Irrigation Decision-Making Processes and Conditions

A Case Study of Sri Lanka's Kirindi Oya Irrigation and Settlement Project

Charles Nijman

INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

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Please direct inquiries and comments to:

Information Office
International Irrigation Management Institute
P.O. Box 2075
Colombo
Sri Lanka

Cover photograph by Douglas J. Merrey: Gated cross-regulator with overflowing side wall in the Left Bank main canal of Kirindi Oya.

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Weights and Measures

1	meter (m)	=	3.28 feet
1	millimeter (mm)	=	0.039 inch
1	kilometer (km)	=	0.62 miles
1	hectare (ha)	=	2.47 acres
1	million cubic meters (mcm)	=	810 acre feet
1	ton (t)	=	1,000 kilograms (kg)
1	cubic meter per second (m^3/sec)	=	35.3 cubic feet per second (cusec)
1	square kilometer (km^2)	=	0.39 square mile

Abbreviations

ADB	Asian Development Bank
AHT/SCG	Agrar-und Hydrotechnik GMBH/Salzgitter Consult GMBH
EIRR	Economic Internal Rate of Return
FAO	Food and Agriculture Organization of the United Nations
IFAD	International Fund for Agricultural Development
IIMI	International Irrigation Management Institute
INMAS	Integrated Management of Major Irrigation Settlement Schemes
m.s.l.	Mean Sea Level
KfW	Kreditanstalt fur Wiederaufbau
KOISP	Kirindi Oya Irrigation and Settlement Project
PAM	Project Administration Memorandum
PBME	Project Benefit Monitoring and Evaluation
PMF	Probable Maximum Flood
SFC	Subsidiary Field Crops
WAPCOS	Water and Power Consultancy Services

Glossary

bethma	sharing of certain irrigated areas during dry seasons
chena	slash-and-burn cultivation
kanna	cultivation
maha season	main wet season
paddy	rice
tank	reservoir
yala season	secondary wet season

Foreword

INTRODUCING A MANAGEMENT perspective in all stages of irrigation development is one of the crucial challenges we are faced with in improving the performance of irrigation systems. Economists, engineers, sociologists and other disciplinary specialists working in the irrigation field all contribute certain diagnostic approaches and tools, but these cover only some of the issues relevant to irrigation managers. The organizational analysis presented in this paper is the second on the theme and part of an effort by the International Irrigation Management Institute (IIMI) to look at irrigation in a more integral manner.

The analysis presented is unique in its focus on the functionality of different disciplinary approaches in actual decision-making processes during planning, design and operation of irrigation systems. It also takes an integrative perspective of how different management conditions as human resources, their motivation and incentives, management information systems, organizational structure and other management control systems influence these decision-making processes, and ultimately the performance of the irrigation system.

Internal and external reviews of this paper have stressed the importance of the systematic and integrated approach taken in the analysis, its high quality, and the wider applicability of the findings and recommendations. Given the systematic performance problems in the irrigated sector, it is not surprising that some of the findings presented in this report are rather sensitive to the involved actors, the agency and national government, as well as the consultants and donor. However, this management analysis presents systematic flaws of the irrigation sector rather than performance of individual staff or organizations, and we have attempted to present the text as such, as far as this is really possible for such a detailed case study. We sincerely hope that all who read this book will do so in this spirit, and will distill its significant contributions to irrigated agriculture.

Indeed, the second case study of this kind by IIMI presented in this paper is an important effort towards a better problem definition of the widespread underperformance in irrigated agriculture.

Khalid Mohtadullah
Director for Research
International Irrigation Management Institute

Preface

THE DETAILED STUDY of irrigation decision-making processes and managerial conditions presented in this paper is part of IIMI's efforts to integrate a management perspective into the assessment of irrigation performance. This management perspective requires an amalgamation of two key disciplines involved in irrigation management, irrigation engineering and management sciences, into an analytical framework for irrigation management. Irrigation engineering approaches are evaluated by their contribution to the actual decision-making processes during system planning and design, and system operation. Yet, in the analysis of the most relevant decision-making processes, conceptual contributions of other disciplines such as economics, sociology and agronomy have to be considered as well.

Developing such a management perspective requires inputs from practitioners, researchers and specialists of all these disciplines. The development of a management perspective is, therefore, initially done through case studies, of which this paper is one. This case study deals with the development of a new irrigation-cum-settlement system, while a parallel case study deals with a rehabilitation project, the Uda Walawe system in South Sri Lanka (Nijman 1991).

Apart from available hardware data in the form of reports, files and studies on the Kirindi Oya system, this study is based, to a large extent, on a large number of interviews with a wide scope of involved actors — from farmers and gate tenders of the Kirindi Oya system to top officials of the involved managing agencies, the responsible ministries and the donor. Moreover, external consultants, researchers, former decision makers and an involved ex-Member of Parliament have been interviewed. Their knowledge and opinions, together with the data provided the basis for an analytical framework for the study.

Even though supported by this analytical framework and its "objective" management perspective, the story represents the author's distillation of the

"true" picture of irrigation management in the Kirindi Oya system. Thus, only the author is responsible for this paper; the views expressed herein are his own.

It is certainly not the objective of this analysis to find fault with individuals in agencies, the government, consultancy firms or the donor regarding their involvement in the Kirindi Oya system. Instead, the paper tries to provide an overall picture of the effectiveness of the decision-making processes with respect to delivering water, and demonstrates the systematics in certain bottlenecks in irrigation management; reviewers have all remarked that the validity of the "system" described in this picture goes beyond the Kirindi Oya system or Sri Lanka. Findings of the parallel case study on the Uda Walawe system were largely the same. To a certain degree, many of these findings and recommendations apply to government agencies and donors involved in irrigation in other developing countries as well. If at all individuals can be identified, they should certainly not be criticized because this paper is about the performance of the "system" of irrigation development and management in developing countries, and not about individual performance.

Much of the data collection for this case study was carried out during *maha* 1987/88 and *yala* 1988. Interviews were conducted from maha 1987/88 to maha 1989/90. The study does not cover changes in the management of the Kirindi Oya project, which have occurred since maha 1989/90.

Given the dependence of this study on the interaction with irrigation practitioners and researchers, I am very grateful to the large number of people, who afforded me their time for interviews, often iteratively. I hope that most of them could recognize their contributions in the analysis and recommendations given in this paper. Moreover, I am very grateful for the cooperation and assistance I received from the staff of the Irrigation Department, particularly Mr. S.A.P. Samarasinghe (Chief Resident Engineer), Mr. Ivan Silva (then Resident Engineer, Right Bank), Mr. B.K. Jayasundera (then Senior Irrigation Engineer), and from the staff of other involved agencies, notably, Mr. Chandra Ranasinghe (then Project Manager, Settlement), Mr. Sena Jayasuriya (then Assistant Project Manager, Settlement), Mr. U.M. Liyanage (Project Manager, Irrigation Management Division), Mr. Gunawardana (then Project Manager, Irrigation Management

Division), and Mr. Boosa (then Department of Agriculture, Extension Division). In addition, I would like to thank Mr. Nanda Abeywickrama (then Secretary, Ministry of Lands and Land Development), Mr. M.S. Wickramarachchi (Land Commissioner) and Mr. E.P. Wimalabandu (Project Director, Irrigation Department) for providing the necessary support to carry out this study. I am also grateful to the staff of the Agrar-und Hydrotechnik GMBH/Salzgitter Consult GMBH and the Asian Development Bank for their cooperation in this research.

Useful comments on a draft of this paper were provided by a number of agency and government staff. I would like to thank, in particular, Mr. W.M.N. Botejue, Acting Director of Irrigation and Mr. D.M. Ariyaratne, Director of the Irrigation Management Division for their comments and suggestions, which I have tried to accommodate, as much as possible, in the final text. I am also grateful to those members of the Asian Development Bank, who helped me by providing valuable comments and critical suggestions in the process of this research. However, they may not agree with some of the conclusions arrived at.

This study would not have been possible without the valuable advice and comments from a number of IIMI staff in Tissamaharama and Colombo. Also, I would like to thank, in particular, Dr. Douglas J. Merrey, Dr. P.S. Rao, Dr. Masao Kikuchi, Mr. Nihal Fernando, Mr. P.G. Somaratne, Prof. Drs. A.A. Kampfraath, Dr. Fred Valera, Dr. R. Saktivadivel, Dr. Hammond Murray-Rust, Prof. Khin Maung Kyi, Ms. Inge Jungeling, Dr. Chris Panabokke and Mr. Ranjith Ratnayake. Special thanks are due to Mr. Adriza for his assistance in preparing some of the figures.

The research was supported by the Research and Technology Department (DPO/OT) of the Ministry of Foreign Affairs of the Netherlands through my secondment to IIMI for a period of four years. Additional research and publication were funded with IIMI's unrestricted core funds, for which I am very grateful to IIMI.

I gratefully acknowledge Prof. Drs. A.A. Kampfraath for providing indispensable technical guidance in the development of the analytical framework and its application to this case study, Dr. P.S. Rao for the support and technical supervision provided in an early stage of this case study and Mr. Charles Abernethy for the support and supervision at later stages of the study. Finally, while acknowledging the assistance rendered by various

individuals in the course of this research, the author takes the full responsibility for the facts and the opinions contained herein.

Reading Advice

Readers with very limited time who want to grasp the main message in the paper are advised to read the Executive Summary and Chapter 11, which contain the overall picture, conclusions and recommendations.

Readers with limited time who, in addition to the above, are interested in the opportunities for improvement of key decision-making processes and managerial conditions rather than in their detailed description and analysis may also read chapters 6 and 10.

Charles Nijman
Management Specialist

"Let not even one drop of water that falls on the earth in the form of rain be allowed to reach the sea without first being made useful to man."

King Parakramabahu the Great (1153-1186 AD)

Executive Summary

THE OBJECTIVE OF this report is to provide an insight into a management perspective on decision-making processes in system creation and system utilization. This management perspective is based primarily on information obtained from irrigation managers and external consultants and through direct observations in the Kirindi Oya system, a major irrigation system in Sri Lanka, and in the head office of the Irrigation Department and other relevant government bodies from March 1988 to the end of 1989. It is also based on reports, files and records of the Irrigation Department, and on interaction of the author with IIMI research staff residing in the project area as well as those based at IIMI's Colombo office, who were working on a parallel IIMI research project in the Kirindi Oya system. The paper focuses on both the management of a major donor-funded new construction program and the operation of the system after construction. The report does not cover the developments in the project after the end of 1989.

PROCESS-BASED ANALYTICAL IRRIGATION MANAGEMENT FRAMEWORK

This study uses an analytical irrigation management framework, which has been derived from a general management framework developed by Prof. Drs. A.A. Kampfraath and his colleagues at the Department of Management Studies of the Wageningen Agricultural University in the Netherlands. This framework classifies the decisions, which are made in an organization according to their contributions to the overall performance of the organization, instead of looking at the performance of structural appearances of the organization (e.g., persons, divisions). This means that a process

orientation rather than a structure orientation is adopted to evaluate the effectiveness of the decision-making processes themselves. For example, in this study, the primary criterion of evaluating client participation is its impact on, for example, the water allocation processes.

Management of water is considered the primary irrigation activity. To evaluate the internal management processes in any irrigation system, key decisions with respect to water delivery should be defined. In *system utilization*, decisions on seasonal allocation, in-seasonal allocation and water flow regulation have been recognized as key decisions. For the evaluation of *system creation*, desired system objectives, feasible system objectives and functional system requirements have been taken as the most relevant areas of key decision-making.

This study of the Kirindi Oya system begins with a description and analysis of the technical and managerial aspects of these key decision-making processes and their mutual adaptation. Indicators are established for the management performance of these key decision-making processes in the Kirindi Oya system. Opportunities for improvement of the management performance of each key decision-making process are indicated in terms of requirements for the processes and managerial conditions (i.e., people, provision of information, systems and methods, provision of knowledge, organizational rules). The following is a short summary of the most significant findings and recommendations for the management of system utilization and system creation in the Kirindi Oya system. These are applicable, to a large degree, to the Irrigation Department as a whole, and, in varying degrees, to other irrigation management agencies.

SYSTEM UTILIZATION: OPERATIONAL ACTIVITIES

Seasonal and In-seasonal Allocation

Recent studies by the Irrigation Department (Dharmasena 1988) and IIMI (1990) on the available water resources of the Kirindi Oya system have

shown that the actual water availability of the system is 25 percent to 60 percent less than what was expected at the time of planning and design; the Kirindi Oya system is structurally a water-short system.

Seasonal allocation plan. In its seasonal assessment of the irrigation water requirements, the Irrigation Department relied mainly on theoretical calculations based on measurement data of seasonal water deliveries achieved in the past. These water deliveries were realized mainly in a demand-driven mode and are considered to represent the preferences of the water users. The Irrigation Department did not assess the water-user requirements in regard to cultivation calendars (of staggered irrigable areas), cropping patterns, irrigated extents and acceptable cultivation risks. The Irrigation Management Division carried out a separate assessment of requirements of the water users at field-channel, distributary-channel and project levels only in regard to cultivation calendars, cropping patterns and irrigated extents; water requirements in regard to acceptable cultivation risks were not assessed at all.

Though there was no interaction between these two parallel demand assessments, a proposed seasonal allocation plan was developed by the Irrigation Department and forwarded, through the Government Agent, to the water users at precultivation and cultivation meetings. The water user representatives organized by the Irrigation Management Division were developing their own proposal prior to the precultivation meeting. But, at precultivation and cultivation meetings as well as at meetings of the Project Coordinating Committee and its Subcommittee, no effective interaction took place between the water user representatives and the Irrigation Department staff to match the plan of the latter with the demands of the former. Instead, the proposal of the Irrigation Department was pushed by the different involved agencies causing frustration among the water user representatives, who had developed their own proposals starting from yala 1988, and tried to carry them out, with different levels of success. This resulted in more and more *ad hoc* decision-making processes and outcomes and, from the point of view of the water users, reduced the credibility of the Irrigation Department.

The lack of interaction between the agency staff, the water user representatives and the Irrigation Management Division was due to several underlying causes. One was the failure of the staff of the Irrigation

Department and the Land Commissioner's Department to lay much emphasis on management inputs in the communication with the water users. Most agency staff had an aversion to the political nature of the role of the Project Manager of the Irrigation Management Division. Moreover, to evade complaints being made about the quality of the construction works, the Irrigation Department and the Land Commissioner's Department did not like water user participation. In addition, personal conflicts among the different Project Managers impeded effective interaction.

The progress of implementation of the seasonal plan in the main canal took place in conformity with the schedule of staggered cultivation. But delays occurred within the distributary-channel subsystem due mainly to the difficulties the water users had to face in obtaining inputs and credits. At that level, there was no monitoring or guidance of the Irrigation Department or the Irrigation Management Division to expedite the start of the cultivation season. Such monitoring and guidance could have instilled discipline among farmers to adhere to the cultivation calendar. As a result, without exception, the completion of cultivation seasons had to be put off for a couple of weeks.

In-seasonal allocation. Demand assessment during the season was done mainly by the gate tenders without any guidance, monitoring or evaluation by higher-level staff. The higher-level staff adhered to the officially accepted theoretical water requirements and the management of the difference in supply and demand was left to the field-level staff. It usually resulted in water flows in excess of the real requirement and wastage of water. Consequently, the higher-level staff could not exert any pressure on the water users to economize on water use in the system. The only available control in this respect was the shortage of water at specific locations; for head enders this control usually did not exist and there was wastage of water.

Matching of supply and demand that is largely localized, leads to oversupplies at the head end and undersupplies at the tail end of a water delivery system or subsystem. The only way to resolve this problem is to make this matching of supply and demand less localized through the involvement of higher-level staff.

The establishment of an information feedback system like the Water Management Feedback Center could provide a tool for the higher-level staff to get themselves more involved in these processes. However, this tool was not seriously utilized in the Kirindi Oya system, because most of the

Irrigation Department staff were not willing to get involved in allocation processes.

The discrepancy between the managerial and technical aspects was made obvious in the introduction of rotational deliveries. Whereas the role of the Water Management Feedback Center was to schedule these deliveries and get regular feedback for adaptations, the office responsible for the implementation of these scheduled deliveries (i.e., the Resident Engineer's office) did not even seriously calculate the corresponding water levels. The disparity between what the Irrigation Department officially claimed it intended to achieve and what it actually attempted to achieve through its allocation decision-making processes made the allocation strategy ambiguous.

The "macro-control" of the issues from the head sluices exercised by the Water Management Feedback Center was the only managerial influence in the whole system. In the absence of any other managerial controls on the allocation decision-making processes this control must be considered as the best feasible approach under the given constraints; but it caused problems owing to lack of feedback and integration of demand requirements in the allocations from the head sluice.

At all hierarchical levels the seasonal and in-seasonal allocation decisions were dominated by a desire to minimize management inputs of staff combined with a desire to minimize the complaints to agency staff by the water users and politicians.

Main recommendations. Improvement of the allocation processes seems possible, only if more interaction with the water users is pursued during the preparatory stages of seasonal and in-seasonal planning. Moreover, monitoring and evaluation of the actual progress of implementation within the distributary-channel subsystem are required to speed up the implementation of the seasonal plan as well as to adjust water deliveries to the actual progress. Such improvements will require better management inputs into the interaction between different levels of staff of the Irrigation Department (ID) and between the Irrigation Department staff and the water users. The fact that there is a large number of water users in a small-holder system like Kirindi Oya caused the Irrigation Department to organize the water users into viable groups, which are to be represented by their respective leaders.

Such improvements in management inputs, managerial attitudes, interaction between ID staff and the water users and subordinates, information flows, and allocation strategies all seem to depend on the more basic precondition of more commitment and accountability of all levels of staff to the seasonal and in-seasonal water delivery performance. Priority for improvement lies with building up such an overall institutional support to the allocation performance. This has to be initiated and developed by the head offices of the Irrigation Department and the Irrigation Management Division rather than only at project level.

Potential performance indicators of the allocation concern are, for example, the scheduled and realized water duties, cropped areas, and yields for the main canal, branch canal, and distributary channel subsystems, which could be monitored on a regular basis. The related contribution or accountability of different staff to these performance indicators can be developed over time with experience in using these indicators. Without seriously introducing these performance indicators for assessment of staff performance, especially the water-related indicators, improvements in the allocation seem very unlikely.

Water Flow Regulation

Guidance, and motivation of gate tenders, and the monitoring and evaluation of their operational methods and procedures were completely absent in the Kirindi Oya system. The water flow regulation was not adhered to by staff of levels higher than field staff, except for the operation of the head sluice. If the gate tenders are not guided and supported in the establishment of proper operational methods, the establishment of *ad hoc* methods is inevitable. This is the beginning of a self-reinforcing process with the *ad hoc* methods causing fluctuations in the main canal, which in turn would make the monitoring of the actual operational methods and actual allocation processes by higher-level staff irregular, as well as very difficult.

It was difficult to coordinate operations of the different structures of the system, because the adjustment of gate settings was not done at the correct time, the gate settings were not to the required size, and the frequency of

adjustments was incorrect. This was especially true for the main canal, which was badly taken care of, making the conveyance of water along it ineffective.

Most staff of the Irrigation Department expected these problems to be solved, over time, through on-the-job experience of the gate tenders. However, without the guidance of higher-level staff on the timing, size and variation of discharge, and required operational methods, the building up of such experience was almost impossible. Further, more experience would not have ensured better management of the conveyance along the main canal, as distribution remained a prime concern.

Main recommendations. To achieve improved water flow regulation, staff at a level higher than field staff should monitor and evaluate the actual implementation to ensure that the conveyance along the main canal is taken care of appropriately. Only by such monitoring and evaluation can the higher-level staff become familiar with the actual operational methods, which enable them to monitor and improve these methods. Increased monitoring and evaluation of the work of the gate tenders will not only help them, but also motivate them to perform better when they see the interest shown by their superiors.

Improved management performance regarding the water flow regulation is unlikely without overall institutional support and accountability for the water flow regulation performance by the Irrigation Department staff. As for the allocation concerns, this accountability will have to be initiated and developed by the Irrigation Department head office or the highest level policymakers rather than by project-level management only.

SYSTEM CREATION: PLANNING, INVESTIGATIONS AND DESIGN

Desired System Objectives

According to most of the local community, the local politicians and the project beneficiaries, certain coveted national, political and agency priorities (i.e., quick results and engineering prestige, respectively) dominated the

selection of the Lunuganwehera dam site, and it had resulted in much less desirable and sustainable project objectives than for the alternative Hurathgamuwa site.

The donor did not intervene in this macro-level decision, which was highly political. Further elaborations of the desirable project objectives in terms of crops to be grown, water duties, cropping intensities and the areas to be commanded, were done mainly by the donor staff and the consultants. The desirability of these project objectives from the point of view of the local community, the local politicians and the project beneficiaries was not determined.

Also, the interaction of the donor staff with the agency staff for assessing the real desirability of the proposed project and its components was less objective and thus ineffective. Effective interaction was necessary because of the link between these elaborations and funding decisions, of which the latter had agency and political priority.

The desired objectives of the Kirindi Oya project were, to a large extent, determined and fixed at the commencement of the project in 1977. These objectives were specified in terms of the area to be irrigated, the crops to be grown, water duties, cropping intensities and the number of people to be settled within a certain time frame. Their fixed nature evolved from the fact that these objectives underlay the Economic Internal Rate of Return (EIRR), which was rather marginal for the Kirindi Oya Irrigation and Settlement Project (KOISP) and thus allowed for very little flexibility at later stages.

At later stages of the project, the water duties, as assumed in 1977, appeared to be undesirable at project and field levels and thus unrealistic. So, it was assumed that the directly related project benefits in terms of the size of the command area, cropping intensities and the related Economic Internal Rate of Return (EIRR) could only be attained by growing subsidiary field crops during the yala season in all New Areas. This has not yet been achieved.

The commitment and accountability of the government, the agencies and the beneficiaries were not built into this decision making to ensure the sustainable achievement of the project objectives.

Feasible Objectives for New Construction

The donor staff and the consultants as well as the government and the agency staff were not objective in assessing the feasibility and funding of the Kirindi Oya project at the Lunuganwehera site. Consequently, the feasibility and appraisal assessments of the Kirindi Oya project were more oriented toward developing a plan feasible in terms of the EIRR. It was project justification, rather than objective assessment of the feasibility of the project objectives in terms of assumed water duties, cropping intensities, irrigated extents, project implementation schedules and related water delivery concepts, and management inputs.

As a result, they could not grasp the fact that the feasibility of the chosen system development concept was doubtful, and a more advantageous and probably more feasible alternative at the Hurathgamuwa site was not studied. Major bottlenecks such as the lack of motivation and willingness of the different levels of staff and the water users to increase their management efforts were not anticipated at all in the feasibility assessments. In addition, the bias toward proposals that attract and favor project funding led to overly optimistic assumptions about the benefits of the construction project. These benefits were fixed at the start of the project and were justified with theoretical scientific approaches, which consequently had to be applied rigidly during project design and implementation to reach these objectives, at least theoretically. The resulting inflexibility and time pressures during system design and implementation were major factors contributing to the impracticability of the project and they led to, for example, a too large command area for the available water resource, a necessity to grow subsidiary field crops during yala, and insufficient time for the organization of the water users.

Main recommendations. More accurate determination of the feasibility of objectives for river basin and system development will have to be done necessarily by the managing agency itself, instead of by the outside donor staff or the consultants. The donor staff and consultants should only be involved in the feasibility assessment of a plan already developed by the managing agency. Past experiences and achievements by the managing agency instead of theoretical scientific simulations of opportunities should play an important role in this feasibility assessment. The donor staff and the

consultants should be objective in this assessment, and be able to pronounce as unfeasible a project proposal, if it is found to be unsound. Implications for their internal performance assessment and loan targets should not be allowed to influence project feasibility and appraisal.

Functional Requirements for New Construction

Functional requirements of the Kirindi Oya system were determined largely on the basis of theoretical simulations of water requirements and a rigid turnout area concept, with little or no reference to real-life problems. Most functional system requirements were not made explicit in the operation and maintenance manual and design criteria. Thereby, an unrealistically high management performance was implicitly assumed. In the absence of regular and effective interaction between the Designs Branch of the Irrigation Department and the system managers regarding the feasibility and the actual functionality of these general requirements, the latter have remained theoretical. And there was no interaction between system managers and local communities or beneficiaries to determine more system-specific functional requirements. Given the vested interests of the different parties involved, and the leverage used by the donor to push a main system water delivery concept which it perceived as feasible, at least theoretically, such effective interaction was very difficult.

While most involved actors were aware of the theoretical and inconsistent nature of the above approach, especially in view of the unfeasible managerial requirements, none of them was really made responsible for solving this managerial problem. The resulting accountability gap was considered mainly the donor's problem and all concerned parties confined themselves strictly to their terms of reference.

Main recommendations. The determination of more appropriate functional system requirements and opportunities for system creation will have to be done necessarily by the system managers of the Irrigation Department and not by the Designs Branch in Colombo with possible outside interventions by the donor staff. A less rigid and more appropriate design concept which fits the general local functional requirements better (e.g.,

management inputs, control over water flow) is required for Sri Lankan irrigation systems.

The development of such a design concept by the Sri Lankan agencies (i.e., the development of their own professionalism in this direction) seems unlikely, if foreign funds continue to be made available without any conditions being imposed by the Government of Sri Lanka or the donor agencies to make the managing and construction agencies accountable to their design assumptions and evolving system performance. The development of appropriate functional system requirements for new or existing irrigation systems will only be possible if the government and the donors allow appropriate time and funds for the required managerial processes. For example, there should be gradual development or rehabilitation from the head end to the tail end of command areas and catchments without predetermined (peak) irrigation requirements and related irrigable areas evolving from feasibility-level decision making.

PRIORITIES FOR IMPROVEMENT OF IRRIGATION MANAGEMENT

Prioritizing among the areas of management concern and the opportunities for improvement should evolve from internal decision-making processes, and strategic exercises within and between the Irrigation Department and the Government of Sri Lanka rather than from outside. In addition, from the related suggestions in this paper, the donors could identify some opportunities for improvement of their roles in these decision-making processes.

A comparison of the key decision-making processes and their managerial conditions discloses inconsistencies between different key decisions in irrigation management. The determination of the desired system objectives was based on unrealistic political and agency priorities, and was an imperative of loan acquisition by the Government of Sri Lanka. Consequent feasibility assessment was focused on loan justification, while the functional requirements were approached theoretically and remained implicit. The

actual real-life desirability, feasibility and functionality of the project objectives and requirements have not been assessed at all, except by the donor staff and the consultants and as perceived at top levels in agencies and the government. Overall, the system creation decisions ignored the management issues occurring during system utilization, while all system utilization decisions were oriented to combining a minimization of management inputs with the maintenance of a "no-complaint" situation.

The lack of accountability and responsibility toward the water delivery performance in system creation and system utilization is the crux of the whole irrigation management problem; it dominates all key decision-making processes with respect to water delivery. The lack of motivation and willingness of agency staff to increase its management efforts in the water delivery aspects of system creation and system utilization is ultimately due to a lack of accountability and responsibility of the managing agency as a whole for its water delivery performance.

The political and agency-wide priorities for construction activities and related funding make these system creation and rehabilitation processes the most likely starting point for building such accountability through the leverage provided by these funds. A more objective assessment of the *potential* or *feasible* irrigation management performance during the system creation and rehabilitation processes can be a first step in giving more value to the only resource, which is presently not attributed much value in irrigation, i.e., water.

CHAPTER 1

Introduction

FOCUS OF THE STUDY

KIRINDI OYA IS a large gravity irrigation system in a dry-zone environment in southern Sri Lanka, where cultivation is done by small holders. In the "Old Areas," the majority of these small holders have been settled for a long time: for 100 years in the Ellagala system and for 25 years in the Badagiriya system. Farmers were settled in the "New Areas" during the past ten years. Apart from a number of relocated farmers, all the other settlers originated from the overpopulated wet zone of southern Sri Lanka. This report describes and analyzes the decision-making processes of the different line agencies, the donors, the consultants and the water users to the extent that all these actors were involved in system management and in the planning and designing of the New Areas of the system, i.e., the Kirindi Oya Irrigation and Settlement Project (KOISP).

In this report, the focus is on the management of water as the primary irrigation activity. Activities like agricultural production and the organizing of water users are considered processes complementary to the management of water. Other activities like maintenance, improvement or construction processes do not necessarily involve irrigation, and are, therefore, considered to be derived processes. Decisions concerning water are made during irrigation system creation (planning, investigation, design and construction) as well as during system utilization; both categories of decision making are examined here.

In this paper, "system" refers to the physical infrastructure (i.e., canals and structures), staffing, people that influence the decision-making processes, and to the other facilities (communication equipment, vehicles, computers, forms, etc.) used in the process of delivering water to the water users. The water users are considered part of the system to the extent that

they influence the decision-making processes about water delivery, but they are the system's client with respect to the service delivery.

Utilization of water by the water users is considered to be managed by the water users themselves, and the analysis will not cover these tertiary and on-farm level decision-making processes. Neither will it go into details of the differences in interest of the water users or ways in which the water users, individually or in small groups, can influence the decision-making processes. The analysis will focus on agency processes and the ways in which agencies provide for participation by different groups.

By looking at all decision-making processes that relate to water, it is envisaged to obtain a "management perspective" in terms of an overall view of all activities that have to be dealt with by the managers, and of the interests and biases of the managers involved.

The specific result of looking at the decision-making processes by means of an analytical management framework is that the analysis becomes less dependent on opinions and feelings that people have about the organization, and will be less distracted by conflicts among the different managers. Naturally, such conflicts occur in the Kirindi Oya system as they do in all other organizations. The incidences described in this paper are not meant to point a finger at any individual but only to show the systematic picture of biases and interests in the institutions and how they influence the management processes. The analysis of the decision-making processes in the Kirindi Oya system is done by means of an analytical irrigation management framework based on an existing general management framework developed by Professor Kampfraath and his colleagues of the Department of Management Studies of the Wageningen Agricultural University (Kampfraath and Marcelis 1981).

OBJECTIVES OF THE STUDY

The International Irrigation Management Institute (IIMI) envisaged two primary objectives for this case study. The first was an objective of the Consultative Committee of IIMI and the Government of Sri Lanka to have an organizational analysis of the Kirindi Oya system — and thereby also of

the managing agency, the Irrigation Department as a whole with respect to its influence on water delivery in the Kirindi Oya system — by means of an analytical management framework. This paper gives the outcome of this organizational analysis.

The second objective of IIMI was to develop an analytical irrigation management framework on the basis of the aforementioned general management framework. The development of this analytical framework occurred concurrently with the organizational analysis of the Kirindi Oya System, and that of a parallel case study of the Uda Walawe system in southern Sri Lanka (Nijman 1991).

A generic paper on the analytical irrigation management framework which will cover the irrigation management processes beyond the Sri Lankan case studies will be published in the near future. In addition, the analytical framework is envisaged to be used in comparative management research of different Sri Lankan systems, and also of irrigation systems in other countries.

The analytical irrigation management framework can translate different categories of decision-making processes that occur in organizations into irrigation management decision-making processes. For example, production planning will be translated into processes of seasonal and in-seasonal allocation of water, which are directly related again to the allocation of land and crops.

The analytical framework can be used to identify possible directions and ways for the better harmonization of all the efforts in an irrigation organization toward a common interest. A limitation, however, is that such an analysis by itself does not guarantee the better harmonization of efforts as this is a gradual process which requires the willingness and cooperation of a sufficient number of involved actors, if it is to succeed.

RESEARCH METHODOLOGY

A Short Introduction to the Analytical Irrigation Management Framework

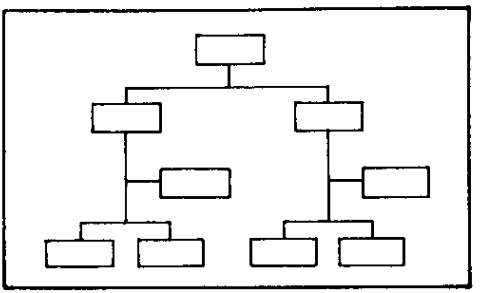
In this analytical framework, decision making is considered to be the major force determining the performance of irrigation systems. To develop a management perspective of the organization, this analytical framework classifies the decision-making activities according to their potential contributions to the performance of the organization, and not according to the subjects involved (e.g., participation, communication, resource mobilization, crop diversification, sustainability, involved staff time, financial inputs). The evolving groups of decisions are defined as management concerns. The different management concerns cover those key decisions to be taken by an organization as a whole to reach a certain performance level.

In this context, focusing on decision-making processes means moving away from the hierarchical, structural appearance of the organization. The structural appearance represents individual units with functions, tasks and responsibilities. However, an organizational structure evolves over time. Structural changes in the past originated not only from requirements of processes, but also from the internal dynamics of the organization — the evolution of existing hierarchical levels, the presence and influence of certain leading officers at a given moment, or the division of the organization into historically determined departments. The internal dynamics of the organization gradually "bias" the structure with respect to the effectiveness of the processes. Thus, to evaluate the performance of the different key decision-making processes, it is necessary to temporarily omit this structural appearance. The importance of structures is not denied but is looked upon as a mediating force with respect to its influence on decision-making processes and thus considered to be of secondary relevance.

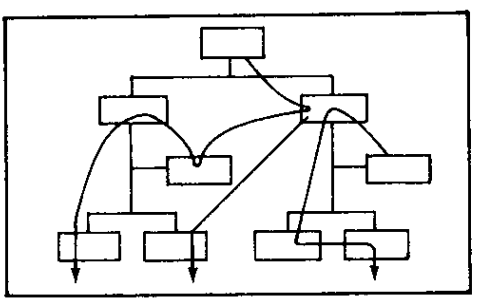
Figure 1 presents a schematic look at orientations of the decision-making process in management.

Figure 1. Orientations of the decision-making process in management.

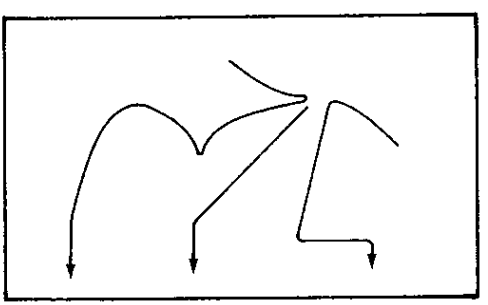
Structure orientation



Structure and process orientation



Process orientation



Two main categories of decision-making activities and their related management concerns can be recognized on the following lines:

1. Irrigation system creation, rehabilitation and maintenance

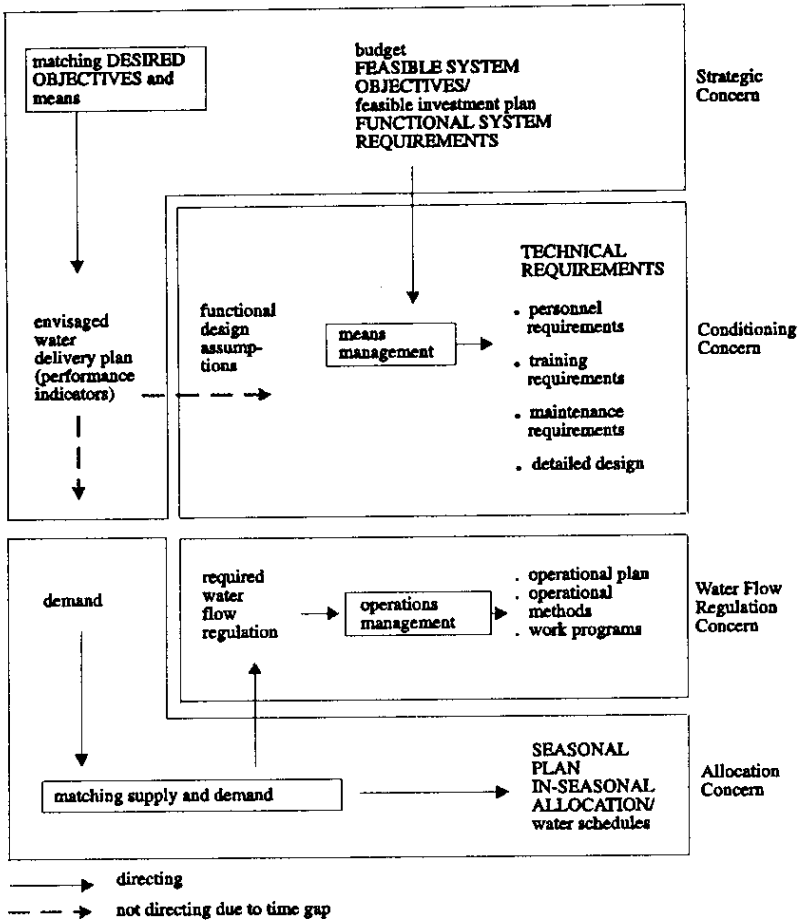
This group comprises the decision-making processes for the determination of the requirements (physical infrastructure, staff, cars, information systems, etc.) for irrigation capacities. These capacities must be available for the achievement of results (i.e., water delivery performance) and the required decision-making processes (for allocation of water and water flow regulation as well as the *de facto* gate operations and consequent water flows). Since KOISP deals mainly with system creation this category will be referred to as "system creation" in this paper. Kampfraath divides this group into two subgroups: "strategic concern" and "conditioning concern" (ibid., 33).

The *strategic concern* covers the decision-making processes with respect to the determination of desired system objectives, feasible system objectives and functional system requirements. Short descriptions of these different key decision-making processes of the strategic concern are given below and also in the introductions of chapters 7 to 9.

Desired system objectives. These are desirable objectives that are set for the intended irrigation investments, without considering their feasibility as such. These objectives evolve from the related objectives of the national government, the politicians, the donors, the local community and the beneficiaries. Such objectives, whether implicitly or explicitly stated, may include the reduction of cultivation risks through more control over water in certain areas at a certain point in time, a desired increase in agricultural production, alleviation of poverty, reduction of unemployment, settlement of landless people, appeasement of political supporters or geopolitically sensitive areas, saving of foreign exchange through increased exports or reduction of imports, sustainability of the environment, etc.

Feasible system objectives. The matching of desired system objectives with available resources (funds, staffing capabilities, future staffing and maintenance budgets) evolves into the determination of feasible objectives such as planning the area to be commanded by irrigation water at a certain point in time, the different crops to be grown, the cropping intensities, the acceptable cultivation risks, the predicted water delivery performance, etc.

Figure 2. Irrigation management concerns.



Functional system requirements. Given the feasible system objectives and the available resources, the functional system requirements can be specified. These, in turn, can be divided into component requirements, such as the

physical infrastructure, staffing, communications, and possibly the organization of the water users into groups.

The functional infrastructure requirements refer to, among others, the following: water levels required to command certain areas, canals to maintain these water levels, structures to control water flows and levels, storages to collect and store water from the catchment and intermediate storages to collect runoff or reuse drainage water or increase responsiveness at these locations.

The functional staffing requirements refer to the number and quality of staff required for the utilization of the irrigation infrastructure at the envisaged water delivery performance. The functional communication requirements refer to the quantity and quality of communication and related facilities and staffing requirements needed to reach the envisaged water delivery performance. Similarly, it can be considered a requirement to organize the water users into groups to share water in view of other assumptions regarding the functional requirements.

The *conditioning concern* covers the decision-making processes regarding the technical requirements for irrigation capacities. The technical infrastructure requirements include the technical standards to be used, like densities of engineering materials, coefficients of expansion and shrinkage, permissible concrete stresses, seepage gradients and uplift or protection. Among the technical staffing requirements are the selection criteria or professional development programs. The tendering of construction, rehabilitation, maintenance contracts and the monitoring and control of the actual acquisition of the irrigation capacities are also technical requirements.

2. *Irrigation system utilization*

This group comprises the decision-making processes for the determination of the utilization of the available irrigation capacities (i.e., decision making on priorities, timing, quantities, and methods of achieving required water deliveries). This group can be split up into the "allocation concern" and "water flow regulation concern."

The allocation concern. This comprises the decision-making processes in regard to quantity, place, and time of allocation of water or, in other words, the matching of supply and demand. It also deals with the quality — the adherence to the requirements of the allocation strategy — of the water

delivery in terms of timeliness, adequacy, equity, reliability, responsiveness, predictability, efficiency, variability, etc. In Sri Lanka, it entails key decision making on the following:

Seasonal allocation plan. At the beginning of each season, the matching of the available supply to the existing demand and allocating water to subsystems for irrigation and other purposes, possibly leads to a plan which incorporates the cropping pattern, cultivation calendar and related cultivation risks.

In-seasonal allocation. Similarly, during the season, the matching of the available supply to the existing demand and allocating water to subsystems for irrigation and other purposes, possibly leads to a more or less regular in-seasonal allocation schedule which also incorporates the cropping pattern, cultivation calendar and related cultivation risks. These allocations are expressed as operational targets for the capture of water from a source, for storage in (intermediate) reservoirs and canals, for conveyance along canals, and for distribution through offtakes.

Water flow regulation concern. To realize these allocations, structures have to be operated to capture water from a source, to store it, to convey it through canals, and to distribute it through offtakes in line with operational targets. This means that managers must determine operational methods for the actual gate operations of different structures and, depending on the required water delivery performance, possibly develop a plan for the coordination of the operational methods of the different structures in the system to regulate water flows and levels.

A mutual adjustment of the allocation and water flow regulation concerns will always be necessary. The operational practices of the water flow regulation concern provide starting points for the allocation concern. On the other hand, the allocation concern determines the operational targets for the water flow regulation. In all situations, it will be the water flow regulation that deals with the final decisions with respect to the realization of water deliveries and thus of the allocation plans.

This paper deals with all the above concerns except the conditioning concern, which is considered to be of secondary relevance with respect to the problem of water delivery performance. Moreover, describing actual technical system requirements would require the incorporation of issues like

interference by politicians in staff selection and the more "informal" procedures during construction. Though not irrelevant, these reasons have made the conditioning concern a lower priority compared to the other concerns in the case studies and the development of the analytical framework.

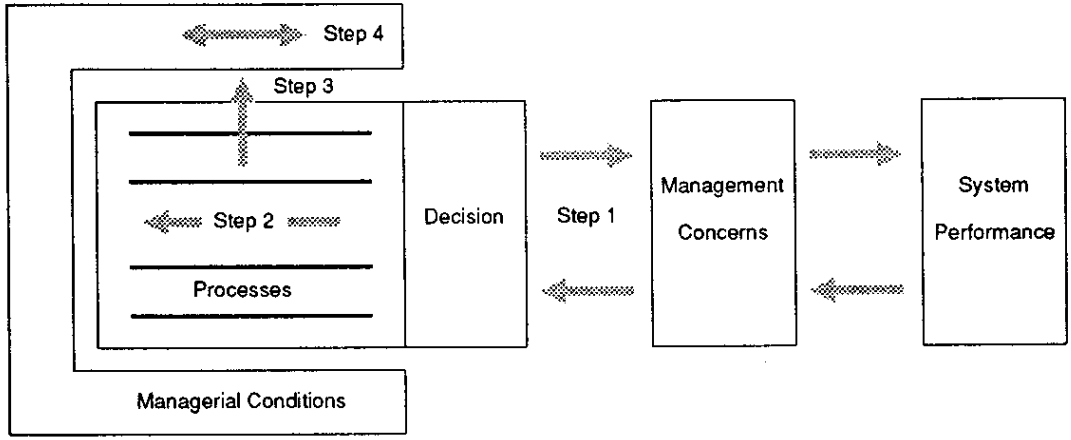
The analysis of irrigation management in this paper is *resource- or water-based*, because of the direct link between the physical processes of water flows and gate settings, and the decisions that resulted in these processes. At the same time it is *performance-based*, because it starts from the overall system performance, and the relative contributions of the different key decisions or management concerns to this overall system performance (step 1 in Figure 3).

The decision-making activities are described in terms of their *outcomes* (i.e., decisions) and in terms of *processes* that lead to these decisions (step 2 in Figure 3), the steps in decision preparation and decision making, and the information necessary for the management control of these processes.

The situation in which the decision-making activities take place will be described in terms of managerial conditions (step 3 in Figure 3). These managerial conditions are considered to influence — not to determine — the decision making and thus its outcome; changes in these managerial conditions and their actual functioning can be used to influence the decision making and the performance of the organization, i.e., conditioning of the decision making (step 4 in Figure 3). Kampfraath and Marcelis (ibid., 47) have classified the managerial conditions into the following five groups:

* People (involved as individuals and as groups)
* Organizational rules
* Provision of information
* Provision of knowledge
* Systems and methods (i.e., the material and nonmaterial means, such as spatial division, simulation models, budgeting forms, checklists, etc.)

Figure 3. Performance-based approach of management analysis.



The description of the existing decision-making activities for each aforementioned management concern or key decision will allow the analysis of the existing situation and identification of opportunities for improvement; an improvement, if the existing managerial conditions do not provide sufficiently for requirements which allow a good execution of management activities and management control activities.

In the analysis and conditioning of a decision-making process two different aspects of the process are taken into account:

1. The *technical* aspect covers alternative technical or substantive approaches for seasonal planning, operational plans, operational methods, etc., and the assumptions made and data used in the decision making as well as the clarification of priorities.

2. The *managerial* aspect is the method of making a choice or, in other words, the process or the different ways of processing the decision making. For example, the water users and staff of different agencies can be involved in different phases of the processes dealing with the seasonal plan, operational plan, operational methods, etc., with different levels of authority, responsibilities, and information. In general, management analysis focuses on this managerial aspect of the decision-making process, which, however, cannot be seen separately from its technical aspect.

One of the points of analysis in this case study of the Kirindi Oya system is how well these technical and managerial aspects are adapted to suit each other. This point is described and analyzed for all the aforementioned key decisions, in chapters 3 to 5 and 7 to 9.

In the conditioning of a decision-making process, the mutual adaptation of the process and its managerial conditions have to be taken into account. Marcelis (1984, 93) suggests that if there is a lack of balance between the mutual adaptation and managerial conditions, the proper outcome of the decision making is doubtful. To facilitate the mutual adaptation of processes and their managerial conditions, and to develop a relation between overall system performance and the contributions of the different key decisions and management concerns to this system performance, the concept of *the level of perfection* of the decision making has been introduced by Kampfraath and

Marcelis (1981, 35). The level of perfection is a performance indicator for decision-making processes and it is determined by means of four criteria: systematics, feedback, foreseeing and intefration (see Table 1). In this paper,

Table 1. The levels of perfection on a scale of 0-100 percent (after Kampfraath and Marcelis 1981,39).

Level of perfection (%)	SYSTEMATICS: To what degree are the decisions made according to a more or less fixed pattern?	FEEDBACK: To what degree are the decisions made tested continuously for appropriateness?	FORESEEING: To what degree does decision making foresee the scope of the decision?	INTEGRATION: To what degree are problems seen on a wider context before the decision is made?
Very low 0.20	no rules: a certain routine exists	never: unless unconsciously	hardly: ad hoc decision making	no: problems are examined myopically
Low 20-40	"rules of thumb:" broad rules form the basis of decision making	sometimes: obvious experiences are proposed	somewhat: necessities are considered	somewhat: convincing subsidiary influences are incorporated
Average 40-60	rules: important decision-making processes are supported with rules	regularly: the most important information is considered	reasonable: priorities are considered	in a broad context: directly related plans are considered
High 60-80	procedures: combinations of mutually attuned rules	often: most information from the past is considered	far: foreseen developments are considered	in a broad context: important influencing factors are incorporated
Very hugh 80-100	systems: balanced systems of mutually attuned procedures	always: all relevant information from the past is considered	very far: expected developments are reviewed and considered	in the entire context: all influencing factors are incorporated

this concept will be utilized as a means of analysis of the actual decision-making processes. The levels of perfection for the different irrigation management concerns and key decisions used in this paper are listed in Annex 1, which also gives a more elaborate idea of the rationale behind this classification. This concept of the level of perfection of a decision-making process will be used in future for comparative research with respect to the managerial performance of different irrigation systems to develop normative indicators for the different key decisions. Such norms will be used for self-evaluation exercises for system managers.

