of inaccessibility, maintenance of facilities will be made difficult; and very importantly, and 2) farmers will have increased difficulty in getting their products to markets.

ANNEX 3

PROJECT APPRAISAL CRITERIA

ANNEX 3

PROJECT APPRAISAL CRITERIA

INTRODUCTION

Irrigation projects in Guatemala have been subjected to appraisals as part of the planning process since the earliest BID/GOG projects in the 1970s. A cursory review of some of those studies reveals severe deficiencies in their assumptions and methodologies. A glaring difference exists between the assumptions made about crop mixes and market prices for project planning and reality. There is no evidence that farmer preferences were ascertained or that they were involved in the planning process in any way. But poor appraisal methodology is not the principal reason the public sector irrigation units failed to meet design expectations. Portions of the canal systems were never constructed or were constructed with reduced capacity. As indicated in Chapter Four, weak management contributes to poor sub-sector performance.

Project appraisal techniques improved significantly in public-assisted projects in the 1970s. For example, every potential *miniriego* project for which a farmer group was able and willing to organize, was evaluated for physical and financial feasibility. Although mistakes were made in appraisal -- particularly in early projects -- DIGESA technicians improved their methodological expertise over time. Principal weaknesses lie in the assumptions used about agricultural markets and farmer behavior. Technicians still lack firm information upon which to base predictions. Improved methods can increase the soundness of their analysis greatly.

The appraisal process broke down under the load imposed by rapid implementation of groundwater *miniriego* projects financed by the USAID Emergency Fund. Wells were drilled primarily according to the criterion of physical feasibility; economic and social feasibility analyses were not achievable within the proscribed time frame. As a consequence, most of the wells do not meet the needs of potential users and lie dormant. In this case the appraisal process was compromised by administrative urgencies.

Considerable improvement can be made by drawing on experience gained with irrigation projects in Guatemala. The objective of this Annex is to suggest appraisal criteria and approaches for improvement. The focus is on economic criteria, analysis of which has been particularly lacking.

THE ROLE OF APPRAISAL

The object of project appraisal is to subject the scheme to critical scrutiny which will reduce the likelihood of failure. Appraisals are also used to decide among alternatives. They provide a basis for financial investments. Except for physical feasibility, no single criterion need necessarily take precedence over the others. For example, financial appraisal might reveal that a particular investment will be only marginally profitable, but the social appraisal could offer compelling reasons for undertaking the project.

Physical Feasibility

Physical feasibility is an engineering concept: to succeed the project must have access to an adequate and reliable water supply; have irrigable soil and manageable topography; have a means to install a water conveyance system; and meet other criteria. With the exception of hastily-prepared feasibility reports for Catarina, La Blanca, and Nica, engineering considerations have been dealt with in an acceptable manner.

Financial Feasibility

Financial feasibility analysis considers the ability of the project to produce positive net revenue streams. While an irrigation project may not be conceived to be profit making in itself, cost recovery measures might make the project sustainable without imposing a charge on the government budget. Alternatively, the augmented tax revenues from higher-earning beneficiaries might make it feasible. Certainly the farmers and their families who are its direct beneficiaries must receive additional net income; if they fail to do so they will not continue to participate and the project will fail.

Economic Feasibility

Economic feasibility is a broader concept; it recognizes that society loses the alternative use of any productive resources that are used to build and operate this project, and that its valuation of resources may differ from that of private decision-makers. Two such examples are nonrenewable resources or labor which is otherwise unemployed. Society may also incur costs or reap gains external to the private calculations of individuals within the project. Such costs include additional costs that will be incurred for agricultural extension services, irrigation system O&M, and administration; benefits to society may include lower costs to consumers or higher incomes to suppliers of agricultural inputs. Finally, society may not be concerned with financial flows that are simply transfers between individuals but do not consume any economic resources. The literature on economic feasibility analysis is extensive, but a good introduction is given in Gittinger (1982). Bottrall (1981) presents a useful methodology for evaluating irrigation management.Financial feasibility:

Social Feasibility

Social feasibility concerns the ability and willingness of people to learn how to produce with irrigation, cooperate in operating the systems, and deal with commercial markets. It requires a subjective determination of how well an individual or group will adapt to the social changes brought about through irrigation such as higher incomes, changes in income distribution, production of commercial crops in lieu of subsistence crops, higher labor utilization, more hired labor, and many other factors.