Although a correct evaluation of the present level of perfection of the decision making in the Kirindi Oya system is only possible in comparison with other systems, it is used in this paper to identify opportunities for improvement in a systematic way if the present quality of decision-making processes requires such improvement.

Sustainability

Among the multiple objectives in irrigated agriculture are increased agricultural production, increased equity of water delivery within systems and increased welfare for beneficiaries. During the past decade, the development jargon has been enriched with the term, "sustainability." The concept of sustainability is not usually applied in management analysis in developed countries, environmental sustainability being an exception. A lower level of political and organizational development of the society as a whole, typical of many less-developed countries, has made this concept applicable in these countries.

In this paper, sustainability refers to the degree to which the objectives pursued in the different management concerns, or key decision-making processes, are better mutually attuned to each other. Practically, this means that a system is considered more sustainable if the objectives during planning and design, like envisaged water delivery performance, lifetime of investments, increased incomes and envisaged maintenance levels, are well in line with the actual or most likely achievements of the same managing agency during future system utilization in the same system, region or country. Simultaneously, it refers to the degree to which the actual objectives during system utilization conform to the assumptions used during the

planning and design. The concept of "environmental sustainability," used now and then in this paper refers to the degree to which the system affects its environmental ecosystem in the short or long term.

Data Collection and Analytical Procedures

The data that underlie this study were collected primarily through interviews with the decision makers as well as through observation of the decision-making processes and the physical processes. In addition, reports, files, records, etc. were studied to gather important facts and figures. These data were collected mainly during maha 1987/88 and yala 1988. However, interviews with the most relevant decision makers continued up to maha 1989/90. For the management processes within the distributary-channel subsystem the study focused on Tract 5 of the Right Bank of the Kirindi Oya system which facilitated interaction with other IIMI research at distributary-channel level in that area.[1]

Opinions of the different decision makers about the organization and their role in these processes helped to obtain a better understanding of the actual decision making. Cross-checking of opinions and iterative inquiry were necessary to obtain a more balanced view of formal and informal processes. Balanced evaluation of opinions became possible gradually through increased familiarity with the organization and the actual processes. This familiarity reinforced itself more and more making it possible to raise more specific questions on the actual processes and obtain more specific answers. Of course, the framework itself provided guidelines in prioritizing among the enormous mass of issues, information and opinions and focusing on the important and relevant issues and facts.

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1 Extensive research has been done by IIMI on KOISP covering a variety of subjects: performance of irrigation management in terms of distribution of water at distributary- and field-channel levels, economics of different crops and irrigation institutions (mainly water user organizations) (Merrey and Somaratne 1989; IIMI 1988, 1989a, 1989b, 1990; Sri Lanka Field Operations 1989) and land settlement issues that relate to irrigation management (Stanbury 1988, 1989).

Important additional information, especially regarding the interface between the water user organizations and agencies and regarding the water flow regulation of the Right Bank main canal was obtained from the involved IIMI research staff in Colombo and in Tissamaharama.

ORGANIZATION OF THE PAPER

A description of the history, organizational setup and physical infrastructure of the Kirindi Oya system, and the new construction project is given in Chapter 2. Descriptions and analyses of the key decision making on the seasonal allocation plan, the in-seasonal allocation, the water flow regulation, the desired and feasible system objectives and functional system requirements in the Kirindi Oya system are covered in chapters 3 to 5 and 7 to 9. Opportunities for improvement of the key decision making on system utilization and system creation are given in chapters 6 and 10, respectively. An overall picture of the decision-making processes and managerial conditions of all these key decisions is given in chapter 11. The conclusions and recommendations for all key decisions are covered in Chapter 11.

CHAPTER 2

Kirindi Oya Irrigation and Settlement Project

BACKGROUND TO THE COLONIZATION OF THE DRY ZONE

SRI LANKA HAS a long history of irrigated agriculture in the dry zone of the country. Well-developed irrigation systems in the dry zone became the foundations for the great kingdoms of ancient Ceylon. For yet unknown reasons these kingdoms rapidly declined after the fourteenth century and the wet zone of the country became politically and economically more important. During the colonial period, the political and economic dominance of the wet zone continued while the dry zone further deteriorated as is illustrated by the following citation:

> In the early part of this century large parts of the Dry Zone were almost uninhabited, there was scarcely any commodity production and only a very limited development of economic infrastructure (conditions which still prevail in some pockets within the region). Some very tentative efforts were made at organized land settlement in the Dry Zone in the nineteenth century, but it was not until the 1930s that a consistent policy for such settlement was formulated, under the State Council elected on the franchise extended under constitutional reforms after 1931.
>
> The drive to "colonise" the Dry Zone came from a complex of objectives, including the aims of relieving overcrowding in parts of the Wet Zone and of increasing food production within the country, but also for the purpose of protecting Sinhalese peasant agriculture — which was believed to have been adversely affected by the growth of the plantation economy in the nineteenth century. The policy of colonisation was further intimately bound up with political objectives of the nationalist movement, which linked the colonisation of the Dry Zone with the idea of a return to

the old heart of the country and a recovery of the lost greatness of the Sinhalese people (Harriss 1984, 316).

HISTORY OF THE KIRINDI OYA RIVER BASIN

Brohier (1934, III:22) describes the irrigation systems that were built more than 2,000 years ago by the rulers of the southern kingdom around Tissamaharama. With the decline of these kingdoms the tanks of these irrigation systems were neglected and finally abandoned.

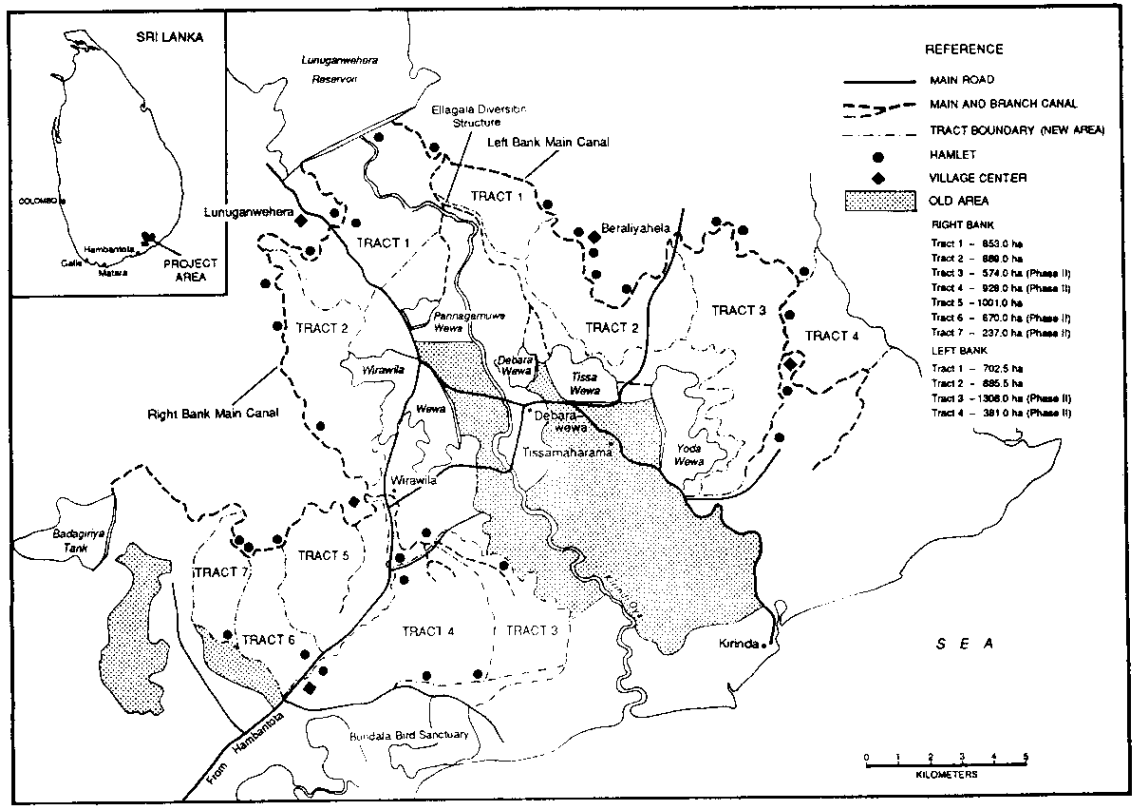
The British Governor, Henry Ward visited the abandoned tanks of the Kirindi Oya River Basin in 1859 and was sufficiently impressed by them to initiate the partial restoration of the anicuts and tanks, which was accomplished in 1876.

At that time, land settlement was less of an objective than the restoration of these impressive ancient systems and the increasing of the agricultural production and revenue for the colonial government. However, because there were few people living in the area to profit from the restoration at that time, it met with much public criticism in terms of suspected waste of public money.

The restoration and improvements continued until 1906, after which, for some time, no further studies were undertaken on the possible extension of the irrigated area around Tissamaharama.

The Old Areas of the Kirindi Oya system are shown in Figure 4. The Ellagala system consists of a diversion of the Kirindi Oya River and six small reservoirs which are supplied by this river diversion. The six reservoirs are, Weerawila, Tissa, Yoda, Pannagamuwa, Gamunupura and Debara. The Badagiriya system has its own catchment area and stores the inflow of the Malala Oya River in the Badagiriya Reservoir. Whereas the Tissa and Yoda reservoirs were originally constructed over 2,000 years ago and were rebuilt several times afterwards, the Badagiriya Reservoir is only 25 years old.

Figure 4. Location map of the Kirindi Oya Irrigation and Settlement Project.



Source: ADB 1986: IV

EVOLUTION OF THE PROJECT

Further development of the Kirindi Oya Basin was considered as far back as the 1920s. In 1956, a Reconnaissance Report on the natural resources of the Kirindi Oya Basin was drawn up. "The Water Resources Development of Ceylon," published in 1957 by the Irrigation Department showed the feasibility of constructing a number of reservoirs in eight major river basins including the Kirindi Oya River Basin.

Beginning in 1961, further studies were done by the Irrigation Department (e.g., Munasinghe 1986, 57) and proposals for eight different ways of developing the eight river basins were submitted in 1962. The estimated cost of development of the Kirindi Oya system was very high compared to the development costs of the other river basins and therefore it was delayed until the assistance of the Asian Development Bank (ADB) was secured by the Government of Sri Lanka.

In 1977, the ADB approved a loan of US$24.0 million as the total foreign currency cost of the Kirindi Oya Irrigation and Settlement Project (KOISP) to develop the Kirindi Oya River Basin. This amount was reduced to US$20.0 million after the International Fund for Agricultural Development (IFAD) decided, in 1978, to co-finance the project with US$12.0 million. In 1979, the Kreditanstalt fur Wiederaufbau (KfW) also became a co-financier with US$13.3 million. The Government of Sri Lanka contributed US$6.5 million.

The KOISP envisaged the enlargement of the existing irrigated area of the Kirindi Oya River catchment; in addition to the existing command area of 4,525 hectares (ha) of the Ellagala and Badagiriya systems (the Old Areas), 8,409 ha of new irrigated land (New Areas) were to be developed (ADB 1982, 82).

In 1982, two years after construction activities started, the project was reappraised due to cost escalations and the cost was estimated at US$106.0 million. Because the "financing gap was considered too large to be met from available sources, and because of implementation delays, the Government agreed with the bank and the co-financiers to implement the project in two phases" (ADB 1986, 46).

Phase I, estimated to cost US$79.8 million, envisaged the rehabilitation of the existing areas, the creation of 4,200 ha of new irrigated land (tracts 1

and 2 of the Left Bank and tracts 1, 2 and 5 of the Right Bank) and the settlement of 4,200 families.

Phase II, estimated to cost US$33.1 million, included the addition of 4,200 ha to the command area (tracts 3, 4, 6 and 7 of the Right Bank and tracts 3 and 4 of the Left Bank), the settlement of another 4,200 families, and agroforestry and livestock development (ADB 1986, i). Phase II was financed by the ADB (US$26.6 million) and the Government of Sri Lanka (US$6.5 million).

The objectives of the project were "consistent with the Government's major economic goals: i.e., increased agricultural production, particularly of paddy; employment generation; foreign exchange savings; and land settlement" (ADB 1982, 19).

These objectives were translated into the targets of: 1) construction of irrigation works; 2) construction of hamlets with community buildings and wells for drinking water; and 3) construction of an adaptive research station and provision of facilities thereto. Foreign consultants were to be engaged for, among others, the supervision of construction and water management.

The irrigation works comprised: 1) the construction of a large storage reservoir, the Lunuganwehera Reservoir, upstream of the Ellagala river diversion to increase the cropping intensity in the Ellagala and Badagiriya systems and to command the newly irrigated areas on the Right Bank and the Left Bank of the Kirindi Oya River; 2) the downstream development of the newly irrigated areas; and 3) the rehabilitation of the Ellagala system.

THE ORGANIZATIONAL SETUP

The agencies most directly related to the water delivery decision-making processes in the Kirindi Oya system were the Irrigation Department, the Land Commissioner's Department and the Irrigation Management Division. Their organizational setup and main coordination structures within the Kirindi Oya Irrigation and Settlement Project (KOISP) are described below.

Irrigation Department

The work of the Irrigation Department in the Kirindi Oya Irrigation and Settlement Project was officially headed by the Project Director, who was also the Deputy Director for Major Construction. The Project Director was based at the Colombo head office of the Irrigation Department and performed mainly administrative tasks related to the monitoring and evaluation of the progress of implementation of the project as a whole for the ADB and the government (Wimalabandu et al. 1985, 4).

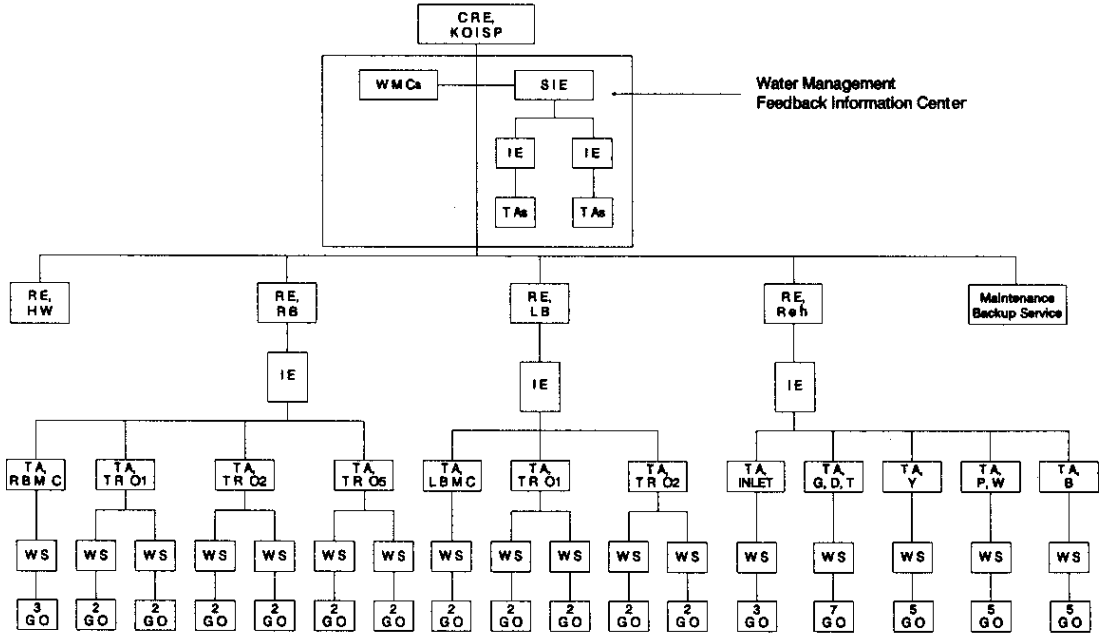
With respect to technical issues, project coordination was handled by the Project Director in his capacity as Deputy Director, Major Construction "in consultation with the Deputy Director, Designs" (Irrigation Department 1984, 13). During the actual design phase, the Deputy Director, Designs coordinated the inputs of different specialized divisions in the head office of the Irrigation Department (Ponrajah 1988, 28).

At project level, the Chief Resident Engineer (CRE, in Figure 5) functioned as the Project Manager for the construction of the irrigation works and for the utilization of these works for delivering water (Irrigation Department 1984, 26). For specific components of the project, the Chief Resident Engineer was assisted by four Resident Engineers: 1) the Resident Engineer, Rehabilitation (of the Old Areas)(RE, REH); 2) Resident Engineer, Head Works (RE, HW); 3) Resident Engineer, Right Bank (RE, RB); and 4) Resident Engineer, Left Bank (RE, LB).

The Resident Engineers were responsible for the construction activities and for the delivery of water in their areas. The Resident Engineer, Head Works was responsible for the water delivery and maintenance of the head works of the Lunuganwehera Reservoir only.

The implementation of the project was done by the Water Management Feedback Information Center in cooperation with the Resident Engineers. This center consisted of the Water Management Consultants (WMCs), who were placed under the Chief Resident Engineer, and who were assisted by a Senior Irrigation Engineer (SIE), three Irrigation Engineers (IEs) and several Technical Assistants (TAs). The exact working relation between the Water Management Consultants and the Irrigation Department staff, however, had always been rather indistinct (see also Ministry of Lands and Land

Figure 5. Organization structure of the Irrigation Department at project level.



Source: AHT/SCG 1989:II.4.

Development 1982b). The organizational structure of the Irrigation Department within KOISP at project level is shown in Figure 5.

Land Commissioner's Department

Although the Deputy Director, Major Construction of the Irrigation Department was the Project Director for all aspects of the project, he had no administrative powers over other line agencies. His duties regarding the land settlement aspects were limited to monitoring and evaluation of the project implementation progress.

At head-office level, the land settlement tasks of the Kirindi Oya project were directed, administratively and technically, by the Additional Land Commissioner (Development). He not only coordinated, but was also responsible for all decisions regarding settler selection and distribution of settlers over the hamlets and the command area.

At project level, a special Additional Government Agent (Lands) functioned as the Project Manager (Settlement) who was responsible for the same activities at project level. In addition, he represented the Government Agents of Hambantota and Monaragala districts in the project. He was assisted by an Assistant Project Manager (Lands). All those staff were officers of the Sri Lanka Administrative Service.

Colonization Officers were in charge of the land settlement activities at tract level and Field Instructors at hamlet level. At the time of settlement, the settlers were organized into groups, mainly to facilitate communication between the department staff and settlers for distribution of settler provisions like food and for organizing meetings. Within these groups, leaders were appointed on the recommendation of the Field Instructors (Merrey and Somaratne 1989, 47). Construction activities regarding the infrastructure of the hamlets and towns under the project were also done by the Land Commissioner's Department.

Irrigation Management Division

In 1986, the Irrigation Management Division appointed two Project Managers, one each for the Old Areas and the New Areas of the Kirindi Oya

system. They were supposed to organize the water users into sustainable water user groups that would become effective after construction was finished.

To that end, the water users were to be organized into: 1) "informal groups" at field-channel level, 2) "distributary-channel organizations" at distributary-channel level, and 3) "a Project Committee" at system level; one each for the Old Areas and the New Areas.

The informal water user group at field-channel level, in principle, selected a leader by consensus, to represent the group in the distributary-channel organization. The major duties of this field-channel water user group were the cleaning of field channels, organizing water saving activities, collection of data, conflict-solving among the water users, assisting in the collection of service fees, etc. (see also Ministry of Lands and Land Development 1985a, 5).

The distributary-channel organization could fix its own procedures and determine the quorum. It was supposed to select, in principle, a president, and a secretary by consensus and, if necessary, a treasurer. The Irrigation Management Division advised that in the initial stages, a divisional-level officer of one of the involved line agencies should function as secretary, who could later be replaced by a farmer.

The duties and functions of the distributary-channel organization were water management (e.g., rotational distribution of water within field channels), maintenance (e.g., programming, organizing collective work activities, assisting officials in the collection of service fees) as well as preparation and implementation of agricultural programs and sociocultural activities (ibid., 9).

Representatives of the distributary-channel organizations of the New Areas were in the Project Committee which met once a month. Other members of that Project Committee were the different divisional-level officers working in the New Areas (e.g., Irrigation Engineers, Technical Assistants, Colonization Officers, Agricultural Instructors) and the Project Manager of the Irrigation Management Division. District-level officers might have attended the meetings on invitation. The Project Manager chaired the meetings.

Among the main functions of the Project Committee were:

* Formulation and implementation of a cultivation program for the season/year.
* Holding of timely cultivation meetings.
* Solving problems connected with distribution of irrigation water.
* Arranging for timely provision of credit, seed and other inputs.
* Monitoring of the program and taking corrective action where needed.
* Recovery of operation and maintenance (O&M) costs.
* Arranging for O&M of all capital assets and approval of items to be handled under the maintenance program of the Irrigation System.
* Promoting formation of Farmers' Organizations and their participation in project activities.
* Identifying training needs of farmers and officers serving in the project, and arranging for training.
* Reporting, at the required regularity, to the Subcommittee of the District Agricultural Committee and to the Irrigation Management Division (Ministry of Lands and Land Development 1984b, 5).

Thus, in addition to organizing the water user organizations, the Project Managers had to coordinate the activities of the different line agencies regarding the agricultural implementation programs in the system. In other words, the project managers implemented the so-called Program for Integrated Management of Major Irrigation Schemes (INMAS Program). (See also, for example, MLLD 1984a, Annex 4).

At district level, the Subcommittee of the District Agricultural Committee was expected to strengthen further the coordination between the different line agencies as regards programming, monitoring and implementation of the cultivation plan and the organizing of the water users into groups. This committee was chaired by the Government Agent and its meetings were attended by all involved district-level officers. The Range Deputy Director of Irrigation functioned as secretary to this committee.

Several project-related officers, such as the Chief Resident Engineer and Project Manager (Settlement), did not attend these meetings because the Project Coordinating Committee and, since 1988, a subcommittee of it functioned as a similar body for the agricultural implementation program.

A Central Coordinating Committee for Irrigation Management functioned at the national level with all heads of involved departments attending to the implementation, monitoring and evaluation of the INMAS Program at this level.

Coordination between the Different Line Agencies

Apart from the coordination mechanisms foreseen in the setup of the Irrigation Management Division and the INMAS Program, several other coordinating bodies had been provided for in the Kirindi Oya project since its inception in 1980.

In order to coordinate the activities between the different line agencies involved in the project (mainly the Irrigation Department, the Land Commissioner's Department, the Department of Agrarian Services, the Agricultural Department [Research and Extension], the Crop Insurance Board, the local banks and, from 1986, the Irrigation Management Division), a Project Coordinating Committee was set up at project level under the chairmanship of the Government Agent. In practice, the Project Manager (Settlement), in his capacity as the Additional Government Agent, chaired the meetings on behalf of the Government Agent.

A Central Coordinating Committee was set up for coordination among the line agencies at national level. Moreover, the Deputy Director, Major Construction was appointed Project Director for the overall coordination of the project and, in particular, for the supervision of the Project Manager (Irrigation) and the Chief Resident Engineer and for "liaison with the Project Manager (Settlement)" (ADB 1982, 32).

PHYSICAL FACILITIES

Under KOISP, about 8,400 ha of newly developed land (4,200 ha each in Phase I and Phase II) would be irrigated and 4,525 ha of the existing Ellagala and Badagiriya systems (Figure 4) would receive improved irrigation facilities. For this purpose, the Irrigation Department constructed the Lunuganwehera Reservoir, the second largest it has constructed. The schematic layout of the Kirindi Oya main irrigation system is shown in Figure 6. Basic characteristics of the overall system are given in Table 2.

Although a more elaborate description of the system's functions is given in Chapter 9, the following short description of the main design characteristics and envisaged hydraulic functions of the design is meant to give some preliminary insights for a better understanding of chapters 3 to 5 on the allocation and water flow regulation concerns.

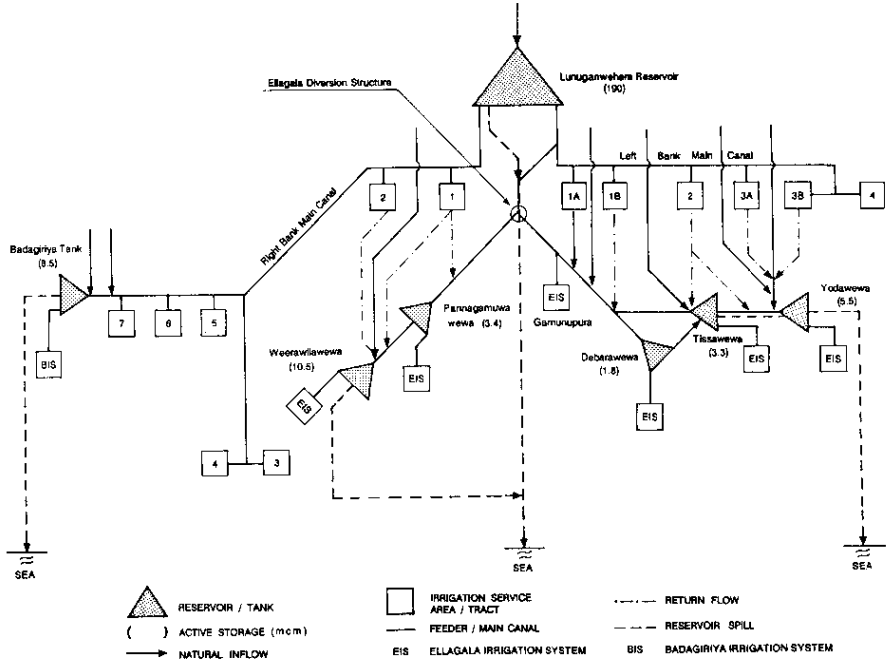
Except for the inflow from the catchment of the Malala Ara River into the Badagiriya Reservoir, the runoff from the catchment of the Kirindi Oya River was the only water resource for the overall system. The other reservoirs of the Ellagala and Badagiriya systems possessed catchment areas of their own, but within the Kirindi Oya River catchment. Their total annual inflow amounted to approximately 15 mcm (AHT/SCG 1987b, 3). In addition, the Ellagala system received drainage water from the newly developed command area as indicated in Figure 6.

The total inflow upstream of the Kirindi Oya system was stored in the main reservoir, the Lunuganwehera Reservoir. Because of its large storage capacity (large compared to the average annual inflow), the short-term water level fluctuations in the reservoir were limited. As long as enough water was available in the main reservoir the supply of water to the main canals appeared to be reliable and independent of the upstream conveyance system.

Two gated undershot-type sluices issued water from this reservoir to the Right Bank and Left Bank main canals. These sluices have been designed to ensure the maximum required discharge with the minimum reservoir level at an elevation of 47.5 m above m.s.l. (Selvarajah 1986, 99).

The water for the Ellagala system was diverted from the Left Bank main canal through a feeder canal into the old river course, and from there taken downstream by the existing Ellagala anicut diversion structure. The offtake from the Left Bank main canal to the feeder canal was equipped with a radial

Figure 6. Schematic layout of the Kirindi Oya main system.



Source: AHT/SCG 1989:II.3

Table 2. Basic characteristics of the Kirindi Oya system.

No.	Phase	System / Subsystem	Canals: Command area (ha)	Canals: Length (Km)	Canals: Intake canal capacity (m^3/s)	Canals: Catchment (Km^2)	Reservoirs: Max. Capacity (mcm)	Reservoirs: Area (ha)	Reservoirs: Depth (m)	Reservoirs: Level (m Above MSL) Sluice	Reservoirs: Level (m Above MSL) Spill	Reservoirs: Level (m Above MSL) Max. Supply
1		*Ellagalla*	3,170	5.0	12.7	6.0	0.8	178	2	25.73	28.49	28.19
	o	Pannagamuwa	177	+ 12.5	9.9	8.3	13.0	380	3.8	21.15	24.81	24.81
	o	Weerawila	391		1.7	5.6	0.8	80	2	21.76	23.29	23.29
	o	Debera	382	8.3+8.9	10.7	40.0	4.3	275	3.4	17.07	18.29	20.42
	o	Tissa	1,113		1.7	89.0	12.7	500	3.1	11.40	13.72	13.72
	o	Yoda	1,139				0	0	0	-	-	-
	o	Gamunupura	105									
2		*Right Bank* Main Canal	5,050	32.0 (32.0)*	13.0							
	I	1st Tract	583									
	I	2nd Tract	889									
	II	3rd Tract	574			—	—	—	—	—	—	—
	II	4th Tract	928									
	I	5th Tract	1,001									
	II	6th Tract	570									
3		*Left Bank* Main Canal	3,275	22.5 (12.9)	11.9							
	I	1st Tract	702			—	—		—	—	—	—
	I	2nd Tract	886									
	II	3rd Tract	1,308									
	II	4th Tract	381									
4		*Badagiriya*	806	12.5	2.7	350	11.5	490	5	19.66	24.08	24.08
		Kellyamaralana					0.2	10	2			
Total			12,909			499	43.3	2,145	—	—	—	—
Lunuganwehera Reservoir			12,909	—	—	914	284 (197)[b]	3,150	18	45.72	50.60	58.22

* *Under Phase I* [b] *Active storage*

Source: AHT/SOG 1987b:4.

gate. The Badagiriya system could be supplied through the tail end of the Right Bank main canal.

The main canals were double-banked and situated along contours. The branch canal and distributary channels were situated along ridges. To maintain a constant head as a control water level of the offtakes along the canals for variable discharges, the main canals were supplied with undershot-type gated cross-regulators and the distributary channels with fixed weir regulators. A constant head could supposedly be ensured by maintaining full supply depth — which was equal to the height of the side walls — upstream of the cross-regulators. The canal system was supposed to function under steady flow conditions and operation of the cross-regulators was assumed to be necessary only in case of rainfall or change in water issue from the head sluice. In practice, the main canal very seldom functioned under steady flow conditions (IIMI 1989a, 125).

The spacing of cross-regulators along the main canal was determined by the design requirement that the control water level that had to be maintained at the most upstream offtake of a particular cross-regulator should be at least two thirds of the full supply depth (Ponrajah 1988, 111). This had led to a Right Bank main canal in Kirindi Oya with 14 regulators evenly spread along its 24.5-km length.

The gated cross-regulators in the main canal were provided with one to five parallel slide gates, depending on the discharge capacity of the main canal at the location of a particular cross-regulator. It was assumed that the discharge through the cross-regulator was evenly spread over these gates to prevent erosion of the canal downstream of the cross-regulator. Moreover, the parallel gates provided for flexibility in substituting for gates that break down.

It had been assumed that the side walls of the cross-regulators could be used as spillways in exceptional cases. The side walls were rather narrow, because they were not designed to function as a hydraulic level control.

The offtakes to the branch canal and distributary and field channels had single-gated undershot-type regulators. The concrete turnouts to the individual allotments were provided with wooden slide gates that were supposed to create a control water level by completely blocking the canal at the point where water was issued simultaneously to the two opposite turnouts.

The layout also provided for subbranch canals and, subdistributary and subfield channels that served through diversion offtakes, through which the total flow could be diverted.

There was one broad crested weir at the head of each main canal to measure the water releases; however, this measuring structure in the Right Bank main canal remained submerged. There were no reliable devices to measure the issues through the head sluices of the reservoirs of the Old Areas. Sharp crested measuring weirs were built downstream of all offtakes to distributary and field channels in Phase I of the project. In the distributary channel, a baffle wall was located immediately upstream of the weirs to prevent turbulence and to make reading of the water level over the weir easier and more reliable.

It must be mentioned that about 30 percent of the measuring structures along the Right Bank main canal did not function properly as they were either damaged or submerged. In tracts 1 and 2 of the Right Bank, upto 50 percent of the measuring structures were broken: "In particular, the baffle walls were proved to be very inconvenient and most of them were broken....the main reason for this was that the baffle wall tended to act as an obstacle, especially when blocked by weeds" (IIMI 1989a, 82).

Submergence seemed to be caused mainly by the low quality of construction in terms of too low excavation quantities compared to the design specifications (ibid., 83). These structures were replaced, some in Phase I and others in Phase II, by broad crested weirs which were less brittle and had a higher submergence limit. However, for the structures that were fully submerged, these replacements might not be effective because of the topography of the canal bed (ibid., 83).

No direct turnouts from main and branch canals, and distributary and field channels were found. However, direct offtakes to field channels from the main canal and secondary branch canals were quite frequent.

Except for the turnouts along the field channels that had to be operated by the water users themselves, all the other structures were to be operated by the gate tenders, who functioned under the Resident Engineers. The staff of the Resident Engineer, Head Works, operated the head sluices from the reservoir to the main canal.

The drainage system provided for main and drainage canals. The main drainage canals of all Phase I tracts ended up in the Ellagala system except

for the Right Bank tract 5, which drained its water into the Bundala Bird Sanctuary. Surface runoff from the lands upstream of the Right and Left Bank main canals was channeled through under-crossings and a siphon into natural drainage courses that led to the Ellagala system.

A SHORT NOTE ON THE PERFORMANCE OF THE KIRINDI OYA SYSTEM

The Kirindi Oya system had been extremely water-short since the development of the New Areas in the early eighties. The average cropping intensities attained in the Old Areas and the New Areas have been 130 percent and 110 percent,[2] respectively (IIMI 1990, 211). In the appraisal assessments of 1977, 1982 and 1986, the expected levels of cropping intensity were 200 percent, 200 percent, and 170 percent respectively. In addition, several crop failures have occurred in the system since the development of the New Areas. This structural water-short nature of the Kirindi Oya system was due to a combination of factors such as high water duties, cropping patterns other than the assumed, errors in the planning assessments of the available water resources and size of the already existing command area in the Ellagala system. In addition, several years of exceptionally dry weather led to crop failures even in the Ellagala system. A more elaborate discussion of the performance of the Kirindi Oya system could be found in Chapter 8.

The then existing water delivery performance of the Kirindi Oya system was neither exceptionally good nor bad for Sri Lanka. However, due to the extreme water-short nature of the system, coupled with the higher duties than the assumed, the then prevailing water delivery performance could be considered as insufficient and in need of improvement as shown by the analysis of the present system utilization processes described in chapters 3 to 5.

2 The difference between the Old Areas and New Areas is due to the priority in water allocation, which the Ellagala system receives in comparison to the New Areas.

CHAPTER 3

Allocation Concern: Seasonal Allocation Plan

THE ALLOCATION CONCERN in Sri Lankan irrigation systems refers to seasonal and in-seasonal decision-making processes. The seasonal allocation plan is discussed in this chapter, and the in-seasonal decision-making processes in the next.

Seasonal allocation requires assessment of the supply to the system as a whole and the supply to each subsystem. This assessment can incorporate supply parameters like rainfall in the catchment area, hydrological simulations, actual inflow and storage in reservoirs. Seasonal allocation also requires an assessment of the demand of the overall system and the demand of each subsystem. Assessment of the demand for the season covers the requirements for irrigation and nonirrigation purposes of the water users, the politicians and the staff of involved agencies. These requirements may refer to demand parameters such as the areas to be irrigated, the water duties, the cropping pattern, the cultivation calendar and the related cultivation risks for different subsystems. Implicitly or explicitly, the water duty relates to the water delivery performance — whether required by the water users or envisaged by the agency during the season — in terms of adequacy, timeliness, responsiveness, predictability, delivery performance ratio, operation efficiency and equity.

Requirements concerning the water duty, cropping pattern (e.g., shorter- and longer-term varieties of rice) cultivation calendar, and related cultivation risks may also implicitly represent demand preferences with respect to the input of labor in irrigation and agricultural practices (i.e., potential and preferred farm power), factor substitution (e.g., water for insecticides) and related agricultural productivity. Or else, the expected water delivery performance may implicitly incorporate the preferences of the agency staff (e.g., minimization of management input, minimization of accountability toward or interaction with the water users and the politicians).

Allocation decisions have to be preceded by a matching of supply and demand. If demand is larger than supply for the overall system or for one or more of the subsystems, prioritization may be required among the

abovementioned parameters that determine the explicit and implicit demand requirements of the subsystems. It may also require prioritizing among the different subsystems.

THE DECISION-MAKING PROCESSES

Supply Assessment

Technical aspects. Assessment of the supply to the overall Kirindi Oya system takes into account the storage of the Lunuganwehera Reservoir and the existing inflow. The storage was estimated on the basis of the water level in the reservoir and a rating curve established by the Irrigation Department on the basis of topographic maps. The maps were probably based on terrestrial surveys done in 1943/44 (WAPCOS 1986, III:5).

The inflow into the Lunuganwehera Reservoir was assessed by the water level of the Kirindi Oya River just upstream of the reservoir on a biweekly basis. Using the water level, the expected inflow was derived from the 50, 80 and 90 percent exceedance probability curves as calculated by the Water Management Consultants (AHT/SCG 1989, IV:10). Meteorological data collected by the Hydrology Division of the Irrigation Department from several hydro-climatological stations in the catchment area of the Lunuganwehera Reservoir were not used as an early warning system, but they served statistical purposes.

Following several crop failures in the Kirindi Oya system since the development of the New Areas, there arose a serious doubt about these expected probabilities. The Hydrology Division of the Irrigation Department suggested that the original estimates might have been 40 to 60 percent too high (Dharmasena 1988, 70). A more conservative estimate made by means of the area ratio calculation as computed by IIMI would still result in a possible overestimation of 25 to 45 percent of the original estimates (IIMI 1990, 15).

The Irrigation Department and IIMI stated that the data available are insufficient to make reliable estimations. Thus, no reliable cultivation risks could be estimated at present, which is a major problem in an irrigation

system in a dry-zone environment with very variable annual inflow volumes and which frequently has to start cultivation with an empty main reservoir (see for example Dharmasena 1986, 25).

The supply to the different subsystems had not been assessed on a seasonal basis while the supply to the New Áreas commanded by the Right Bank and Left Bank main canals has been assessed along the above lines. Because of the priority rights of the Ellagala system, its supply was equal to its perceived seasonal demand minus the available storage in its own reservoirs. But the actual supply depended on the degree to which the available active storage in the Lunuganwehera Reservoir could supply that demand. The supply to the reservoirs of the Ellagala system from its own catchment areas was neglected in the seasonal allocation planning. The supply to the Badagiriya system has been assessed by the water level in its own reservoir only.

Managerial aspects. The assessment of the water level in the Lunuganwehera Reservoir was done by the staff of the Resident Engineer, Head Works, on a daily basis. They informed, daily, the Senior Irrigation Engineer of the Water Management Feedback Center about these levels by telephone, and he eventually calculated the supply to the overall system.

Demand Assessment

Technical aspects. The demand of the New Areas of the system had been mainly assessed theoretically by calculating the theoretical crop water requirements (using the Penman formula) for each tract and assuming certain field application and conveyance losses. The overall theoretical demand of the New Areas had been assessed through the aggregation of these estimates for different tracts, at the same time incorporating estimates of different losses that occurred in the process of conveying water to these tracts (Jayasundera 1989).

Many assumptions had to be made for the calculation of the theoretical crop water requirements at field level. The uncertainties and inaccuracies that were implied in the assumptions (see Annex 2), make these theoretical calculations a rather unreliable guide for assessing demand and evolving water allocation decisions, especially for smaller subsystems. For larger subsystems, the calculations could have been more reliable provided that the assumptions were adapted to the overall water duties for those subsystems;

however, in that case, the theoretical calculations are less useful or less necessary.

Historical data on the water demand of the Old Areas and Left Bank and Right Bank subsystems, were collected for several seasons in the Kirindi Oya system. This provided some insight into the reliability of the assumptions that underlie the overall water requirements of these different subsystems. This reliability was increased through the use of the same assumptions for evaluating daily actual water issues to the Right Bank and Left Bank subsystems during the season, for which measurement data were available. For the Old Areas, such data were not available because reliable measurement structures were absent.

This historical information was complemented by incidental feedback from the staff of the Irrigation Department and the water users during the season giving some additional weight to the reliability of the assumptions. For smaller subsystems, the available measurement data were too unreliable, and feedback too unsystematic to prove the reliability of assumptions.

For the Old Areas, the demand has not been assessed by means of theoretical calculations, but by a gross assessment of the average water duty from which the available storage in the system was deducted.

Information on seasonal requirements, the starting and completion dates for the season, and crops to be cultivated were collected at field-channel level by means of special forms. This information was later converted into agricultural implementation plans at distributary-channel and project levels.

Managerial aspects. The irrigation requirements of the New Areas were calculated by the Senior Irrigation Engineer of the Water Management Feedback Center along the above theoretical lines, using some historical data on gross water duties for the same areas. The estimates of the theoretical requirements were adjusted to fit these overall water duties from the head sluice in earlier seasons. The irrigation requirements of the Ellagala and Badagiriya systems were calculated by the Resident Engineer of the Old Areas and forwarded to the Water Management Feedback Center. Since the allocation in Old Areas and New Areas during the season is essentially demand-driven, the historical gross water duties were considered to represent the actual requirements of the water users. This demand-driven nature was considered to make interaction with the water users unnecessary at this stage.

In all these assessments, cultivation of rice was assumed to be the only preference of the water users.

The assumptions used in these calculations (described in Annex 2) had been evolved from the cooperation between the Senior Irrigation Engineer and the Water Management Consultants and they were laid down by the Senior Irrigation Engineer in a spreadsheet program to facilitate speedy calculations. There had been some disagreement between these two parties concerning the assumptions to be made. The impact of the disputed issues on the estimated theoretical peak water requirements was, however, rather minor except for the assumptions regarding seepage and percolation.

Despite these disagreements, the Senior Irrigation Engineer, in the end, mainly followed the advice of the Water Management Consultants, because this absolved him from any responsibility for possible crop failures. Moreover, the Senior Irrigation Engineer was satisfied with the evolving relation between the actual and theoretical overall seasonal water duties for the Right Bank and Left Bank main canal subsystems. On account of this correspondence of gross water duties, the assumptions regarding the specific parameters that led to the theoretical water duties were less relevant anyway.

While the Water Management Feedback Center did not seek any interaction with the water users to assess the actual irrigation requirements as perceived by it for the cultivation of rice, it also did not interact with the water users or their representatives to assess their requirements in terms of the cultivation calendar. Instead, as for yala 1988, the water user representatives attended the distributary-channel-level and project-level meetings of the Irrigation Management Division and discussed the information on the required cultivation calendar and cropping patterns gathered through special forms prepared for every field channel. These project-level meetings decided on a preferred cultivation calendar, which was presented by the water users at the precultivation meeting. These proposals of the water user representatives reflected the optimum cultivation period (from an agronomic point of view) to obtain a good harvest, a distrust toward the Irrigation Department with respect to the service to be delivered, and a preference for rice cultivation.

Prior to the precultivation meeting, seasonal allocation plans were prepared separately by the Senior Irrigation Engineer, the water user representatives and the Irrigation Management Division. The

distributary-channel-level meeting and project-level meeting of the Irrigation Management Divisions were not attended by those officials of the Irrigation Department, specifically the Senior Irrigation Engineer of the Water Management Feedback Center who had responsibilities in the preparation of the seasonal plan.

The Project Manager and the water user representatives of the Irrigation Management Division for the New Areas learned, informally, about the proposals or plans of the Irrigation Department regarding the cultivation calendar. However, the Project Manager of the New Areas formally supported the opinion of the water users in all situations — whether reasonable or not — in order to maintain the function of the Irrigation Management Division as a forum for the opinions of the water users, or, at least, of their representatives.

The fact that the opinions of water user representatives were promoted showed that the field-channel-level water user groups of the Irrigation Management Division were rather weak. A small survey by IIMI revealed that "many of the ordinary farmers were not aware of the role of the organization, their own role, or the role of the [field-channel leader] in it" (IIMI 1989b, 37). And it appeared that 90 percent of the farmers did not know who their farmer representative was (Somaratne 1989). The same researchers concluded that there existed "a vast communication gap between the farmers and farmer representatives as well as between officers and farmers" (IIMI 1990, 70).

Some of the factors that led to this weakness were the hasty selection process of the leaders, the absence, at the early stages, of institutional organizers to facilitate the group processes at field-channel level and the top-down approach to implementing the program (IIMI 1988, 74).

Thus, the representativeness of the water user representatives for the interests of the water users could be doubted, especially at the distributary and field-channel levels. However, for the seasonal decision-making processes, the demand side mainly covered the cultivation calendar for different tracts, opinions about which could be assumed to be adequately represented by those water user representatives of the Irrigation Management Division.

Matching of Supply and Demand into a Seasonal Allocation Plan

Technical aspects. The matching of supply and demand for the overall system was preceded by the allocation of the total volume of the seasonal water requirement to the Ellagala system from the Lunuganwehera Reservoir, because of the *de facto* priority rights that had been given to Ellagala by the Government of Sri Lanka.

Further matching of supply and demand for different tracts of the New Areas takes into account the estimated theoretical demand — adjusted to the historically established gross water duties — and the remainder of the estimated available seasonal supply. If the storage in the Lunuganwehera Reservoir was much less than the estimated total demand, the cultivation risks were calculated for the different number of tracts to be irrigated. These risks were again based on the unreliable probability curves given by the Water Management Consultants in the Water Management Strategy Plan (see page 36). During the time of observation for this study, the Badagiriya system was allocated water from Lunuganwehera, only if excess water resources were available after the allocation of the requirements for the Ellagala system and New Areas.[3]

Managerial aspects. A short description of the actual seasonal allocation decision-making processes during yala 1988 and maha 1988/89 as well as an elaborate description of the different steps in the seasonal allocation decision making in the Kirindi Oya system are given in Annex 3. The following section gives a concise summary of this annex.

The first step in the seasonal allocation planning was (as described earlier) the calculation of irrigation requirements by the Senior Irrigation Engineer of the Water Management Feedback Center. Since the gross water duties had been established in a demand-driven mode of allocation during earlier cultivation seasons, no interaction between staff of the Irrigation Department and the water users was considered necessary at this stage by the Irrigation

3 During 1990, this situation was reversed by intervention from the highest political levels and the Badagiriya system was given preference in water allocation.

Department. These water duties also implied the cultivation of rice, generally preferred by the water users. No interaction took place at this stage to determine a preferred cultivation calendar. Without any such interaction, the Water Management Feedback Center developed a proposed seasonal plan, including envisaged water duties, cropping pattern, staggered cultivation calendar and involved cultivation risks. This proposal was forwarded to the Chief Resident Engineer.

The Chief Resident Engineer matched the proposed dates with the required maintenance activities, whereby the maintenance activities got more priority if they conflicted with cultivation interests. After the incorporation of the maintenance activities in the calendar, the proposed seasonal plan was forwarded by the Chief Resident Engineer to the Government Agent of Hambantota District.

The Government Agent consequently organized precultivation meetings for every tract (New Areas) or reservoir (Old Areas). These precultivation meetings were meant to get a first understanding of the requirements of the water users regarding the seasonal allocation plan. Before these precultivation meetings were introduced, the seasonal allocation planning was done separately by the Irrigation Department and the Irrigation Management Division. Then, the demand assessment regarding the cultivation calendar and cropping pattern had been done only by the Irrigation Management Division, through the distributary-channel-level and project-level meetings as described earlier (page 39). In the absence of any interaction at this stage, this seasonal planning by the water user representatives and the Project Manager had little influence on the plans of the Irrigation Department at these preparatory stages.

The decisions that have evolved from these two isolated decision-making processes came together for the first time at the precultivation meeting and if they did not match — this refers, in practice, mainly to the cultivation calendar — the proposals of the Irrigation Department were, in general, pushed by the attending officers for a number of reasons. Of these, the first was that the Irrigation Department was held responsible for the successful implementation of the plans. The second was that most agency staff did not like the rather political role of the Project Manager of the Irrigation Management Division for the New Areas, who always supported the water users' demands, even if those demands were unreasonable or insulting to the

agency staff (see also Annex 3). The water users, in their turn, could comment on and make tentative decisions on the proposed areas to be cultivated, the crop varieties to be cultivated and the cultivation calendar.

The outcome of the precultivation meeting was subsequently discussed at the *Project Coordinating Committee* with the officers of different line agencies and with the Project Managers of the Irrigation Management Division. At this meeting, the officers agreed on a proposed plan for the season which, according to the Sri Lankan regulations, had to be authorized by the water users at the cultivation meeting. As at the precultivation meeting, the proposals of the Irrigation Department were pushed at the cultivation meeting too, and any opposition of the water users was played down. Until Yala 1988, the water users had to agree to the proposed seasonal plan as they were unable to influence any changes in the proposals by the Irrigation Department during precultivation and cultivation meetings. In later seasons, however, the water users started to push their own cultivation calendars, which led to many conflicts, as has been described in Annex 3 and in IIMI 1990, 55.

In August 1988, the Project Coordinating Committee decided to form a *Subcommittee* of the *Project Coordinating Committee* to discuss the seasonal allocation plans in more detail. This decision was made after a dragged on reluctance to pay much attention to the seasonal planning by the staff officers of the Irrigation Department and the Land Commissioner's Department. It was only after conflicts arose (Annex 3) that these officers finally accepted the complexity of the different interests in the seasonal allocation planning, especially in view of the future necessity to introduce subsidiary field crops, and subsequently delegated this seasonal planning to a special subcommittee.

Like the Project Coordinating Committee, this subcommittee was chaired by the Project Manager (Settlement). The Chief Resident Engineer, the Project Managers of the Irrigation Management Division, and the representatives of the Department of Agriculture (Extension) and the Agrarian Services were members of this subcommittee. The efforts of the Project Manager of the Irrigation Management Division for the New Areas to let the water user representatives participate in this meeting were opposed by most officers, just as they opposed their participation during the Project Coordinating Committee. The Project Managers of the Irrigation Management Division themselves were supposed to be sufficient

representation for the opinions and preferences of the water users. Thus, while this subcommittee provided for a more careful preparation of the seasonal planning between the agencies, the divergence of expectations of the water users was not tackled at all.

During 1989, the *Subcommittee of the District Agricultural Committee* became operational as well. This subcommittee was a decision-making body, provided for by the INMAS Program for the agricultural programming and implementation in the district. In principle, the same officers who were in the Project Coordinating Committee attended this meeting. Farmer representatives from all projects in the district also attended this meeting. However, the Chief Resident Engineer and the Project Manager (Settlement) of the Kirindi Oya system did not attend it, because they did not have any involvement in the district administration.

As the Kirindi Oya system was still under construction, the agricultural planning could not be considered separately from the ongoing construction activities by the same staff. Without a complete separation of these activities, the Subcommittee of the Project Coordinating Committee seemed indeed more useful than the Subcommittee of the District Agricultural Committee. However, an advantage for the water users of the Subcommittee of the District Agricultural Committee was its legal basis in the Irrigation Ordinance. On the other hand, for the agencies involved in the construction of irrigation and land settlement infrastructure, this legality appeared to be a disadvantage, for without it their construction priorities would have been better represented.

An improvement in communication between the Subcommittee of the Project Coordinating Committee and the Irrigation Management Division was tried out at a later stage after the personal intervention of the Director of the Irrigation Management Division. This led finally to the attendance of the water user representatives at the subcommittee. Despite this improvement, the subcommittees, on their own, appeared to be yet unable to tackle the problem of the divergent expectations of the water users and the agencies (IIMI 1990, 54).

The aforementioned problems of lack of coordination were evinced from the personal conflicts between the Project Manager of the Irrigation Management Division and the Project Manager (Settlement); this situation improved with the arrival of a new Project Manager (Settlement) (ibid., 51).

Implementation of the Seasonal Allocation Plan

Technical aspects. Five days in advance of the agreed dates, the water issues to the Right Bank main canal had begun, so that the canal was filled up before the agreed dates. The initial discharge into the main canal was about 30 percent of the discharge required for land preparation, because of delays in the use of water by the farmers. Many farmers in the New Areas of the Kirindi Oya system were nonresidents, who came to the project area only when the water issues actually started. Moreover, delays in land preparation were attributed by the water users to delays in the supply of inputs and credits.

Managerial aspects. If the water users complained that the 30 percent discharge was not sufficient, the Water Management Feedback Center gradually increased the discharge to 100 percent. The Irrigation Department does not intensively monitor the progress of the land preparation in the different distributary-channel systems, because such delays are considered to be determined mainly by external factors like the untimely availability of inputs and credits.

The role of the Irrigation Management Division in the Kirindi Oya system in facilitating the availability of these inputs and credits to farmers and the cleaning of field channels to reduce delayed land preparation was not impressive; "the Division has failed to attend to these functions because of lack of line agency cooperation and because its main focus has been on irrigation problem solving [i.e., issues related to faulty construction]. It could be seen that the cultivation calendar agreed upon was not adhered to in any of the seasons and as a result water issues had to be extended." (IIMI 1990, 51). Neither the Irrigation Department, nor the Irrigation Management Division made much effort to reduce delays in the land preparation within the different distributary-channel subsystems.

Mutual Adaptation of the Technical and Managerial Aspects

Demand assessment by the Irrigation Department was limited to the gross water duties, which were derived from the historical measurement data of the demand-driven allocation to the Right Bank and Left Bank main canals.

Further demand assessment in terms of cropping pattern and cultivation calendar was done separately by the Irrigation Management Division without the attendance of responsible Irrigation Department staff. This lack of mutual adjustment of the parallel seasonal planning processes between the Irrigation Department and the Irrigation Management Division led to divergent expectations regarding the cultivation season. During the period of observation, these divergent expectations clashed in the precultivation and cultivation meetings where effective exchange of ideas was impossible.

If the seasonal planning of the Irrigation Department and the Irrigation Management Division were more integrated, communication between the two sides alone would have reduced the frustrated feelings to a large extent, and would have increased the likelihood of evolving the required trade-offs by both sides on water duties, cultivation risks and especially, the cultivation calendar.

The overall impact of the different subcommittees in reducing this divergence of expectations between the agencies and the water users on the seasonal allocations appeared to be limited (IIMI 1990, 17); the subcommittees alone could not cope with the required mutual adjustment of the planning processes of the Irrigation Department and the Irrigation Management Division. The expectations of the water users, as laid down in the seasonal plan of the Irrigation Management Division, were, however, an essential part of the demand; with the given water resources, matching of supply and demand should essentially focus on real-life demands rather than on theoretical water requirements and maintenance interests alone.

In the developed countries, these theoretical water requirements might give reliable information on the demand, or if not, the deviations could be corrected with a phone call from the involved water user. However, in a system with a vast number of smallholders lacking communication facilities, and with unreliable feedback on realized deliveries or water conditions of the individual fields, these calculations seem less relevant. Its application also diverts attention and efforts from the more important assessments of the actual demands.

An indifference and an unwillingness on the part of the staff of the Irrigation Department and the Land Commissioner's Department to put much serious management inputs into the communication with the water users were important underlying causes. Their unwillingness might have

been partly caused by what Moore has described as elitist feelings of engineers toward farmers and other agencies (Moore 1980b, 103). In addition, many engineers had an explicit aversion toward the "interference" of the Irrigation Management Division in their work, and many even considered the Irrigation Management Division as a rival who wanted to get rid of the Irrigation Department in the long run.

In the Kirindi Oya system, these behavioral aspects and fears were strongly reinforced by a priority for construction and maintenance targets, which gave important opportunities for the management inputs of many agency staff. Strongly related to this were the justified fears of the staff of the Irrigation Department and the Land Commissioner's Department that the water users would come forward with undesired criticism of the quality of construction of irrigation and settlement infrastructures.

The indifference was also expressed in the approach of the Irrigation Department staff toward its own credibility in the eyes of the water users. For example, Merrey and Somaratne (1989, 28) describe a crop failure during 1986/87, for which the water users partly blamed the Irrigation Department for spilling the water in order to repair the spillways of the Lunuganwehera Reservoir, a year after its inauguration. The water users were not informed of it at any stage — before or during the repair, during the water scarcity, or after the crop failure — why this water was spilled or why this repair was so exigent.

During the period of observation of this study, the Irrigation Department on several occasions came up with unrealistic proposals that were certainly not aimed at increasing its credibility. During yala 1988, for example, the staff of the Irrigation Department first wanted to grow short-term subsidiary field crops even though there was enough water for rice cultivation in the reservoir and they knew that all institutional factors needed for growing subsidiary field crops (crop insurance, marketing, knowledge of operating the system for subsidiary field crops, etc.) were not available.

Later, when they were forced to move ahead with the cultivation for maha 1988/89 before they were able to finish their maintenance work, they continued to complete the work beyond the agreed starting date for cultivation without informing the water users (who had proceeded with arranging labor, tractors, etc.), the Government Agent or the other related agencies.

This attitude and consequent reduced credibility of the Irrigation Department staff with regard to the seasonal allocation decision-making processes made effective communication between the Irrigation Department and the water users difficult. Moreover, the implicit — but obvious to the water users and the other agencies — priority for construction has made the water users suspicious about the motives of the Irrigation Department in proposing certain dates, especially after the drought years. This attitude led to processes that were even more unsatisfactory and time-consuming for the Irrigation Department. For example, even if the Irrigation Department was correct in claiming that some maintenance works could not be postponed (e.g., the work on the main canal, in September 1988, because of financial reasons as described in Annex 3), the water users did not trust the Irrigation Department. As a result, no compromising was possible as the water users insisted on what they perceived as their interest without relying on the expertise and concerns of the Irrigation Department.

The agencies thus lost control over the seasonal allocation processes and the Irrigation Department depended on whatever the water users decided at the cultivation meeting. In the cultivation meeting of maha 1989/90, for example, the water users decided that all areas would start cultivation at the same time, even though the Lunuganwehera Reservoir was almost empty. Although the Irrigation Department protested and proposed the postponement of cultivation for some time, the Government Agent and the Irrigation Department did not dare to overrule the decision of the water users and were forced, due to the lack of water, to stop the water issues to tracts 2 and 5 a week after the land preparation had started.

Ultimately, this attitude led to increased problems for the involved agencies as they forced the water user representatives and the Irrigation Management Division to make their preferences known in other less regularized ways. Moreover, the department lost its credibility with the water users; it is exactly this credibility that would be needed, if the Irrigation Department wishes to improve the water delivery performance, cropping intensity, and productivity of the whole system.

The seasonal allocation planning in the Kirindi Oya system was focused mainly on the cultivation calendar. The cultivation calendar was the most easily accessible item for the water users, and the allocated water duties were generally demand-driven and thus satisfactory. However, apart from the

ineffective communication, there was no reason why the decision making regarding the other allocation parameters (i.e., cultivated extents, water duties and cultivation risks), should be done solely by the Irrigation Department, and mainly by the Senior Irrigation Engineer. The Chief Resident Engineer, and through him the Government Agent, were informed about the assumed water duties and the cultivation risks involved. While the water users and other agencies might have had a vague idea of these issues over the years, they did not possess sufficient understanding of the issues and trade-offs.

The assumptions regarding the average water duty and cultivation risks were considered either too high or too low by the water user representatives; if the Irrigation Department could have shared this information with them, they could have seen for themselves what the consequences of certain decisions were for their own subsystems in terms of water duty and cultivation risks, as well as for the overall system in terms of productivity. Though the Irrigation Department was responsible for the implementation of the envisaged program, it was questionable whether the Irrigation Department alone should have held this responsibility and faced the risks involved.

Interaction between consultants and the Irrigation Department. The Water Management Consultants had only a limited and indirect role in the seasonal allocation decision-making processes through their Water Management Strategy Plan and the Operation and Maintenance manual. Some remarks must be made, however, on the relevance of these manuals and the processes that have led to them.

The manuals of the consultants envisaged several scenarios of cropping patterns and calendars under different water availability situations at the beginning and during the season. Such planning tools could have been relevant to decision-making processes in the Kirindi Oya system, only if the criteria used in them reflected the criteria that had to be used in reality by the Irrigation Manager. Therefore, it was a pity that no matching of the criteria used by the external consultants (maximization of productivity per quantity of water and thus, maximization of the system productivity only) and the Irrigation Department (reduction of cultivation risks for the individual water users resulting in a conservative allocation of land for cultivation) had taken place, and it had ultimately made this planning tool completely theoretical.

At the time the Water Management Strategy Plan and the Draft Operation and Maintenance Manual were written, the interaction between consultants and the Irrigation Department staff was rather ineffective. The consultants complained of insufficient cooperation extended to them by the Irrigation Department staff in their work. In fact, initially, the Irrigation Department staff had resisted their role. Moreover, it appeared that the attitudes of the first group of consultants had contributed to worsen this lack of cooperation. However, at a later stage, the interaction improved. The final Operation and Maintenance Manual was more practical than the earlier draft for it incorporated several managerial realities of the Kirindi Oya system.

The Terms of Reference for the consultants were rather inconsistent and ambiguous in many ways. For example, though it mentioned "assisting the Irrigation Department to formulate a long term strategy for water management of the Project" (AHT/SCG 1987, A:2:4), it said little about how the consultants should interact with the Irrigation Department staff, or whether their criteria should match managerial realities in the Kirindi Oya system. Although the Irrigation Department did not call for foreign technical assistance — at least during the construction phase — the donor, on the other hand, is said to have demanded that the loan he withheld if the former would not accede to their terms. Such an approach would not have been conducive to a healthy atmosphere for "assisting the Irrigation Department to develop a long term strategy for water management in the Project" (ibid.). This created a rather difficult work situation for the consultants.

Institutional support from national levels. The priority for construction activities was not restricted to the project level. Guidance, monitoring and evaluation of the Kirindi Oya system by the head office of the Irrigation Department focused on construction aspects only. The head office staff who visited the project were interested only in the construction aspects and not in the actual utilization of the new system. Elaborate monitoring and evaluation systems existed as regards the construction progress (Wimalabandu et al. 1985). The Project Coordinating Committee and the Central Coordinating Committee also focused their attention on the construction and neglected the agricultural implementation.

This institutional focus on construction resulted in a lack of guidance for the responsible decision makers in better decision-making techniques and in scanty interest, appreciation, or support for their actual performance in the

seasonal decision-making processes. Not even the minutes or decisions of the relevant meetings were monitored by the head office. The only performances measured by the head office were the seasonal duties for the overall system, extents cultivated, and the planned and realized cultivation calendars. This performance monitoring has not been evaluated, because it was considered system-specific and subject to varying rainfall intensities.

It required an unlikely individual motivation of a staff member to do a good job without institutional support, in face of the opposition of colleagues when construction and cultivation interests conflicted, with the water users seldom satisfied whatever the performance was, and with the constant possibility of interventions by politicians. A more likely choice for a responsible decision maker was to maintain a low profile, and continue it even after the construction was completed.

In contrast to this limited institutional support, the benefits of a shorter cultivation season through better adherence to the cultivation calendar could have been enormous. For the Uda Walawe system, for example, it had been calculated that a reduction of the cultivation periods by better monitoring and evaluation of the land preparation could have led to additional annual water savings of approximately 9 percent for each week per season. For two weeks per season, the related benefit-cost ratio could be as high as 192, provided the water saved would be used for additional cultivation (Kikuchi 1990, 2). The related benefits could be as high as "a 3-month-salary-worth bonus...to all employees, or a 12-month-salary-worth bonus to the water management related employees" (ibid., 3). For the Kirindi Oya system, the calculation of such benefits appeared less easy, but the size of benefits of a shortening of the cultivation season would be similar. Moreover, in contrast to the Uda Walawe system, the irrigation infrastructure in the Kirindi Oya system was readily available to utilize water savings for additional cultivation in the then water-short command area.

CHAPTER 4

Allocation Concern: The In-Seasonal Allocation

THE SEASONAL ALLOCATION decisions in terms of the area to be cultivated, cultivation calendar, cropping pattern, the envisaged water duties and cultivation risks for different subsystems provide the starting points for the in-seasonal allocation decisions. The seasonal allocation decisions are taken only once during the season — with perhaps some adjustments during its implementation, i.e., land preparation — while the in-seasonal allocation decisions are, in principle, taken more frequently during the season.

In-seasonal allocation requires assessment of the supply to the system as a whole and the supply for different subsystems. This assessment can incorporate supply parameters such as rainfall in the catchment area, hydrological simulations, actual inflow, storage or level in reservoirs, and storage or level in upstream canals. The frequency of the assessment of the supply can vary from continuous to *ad hoc*, and this frequency may depend on the water availability situation (abundant, tight or short).

The demand during the season is made up of different requirements for irrigation and nonirrigation purposes of the water users, the politicians and the staff of the involved agencies. These requirements may refer to demand parameters, such as the areas to be irrigated, the water duties, the cropping pattern, the cultivation calendar and the related cultivation risks for the different subsystems.

The assessment of demand can be based on such parameters as cultivated area, on-farm vertical percolation and lateral seepage rates, canal seepage rates, expected and actual rainfall in the cultivated command area, canal operational losses and evaporation from crops. It can also be based on the water level at the head of the concerned subsystem or on the requests of the water users or the politicians. This assessment can be done more or less frequently and that frequency may also vary with water availability.

Implicitly or explicitly, the water duty relates to the water delivery performance required or expected by the agency during the season in terms of, for example, adequacy, timeliness, responsiveness, predictability, delivery performance ratio, operational efficiency and equity.

Requirements with respect to water duty, cropping pattern, cultivation calendar and related cultivation risks may also directly or indirectly represent demand preferences with respect to the input of labor in irrigation and agricultural practices (i.e., potential and preferred farm power), factor substitution (e.g., water for insecticides), and related agricultural productivity. On the other hand, the expected water delivery performance may implicitly or explicitly incorporate the preferences of the agency staff (e.g., minimization of management input, minimization of accountability toward, or interaction with the water users and the politicians).

Allocation decisions have to be preceded by a matching of supply and demand. If demand is larger than supply for the overall system or for the different subsystems, prioritizing may be required among the abovementioned parameters that determine the explicit and implicit demand requirements of different subsystems. The allocation decision making may also require prioritizing among the different subsystems. The allocation decisions with respect to water duties may be made more or less frequently; these may also vary with the availability of water. The allocation decisions in terms of operational targets for conveyance and distribution for the water flow regulation may be expressed in an explicit or implicit water schedule for different subsystems that may or may not incorporate the hydraulic and managerial responsiveness. The responsiveness used may be based on assumptions, experience, feedback, historical data or a combination of all these, possibly with some form of statistical analysis.

THE DECISION-MAKING PROCESSES

Supply Assessment

Technical aspects. The in-seasonal assessment of the supply to the whole system has been done in the same way as the seasonal assessment as described earlier (page 36), and the same data were used. During the season, monitoring of the water level in the Lunuganwehera Reservoir was done daily. Inflow data for the reservoir were collected on a biweekly basis. Data on rainfall in the catchment area were collected by the Hydrology Division

of the Head Office of the Irrigation Department and were not made available to the Water Management Feedback Center.

The supply available to the branch canal and distributary and field channels has been assessed by the water levels in the upstream canals. In principle, this water level should have been constant at full supply depth, which was the control water level for the offtake structure. However, in practice, the water level appeared to fluctuate, especially toward the tail end of the canal. Since the water levels fluctuated more at the tail end of the main canals, the assessment of the water level occurred more frequently at the tail than at the head of the main canal. Officially, this assessment should have been done twice a day; nevertheless, in practice, it has been observed to happen once in every 3 or 4 hours (Malaterre 1989, 18).

The difficulties of assessing the supply to the distributary channel caused by fluctuations of the water level in the main canal were compensated partly by a large safety margin in the allocation to the distributary channel and partly by the temporary reduction of allocations to some field channels.

Managerial aspects. The first step of the in-seasonal allocation decision making was the assessment of the available supply to the overall system by the Senior Irrigation Engineer of the Water Management Feedback Center. The Irrigation Department did not have rules to determine how this supply should be assessed. In the Kirindi Oya system, this assessment depended on the Water Management Feedback Center, partly based on advice from the Water Management Consultants.

Demand Assessment

Technical aspects. The in-seasonal demands of the overall system and of the different subsystems have been assessed theoretically by using the same method of calculation of theoretical water requirements as for the seasonal assessment. The same estimates and assumptions given in Annex 2 were used. In addition, feedback of measurement data of water deliveries made to all distributary-channel subsystems was envisaged by the Water Management Feedback Center to provide for regular, if not daily, monitoring and evaluation opportunities of these theoretical assessments.

Actual feedback appeared unreliable for two reasons. First, approximately 30 percent of the measuring structures along the Right Bank main canal were

broken or submerged[4] (IIMI 1989a, 82). And, backwater that occurred in many distributary channels affected the measuring weirs making the measurements unreliable. Under these conditions overestimates of the discharge were given by the theoretical weir equation used by the Irrigation Department (ibid.). Second, cross-checking of the measurements was stopped, because of the unreliable performance of the gate tender doing the job.

As a result, these theoretical assessments of the irrigation requirements had no practical value in the in-seasonal assessment of demand. The actual assessment of demand of the Right Bank and Left Bank main canals was the result of the localized demand assessments for the branch-canal, distributary-channel and field-channel subsystems. The demand of the field-channel subsystem has been assessed at least twice a day at the water level above the measuring weirs of the field channels and also at the requests of the water users of those field channels.

Similarly, the demand of the distributary-channel subsystems has been assessed by the water level above the measuring weir and at the requests for more or less water to the field channels. The demand of the Right Bank main canal subsystem was assessed by the water levels along the main canal — low water levels occurred usually at the tail end of the main canal — and at the requests for more or less water at the offtakes to the distributary channels.

The actual demand of the field channels has usually been assessed in this way to get a continuous flow in the field channel, for continuous issues were automatic and required less labor input. Moreover, it reduced the need for herbicides, as inundation impeded the growth of weeds to a large extent.

Managerial aspects. Demand assessment was done mainly as a reaction to complaints. After water issues to distributary channels started, the maximum possible discharge was allocated during land preparation. No

4 The measuring weirs and baffle walls were broken, mainly on the instructions of staff of the Resident Engineer (Right Bank), because they faced difficulties in issuing enough water to many of the distributary channels during land preparation, and more water could be issued, if these structures were broken. The difficulties in issuing these peak discharges were due to blocking of the baffle walls by weeds and underestimation of the design discharge for the overall Right Bank command area (as well as for individual distributary channels) due to several reasons which are given in chapters 8 and 9.

assessment of the actual irrigation requirements of the distributary and field channel subsystems has been done at all during land preparation. It was only after all the water users have completed land preparation, the overall allocation was reduced somewhat and demand assessment along the abovementioned lines took place as a reaction to the water users' complaints to the gate tenders or to the Resident Engineer's office. The water users preferred a continuous issue to their field channel, but if the discharge in the distributary channel did not allow this for all field channels and this discharge could not be further increased, the gate tenders, at the requests of the water users, implemented a demand-driven *ad hoc* rotation between field channels.

The demand assessment for the main canal did not occur during land preparation either, because then all canals, including the main canal, were overloaded with the maximum possible discharge. Once the land preparation was completed, the main canal discharge had been reduced and demand assessment occurred by trial and error, i.e., through reactions to complaints of the water users expressed to the Resident Engineer's staff. In addition, a regular monitoring of the actual water levels along the main canal was done in an approximate way by the staff of the Water Management Feedback Center.

Matching Supply and Demand into In-seasonal Allocation Schedules

Technical aspects. The in-seasonal matching of supply and demand was, as in the seasonal matching, preceded by the allocation of the total demand of the Ellagala system from the Lunuganwehera Reservoir. For the New Areas, matching of supply and demand took into account the residual supply to the overall system as well as the theoretical demand that had been adjusted to the overall gross water duties. The allocations were laid down in water schedules containing the allocations to all subsystems for the whole cultivation season from the moment of completion of land preparation.

These scheduled allocations assumed that the water users along a field channel would rotate a one cusec (i.e., 28.3 l/s) discharge during a certain allocated period. This fixed allocated period was again a part of a rotation along the distributary channels. The discharge to the main and branch canals and distributary channels was scheduled to be continuous. The schedules

were thus specific in the discharge and the duration for all canals. The scheduled allocations along the distributary channels and field channels were of the "fixed duration-fixed discharge" type and were aimed at saving water through more control of the delivery of water volumes. Within the field channel this increased control were to be realized by the water users themselves. The schedules were, in principle, not changed anymore during the season, even if the supply available to the overall system fell short of the theoretical demand.

Managerial aspects. Based on the decisions made at the cultivation meeting, the Senior Irrigation Engineer calculated the theoretical water use requirements of all subsystems. The allocations to different subsystems were laid down in the water schedules that were fixed for the whole season. These water schedules formed the operational targets for the actual water flow, which was regulated by the Resident Engineer's staff. At the start of the season no interaction between the Water Management Feedback Center and the water users or the staff of the Resident Engineer took place regarding these schedules. Deviations of the actual allocations from the scheduled allocations were supposed to be monitored by the Resident Engineer and the Water Management Feedback Center, but adjustments by the Water Management Feedback Center occurred at the beginning of the next season only. Such adjustments have not taken place frequently, because actual water deliveries did not correspond at all with the scheduled deliveries. In-seasonal changes were the responsibility of the Resident Engineer's staff, who were expected to broadly adhere to the water schedules of the Water Management Feedback Center.

In his scheduling, the Senior Irrigation Engineer implicitly used the criterion of equitable water distribution among all the water users and all subsystems, taking into consideration the priorities described for the seasonal allocation decision making (Annex 3). Thereby, he tried to minimize the cultivation risks for the water users by keeping his estimates on the safe side, and at the same time, strove to economize on water use by scheduling rotational deliveries.

There were no official requirements for the Irrigation Department to do this scheduling, except for the stated preference for rotational deliveries in the Technical Guidelines (Ponrajah 1988, 244). The Asian Development Bank (ADB) was more explicit in the implementation of rotational issues as

loan covenants (ADB 1982, 39 and 48). This requirement directly evolved from the assumptions regarding the future water delivery performance during the planning and designing stage (ibid., 39) will be described in Chapters 8 and 9. The Senior Irrigation Engineer adhered to these requirements.

Implementation of the In-seasonal Allocation Schedules

Technical aspects. While the water schedules were, in principle, not changed during the season, they did imply some changes during implementation. One change envisaged in these schedules was that which followed a heavy rainfall exceeding 75 mm, when the allocations to the command area were stopped for seven days and, after five days, water was issued for two days to refill the main canal. Thus, the same fixed rotational allocations, as laid down in the water schedules, could be maintained after such heavy rainfall. The 75 mm rainfall limit represented a rule of thumb of the Irrigation Department.[5] The rainfall was measured at four locations in the command area: the Lunuganwehera dam site, tract 5 on the Right Bank, tract 2 of the Left Bank and Tissamaharama. Due to the high spatial variability of rainfall, the actual assessment of rainfall in the Right Bank area could be erratic as will be described later. Another such change was the reduction of the cultivated area at a certain moment, if crop failure in that area could not be prevented.

The operational targets for conveying water along the main canal were laid down in a standing order of the Irrigation Department. This standing order required the water level upstream of all cross-regulators to be of the same level as the side walls of the cross-regulators, i.e., at full supply depth. This full supply depth was the control water level for the offtakes to branch canals and distributary channels.

However, in actual practice the operational targets laid down in water schedules for distributing water were not met at all. Rather, the schedules

5 This rule of thumb also prescribes an interruption of three days for sandy soils and seven days for clayey soils. From these rules, the Senior Irrigation Engineer derived, at first, an interruption of five days for the Kirindi Oya system. However, later he introduced the seven-day interruption, probably because it would enable him to maintain the same water schedules better.

were used by the Senior Irrigation Engineer only for monitoring and evaluation of the actual allocations through the head sluices to the Right Bank and Left Bank main canals.

Managerial aspects. The processes related to the implementation of water schedules in the Kirindi Oya system are described in detail in Annex 4. The following section will give a concise overview of these processes.

The water schedules of the Water Management Feedback Center, recorded in special forms, were submitted to the Resident Engineer's office. The staff of the Resident Engineer had to translate the scheduled discharges into target water levels by means of a theoretical weir equation. This calculation and the subsequent distribution of the forms to the field staff and water user representatives were not done effectively during maha 1987/88 by the Resident Engineer's staff. Neither did they try to implement the scheduled rotations in a serious way. Instead, they preferred to minimize their own management inputs into the water delivery process by completely delegating the actual allocation to the gate tenders, who were instructed to give the water users as much water as they wanted. The staff of the Water Management Feedback Center had no influence over these processes, because the gate tenders were administratively under the Resident Engineer.

At the beginning of the cultivation season, the actual in-seasonal matching of supply and demand started without any assessment of the demand. Therefore, the first allocation to the Right Bank main canal was arbitrarily fixed at 30 percent of the design discharge. After this first issue, the allocation was increased whenever the actual matching of supply and demand in the Right Bank command area required a higher allocation through the head sluice.

The actual matching of supply and demand started at the level of the field-channel subsystem. The allocation to a field channel was estimated by the gate tenders who, through experience, related a certain water level to an allocation and it was increased whenever requested by the water users. An increased allocation to one field channel was compensated by a reduced allocation to another in order to maintain the required water levels along the distributary channel. If reduction to other field channels was not possible or considered too difficult or cumbersome, and the water levels along the distributary channel became too low, the allocation to the distributary channel, as a whole, was increased by the gate tender himself. The demand

for the main canal was assessed by the water levels along the main canal and also from the requests made to the Resident Engineer's office by the water users and the field staff. If these levels were too low — as it was usual at the tail end — and this could not be solved by the reduction of the allocations to branch canals and distributary channels; the allocations through the head sluice would be increased. Thus, instead of a rotational water delivery method, a combination of continuous and on-demand deliveries was practiced despite its description as "unsuitable" in the Technical Guidelines (Ponrajah 1988, 244).

The feedback requirements of this localized matching of supply and demand were less and during the observation period of this study the only feedback to the Resident Engineer's office and the Water Management Feedback Center on the actual allocations to branch canals and distributary and field channels was through field visits or through irregular requests of the water users and the different hierarchical levels of the Resident Engineer's staff.

It was due to the fact that the target issues were unknown to them, the actual allocations from the main canal to branch canals and distributary channels could not be effectively monitored and evaluated by the Resident Engineer's staff and the Water Management Feedback Center. In fact, the Resident Engineer's staff did not carry out any systematic monitoring and evaluation of these actual allocation processes of the gate tenders.

The Water Management Feedback Center tried to enforce some water saving, however, by comparing the actual water issues from the head sluice to the Right Bank main canal with the scheduled allocations, i.e., with the theoretical water requirements. Such enforcement through written comments on the performance of the Resident Engineer (Right Bank) with regard to water delivery and construction, the performance on water delivery also being compared with that of the Resident Engineer (Left Bank), could not be fully effective in the absence of strong institutional support from the Chief Resident Engineer and the Project Director. Moreover, the Water Management Feedback Center had no arguments against or desire to refuse, requests from the Resident Engineer for extra water, because refusal would have made them also responsible for water shortages within the command area, whatever the quality and quantity of the Resident Engineer's management inputs. Since the Resident Engineer's staff did not like the

efforts of the Water Management Feedback Center to obtain more management inputs from them, they made things worse by neglecting and obstructing instructions from the Water Management Feedback Center.

Several changes in the organizational setup were tried out by the Chief Resident Engineer and the Project Director, some of which contributed to improve the situation slightly, but none of them would give the Water Management Feedback Center the administrative power it required to have more control over the actual allocation and water flow regulation processes.

Construction targets got a clear priority from the Chief Resident Engineer and the head office. On the other hand, similar to what Moore described as "negative incentives" for effective interaction with the water users (Moore 1980b, 106), the atmosphere among the Irrigation Department staff in the Kirindi Oya system was such that activities like farmer training classes were considered "dirty work" by many officers. The whole attitude of the Resident Engineer's staff (for example, toward the calculation of the water levels and the implementation of the training classes) could be characterized as something like, "We are instructed to do this, but we do not like it and we are not going to implement these rotations anyway; so what a waste of time."

This naturally led to frustrated feelings among the staff of the Water Management Feedback Center, because it made their scheduling and monitoring work useless. "To save the name of the Irrigation Department" they started to monitor the actual allocation processes themselves. This led to problems, because of the conflicting instructions given to the gate tenders by the Resident Engineer and the Water Management Feedback Center. The Water Management Feedback Center, once it realized this, limited its monitoring to the head sluice and operational methods of the gated cross-regulators in the main canal.

Overall, the minimization of management inputs by the Resident Engineer's staff was the most important deciding factor of the actual allocation processes and consequent operational targets for conveyance and distribution below the head sluice. Less important was the reduction of cultivation risks by passively striving for a no-complaint situation. Only the Water Management Feedback Center used the economizing factor on water use for the system as a whole, through its "macro-control" on the allocations through the head sluice.

Mutual Adaptation of the Technical and Managerial Aspects

Demand assessment was done mainly by the gate tenders. The Water Management Feedback Center and higher-level staff of the Resident Engineer's office adhered to the officially accepted theoretical water requirements leaving it to the field-level staff to manage the difference between the supply and the actual demand for water. Consequently, the higher-level staff did not exert any pressure on field-level staff to economize on water use in the system during water-abundant seasons. The only available pressure in this respect was the short-term availability of water at specific locations and there was no such pressure for head enders, which resulted in the wastage of water.

Mainly localized matching of supply and demand led to an oversupply at the head and undersupply at the tail end of a system or subsystem. The only way to resolve this problem was to make the matching of supply and demand less localized through the involvement of higher hierarchical levels.

The establishment of a Water Management Feedback Center provided the tool, i.e., an information feedback system, to the higher-level staff to get more involved in these processes. However, this tool was not seriously utilized in the Kirindi Oya system, because the willingness to get involved in allocation processes appeared to be absent among the majority of the staff of the Irrigation Department in the Kirindi Oya system and the involved staff at the head office.

The discrepancy between the managerial and technical aspects was made obvious in the introduction of the rotational deliveries. Whereas the Water Management Feedback Center was established to schedule these deliveries and get regular feedback for adaptations, the office of the Resident Engineer (Right bank) did not even seriously calculate the corresponding water levels. The disparity between what the Irrigation Department officially stated what it wanted to achieve, and what it actually achieved through its allocation decision-making processes made the allocation strategy ambiguous.

Although they were aware of the discrepancies, this situation was allowed to continue at all levels by those who were responsible for them. Also, the staff of the Irrigation Department continued to talk about rotational deliveries in public, but they did not actually introduce them. This would certainly not

have increased the credibility of the Irrigation Department in the eyes of the water users, the field staff or other agencies. Possible reasons why a clear decision with regard to the rotational deliveries was not made were that: 1) the decision was directly linked to funding for the construction of more tracts (tracts 3 and 4 of the Right Bank) and, 2) to the availability of water for the overall system. A clear decision against rotational deliveries implied higher water requirements than assumed. It would not have favored the extension of the command area, and would have conflicted with construction priorities.

Instead of making a clear decision regarding rotational deliveries, the actors involved in the in-seasonal allocation let the issue drift. Monitoring of the in-seasonal allocation by the head office was restricted to the monthly reports covering the daily issues through the head sluices, the storage in the Lunuganwehera Reservoir, the cultivation calendar, and the area cultivated. These monthly returns sent to the head office were filed and preserved and no other regular or *ad hoc* interaction occurred between the Chief Resident Engineer or the Water Management Feedback Center and the head office regarding the water delivery performance. However, it so happened that once during the period under study, the Director of Irrigation himself asked the Senior Irrigation Engineer why the water duty for the Right Bank and the Left Bank were different.[6]

This was one of the reasons why the description of the decision-making processes often refers to individuals; the management was left to individuals and there was little guidance, monitoring or evaluation by the Chief Resident Engineer and the head office. Without guidance, monitoring or support from higher levels, it was not possible to carry out the in-seasonal allocation as it had been planned in advance. If the head office did not require feedback on the water delivery performance and the problems encountered and solutions found, it would strongly suggest the fact that the head office was not

6 In the opinion of the Water Management Feedback Center, this difference was due to the relatively more attention paid by senior staff of the office of the Resident Engineer (Left Bank) for allocation and water flow regulation processes. Moreover, as the Left Bank main canal was much shorter than the Right Bank main canal, the water flow regulation through the Left Bank main canal was easier compared to the Right Bank main canal.

interested in management performance and its outcome. Logically, this would also not have stimulated staff to improve their performance.

The "macro-control" exercised by the Senior Irrigation Engineer in the absence of any other managerial controls on the allocation decision-making processes must be considered as the best feasible approach under the given constraints. But it caused problems due to the lack of feedback and integration of demand requirements in the allocations from the head sluice.

It has been often stated that it was logical for water duties to be much higher during the commissioning stage of an irrigation system than during regular operation. Franks and Harding (1987, 261) mention that technical measures like the consolidation of canal and field bunds as well as the development of hard pans tends to reduce seepage and percolation. According to them, the leveling of land due to repeated land preparation would also have reduced water use over time. The only managerial measure they recommend in this connection is to gain experience in the operation of the system and control of the water flows.

The allocation processes in the Kirindi Oya system suggested that the absence of any involvement of any higher-level staff in the decision-making processes due to the priority given to construction targets as the main reason for the increased water duties. This was, in fact, contrary to the oft-mentioned importance of good allocation in the early years of an irrigation system to build up confidence and discipline among the water users.

Water user participation. One of the goals of starting water user organizations of the Irrigation Management Division was to introduce rotational water deliveries (e.g., MLLD 1984b, 12). However, in the Kirindi Oya system the Irrigation Management Division was not at all involved in the in-seasonal allocation. Even when the implementation of the rotational deliveries during maha 1987/88 became chaotic, the Irrigation Management Division did not intervene. Possibly, the mechanisms of allocating water by the gate tenders and additional *ad hoc* instructions of higher-level staff were considered to be too inaccessible by the Project Managers of the Irrigation Management Division for them to play a meaningful role, especially if short-term results were required to justify the existence of the Irrigation Management Division to the water users and their representatives. Since the in-seasonal allocation processes were, to a large extent, demand-driven, their participation in matching supply and demand would have contributed

theoretically to system-wide performance only. It was not a very interesting and popular target for them as well as for the staff of the Irrigation Department.

Improvement of the present no-complaint system of in-seasonal allocation should be initiated by the Irrigation Department rather than by the Irrigation Management Division, because the main actors in the decision making were the gate tenders, who were placed administratively under the Irrigation Department. Interventions of the Irrigation Management Division in the no-complaint situation might have caused more delays than improvements.

IIMI researchers had the impression that the staff of the Irrigation Department had become more accountable to the water users during the observation period. They prompted the water users to approach them directly with their problems, instead of channeling them through meetings of the Irrigation Management Division. Moreover, the staff of the Irrigation Department came to use the Irrigation Management Division setup to a certain degree, by accepting complaints from water user representatives only, instead of from individual water users.

This practice saved them time, and they enforced more coordination at field-channel level before the water users would come to the Irrigation Engineer of the Resident Engineer's office. Thus, in an indirect way, the water user groups of the Irrigation Management Division did have some positive impacts on the in-seasonal allocation, although all staff of the Irrigation Department would deny this. However, these interactions with the water users were marginal compared to what was required for real improvements in the in-seasonal allocation processes.

The usefulness of technical assistance for in-seasonal allocation processes. As it was often the case, the donors wanted the development of an Operation and Maintenance Manual that would give guidelines for the management of the new Kirindi Oya system. Kredit fur Wiederaufbau went even further by making it a condition to their financial contributions that the Irrigation Department employ foreign consultants to write such a manual. The Irrigation Department agreed and they even assisted the foreign consultants by preparing a draft Operation and Maintenance Manual which was subsequently perfected by the consultants (Irrigation Department 1986a).

This Irrigation Department manual provides all the basic instructions for the in-seasonal allocation of the Kirindi Oya system, such as the calculation of crop water requirements, feedback of realized water issues, etc. The usefulness of the draft and final manuals to the abovedescribed actual allocation processes was rather limited, because the instructions were specific to purely supply-driven processes. How these supply-driven processes should be executed with the unreliable assumptions of the theoretical water use was not described in it.

In addition to the Operation and Maintenance Manual, a Water Management Strategy Plan was developed to allay the fears of the donors that not enough water would be available for the entire envisaged command area. The practical utility of this plan as an actual allocation strategy was of secondary importance to the Water Management Consultants and the donors. Because of the divergence of criteria used in the plan from those used by the Irrigation Department, the plan was not followed in actual practice.

The technical assistance of the Water Management Consultants in the Kirindi Oya system provided for certain tools like water schedules, a time frame for rescheduling, and an information feedback setup that could be used to improve the allocation process. The utility of these tools in the actual processes seems rather limited just as it is often with consultants' advice and reports. Much money, effort and frustration could have been saved, if it would be possible to establish beforehand, and in a more reliable way, the desirability, feasibility, utility and acceptability of certain tools.

At present, the utility often depends on individuals, who work in a project, which makes the *ex ante* determination even more difficult. Only the Irrigation Department itself can effectively determine priorities in this respect and support them with an appropriate institutional setting (i.e., managerial conditions). This aspect will be dealt with more extensively in Chapters 7 to 9. In the absence of such explicit priorities, the activities of consultants could have been better focused on specific approaches in dealing with imprecise theoretical water use assessments, transforming the management mode from "fully localized and on-demand" to "system-wide and planned."

CHAPTER 5

Water Flow Regulation Concern

THE OPERATIONAL TARGETS for distribution and conveyance that have evolved from the in-seasonal allocation processes constitute the starting point of the water flow regulation decision making. These targets encompass requirements with respect to the timing, duration and size of water flows to different subsystems, i.e., water flow delivery and related water flow regulation. The allocation decision making has to take into consideration the requirements of the hydraulic and related managerial aspects of water flow regulation.

Efficient water flow regulation requires the proper operation of the different control structures and related communication facilities. Careful preparation and calculation of these requirements can reduce the occurrence of inappropriate operational methods which cause losses and unnecessary delays in water delivery. The cost of preparation and calculation of requirements must be outweighed by the benefits of efficient water flow regulation and delivery.

Preparation and calculation will be useful, especially if iterative processes occur, as is the case for water flow regulation and delivery.

Preparation and calculation of the requirements for water flow regulation refer mainly to operational methods for control structures and possibly to an operational plan for the integrated and coordinated operation of the different structures along canals.

Operational methods (or procedures) cover the timing, frequency, and size of gate settings of individual control structures necessary to realize flow changes through these structures. These operational methods can vary for different flow conditions in a canal as, for example, filling or emptying of the canal, flow and variation of level, light or heavy rainfall and emergency shut-down. The operational method can incorporate different parameters like upstream and downstream water levels, backwater effects, and level-discharge curves. These curves can be assessed through experience, through theoretical formulae, or through more or less frequent calibration. The operational methods which can be determined as and when necessary,

and at different hierarchical levels may or may not be laid down in an operational plan.

An operational plan will indicate how and at what times a particular control structure in a system or a subsystem has to be operated during a certain period. These operational plans can be made as and when necessary, and at different hierarchical levels. Different types of structures (e.g., intake works, cross-regulators, offtakes, turnouts) may be covered by such a plan.

Once the preparatory stage of the water flow regulation is completed, the assignment of water flow regulation activities to the staff can be done through specific instructions and may or may not be adapted to the actual time required or spent.

THE DECISION-MAKING PROCESSES

Technical Aspects

The operational target for the distribution from the Lunuganwehera Reservoir through the head sluice to the Right Bank main canal had been indicated in discharge. The corresponding opening of the head sluice (a radial gate) was calculated by means of an equation "that relates the discharge through the gate to the gate opening and the reservoir water level. The equation had apparently been calibrated against field measurements by the project staff. It was observed once during the season that, in the absence of a chart or a precomputed table to help in this process, the computation of gate opening was not entirely error-free. This process, however, had been systematized through the use of computer spread-sheet software" (IIMI 1989a, 60).

No exact time of operation for the realization of this distribution target had been given. Neither were there requirements regarding undesirable timings to realize changes in issues to the main canal (e.g., changes in the afternoon which would have caused changes in the water level at night further downstream in the main canal).

A change of discharge was realized through one adjustment (which was not gradual) of the radial gate opening. The gate was electrically powered, with a manual backup provision in case of a power failure.

It was difficult to monitor the actual issues by means of the downstream water level above the measuring weir at the head of the main canal, because this structure remained submerged. Therefore, there was no feedback of actual water issues through the head sluice to the offices of the Resident Engineer (Right Bank) or the Water Management Feedback Center. On the other hand, IIMI researchers found that the meters on the head sluice radial gates were quite accurate (a variation of only 3 percent at a specific moment) (ibid.).

Neither was there any feedback on the exact time of realization of a change in discharge to the main canal. During maha 1989/90, this situation had been apparently changed and the Water Management Feedback Center started to indicate the required time of operation. And, instructions were given that the Water Management Feedback Center should be informed of any change in the actual time of operation.

The operational target for the conveyance through the main canal maintained a full supply depth upstream of the cross-regulators. This full supply depth was the control water level for the discharge through the offtakes to the distributary channels. The operational methods, by which the full supply depth was maintained, were guided by two standing orders: 1) if the water level in the main canal increased above full supply depth, the excess had to be released gradually through the gates of the cross-regulator; and 2) the released discharge had to be spread evenly over the parallel gates of the cross-regulator to prevent erosion of the canal bund and to extend the life of the cross-regulator. In addition, two instructions were given to further improve the operational methods: 1) refrain from operating the cross-regulators to stabilize the water level in the main canal soon after a heavy rainfall (even if water overflowed the side walls of the cross-regulators and the water level exceeded full supply depth); and 2) increase the control water level above full supply depth if the height of the side walls of the cross-regulators did not correspond to the water level needed to realize the envisaged discharge to the distributary channel.

These standing orders and additional instructions did not specify the required timing, frequency or size of the gate setting. However, in the opinion

of the staff of the Kirindi Oya system these standing orders were sufficient for a proper operation of the main canal, provided the gate tenders have built up some experience in water flow regulation.

There were no special procedures for refilling an empty main canal. The Water Management Consultants had advised that the discharge to the empty canal from the reservoir should be built up gradually. In practice this was done anyway, because only 30 percent of the maximum discharge was issued first at the beginning of the season pending the arrival of the water users from their original villages.

The operational targets for distribution from the main canal into the distributary channels were expressed in the required water levels above the measuring weirs at the head of the distributary channels. The times of the corresponding gate settings were, in principle, specified in the water schedules of the Water Management Feedback Center, but as these operational targets were not followed, these times were not adhered to in the actual operations. The required frequency of adjustment and the size of gate setting were also ignored.

The operational targets for conveyance along the distributary channel were not specifically defined by the Water Management Feedback Center or the Resident Engineer's staff. They, however followed the operational targets for distribution to the field channel, which was the water level above the measuring weir at the head of the field channel.

No plans were made to integrate operational methods and procedures (for timing and determination of size and frequency of adjustment of gate settings) of the different offtaking and cross-regulating structures along the same canal. Instead, the actual operational method and procedure for each change of water level in a main canal, or for each change in distribution to a distributary channel, were established on an *ad hoc* basis. This will be described in the next section.

Managerial Aspects

Issues from the head sluice. The Senior Irrigation Engineer of the Water Management Feedback Center requested the Resident Engineer (Head Works) to provide specific allocations to the Right Bank main canal and set him the operational targets for the head sluice. A copy of this request was

sent to the Resident Engineer, (Right Bank) to inform him about the envisaged change in allocation to the Right Bank and he was requested to take necessary action. This necessary action involved the dispatch of instructions to gate tenders cautioning them to be alert to the expected change in water flow and level, and also instructing them to operate the structures to realize the envisaged operational targets for conveyance and distribution.

Establishment of operational methods for conveyance and distribution along the main canal. The procedure for the dispatch of instructions to gate tenders was for the Resident Engineer (Right Bank) to instruct his Irrigation Engineer and the Technical Assistants to inform the gate tenders of the envisaged change in water flow. The Technical Assistants warned the gate tenders to be alert only occasionally. And, when they did so, the warning referred to the approximate timing only, never to the size and duration of the change in flow. They neither instructed the gate tenders nor guided them in establishing operational methods other than the aforesaid broad rules and instructions.