ECONOMIC MEASURES OF PROJECT WORTH

The two principal economic measures of project worth used in irrigation project appraisal are the internal rate of return (IRR) and the benefit-cost ratio (BCR). The former is used almost exclusively in agricultural project appraisals by the international banks; the latter is used by the US Bureau of Reclamation.

The IRR is the rate of return on funds invested in the project. If the rate exceeds the opportunity cost of these funds (the rate at which money can be borrowed), the project is financially justifiable. An IRR equal to the cost of funds used is "break-even." If this is true, when all costs and benefits attributable to the project are included at their opportunity cost to the economy, the project is economically justified.

The BCR is the quotient of the present value of the expected stream of future benefits divided by the present value of the expected stream of future costs. Other things being equal, if the quotient is equal to or greater than 1.0, the project's benefits exceed its cost and it may be undertaken.

Either the IRR or BCR can be used in project appraisal. The two measures are related. Both depend on establishment of benefit and cost streams and calculation is not "mechanical;" it is an art (some would say a guessing game) requiring experience and judgment in estimating future revenues and costs. Overoptimism of future outputs and prices, and failure to include all costs are the most common sources of the failure of irrigation projects to meet their goals.

Benefit streams (revenues) depend upon how quickly and well farmers learn to use the irrigation, what farmers will grow, how many crops per year will be planted, what prices will be, what yields will be obtained, and importantly, how soon (when) will production estimates be realized. On the cost side, difficulties arise from estimating construction prices and schedules, estimating ongoing costs to operate and maintain the system, and including external costs imposed such as drainage in the costs.

Irrigation projects are capital intensive with most of the costs incurred early, and all benefit streams occur far in the future. So, the present value of a distant future benefit becomes quite small. This is why irrigation projects do not lend themselves to IRR or BCR analysis, except to differentiate among competing irrigation alternatives. Existing irrigation projects frequently will have returns far greater than new ones. Not only are additional construction costs less for established projects where most of the investment has been done already, but existing projects serve farmers who already have experience with irrigation. They already have made their learning mistakes, so production is likely to increase more quickly on older projects than on new ones. Earlier production has a profound effect upon the IRR or the BCR calculation.

CONSISTENT APPLICATION OF CRITERIA

Regardless of which appraisal criteria or measures are used, their application must be consistent. If each competing project is subjected to the same criteria, everyone can understand what criteria must be satisfied. Second, application of consistent criteria helps eliminate bias. Third, consistent application helps eliminate projects which do not meet pre-determined levels of acceptance, so poor projects are less likely to be funded because of a methodological difference in the analysis. Finally, consistency serves as a rationing mechanism for allocating scarce funds. Consistency is important in the case of *miniriego*, where projects are evaluated a few at a time. DIGESA cannot wait for 50 or 60 proposed projects to accumulate before deciding which are worthy of funding; each must be evaluated on its own merits without knowing what others will follow.

A systematic appraisal was proposed by Ortiz (1989). He proposes a point system consisting of eight criteria:

- Irrigation potential;
- Existence of diversified, commercial agriculture;
- Presence and capacity of government institutions;
- Market potential;
- Socioeconomic impact;
- Organizational capacity of irrigators;
- Availability of credit services; and
- Potential for environmental degradation.

Although definitions are vague and assignment of points is subjective, this represents a first step in design of a systematic appraisal process. The principal missing ingredient is the lack of application of measures such as IRR or BCR. Further, a system that uses subjective assignment of points risks approving a project that meets the minimum overall point requirement, but has such low scores in one or two criteria that the project should not be funded.

CONCLUSIONS

Past irrigation project appraisals have been deficient. Economic and social dimensions are sometimes inseparable, however, which emphasizes the need for a multidisciplinary approach. It is important that the appraisal get feedback from farmers as to what they will grow with irrigation, or whether they intend to irrigate at all.

Training of DIGESA personnel in the art and science of irrigation project appraisal should be made a priority. An appraisal framework that can be applied with consistency against proposed new projects should be adopted. Project appraisal manuals should be prepared to help achieve this objective.