As the gate tenders had neither very precise instructions on the operational methods for realizing the operational targets for distribution and conveyance, nor an idea of the size, duration and often even the timing of the change of flow in the main canal, the actual operation was a time-consuming trial-and-error process for them.

Since the water level fluctuated, maintaining full supply level in the main canal upstream of the cross-regulators required regular intervention by adjusting the gates of the cross-regulators. Such fluctuations of water level were caused by changes in the discharge through the head sluice, the operation of cross-regulators or offtakes upstream of the concerned cross-regulator or rainfall.

According to the standing orders, a flow in the main canal in excess of the full supply level had to be released gradually through a cross-regulator to limit fluctuations in downstream reaches of the main canal. If the gate tender did not release the discharge gradually, the fluctuations in the downstream reaches of the main canal would have increased.

There were no prescribed maximum or minimum limits for the control water level and its allowable deviation was unknown even to higher-level staff. However, some gate tenders had set certain margins on their own which

they used for determining the time of operation of the cross-regulators (Malaterre 1989, 18).

Due to the fact that the fluctuations in the main canal can be controlled by draining through Branch Canal 2, it had been assumed that it was not really necessary for the gate tenders, the Technical Assistants, or the Irrigation Engineer to take care of these fluctuations as long as the discharge into the main canal was large enough. As a result, the gate settings were rather *ad hoc* and the main canal was constantly fluctuating (IIMI 1989a, F:93).

It was only when the flow fluctuations directly led to some problems, the gate tenders were forced to release water gradually. That was what appeared on 11 June 1988 in the Right Bank main canal for the operation of the cross-regulator situated just downstream of the offtake to Distributary Channel 5 of tract 1. At 1.30 p.m. on that day, the discharge to the main canal from the head sluice was increased by 0.4 m^3/s. As a result, the water level of the main canal at Distributary Channel 5 started to rise, and began to overflow the side walls of the cross-regulator. The gate tender, who was probably not alerted by the Technical Assistant to the expected change in discharge, opened the gates of the cross-regulator only at 8.00 p.m. As he opened them completely in one operation, the level of the main canal upstream of the siphon (which was situated downstream of this particular cross-regulator of Distributary Channel 5) started to rise quickly and the main canal bund overtopped. According to IIMI researchers, the main canal has overtopped upstream of that siphon on several occasions.[7] In this case, the gate tender had failed to learn from the experience of the first few occasions the need to release the discharge gradually to prevent overtopping of the main canal upstream of the siphon, even though the geographical proximity to the site of overflow should have provided him a direct incentive to do so.

In general, the discharge through the cross-regulators was not spread evenly over the parallel gates, as it was required by a standing order. Usually, one gate was opened fully and one or two others were opened only partly, the excuse of the gate tenders for it being that debris obstructs the partly opened gates or, that the gates were not functioning well. However, a more

7 The Irrigation Department envisaged to solve this problem by raising the bunds of the main canal.

probable reason would have been that the operation to open all gates partially so as to spread the discharge evenly was a laborious job due to the high water pressure when compared to the opening of only one gate at a low water pressure. Moreover, it was easier for the gate tender to recognize the required size of opening for an average discharge for only one gate rather than for a number of gates.

The establishment of the proper operational methods by the gate tenders was further complicated by the delegation of the in-seasonal allocation to them. As a result of that the performance of the gate tenders was appraised by the level of complaints of the water users to higher-level staff.

These complaints of the water users were usually about the in-seasonal allocation to their own subsystem. Consequently, the gate tenders in their operational practices would generally have given priority to allocation to the distributary channels than to conveyance along the main canal. In practice, the options opened to the gate tenders for giving priority to allocation to the distributary channel were the following:

* They could have allocated enough water to the distributary channels without contravening the standing orders (maintaining full supply level and gradually releasing increased flow), and issued a certain extra discharge to reduce fluctuations in the main canal. These fluctuations could be quite substantial in offtakes further upstream of the cross-regulators (IIMI 1989a, F:71).

* They could also have issued more water than what was planned to the distributary channel to make sure that the water users would not complain.

* If the discharge to the distributary channel was not enough, they could have closed the gates of the cross-regulator a little and allowed some overflow over the cross-regulator. This could be done either temporarily, as they were able to defend their actions to any supervisor by arguing that the water level in the main canal was fluctuating (i.e., rising) or permanently, if the water users claimed that they did no get enough water.

* They could have operated one or more gates of the cross-regulators without operating the gates of the offtakes. This means that the

> allocation to the distributary channel was realized through manipulation of the control water level in the main canal at the expense of the operational targets for the conveyance through the main canal. That was the option most frequently chosen by the gate tenders (IIMI 1989a, 94).

Thus, the criteria used in the establishment of actual operational methods were the minimization of management inputs by higher-level staff, the minimization of complaints to higher levels, reduction of overflowing of canal bunds, as well as easiness of the operational method for the gate tenders.

Monitoring of the actual operational methods. Monitoring of the actual operational methods of the gate tenders by the Irrigation Engineer, the Technical Assistants, and the staff of the Water Management Feedback Center took place rather haphazardly. And they had given *ad hoc* instructions to gate tenders during irregular field visits. In one case which was observed by IIMI, the Technical Assistant and the Irrigation Engineer had given contradictory instructions to a gate tender during separate field trips which occurred within a space of 5 minutes.

In another case, a deputy director of the head office of the Irrigation Department who visited the system observed the overflow of the side walls of a cross-regulator and fined the involved gate tender, without checking the reasons for that overflow. The reason in that case was the insufficient height of the side walls — because of faulty construction — which made the full supply depth insufficient to issue enough discharge to the distributary channel situated upstream of the cross-regulator.

The aforementioned priority for distribution targets resulted in badly managed conveyance and a constantly fluctuating main canal (see also IIMI 1989a, F:93). These fluctuations of the main canal water level in turn made it very difficult for higher-level staff to monitor the realization of the conveyance and distribution targets and the actual operational methods used by the gate tenders. This was especially due to improper monitoring.

Apart from the fact that the Technical Assistants of the office of the Resident Engineer (Right bank) did not put much effort into monitoring, they were each responsible for only one tract. Conveyance of water along the main canal to downstream tracts was not of interest to them as long as enough water was allocated to the main canal as a whole. Moreover, Branch Canal

2 could always be used to drain the excess, which was due to discharge variations.

Since nobody was responsible for the conveyance of water along the main canal, the Resident Engineer made the monitoring of the adherence to conveyance targets, first, the responsibility of his Irrigation Engineer, and later, of himself. However, both were also responsible for the construction and did not have the time to do that job properly.

For maha 1988/89, the Resident Engineer envisaged to make conveyance the responsibility of the Technical Assistant of the tail end tract as it should be in his interest to get water to the tail end in a more reliable way. Had this strategy materialized, the Technical Assistant could have ensured a reliable water supply rather easily, through a higher allocation to the main canal as a whole. This strategy was applied during maha 1987/88 as well.

As the Resident Engineer's office did not pay much attention to the guidance of the gate tenders in establishing operational methods and monitoring of the actual methods used, the Water Management Feedback Center was compelled to take up this task. The Senior Irrigation Engineer and the Resident Engineer agreed upon an informal supervision and monitoring of the water flow regulation by the Water Management Feedback. Center, and it was later formalized by the Chief Resident Engineer.

However, this authority was not always appreciated and respected by the staff of the Resident Engineer (Right bank) as they were allocating water not according to the allocation schedules of the Water Management Feedback Center, but in line with a completely delegated allocation (i.e., a combination of continuous and on-demand allocations) and water flow regulation was done accordingly.

Apart from that, even if the Water Management Feedback Center wanted to intervene in other instances in the actual water flow regulation, it did not have enough information and insight into the actual allocation and water flow regulation processes to give appropriate instructions in specific situations. Therefore, the Water Management Feedback Center limited its monitoring to the nature of the operational methods and sent instructions about more structural improvements regarding these methods to the Resident Engineer to be implemented by his staff. An example was the instruction to maintain a control water level different to the full supply depth, if the latter did not permit the issue of the required discharge to the distributary channel. On

another occasion, after a heavy rainfall, the Water Management Feedback Center instructed the gate tenders, through the Resident Engineer, to refrain from operating the cross-regulators, even if it meant that the side walls of the cross-regulators would spill. This practice was envisaged to stabilize the main canal flow soon after the rain. In another case, the Water Management Feedback Center took care of some conveyance problems arisen due to destabilization following the daily cleaning of the rack at the entrance to the siphon. This rack, used to prevent human beings and animals being pulled into the siphon, collected weeds and garbage. Every morning the rack had been cleaned, and the resulting decrease of friction caused a fluctuation of the water level in the main canal equal to 0.45 meters. The Water Management Feedback Center investigated this problem and advised the Resident Engineer (Right Bank) to remove the rack and fix a barbed wire protection at the entrance to the siphon.

Establishment of operational methods for conveyance and distribution in the distributary and field channel subsystems. As for the main canal, the allocation processes within the distributary- and field-channel subsystems were completely delegated to the gate tenders. The difference was that in the case of the distributary-channel subsystem the gate tenders were able to coordinate the allocation to the different field channels and the corresponding water flow regulation by themselves.

As the gate tenders carried the responsibility for this subsystem without any guidance, monitoring or evaluation from higher-level staff, the operational targets and methods were all established *ad hoc*. Despite this fact, the operational methods were necessarily mutually well-adapted to each other. As the first operational target for conveyance, they adopted the water level in the tail end of the distributary channel. They walked upstream and adjusted the allocations to the field channels, and if that resulted in very low water levels along the distributary channel, they increased the allocation to the latter. The operations of different structures within a distributary canal subsystem were reasonably well-organized.

A plan for integrating operations along the main canal. The integration of operations along the main canal could have improved the conveyance along it, but there was no plan for such integration. Some form of integration of the operation of different structures would be possible, if a special Technical Assistant was responsible for that conveyance.

According to the plan proposed by the Water Management Consultants for two or three reaches of the main canal, the gate tenders would first drive downstream along the canal and adjust gate settings from head to tail, and then drive upstream to refine gate settings. This would have been done first at the head reach and afterwards at reaches further downstream of the head sluice. Only in the case of major changes would they have to start at the tailend and refine gate settings from head to tail. "Water must be delivered to the <distributary canals>[8] by the main or branch canal operator; no <distributary canals> operator can arbitrarily turn water out of the main or a branch canal" (AHT/SCG 1989, IV:60). The main idea behind this plan was the strict separation of conveyance and distribution.

As it was unable to achieve the required operational targets for distribution and conveyance after a change of discharge through the head sluice, this plan was considered unrealistic by the Water Management Feedback Center. The operational targets for distribution were, to a large extent, determined by the gate tenders of the respective distributary channels. The provision of specific operational targets for the conveyance through the cross-regulators was considered unfeasible. One reason for this was the difficulty in calibrating the cross-regulators of the main canal, because the water level depended on both upstream and downstream water levels and the changing hydraulic characteristics (e.g., hydraulic resistance or rugosity) of the main canal. Another reason was that the Irrigation Department officially assumed steady-state conditions in the canal. Therefore, the standing order to maintain full supply depth above the cross-regulators would have provided all distributary channels with a sufficient and stable discharge, and conveyance targets need not have been adjusted at all. Thus, after water flow changes, the abovementioned operational methods were supposed to stabilize the main canal flow. Research on water flow regulation in the Kirindi Oya system has shown a great instability of the main canal which contradicts these official assumptions (IIMI 1989a, F:93).

The staff of the Water Management Feedback Center remained skeptical about the need to further professionalize the water flow regulation in the main

8 Contents within angle brackets are additions or alterations made by the author.

canal, for they considered the unsteady flow conditions to be of minor relevance, and they expected that the on-the-job experience the gate tenders gained over the years would reduce this unsteadiness. However, it must be said that the Kirindi Oya system has been in operation for several years, and it seems doubtful if further improvement through the "on-the-job experience" of gate tenders would occur without guidance, monitoring and evaluation by higher-level staff.

Mutual Adaptation of the Technical and Managerial Aspects

The technical aspects and managerial aspects of the distribution from the Lunuganwehera Reservoir through the head sluice to the Right Bank main canal seemed well-adapted to each other. The water issues through the head sluice constituted the starting point for further water flow regulation. Therefore, improvement of communications between the Water Management Feedback Center and the offices of the two involved Resident Engineers about the exact timing of the issues and the actually realized issues could have been useful.

The standing orders of the Irrigation Department regarding the conveyance and distribution along the main canal had left too much freedom or leverage for decision making to the gate tenders, especially with regard to conveyance. During the commissioning period, the gate tenders were relatively inexperienced with respect to possible operational methods. If they are not guided and supported in the establishment of operational methods, the *ad hoc* establishment of these methods is inevitable. Consequently, monitoring of the actual operational methods and actual allocation processes by higher-level staff would become very difficult due to the resulting fluctuations in the main canal.

The absence of instructions regarding the required gate settings in terms of approximate timing, and required size and frequency of adjustments made coordination of the operations of different structures in the system difficult. As a result, very effective conveyance of water along the main canal was impossible. Management measures such as those proposed, but not implemented by the Resident Engineer could have led to the provision of the necessary instructions to the gate tenders. The proposals of the Water

Management Consultants required the introduction of allocation scheduling at higher levels than the field level, which would have in turn required much more management inputs from them.

Most staff of the Irrigation Department expected these problems to be solved over time through on-the-job experience of the gate tenders. However, without guidance on the approximate timing and size of discharge variations and required operational methods from higher-level staff, the building up of such experience seemed impossible, at least in regard to conveyance along the canal.

Moreover, added experience alone will not ensure that conveyance along the main canal are managed better, because of the continuing priority for distribution. Therefore, the higher-level staff will at least have to follow up with monitoring and evaluation of the actual implementation to ensure that conveyance along the main canal is appropriately taken care of. It is only by monitoring and evaluation that they can become familiar with the actual operational methods, which will enable them to further monitor and improve the operational methods being used. Increased monitoring and evaluation of the gate tenders will not only help them, but also stimulate them to perform better because of the interest shown by their superiors.

The major constraints for such processes were the priorities for construction targets and the lack of motivation of the staff to get involved in these water flow regulation processes. Therefore, as long as the office of the Resident Engineer (Right Bank) and higher-level staff give priority to construction targets and minimize their inputs into the allocation and water flow regulation processes, no new organizational arrangement [such as that introduced earlier within the office of the Resident Engineer (Right Bank)] will succeed in overcoming the effects of this priority for construction targets. Therefore, for the sake of improved water delivery processes and the credibility of the Irrigation Department, it seems better to have a separate office entrusted with such duties.

The engineer who is hierarchically and financially in charge of the allocation and water flow regulation processes should himself be motivated and be willing to focus on these processes, rather than on construction or maintenance work.

The guidance of the actual water flow regulation by the Senior Irrigation Engineer of the Water Management Feedback Center was difficult in a

situation where he was not aware of the actual operational targets for distribution and conveyance at a particular moment, and where he did not get feedback from the water users and the gate tenders on the realization of these targets. However, the monitoring of the operational methods by the Water Management Feedback Center was a good initiative that resulted in some well-adapted instructions like those for the formalizing of a control water level other than the standard full supply depth, and refraining from the operation of the cross-regulators after heavy rainfall.

CHAPTER 6

System Utilization: Opportunities for Improvement

IN THIS CHAPTER, it is assumed, for the purpose of discussion, that the Irrigation Department has the ambition to improve the water delivery performance and productivity in the Kirindi Oya system, as for example, by increasing the cropping intensities in the extant command area. And to achieve this, a higher level of perfection of the seasonal allocation and in-seasonal or water flow regulation decision making is required. No indications can be given as to which of these opportunities deserves priority, because no comparative data regarding the relation between system performance and the levels of perfection of the different key decisions have been collected as yet. In the absence of such normative values, the given opportunities could be used by the Irrigation Department as a kind of a check list.

It must be noted that a very low or a very high classification is not a judgement in itself. For example, a very low level of perfection may lead to a satisfactory performance and may thus be cost-effective. However, in case the performance is considered unsatisfactory, a higher level of perfection is assumed to lead to a higher performance. Also, a higher level of perfection does not necessarily lead to a better outcome. In certain cases it may be necessary to increase the quality of the decision (e.g., a better assessment of the water level above a measuring weir) rather than the level of perfection.

Several opportunities for improvement enumerated in this chapter also apply to other systems of the Irrigation Department. In its review of this paper, the Irrigation Department argues that the Kirindi Oya system was still in a commissioning stage and with related construction priorities and biases of its staff, the observation period of the present study cannot be considered representative for analyzing the system utilization processes and conditions of the Kirindi Oya system. However, while recognizing the influence of the comparatively high construction biases to a certain extent, the author does not agree with this argument, because most project and head-office staff

indicated that the allocation, and water flow regulation would not be improved essentially after the observation period; only further on-the-job experience of the gate tenders was expected over time. Moreover, the analysis of the managerial conditions is, to a large extent, not specific for the Kirindi Oya system, and it gives a more general picture of how the Irrigation Department manages a system like Kirindi Oya. Further, it does not make generalizing statements, if they would not apply to the department as a whole.

SEASONAL ALLOCATION PLANNING

Present Management Performance: The Level of Perfection

The overall level of perfection of the seasonal allocation decision-making processes could be classified as low (20–40%). This quantitative judgement is based on the following criteria and the classification in Table 1 in Chapter 1 and it also follows the classification in Annex 1.

Feedback. The only feedback the Irrigation Department got with respect to the appropriateness of its seasonal allocation decisions was in relation to the cultivation calendar. However, feedback on the cultivation calendar and the staggering along the main system was not something the Irrigation Department was looking for actively, but they were confronted with it by the water users, the Government Agent and the Irrigation Management Division: A low level of perfection (20–40%).

The Irrigation Department had not tried to obtain feedback on the appropriateness of the envisaged water duties for the different subsystems, and the related trade-offs with areas to be irrigated and cultivation risks. The only feedback the Water Management Feedback Center was getting on the reliability of its estimates of the water duty were the seasonal totals of the issues from the head sluice of the Lunuganwehera Reservoir. Regarding the areas to be cultivated, cropping pattern (quite essential if introduction of subsidiary field crops was to be pursued), and cultivation risks, it did not get

any feedback except for a crude impression through what was experienced in earlier seasons: A very low level of perfection (0–20%).

During the period of observation, no feedback at all occurred regarding the actual implementation progress of the land preparation and the appropriateness of the water allocations within the different distributary-channel subsystems: A very low level of perfection (0–0%).

Foreseeing. An assessment was made of supply and demand for the whole season and the cultivation risk was quantified: An average level of perfection (40–60%). It must be mentioned in this respect that the unreliability of the data used for the supply assessment did not have an influence on the level of perfection, but rather on the quality of the decision itself.

However, due to the increasingly *ad hoc* nature of the seasonal allocation decisions, in some seasons like maha 1989/90, these assessments were not taken into account at all in making the decisions. Overall, this was a level of perfection that varied between very low to average (0–60%).

The influence of the present water duties and cropping pattern (only rice) on future allocation decision-making processes was not taken into account; a serious strategy toward future water duties and cropping patterns did not exist. That was a very low level of perfection (0–20%). There was, however, a strategy of minimizing the cultivation risk to improve the confidence of the water users in the Irrigation Department: A low level of perfection (20–40%).

Integration. The cultivation calendar was matched with maintenance activities, but not with the related water user and agricultural requirements. The theoretical "system interest" (i.e., productivity of water and irrigated extents) and the interests of individual water users or groups of them (i.e., demand-driven water duties, cultivation calendar, reduction of cultivation risk, and cropping pattern) were considered, to a certain degree, in the calculations of the Senior Irrigation Engineer of the Water Management Feedback Center: A low level of perfection (20–40%).

However, the related decisions of the water user representatives, the Irrigation Management Division and the Department of Agriculture regarding the cultivation calendar were generally not considered. Thus, the water user representatives and the Irrigation Management Division enforced incorporation of some of their interests into the cultivation calendar, which resulted in a decreased match with the required maintenance: A very low to low level of perfection (0–40%).

Systematics. Clear and specified rules exist in Sri Lanka regarding the seasonal decision-making processes of the Irrigation Department, the Government Agent and the water users. The decisions that have to be made at each step are specified in Ministry Circular No. 121 of 31 May 1982 (MLLD 1982a) and others. If these rules actually determined, to a large extent, the actual pattern of the seasonal allocation processes in Sri Lanka, the decision making could be classified to be of an average level of perfection (40–60%).

Also, rules have been developed regarding the different meetings held on the determination of areas to be cultivated, cultivation calendar and cropping pattern by the Irrigation Management Division (MLLD 1984b). However, there were no rules as to how these processes of the Irrigation Management Division should be integrated with the seasonal decision making of the Irrigation Department, the Government Agent and the water users. The rule regarding the Sub-committee of the District Agricultural Committee had not been put into operation for the Kirindi Oya system.

Thus, these procedures for the seasonal allocation processes were comparatively[9] well-developed. This was probably due to their major influence on the success of the season, and on the crucial choices made in the successful parts of the system. This has been true for the traditional village reservoirs (Leach 1961, 53) as well as for major systems like the Kirindi Oya.

However, the availability of rules did not guarantee a more regular pattern of the decision-making processes and a consequent higher level of perfection. During the commissioning period of the Kirindi Oya system, these rules were not strictly adhered to and seasonal allocation planning got less detailed attention than in other systems.

Due to the resulting lack of confidence of the water users in the departments involved and the absence of rules regarding the position of the

9 Comparatively, because the level of perfection of most other decision-making processes that are discussed in this paper will appear to be lower. This comparative high level signified the fact that traditionally this seasonal decision making was the main involvement of the Irrigation Department and the Government Agent in the allocation processes. During the season, the Irrigation Department operated mainly the head sluice in line with these decisions. In-seasonal allocation below the head sluice was left to the Department of Agriculture and the water users.

Project Managers of the Irrigation Management Division, the decision-making processes had become rather *ad hoc* in the preceding seasons. The level of perfection was thus low (20–40%).

In the absence of more fundamental management research to determine the relative importance of these different aspects of seasonal allocation planning, it was difficult to determine an overall level of perfection except by averaging the above values. After averaging, the overall level of perfection of the seasonal allocation decision-making processes could be classified roughly as low (20–40%).

Opportunities for Improvement: Requirements with Respect to the Processes

Here, and in the following section, it will be assumed that the Irrigation Department wants to improve the present low (20–40%) level of perfection of the seasonal allocation decision making to an average (40–60%) level. In certain cases, it may be necessary to increase only the quality of the decision making. For example, in the case of the reliability of the hydrological data used for the assessment of the supply to the system, the quality depends on the degree of accuracy of measurement tools.

Technical aspects. To reach an average level of perfection (40–60%), demand assessment and matching of supply and demand should consider at least the cultivation plans (cultivation calendar and cropping pattern) of the water user representatives, the Irrigation Management Division and the Department of Agriculture.

The Irrigation Department should reconsider the usefulness of the theoretical water requirements as against the use of gross water duties for specific subsystems. The application of the theoretical requirements seems a waste of time, especially without the field-testing of the key parameters. Moreover, it diverts management attention and inputs from assessing the more relevant real requirements and preferences of the water users, politicians and the Department of Agriculture regarding cultivated extents, water duties, cultivation calendar, cropping pattern and the related cultivation risks.

In addition, the assessment of water duty requirements for important subsystems by means of historical water delivery data for both

water-abundant and water-scarce situations should get more serious attention. This will increase the quality of the decisions, and indirectly the level of perfection, because more reliable feedback data will reduce the chances of *ad hoc* seasonal allocation decision making through increased clarity and reliability of the options and risks. For that purpose, it is necessary that at least the head sluices of the reservoirs of the Old Areas should be provided with reliable measurement structures. Moreover, water-level readings should be made more reliable by regular calibration (every two or three years, depending on the siltation at a specific location).

The Irrigation Department will have to undertake additional research regarding the reliability of the hydrological data of the Kirindi Oya system(IIMI 1990, 15). This may lead to more reliable inflow probability curves, indispensable for estimation of the cultivation risks. This estimation is required to reach an average level of perfection (40–60%), and thus for improvement of the seasonal allocation planning in the Kirindi Oya system.

For an average level of perfection (40–60%), the consequences of each season's allocation decisions on future expectations must be considered to some degree. This is especially important in the Kirindi Oya system, because of its water-short nature.

Performance evaluation requires registration of the final allocation plans for the main canal, branch-canal and distributary-channel subsystems and comparison with the plans of the earlier seasons to evaluate their quality. The progress of implementation of the seasonal allocation plan should be monitored and evaluated weekly.

Managerial aspects. The Irrigation Department will have to determine the ways by which it can interact more effectively with the water users and other agencies during the seasonal allocation planning.

This requires decision making about the type of consultations that needs in the preparatory stages to take into account the water user preferences regarding the water duties, cultivation risks, crops, cultivation calendar and cultivated areas. Interaction with the planning processes of the Irrigation Management Division may be one way of improving mutual understanding and adjustment, but due to unwillingness to cooperate with the Irrigation Management Division, other ways may be preferred and should be developed by the Irrigation Department.

Interaction with the water users is especially important during the preparatory phase of the seasonal allocation decision making; at that stage the water users can be consulted about their requirements and can be briefed about the trade-offs that have to be made between cropping pattern and cultivation calendar or between different subsystems. Involvement during these early stages can reduce divergence between expectations of different interest groups at the time of decision making, i.e., at the cultivation meeting. The precultivation meeting and the District Agricultural Committee meeting also provide opportunities for incorporating the preferences of water users and other agencies', but as has been shown in Chapter 3, they will not be able to prevent large divergences in expectations of the different interest groups at the time of decision making, i.e., at the cultivation meeting. The acceptability of the final decisions by the water users would be much higher, if their representatives are more involved in the whole process, and the water users become better aware of the priorities that have to be made and the criteria used in processing their preferences.

For an average level of perfection (40–60%), more interaction with the water user representatives, the Irrigation Management Division and the Department of Agriculture are required during the preparatory stage of the seasonal decision making, (the project-level meetings of the Irrigation Management Division and meetings of the Subcommittee of the District Agricultural Committee or the Project Coordinating Committee).

For a high level of perfection (60–80%), the Irrigation Department should incorporate important influencing factors into the decision making by those groups, which means that they should get involved in the decision making at distributary-channel level, if they are to be involved, to some degree, in the seasonal decision making at that level.

The interaction with different interest groups should not only focus on the cultivation calendar, cropping pattern and irrigable areas, but should also incorporate the related cultivation risks for an average level of perfection (40–60%), and the water duties for a high level of perfection (60–80%). This interaction will make the different groups more aware of the different trade-offs and also will enable them to reach a comprise.

The different steps that will be taken in the decision making, their maneuverability, if any, and the criteria that apply to the decision making

have to be clear to the participants at an early stage. Criteria that could be used are as follows:

* There should be correlation between the stagger systems of the different subsystems to match, as far as possible, the canal capacities, the optimal cultivation periods of the different subsystems and any differing preferences.
* There may be priorities for certain subsystems regarding cultivation calendar, crops, area to be cultivated, water duties and related cultivation risks.
* There should be seasonal rotation of benefits and preferences among the subsystems. For example, if one subsystem gets priority for a particular season, another subsystem should get it in the following season.
* Water duties required for the different subsystems and water delivery or sharing methods that may be necessary should be set.
* Fees that have to be paid if the clients request extra water (over the specified quantity) should be set.

The Irrigation Department shall consider, to some degree (40–60%), or fully (60–80%), the consequences of the allocations for this one specific season for the future expectations. A more explicit and active strategy incorporating priorities with respect to the different allocation parameters, i.e., cultivated extents, water duties, cropping pattern, cultivation calendar and cultivation risks will be required for an average level of perfection (40–60%). This will enable the reduction of *ad hoc* decision making. For a high level of perfection (60–80%) an explicit and coherent strategy should exist for all important subsystems.

In addition, the head office of the Irrigation Department and the Irrigation Management Division should pay more attention to the processes of the seasonal allocation planning. Opportunities for guidance, monitoring and evaluation of their staff in these complicated and often semipolitical processes are not the only advantages, but increased attention will give a higher status to the managerial aspects and stimulate the staff to perform better in this aspect of their profession.

An average level of perfection (40–60%), will require performance evaluation through registration of the final seasonal plan, comparison with important earlier experiences and regular (e.g., weekly) monitoring of the actual implementation progress of the seasonal plan by the head office. After completion of the land preparation, an evaluation report on the realized implementation of the seasonal allocation plan should be sent to the project office and head office. For a high level of perfection (60–80%), this monitoring should become more frequent and weekly reports on the progress of monitoring and evaluation should be sent to the head office. The aforementioned performance evaluation shall not lead only to the filing of papers, letters and reports, but also to feedback on the performance assessment to the lower hierarchical levels. This performance evaluation is a basic requirement to the building up of responsibility and accountability at different staff levels with respect to the seasonal allocation decisions and their implementation. Such systematic accountability is presently absent.

Opportunities for Improvement: Requirements with Respect to the Managerial Conditions

People. The professional capabilities, in regard to agricultural aspects, of staff of the Irrigation Department involved in decision making should be improved. Inclusion of more agronomic subjects in their education, adjustment of the staff selection criteria and special training courses are options in this respect.

The water users or their representatives and the staff of the Irrigation Management Division and other agencies require an increased awareness and understanding of the trade-offs to be made between the seasonal allocation parameters. An increased awareness will evolve automatically from increased interaction with the planning done by the Irrigation Department, but in addition, special training courses may help improve this awareness.

The managerial capabilities of the staff of the Irrigation Department should be improved to enable them to interact more effectively with the water users, their representatives and other agency staff. Inclusion of managerial subjects in the education of the engineers, addition of selection criteria

regarding managerial capabilities for future system managers, changes in training and professional development programs may be required.

The above opportunities may give the impression that several training options would solve many problems, which, however, is not the case. Increased motivation and willingness of the Irrigation Department staff to improve its performance are preconditions for training.

Therefore, the Irrigation Department should develop strategies to decrease indifference and increase the willingness of its staff to be involved in managerial aspects of the seasonal allocation processes. Irrigation Engineers, especially those of higher echelons, should accept the management duties of their jobs, and understand the extent to which they have to spend time on this. This will happen only if their technical and managerial performances in allocation processes are seriously monitored and evaluated by their superiors.

More guidance, professional recognition of involvement in allocation decision making, special career paths, incentive systems, and performance evaluation may be involved in such a strategy. The accountability of the staff, whether towards higher levels, towards the water users or, more directly, towards the use of the water resource should increase. The latter may be achieved by increasing the value of the water resource, by selling it, by making subsidies more explicit in loans to the irrigation sector or through more performance requirements from higher-level staff, the government and the donor (see also Nijman 1990, 1991, and Chapters 7 to 9).

Provision of information. More information on the actual requirements and preferences of the water users and other agencies regarding the cultivation calendar, cropping pattern, irrigated extents, and cultivation risks as well as the trade-offs between these factors should be provided during the preparatory stages of the seasonal allocation decision making, and also during the implementation of the seasonal plan for an average level of perfection (40–60%). In addition to these, similar information on water duties must be provided for a high level of perfection (60–80%).

The requirements for an average level of perfection (40–60%), are met at project- and district-level meetings of the Integrated Management of Major Irrigation Settlement Schemes (INMAS) Program, while for a high level of perfection (60–80%), information exchange at distributary-channel level should also be considered. Provision of such information during the

preparatory phases of the seasonal allocation planning by the Irrigation Department and the Irrigation Management Division leads to improved mutual understanding and adjustment and less-divergent expectations. Improvement of the provision of information to the water users on the decisions, arguments, and criteria involved in the decision making may strengthen their confidence.

In addition, more reliable historical measurement data on realized water deliveries to important subsystems should become available for the determination of realistic water duties. It will require regular calibration (e.g., every two or three years, depending on the siltation at a specific location).

For an average level of perfection (40–60%), information at project level regarding the actual implementation of the seasonal allocation plan along the main system and within the distributary channels should be available weekly. At the end of the land preparation, an evaluation report on the actual implementation should be sent to the head office of the Irrigation Department. The aforementioned information flows necessary for an average level of perfection (40–60%), require increased management inputs and efforts of different staff levels. These were unlikely to occur without increased institutional support from the head offices of the Irrigation Department and the Irrigation Management Division, through guidance, evaluation and appreciation of such increased performance. To that end, regular (40–60%) or frequent (60–80%) monitoring of the processes of the seasonal allocation decision making by the head offices of the Irrigation Department, the Irrigation Management Division and the Ministry is required for guidance, evaluation, and especially, stimulation of staff. In that situation, the staff involved is not appraised for its performance, other than "negatively," i.e., in cases of complaints.

Systems and methods. For an average level of perfection (40–60%), the Irrigation Department, the Irrigation Management Division, the water users, politicians and other agencies should jointly develop a system or strategy for prioritizing among the allocation parameters to optimize irrigation and cultivation and also for prioritizing among important subsystems, if the demand exceeds the supply for the season. The need of such a system or strategy is more urgently felt in the Kirindi Oya system than in other systems, because of its structural water-scarce nature. For a high level of perfection

(60–80%), a coherent strategy should exist for all important subsystems and the overall system.

Such a strategy could comprise principles and criteria applicable during water shortage for the systematic reduction of the irrigated extent (e.g., priority rights, bethma, alternating yala seasons for different subsystems) and changes in cropping pattern (e.g., short-term varieties, subsidiary field crops), cultivation calendar (e.g., land preparation with rainfall during maha season), and water duties (e.g., acceptable reductions of water issues to different subsystems, or an agency-managed, instead of farmer-managed rotation during the implementation of the seasonal plan).

Provision of knowledge. The Irrigation Department should initiate a synthesis on managerial techniques and attitudes (e.g., criteria for rationalizing the matching of supply and demand under different water availability situations, methods for reliably assessing the actual requirements of the water users) that may prove or have proved more or less successful in reaching mutually acceptable seasonal allocation decisions in the Sri Lankan management situation in different irrigation systems under different water availability situations.

Organizational rules. The Irrigation Department should develop rules that will facilitate the interaction between its own seasonal planning, especially during the preparatory stages and the requirements and preferences of the water users and the Irrigation Management Division. The Ministry of Lands and Land Development and the Irrigation Management Division provide for such rules. The related rules of the Irrigation Department are passive and adapted to the requirements of the Irrigation Management Division rather than to the requirements of the seasonal allocation processes.

For an average level of perfection (40–60%), clear responsibilities toward the seasonal planning will have to be defined for the Irrigation Department and the Irrigation Management Division at project and distributary channel levels. These responsibilities should be related to explicit and clear performance indicators for the seasonal planning.

For an average level of perfection (40–60%), the Irrigation Department would have to enforce rules requiring the Water Management Feedback Center to consider the planning at project level and district level (by the water user representatives, the Irrigation Management Division and the

Department of Agriculture in INMAS meetings). For a high level of perfection (60–80%), rules that require the involvement of the Water Management Feedback Center in the planning at distributary-channel level should also be enforced.

The function of the cultivation meeting as a decision-*making* body is confused with that of a decision-*preparation* body and this creates problems and frustrations for all parties. Instead of doing away with the cultivation meeting, a solution may be to formalize it as an extension meeting and decision-making body with an additional function of hearing remaining (unrepresented in the final decisions) water user grievances, which may be referred to the Ministry and the Departments, for example, through the minutes.

In general, the Irrigation Department, the Irrigation Management Division and the Ministry should pay more attention to the functioning of different rules for the seasonal allocation decision making during the commissioning of a system like the Kirindi Oya system.

The managerial approaches of the Project Managers of the Irrigation Management Division are not quite consistent over the system. The Project Manager for the New Areas adopted the role of "farmer leader." The Project Manager of the Old Areas did the opposite by acting as "facilitator." He encouraged the water users to try to solve their problems first by working with the line agencies directly and, only if it fails, to channel it through the Irrigation Management Division meetings. The "facilitator" approach appeared more sustainable and effective in interacting with officers of different line agencies, but it made the Project Manager less popular with the water users.

The Irrigation Management Division apparently leaves it to the Project Managers to decide the role they want to play, which seems strange given its major influence on the success of their functions with respect to the effectiveness of the interactive processes. Information Booklets No. 2 and No. 3 on the INMAS Program (MLLD 1984b and 1985a) do not mention anything about their role.

The only guideline available on the role of the Project Manager does not specify how the coordinating role has to be realized other than stating that "the effectiveness of the implementation process would therefore depend to a very large extent on the ability of Project Committee and Project Manager

to exercise pressure on line agency staff to meet the needs of the programme" (Ratnayake 1985, 5).

The Director of Irrigation, writing in 1986 in conformity with the above guideline, says that the Project Managers have been selected mainly with respect to their "personalities" and "inborn qualities of leadership" (Pefera 1986, 26). The latter quality suggests that they are expected to become farmer leaders. This stressing of the importance of the personal qualities of the Project Managers is a feature commonly used in organizations to compensate for the lack of other institutional support.

The managerial "committee" setup does not facilitate the interactive processes, mainly because they are not effectively utilized by the Irrigation Department and the Irrigation Management Division. Moreover, the degree to which the committees of the Irrigation Management Division are really meant to be facilitative remains unclear. If this utilization cannot be improved, the Departments should look for better, more acceptable and more facilitating systems for coordination and interaction. However, the disadvantages of the "unified command" system — that it would harm the integrity and accountability of the different line agencies — remain valid as well.

Ideally, improvement of the overall institutional setting of the Project Managers and the Irrigation Management Division would evolve from a changed attitude of the Irrigation Department staff toward their managerial tasks, which would make the existence of the Irrigation Management Division as a separate organization superfluous. Such changed attitudes will only evolve through increased accountability of the Irrigation Department staff toward the water delivery performance.

IN-SEASONAL ALLOCATION

Present Management Performance: The Level of Perfection

The overall level of perfection of the in-seasonal allocation processes in the Kirindi Oya system could be classified as low (20–40%) following the classification in Annex 1. This quantitative judgement is based on the following criteria.

Feedback. Reliable feedback of realized water deliveries to distributary and field channels did not take place. Feedback occurred only in case of urgency, i.e., if the water users could not be helped by the gate tenders. It was a low level of perfection (20–40%). No regular feedback regarding realized conveyance targets occurred for all the subsystems; it happened only if localized shortages occurred. Again, a low level of perfection (20–40%). No performance evaluation by the head office took place regarding the achieved water delivery performance, except through complaints: A very low level of perfection (0–20%).

Foreseeing. There was short-term and *ad hoc* planning of operational targets for distribution and conveyance, mainly based on necessities and urgencies: A very low level of perfection (0–20%).

Integration. Operational targets for distribution to branch-canal and distributary-channel subsystems were considered individually. Operational targets for conveyance along the main canal were not integrated with those for the distribution. It was a very low level of perfection (0–20%). The operational targets for distribution within a distributary-channel subsystem have taken into account the short-term agricultural and water-user priorities: An average level of perfection (40–60%).

Systematics. No rules existed as to how the gate tenders should match supply and demand below the offtake from the main canal. A general instruction meant for the Technical Assistants stated that they had to satisfy demands at field-channel level first, and then maintain a correct water level in the distributary channel, possibly by varying flows to different field channels and adjusting the flow to the distributary channel only in case of necessity. This instruction could have been hardly called a rule of thumb for

it gave no concrete support in determining the actual pattern of decision making. In practice, this instruction acted more as a confirmation of a routine that has evolved over time at field level: A very low level of perfection (0–20%).

Regarding the operational targets for the conveyance along the main canal, a rule of thumb existed which stipulated that the upstream water level above the cross-regulator had to be maintained at full supply depth. However, it could hardly be said that this rule of thumb determined the pattern of decision making, which means that no effective rule really existed. And some kind of routine to determine the operational targets for the conveyance slowly developed: A very low level of perfection (0–20%).

A rule of thumb for the allocation to the whole Right Bank during rainfall was actually followed during the period of observation of this study: A low level of perfection (20–40%). There were no rules that applied during rainfall to the flow below the offtake to the distributary channels: A very low level of perfection (0–20%). And there were no rules yet applied regarding the determination of operational targets for conveyance in the main canal during and after rainfall: A very low level of perfection (0–20%).

Opportunities for Improvement: Requirements with Respect to the Processes

As it has been considered that only a gradual improvement of the level of perfection is feasible, it is assumed here that the Irrigation Department aims at improving its level of perfection from low (20–40%) to average (40–60%). However, in certain cases where, for example. an average level of perfection leads to a low quality decision, it may be necessary to increase the quality of the decision (e.g., through more accurate water level measurements or feedback) rather than to increase the level of perfection.

Technical aspects. For average (40–60%) and high (60–80%) levels of perfection the in-seasonal assessment of supply to the different distributary channels along the main canal will have to depend on the water level above the measuring weir at the head of the distributary channel alone; the water level in the main canal will be relevant for the conveyance only. This means that the main canal should not be used anymore as a small reservoir for distribution purposes, but as a conveyance canal only.

The required frequency of such assessments will have to be determined by higher-level staff and the observations shall be referred to them, if they deviate from the allowed variation set by them. This allowed variation will be larger for an average level of perfection (40–60%), than for a high level of perfection (60–80%), because for a high level of perfection more frequent feedback and allocation adjustments are, in principle, required than for an average level of perfection.

The frequency of assessment may have to be varied according to the degree of fluctuation of the main canal water level, and possibly for different water availability situations. Systemizing the frequencies for the distributary channels along the main and branch canals will be required to facilitate guidance, monitoring and evaluation by higher-level staff.

For an average level of perfection (40–60%), the assessment of demand by means of the theoretical calculations should be abandoned completely. Instead, the demand assessment should be done by means of the water levels along the distributary channel, especially the tail end, and by means of the water levels above the measuring weirs at the head of the field channels. Requests from the water users or their representatives are also used for the demand assessment. The frequency of this assessment may be several times a day, but will be less for an average level of perfection (40–60%), than for a high level of perfection (40–80%), because of the larger margin allowed for localized variation of the allocation.

For an average level of perfection (40–60%), regular feedback on effective rainfall for important places in the command area (e.g., for every tract in the Kirindi Oya system) takes place and is used for the demand assessment. For a high level of perfection (60–80%), this effective rainfall is measured for all important subsystems (e.g., all distributary-channel subsystems) and feedback occurs daily, if it is relevant for the allocation decisions.

For an average level of perfection (40–60%), the allocations to the distributary channels are regularly (e.g., weekly or biweekly) adjusted and laid down in allocation schedules. For a high level of perfection (60–80%), these adjustments are more frequent. Allocations to distributary channels and field channels are implemented accordingly, whereby a larger variation is allowed for an average level of perfection (40–60%), than for a high level of perfection (60–80%).

For an average level of perfection (40–60%), the residual effective rainfall is incorporated in the weekly or biweekly allocation schedules while for a high level of perfection (60–80%), the probable effective rainfall is considered.

For an average level of perfection (40–60%), the separate operational targets for the conveyance are expressed for the most important points along the main canal. For a high level of perfection (60–80%), this is done for all important points along the main canal.

A precondition for reaching an average or high level of perfection of the in-seasonal allocation is the possibility of assessing the water levels at the heads of the subsystems accurately. For example, the measuring weirs should function accurately under free flow conditions. This should be the case at least for the measuring weirs at the heads of the main and branch canals and distributary channels.

Managerial aspects. Staff of hierarchical levels higher than the field level should become actively involved in the in-seasonal demand assessment and consequent allocation processes below the head sluice to increase the level of perfection to average (40–60%) or high (60–80%). Without their involvement in these processes it will not be possible to limit the localized overconsumption of irrigation water.

The staff of higher hierarchical levels will have to regularly (40–60%) or more frequently (60–80%) reschedule the allocations to distributary and field channels. Such staff will also have to make decisions regarding the allowable margins of deviation from these scheduled allocations for field-level staff and regarding ways to monitor these deviations.

The Irrigation Department will have to determine the stages of the decision-making processes regarding the in-seasonal allocation at which the water users should be consulted and the hierarchical levels of staff, who should consult the water users. These consultations may take place at the beginning of the season to discuss the principles of allocation, or at regular (40–60%) or more frequent (60–80%) intervals during the season. Simultaneously, regular (40–60%) or more frequent (60–80%) interaction with the Department of Agriculture and other relevant agencies is required for a better tuning of allocations to agricultural programs.

Allocation principles could be a subject for discussion, consultation or negotiation with the water users, or their representatives or field staff. The

allocation principles cover qualities of the water delivery service, as for example:

* The water duty required for the different subsystems.
* The flexibility of the operational targets required for distribution to distributary and field channels, in terms of duration or flow rate.
* The maximum permitted total responsiveness (managerial and hydraulic) or delays in realization of exceptional adjustments to the scheduled allocations.
* The allowance necessary to cope with variations in discharge to the different subsystems (or variations in water level).
* The predictability of the water issues in terms of the required information supply to the water users and the field staff about allocation schedules and adjustments.

These subjects of discussion should be the criteria that has to be followed in the allocation decision making for different water availability situations, (e.g., equity between subsystems), cultivation risks and agricultural productivity.

The form of these consultations, with or without the cooperation of the Irrigation Management Division, will have to be determined by the Irrigation Department. During the period of observation of this study and in the perception of the engineers, the relationship between the Irrigation Department and the Irrigation Management Division seemed to be too strained to expect much of an increased cooperation between them without the commitment of the engineers at project and head-office levels.

The attitude of the Irrigation Management Division is based on the expectation that pressure from bottom (i.e., from the water users) on the Irrigation Department staff will increase their accountability. With regard to the in-seasonal allocation, the mechanisms of the different hierarchical levels of the Irrigation Department at project level are such that passive or active obstruction of such pressure from the bottom is very easy. Without a real commitment of the staff of the Irrigation Department the complaints or protests of the water users will not be very effective in the short run, and may even be counterproductive in the long run.

Consultations initiated and maintained by the Irrigation Department can be attended by the more or less centralized staff levels, where allocations are scheduled, and also by lower hierarchical levels. Apart from that, procedures have to be established regarding urgent complaints and requests by the water users.

In order to increase the managerial responsiveness to adjustments required for the allocation schedules, good communication lines have to be established with the field-level staff as well. If such lines do not exist, it will become more difficult to deliver water within the requirements that evolve from the consultations with the water users, including the separation of operational targets for conveyance and distribution. These communication lines should be even better for a high level of perfection than for an average level of perfection.

For an average level of perfection, higher-level staff should regularly instruct, guid, monitor, and evaluate the field staff regarding the actual implementation of the scheduled allocations. This will not only improve their allocation decisions, but also will stimulate them.

For the same reasons, it is required the head office to play a more active and initiating role in guiding, monitoring and evaluating the in-seasonal allocation processes in its irrigation systems. Performance evaluation through registration of allocation schedules and comparison with earlier important experiences and regular monitoring and evaluation of actual implementation of the most important operational targets are required for an average level of perfection (40–60%).

The credibility of the higher-level staff in regard to the matching of supply and demand is very important in their interaction with the water users and the field staff, and this is something which should be carefully cultivated by the staff of the Irrigation Department.

A related observation regarding the managerial requirements for the in-seasonal allocation is that the combination of construction activities and water delivery processes is presently a major constraint to attain the required discipline and motivation of the staff of the Irrigation Department for maintaining communication lines necessary for an average level of perfection (40–60%). A separation of these interests is essential, especially in a system under construction (like the Kirindi Oya system) or rehabilitation

where the early years are very important for establishing the credibility of the Irrigation Department with regard to the allocation scheduling.

If the Irrigation Department wants to achieve an average level of perfection of the in-seasonal allocation decision making, it should have the courage to argue against "pushing" politicians. Their priority for construction targets has direct consequences for the immediate and future water delivery performance and the credibility of the allocation decision making by the Irrigation Department in the system, which in a wider perspective serves the national interests as well.

However, it requires that the Irrigation Department itself makes a policy change of abandoning its overall priority for construction interests. Also, the donor should realize the importance of building not only the infrastructure, but also the management processes. These aspects will be more extensively dealt with in later chapters.

Opportunities for Improvement: Requirements with Respect to the Managerial Conditions

People. Staff of levels above field level have sufficient expertise to handle demand assessment and the matching of supply and demand. But their understanding of the importance of agricultural interests in this matching is not sufficient. An improved understanding of this aspect can be achieved by including agronomic subjects in their education and also by means of agronomically-oriented training courses or such other professional development programs. In addition, experience in quantifying water duties in terms of flexibility, predictability, variability and responsiveness have to be developed by the staff and the water users.

A first need is an increased awareness of the staff of the Irrigation Department about the managerial aspects of their daily work content. In addition, higher-level staff will have to interact more effectively with lower-level staff and the water users. It requires improved managerial skills and attitudes. As for the seasonal allocation, inclusion of management subjects in the education of the staff, addition of managerial skills in the selection criteria for future irrigation managers, and changes in training and professional development programs are required. More awareness of the

influence of managerial attitudes on motivation and performance may also be helpful.

However, increased awareness of the managerial aspects of the in-seasonal allocation processes and related skills will not increase the present level of perfection. Motivation and willingness of the staff of the Irrigation Department to improve its performance in this respect are more important.

Provision of information. The staff that prepares the allocation schedules requires regular (40–60%) or frequent (60–80%) feedback on realized water issues to distributary channels and field channels, and corresponding water levels in the main canals. Also, they should get feedback on adjustments of scheduled allocations. That feedback can be realized through forms, but the information provided in forms have to be cross-checked daily by independent measurements of water issues to, at least, distributary channels and through regular field visits by higher-level staff.

Regular feedback on the residual effective rainfall is required for an average level of perfection (40–60%). For a high level of perfection (60–80%), frequent feedback on actual demand incorporating effective rainfall is required.

In addition, for average and high levels of perfection, good communication lines are required to be able to react to exceptional deviations from the scheduled allocations that cannot be covered by the established allowable margins. Related to this are the information-processing requirements; computers and standard software should be used to make frequent and quick changes in the schedules and to produce printouts of these schedules and other notes for dissemination to the field staff and the water users. The Water Management Feedback Center has developed such software (a Lotus 1-2-3 spreadsheet program) for the Kirindi Oya system (Jayasundera 1989). It is used now mainly for theoretical calculations, but it can be easily applied to quick allocation scheduling and the dissemination of the new schedules. In addition, to make management less dependent on individual staff members, allocation experiences, seasonal reports, etc., can be recorded in a database.

For an average level of perfection (40–60%), performance evaluation by the head office through registration of allocation schedules and comparison with earlier important experiences, and regular monitoring and evaluation of

actual implementation of the most important operational targets are required. Potential performance indicators for the in-seasonal allocation concern are the water duties for main canals, branch canals and distributary channels, which can be monitored regularly. That again requires increased accountability of the Irrigation Department as a whole toward its water-delivery performance, which is unlikely to come about without related commitments from the external environment.

Systems and methods. For average and high levels of perfection, it is necessary to have a system of allocation for different subsystems that can be relatively easily monitored by *higher-level* staff and is acceptable to the water users. Such a system can systematize the allocation decision making and facilitate the interaction among staff and between staff and the water users. Four such methods of allocation are possible:

1. Fixed discharge and variable duration: This method requires more management inputs from agency staff, but allows the water users to standardize the rotation within the distributary and field channels to a certain extent.

2. Variable discharge and fixed duration: This method is easier for agency staff, but requires much more management inputs and internal organization from the water users to manage the varying durations to different farm plots, if the supply is tight compared to the demand.

3. Variable discharge and variable duration: A method that requires more management inputs from agency staff than from the water users.

4. Fixed discharge and fixed duration: A method, which presently exists merely on paper; if actually implemented it will be the least management-intensive for the agency, but will not allow for a tight water supply over the whole season.

If the Irrigation Department intends to supply water to match the demand, the second option may be suitable for the agency in the long run. However, to attain an average level of perfection (40–60%), only the first and third options seem to be feasible now in the Kirindi Oya system. If the Irrigation Department allows a more abundant water supply to the different

subsystems, any of the rotational allocation options may be feasible for the agency and the water users; in such a situation the third option is the least management-intensive for higher-level agency staff and was being implemented at the time of this study. Performance improvement with the fourth (or second) option requires the enforcement of increased management inputs from the water users only, which seems unlikely to occur in the absence of viable and effective water-user groups, as it is the case now. The first option seems more appropriate for that purpose, whereas the third can be used in a transitory trial-run period. In all cases, it is important that the adopted allocation method is acceptable to the water users of the different subsystems — which will probably require some compromising on the allocated water duties — and that the water users are aware of the scheduled allocations.

For an average level of perfection (40–60%), a system which makes more effective use of rainfall has to be developed. Several such systems have been proposed in the past by the consultants, but their application to save water is deferred pending institutional support of the Irrigation Department.

An important requirement for an average or high level of perfection is a system for the methodical recording of allocation experiences concerning the subsystems of a specific irrigation system in such a way that the departure of field-level or higher-level staff will cause minimum disruption (due to loss of experience) of the water delivery service. Such discontinuities in supervision will reduce the credibility of the delivery service of the Irrigation Department. Methods of recording allocation experiences may include the filing of minutes of meetings of the water users and staff, and the building up of a data bank of the pros and cons of allocations to specific subsystems, seasonal reports which highlight the main seasonal and in-seasonal allocation processes, etc. Such a data bank on the different irrigation systems of the Irrigation Department will be a storehouse of experience on how the allocation processes, water duties, cropping patterns, cultivation calendars, and cultivation risks evolved over time in specific irrigation systems.

Provision of knowledge. The technical knowledge necessary for the in-seasonal allocation, specially for the envisaged quantification of water duties in terms of flexibility, predictability, variability and responsiveness is found to be lacking. As mentioned before, the knowledge and experience gained by the field-level staff, each of whom handles one task or a part of

the allocation process, is neither preserved nor pooled together, and is lost with the departure of the staff from the system.

Despite the availability of an enormous amount of irrigation management literature related to the water user organizations, there is little exchange of knowledge and practical wisdom of systematic mechanisms of interaction among higher-level agency staff, field staff and the water users in regard to in-seasonal allocation. Such exchanges should be initiated by the Irrigation Department itself to dispel any misunderstanding of its engineers that knowledge of that sort is a threat to their profession.

Organizational rules. For an average level of perfection (40–60%), the Irrigation Department should develop clear and consistent rules for the assessment of demand and matching of supply and demand in its irrigation systems. It also should develop methods of assessing supply and demand and matching them, and determine the hierarchical levels at which these decisions to be made, the feedback requirements, etc.

For a high level of perfection (60–80%), it is necessary to establish combinations of mutually attuned rules with respect to the frequencies of supply and demand assessment, the hierarchical levels where allocation scheduling would have to take place, the feedback requirements, the incorporation of effective rainfall in the allocation schedules, etc.

A common solution to the interference of distribution and conveyance targets along main and branch canals is to establish separate organizational structures for distribution and conveyance. The separation of the Water Management Feedback Center from the offices of the Resident Engineer in the Kirindi Oya system is a way of achieving the separation of the conveyance and distribution along the main canal. That separation may help to reduce the interference to a certain degree but, in the Kirindi Oya system, it does not prevent gate tenders (or localized managers like the Resident Engineer's staff) from deciding among themselves and making *ad hoc* adjustments of the distribution targets in response to immediate water users' demands. Only if the level of perfection of the in-seasonal allocation is upgraded and these *ad hoc* water user demands are taken care of, the water users and gate tenders will develop the confidence required for a further improvement of the separation of distribution and conveyance targets. That increased level of perfection will not evolve without the increased accountability of the different staff with respect to the water-delivery

performance; without such accountability, different configurations of the organizational structure cannot solve the problem of conflicting interests of conveyance and distribution.

Rules governing the hierarchical and financial authority of staff involved in in-seasonal allocation are a requirement to make this decision making less dependent on individual motivations, behavior and attitudes. In the Kirindi Oya system, the prevalence of the interests of the local Resident Engineer over those of the overall system is reinforced by the organizational structure in the absence of any accountability toward the water-delivery performance. Therefore, it seems better to have a direct line of authority from the project-level Water Management Feedback Center to the field-level staff with clear responsibilities and accountability along the line. For an average level of perfection (40–60%) and a high level of perfection (60–80%), more guidance, monitoring and evaluation by the project-level O&M staff requires more direct authority and responsibilities for the project-level Water Management Feedback Center, from the top officials to the field-level staff involved in allocation processes. The different levels of staff in this line should be made accountable and responsible for the water use within their areas.

This study suggests that the staff involved in in-seasonal allocation should work independently of staff involved in construction activities, and should have their own career paths as well. Rules should be established — and enforced — about the relation and interaction between the Irrigation Department and the Irrigation Management Division.

Managerial rules about the frequency of consultations on allocation principles with water users, their representatives and agency staff should be developed and enforced as well. These rules should include requirements with respect to decisions to be made at these consultations (e.g., the criteria listed under managerial aspects of the required processes), and the recording of the proceedings. It will also be required that the Irrigation Department should establish rules about the responsibilities, entitlements and rights of the water user organizations to enable those groups to play a meaningful role in the allocation decision-making processes. Given the increased management inputs required for a serious effort to interact with the water users (which itself is a prerequisite for viable and effective water user groups) a meaningful role for the water users seems unlikely to evolve without

increased accountability of the Irrigation Department staff and the Irrigation Department as a whole toward the water delivery performance.

WATER-FLOW REGULATION

Present Management Performance: The Level of Perfection

The overall level of perfection of the water flow regulation was very low (0–20%). This quantitative judgement was based on the following evaluations of its characteristics:

Feedback. There was hardly any feedback regarding the operational methods implemented or their appropriateness. Even obvious shortcomings or disparities were not communicated, unless complaints were received from the water users or overflowing of the canal bunds occurred. Only the Water Management Feedback Center made some attempts to improve the operational methods being used: A very low level of perfection (0–20%).

Foreseeing. The actual operational methods were established on an *ad hoc* basis. Some experience of the consequences of certain operational methods for the distribution had been gained over time, but the absence of information on the degree and duration of the discharge variations would prevent the consequences for the conveyance being foreseen: A very low level of perfection (0–20%).

Integration. The changes in the upstream water level due to operation of cross-regulators and offtakes were integrated with their influence on the distribution through the offtakes. It was realized by operating the cross-regulators only in case of water level variation. That integration with the distribution occurred at the expense of the conveyance along the main canal. Operations of cross-regulators along the canal were not integrated at all with the other changes and adjustments: A very low level of perfection (0–20%).

A better integration existed within the distributary-channel system from the point of view of maintaining enough head for distribution to the different

field channels as well as conveying water along the distributary channels: An average level of perfection (40–60%).

Systematics. The complete delegation of the water-flow regulation decision making to the gate tenders led to *ad hoc* operational methods, although some on-the-job experience over the years was gained by the gate tenders, but not their supervisors: A very low level of perfection (0–20%).

The standing orders of the Irrigation Department applied in the Kirindi Oya system did not match the unsteady flow conditions in the main canal and thus did not systematize the decision making. The instruction of the Water Management Feedback Center to refrain from operating the cross-regulators after rainfall could have led to some systemizing of the decision making, but due to lack of follow-up, that instruction was not strictly implemented: A very low level of perfection (0–20%).

Opportunities for Improvement: Requirements with Respect to the Processes

As it was assumed that only a gradual improvement of the level of perfection is feasible, a further assumption is made that the Irrigation Department aims to improve its level of perfection from a very low (0–20%) to a low (20–40%). However, in some cases the requirements to reach an average level of perfection (40–60%) will be indicated. A higher level of perfection does not necessarily lead to a better outcome. In certain cases it may be necessary to increase the quality of the decision, rather than the level of perfection. Similarly, a good decision that evolves from a low level of perfection might be very cost-effective.

Technical aspects. For a low level of perfection (20–40%), the present practice of using an approximate time of operation of the head sluice by the Water Management Feedback Center and Resident Engineer is sufficient. For an average level of perfection (40–60%), the exact time of actual operation of the head sluice have to be recorded and the Water Management Feedback Center and Resident Engineer have to be informed immediately about the time.

For a low level of perfection (20–40%), the actual discharge through the head sluice have to be measured and such information will have to be provided immediately to the Water Management Feedback Center and the

Resident Engineer. For this purpose, the measuring structure at the head of the main canal should be made functional, and be calibrated regularly. In addition, the Water Management Feedback Center and the Resident Engineer will have to determine the periods and the days unsuitable for the operation of the head sluice.

For a low level of perfection (20–40%), the gate tenders have to be informed about the approximate time and the size of flow variations at their cross-regulator and offtakes. The provision of such information requires the incorporation of data (approximate time and size) of the operation of upstream cross-regulators, distribution to offtakes, and losses during conveyance to their cross-regulator. For an average level of perfection (40–60%), provision of this information to the gate tenders should become more specific. This requires the measuring of the discharge at certain points along the main canal, and these discharge measurements require regularly calibrated staff gauges or measuring structures at all distributary-channel offtakes from the main canal and branch canals.

For a low level of perfection (20–40%), the gate tenders will have to be instructed on indicative operational methods, which would arrange the conveyance along the main canal and reduce the time required to stabilize the main canal after the operation of the head sluice or rainfall in the command area or important changes in distribution in upstream reaches of the main canal.

For an average level of perfection (40–60%), the gate tenders will have to be provided with more specific instructions regarding the operational method to be used for every operation of the head sluice or every occurrence of rainfall in the command area or important changes in distribution in upstream reaches of the main canal. Such operational methods cover the time and size of gate settings, and the frequencies of adjustment for all structures along the main canal, i.e, they include operational plans. For a low level of perfection (20–40%), the data that have to be fed back to the higher-level staff are: 1) the actual time and size of the adjustment necessary for the flow variation to reach important points along the main canal (e.g., the tail end, or the heads of branch canals), and 2) the time required to stabilize the flow at these points after an important change of discharge through the head sluice or heavy rainfall or important changes in distribution in upstream reaches of the main canal.

For an average level of perfection (40–60%), such feedback will have to be supplemented with data on all the realized changes in distribution along the main canal. Moreover, for an average level of perfection (40–60%), regular feedback has to occur about variations of the level along the main canal and branch canals.

Managerial aspects. For a low level of perfection (20–40%), staff of a level higher than field level (at least, the level of the Technical Assistant) will have to get involved in the water flow regulation decision making. They have to instruct the gate tenders about the methods of operation of cross-regulators and offtakes following an important change of discharge through the head sluice or heavy rainfall or important changes in distribution in upstream reaches of the main canal. Moreover, they will have to monitor and evaluate the implementation of these operational methods so as to give the above instructions.

For an average level of perfection (40–60%), higher-level staff involvement have to be more regular, because the water-flow regulation has to be monitored more regularly. In addition, more specific instructions regarding the operational methods are required. The increased involvement of higher-level staff is necessary for the establishment of timing of operations, allowed deviations from the target water levels, frequency of checking different flow-stability situations and allowed adjustments of the size of gate settings for specific discharge variations.

Higher-level staff have to be involved in: initiating certain operational methods, implementing them and monitoring the consequent stabilization of the main canal; identifying possible improvements in operational methods and communication between the different cross-regulator operators, etc.

They have to ensure that quick and reliable information on the realized distributions, the operations of structures and the discharge at specific locations along the canal is available for the operational planning at the time of important water flow changes along the main canal. For an average level of perfection (40–60%), special technical staff is required to prepare the operational plans.

For an average level of perfection (40–60%), more attention may be required for matching the exact timing of the operation of the head sluice with the managerial responsiveness of the staff of the Resident Engineer (Right Bank) and to warn or instruct the gate tenders along the main canal.

This may be done through some form of consultation of the Resident Engineer (Right Bank) with the Resident Engineer (Head Works) about the exact timing. This matching is important, because without an exact starting up time of destabilization of the main-canal flow, the coordination of the operations of the cross-regulators along the main canal becomes less exact and small destabilizations are propagated with increased amplitude along the main canal to the tail end.

Opportunities for Improvement: Requirements with Respect to the Managerial Conditions

People. The expertise of gate tenders and higher-level staff involved in appropriate operational methods for water flow regulation decisión making have to be improved. However, the awareness that the conveyance and destabilization of the main canal constitute something to be managed at all — leave alone awareness that it has to be managed before the head sluice is operated — is still absent among the staff of the Irrigation Department. Such awareness and expertise could be improved by training the staff by means of models that simulate the water flow in the main canal under different operational methods and under different situations.

As for the seasonal and in-seasonal allocation, the management of the water flow regulation requires a change in attitude of the staff of the Irrigation Department toward interaction with lower-level staff. The remarks made in earlier chapters about the allocation decision making on training, and the accountability of the staff of the Irrigation Department toward water delivery performance are valid for the water flow regulation as well.

Provision of information. The information on the approximate time of operation of the head sluice that is being provided to the Water Management Feedback Center and the Resident Engineer is sufficient for a low level of perfection (20–40%). For an average level of perfection (40–60%), they should be provided with the actual time of operation as well.

For a low level of perfection (20–40%), the gate tenders should be provided with the approximate time of operation of the head sluice and the approximate size of flow variation. Or, they should be provided with the approximate time and size of flow variation at their cross-regulator. For a

low level of perfection, they shall be provided with indicative operational methods as well.

For an average level of perfection (40–60%), the gate tenders should be informed about the exact time and size of flow variation at their structures, the required time and size of gate setting, and the frequency of checking the resulting changes of the level and adjustment of the gate settings.

For a low level of perfection (20–40%), the data that have to be fed back to the higher-level staff are: 1) the actual time and size of the adjustments necessary for the flow variation to reach important points along the main canal (e.g., the tail end, or the heads of branch canals), and 2) the time required to stabilize the flow at those points after an important change of discharge through the head sluices or heavy rainfall or important changes in distribution in upstream reaches of the main canal. For an average level of perfection (40–60%), such feedback have to be supplemented on a regular basis with feedback on all changes in distribution along the main canal. Moreover, for an average level of perfection (40–60%), regular feedback on level variations along the main canal should occur.

Systems and methods. For a low level of perfection (20–40%), the Irrigation Department would have to introduce a system that facilitate the quick development of more appropriate indicative operational methods.

Provision of knowledge. Knowledge on operational methods used in different systems and their consequences for conveyance and stabilization of the water levels along the main canal have to be built up by the Irrigation Department itself. Such knowledge could also be developed through trial-run techniques or through the use of simulation models to experiment with different operational methods and procedures for water-flow regulation. However, the application of such know-how depends ultimately on the willingness and the motivation of the project and head office staff of the Irrigation Department to improve its performance in water flow regulation.

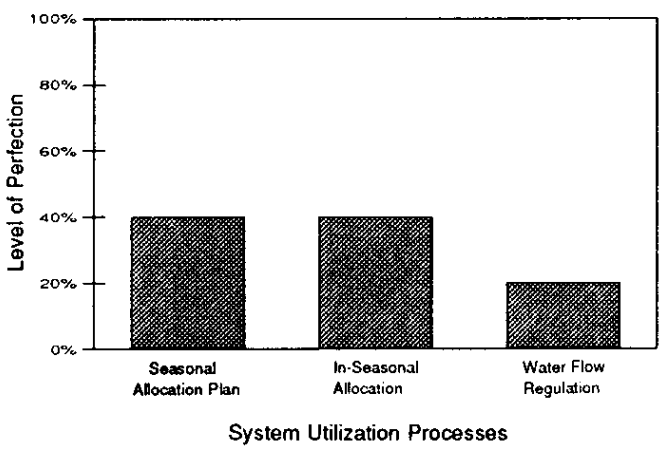
Organizational rules. For a low level of perfection (20–40%), the Irrigation Department should establish broad rules concerning the responsibilities of higher-level staff in water flow regulation (e.g., the involvement required of higher-level staff in the establishment of operational methods, the provision of information to field staff after important flow changes in the upstream reaches of the main canal, and the monitoring of the

consequences for the water flow regulation). For an average level of perfection, more specific rules should be established.

PRIORITIZING AMONG THE DIFFERENT OPPORTUNITIES FOR IMPROVEMENT

The levels of perfection achieved in system utilization processes of the Kirindi Oya system are graphically displayed in Figure 7. It is assumed that higher levels of perfection lead to higher system performance. However, the degree to which the different key decisions contribute to the system performance is yet unknown. The relative contributions of the different key decisions have to be determined through comparative research in different irrigation systems before they can be used as normative indicators of the levels of perfection for the different key decisions to reach a certain performance. Such comparative research will be undertaken in the near future by IIMI's performance research staff. In the absence of such normative values the given opportunities could be used by the Irrigation Department as a kind of a checklist.

Figure 7. Levels of perfection achieved in system utilization processes of the Kirindi Oya system.



CHAPTER 7

Strategic Concern: Desired System Objectives

THE STRATEGIC CONCERN deals with the identification of desired system objectives (e.g., water delivery, land settlement, employment and agricultural production). It matches these objectives with the availability of resources (i.e., the feasible system objectives), and defines the required capacities needed (i.e., the functional system requirements) to reach these objectives. Accordingly, the strategic concern has been split up in this paper into three key decisions: the desired system objectives, the feasible system objectives and the functional system requirements. The latter two are dealt with in Chapters 8 and 9 respectively.

The desired system objectives evolve from the objectives of the donor, the national and local politicians, the line ministries and departments, the national planning organization, the local authorities and the community, and the beneficiaries of an irrigation system.

For an irrigation system one such objective, whether implicitly or explicitly stated, may be the reduction of cultivation risks through more control over water in certain areas at a certain point in time. Other related objectives may be a desired increase of agricultural production, alleviation of poverty, reduction of unemployment, settlement of landless people, appeasement of political supporters or geopolitically sensitive areas, saving of foreign exchange through increased exports or decreased imports, sustainability of the environment, external funding for agency projects, etc.

The study of decision-making processes with respect to the desired system objectives and their managerial conditions has been less detailed than the studies given in other chapters, because they take place at high levels in agencies, the government and the donors. The relevance of this decision making for the water delivery can be very important, but a broad picture as given in this chapter has been considered sufficient. A general overview of the background to irrigation-cum-settlement systems in Sri Lanka has been given in Chapter 2.

THE DECISION-MAKING PROCESSES

Technical Aspects

The Appraisal Report of 1977 describes the explicitly stated objectives of the Kirindi Oya project:

> The objective of the Project is to help meet some of the Government's major economic goals; namely, increased paddy and cotton production, employment generation, foreign exchange saving and land settlement. Under the project, new and improved irrigation facilities will be provided for 12,394 ha. Of this area, 4,525 ha of paddy land are at present under cultivation. The project reservoir, operating in conjunction with the existing tanks in the area, will assure irrigation for cultivation of paddy on these lands during the two seasons each year; additional 8,409 ha of new lands will be developed for cultivation of paddy, cotton and subsidiary food crops. About 8,320 farm families will be settled under the Project in new hamlets and villages complete with the necessary infrastructure, and will be given small farms with which to support themselves. To ensure full benefits from the irrigation and settlement facilities, agricultural extension services will be strengthened under the Project (ADB 1977b, 15).

These were the desired system objectives in 1977. For financial reasons the project was split up, in 1982, into two phases. The objectives were slightly changed in Phase I of the project which started in 1982. Phase I had the abovementioned objectives except the cultivation of cotton and an additional objective for the reservoirs to "assure irrigation for cultivation of paddy on 63% of the area during two seasons each year, while <permitting> the cultivation of one rice crop in the wet season and subsidiary crops in the dry season on the other lands" (ADB 1982, 4)

For Phase II, the cultivation of rice was omitted as a stated objective and replaced by the objective of "increasing the income of project beneficiaries...These objectives will be achieved through irrigation, improved crop management practices, forestry and livestock development, and in the process will encourage crop diversification and a farming systems approach to agricultural development" (ADB 1986, 13).

These were the objectives as laid down in the relevant donor[10] documents. Further elaborations of these objectives by the government appeared to be unavailable. No requirements or objectives were stated by the government regarding, for example, the timespan in which a certain number of people had to be settled or given jobs, or in which a certain increase in agricultural production had to be achieved. Neither was it made clear whether the increased agricultural production would have to be attained through increased cropping intensity, field crops other than rice (i.e. , other field crops [OFCs]), or through extension of the command area.

No feedback from the local community and beneficiaries of the project on the abovedefined requirements or objectives were given in the reports of the donor. The desirability of these project objectives from their point of view thus remained unknown for the reader of these reports. In fact, the objections of the local community and the politicians against the project were ignored.

The sustainability of the project objectives had not been mentioned or considered either. The donor reports give a rather extensive overview of the agricultural sector and derive from that the need for the envisaged increase of agricultural production of the project area (ADB 1977b, 3). The sustainability of this increased agricultural production and the related irrigated project extents were not mentioned.

No objectives were explicitly determined regarding the environmental sustainability of the Bundala and Weerawila bird sanctuaries in the project area (see Figure 1). However, some remarks have been made regarding the impact of the project on public health, deforestation in the catchment area, and soil erosion in catchment and command areas (ibid., 34). And, no objectives were determined in regard to the impact of increasing population pressure on the sustainability of the semiarid climatical environment of the Kirindi Oya system.

Instead, all these objectives were defined implicitly through the explicit priority for quick results: the government had given priority for speedy implementation of the project and quick results for political and financial reasons, rather than for choosing an option, which might have been more

10 Even though several donors were involved in the Kirindi Oya project, the ADB was the main actor on behalf of these donors in the decision-making processes; thus, when "donor" is used in this report without further reference, it refers to the ADB.

desirable in terms of the other project objectives mentioned earlier (Dissanayake 1986, 1).

Managerial Aspects

Several factors have led to the setting up of the Kirindi Oya project. A lack of water for the Ellagala system as a whole resulted from the gradual extension of its original command area, through spontaneous settlement, from the original designed area of 3,500 ha to the actually used area of 4,900 ha. For that reason, the Member of Parliament for Hambantota in the early 1950s initiated investigations into additional water resources (Edirisuriya 1978).

The desire to start investing in the development of the south of Sri Lanka originated with the insurrection of 1971, after which the "government was desperately keen to undertake some development projects that would give employment opportunities and other benefits to people in the south" (Mendis 1988b, 42). The choice for investing in irrigation-cum-settlement rather than in other sectors was most likely based on diverse reasons like the abovementioned water needs of the Ellagala system, a lack of good alternatives for investment, the romantic feelings many Sri Lankans have about the ancient irrigation civilization in the south and the political visibility of an irrigation system.

The decision to build an irrigation-cum-settlement system was taken by the government in the early 1970s (ibid.). At that time there were several options available, amongst which were the Lunuganwehera and Hurathgamuwa sites. Lunuganwehera was the most downstream location in the Kirindi Oya catchment, while Hurathgamuwa was more upstream and located favorably in view of an integrated watershed development plan for the whole south, i.e., the so-called Southern Area Plan.

This plan provided for a gradual development of the irrigation-cum-settlement in the south; agricultural production, land settlement and employment opportunities were not defined to be attained in a short period of time, but were assumed to develop gradually over time. It also envisaged the diversion of 1,234 mcm of excess water resources per year from the wet southwest (Nilwala and Gin river) basins to the dry southeast (Kirindi Oya and Gal Oya) basins by means of a transbasin diversion canal.

The dam site and area to be commanded. At first, the then Prime Minister approved this Southern Area Plan. A perceived advantage of the plan was the gradual implementation that would allow for more consultation with the local communities, the adjustment of the implementation to their needs and capacities and thus more long-term sustainability. Another perceived advantage was the envisaged use of local technologies and manual labor as far as possible. The Planning Ministry had been supporting and pushing the plan, while the responsible decision makers in the Irrigation Department favored the Lunuganwehera site, because of the opportunity to build the longest earth dam ever in Sri Lanka.

The Planning Ministry and responsible decision makers of the Irrigation Department did not agree on the role of western technology. The Ministry of Plan Implementation preferred the conservation and development of national engineering technology to the introduction of foreign expertise, which was considered inappropriate for the Sri Lankan setting; "Technology is like genetic material — it carries with it the code of the society which conceived it" (Elements November 1976 in Mendis 1977, 58). The Irrigation Department preferred to plan the Kirindi Oya system along more scientific, hydraulic engineering lines.

After an unsuccessful attempt to obtain funding from China for the Southern Area Plan, it was dropped for some unclear reasons. Personal conflicts between individuals in the different agencies and involved politicians seemed to have been the main reason (Mendis, Edirisuriya, personal communication).

Meanwhile, preparations continued for the irrigation project in the Kirindi Oya River Basin which was favored by the Irrigation Department (i.e., the Lunuganwehera site). In March 1976, during a visit of a Project Identification Mission of the donor to Sri Lanka, the government — which was at the end of its term — requested the donor "to consider assistance for the Kirindi Oya Irrigation and Settlement Project (KOISP). A Bank Mission which visited the country in May 1976 considered that the Project was suitable for possible Bank assistance, but that technical assistance would be required for further investigations and for project preparation. Subsequently, in July 1976, the Bank approved technical assistance amounting to US$49,000 for the purpose. <A feasibility team of three individual consultants and a staff

member> engaged to carry out the study, submitted their final report in May 1977" (ADB 1977b, 1).

The objectives of the project at the time of this mission are described in the feasibility report as: "the project will help to meet some of the Government's major national objectives; import substitution, new employment opportunities and land colonization. The 6,400 colonists will be settled in new hamlets, and villages, complete with the necessary infrastructure, and will be given small farms with which to support themselves" (ADB 1977a, A:I:3). The Terms of Reference of this feasibility study reveal that these objectives were envisaged to be reached through the construction of the Lunuganwehera dam and Reservoir, the downstream irrigation and drainage system and settlement infrastructure (ibid., A. Annex 1). Apparently, the Lunuganwehera site had already been selected by the government. The donor respected this choice and did not interfere, even while the foreign consultants hired for the feasibility study made clear in their report, in an implicit way, that the arguments for choosing the Lunuganwehera site were not very consistent with earlier findings and reports. This is elaborated on in Chapter 8.

The consultants who wrote this report have consequently, in cooperation with the involved ministry and the Irrigation Department officials, defined three alternative projections (i.e., in terms of the Economic Internal Rate of Return or EIRR), and thus different project objectives in terms of future increases in agricultural production, commanded areas, and number of people to be settled. The alternative projections were, however, exclusively for sites below the Lunuganwehera site. Consequently, "in response to the government's request for further consideration by the <ADB>, an Appraisal Mission visited Sri Lanka from 12-31 August 1977" (ADB 1977b, 1). The mission determined which of these alternative objectives were most feasible in terms of the EIRR; at that stage the donor did intervene in the determination of desirable project objectives in terms of area to be irrigated, cropping patterns, water duties and cropping intensities. Based on their findings and recommendations the donor took the decision to fund the foreign exchange component of the project.

During all these stages, the water users, future settlers and the local community were not consulted. The then Member of Parliament for Tissamaharama strongly opposed the Lunuganwehera site "...where about

<4048 ha> of developed lowland and the two villages, Lunuganwehera and Dewumwehera, will be drowned by the reservoir. About 1500 families will have to leave this area and they will have to be compensated for their lands and property" (Edirisuriya 1978).

He opposed the selection of this site, especially in view of the availability of the alternative Hurathgamuwa site, where a smaller dam would be required which would submerge a smaller area of uncultivable, rocky land. From this site additional water to the Ellagala system could be sent through the Kirindi Oya River for cultivation of yala and maha seasons, and an additional 2,834 ha of suitable lowlands could be brought under irrigation as well (ibid.).

The then Member of Parliament for Tissamaharama expressed this opinion, in the presence of high-level agency staff, to donor consultants who visited the envisaged project area. This must have been at an early stage given the aforementioned Terms of Reference of the Feasibility Study. While different politicians are, of course, bound to have opposing views, the personal impression of the former Member of Parliament was that the donor staff did not take his arguments seriously (Edirisuriya, personal communication).

In 1977, the Southern Area Plan and the related Hurathgamuwa site were again taken into consideration when the United National Party (UNP) government came into power. By that time, the donor had received a report of the Ministry of Plan Implementation regarding their continuing preference for the Hurathgamuwa site, and they asked the new Minister of Lands and Land Development — coincidentally just three weeks in office at the time — to make a decision on the site for the Kirindi Oya dam (Dissanayake 1986, 1). The Minister appointed a commission of five to advise him; three of them agreed that the project should continue at the Lunuganwehera site, while one of them (one of the designers of the plan) dissented and wrote a separate report, and the other did not sign the Committee's report.

An important argument for the Minister in favor of the Lunuganwehera site was that at that time, the preparations for the Lunuganwehera site had been completed by the Irrigation Department and implementation of this option could be started immediately. The Lunuganwehera site was also strongly favored by the then Director of Irrigation. For the Hurathgamuwa site, investigations and plans were not yet ready. The Minister of Lands and Land Development decided to prevent a delay in the implementation and

outcome of the project and opted for the Lunuganwehera site (ibid.). Later he remarked about his motivations for this decision, that he felt like Napoleon Bonaparte who once said "I am not worried if I lose a battle because I can fight another battle and win. I am not concerned if I lose territory because I can regain that territory, but if I lose a minute I can never recapture that minute ever again" (ibid.). Thus, pressure for short-term results was clearly present at that time.

This priority for quick results led to a much less favorable option in several respects: the number of people that could be settled was much less, because of the required resettlement of 1,500 families; the submerging of 4,048 ha of developed lowland; a much larger and thus more expensive dam (which required the hiring of expensive foreign expertise as well); and last but not least, the managerial complexity of settling a large number of people and developing a large command area in a short period of time.

Although the Irrigation Department, the Ministry of Lands and Land Development and the donor did not pay much attention to this managerial complexity, the Ministry of Plan Implementation did so. The latter Ministry objected to the envisaged project objectives as it considered the envisaged site of the reservoir undesirable within a larger framework, i.e., the Southern Area Plan — this plan will be described more extensively in chapter 8.

Moreover, it considered the speedy construction of a large new irrigation system as harmful for the involvement of local communities and future settlers, and thus for the longer-term sustainability of the project (Mendis 1977, 56). An objective that the Southern Area Plan aimed at was a longer-term sustainable national development, rather than a short-term agricultural production boom, which carried with it large risks for long-term sustainability, as many irrigation projects inside and outside Sri Lanka had already demonstrated.

During the early stages of the project, it was mainly the staff of the Irrigation Department that was involved in the preparation and elaboration of the project objectives. In later stages, the officials of the Ministry of Lands and Land Development felt that the settlement aspects had been neglected by the Irrigation Department and the donors. Consequently, they insisted on more facilities in this aspect during the appraisal of Phase II. This resulted in the construction of a water supply system, the sponsoring of permanent housing, an agroforestry program and a livestock development program.

Environmental aspects. The terms of reference of the Feasibility Study required an evaluation of the environmental impact of the project, and possible "methods and feasibility level designs of measures required, if any, to eliminate or minimize undesirable environmental effects" (ADB 1977a, A:A1:4). The Feasibility Study states that "an important difference between the two sanctuaries ala and Weerawila is that the species of bird life are different. The latter are attracted by fish that thrive in the brackish waters of the Bundala Lewaya and other similar lagoons in the sanctuary. It is, therefore, proposed that the Irrigation Department shall take the necessary precaution in the layout of the drainage channel system that effluent water from the irrigable area will not be discharged into the lagoons at such a rate as to reduce their salinity below that required for the flamingos and other bird life there to continue to survive. No extra provision in the estimates is required for that" (ibid., C:XXI:5). How this should be prevented in terms of the Feasibility Level Designs had not been indicated, however.

The Appraisal Report neither accepted this recommendation, nor did it refer to the environmental consequences of the Kirindi Oya project for the bird sanctuaries: "Drainage from the agricultural lands will be diverted around some existing salt solaries in the Bundala Bird Sanctuary by the National Salt Corporation interceptor drains. The natural drainage courses will be sufficient to handle the Project drainage" (ibid., 10). Thus, the salt solaries would be sustained, but the proposed drainage would go straight into the Bundala Bird Sanctuary without any precautions against environmental damage as suggested by the Feasibility Report.

By letting drainage into the Bundala Bird Sanctuary several problems were created within Hambantota District. It was said that about 300 shrimp fishermen were dependent on shrimp cultivation in the lagoons of the sanctuary (Government Agent, personal communication). These shrimp cultures required brackish conditions, and were very vulnerable to pollution. Thus, they were severely threatened by the mass inflow of polluted drainage water. The Government Agent had to intervene on behalf of the fishermen during 1988, and the Irrigation Department had promised to solve this problem.

Interaction with local communities and future beneficiaries. The objectives and requirements of the local community and future settlers were apparently assumed to be in line with the government's broad objectives as

they were not consulted about the proposed project sites and related project objectives. The only reference in this respect was made by the donor's Appraisal Mission which "visited the Project site, conducted field investigations and interviewed farmers and settlers in the Project area" (ADB 1977b, 2).

The donor reports do not mention anything about the opposition to the dam site as for example, that expressed by the local Member of Parliament to one of the early donor missions. This was in spite of the serious implications for the local community of the planned project in Tissamaharama. Two villages and 4,048 ha of developed land were inundated. In addition, they lost land for grazing their cattle, shifting their cultivation and also their irrigated land that came under about 50 small tanks. Moreover, as a consequence of the increased land pressure in the semiarid environment of the system, deforestation increased tremendously and the risks of desertification in the long term were quite large.

For the settlers as beneficiaries of the project, the lack of consultation was partly inevitable, because of their absence during the planning stage of a new construction project like the Kirindi Oya system. Moreover, a lack of match of the envisaged project objectives with their own was, to a certain extent, compensated for by the benefits that they derived from their participation in the project in general; even if the project would eventually become a failure for themselves, they could have still sold the house and land, and were able to make a profit that way.[11]

Achievement of the project objectives adopted by the donor and the government, however, required their participation in certain instances at least. This was demonstrated by the following example: At the time of appraisal of Phase II in 1986, the water availability for the system appeared to be less than that estimated in 1977. For this reason the donor proposed that only subsidiary field crops should be cultivated in the New Areas during the dry season. The different agencies agreed, mainly because the extension of the project by another 4,100 ha and related settlement provisions depended on this assumption. In this instance, the donor again intervened in the

11 This selling of land was not permitted officially, but some cases were noted by IIMI researchers where irrigated land and housing were sold even when no titles for these lands had been distributed at the time.

determination of desirable project objectives, whereby the interaction with the national agencies was less objective in view of their priority for obtaining the loan extension.

The settlers were not consulted about these new system objectives. It is widely known that Sri Lankan farmers prefer to grow rice instead of subsidiary field crops as it is felt that the latter involve, for example, higher cultivation risks, marketing problems and higher labor inputs. An additional reason, which was specific to the Kirindi Oya system, was the fact that many water users were part-time irrigators, who did not live permanently in the area. Rice is a very suitable crop for a part-time cultivator.

Mutual Adaptation of the Technical and Managerial Aspects

It was clear that the objectives of the Kirindi Oya project at the chosen Lunuganwehera site had several characteristics, which were much less desirable and sustainable from the point of view of the local community and the local politicians compared to the alternative Hurathgamuwa site (e.g., speed of implementation, inundation of cultivable land, suitability of soils, required cropping patterns and involved costs). The only positive reasons for the Lunuganwehera site were political interests for quick results, and the engineering prestige the Irrigation Department would achieve by building the longest earth dam in Sri Lanka.

The donor staff and consultants, though aware of this situation, apparently left the determination of these macro-level desirable project and system objectives completely to the national politicians, even if there was strong opposition of the local community, the Ministry of Plan Implementation and the local Member of Parliament. Indeed, the identification of desirable objectives for this type of large irrigation project is decision making of a highly political nature, in which a donor cannot and should not easily intervene.

The lack of consultation with farmers and the local community about, for example, the crops to be grown, water duties and the areas to be commanded had led to system objectives, which were undesirable from their point of view and which might, therefore, be hard to achieve. For example, it had been proven to be impossible in Sri Lanka to force farmers to grow certain varieties

of crops (see for example Jayasekara in a discussion on Uda Walawe in Institution of Engineers 1983,139). In the elaboration of proposed project objectives, the donor did intervene in the decision making about the desirable project objectives. The desirability of these objectives apparently evolved from the necessity to maintain an Economic Internal Rate of Return (EIRR) above 10 percent in 1986, which made the interaction between the donor and the agency staff less objective for assessing the actual desirability.

The desired objectives of the Kirindi Oya project were, to a large extent, determined and fixed at the commencement of the project in 1977. The desired project objectives were specified in terms of the areas to be irrigated, the crops to be grown, water duties, cropping intensities and the number of people to be settled. Their fixed nature evolved from the fact that these desired project objectives underlie the EIRR, which was rather marginal and thus allowed for very little flexibility at later stages. After the water duties, as assumed in 1977, proved to be undesirable and unrealistic at later stages of the project, the directly related desired size of the command area, cropping intensities and the related EIRR could only be attained by assuming it to be desirable and feasible to grow subsidiary field crops during yala season in all New Areas.

Fixing of project objectives in terms of irrigated extents, cropping intensities, water duties and cropping patterns at an early stage seems undesirable in general, especially without an assessment of the sustainability and feasibility of these objectives at the time they are fixed. An EIRR of just above the cutoff (i.e., 10% for the ADB) for a large irrigation investment reduces flexibility and, therefore, seems undesirable. This will be elaborated on in the next chapter.

CHAPTER 8

Strategic Concern: Feasible Objectives for New Construction

MATCHING DESIRED SYSTEM objectives with available resources (e.g., funding for investment, staffing capabilities, future staffing and maintenance budgets) evolves into the determination of feasible objectives for system creation. While the desired system objectives encompassed things like system creation or improvement, cropping patterns, land settlement and system sustainability, the focus in this chapter will narrow down to water related issues. Feasible system objectives are, for example, the area to be commanded by irrigation water at a certain point in time, the different crops to be grown and their cropping intensities, the acceptable cultivation risks, the predicted performance of water delivery, the economic effectiveness and efficiency of an investment, etc.

The feasibility assessment depends, to a large extent, on the assumptions made regarding the expected benefits (e.g., water duties and related irrigable area, crop yields) and available resources (e.g., maintenance funds, water and land resources, quantity and quality of staffing, service fees for cost recovery). These assumptions can be supported by, for example, historical data from similar earlier investments, surveys of the existing benefits and resources, and also by theoretical scientific approximations.

THE DECISION-MAKING PROCESSES

The desired system objectives constituted the starting point for the determination of feasible objectives in building an irrigation system in the Kirindi Oya valley. While the desired system objectives were directly linked to the dam site, because of its crucial importance to all possible project objectives, the feasibility aspects of this dam site will also be discussed in this chapter.

River Basin Development Concept

Technical aspects. The Kirindi Oya system was developed under a *"one-off" river basin development concept*, i.e., as one big reservoir which collects all the runoff from the catchment area and supplies water to the whole irrigation system. To achieve this "one-off" system, the already existing small reservoirs under this new reservoir (except the Ellagala system) were demolished and developed as new irrigable areas. This practice was in contrast to the traditionally applied river basin development concept in Sri Lanka of *"melons on a vine"*, i.e., a cascade of medium-scale and small-scale reservoirs, possibly supported by one or more large reservoirs.

The "one-off" system has the advantage, from a hydraulic engineering point of view, that one reservoir covers a comparatively smaller command area for the volume stored. Thus, the evapotranspiration losses would be less. On the other hand, one big reservoir has the disadvantage that it requires more management inputs from the managing agency to convey and distribute the water to the water users; for intermediate reservoirs the stored water provides for buffers against irregularities in conveyance and distribution. Without such buffers the agency will have to design and construct a more complicated network of canals and control structures for water flow regulation. During the planning and design stages, more detailed and more reliable assumptions have to be made about the water delivery requirements of the water users, and the management inputs and discipline of the water users and the agency staff, to comply with the assumed water delivery performance. Thus, the "one-off" concept considerably increases the managerial complexity of system creation as well as system utilization.

On the other hand, even for a cascade of smaller reservoirs the water users have to be organized and people have to be settled in, which require complex managerial processes (see, for example, Jungeling 1990). However, the managerial complexity of integrating all these different aspects of water management, land settlement and organizing of the water users is determined, to a large extent, by the speed of planning, design, implementation and construction of the system. If, theoretically, more gradual development whether for the "melons on a vine" or the "one-off" system is possible, this managerial complexity could be reduced. For the "one-off" concept, a more gradual development of the command area is often

theoretical indeed, because the investments in a capital-intensive large dam require a fast development of the command area and related benefits to maintain a sufficient Economic Internal Rate of Return (EIRR).

The Irrigation Department seldom faced such managerial problems in the past because the restored (once abandoned) smaller systems were often picked rather eagerly by existing communities. Moreover, some interaction with the local community was achieved through the existing decision-making procedures at district level (Mendis 1988b, 43). However, despite these decision-making procedures at district level such interactions with the local communities did not take place in a recent (i.e., 1979-1986) project to construct 19 small and medium reservoirs upstream of the Badagiriya Reservoir, as described by Jungeling (1990).

An important aspect of the "melons on the vine" reservoirs is their additional value to the community. The intermediate reservoirs were usually restored ancient reservoirs, which had more meaning for the local community than just the provision of irrigation water. Mendis (1977, 55) describes it as follows:

> The tank is the cultural center of the community. It is used for bathing and the bathing time is a significant item in the daily schedule because it gives an opportunity for people to meet each other. The village tank is also a source of food, not only fish but seeds, stems and tubers of aquatic plants. Further the water plants are known to reduce evaporation losses, and may also be used as green manure. During the dry season, the tank bed is de-silted. Some of the silt is used as fertilizer. Clay is sometimes excavated from the tank bed for making pottery, bricks and tiles, In this manner, the tank holds the key to the economic life of the village.

Compared to the "one-off" system, the cascade of reservoirs has another advantage, which is the more dispersed availability of water for drinking and bathing in the command area during the dry intermediate seasons. But the frequent low agricultural productivity is a major disadvantage of the smaller systems.

Under the river basin development concept used by the Irrigation Department, during planning and designing of the Kirindi Oya system, the water resources were considered as a single river basin, as expressed in "A Tentative Plan of Development for the Water Resources of Eight Major River

Basins" of the early 1950s and the consequent Water Resources Map of Ceylon. According to Mendis (1989), this single basin orientation prevented the diversion of excess water resources from the wet zone to the dry zone.

The Southern Area Plan. A Director of the Ministry of Plan Implementation proposed the alternative Hurathgamuwa dam site in the late 1960s, as part of the so-called Southern Area Plan. This site was somewhat upstream of the present dam and envisaged a much smaller reservoir. This smaller reservoir, however, would be fed eventually by a transbasin canal which would supply water from the wet zone to the dry zone throughout the year.

The perceived additional advantages of this Southern Area Plan, which was of the "melons on a vine" type, were the gradual development of the actual command areas and human settlement which would give more time to match the different interests. Moreover, it was argued that irrigation from a number of smaller reservoirs, instead of from one big reservoir, would limit the need for incorporating the upland soils in the command area and save water and fertilizer use and thus foreign exchange. It is a valid argument according to the "Reconnaissance report on the natural resources of the Kirindi Oya basin" of 1957 (quoted in the Feasibility Report of 1977) which, discussing the large proportion of upland soils at the Lunuganwehera site, says "that the Kitulkote and Lunuganwehera sites provided for sufficient flow control to allow for optimum development of the potential water resources but unfortunately did not have sufficient good land near at hand" (ADB 1977a, XXII.6).

Regarding costs, Mendis (1977, 56) argued that "the initial capital investment of each diversion anicut and canal itself will be much less than for a major headworks for a storage reservoir." However, the costs of such a transbasin canal were never investigated in great detail, but were assumed to be very high.

A feasible dam site and related areas to be commanded. In 1957, a first comprehensive resources survey of the Kirindi Oya valley was executed by the Center for Physical Resources Surveys and its consultants. They indicated six possible dam sites, of which two precluded the development of the other sites. The Feasibility Report of 1977 quotes this reconnaissance report:

> It is rarely practical to provide sufficient regulation to ensure complete control of the river's flow, so it is assumed that optimum economic development might approach 80 percent of the mean annual yield. This means that provision should be made to use <204 mcm> of water. Of the six possible developments, Kitulkote, Lunuganwehera, Sudupanawela, Randeniya and Medahenyaya appear to be physically feasible and essentially satisfactory. Either the Kitulkote scheme or the Lunuganwehera scheme appears to be capable of providing sufficient flow control to allow for optimum development of the potential water resource. Unfortunately, neither one commands sufficient good land near at hand. It is possible that either Randeniya or Medahenyaya along with a full Kitulkote development would satisfy the requirements of optimum water utilization (ADB 1977a, XXII.6).

The benefits of these different project options were most probably calculated with a fixed water duty so that the development of the command area depended only on the provision for water storage, but not necessarily on the suitability of the command area for irrigation.

Consequently in 1961 and 1962, the Irrigation Department made proposals for the development of the Kirindi Oya valley. Despite the absence of sufficient good lands near at hand, as mentioned by the reconnaissance report, the Lunuganwehera remained one of the three serious options in these investigations, as it did in 1972 when the Irrigation Department again studied nine possible dam sites and five alternative development plans of which three were considered worthy of a detailed study.

After 1972, the Irrigation Department and the government made a definite decision to select the Lunuganwehera site. During the feasibility and appraisal studies of the donor in 1976 and 1977, this dam site was reconfirmed while only limited information was available on several key aspects that were inevitable for taking this decision.

The reliable investigation reports available were limited and they "guaranteed" that enough runoff would be available (Dharmasena 1986, 11),

and good soils were available for irrigated agriculture as well as for construction of the dam (Munasinghe 1986, 58).[12]

Managerial aspects. The discussion of system development concepts has not been extensive and intensive among Sri Lankan engineers. Kennedy (1933) argued that because the small village reservoirs were too numerous to be efficient, they should be replaced by one large reservoir that would store water more efficiently and economically.

However, he warned that "science must recognize, of course, that the traditional preservation of redundant tanks is, at least in part, due to the other conveniences that they confer on the villages besides that of efficient storage of irrigation. In any case, anything like high-handed interference with the traditional rights would be a calamitous blow to all hopes of cooperative progress" (ibid., 251).

Mendis (1988a) claims that for at least 24 years after its publication in 1933, Kennedy's paper had much influence on the interpretation and understanding of the evolution and development of ancient irrigation systems in Sri Lanka, especially among irrigation engineers. However, he argues that unfortunately the irrigation engineers picked only the hydrological and hydraulic aspects of Kennedy's remarks and highlighted the undeniable fact that the small village reservoir was, in that respect, inefficient for crop production compared to the large storage reservoir. Mendis adds:

> their arithmetic was correct, but little else besides. This unfortunate one-dimensional perspective on a multi-faceted problem led to the conclusion, in the minds of many of these engineers, that the small reservoir was a "stage" in the evolution and development of irrigation systems and that all small reservoirs should eventually be replaced by large storage reservoirs. Although this was a distortion of what Kennedy had said, it was held that this dogma originated from Kennedy, when it became part of a new paradigm in the years to come in the Irrigation Department (ibid., 2).

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12 "No geological aspects of the sites proposed for the construction of the reservoirs had been included in these studies" (Munasinghe 1986, 58). During construction of the dam, it led to enormous increases in cost.

Kennedy advocated the replacement of some small reservoirs in the Gal Oya River Basin by a large reservoir, which was according to Mendis (1977, 54) "a logical step in the systematic development of this region in modern times, since the heavy capital investment necessary for construction of the head- works could bring almost immediate returns from increased production in the existing irrigated area. In this respect, this project followed the logic of the step by step development of the ancient irrigation system," whereby the drought resistance of the system as a whole is increased by the support of the larger reservoir.

The Uda Walawe system was the first to be developed under the "one-off" river basin development concept which omits the reuse of drainage water in the design. Mendis describes the introduction of this concept as supported by the transfer of technology from the outside world. It is true that all major construction in Uda Walawe, Mahaweli and other systems was financed with loans from foreign donors. The increased control over the water delivery and the use of consultants for design and water management have always been conditions for these loans. This external influence has reinforced, directly and indirectly, the present one-dimensional orientation of the system development concept of the irrigation engineers.

As is typical of irrigation engineers, the discussion on their professionality in this respect was initiated and kept alive by one of the few engineers, D.L.O. Mendis, employed outside the big engineering organizations of Sri Lanka. Moore (1980b, 100) states that:

> Irrigation Engineers comprise part of a civil engineering profession which, by virtue of a relatively homogeneous social background and common educational experience, comprises a relatively distinct social group with a strong sense of identity. The behavior and attitudes of Engineers are strongly influenced by professional colleagues and a reputation for professional expertise is a source of group esteem.

Individual engineers do not like to publicly criticize this professionality and endanger the "untouched" status of their profession. As a result, the opinions of Mendis about the one-dimensional river basin and system development concepts are unchallenged by the engineers but, at the same time, neglected (see, for example, the Annual Transactions of the Institution of Engineers, Sri Lanka).

This lack of discussion of system development concepts has two contrasting consequences. One is the high esteem of the Sri Lankan society for the construction capabilities of irrigation engineers. The other is the negative reputation attributed by many irrigation engineers themselves as well as by different parts of the Sri Lankan society, to the construction bias of the engineers and the operation of the irrigation systems.

The Southern Area Plan, dam site and related areas to be commanded. The major decision to be taken regarding the dam site of the main reservoir was whether or not the site of this reservoir had to be adapted to the larger Southern Area Plan. The decision-making processes of the desirability of the dam site and Southern Area Plan will be described in Chapter 11. The decision making regarding the feasibility of the plan and the chosen dam site is described below:

The Asian Development Bank (ADB) Feasibility Report of 1977 referred to this plan and stated that the final option proposed in the Feasibility Report should be considered an intermediate solution within the framework of the Southern Area Plan (ADB 1977b, XII.1). However, in the report, only the options for a dam site below Lunuganwehera were considered. It also included the decision making about a feasible dam site preceding the Feasibility Report. It reported on a study by the Irrigation Department in 1972 which concluded that the highest benefits would be received from a Plan B which involved the construction of two reservoirs, Lunuganwehera of 111 mcm in the lower Kirindi Oya valley and Medaheyaya of 43 mcm in the Uda Oya valley:

> However, Plan B would only receive 10 percent more benefits than Plan EI, and would cost 50 percent more. Therefore, Plan EI was considered to be the most attractive of the three plans. Plan EI would involve the construction of a 147 mcm reservoir at Kitulkotte, two miles below the confluence of the Kirindi Oya and Uda Oyas. The third plan was plan D, which involves the construction of a 200 mcm reservoir at Lunuganwehera. The report concluded that Plan D would costs Rs 65 million, that is Rs 15 million more than Plan EI. The disadvantage of Plan D is that the irrigation development of new lands that this plan would permit would be only <6072 ha> (net) of new irrigable areas, although the annual irrigation potential, with a very large catchment of this reservoir site, would be fairly high, namely <7661 crop ha> per annum,

in 75 years out of every hundred, that is a little more than that of Plan EI (ADB 1977a, XXII.7).

Despite this recommendation to implement Plan EI and the negative remarks about the suitability of the command area of the Lunuganwehera site (in the Reconnaissance Report of 1957; quoted in the Feasibility Report), the Irrigation Department finally chose Plan D in 1977. The Feasibility Report lists the reasons for this choice:

i) The Government desires to obtain the earliest return on their investment. This can be achieved by rehabilitating existing systems and providing supplementary water so that the lands may be cultivated to their full potential. This provides a much faster increase in return than in a new development area that may take ten years to realize its full potential;

ii) The Lunuganwehera site is the lowest possible dam site on the Kirindi Oya. Therefore, the project will require the shortest possible canals to reach the existing paddy development;

iii) The Lunuganwehera site does not require relocation of seven to ten miles of road, that the other sites would; although one mile of road will have to be raised slightly;

iv) Two villages, two tanks, <34 ha> of paddy land, and <228 ha> of private chena land will be inundated but this is not as much developed area as some of the other reservoirs would cover. Of the <3441 ha> to be flooded by the reservoir most of the land is undeveloped crown jungle which would have to be cleared and leveled before it could be cultivated;

v) The Lunuganwehera site is the most downstream dam site on the Kirindi Oya and, thus, provides the highest development of the basin's water resources (ibid., XXII.9).

These arguments did not reflect the real options available at the time and, moreover, many of the arguments listed above were not valid. This will be demonstrated hereafter.

The first argument was independent of the reservoir site as the water supply to the Old Areas would continue through the Ellagala anicut in the Kirindi Oya River. Supplementary irrigation to that system could be

controlled from any of the proposed reservoirs, because all options would improve the river flow regulation.

The second argument was, in practice, also valid for all options as the command areas of other reservoirs would have been different. The Ellagala system that existed did not need a separate canal, while the Badagiriya system could have been commanded with a cheap single bank canal for the Hurathgamuwa option as well. In addition, such a canal would have collected runoff.

The third argument seemed to be of minor importance and it could have been incorporated in a comparison of the EIRR of the different options.

The fourth argument did not mention the pre-project occupancy of the command areas of the different options. The Feasibility Report mentioned that 3,400 ha of low-productive lands existed in the command area. It might be true, but the command area of the Lunuganwehera site was considered very good chena land and many chena cultivators originating from the wet zone were cultivating in the area. The argument that the soils in the command area of the Lunuganwehera Reservoir were unsuitable for irrigation as given in the Reconnaissance Report of 1957 was not referred to. Neither was the fact that the Lunuganwehera Reservoir inundated 5,048 ha of cultivated lowlands, which would have been more fit for rice cultivation than the chosen command area. In contrast, the Hurathgamuwa site would have inundated only land unsuitable for cultivation. Moreover, from that site only one main canal would have been necessary for supplying 2,834 ha of new land.

The fifth argument that the Lunuganwehera site aimed at the highest development of the basin's water resources implied that only a "one-off" concept would be able to do so, which was not necessarily true if arguments other than hydraulic engineering were also considered. Moreover, the highest development was not necessarily cost-efficient. One single large reservoir might have efficiently stored the annual inflow, but considering the extra costs and losses involved due to the managerial complexity of planning and implementation of design, construction, water allocation, water flow regulation and land-settlement processes, it would have been an undesirable and unfeasible option.

The reasons listed in the Feasibility Report did not refer anymore to the argument in 1972 that the Lunuganwehera site would have commanded

6,072 ha only, which was apparently less than the other options, but also less than its theoretical annual irrigation potential of 7,662 ha.

Thus, in the first chapter of the Engineering section of the Feasibility Report, all the arguments against the Lunuganwehera site were listed by the donor consultants. Then, they had given the context of the Southern Area Plan — they have not explicitly referred to the dispute about the Lunuganwehera site in this respect — and listed the reasons why the government opted for Lunuganwehera. However, while showing the inconsistency of building the 30 percent more expensive Lunuganwehera option for a command area with less suitable soils, this choice was left undisputed by the consultants in the Feasibility Report (ADB 1977a, XXII.9). Not a word has been said in favor of, or against the site chosen, which suggests that they disagreed with the selected site given the listing of the inconsistencies in that choice. Anyway, the terms of reference of the consultants did not provide for selection of the dam site because the choice of Lunuganwehera was already fixed (ibid., A. A1.3).

No references were made to the risks of cost overruns in view of the inexperience of the Irrigation Department to build such a large dam on a clayey surface. Yet, the risk for cost overruns was already notified at that time by the then local Member of Parliament: "they will be spending more on this because such a big dam is built on lowland" (Edirisuriya 1978). The huge cost overruns of the construction of KOISP were to a large extent due to problems of the foundation of the dam.

Apparently, during the feasibility stage the donor did not want to study the feasibility of possible alternative sites or the acceptability to the local community, as was described in the previous chapter. The donor left this to the responsibility of the politicians and the government, despite the obvious influence of this choice on the feasibility and despite the rather meager feasibility of a project at the Lunuganwehera site in terms of the EIRR and related assumptions. The feasibility of the option to reuse water in a cascade of reservoirs, which might have decreased the managerial complexity, and increased the water efficiency and related benefits — including the restriction of irrigation to the more suitable lowland areas — was thus not considered, because it was considered a political decision to omit the alternative option for the dam site. The logic of an improved quality of

implementation through more gradual development, as argued by Mendis, was not considered either.

During the preparation phase of this decision making, the Irrigation Department and the consultants judged the benefits of the alternative dam sites mainly on their respective capacities to store the mean annual yield, i.e., an argument based purely on hydraulic engineering. The final decision was dominated mainly by the political priority for quick and visible results and the ambition the engineers had to the building of the longest earth dam in Sri Lanka.

Available Water Resources

The reservoir capacity, annual regulated water resources and potential command area are determined by the available annual water resources and the distribution of water over the year.

Technical aspects. The Feasibility Report of 1977 assessed the average annual inflow into the reservoir at 393 mcm. The Feasibility Report states (at the end of the volume on Engineering) that:

> in the final phase of the feasibility study an error was found in the computer printout of the reservoir yield study. The correction resulted in about 30 percent more water than first thought. Therefore, it is recommended that the size of the reservoir be decreased to full supply level <56.3 m or 55.2 m> or, more desirable, that the extent of the service area be increased (Case III)....Because of the time constraint and the lack of mapping in the proposed extension areas, it was only possible to make a rough estimate of construction costs for Case III, based on pro-rata distribution of Case II costs. It has been recommended to the Irrigation Department that they initiate the investigations necessary to substantiate or expand Case III <i.e., 12934 ha> (ADB 1977a, XXIX.10).

It was not clear in this report whether the earlier assessed average annual inflow of 393 mcm should have been increased by 30 percent or not.

However, this value was adopted by the Appraisal Report of 1977 as the available water resources for the Kirindi Oya project. The hydrological data used for the feasibility assessment were compiled by the Irrigation Department, and adopted by the donor consultants. The data were not

reviewed and evaluated by them; no checks were made about the reliability of these data. The fact that the 393 mcm represented the 50 percent dependable annual inflow, which would have led to a shortage every other year was not explicitly stated in the report. Only the unit hydrograph, which included the flood characteristics of the Kirindi Oya River, was reviewed by the donor consultants.

Since then, the Irrigation Department itself reassessed the inflow twice. Once, at a seminar in 1986 about the construction of the Kirindi Oya system when the Hydrology Division assessed the average (or 50 percent dependable) annual inflow at 384 mcm and the 75 percent dependable annual inflow at 241 mcm (Dharmasena 1986). It reassessed the inflow after newspaper articles appeared criticizing the Irrigation Department over the site chosen for the dam and the water availability in Kirindi Oya (Abeynayake 1988; Edirisuriya 1988). The second time, a more serious evaluation and review led to the conclusion that the originally used historical inflow data were apparently not very reliable, and that the inflow was probably overestimated at that time by 40-60 percent; the correct assessments should have been a 50 percent dependable flow of 346 mcm and a 75 percent dependable flow of 240 mcm (Dharmasena 1988, 70). An IIMI analysis confirmed these findings and concluded — "on a conservative side" — the overestimation was at least 30-40 percent (IIMI 1990, 15).

The annual inflow into the Ellagala system from its own catchment area was not incorporated into all these assessments. Such data were not available or even being collected at that time.

Managerial aspects. Overall, it could be concluded that the assessment of the available water resources (i.e., the basic input for the whole project) for the Kirindi Oya system has been done in a rather nonchalant way; the Irrigation Department itself and the donor have not paid sufficient attention to this assessment. Neither the Irrigation Department nor the donor has developed requirements for the assessment of the reliability of the water resources available to irrigation systems and thus for the assessment of the chances of successful cultivation. A planned water shortage every other year seemed unacceptable.

Feasible Irrigation Requirements, Command Area, and Water Delivery Concept

The determination of a feasible reservoir capacity and dam height has to be preceded by the assessment of the feasible irrigation requirements and the command area. These requirements were established several times for feasibility and appraisal purposes in the Kirindi Oya system.

Technical aspects. The Feasibility Report of 1977 assumed ex-sluice requirements of 1,402 mm and 1,676 mm for maha and yala seasons, respectively, for the cultivation of rice and of 1,402 mm per year for cotton. Cotton was envisaged to be cultivated in part of the command area (ADB 1977a, XXIII.15). In the Appraisal Report of 1977, which accepted a system with a command area of 12,934 ha, the total annual diversion requirement was 209 mcm or a water duty of 1,616 mm (ibid., XXIII.31).

The Appraisal Report of 1977 assumed ex-sluice requirements of 1,244 mm and 1,289 mm for maha and yala seasons. For subsidiary field crops, ex-sluice requirement of 1,137 mm and 432 mm were assumed for maha and yala seasons, respectively. With a total field requirement of 268 mcm, and estimated 43 percent conveyance losses, a total annual diversion requirement of 383 mcm was assumed for an envisaged command area of 12,934 ha, or a water duty of 2,961 mm (ADB 1977b, 64).

In the Appraisal Report of 1982, the respective assumptions were 1,006 mm and 1,250 mm for the whole area including all losses, and assuming the cultivation of subsidiary field crops during yala in all newly irrigated areas. The diversion requirement was assumed to be 194 mcm for an envisaged command area of 13,014 ha, corresponding to a water duty of 1,490 mm (ADB 1982, 105).

The Appraisal Report of 1986 assumed requirements of 1,645 mm and 2,042 mm for rice and 1,128 mm and 1,341 mm for subsidiary field crops, respectively, for maha and yala, assuming the cultivation of subsidiary field crops during yala in all newly irrigated areas. The diversion requirement was 297 mcm for an envisaged command area of 12,800 ha, or a water duty of 2,320 mm (ADB 1986, 68).

These estimates were rather optimistic compared to average water duties achieved in Sri Lanka. One possible performance indicator was the average ex-sluice water duty of 2,290 mm per season or 4,580 mm for double

cropping, used in Sri Lanka by the Irrigation Department for the design of village reservoirs (usually designed for one cultivation per year only). Of course, these water duties were not necessarily comparable, but these standards, or any other standard of Sri Lankan practice or performance could have been used as a standard for comparison to judge the validity of the theoretical calculations. The traditional method of fixing the water duty on the basis of a gross overall duty without considering the theoretical water requirements was quite different, because this gross water duty of 2,290 mm used as a standard by the Irrigation Department has evolved from the Irrigation Department's own experience in system utilization. The use of the theoretical calculations to determine the irrigation requirements was introduced for the design of major irrigation systems.

Other estimates of average irrigation requirements for Sri Lanka that could be used as standards for comparison with the above theoretical estimates were: 1,830 mm in maha and 2,440 mm in yala, or an annual total of 4,270 mm as quoted from Chambers (1978, 64) and World Bank in Cabinet Memorandum (1978) by Moore (1980a, 42); and the standards of 1,530 mm for maha and 2,290 mm for yala or an annual total of 3,820 mm given by Farmer (1957, 184). Edirisuriya mentions that for the dry zone a water depth of 3,050 mm per season or 6,100 mm for double cropping, was required for successful cultivation (Edirisuriya 1988).

All the estimates by the Irrigation Department and the donor staff and consultants through theoretical calculations were rather optimistic compared to the actual average water duties in Sri Lanka, and thus gave more credit to the project as a whole than could be reasonably assumed. The problem of effectively introducing subsidiary field crops in irrigation systems should have given more reasons for accurately assessing the risks involved in this assumption. Apart from the cropping patterns, it is in general more difficult to estimate future irrigation requirements in a new settlement system where no historical information was available. On the other hand, it should not be difficult to establish a gross water duty for a region or country from the actual performance of other irrigation systems.

The traditional design and water delivery concepts in Sri Lanka focused on least-cost construction that provided for little control over water flow. Instead of designing for flexibility in the main system, the systems were designed for invariable on-off water flow to subsystems. This lack of control

mattered less, because of the frequent reuse of water further downstream and the often available intermediate storages. Use of water by the water users in these systems was uncontrolled; but since the design focused on the reuse of drainage water within the system, through single bank contour canals, intermediate reservoirs, etc., the actual water use efficiency was often difficult to judge accurately.

The aforementioned optimistic water duties assumed for the Kirindi Oya system were justified by adopting a water delivery concept in the designs which provided for more control and allowed for variable flows in the canals giving the ability to respond to varying demands from subsystems. This comparatively new water delivery concept was considered a "scientific and modern approach" (e.g., Pemasena 1986, 170). However, it was, at the same time, more expensive because it incorporated large numbers of control structures and measuring structures, more discharge capacity of the canals, double banked canals, etc., during construction, and required more management inputs during system utilization.

Although records of gross water duties achieved in systems with a similar water delivery concept in Sri Lanka (e.g., Uda Walawe) and in other countries were available, such information was not used to judge the accuracy of the theoretical water requirement estimates, or at least to judge the risks involved. Chapters 3 to 5 have demonstrated that the increased management input in the Kirindi Oya system upto that time was limited to the level of the gate tenders and it could be assumed that this had been the case in other Sri Lankan systems with a similar design concept as well. Thus, the change from a cascade of small reservoirs to the more capital-intensive "one-off" system with the related scientific downstream development is based on hydraulic engineering and agronomic assumptions only. It has not yet been proved by research results or otherwise that this "one-off" system is more efficient in water use. Feasibility in terms of cost-effectiveness and sustainability of this new concept is not yet proven.

The Appraisal Report of 1977 acknowledged the water management problems in the Uda Walawe system, but blamed this on the lack of water management training (ADB 1977b, 53). Later in 1982, an Appraisal Report stated that:

> experiences gained from other irrigation schemes, particularly the Gal Oya and Walawe projects, have been taken into account in the design of project components — agricultural extension, research and training components have been designed to help farmers to adjust to the new practices, while water management, both within the system as a whole and on-farm, will be given particular attention. Adequate consultant services have been provided to assist in the formulation of a sound water management plan, the preparation of a comprehensive operation and maintenance manual and the establishment of a proper operation and maintenance organization so as to obviate the risk associated with inefficient irrigation management (ADB 1982, 46).

However, training on on-farm water management practices would not cope with the lack of management input of the agency for a better water delivery performance. Therefore, the donor added the following specific requirements for the Kirindi Oya system: "Prior to June 1984, Irrigation Department with assistance of the water management specialist and irrigation agronomist consultant, will prepare a water management plan for the project area based on a 24-hour/day supply system on a rotational basis with water issues designed to grow paddy under (i) intermittent irrigation method in the upland soils; and (ii) continuous submergence of irrigation in the lowland soils. This plan will also include water issue schedules for subsidiary crops to be grown under furrow basin irrigation" (ibid., 39). No mention is made that despite the availability of a similar plan for the Uda Walawe system, these measures were not implemented at the time.

The Appraisal Report acknowledged, however, that risks were involved despite the above requirements and provisions: "Success in this method of irrigation <i.e., the rotational delivery> will depend entirely on the efficient management of the system and strict discipline among the farmers to comply with the water distribution system designed for their farms" (ibid., 77).

The influence of consultants on these processes was limited, as shown in Chapters 3 to 5. An operation and maintenance manual prescribed the ideal utilization of the system; it was left to the judgement of the consultants to infer what was meant by "ideal". The consultant had to prescribe how the

system could be utilized 100 percent, while he and his counterparts knew that it was not feasible.[13]

Managerial aspects. The estimated ex-sluice water duties for the cultivation of rice given in the Feasibility Report of 1977 and the Appraisal Reports of 1977 and 1986 were respectively, 61 percent, 54 percent and 72 percent of the average duties used by the Irrigation Department for village reservoirs. More optimism was shown when the influence of the cultivation of subsidiary field crops on the water duties was considered, and the estimated ex-sluice water duties given in the Feasibility Report of 1977, and Appraisal Reports of 1977, 1982 and 1986, were respectively, 35 percent, 65 percent, 33 percent and 51 percent of the Irrigation Department's gross design duties for village reservoirs. The variations between these sequential assessments were 86 percent, 97 percent and 56 percent, respectively. It also meant that the assumed benefits of a project could vary roughly within this range through the present method of assessment of feasible project objectives.

These estimates of feasible water duties led to the conclusion that, for the Kirindi Oya system cropping intensities of 170 percent to 200 percent could be achieved on 12,900 ha. However, with the presently realized ex-sluice water duty of approximately 2,134 to 2,438 mm per season, a cropping intensity of 200 percent could be achieved in an area of 4,827 to 5,623 ha only with the 75 percent dependable annual yield of the catchment area. It meant that apart from the existing 4,860 ha of the Ellagala system, no new lands could have been provided with irrigation water for a cropping intensity of 200 percent; or, in the best case, only 763 ha (e.g., the Badagiriya system) instead of 8,300 ha. Clearly, there were some serious flaws in the then prevalent way of assessing the feasible system objectives.

The assumptions made regarding the water duty of a proposed system have a major impact on its economic feasibility. Despite this importance large variations occurred in the assessments by the Irrigation Department, individual consultants and the donor staff. Between the four studied reports a variation of almost 100 percent (i.e., between 1,490 mm and 2,961 mm)

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13 It is similar to accepting the specification of a manufacturer that the machine you are buying performs at 100 percent efficiency in order to justify the acquisition while the buyer and seller know that it performs at 60 percent efficiency.

has been observed. This had an enormous impact on the feasibility of the project as a whole. The feasible water duties in the reports were established by means of the guidelines for calculation of the theoretical water requirements as given by FAO (Doorenbos and Pruitt 1977). In general, these calculations were theoretically sound and did not leave much room for discussion, except for the consideration of losses and the effective use of rainfall. For example, the estimates of effective rainfall in the reports (mostly around 80%) were often rather optimistic, considering the absence of any operational practices to use rainfall effectively.

However, the feasibility of these theoretical estimates were not assessed at all in view of the established or achieved water duties in the Sri Lankan context. Instead, the increased number of control structures and related design features were considered to justify the assumption that the water delivery performance would be greatly improved compared to the traditional systems with less water control provisions. References to average water duties reported in a region or a country to justify the feasibility of the assumed water duties are apparently not a requirement for either the donor or the Irrigation Department staff. With such large variations in water duties in the different assessments, the corresponding variations in feasible command area, cropping intensities and economic feasibility follow automatically.

The absence of such requirements also allows the possible manipulation of the project benefits to make a project feasible in terms of the EIRR instead of really assessing feasible project objectives. An example of a less objective approach toward assuming feasible water duties and cropping patterns is demonstrated by the following remarks in the Feasibility Report of 1977: "The <6473 ha> of new land (Case II) was adopted by the Irrigation Department because it fitted their projected cropping pattern and their estimated yield from the reservoir. However, the consultants have recommended that more acres be considered as upland, and that the upland be planted to cotton. This change in the <Irrigation Department's> scheme results in lower crop water requirements" (ADB 1977a, XXIX.10). Thus, in this case, even the soil classification was adapted to make the project feasible in terms of the EIRR.

Manipulation of the projected benefits appeared to have occurred in the appraisal study of 1982 also, where the assumed water duty was only 1,409 mm for two seasons. In this case, the donor mission faced difficulties in

raising the EIRR above 3 percent: "The revised crop water requirements and adoption of 24-hour rotational basis for irrigation supplies instead of 12-hour basis originally adopted resulted in reduction in the canal design discharge capacities" (ADB 1982, 91). The actual feasibility of the 24-hour rotation and revised crop water requirements in view of the existing practices of the Irrigation Department and the water users were never discussed.

In view of such manipulations, the reliance on the EIRR to establish the actual feasibility of the adopted project objectives became quite dangerous. The assessment of the feasibility of a project is, in general, of more concern to the donor than to the Irrigation Department, the government and the responsible politicians; the concern of the Sri Lankan side was more the acquisition of the foreign funding for a project already perceived desirable, rather than a particular project's actual feasibility, whether in terms of the EIRR or otherwise. To that end, the government and the agency staff delivered the inputs and data required during project preparation to make the project feasible in terms of the EIRR.

Once the plans for the Kirindi Oya system had been finalized and the project started, in 1977, cost overruns appeared and the project had to be reappraised. Only at that stage did the donor staff become really concerned about the feasibility of its assumptions and the risks of cost overruns, as they had become personally responsible at that time for the continuing feasibility of the project till the time of project completion.

The optimistic water duties used relied heavily on a "scientific" design concept, which provide for more facilities for control over water flows. However, this envisaged improved control and related water delivery performance were not achieved in actual practice. Such disappointing results have not led to discussions within the Irrigation Department or the donor about possible remedies, other than the training of farmers and provision of enough operation and maintenance funds. For both parties the basic water delivery concept seemed sufficiently sound in terms of arguments based on hydraulic engineering. The donor staff was apparently somewhat unfamiliar with the causes of the related managerial problems. They tended to emphasize and even pressurize the Irrigation Department to provide physical facilities to increase control over water flow in its systems. The following is an example of the rationale of the donor staff:

> The review also led to the adoption of the double bank full trapezoidal section for the main canals instead of single bank partial trapezoidal section originally envisaged. Thus, removing the major cause of poor hydraulic performance of the canal and low irrigation efficiency experienced with the traditional single bank canals such as those constructed under the Walawe Development Project....For adequate water management, additional cross-regulators were provided (ADB 1982, 91).

This decision of the donor was apparently forced on the Irrigation Department, because the staff of the latter favored the single bank canal. The Irrigation Department seemed to have been less convinced about the necessity of more physical facilities for potential control of water flow as a major solution to poor hydraulic and managerial performance and low irrigation efficiency. At the insistence of the donor they had to adopt the more expensive double bank canal without much resistance.

Technical solutions as double bank canals, cross-regulators, measuring structures, training of farmers, the formulation of a sound water management plan, and more operation and maintenance funds are all arguments that can be used by both parties as reasons to support expectations that the performance of the Kirindi Oya system would be better than earlier disappointments. For the Kirindi Oya system, these solutions were, however, more a part of a ritual to be followed by both parties to justify the investments, rather than those the donor and the Irrigation Department staff really believed in, to remedy the managerial constraints. Provision of control facilities did not solve the major constraint of lack of motivation and willingness of the Irrigation Department staff to increase its management inputs for improved water delivery performance; rather it increased the demands for such management inputs.

A Feasible Reservoir Capacity and Full Reservoir Level

Due to their important influence on the total project costs the reservoir capacity and full reservoir level were vital feasibility parameters for the Kirindi Oya project.

Technical aspects. Determination of a feasible reservoir capacity took place by means of operational studies and flood routing. The first operational

study was a part of the feasibility study. The irrigation requirements used were those given in the above section. The operational studies were done for three different full reservoir levels, 55.17 m, 56.39 m and 57.60 m above mean sea level, of which the most successful was the study with the highest reservoir level. Successful operation was determined as follows: "If during any six-month season, the total shortfall exceed <1.85 mcm>, the crop was deemed to be a failure for the season" (ADB 1977a, XXIII.20). This 1.85 mcm corresponded to 15.4 mm for the six months, which seemed a little low for the calculation of the irrigation requirements and available supply on a monthly basis. For unspecified reasons further raising of the full reservoir level was not considered.

Flood routing was simulated for the same three full reservoir levels. "Flood routing was first performed for a full supply level (i.e., normal pool level) of <57.60 m> above mean sea level by employing the elevation versus capacity and elevation versus surface area relationships for the reservoir, for various spillway widths" (ADB 1977a, XXIII.13).

The resulting optimum full reservoir levels were consequently tested for their economic feasibility for three sizes of command areas each. The three options of the full reservoir level were the more attractive (ibid, XXX.1). For the other two full reservoir levels, the options had a higher EIRR, but increased risks of crop failures. Neither these calculations, nor the other criteria used for determining this attractiveness are given in the Feasibility Report of 1977; it could be assumed that the lower dam heights would irrigate a smaller command area with comparatively more reduction in benefits than in costs, while the higher dam height would have resulted in a marginal increase in annual irrigation potential, and relatively higher increased costs.

A consulting firm involved in the design of the headworks carried out the operational study for the finally adopted full reservoir level of 58.2 m. Its monthly determination of storage in the reservoir led to a level of success of 85 percent for maha and 76 percent of yala. The criteria for success used in this operational study were not clear, however (WAPCOS 1986, III.39).

In 1986, the Irrigation Department was requested to conduct another operational study to determine the storage at ten-day intervals instead of monthly intervals. This enabled a more accurate calculation of the risk of crop failure. "Of the total 1224 time steps...the reservoir became empty 137 times and spilled 100 times" (Dharmasena 1986, 14). The number of

resulting crop failures has not been mentioned. Neither had it been stressed that every three years the reservoir would be empty till October and every four years till mid-October, which severely stressed the seasonal allocation planning processes during the system utilization.

Managerial aspects. The determination of the feasible height of the reservoir dam is based on hydraulic engineering arguments only. The criteria for determining a crop failure were often not given in the assessments. The Irrigation Department and the donor had apparently not developed standard practices and criteria for this important study, which determined the required height of the dam and thus of the major cost factor of the whole project. Only after the first drought seasons occurred, did the donor request an operational study that really tried to assess crop failures, i.e., a study determining storage at ten-day intervals.

Other managerial consequences that could be derived from the operational study and that influenced the feasibility of the envisaged cropping patterns and water duties, like an empty reservoir at the time of the preferred start of the maha season (i.e., August or September), which was frequent, were not recognized explicitly.

The height of the dam has been determined for the predetermined irrigation requirements without incorporating the desirability and feasibility of irrigating a large proportion of uplands and the costs involved. It would not have been difficult to consider these different aspects in an integrated perspective rather than in a completely separate perspective. The preferences and interests of the local community and the Department of Agriculture could also have been considered in this respect.

The "one-off" concept of a dam at the downstream part of a catchment apparently requires storage of the largest quantity of water possible without considering other options. Other dimensions like the reduction of the proportion of the less suitable upland soils, or the potential increases of the water delivery performance of the system (because of such a changed proportion), or the reduced fertilizer use (because of such a changed proportion), or the increase in the limited land available for land settlement in the present layout or the number of people that have to be resettled for a larger reservoir area, and the economic and social costs involved were not considered in this determination of the optimum dam height.

If the abovementioned dimensions were taken into consideration instead of only hydraulic engineering factors and perceived acceptable cultivation risks, the choice for a lower and cheaper dam would have been seen as more feasible.

Feasible Cultivation Calendars, Cropping Patterns and Intensities, and Yields

Some other factors that directly influence the assumed feasible water duties and related command areas are the assumed cropping patterns, cultivation calendars and cropping intensities. Apart from their importance for these assumptions, cropping intensities, cultivation calendars and cropping patterns have a major influence on the economic feasibility assessment, because they are the major outputs of an irrigation system.

Technical aspects. The Feasibility Report of 1977 envisaged an increase of the cropping intensity from 78 percent to 200 percent for the recommended total command area of 10,103 ha. It envisaged the cultivation of rice in 3,553 ha of the Old Areas, 2,326 ha of New Areas, and cotton and other subsidiary field crops in 4,224 ha of uplands. Yields of 4.6 ton/ha were assumed for rough rice.

Justification of the cropping patterns was as follows: First, the land classification and soil suitability were considered: "These <upland> soils can be considered as best suited for varied agricultural development" (ADB 1977a, VIII.3). "It is recommended that the selection of crops to be cultivated in the project area be governed by the economic needs of the country.....In consideration therefore of the above economic situations and furthermore, taking into account the present state of technology in these crops, their yield potentials, farmer's acceptance and experience" the report recommends the aforementioned cropping pattern (ibid., IX.9).

The reference made to the acceptability or feasibility in introducing subsidiary field crops in irrigated areas in Sri Lanka was incorrect, at least in the short and medium terms. Marketing of subsidiary field crops, except cotton, was considered to be done through local markets. However, this could have been quite problematic in Sri Lanka given the volatility of the prices for these products; the absorption capacity for large extra quantities of produce suddenly coming to market was rather limited. In general, the

introduction of subsidiary field crops in irrigation systems in Sri Lanka had been quite problematic, as had been experienced by the donor in the Uda Walawe system before: "The recommended cropping pattern appeared to have been totally neglected by the settlers" (ADB 1979, 50). For example, cotton cultivation did not succeed in the Uda Walawe system.

Furthermore, the assumed 200 percent cropping intensity was incorrect, because the operational studies showed success rates of around 90 percent, which corresponded to a cropping intensity of approximately 180 percent only. It meant that the benefits of the project were overestimated by 10 percent. The yields were justified as follows: "New varieties of paddy, improved cultural practices and adequate inputs of fertilizer, herbicides and insecticides will be combined with dependable irrigation to bring about the expected benefits" (ibid., XXXI.1). "Achievement of the yields depended on the availability of high yielding crop varieties, fertilizers, pesticides and tractors" (ibid., IX.12).

The Appraisal Report of 1977 envisaged an increase of the cropping intensity from 85 percent to 189 percent for the envisaged command area of 12,934 ha (i.e., including Badagiriya). The cropped area[14] was 14,856 ha for rice, 5,169 ha for other cereals, and 4,404 ha for cotton. Yield estimates were 4.0 ton/ha for rice, and 2.0 ton/ha for cotton.

Justification of the cropping pattern was not given. Cotton was chosen, because of macroeconomic priority for import substitution and "the production environment is so similar to that prevailing in the adjacent Walawe Project area that cotton production is deemed to be technically feasible thereat as well" (ADB 1977b, 67).

The yield estimates for rice were the yields that were reached under research station conditions at that time (ADB 1977b, 11). The average yield of rice in the Old Areas at that time was 2.4 ton/ha per season. "... Increased yield is considered attainable in view of the current productivity of

4.0 m.t/ha per season obtained by farmers using improved practices in the project area" (ibid., 20). "To achieve the target, demonstration of new techniques of water management will be essential to the farmers and

14 The total of the areas cultivated during maha and yala seasons.

provision is made for this activity under the Project" (ibid.). Extension facilities and demonstration programs were envisaged.

In the Appraisal Report of 1982 for Phase I, the cropping intensity in the existing areas (including Badagiriya) was assumed to increase from 139 percent (i.e., 94 percent in maha and 45 percent in yala) to 200 percent, because the water availability was assured for these areas. "With adequate water supply, improved on-farm water management practices and increased inputs, mainly in the forms of improved seeds and fertilizers paddy yields are expected to increase from the present 3.2 t/ha to 4.5 t/ha in the maha crop and 3.0 t/ha to 4.8 t/ha in the yala crop" (ADB 1982, 73). Attainment of full yields is assumed to be reached in seven cropping seasons (i.e., 3.5 years) after the completion of the rehabilitation of the existing areas.

For the New Areas of Phase I, the cropping intensity was expected to increase from 16 percent (i.e., existing chena cultivation) to 200 percent at full project development: "yields are projected to reach 4.5 t/ha for paddy on the lowland and intermediate soils <Of the 4,191 ha of total new areas of Phase I, 61 percent was considered upland, 16 percent intermediate and 23 percent lowland> and 3.5 t/ha for intermittently irrigated paddy on the upland soils in the maha season. In the yala season paddy yields were similarly expected to reach 4.8 t/ha for the lowland soils, while subsidiary crop yields in the intermediate and upland soils were projected at 3.0 t/ha for oilseeds (unshelled groundnuts); 1.8 t/ha for pulses (cowpeas); 1.5 t/ha for vegetables (chilli) and 2.5 t/ha for cereals (maize)" (ibid., 77).

Since many settlers were unfamiliar with irrigated cultivation, the donor assumed that "6 years will be needed before the targeted yields are achieved, with only half the anticipated incremental yields being achieved in the first year" (ibid, 143).

At this stage, no further reference was made to similar systems or projects for the justification of these cropping assumptions; not even about the feasibility, opportunities — as experienced in Mahaweli System H at the end of the 1970s or constraints of introducing subsidiary field crops in irrigated areas. "The temptation for the farmers on the well drained (upland) soils to grow rice instead of subsidiary crops in the yala season" (ibid., 46) was acknowledged, but it was assumed to be countered by the price support policy of the government and the accomplishment of effective water management.

However, the risks for the EIRR involved in a possible failure of introducing subsidiary field crops in the upland areas were enormous; the subsidiary field crops represented 22 percent of the total benefits. Moreover, such a failure would also have restricted the total command area, because of the assumed lower water duties with subsidiary field crops.

The Appraisal Report of 1986 envisaged an increase of the cropping intensity in the new areas of Phase II from 20 percent "without" to 170 percent "with" the project. The total command area remained at 12,900 ha at this stage. "At full development yields are projected to reach 4.5 mt/ha for paddy and 3.5 mt/ha for upland paddy during maha season. During yala season paddy yields are expected to reach 4.8 mt/ha while subsidiary field crop yields are expected at 2.5 mt/ha for oilseeds (unshelled groundnuts), 1.8 mt/ha for pulses (green gram), and 1.5 mt/ha for vegetables (chilli)." (ADB 1986, 74).

The reasoning behind the envisaged cropping patterns in the Appraisal Report of 1986 is reflected in the following quotation:

> Soil types determine to a large extent the overall cropping pattern. Other important factors considered in the formulation of the cropping pattern included overall water availability, the Government's agricultural development strategies, the crop preferences of the settler farmers, and the expected financial returns to the farmers.....Because of anticipated water shortages during the yala season, it is recommended that instead of a 100 percent paddy crop, the lowland areas will grow 50 percent paddy and 50 percent subsidiary food crops. The paddy and <subsidiary field crop> areas will be rotated in alternate yala seasons. For the intermediate soils, taking into consideration the farmers' preference for growing paddy, about 20 percent of the lower reaches are expected to be planted to paddy during yala. Similarly, farmers in the upland soil areas will grow paddy during maha in areas where the sub-soils are nearer to the surface, thus inducing a higher groundwater table and lower percolation losses. It is also expected that higher <subsidiary field crop> prices would induce farmers to grow a small percentage of <subsidiary field crops> during the maha season in the intermediate and upland soils areas (ibid., 73).

The cropping intensity of 170 percent was derived from the information in the Appraisal Report of 1982 that "serious water shortages will be

experienced in five out of 27 yala seasons, implying a cropping intensity of 180 percent" (ADB 1986, 74). In 1986, the estimated annual water supply was less, which led to a cropping intensity of 170 percent.

On the estimated yields, the report says that "the Project provides for a range of agricultural support services including research (support from the Phase I project), and extension (an intensive program of on-farm crop and water management demonstrations), training facilities, credit support and marketing. All these efforts are directed towards the achievement of the projected crop yields" (ibid., 20).

In all the abovementioned assessments, there was no reference to the reliability of data (soil, topographic or hydrology) used. In general, the projected benefits had to be achieved through an ideal attitude and performance of the water users and agency staff in adhering to the assumptions. Feedback or historical information regarding the preferences or acceptability of assumptions like the cultivation of cotton (ADB 1977a), or oilseeds, pulses, cereals and vegetables (ADB 1982), and green gram was not referred to.

In practice, such preferences were given as perceived by the agency, the consultants, or the bank staff only, and the actual preferences remained unknown. These perceived preferences were sustained by agencies, consultants, and donor staff even in 1986, though it could have been assessed then that those preferences were unrealistic.

Managerial aspects. The assumptions made regarding the feasible cropping patterns and intensities and cultivation calendars were mainly determined by their reduced water requirements and the direct influence on economic feasibility, rather than by their actual feasibility. The feasibility of the envisaged crops in the eyes of the agencies and farmers was never mentioned or considered in the reports, except for two vague indications: "the farmer's acceptance and experience" (ADB 1977a, IX.9) and "temptation for the farmers to grow rice instead of subsidiary field crops in the yala season" (ADB 1986, 46). Justifications for cropping patterns and intensities, and cultivation calendars were thus not made explicit.

Major constraints like marketing and crop insurance and credits needed for successful motivation of farmers to grow subsidiary field crops were not referred to in any of the reports, though the Appraisal Reports had separate annexes for these subjects. It was only in 1986 that a marketing consultant

was hired and additional technical assistance by IIMI was considered necessary to support the introduction of subsidiary field crops. Even by 1986 no reference at all was made by the donor to experiences in cultivating subsidiary field crops since the late 1970s in Mahaweli System H.

Solutions mentioned in the Appraisal Reports such as crop and water management demonstrations, a "whole farm approach" (ADB 1986, 98), and the formulation of a technical report on irrigation and agronomic aspects of the introduction of subsidiary field crops did not actually deal with the major problems of introducing them, i.e., the institutional constraints. For this purpose, the donor started a parallel project on institutional strengthening of the Irrigation Department and the Irrigation Management Division.

The degree to which these efforts justified the continuation of the envisaged introduction of subsidiary field crops could be doubted. A major flaw was that no agency was made responsible for realizing their introduction. At the time of the appraisal of Phase II, the donor staff inquired from the involved agencies about possible constraints and the feasibility of introducing subsidiary field crops in the Kirindi Oya system. All agencies agreed that no major problems would be met, and response was prompted probably more by their priority for an extension of the project, and thus of the command area and the political pressure to settle more people, than by the actual feasibility of introducing these crops.

At the time of appraisal of Phase II, the donor still assumed that the Badagiriya Reservoir would have a cropping intensity of 170 percent, while several seasons without cultivation had passed and the Irrigation Department and other agencies did not intend to supply water to Badagiriya anymore — initially in 1977 Badagiriya had been incorporated in the project only to increase the project benefits. The above cases suggest that the interaction between the agency and the donor staff was not very effective for the assessment of the actual feasibility of the envisaged system objectives.

The donor, the government and the agencies opted for subsidiary field crops in yala to make an extension of the command area feasible rather than reducing the risks for the existing settlers and providing the existing water-short Badagiriya system with water at much less cost. The donor was not aware of all the arguments involved, and was apparently not even aware of the water shortage of the Badagiriya system (ADB 1986, 65).

The government and the agencies, especially at field level, were aware of these options, but were apparently unable or unwilling to convince the politicians of the unfeasibility of further settlement and the costs involved. During the actual implementation, little serious effort was made to introduce subsidiary field crops, and no agency was given the responsibility for it, even though the economic feasibility of the Kirindi Oya project depended, to a large degree, on the success of the introduction of subsidiary field crops.

Feasible Maintenance and Related Life Span of Project

Technical aspects. The EIRR calculation assumed a life span of 50 years for the Lunuganwehera dam and downstream development. Assumed production increases were also incorporated for a period of 50 years. Experience with similar irrigation systems elsewhere shows that the water delivery performance drops after several years due to lack of maintenance funds and managerial control over the maintenance processes. Experience is that many irrigation systems have to be rehabilitated every 15 years or so; 50 years is thus quite optimistic. The donor did not mention this problem in any of its feasibility or appraisal reports.

The background to the estimated maintenance costs over the 50 years has not been given. Operating costs were not based on historical data, but on the improved operating criteria used by the World Bank for the Tank Irrigation Modernization Project in Sri Lanka (ADB 1977a, XXIX.5).

These yearly operation and maintenance costs for irrigation, land settlement and agricultural development facilities over the 50-year life span were estimated to be around US$491,000 (ADB 1982, 147) or 0.6 percent of the investment costs at that moment. This percentage appeared to be rather low. The donor mentioned that the "Government of Sri Lanka has assured the Bank that adequate budgetary allocations will be made to the Irrigation Department and other agencies for operation and maintenance expenditures of the Project facilities" (ibid., 38). The meaning of "adequate" was not specified.

Managerial aspects. The availability of sufficient maintenance funds is problematic in many developing countries. Thus, whatever maintenance costs were assumed to be necessary by the donor or the Irrigation Department, it was very unlikely that the Department would be able to obtain

funds to maintain the physical infrastructure over a period of 50 years without a major rehabilitation.

A certain air of unreality between the donor and the Government of Sri Lanka existed in this respect. The donor had included a covenant to the loan, in which the government assured the donor that it would make these funds available (ADB 1982, 49). Accordingly the donor was formally not responsible for insufficient operation and maintenance of funds. However, the involved donor and the officials of the government knew at the time of signing that the government funding would not be realized. Most interviewed top-level government officials acknowledged that they agreed to this type of loan covenant, although they knew that there was little chance that it would be adhered to. In that perspective, it tends to be a more ritual to facilitate loan approvals, rather than a way of solving perceived serious constraints for the feasibility of the whole project.

The Government of Sri Lanka and the Irrigation Department will not be accountable to the donor for the actual feasibility of the donor's assumptions regarding the envisaged irrigation system; nor will they be accountable for the level of O&M funds or the life span of the project. On the other hand, neither are the donor officials apparently accountable to anybody regarding that type of unrealistic assumptions. Realistic and true assumptions for the feasibility of the envisaged irrigation system become very unlikely within such a setting.

Feasible Cost Recovery from Beneficiaries

Technical aspects. Cost recovery from beneficiaries was perceived as a crucial aspect of the maintenance feasibility of the system. For that reason the donor, in coordination with other donors, stipulated the following requirements regarding countrywide cost recovery of the loan:

> The Irrigation Ordinance (Chapter 453 as amended by Act No.48 of 1968) enables the Government to levy charges and recover costs of irrigation projects. The amount of charges is to be determined by a competent authority on the basis of the value of the lands benefitted, and the capital and maintenance costs of the Project facilities. An assurance has been obtained from the Government that a cost recovery plan will be prepared

> and submitted to the Bank by 1 January 1979, with respect to full recovery of operation and maintenance cost and a portion of the capital cost of the project from the beneficiaries. The Government will also ensure implementation of the approved cost recovery program. Submission of the cost recovery plan acceptable to the Bank will be a condition precedent to major disbursements anticipated in mid-1979 (ADB 1977b, 31).

However, the Government of Sri Lanka experienced difficulties in the actual collection of service fees from the water users. The donor acknowledged this in 1982, but insisted and obtained assurances from the government along the following lines: "...by 31 December 1983, prepare and submit a cost recovery program acceptable to the Bank whereby progressive increases in irrigation service fee commencing with effect from 1 January 1986 will result in recovery from Project beneficiaries one-half of the total operation and maintenance costs of the Project by 31 December 1990, and recovery of total operation and maintenance costs by a date to be specified in the cost recovery program (Principal Loan Agreement..)" (ADB 1982, 49).

If capital costs were recovered from farmers of the Kirindi Oya system the charge would amount to Rs 13,600 per ha/year in 1982 prices (ibid., 41), which was considered unreasonable by the donor, given the estimated net farm income of Rs 19,000–23,000 per ha/year (ibid., 150). That income was, however, considered enough to recover the full operation and maintenance costs of Rs 494 per ha/year (ibid., 41). The modest introductory level of operation and maintenance cost recovery rate must be seen "in the context of the present levels of nonpayment of fees, and of recent reductions in fertilizer subsidies and increases in transportation costs" (ibid.).

In the second Appraisal Report of 1986, the donor acknowledged that the government had implemented the promised cost recovery scheme, but that the recovery rate had dropped from 42 percent in 1984 to 8 percent in 1985. Reasons given by the government include:

> (i)the as yet incomplete coverage of IMD's program, and thus the inadequate administrative functions in some districts; (ii) in many locations, the worsening security situation; (iii) in some places, farmers' perception that their margins were not adequate to pay these higher fees; and in some cases; (iv) no apparent connection between the irrigation service fees and adequate/improved service. Concerned by this

performance and the implied inequities between paying and non-paying farmers, in June 1986 the government temporarily froze irrigation service fees (ADB 1986, 30).

The donor considered the government's temporary pause justifiable, but at the same time it was deemed that the decision to exempt all systems in the country smaller than 200 ha (instead of smaller than 80 ha) from cost recovery as being too high, as it would "effectively exempt more than 40 percent of countrywide irrigated areas....The government has reiterated its intention to ultimately recover full O&M costs and has agreed to include in the <Sri Lankan Major Irrigation Rehabilitation Project> study consideration for reintroducing the limit of 80 ha above which irrigation fees would be collected" (ibid.).

Managerial aspects. The donor, together with other donors, has emphasized the enforcing of a cost-recovery program. Apart from loan covenants (ADB 1977b, 40; 1982, 44 and 1986, 49) they monitored the progress of recovery and invested in related studies and programs. Despite this the government and the donor staff appeared to be somewhat equivocal regarding this loan covenant, which was similar to that for the allocation of operation and maintenance funds.

The threats made to enforce these cost recovery programs were rather strong. The Kirindi Oya Appraisal Report of 1977 states that "Submission of the cost recovery plan acceptable to the Bank will be a condition to major disbursements anticipated in mid-1979" (ADB 1977b, 31). Implementation of such a program was incorporated in the loan agreement.

In 1982, the donor went so far as to threaten the Government of Sri Lanka that it warned: "in the event the program is not implemented with effect from 1 January 1986, the Bank may consider invoking Section 8.07(b) of the Loan Regulations, which permits the Bank to accelerate the loan maturity "(ADB 1982, 41).

Despite these threats, the donor very seldom uses its power to enforce the covenants, because of overriding excuses from the side of the government.[15] In the absence of a real water delivery service by the Irrigation Department,

15 Moreover, if the donor tries to stop or delay loan disbursement to enforce a loan covenant, it is usually overruled by political lobbying and pressures at the level of the donors' Board.

there exists little valid rationale also for the cost-recovery program and enforcement of cost recovery is a political issue. Successful implementation depends very much on the commitment of politicians to this program. Without it, the chances for a successful program are very limited although the government and the donor can agree on the covenants.

Feasible levels of cost-recovery rates depend on this political commitment. As long as the politicians are not involved, the evolving proposals by the government constitute its efforts at fulfilling donor requirements to obtain the foreign funds, rather than a feasible program. Consequently, neither the politicians nor the government feel that they are accountable for implementing this enforced cost-recovery program. The feasibility is again more the concern of the donor than of the government and the Irrigation Department.

Feasible Implementation Schedule

Technical aspects. At first, in 1977, the full implementation of the Kirindi Oya project was assumed to take six years (ADB 1977a, XXVII.1). Neither the explicit reasons for the assumption that the actual construction would take three years and not five years; nor the risks for delays were given. At the time this report was being written, it was officially estimated that the construction of Phase I and Phase II would take 12 years. It appeared that the construction of projects is often estimated too optimistically to realize a higher EIRR.

Managerial aspects. Planning and scheduling of the implementation of the Kirindi Oya system had been done by the donor and not by the Irrigation Department. Partly, it was because different agencies were involved in the implementation and partly and more importantly, it was due to the influence of the project progress on the EIRR, which made it more necessary that the donor itself planned project implementation. An actually feasible implementation schedule was thus never established, which could have a serious impact on the actual achievement of the EIRR of the project.

Economic Internal Rate of Return

The overall feasibility of a project is determined by the donor by means of the Economic Internal Rate of Return (EIRR). Its calculation uses all the aforementioned assumptions regarding costs and benefits. Benefits are assessed for the "with" project and "without" project situations. This is in practice, difficult to assess, especially because reliable data about the Old Areas were not available. Also, it was difficult to assess what the future yields of the Old Areas would be for the "without" project situation.

Technical aspects. The Feasibility Report of 1977 calculated the construction costs of nine options, i.e., three different command areas for three different dam heights. Comparison of these alternatives showed that the three systems, which included the optimum dam height were "more attractive" (ADB 1977b, XXX.1). The criteria used for determining this attractiveness remained unclear in the report. The EIRRs of these three more attractive systems were calculated given the assumptions described in this chapter.

Command areas of 9,452 ha, 9,978 ha, 12,932 ha would have led to EIRRs of 10.6 percent, 10.8 percent and 11.8 percent, respectively. "Based on the EIRR's estimate, the project is economically feasible and would be an asset to the country. Case III <i.e., the 12932 ha> is the most viable alternative based on economic evaluation" (ibid., XXXII.1).

Sensitivity testing was done by the donor for a selected combination of risk factors like construction delays of one year, cost overruns, and reduction of benefits by 10 percent, 15 percent and 20 percent.

> As Case I <i.e., 9452 ha> has an EIRR close to ten percent (10.58 percent) under normal conditions, it cannot withstand any additional constraints without dropping below 10 percent EIRR. Case II <i.e., 9978 ha> is in a little better position in that it can withstand a ten percent increase in costs or reduction in benefits, if completed on schedule, without dropping below 10 percent EIRR. Case III <i.e., 12932 ha> with a normal 11.80 percent EIRR would have almost a 10 percent EIRR even if costs rose or benefits dropped as much as twenty percent, but not a combination of the two. However, Case III is quite sensitive to delays in completion of the project (ibid., XXXII.5).

The Feasibility Report concludes that "Although Case II was studied in depth at the request of the Government, it appears that Case I should be considered as the initial stage of Case III, the expanded project; since Case I has been fully documented, but the Case III project needs additional studies" (ibid., II.6).

Three months later, the Appraisal Report of 1977 envisaged Case III only and calculated an EIRR of 17.6 percent, while it estimated the total investment costs 50 percent higher at US$66.80 million compared to US$44.9 of the Feasibility Report! These increased costs were mainly due to envisaged price escalations (US$11.1 million) and the necessity to buy Foreign Exchange Entitlement Certificates[16] (US$15.6 million) (ADB 1977b, 78). However, these were not considered in the calculation of the EIRR; especially the latter was not considered to be representative of the national opportunities for the investments. The estimated investment cost used for the EIRR was US$44.9 in the Feasibility Report of 1977 (i.e., Case II or 9,978 ha) (ADB 1977a, XXVII.5), and US$29.9 in the Appraisal Report of 1977 (i.e., Case III with 12,932 ha) (ADB 1977b, 91), which led to the considerably increased EIRR in the latter. No reasons were given or could be identified in the Appraisal Report for this 50 percent lower estimate of the project cost.

A sensitivity analysis led to an EIRR of 12.2 percent in the worst case, i.e., reduction the of cropping intensity from 189 to 170 percent, an increase in the construction cost of 20 percent, and a delay in completion of two years. Reduction of the cotton yield by 50 percent, which alone resulted in a decrease of the EIRR from 17.6 percent to 13 percent was not considered in this combination (ibid., 90).

Serious cost overruns were mentioned to be due to "rapid inflation in Sri Lanka, the effect of which was accentuated by implementation delays" (ADB 1982, i). This led to the splitting up of the project into two phases. Apart from the rehabilitation, only 4,200 ha of new lands would be developed under Phase I and a further 4,100 ha under Phase II. Phase I was estimated to have an EIRR of 11.0 percent, and Phase I and Phase II together 13.0 percent (ibid.,

16 Foreign Exchange Entitlement Certificates were valued at 65 percent of the official exchange rate and were imposed in an attempt to promote "nontraditional" exports and to cut down on nonessential imports.

45). Sensitivity analysis of Phase I would have reduced the EIRR to around 8 percent in the worst case, i.e., a one year further delay, a 20 percent decrease in benefits and an increase of costs.

The EIRR for Phase II, i.e., the construction of the last 4,100 ha of the command area, was estimated at 19 percent. "The EIRRs of the Phase I project and the complete KOISP (i.e., Phase I and Phase II) have been updated to 8 percent and 10 percent respectively" (ADB 1986, 36). Sensitivity analysis led to an EIRR of 13 percent in the worst case, i.e., a combination of 20 percent increase of costs and decrease in benefits and a one-year delay in the accrual of benefits.

A preliminary conclusion (i.e., without considering the managerial aspects of the EIRR) of the above evolution of the EIRR was the amazing variability of the EIRR over time. For example, the much higher EIRR of the Appraisal Report of 1977 — which used a 50 percent lower cost estimate for calculating the EIRR — came only three months after the Feasibility Report. Another strong example was that while the Feasibility Report of 1977 considered the 11.8 percent EIRR of the implemented Case III very sensitive to delays in construction, the reappraisal of 1982 showed an EIRR of 11.0 percent for a project which envisaged only half the new command area and the related benefits and extensive cost overruns and delays in the construction of the headworks.

Managerial aspects. Given the enormous variations that occurred in the assessment of the feasible water duties, cropping patterns and related command areas, the use of the EIRR seems rather prone to manipulation. Because average variations of 65 percent of these factors occurred between all feasibility and appraisal studies, the EIRR could have been used by the donor, the government and the agency staff to make any project feasible or unfeasible. Also, a 50 percent variation in project costs between different assessments in a period of three months demonstrated such manipulations. As a result, all feasible objectives for the Kirindi Oya project were determined more by the EIRR than by their actual feasibility.

In view of these average variations of 65 percent and the sensitivity criterion of a one-year delay, 20 percent deviations of costs and benefits were rather marginal. Instead, the sensitivity analysis should have assumed the range of the envisaged improvements of the water duties, as for example, 35 percent, 65 percent, 33 percent and 51 percent for the Feasibility Report of

1977, Appraisal Report of 1977 and the Appraisal Reports of 1982 and 1986, respectively.

While the first Feasibility and Appraisal Reports did not refer to risks in the assumptions made, the Appraisal Reports of 1982 and 1986 listed such risks (ADB 1982, 46 and 1986, 37), but did not incorporate them in the sensitivity analysis.

The abovementioned arguments illustrate the atmosphere in which the feasibility and appraisal of a system like the Kirindi Oya system took place. The assumptions made during the feasibility and appraisal phase have been governed by the predetermined intention of the Irrigation Department, the government, and the donor to build the Kirindi Oya system. In fact, all those who were interviewed during this research, and who had been involved in this decision making pointed to the fact that the political decision to build the Kirindi Oya system had to be confirmed by feasibility and appraisal reports instead of the other way around. The consequent unfeasibility of these project objectives were taken for granted by the Irrigation Department, the government and the donor staff, which actually meant that they stopped taking responsibility for their own creation.

The assumptions used during the feasibility and appraisal phase were optimistic but were in accordance with the prevailing "scientific lines" (ADB 1977a, IX.58) used by the irrigation engineers, agronomists and hydrologists of consultancy, the Irrigation Department and the donors. Especially, the dominance of arguments based on hydraulic engineering for the determination of feasible dam sites, available water resources, reservoir capacity and water delivery concepts was demonstrated in these decision-making processes of the Kirindi Oya project.

National Opportunities

Technical aspects. Requirements regarding maximum allowed investment per settler, or per increase in agricultural production, or per area to be commanded, or per job created did not exist for the determination of feasible system objectives. In fact, no alternative national opportunity for the investments was considered other than the financial, i.e., the EIRR. Also, no requirements were specified for the longer-term sustainability of the investments; the choice for irrigation was not specified in the required

sustainability of increased agricultural production, number of settlers and area to be commanded. Such requirements would have been logical given the experiences in Sri Lanka with, for example, Uda Walawe, where approximately one-third of the envisaged command area has never been commanded. This had direct implications for the people settled in those areas and the opportunities for the funds available for investment.

Managerial aspects. The absence of any requirements of the government for the maximum investment per settler, per increase in agricultural production, per mcm stored, per job created, or per area commanded reflect the priority given to political, rather than economic factors in obtaining foreign funds for large-scale projects like the Kirindi Oya system. The manipulation of the EIRR to sanction the project has led to an enormous wastage of money, serious environmental risks and frustrations of the water users, agency staff, consultants and donor staff.

Those who were involved in these decision-making processes argued that the EIRR was oriented toward economic opportunities only, while a project like the Kirindi Oya system contained social and political benefits (e.g., settlement and employment) also. This might be true, but those other benefits were to achieve at a price. Moreover, the present assessment of feasible system objectives has resulted in settlers without irrigation water and thus without the expected employment.

The attitude of politicians, the government and the agencies in obtaining international loan funds is oriented toward rather short-term benefits; in that the benefits to settlers of a water supply system are overlooked and the advantages of other options (double bank canals versus a single bank canal, a small dam versus a large dam) are ignored. Whatever the donor is willing to fund is considered to be a gain to the department and related individuals. Some top officials explicitly stated that most loans were considered to be 80 percent grants. The national opportunities of utilizing these funds were not seriously considered.

Mutual Adaptation of the Technical and Managerial Aspects

Given its enormous relevance to the Sri Lankan society, discussion of river-basin and system-development concepts should become more open,

whereby engineers with different opinions present their arguments and try to improve their overall professionality, rather than narrowing their professional scope to the perceived "pure" hydraulic engineering, agronomic and civil engineering priorities.

The taboo on exchanging experiences and criticizing colleagues of the engineering profession about managerial, settlement, ecological and environmental issues should be replaced by an awareness that under it, the Sri Lankan engineering profession is static and not innovative at all, and the cost to the Sri Lankan society as a whole could be enormous as has been demonstrated in this chapter.

However, given the present priorities for construction in the Irrigation Department, such a discussion seems unlikely to happen, if new contracts and loans are made available without any requirement for such open discussion from the government of Sri Lanka and the donors.

This study will not give a judgement on the feasibility of the Southern Area Plan, certainly not without a detailed picture of the huge costs and management requirements involved. It merely recognizes several valid arguments against the blind acceptance by the Irrigation Department of the "foreign," "one-off" concept with the theoretical and scientific arguments, which favor its effectiveness and feasibility. From the point of view of feasibility of the system objectives, the choice of the Lunuganwehera site was rather irrational, but neither the government nor the donor has highlighted obvious drawbacks like the less-feasible soils and the relatively high costs. The feasibility and appraisal studies of the donor did not incorporate the feasibilities of alternative dam sites, because the choice of the Lunuganwehera site was considered a political decision, despite the rather meager feasibility of a project at the Lunuganwehera site in terms of the EIRR and related assumptions. Indeed, the identification of desirable objectives for this type of large irrigation projects is decision making of a highly political nature, in which a donor cannot easily intervene. But, the donor should assess the feasibility of a proposed project in a completely objective way to facilitate awareness among all involved parties of the economic consequences of politically inspired decisions.

The donor's assessment of the feasibility of water duties, command area, water delivery concept, cropping patterns and intensities, maintenance and cost recovery fell short, as those assessments were based on overly optimistic

assumptions in the application of theoretical formulae concerning water requirements and water flow regulation as well as concerning staff motivation. The reliability of data used was often not properly assessed.

The scientific water delivery concepts and related theoretical water requirements have changed the standard water duties for Sri Lankan irrigation systems overnight, sometimes by 100 percent. This change has been too optimistic, and it is surprising that these assumptions continue to be made rather than being adjusted to the average water duties experienced with the new design concepts. The theoretical water requirements are unfit for the assessment of feasible water duties in Sri Lanka and should be replaced by actually realized water duties in systems with similar design concepts.

This overoptimism, in combination with the assessment of the available water resources at a level whereby every other year would be water short, has made the Kirindi Oya project a "technological-folly," as titles of articles in Sri Lankan newspapers have suggested. Without these scientific assessments, the actual feasible objectives with the available water resources would have been an increased cropping intensity of 200 percent in the Ellagala system only (with possible reuse of water elsewhere).

Similarly, the decision making about the trade-off between options like subsidiary field crops, extension of the command area and supply of water to the Badagiriya Reservoir was biased toward extension of the command area, related construction activities and settling of more people, at whatever cost it could be. Instead, the agencies, the government and the donor should have established the real feasibility of the different options given their acceptability to the farmers, the existing managerial capacities of the different agencies involved and the costs of the different options.

The introduction of subsidiary field crops was not very seriously attended to by agencies or by the government. Neither did the agencies nor the donor really worried about the feasibility of the required maintenance funds and cost-recovery programs. The donor, of course, worried about the EIRR in these choices, which seemed rather odd in view of the intended function of the EIRR; apparently the perceptions of the donor and the Government of Sri Lanka in this regard were quite different. In practice, however, they were not so different; for both parties the EIRR was a charade to justify investment decisions.

For the Sri Lankan parties, the opportunities are determined, at any cost, by relatively short-term political and agency priorities only. These priorities, rather than the need for cost-effective investments, dominate their everyday decision making.

This attitude of all parties toward the donor funds makes the EIRR an instrument for project justification only. Consequently, the agencies and the government will also care less about the feasibility of certain objectives like the introduction of subsidiary field crops, envisaged water duties, water delivery and cost recovery, because the government and the agencies need to justify the EIRR only. As a matter of fact, questions of the donor regarding the feasibility of proposed objectives directed at staff of the agencies and the government are not completely fair in this atmosphere of political and agency priority for obtaining these foreign funds for a project. As a result, the actual realization of these EIRR-derived feasible objectives is considered, to a certain degree, less a problem of the agencies than a problem of the donor.

The donor staff and consultants involved in the Kirindi Oya system, in fact, showed a similar attitude during their feasibility and appraisal missions; they wanted the agencies to give them those figures which would result in an acceptable EIRR to get the loan approved — at least, this happened for the Appraisal Report of 1982 when the donor staff had become responsible for the continuing feasibility of the project.

As a result of these processes, the real feasibility of the whole Kirindi Oya system was shrouded in a cloud of goodwill and related rituals (e.g., the funds for operation and maintenance, the formulation of a water management plan, the cost recovery) from all sides to get the loan approved.

The donor staff and consultants will never be able to really assess feasible project objectives. The necessity to use outside and comparatively objective consultants for feasibility assessments, because of a positive bias of the national government and agencies toward donor funding is acknowledged. On the other hand, such an assessment should be based on explicitly defined and elaborated system objectives proposed by the national government and the agencies. If a project proposal is not defined and developed by the national agency, it will not feel committed to and be responsible for the identified project objectives.

Therefore, if the government and the agencies are to play this role, the donor involvement in these processes will preferably have to be limited only

to assessing the technical and managerial feasibility of an already developed plan. This increased responsibility and role for the national parties cannot be achieved without the donor staff and consultants being objective in approving loans. Increased objectivity will require more freedom for the donor staff and consultants to judge whether or not the EIRR of a project proposal is below the cutoff rate, and thus facilitating a loan refusal for an unfeasible project proposal; whether it be unfeasible in the short term or long term. If the donor decides to grant a loan even when the cutoff rate is not achievable, the subsidies involved will at least become explicit. The realization of loan targets at present, is an important informal staff performance indicator within the donor, which does not stimulate a more careful assessment of the feasibility. The efforts of the staff of the donor to be more careful in the assumptions concerning the feasibility depends on their individual motivation rather than on an institutional incentive of the donor organization. The donor requires the EIRR to remain above 10 percent at the end of the construction period, i.e., at project completion. Developments with respect to the EIRR after that time are not monitored and the performance of the donor staff is not appraised by it. Similarly, donor consultants cannot be expected to be completely objective toward the feasibility of a project, given the donor's own interest in realizing loan targets.

CHAPTER 9

Strategic Concern: Functional Requirements for New Construction

WITHIN THE FRAMEWORK of the identified desirable and feasible project objectives, including the selected dam site as described in Chapters 7 and 8, specific functional system requirements have to be determined for the envisaged investments with the available resources, i.e., requirements regarding the physical infrastructure, staffing, communications, and possibly the water user organizations.

Functional requirements regarding the command area refer to its size, suitability and location of the command area. Functional requirements with respect to canals may be the conveyance through the main canal and distribution to other canals. Conveyance and distribution functions can be expressed in terms of (peak) discharges or water levels and their variability, passive and active controllability, responsiveness, equity, safety and long-term flexibility.[17] The canal may also function to capture drainage and runoff water from its own catchment. Sometimes it serves as a semi-storage reservoir as in the case of a contour canal. Moreover, it can function to deliver drinking and bathing water for people and livestock. A passive function may be the maintaining of a certain groundwater level in its surroundings.

Similarly, the functional requirements of a reservoir may be the storage capacity and flood resistance. And, a reservoir can function as a culturally important meeting point for a village, or a fishing ground or it may provide recreation, and bathing and drinking water, especially during off-seasons or maintain a certain groundwater level in its immediate surroundings.

Functional requirements with respect to structures can be the (peak) discharges, control water levels, passive and active controllability,

17 Long-term flexibility refers to the degree to which a system is able to change in cropping pattern and operational mode in the future without changing canals and structures (Tiffen 1983, 3).

adjustability, easiness to operate, sediment passing capacity, permissible head losses, safety in case of breakdown, and operation efficiency.[18]

Functional requirements with respect to staffing refers to the intensity and frequency of interventions required, and the related communication requirements between different levels of staff and between staff and the water users, and other parties of interest like politicians and other agencies.

Functional requirements are not the same as a design concept, but are the requirements related to an appropriate design concept. Actual design is a different process which comprises the implementation of the design concept. In many design concepts, as in the Kirindi Oya project, functional requirements may include the water users as well, as they may be required to function as a group to share the allocated discharge effectively among themselves.

THE DECISION-MAKING PROCESSES

Chapters 7 and 8, on the desired and feasible objectives, provide a detailed assessment of the choice of the dam site, because of its great influence on the costs and potential benefits (i.e., the command area) of the project. The feasible objectives determined the broad functional requirements of the dam as well. Within this framework, however, more specific studies were done to determine the exact functional requirements of the dam and downstream development works.

Reservoir Capacity

Technical aspects. A general functional requirement for the reservoir capacity is the "smallest capacity that would be required for the cultivation of the largest cultivable area for a pre-determined cropping pattern and intensity. The water surface area of such a reservoir at full supply level should

18 Operation efficiency is the average proportion of the effective volume delivered and the actual volume supplied for a certain structure (Schuurmans 1989, 696).

preferably be less than 25 percent of the irrigable area" (Ponrajah 1988, 32). However, for a reservoir in the most downstream part of a catchment area as the Lunuganwehera Reservoir, this requirement was the largest reservoir capacity to store as much water as possible.

This capacity and the irrigable extent are in principle "determined from an operation study taking into account the inflow from all sources in the catchment, diversion inflow from other catchments, evaporation and seepage losses from the reservoir and the irrigation requirements of the crop cultivated" (ibid.). Apart from the operational study done for the Feasibility Report, another one was done to determine the actual dam height and reservoir capacity. The irrigation requirements used for this operational study might have been 1,829 mm and 2,682 mm for the maha and yala seasons or a total of 4,511 mm, including effective rainfall.

The exact values were not clearly indicated; the quoted source suggested that an incorrect calculation has been made in totaling the water duty of lowland (731 mm for maha and 1,280 mm for yala) and upland (1,097 mm for maha and 1,372 for yala). Net water requirements or any justification for these estimates were not given (WAPCOS 1986, III.55). In this operational study, the cultivable area used was the same as that envisaged in the Appraisal Report of 1977, which was based on a much lower assumption of the annual diversion requirement of 2,961 mm with a 200 percent cropping intensity.

Alternative full reservoir levels of 57.3 m, 57.6 m (the optimum level adopted in the Feasibility Report of 1977), 57.9 m and 58.2 m were considered and their percentages of success assessed. The dam height of 58.2 m logically gave the highest percentage of success (i.e., maha 85.39 percent and yala 76.47 percent), because the reservoir would have stored more water with this dam height. The storage of the greatest volume of water was apparently the main criterion. As for the feasibility assessment, the actual number of crop failures was not clear from the operational study because it was done for monthly intervals.

The design report did not give the percentage of success of other dam heights. It stated that "any further raising of the reservoir level would have caused submergence of a large part of Lunuganwehera-Tanamalwila road and agricultural lands" (ibid., III.18). The extra costs involved in replacing the road were the major reasons for not raising the dam bund further. Other

functional requirements for the reservoir capacity and dam height like the size of the area submerged, the number of people settled and the cost-effectiveness of raising the dam were apparently not considered.

Managerial aspects. For the Kirindi Oya system a number of assessments have been made regarding the irrigation requirements: the Feasibility Report (ADB 1977a), the Appraisal Reports (ADB 1977b, 1982 and 1986), the Design Report (WAPCOS 1986), the Water Management Strategy Plan (AHT/SCG 1987b), the Operation and Maintenance Manuals (Irrigation Department 1986a and AHT/SCG 1987a and 1989) and operational studies by the Irrigation Department (Dharmasena 1986, 11).

Of these assessments, one seldom referred to the other. Further, criteria regarding the appropriate application of the irrigation requirements were not provided in these assessments; they were left to the judgement of the individual experts. In addition, it was remarkable that water duty values of doubtful accuracy used by a consulting firm (i.e., 1,828 mm for maha [731 mm for upland, 1,097 mm for lowland] and 2,652 mm for yala [1,280 mm for upland, 1,372 mm for lowland]) were apparently acceptable to the Irrigation Department the government and the donor.

This "free" and uncontrolled use of the theoretical water requirements allowed this consulting firm, for example, to use two different calculations of the irrigation requirements (i.e., the above and those in the Appraisal Report of 1982) in the same operational study for the assessment of the reservoir capacity and full reservoir level. This was especially remarkable when considered the fact that the first was twice as high as the second!

The irrigation requirements of the operational study were not justified. While such an operational study had potentially serious consequences for the percentage of success, cost of the dam, the area that can be commanded and the potential cropping intensities, the donor and the Irrigation Department had apparently accepted the assumed values without any justification. The reliability of the assumptions regarding the irrigation requirements has not been elaborated upon by any party.

On the other hand, the decision making regarding the reservoir capacity seems to have been determined mainly by a need to maximize capacity without submerging the Lunuganwehera-Tanamalwila road. Reducing the reservoir capacity or irrigating only the suitable soils has not been considered. Maximization of the command area was a priority of the major

parties involved: the Irrigation Department, because of the glamour of building such a long dam; the government, politicians and the Land Commissioner's Department, because of the pressure to settle as many people as possible; the donor, because of a more favorable EIRR for a larger command area. Local communities of Tissamaharama, Badagiriya Reservoir area and upstream catchment areas were not involved in this decision making. It remained unclear why operational studies were done for several lower full reservoir levels when the preference was for the highest level (58.2 m).

Reservoir Spillways

Technical aspects. Functional requirements for reservoir spillways referred to the need to safely discharge runoff from storms of a determined frequency which was based on a permissible risk. An ungated spillway (which seemed more suitable in view of possible mechanical problems of gates, etc.) was not chosen by the Irrigation Department for the Lunuganwehera Reservoir, because no technical guidelines were available for such large embankments (WAPCOS 1986, VII.1). The number and size of the spillway gates were determined through various flood routing studies.

In the Kirindi Oya system, the design requirement of the donor was for a flood that would occur once in 10,000 years. But the responsible engineer followed the standard of the Irrigation Department and made the flood design that for a flood to occur every 1,000 years. The mistake, which was discovered after the completion of the designs, was compensated for by assuming controlled flooding during a flood of the 10,000th year and a highest flood level of 60.0 m (instead of 59.4 m) which would provide extra storage. The dam height was slightly increased for this purpose.

The foreign consultants assumed that the envisaged 1,416 m^3/s flow during a flood would create considerable problems for the downstream command area and villages (WAPCOS 1986, III.35). They advised that an early warning system be installed. The Irrigation Department had setup such a system and issued a number of standing orders to the Chief Resident Engineer and local authorities (e.g., the Assistant Government Agent).

Safety factors of the spillway gates were upgraded from Japanese to Indian standards to take into account potential lower qualities of Sri Lankan

gates compared to the quality implied in the Japanese standards. This led to some controversy with the manufacturer who claimed that these new requirements for the spillway gates were not defined beforehand and led to unnecessary cost overruns.

Manual operation of the spillway gates was a requirement of both the Irrigation Department and the donor. In addition, the consultants advised (ibid., III.36) installing a generator to take care of power failures and this was done.

Some controversy arose over the characteristics of the stilling basin. According to the Irrigation Department, much less reinforcement was necessary as the rock formations were even stronger than those that function as stilling basin in the Uda Walawe system. The consultants who were initially more cautious, admitted after excavation of rock faces on both the left and right ends of the stilling basin that lining was not needed. The bottom of the stilling basin was lined for additional safety, given the limited costs of the required concreting (ibid., VII.15).

Managerial aspects. In regard to the requirements of the reservoir spillways, the Irrigation Department felt that history did not record any devastating floods for the last 2,500 years and that the dam could have been built at a lower cost, if they would not have depended so much on scientific concepts such as the probable maximum flood or the flood of a 10,000th year (Irrigation Department 1986b, 108). In fact, they considered the donor as a bank which was too conservative and giving priority to security over unreasonable cost increases. The exact incremental costs of adhering to safety limits of the donor were unknown (ibid.).

The argument that no major floods were reported in the area seemed relevant. Indeed, it was doubtful whether scientific concepts like the Potential Maximum Flood or a 10,000th year flood were appropriate in the Sri Lankan context. The result was that Sri Lanka has built a dam at unnecessarily high costs just to fulfil requirements of the donor agency. Requirements regarding safety and risk prevention are usually stipulated by the donor at the time of acquisition of the loan and they could have been incorporated into the decision making about the desired system objectives.

The decision-making processes concerning the embankment, spillways and spillway gates reveal that the Irrigation Department did not have sufficient experience to determine, on its own, the related appropriate

functional requirements. It led to the use of foreign consultants for design monitoring and evaluation a necessity. The Irrigation Department could have done without such outside assistance and the high costs involved, only if it had opted for smaller dams.

There was resistance to foreign consultants in general (e.g., Irrigation Department 1986b. 166), with their cost amounting to 7 percent of the total cost of the Kirindi Oya project. This resistance was intense against

the consultancy fees (25% of the total) spent on a Project Implementation Consultant which was considered exorbitant. However, this consultant also functioned most probably as a kind of "watchdog" for the donors, and in that respect his presence was a logical consequence of the acquisition of a foreign loan. Similar complaints about the consultancy costs in downstream development (25% of the total) seemed to be even less justified. In this system utilization, the Irrigation Department itself often had problems in mobilizing motivated staff as has been demonstrated in Chapters 3 to 5.

The attitude of the Irrigation Department staff toward foreign consultants in the Kirindi Oya system seemed a little ambiguous. They accepted the foreign funding, the related functional requirements (e.g., safety factors and expensive but inappropriate water delivery concepts) and thus the related technical assistance, monitoring and supervision. But they resented monitoring, supervision and technical assistance for the more problematic aspects. It all seemed part and parcel of the same choice. If they resented water management consultants, they should have developed their own expertise in that area. Without it, a donor could not justify the absence of consultants, even though many donor staff were aware that consultants were often ineffective.

Head Sluices

Technical aspects. Functional requirements of the head sluices in Irrigation Department systems are given as: "the intake and opening sizes of the sluice in a reservoir should be the minimum to release the necessary demand when the reservoir is at its lowest stage called the Minimum Operation Level." The water issues at Minimum Operation Level are limited to two thirds of the peak release (Ponrajah 1988, 33, 95).

The required controllability or manageability of flow, flexibility (fixed, or stepwise, or on-off), easiness and intensity (or convenience) of operation are not explicitly defined. However, it implied that a rather high level of controllability is required, given that two thirds of the daily peak discharge should be issued at Minimum Operating Level, and given that a discharge measurement structure is installed downstream of the head sluice (ibid., 147). These requirements were followed for sluices in the Kirindi Oya system; a trash rack was also required and its hydraulic influence had to be considered (Selvarajah 1986, 100).

These requirements necessitate the capability and motivation of staff to actually control the flow through the head sluice. Most engineers of the Irrigation Department were involved in some way in the operation of the head sluice and they might have been familiar with its controllability.

The irrigation requirement for the Right Bank head sluice and main canal was based on the maximum monthly diversion requirements defined by the Appraisal Report of 1982, which envisaged extremely low water duties for the Right Bank areas, including the Badagiriya system; 884 mm for maha and 1,280 mm for yala. The maximum peak requirement of 1.3 l/s/ha, as assumed by the donor, would occur in July. But this peak requirement usually occurs during the land preparation (usually in September and April).

However, "the designed canal capacities have been kept 50 percent higher than the peak requirement to cater for variations in crop pattern and crop water requirements" (WAPCOS 1986, VIII.2). This adjustment by WAPCOS leads to the more generally used diversion requirement of 2.0 l/s/ha or 13.1 m^3/s. However, why the Irrigation Department and WAPCOS used 50 percent (and not 20% or 100%) as multiplier is not clear from the report. Probably a large margin was assumed to enable the flexibility to issue more water in case of crop diversification, little rainfall, etc.

Managerial aspects. Functional requirements of the head sluice were determined by the Irrigation Department in conformity with the Technical Guidelines. Other options were not considered. As described by other IIMI research (IIMI 1989a, 56), this head-sluice concept functioned satisfactorily.

System Layout

The functional requirements for system layout comprise drainage, boundaries of command, tract and turnout areas and areas for settlement.

Technical aspects. The canal system in a major project "provides for the supply of water for a regular pattern of turnout areas. The unit farm size in the turnout area is determined on the basis of land use classifications, cropping patterns, and on values of income to be derived that are considered satisfactory for an average farm family. The Blocking Out Plans for farms of Major Projects are therefore prepared on the basis of the above distribution system" (Ponrajah 1988, 214)."The irrigation system is designed on the basis of Turn Out Areas (TA) of defined size, served by Field Canals, etc." (ibid., 101).

The underlying assumption of this turnout area concept is that water allocations and deliveries in a "regular" canal pattern are easier to control for the agencies. This is due to the fact that the regular pattern is based on standard one-cusec discharges and standard rotations. However, these assumptions also necessitate a degree of motivation and discipline of staff and the water users to limit their water use for the benefit of the overall system and the national economy.

These assumptions have not yet been proven true. The disadvantages of this regular pattern of parallel distributary and field channels are the need for more control structures, increased construction quality and costs, increased operation and maintenance costs, the requirements of the water users' associations to share water within field channels, the coordination of land settlement processes with layout and the water user groups, and increased water management capacities.

It is only when a part of the command area cannot be irrigated from a distributary channel at a reasonable cost, a field channel taking off directly from a main canal is envisaged. The general feeling is that such field channels use more water than parallel field channels off distributaries, just like fields with a direct outlet from a distributary channel are considered to use more water than they would with a field channel. It is, however, difficult to assess to what degree excess water taken from direct outlets is wasted or reused downstream of a particular field.

The layout of an irrigation-cum-settlement system is completely governed by this turnout area concept. Given the fact that the ratio of irrigation requirements for lowland and upland is 1:2, the "one-cusec" concept implicitly requires a very accurate assessment of the proportions of upland and lowland soils in a turnout area to achieve an appropriate layout. However, these proportions of lowland and upland in the turnout are seldom assessed reliably; not only in the Kirindi Oya system, but also in many of the Mahaweli systems the assessment of soil types has been unreliable or, because of the requirement of speedy construction, not been done at all.

The layout of development downstream of the Lunuganwehera Reservoir aimed at commanding the largest possible area. Therefore, the suitability of soils, the requirements of settlements and provision of drinking water were made subordinate to this one-dimensional objective.

This approach led, for example, to a relatively large proportion of upland areas in the command area, and at the same time relatively little space for the settlements. Consequently, the criterion of a maximum allowed travel time from hamlet to field could not be maintained sometimes.

The recurrent problems in obtaining drinking water in settlement schemes in the dry zone were highlighted in 1957 by Farmer (1957, 353), but were not incorporated in the planning of the canal layout in the Kirindi Oya system. Except for the main tanks of the Ellagala and Badagiriya systems, all the other 50 then existed small tanks were demolished by the Irrigation Department, because "it was not possible to have two types of systems at the same time" according to the responsible Resident Engineer at that time. Another argument against the incorporation of these tanks in the layout was the risk of breaching of bunds with the increased water availability.

The advantages of the small tanks in terms of the permanent availability of drinking water in the command area or in terms of decentralized buffers for unregulated irrigation and drainage flows were neglected. Other functions attributed to reservoirs, but not translated into requirements by the Irrigation Department were the provision of drinking water in the off-seasons, and the several requirements with respect to the ecosystem function of the village tank, e.g., cultural center, bathing, food in terms of fish, seeds, stems and tubers, fertilizer and clay (Mendis 1977, 55).

Requirements for the layout of the *drainage system* as given by Ponrajah are: (1988, 105): (a) Farm drain between adjacent farms — minimal size;

(b) turnout drain between adjacent areas and between adjacent groups of farms as in escape drain from the end of the field channel — duty of ha per cusec; (c) secondary drains service turnout drains — duty of ha per cusec; (d) main drain service secondary drains and generally existing drainage lines, streams and rivers — only training is required.

However, during actual construction of the system by the Irrigation Department these requirements appeared to be different; the construction of drainage canals got little priority compared to other construction targets and, in practice, drainage canals were constructed only if complaints about drainage problems and salinization from water users reached a level that cannot be ignored.

Managerial aspects. Functional requirements for the system layout were dominated by the "regular" pattern of turnout areas served by one-cusec canals and the increased number of control structures. This system has been introduced to Sri Lanka in Mahaweli System H by a consulting firm. The regular pattern of main, secondary and tertiary canals existed earlier too, but lengths and capacities of those varied. Very long distributary channels and field channels could be especially problematic. Despite increased costs of this new layout concept, the validity of the assumptions in terms of improved water delivery performance has never been assessed.

Rather, the technical soundness and rationale of the turnout area concept were blindly accepted and the concept implemented, and the matching of theoretical water requirements and actual irrigation requirements was considered the responsibility of the Department of Agriculture and its research stations. It was still the official opinion of the Designs Branch. Though the Technical Guidelines were originally not meant to be a "Bible," they were often followed that way by the Irrigation Department.

Lack of interest for nonengineering aspects like soil suitability, drinking water and environmental and settlement aspects among the involved staff of the Irrigation Department had led to creating layouts that were not at all adapted to the actual local situation and requirements, nor to the management capabilities and motivation of the staff. The efforts to maximize the command area were not based on a sound discussion of all relevant factors, but were subordinate to the engineering rationale of the Technical Guidelines, and in a way, to the choice for the "one-off" system.

Following this rationale, the design staff in the head office and at the project site were mainly judged by their loyalty and attainment of targets, not by their creativity regarding the nonengineering appropriateness and feasibility of the designs. Drainage canals, important for the newly settled farmers, were given low priority.

Peak Irrigation Requirements

Technical aspects. Within the canal layout described above, important functional requirements for the downstream development were the peak irrigation requirements at field level which formed the basis for designing the peak irrigation requirements of the canals.

Peak irrigation requirements of field and distributary channels depended directly on the water requirements of the turnout areas. Those irrigation requirements were determined by the Irrigation Department on the basis of the theoretical water requirements or the "depth of water needed to meet the water loss through evapotranspiration of a disease-free crop, growing in large fields under nonrestricting soil conditions including soil water and fertility and achieving full production potential under given growing environment" (FAO 1977 in Ponrajah 1988, 48).

Evaporation standards for Sri Lanka had been determined in the Maha Illuppallama research station and were considered appropriate for the whole dry zone. Irrigation requirements could be determined assuming standard farm and conveyance losses, land preparation requirements, and the 75 percent probability rainfall as the effective rainfall. The reliability of these assumptions was rather questionable as has been discussed in Annex 2 and also in IIMI (1990, 75).

The peak irrigation requirement for the turnout area was also based on the assumption that lowland farms are irrigated 24 hours a day and upland farms 12 hours a day, while their water requirements were assumed to be the same. The field-channel duty was assumed not to vary with the cropping pattern (ibid., 102), and its capacity was fixed at one cusec. Depending on the proportion of upland and lowland in the turnout area, the size of the turnout area was adjusted to the fixed-channel duty.

A major assumption in this respect was that the upland farms have the same irrigation requirements as lowland farms. Another important

assumption was that the peak irrigation requirement which theoretically occurs in July (ibid., 128), is larger than the peak irrigation requirement during the land preparation period. But this is generally not the case in Sri Lanka. The theoretical crop water requirements during the land preparation period are very small, while the actual water requirements are generally the highest of the whole season.

The size of the distributary canal feeding a group of field canals depends directly on the number of field canals served by the distributary canal. The Main/Branch canals are designed to supply the needs of the distributary canals simultaneously (Ponrajah 1988, 101).

This procedure was not followed for the Kirindi Oya system main canals; their peak irrigation requirements were determined simultaneously with the head sluice as has been described before. It had been followed, however, in the case of the distributary channels.

The validity of the assumed peak water requirements was further weakened by the lack of reliable soil data to determine the size of the turnout area. In actual layout designs of the Kirindi Oya system the divisions of upland, intermediate land and lowland seemed to be determined more by the layout of the field and distributary channels than the other way around.

No reference was made to actually achieved peak irrigation requirements in similar systems in Sri Lanka. For the land preparation in the Kirindi Oya system IIMI determined a peak irrigation requirement of 880 mm (as against the assumed values of 125 and 200 mm for lowland and upland soils) and peak water requirements as high as 3.41, 3.58 and 2.68 l/s/ha at the heads of sample branch canals and distributary and field channels in the Kirindi Oya system (Sri Lanka Field Operations 1989, VII.6). A clear difference, thus existed between the perceived peak irrigation requirement (determined by means of the theoretical water requirements as described in the Technical Guidelines) and the actual peak irrigation requirements of the water users and staff involved in water delivery.

The maximum capacity required for a field channel was fixed at a cusec or 28.3 l/s, which was considered sufficient to supply a turnout area of 16 ha in lowland or 8 ha in upland. The freeboard in the field and distributary channels was required to be 0.45 m. An implicit requirement was that the channel capacities allowed for discharge variations: up to 46 percent for field channels without encroaching on more than 5 percent of the required

freeboard, and up to 20 to 60 percent for distributary channels without encroaching on more than 10 percent of the required freeboard (as specified in Ponrajah 1988:129). At the same time, the permitted maximum encroachment on the freeboard allowed the occasional increasing of the turnout area to 22 ha for lowland or, to 12 ha for upland (ibid., 104).

Managerial aspects. The managerial processes regarding the peak irrigation requirements demonstrated amazing nonchalance. The assumption that the Right Bank main canal design discharge was 50 percent of the discharge assessment in the Appraisal Report of 1982 cannot be called a professional "rule of thumb." It should have been considered, instead, as a factor that leads to the "rule of thumb" design discharge of 2.0 l/s/ha for the humid tropics without the consideration of its validity for Sri Lanka.

This assumed design discharge of 2.0 l/s/ha for the whole command area had apparently led to overloading of the main canal during the land preparation (see chapters 3 to 5), and only half at the originally envisaged command area of the Right Bank had been developed.

A strange engineering rationale seemed to be dominating this decision making, which allowed usage of a factor of 50 percent, but apparently not a factor of 150 percent or 300 percent, to design the canals for land preparation. An implicit argument to limit the design capacity and thus the maximum issues during land preparation (a form of passive control) might have been used. This rationale might have been used for the distributary channels and field channels as well.

The use of different bases to determine the peak requirements for the main and distributary channels (i.e., 50 and 25 percent respectively) implicitly suggests that a larger flexibility of the main canal discharge was required. The Technical Guidelines and the different project reports do not support these calculations and the implicit requirements used. "As long as sound engineering calculations are used, any assumption is allowed..." seems to be the criterion used in this decision making.

Another major weakness in the determination of the peak requirements was its dependence on the accurateness of the assessment of the soil types, because this has been often neglected in the actual construction of irrigation systems. The turnout area was determined by assuming that the uplands are irrigated only 12 hours a day. The rationale in this respect seemed to be that several engineers (including the compiler of the Technical Guidelines) argue

that it has never been proved that uplands need more irrigation water than lowlands, because a hard pan is formed after ten years. Thus, the long-term irrigation requirements of lowlands and uplands are assumed to be the same. However, the longstanding experience with the top-end blocks of the Uda Walawe system proved it to be vice versa (e.g., Nijman 1991b, XX).

Unfortunately, it appeared that an unwillingness to accept the expertise of other disciplines, soil science in this instance, as well as an indifference to the actual problems during the allocation and water flow regulation processes dominated this attitude of the engineers.

Controllability of Flow

Related to the requirements regarding the layout are requirements regarding controllability of water flow which involve the control of inflow into a canal, conveyance through a canal and distribution from one canal into another.

Technical aspects. The controllability of inflow into the main canal has been described earlier in the section on head sluices. No explicit requirements existed regarding the water flow regulation below a head sluice. The requirements regarding the conveyance along the main canal were less explicit. Given the assumption that subsidiary field crops in uplands would be irrigated only 12 hours per day, "wherever possible regulation reservoirs are incorporated in the canal system for overnight *storage.* If this is not possible, the required regulation is effected from the head sluices" (Ponrajah 1988, 101).

The Feasibility Report envisaged intermediate storages "along the right and left bank canals to accommodate fluctuations in operation" (ADB 1977a, XXVI.4). This nuance — between overnight storage and intermediate storage — reflected the opinion of the Irrigation Department, until very recently, that fluctuations in the main canal do not occur. It consequently designed the canals for steady flow conditions. Even with overnight storage however, fluctuations would occur, especially with daily regulation at the head sluice. Despite these stated requirements of the Irrigation Department, there were no systems with night storages in Sri Lanka.

In the Kirindi Oya system, the Irrigation Department initially designed a single bank main canal. The main reason for this change was the political

pressure to produce quick results, and the experience was that single banks are simple to construct and can be built rather quickly. Another advantage of this type of canal is its capacity to collect runoff from its catchment area. As siphons or under-crossings are not needed, it is also relatively inexpensive. Moreover, the canal provides for regular pools along its course which can function as intermediate storages. Disadvantages are its sluggishness in transporting water from head to tail, and the resulting decreased capacity to distribute variable flows, especially if no cross-regulators are provided. This seemingly reduced flexibility of the canal is, however, partly compensated for by the increased storage available in the canal.

Without cross-regulators, no effective use of rainfall can be made (except on-farm), unless intermediate storages are provided downstream. With cross-regulators the water flow in a single bank canal remains sluggish, if regulation occurs at the head sluice. Because of this perceived reduced controllability of flow of the single bank canal, it was abandoned during construction and a double bank canal was built instead. The fact that the Irrigation Department staff were incapable of realizing the implicit design assumptions to control water flow during the actual utilization of Department's irrigation systems with double bank canals, has been neglected.

The exact requirements of the Irrigation Department regarding *cross-regulators* were unknown. Presumably, the main objective was the ability to be more responsive to localized changes in demand, and thus reduce the regulation required at the head sluice. Steady flow was assumed to ensure this responsiveness along the main system up to its tail end.

The losses which were caused by localized interventions during conveyance to the downstream main canal were preferred by many irrigation managers to the losses that would be caused by the inability to make any adjustment at all without cross-regulators. However, the Designs Branch had not derived requirements from the actual practice with conveyance and distribution in existing systems, but considered the canals to be operated under steady conditions, which made any additional requirements redundant.

Implicit requirements regarding the water flow through the parallel gates of the cross-regulators are the reduction of erosion of the canal downstream of the structure and the flexibility to operate the structure in case of

malfunctioning of one or more of the parallel gates. A related implicit requirement is the simultaneous opening of the parallel gates.

At the same time, the heights of the side walls of the cross-regulators are designed to maintain sufficient head upstream of the cross-regulators to distribute water to the distributary channels. However, there are no requirements with respect to the size of the sidewalls for passive upstream level control. It is a requirement that conveyance along the canal be made completely through the slide gates of the cross-regulators. Related management requirements do not exist.

There are no specifications regarding the maximum manual effort required for the operation of gates in canal structures. The Technical Guidelines give possible hoist capacities with different manual efforts, but without any limits. In the Kirindi Oya system, however, it appeared that because of the heavy effort required to operate the gates, the gate tenders preferred to operate only one gate instead of the number required by a standing order. This practice led to more erosion downstream.

Distribution from the main canal and distributary channels occurs through *turnout structures*. No requirements have been specified regarding these structures, but it could be assumed that the prescribed undershot type of structures were chosen, because they were less sensitive to upstream water level fluctuations (i.e., they exercise a degree of passive control). Given the assumed steady flow conditions this however, was not a requirement.

Maximum distribution to the distributary channels requires a control water surface in the main canal. "The control water surface in the supply canal considered for the design of the turnout can vary from 2/3 full supply depth to full supply depth in the supply canal depending on the location of the turnout with reference to the regulator for same in the supply canal" (Ponrajah 1988, 108). The maximum upstream spacing of cross-regulators is thus determined by the condition that the water level in the main canal would not drop below 2/3 full supply depth, assuming steady flow conditions. This 2/3 full supply depth is a "rule of thumb" that originates from the traditional unregulated canals.

However, due to the existed unsteady flow conditions in the Kirindi Oya system, the actual maximum distribution through the turnouts in the irrigation systems of the Irrigation Department varied (e.g., IIMI 1989a, F.71).

To be able to cope with deviations from assumptions made in the design of the turnout structures, the diameter of the pipe or height of the box culvert was increased by 25 percent (Ponrajah 1988, 109). No reasons as to why this increase of 25 percent had been effected were given in the Technical Guidelines, but the Designs Branch argued that it had been calculated to cover deviations between assumed and actual rainfall.

Functional requirements for turnout structures are thus implicit, i.e., a certain degree of passive control whereby the maximum discharge is equal to the theoretical crop water requirements, the assumed losses and a margin of 25 percent.

The water consumption by the water users and staff has not been taken into consideration. During the development of a large command area under constant time constraints as in the Kirindi Oya system, such adaptation or detailed surveying of the "blueprint" layout as prescribed by the Technical Guidelines was rather difficult, and estimation of the consumption by the water users and staff was difficult as they were not yet in the area. On the other hand, the use of the theoretical crop water requirements, assumed losses and a 25 percent margin seemed inappropriate without sufficient and reliable data, for example, data on soils, and more realistic assumptions about future operational practices and irrigation requirements.

The preferred irrigation requirement of the water users in Sri Lanka for the cultivation of rice tends to be a continuous supply. If that was impossible the water users preferred flexible operational practices by the gate tenders, so that they could get water to their fields whenever they required it, rather than at times determined by the higher levels of the agency.

The turnout area concept, however, was based on the requirements of the crops and assumptions regarding increased (or perfect) control over water flow by the agency. The above functional requirements of the turnout structure seemed to have contributed to this goal by restricting the maximum discharge to a certain degree.

Lack of controllability of distribution through turnout structures was further aggravated by backwater effects, which often influenced the *measurement structures*, sharp-crested weirs below the turnout (IIMI 1989a, 82). Experience gained by the Irrigation Department in Gal Oya with broad-crested weir type measuring structures that were less influenced by backwater effects, has not been incorporated in the functional requirements

for the Kirindi Oya system, according to the Designs Branch, because "these structures were built by consultants and the district level Irrigation Department <i.e., Deputy Director Range>, and <the Designs Branch> do not know how they perform."

No reference is made in the Technical Guidelines to the influence of the different types of *regulators* on the water flow regulation. "The weir regulator is more suitable for use in small canals due to limitations of afflux [19] and length of weir. Gated regulators can be adopted for medium size canals with vertical wooden gates and screw lift hoists and with radial gates in large canals" (Ponrajah 1988, 111). This means that the weir is considered expensive, because of its length and the higher canal bund it needed. Increased siltation is another disadvantage listed by the Designs Branch.

The major reason given for not having weir regulators was the construction cost it involved; other requirements were ignored. The actual functions of the structures were not considered, it seemed, in the decision making. A weir regulator (e.g., a duckbill weir) allows for the reduction of fluctuations in the canals (i.e., passive control), while ensuring conveyance along the main canal. It also functions as a hydraulic control (by ensuring the hydraulic independence of upstream and downstream canal reaches) and can be used as a measuring structure. The gated regulator provides for more flexibility to "push" water to the tail end of the canal, but at the same time allows for manipulation of the maximum allowed distribution at the expense of conveyance and stable flow conditions. Moreover, it is prone to backwater effects given the very low main canal slopes in the Kirindi Oya system. In fact, the small slopes prevent the use of weir regulators in main canals. The slope requirements are determined by the maximum command area (ibid., 130) that could be reached while keeping siltation within acceptable limits (ibid., 106). Arguments in favor of water flow regulation and controllability of conveyance were not considered in this respect. More control over water flow could have been achieved by using weir-type regulators, instead of maximizing the area commanded in the relatively unsuitable upland soils, which was the then focus.

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19 Afflux is the upstream rise of water level above the normal level of water in a channel and it is caused by obstruction or contraction of a normal waterway, by structures such as a bridge, a weir or a regulator (ICID 1967, 254).

Conveyance in all canals is assumed to occur according to Manning's formula,[20] which implicitly assumes a steady water level upstream of cross-regulators. A requirement is that the velocity of flow should be "between the limiting velocity of silting and scour respectively"(ibid., 106). The critical flow velocities are determined assuming steady flow conditions. If a discharge, which is either more or less than the design discharge is conveyed through a canal, these velocities do not apply anymore, which is inevitable for irrigation canals with variable flows.

No functional requirements for *siphons* regarding their influence on the water flow were set, although such requirements should have followed as a direct result of the introduction of double bank canals and their assumed higher water flow control. The influence of debris in the trash rack on daily water fluctuations (see Chapter 5) was not considered. The Designs Branch assumed that in later stages improved maintenance would have prevented the presence of trash in the main canal.

The Technical Guidelines envisaged the use of uncontrolled spillways "to protect the canal and adjacent property from damage which would result from the admission of uncontrolled storm run-off into the canal from drain inlets or an uncontrolled excess flow within the canal" (ibid., 114). In addition, a gated spillway was constructed upstream of the siphon; if the siphon was blocked, all discharge could be drained through these radial gates. However, a gate tender was needed to operate that spillway and it appeared to be unfeasible during emergency situations like heavy rainfall at night.

Managerial aspects. The layout-related requirements in regard to the controllability of water flow have not been explicitly stated; if regulation reservoirs were not available or possible, "regulation was effected from the head sluice." The requirements which would allow this regulation at the head sluice remained unspecified. The Irrigation Department's official view on controllability of water flow was that its canals operated under steady flow conditions. Actual experience with fluctuations of water levels along the canals was ignored, most probably because many engineers considered these fluctuations to be of minor importance. They were indeed of minor priority

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20 The Guidelines state that flow in the field channels and distributary channels is assumed to be in line with Manning's formula; but in practice the v=Q/A calculation is applied to determine the critical and normal flow velocities (Ponrajah 1988, 129).

in the single bank canals where less control over water flow was assumed anyhow. Different requirements assumed for the double bank canals were not considered in the Technical Guidelines, nor during the design phase of the Kirindi Oya system. The Irrigation Department did not want to accept even the existence of such fluctuations, given their unfamiliarity and constraints faced in the implementation of improvements.

The Irrigation Department appeared to have readily accepted the scientific water delivery concepts and designs with double bank canals, which came to them with the foreign funding; but the Department was indifferent and unmotivated to manage them according the implicit assumptions. In fact, its own assumptions regarding the water delivery concept was quite different from those of the expatriate consultants and donors. This again signified a need for more explicit and realistic assumptions by the Irrigation Department, consultants and the donor staff, before a project was considered feasible.

For the Kirindi Oya system, the Feasibility Report assumed the construction of double bank main canals (ADB 1977a, XXVI.19). The Irrigation Department, however, started building single bank main canals in the system. The reason for this was apparently the requests from the politicians for quick results. At the time of reformulation of the project in 1982, the construction of the single bank canals was far behind schedule. The visiting donor mission, which also disagreed with the construction of single bank canals, demanded their replacement with "normal" double bank canals, thus "removing the major cause of poor hydraulic performance of the canal and low irrigation efficiency experienced with the traditional single bank canals such as those constructed under the Walawe Development Project" (ADB 1982, 91). The involved donor officers were assuming that the single bank canal was "the major cause" and this assumption showed a bias toward modern scientific design principles which are yet to be proven as appropriate for Sri Lanka.

Even then, engineers of the Irrigation Department were not quite certain which water delivery concept was better. Many believed that their earlier water delivery concept was much cheaper, needed less foreign funds and expertise, and was at least equally efficient in water use. A major drawback was that most older systems could not cultivate during yala seasons. A synthesis or additional research to professionalize this issue, however, had

not been done, which again showed the lack of interest or indifference of the Irrigation Department as a whole to that issue. Occasionally, the water users have expressed their regrets that the Right Bank main canal in the Kirindi Oya system was not a single bank canal because, in their opinion, it would have allowed for the collection of runoff, which was important, especially during times of water shortage.

At the time that the donor demanded the change from single bank to double bank canals, the staff of the Irrigation Department did not insist on single bank canals and agreed to the preference of the donor. The deciding factors were the requirements of the donor rather than the sustainability of this change from single bank to double bank canals in the Sri Lankan context. The Technical Guidelines, moreover, did not provide for a choice between single bank and double bank canals.

The requirements of the Irrigation Department for *cross-regulators* were different from those of the donor. According to the donor, "For adequate water management, additional cross regulators were provided" (ADB 1982, 91). What "adequate water management" meant was unknown, but it probably referred to more localized control over water levels. Such remarks, again showed the detailed interventions by the donor staff and thus their commitment and belief in the scientific water delivery concepts.

The Designs Branch has no specific conveyance and distribution requirements for the cross-regulators in terms of the degree of passive or active control of water level, interdependency of canal reaches and localized responsiveness or flexibility for "pushing." This was, again, due to the fact that the canals were assumed to operate under steady flow conditions.

The requirements specified for the manual effort needed to operate the slide gates of the cross-regulators were explicit. Despite these requirements, the operators did not operate the gates according to design assumptions (as described in Chapters 3 to 5), but that did not led to any reconsideration of those requirements or to the evolvement of design guidelines.

The fact that all the aforementioned requirements and their relations to the chosen design options were not made explicit was a major weakness which prevented a continuous reappraisal of the validity of the chosen design options in view of these requirements. Such reappraisals were almost nonexistent in irrigation engineering at that time.

Similarly, the functional requirements for *turnout structures* were not made explicit in the Technical Guidelines; it is implied that the turnout structures limit the need for active control through the use of undershot gate type structures and restrict the potential discharge to the assumed theoretical water requirements, losses and a 25 percent margin. The assessment of these theoretical irrigation requirements remained very imprecise as described under the earlier section on Peak Irrigation Requirements. Determination of really appropriate functional requirements on the above lines would have required localized assessment of irrigation requirements, rather than theoretical water requirements only. More detailed surveying and study of the local situation and experience of the existing communities and more gradual development would have enabled a more accurate assessment of these irrigation requirements.

No functional requirements for *measurement structures* were given in the Technical Guidelines. Measurement structures for distributary and field channels were not even explicit requirements as such, but were prescribed as part of the turnout structure. The required submergence limit has not been made explicit and the appropriateness of the prescribed sharp-crested weir was, therefore, not clear. The implicitness of these requirements did not enhance the likelihood of discussion of its appropriateness either. This sharp-crested weir type of measuring structure appeared to be inappropriate during Phase I, because it limited the maximum water issues and thus stimulated breakage — by staff of the Irrigation Department and the water users — to increase the water issues. In contrast, a broad-crested weir with a higher submergence allowance, less head loss and less prone to breakage had been successfully built in the Gal Oya system.

Even when confronted with the above facts, the Designs Branch seemed unwilling to consider the inappropriateness of the sharp-crested weir. Reports made by the Water Management Feedback Center on problems with the sharp-crested weir did not lead to changes and intervention by the donor (ADB 1988, 3) was required to replace the existing sharp-crested weirs in Phase I areas by broad-crested weirs and to use only the latter in Phase II. Even after this intervention by the donor, the Irrigation Department continued to construct new sharp-crested weirs in Phase II for some time. The unwillingness of the Designs Branch in this case seemed to be motivated mainly by the seniority of the involved officers and a disinterest in the actual

functionality. The decision-making processes regarding the functional requirements for the measuring structures, i.e., submergence allowance, proneness to breakage and acceptable head loss were dominated less by the issues themselves than by aspects of human relations.

As it was for the decision-making processes about the single bank canal and the exclusion of night (or regulation) reservoirs as prescribed by the Technical Guidelines, the processes regarding the measurement structures showed a great disinterest and indifference by the Designs Branch toward the actual functionality of its design standards for the infrastructure below the head sluice. In addition, the processes showed the courage required from irrigation system managers, who were always less senior than the decision makers in the Designs Branch, to contribute to the improvement of the functional requirements and the evolving of design concept. Creative ideas by junior staff were discouraged. These processes showed that serious improvement of these functional requirements and related design concepts will not be an easy process.

Without explicit functional requirements, the discussion on appropriate structures will always have to be derived from international reference guides and textbooks, i.e., from the "conventional" engineering wisdom. Such structures may, however, have functional requirements, which are less valid for Sri Lanka in general, or for specific systems in particular. The evolving discussions will then be of the type which could be described as, "the present trend is to use siphons," borrowing an expression from one of the Annual Transactions of the Institution of Engineers, Sri Lanka. However, such arguments are not analytical or professional.

Communications, Staff, and Water User Inputs and Discipline

Technical aspects. The chosen layout and water delivery concept are also related to requirements for communications, staff, and the water user inputs and discipline. Without intermediate storage, the in-seasonal allocation and consequent water flow regulation processes in the Kirindi Oya system would have to be coordinated by higher-level staff of the Water Management Feedback Center.

These requirements have been elaborated by the Water Management Consultants in several reports. Their terms of reference included almost all issues related to the utilization of the irrigation systems given the envisaged design (MLLD 1982b, A.2). Their reports recommended ways the new irrigation system had to follow, whereby they implicitly assumed rational decisions of all staff toward water efficiency only, without considering existing motivational constraints. The practical validity of these recommendations was very limited in the actual utilization of the system.

In practice, the water delivery concept used required much discipline and effort to achieve the implied information flows from a centralized office to the field and vice versa. The ability of the water users and field staff to respond to sudden changes in the requirements was limited without intermediate storage of such information flows. The requirements of disciplined on-farm water management by the water users were high and also they included requirements regarding the cooperation and association of the water users to cope with the water allocated and delivered. Requirements regarding the water user organizations in their turn created complicated and unrealistic requirements regarding the settlement processes as has been described by Stanbury (1989). Such requirements were not specified in the land settlement part of the Technical Guidelines of the Irrigation Department (Ponrajah 1988, 155).

All these management related requirements appeared to be unfeasible in the actual utilization of the systems of the Irrigation Department, even if certain individual staff members were motivated to achieve such control over water flows. The design envisaged an upstream mode of allocation and regulation, which in practical operation, could not be achieved, as has been shown in Chapters 3 to 5.

More creative canal layouts combining single bank (or contour) canals, cross-regulators and intermediate storage were not considered for the Kirindi Oya system. However, such a layout would have had several advantages: it required less communication between head sluice and different reaches along the main canal; it required less managerial control over water flow through the provision of buffers for flow fluctuations; it collected runoff from the canals' own catchment; and, it was less costly than the double bank canal. Such a water delivery concept would have allowed for more localized

responsiveness to changed requirements. Less control over water flow, but more reuse of runoff and drainage water has been envisaged.

Little feedback was available from the beneficiaries, the local community and the staff that managed irrigation systems regarding the feasibility and desirability of all the aforementioned functions. The sustainability of these assumptions thus remained unknown.

Managerial aspects. Functional requirements regarding communications have not been considered at all. Communications required to control water flow as assumed in the then extant design concept and described in the Technical Guidelines, were implicit and unclarified.

Compared to the traditional design concepts, the then existent "scientific" design concept, however, assumed an enormous increase of control over water flow processes, and thus an increase of related communication processes. The absence of such requirements suggested again the lack of interest on the part of the Irrigation Department in that type of nonengineering issues, and also in the related sustainability of the assumed benefits of the modern design concept. A former Chief Resident Engineer, however, made an attempt to specify such requirements for the Kirindi Oya system by writing three pages on this subject (Irrigation Department 1986a, 21). He envisaged daily monitoring of water levels in all canals and regular — how regular was not clear — adjustment of the allocations. Feasibility, ability to implement, and relation to the functional requirements of other system components were ambiguous and the guidelines were rather imprecise.

The donor hired the Water Management Consultants to determine, among other things, the communication requirements after project construction was completed. These requirements might have represented, to a certain degree, the requirements that might have been assumed in the design of the system. This was not clear, because the Designs Branch assumed steady flow and thus virtually there were no communication requirements. The Chief Resident Engineer's manual also envisaged less communication than that of the Water Management Consultants. Theoretically, even more communication requirements could have been incorporated than those that were defined by the Water Management Consultants; it was unclear why the consultants had limited them. Nevertheless, the communication requirements as defined by the Water Management Consultants, were far too

ambitious for the actual managerial capabilities and motivation of the Irrigation Department staff.

The utility value of writing up such requirements after the design and construction of a system is questionable. It is only before and during the actual design and construction that the functional requirements of different system components can be matched into a feasible overall design concept. The practice of writing Operation and Maintenance Manuals after project construction even justified, to a certain degree, the lack of consideration of this aspect by the Irrigation Department and the donor before and during design and construction. The new "one-cusec" canal concept has created functional requirements for the water user groups as well. The Irrigation Department and its Technical Guidelines did not recognize the organizational problems that might evolve from the need to share water among the water users. To improve the productivity in its major irrigation systems through increased participation in system management, the Ministry of Lands and Land Development instructed the Irrigation Department to set up the water user organizations. The department was originally not very eager to do so, and because of this lethargy, the government established the Irrigation Management Division as a separate organization under the Ministry of Lands and Land Development.

The functional requirements of these water user groups are the sharing of a one-cusec discharge among members of each field-channel group and the cleaning of field channels. However, it is difficult to motivate the water users to carry out functional system requirements that are inconsistent with their individual requirements, such as a continuous water supply. This is even more difficult for the Irrigation Management Division, for they are not involved in the day-to-day water allocations.

Despite the lack of organized sharing of this one-cusec discharge, its rationale and feasibility remain unchallenged as yet. Many engineers consider the unorganized sharing as satisfactory, while ignoring the related breakage of bunds, obstructions, water theft, etc., by the water users who feel that they could get sufficient water at the right moment, or during water shortage.

In fact, many engineers considered that this problem was not their responsibility as the one-cusec discharge concept evolved from agricultural research; and if it did not work satisfactorily, it was a problem for the

agricultural people or the water users, because the engineers have already done their job. This attitude showed that, despite their scientific design concepts, irrigation management for the Irrigation Department was still restricted to releasing water from the head sluice; and below that point "there is nothing to be managed" as some engineers used to say.

In irrigation-cum-land settlement systems like Kirindi Oya the functional requirements for land settlement and irrigation could be approached in an interrelated way, because of the possible influence of land settlement processes on the processes of organizing the water users into groups. These interrelationships have been the subject of a separate IIMI research project in the Kirindi Oya system (Stanbury 1989) and are not elaborated upon here.

Stanbury's study shows that mainly due to priorities for construction targets and political interference in settler selection processes, the required match between land settlement and the water user group requirements is often not achieved. Nonresidence of settlers, lack of correspondence between turnout area groups and residential groups, poor communication between agency staff and settlers during construction are major evolving bottlenecks in this respect. While Stanbury gives several recommendations, the underlying priorities of politicians and agency staff are difficult to incorporate; effective matching of settlement and the water user group processes are rather ambitious and sophisticated, given the institutional weaknesses.

The Irrigation Department itself considered land settlement a part of its Blocking Out Plan (i.e., the layout of the canal system and turnout areas) and other construction activities, and the human aspects were limited to the provision of some basic needs (Ponrajah 1988, 214 and 1981, 17). How those settlers would finally become disciplined sharers of the one cusec per field channel discharge was not considered. The donor went along with this approach. The Ministry of Lands and Land Development, however, considered the total financial effort for settlement in the original project, i.e., about 10 percent of the total project (ADB 1982, 93), rather limited for sustainable settlement. Its arguments were accepted by the donor, and this percentage was increased to approximately 30 percent for Phase II (ADB 1986:19). In addition, livestock development and social forestry components were added to Phase II. Though that increase in funds might have contributed to more sustainable settlements as such, the increased investments in the

settlements would not lead, by themselves, to more sustainable water user groups, and sharing of the one cusec per field channel discharge.

Mutual Adaptation of the Technical and Managerial Aspects

Determination of the irrigation requirements was governed by optimistic assumptions in terms of effective rainfall, the water user requirements during land preparation, the cultivation of subsidiary field crops, etc. This was caused by the necessity of the donor and the government officials to achieve an acceptable EIRR. Many engineers were aware of the shortcomings and dangers of following the theoretical water requirements, but were forced to do so, because of their international status and wide acceptance by the engineering profession. Moreover, the Irrigation Department insisted its engineers to use these theoretical water requirements. In principle, the use of theoretical water requirements allowed for assumptions regarding less efficient managerial practices (e.g., communication problems and consequent excessive land preparation water requirements and little effective use of rainfall), but that was considered unprofessional by most officers of the Irrigation Department.

While these considerations were relevant, the underlying priorities and arguments remained uncertain, and as a result their consequences for the future of the Kirindi Oya system also remained unclear. It was possible that no justifications were given for the irrigation requirements used in the operational study to determine the required reservoir capacity, or for those used in the calculation of the discharge in the main canal; or, that an unrealistic command area was envisaged by the Appraisal Study of 1982 which, remained unclear up to then.

It seem that a certain consistency is required in the use and justification of irrigation requirements during different project phases and by different professionals involved. If different people want to introduce their own estimates, they should be allowed to do so only with justifications and references to earlier estimates. Apart from that, the concept of theoretical water requirements is usually not considered separately from actual irrigation requirements. Between the moment of the release of water from the head sluice and the application of irrigation water by the water user for irrigating

his or her crop, a complex of internal agency processes and interaction between agency and the water users created irrigation requirements, which appear in practice, to be quite different from the theoretical water requirements. This difference is caused not by measurable losses alone, but to a large extent, by managerial losses as well. This discrepancy strongly suggests that the use of the theoretical water requirement calculations for assessments of the system feasibility and for the determination of functional system requirements should be abolished.

The implicit functional requirements of the system layout appeared to be the outcome of a very rigid "blueprint" engineering approach, whereby the required localized information was usually unavailable due to time pressures. This has led to layouts which often incorporated soil proportions inappropriate for the related canal capacities and large proportions of upland soils, which were less suitable for irrigation, and which often did not optimally use the reservoirs and drainage lines. For the assumed increased control over water flow these were rather unsustainable characteristics.

Important nonengineering aspects of the layout (e.g., ecological and environmental changes related to drinking water, groundwater table, fishing, settlements, and the existing and new reservoirs) are not considered. The potentially required or preferable additional intermediate regulation reservoirs or single bank canals are singled out through this one-dimensional approach.

More sustainable determination of all functional requirements necessitates more gradual development, less time pressure and incorporation of more requirements, preferences and experiences of the existing local population, especially regarding the sites of intermediate reservoirs.

A common practice of consultants and the Irrigation Department staff is to present their assumptions without any background information or justification. An example is the use of the multiplication factor of 50 percent for head sluice and 25 percent for turnouts for determining the peak irrigation requirements. Without such justifications, and thus without making the underlying functional requirements explicit, the discussion of appropriateness of these requirements and adequacy and improvement of the evolving assumptions for future projects is difficult. Without making the underlying functional requirements and assumptions explicit, the professionalization of irrigation engineering also becomes difficult.

The confusion about control over water flow versus collecting runoff and drainage water was similar; given its management capabilities and motivation, the political interference involved and irrigation and nonirrigation requirements of the water users and the local communities the Irrigation Department has not developed any clear functional requirements toward controllability of water flow. Since the Irrigation Department has not developed consistent requirements, there was no defense against the "scientific" engineering approaches proposed by consultants and the donors. It, however, implicitly assumed sophisticated managerial practices, noninterference of politicians, and disciplined water users and staff.

Such unprofessional remarks as "the present-trend is to use siphons" which occurred in the Annual Transactions of the Institution of Engineers evolved from this "dependent" way of developing design concepts without-making the local requirements explicit. It is only with explicit local requirements that appropriate design options can be developed.

Some engineers of the Irrigation Department feel overwhelmed by political pressure to accept these inappropriate design concepts along with the foreign funds. However, apart from that there are many forces (e.g., seniority, construction priorities instead of appropriate functional requirements) within the Irrigation Department that impede such processes. As long as new construction and rehabilitation projects, which do not require more sustainable design concepts continue, changes seem unlikely.

The donor had a bias in favor of a rather one-dimensional orientation toward the characteristics of a sound design concept; as long as that concept was adopted and implemented, it was perceived that it has enforced the basic conditions for an efficient and effective irrigation system. At the same time such conditions allowed the donor to blame the agency, if things went wrong. Institutional constraints such as ineffective water user groups and lack of management capabilities and motivation of the Irrigation Department staff were acknowledged, and in Phase II some efforts (an institutional strengthening project, and an IIMI research project focusing on crop diversification) were made to solve them.

The influence of the donor on the choices with respect to the functional requirements, whether directly or through consultants, is enormous and underestimated. In contrast to this enormous influence, its monitoring of a project like Kirindi Oya was very restricted (only one visit a year to the

project by the responsible project officer), and a good knowledge and understanding of the bottlenecks regarding the functional requirements of a system like Kirindi Oya are unlikely to develop, whatever the quality and motivation of the involved donor officer.

Nevertheless, this officer is still expected to monitor and evaluate the project, and to intervene in key decision-making processes. The officer is forced to come up with solutions, because as far as the donor is concerned, he or she is responsible for clearing the impediments to attain a sufficient EIRR till the end of the construction period. In contrast, the government and the agency staff do not have such accountabilities and responsibilities.

The unsustainability of this process lies in the fact that whatever solution that this officer will push at a certain moment (e.g., standard rationalized layout with turnout areas, increased numbers of control and measurement structures below distributary-channel offtakes, cross-regulator gates, etc.), the chances that they are well-adapted to the local situation seem very small. As this study shows, the performance problems are very complicated and those are the result of many long-term and ongoing processes, solutions for which can only be identified and implemented by the Irrigation Department alone. Donor loans and consultants can play no more than a facilitating role in this respect. However, since agency staff is less concerned with the actual EIRR than the donor, and also that the continuation of the project is more important for them, they will not impede demands from the donor officer and consultants, and consider it feasible and functional as long as the loan will not be endangered. For the involved donor staff, any solution to the prevailing bottlenecks, whether real or assumed, is a rationale to convince the management that they are trying to solve problems, and thus a justification for the approval or continuation of a loan.

CHAPTER 10

System Creation: Opportunities for Improvement

IN THIS CHAPTER it is assumed that the Irrigation Department and the donor wish to improve the water delivery performance and productivity in the Kirindi Oya system to enable, for example, further increases in cropping intensities in the existing command area. It is also assumed that, to achieve this improvement, a higher level of perfection of the determination of feasible objectives and functional requirements for system creation is required. No indications can be given as to which of these opportunities deserves priority, for no comparative data regarding the relation between system performance and the levels of perfection of the different key decisions are available yet. In the absence of such normative values, the given opportunities can be used by the Irrigation Department as a kind of a checklist.

A higher level of perfection does not necessarily lead to a better outcome. In certain cases, it may be necessary to increase the quality of the decision rather than the level of perfection. Similarly, a good decision that evolves from a low level of perfection may be very cost-effective. Several opportunities for improvement given in this chapter apply to other Irrigation Department systems as well.

DESIRED SYSTEM OBJECTIVES

An evaluation of the levels of perfection and managerial conditions has not been done for this key decision. Chapter 7 demonstrated that most desired system objectives have been specified at the beginning of the project. Consultations with the local community and the beneficiaries were not done at that time. Objection of the local community to the Lunuganwehera site was overruled. The actual desirability of other project objectives from their point of view remained unknown. During the implementation of the project,

there was only very little scope to change the desired system objective and this latitude was mainly restricted to the decision making about the cropping pattern and to the extension of the new command area (in 1986) by an extra 4,100 ha. The level of perfection was thus very low (0–20%). However, further systematic evaluation of managerial conditions and opportunities for improvement along the lines of the other key decisions has been considered inappropriate given the sensitive political nature of this level of decision making.

FEASIBLE OBJECTIVES FOR NEW CONSTRUCTION

The Present Management Performance: The Level of Perfection

In this section, the overall level of perfection of the feasibility-level decision-making processes was classified as very low (0–20%). A very low or high classification is not a judgement in itself, as a very low level of perfection may lead to a satisfactory performance and may thus be cost-effective. However, in case the performance is considered unsatisfactory, a higher level of perfection is assumed to lead to a higher performance. The quantitative judgement is based on the following process characteristics.

Feedback. There was no feedback from the agencies, beneficiaries, publications or the local community regarding the major assumed feasible objectives, i.e., maintenance, the cropping intensities, the cultivation of subsidiary field crops, the water duties and the water delivery concept: A very low level of perfection (0–20%).

Foreseeing. The sustainability of the assumed water duties, the water delivery concept, cultivation of subsidiary field crops, and maintenance over the assumed 50-year lifetime of the system was not clear. Formally, they were assessed to be sustainable and incorporated as such in the EIRR, but in fact no real assessment of this sustainability had been done. Necessities for extending the lifetime of this system beyond the more realistic lifetime of

only 15 years before a major rehabilitation, were not indicated (e.g., level of maintenance funds and practices, level of perfection of allocation and water flow regulation processes): A very low level of perfection (0–20%).

Integration. The feasibility assessments of the envisaged dam site, dam height, reservoir capacity, success of cultivation, water duties, maintenance, water delivery concept, land settlement, cultivation of subsidiary field crops, maintenance, and cost recovery occurred separately; the mutual interdependence of those objectives was not taken into account in the different assessments. For example: the consequences of insufficient cost recovery for maintenance; of insufficient maintenance for water duties, cropping intensities and cultivation of subsidiary field crops; of dam sites for water duties and water delivery concept, etc., were not incorporated or considered: A very low level of perfection (0–20%).

Systematics. Few rules apply to the setting of feasible objectives by the agencies. However, a routine that had developed over time was that the feasibility assessment of a project included reconnaissance, feasibility and appraisal studies: A low level of perfection (20–40%).

Despite this somewhat regular pattern of decision making, the actual assessment of feasible system objectives for the Kirindi Oya project were determined in a rather *ad hoc* way by the responsible politicians, the donor and the consultants, in regard to the Southern Area Plan as well as the Lunuganwehera site: A very low level of perfection (0–20%).

Following this, the donor confirmed the feasibility of the decision taken by the Minister of Lands and Land Development, based mainly on available data and theoretically sound assumptions in terms of an acceptable EIRR. The donor did not require an assessment of the actual feasibility of the envisaged project objectives. No requirements existed regarding type and frequency of consultations with the agencies, the government and the beneficiaries to assess the feasibility of, for example, the introduction of subsidiary field crops and envisaged water duties: A very low level of perfection (0–20%).

Opportunities for Improvement: Requirements with Respect to the Processes

As the project objectives for the Kirindi Oya system appear to be rather unfeasible, it is assumed in this section that more feasible system objectives will evolve by increasing the level of perfection, from very low (0–20%) to low (20–40%).

Technical aspects. The available water resources should be determined at 75 percent dependable availability, i.e., the 75 percent regulated flow, or any other level which is considered feasible to achieve the other envisaged project objectives. A feasible level of this assessment is of utmost importance, because all other project objectives completely depend on this basic input.

Feasibility of project objectives like suitable dam site, water duties and related water delivery concept, cropping patterns and intensities, full reservoir level and dam height, maintenance levels and related life span of the project, and the implementation schedule should be related to past experiences rather than to optimistic assumptions only.

For a low level of perfection (20–40%), obvious experiences with respect to these assumptions of local community, beneficiaries, agency and donor staff, whether published or not, should be considered in the decision making. Obvious experiences in this respect relate to suitability of the soils in planned systems and subsystems, different options for the dam site, average water duties, acceptable cropping patterns, probable or achieved maintenance levels, probable implementation schedule, resettlement and environmental sustainability. Strong mutual influences between these different assumptions (e.g., dam site and soil suitability, dam site and resettlement consequences, dam site and environmental sustainability, maintenance levels and project life, dam site and water duty, managerial capacity or motivation and water duty) are incorporated as well.

For an average level of perfection (40–60%), the most important experiences of the local community, the beneficiaries, the agency and the donor staff, regarding the assumptions, whether published or not, are considered. Moreover, directly related mutual influences between the dam site, water duties and related water delivery concept, cropping patterns and intensities and command area, full reservoir level and dam height,

maintenance levels and related life span of the project, implementation schedule, resettlement, and environmental sustainability are also considered.

Managerial aspects. Most importantly, the assessment of feasible system objectives should be picked up by the Irrigation Department and the Government of Sri Lanka as a priority area for improvement. Outsiders will not be able to prescribe improved system development concepts and more feasible system objectives, but can only assist within the priorities set by the Irrigation Department and the government. The Irrigation Department should work with the Department of Agriculture and the Land Commissioner's Department, national politicians and the Ministry of Plan Implementation to develop a concept for river basin or system development which can lead to mutually acceptable feasible objectives for further irrigation investments in Sri Lanka. Such a river basin or system development concept may consist of feasible water duties, a more appropriate water delivery concept, feasible maintenance levels, feasible life spans, feasible resource mobilization, and feasible gradual extension of command area related to actually achieved water duties and cropping intensities.

Any requirement set by the donors or the government will become fully successful, only if the Irrigation Department takes the lead in the development of feasible and sustainable system or river basin development concepts.

At the same time, the Government of Sri Lanka should establish coordinating mechanisms at project, district and national levels, that are authorized not only to monitor and evaluate, but also to adjust objectives over time, if considered necessary. For this to be effective, the higher hierarchical levels will have to stimulate information exchanges between different levels of staff regarding the feasibility of envisaged system objectives.

More official involvement of the water user groups, the local community and local politicians on a more regular (40–60%) or less regular (20–40%) basis in the determination of feasible system objectives is required as well. More interaction creates more demands and expectations from them. This requires a compromise between these demands and the different attitudes of the involved politicians. The politicians make use of and profit from the existing "responsibility gap."

To the degree that foreign funding will be required for irrigation investments, potential donors should assess the feasibility of a proposed plan in an objective way, and base more (40–60%) or less (20–40%) on earlier experiences and achievements with the involved agency. The foreign donor should not become involved anymore in the decision making on the feasibility of project objectives; the proposal of the agency, as a whole, should be considered feasible or unfeasible. The managing agencies should be made responsible for their actual achievements through this more objective way of feasibility assessment, which is strongly related to reality and actual achievements. Spending pressures of donors should not influence the objectivity of donor staff and consultants involved in this assessment.

Opportunities for Improvement: Requirements with Respect to the Managerial Conditions

People. For a low level or an average level of perfection, the technical capabilities of the Irrigation Department and the donor staff should become less one-dimensional in terms of the reliance of these capabilities on scientific simulations of reality. More incorporation of experience in the actual day-to-day management of existing systems by engineers and other agency staff may be a first step. These should be initiated by a change in the entire setup of feasibility assessments by the agencies, politicians and donors, which will be described in this section under Organizational Rules.

More problematic may be the required change of attitudes, especially in view of the present indifference of the Irrigation Department staff. It is required for the more long-term, complex decision-making processes oriented toward more careful assessment of feasible system and project objectives. More openness by engineers in discussing their own professionalism is required to arrive at a more feasible concept for irrigation system development. More managerial skills are required to interact with other agencies, own staff, politicians, local communities and beneficiaries.

More realistic feasibility assessment requires more objectivity of the donor staff toward the actual loan approvals. The Irrigation Department and the government staff should become more accountable to the loan and project objectives in the medium term and long term.

Provision of information. For a low level of perfection (20–40%), information should be provided on past experiences regarding feasible water duties and water delivery concept, cropping patterns, suitability of soils in command areas, maintenance levels, implementation schedules, resettlement and environmental sustainability. Such information can be provided by agency staff, beneficiaries and local communities. In addition, it could be derived from publications. For an average level of perfection (40–60%), the most important experiences in this respect were considered.

For a low level of perfection (20–40%), information should also be provided on convincing mutual influences between these different assumptions (e.g., dam site and soil suitability, dam site and resettlement consequences, dam site and environmental sustainability, maintenance levels and project life, dam site and water duties, managerial capacities or motivation and water duties). For an average level of perfection (40-60%), information should be provided on influences that may affect these assumptions.

For a low level of perfection (20–40%), explicit information should be provided regarding the 75 percent dependable regulated flow, or any other level which is considered feasible to achieve the other envisaged project objectives.

Systems and methods. The Irrigation Department needs a more appropriate concept for river basin and system development which will facilitate the proper identification of feasible project objectives. In addition, the EIRR should be used only if it can determine the opportunity of a feasible project in comparison with other investments. It should not be used for determining the feasible system objectives without appropriate justification of the underlying assumptions.

For a low level of perfection (20–40%), the feasible water duties should not be determined by using the theoretical water requirements without any further justifications and calculations of the involved risks of the assumptions.

For a low level of perfection (20–40%), the operational studies will, at least, have to calculate the number of crop failures, the number of people to be resettled, the area inundated, costs of construction and water availability involved. For an average level of perfection (40–60%), it should also indicate

the feasibility of the envisaged regulated flow in view of the envisaged cultivation calendars.

For a low level of perfection (20–40%), the sensitivity analysis should incorporate the risks involved in the assumed water duties, cropping patterns, cropping intensities, maintenance levels, project sustainability, dependable regulated flow and the implementation schedule.

For a low level of perfection (20–40%), arrangements have to be made for more effective interaction between disciplinary specialists and different agencies, beneficiaries, and local community about the timing and feasibility of important project objectives like a suitable dam site, the soil suitability of areas to be commanded, water duties, water delivery concept, and cropping patterns and intensities. For an average level of perfection (40–60%), a planning system should be used for more systematic stepwise decision making and planning of these consultations.

Provision of knowledge. Knowledge about alternative river basin and system development concepts and related feasible system or project objectives should be developed by the Irrigation Department and the donor. This can be done, for example, through monitoring, evaluation, and research and pilot projects of different concepts in terms of more gradual development of the command area and establishment of realistic water duties, a more appropriate water delivery concept, feasible maintenance levels, feasible life spans, feasible resource mobilization, and feasible gradual extension of command area related to improved water duties and cropping intensities.

In the same way, managerial knowledge about different techniques to interact with different groups, stepwise project preparation, the use of criteria in different phases, and the gradual implementation of projects, should be developed by the Irrigation Department and the government. Lessons can be learnt from comparable projects in developed countries, or in less-developed countries where conditions are probably more similar.

A separate issue is the managerial knowledge how such interactive processes can be attuned to the requirements of the donor as a bank. The donor should determine in advance its own realistic requirements for feasibility assessments, which would result in feasible project objectives.

Organizational rules. For a low level of perfection (20–40%), the Irrigation Department should develop broad rules for the determination of the feasibility of a specific project, possibly within the framework of a whole

new river basin or system development concept. These broad rules should determine the responsible staff members, the different steps to be taken during the project preparation and the consultations with different groups. For an average level of perfection these rules should become more specific.

The donor should develop more (40–60%) or less (20–40%) specific requirements regarding the feasibility of proposed project objectives, which have to be determined by the Sri Lankan agencies, local communities and beneficiaries before the donor becomes involved in this process. Thus, the donor should consider only the quality of the plan and its feasibility or unfeasibility in view of important requirements, as for example, those related to earlier experiences and achievements. Responsibility and accountability toward feasibility of project objectives should be given to and remain with the Irrigation Department and the national government; their commitment toward project objectives should be the major focus in future design and development of loan procedures by the donor. The government in its turn should give the responsibility to the Irrigation Department to clarify accountability and reduce short-sighted political interventions. The donor staff and consultants should not influence these feasibility assessments of components of projects but should determine the feasibility or the unfeasibility of the overall project proposal submitted to them.

Nonavailability of counterparts with sufficient capabilities and authority should not lead to any inappropriate feasibility assessments, because the government itself, and not the donor staff and consultants, will have to develop these feasible plans. This will probably require much longer and phased project preparation periods, and for larger systems, more gradual implementation. On the other hand, better preparation will allow for fewer delays in construction and will contribute to achieve more sustainable results.

More accountability of the agency and the government toward the water delivery performance can be enforced, to a certain extent through the incorporation of achievements of the agency in the feasibility assessments for future investments, or to a larger extent, through direct accountability of the agency toward the investments and thus toward the government or the donor; i.e., project benefits have to repay part of the loan.

For a low level of perfection (20–40%), in addition to the above requirements, broad rules ("rules of thumb") should be introduced to

systematize the decision-making processes, while further perfection (40–60%), will require more specific rules.

The donor should make its staff and consultants fully accountable for the use or misuse of the EIRR; performance appraisal of the donor staff should be based on the quality of their feasibility and appraisal assessments and monitoring of their projects, rather than on the number and size of realized loans. This implies that the donor staff should be allocated much more time for assessing the feasibility of proposed project objectives and design, and evaluation of performance later on. However, no time should be allowed to them for project proposal development and design. Pressures to "sell" loans or reach predetermined loan targets should not be allowed to influence feasibility assessments by the donor staff and the consultants.

At project and national level, coordinating mechanisms will be required for monitoring and evaluation of project progress and system utilization processes. These coordinating bodies should be more dynamic and should be given authority to adjust project objectives, if the existing project objectives are considered unrealistic.

FUNCTIONAL REQUIREMENTS FOR NEW CONSTRUCTION

The Present Management Performance: The Level of Perfection

In this section the overall level of perfection of the decision making with respect to the functional system requirements is classified as very low (0–20%). The quantitative judgement was based on the following process characteristics.

Feedback. The whole design concept was based on assumptions, and no feedback on the validity of these assumptions was considered: A very low level of perfection (0–20%).

Foreseeing. Many assumptions were often related more to the medium term and the long term than to the short term. For example, the idea that due

to the formation of a hardpan, percolation of upland soils would become similar to that of lowland soils after ten years, and that the water users would do their land preparation more disciplined in the long run could be considered the long-term necessities of the system: An average level of perfection (40–60%). That, in this example, the argument about the water use of the uplands might be faulty was more a matter of the quality of the resulting decision than of the level of perfection itself.

But the consequences of actions like the overloading of the canals and offtakes during the first ten years were not considered; nor were the consequences of water shortage every other year. Lack of cooperation of the water users, feasibility of crop diversification, probable political intervention in allocating water to the Ellagala system, New Areas and Badagiriya and their short-term consequences on the viability of the assumed irrigation requirements, controllability of water flow, etc., were not considered: A very low level of perfection (0–20%).

Integration. The decision-making processes concerning the functional requirements considered neither the unsteady flow conditions, nor the required managerial capacities and motivation and realistic intensity of communication. Further, they did not consider the need to organize the water users to realize the very low water duties within the turnout areas. Also, the drinking and bathing water requirements and other more ecological and social functions of the irrigation canals and intermediate reservoirs were not considered: A very low level of perfection (0–20%).

Systematics. Determination of functional requirements has taken place implicitly through the application of scientific engineering concepts laid down in the "Technical Guidelines", which simulated the actual field reality in an inappropriate way. These guidelines are not rules as such, but directions to systematize the designs. The "Technical Guidelines" also contains a chapter on design procedures (Ponrajah 1988, 28), which certainly is meant to systematize this decision making. The level of perfection implied in these procedures is high (60–80%), but they deal less with the determination of the functional requirements and related design concepts than with the implementation of the design process as such.

The determination of the functional requirements, as described in this chapter, is not really governed by rules, but rather by a certain broad mutual understanding between the Irrigation Department, the foreign consultants

and the donor staff as to which functional requirements are best from an engineering point of view. They are generally used by the Irrigation Department to support speedy design and construction. Due to lack of rules, the determination of key functional requirements, (e.g., the irrigation requirements, the use of existing and intermediate reservoirs, the type of cross-regulators, etc.), gives inconsistent outcomes: A very low level of perfection (0–20%).

Opportunities for Improvement: Requirements with Respect to the Processes

As the present design concept of the Irrigation Department seems to be based on inappropriate assumptions and inappropriate functional requirements, it is assumed that more appropriate functional system requirements will evolve from an increase of the level of perfection, from very low (0–20%) to low (20–40%).

Technical aspects. For a low level of perfection (20–40%), improvement of the determination of the functional system requirements requires that at least the most obvious experiences of system managers and beneficiaries in the utilization of existing irrigation systems be considered. Such experiences refer, for example, to (peak) irrigation requirements, required controllability of head sluice and main system, communication requirements, system layout, drinking and bathing water requirements and other functions of existing village tanks. For an average level of perfection (40–60%), the most important experiences of system managers and beneficiaries have to be considered.

For a low level of perfection (20–40%), necessities for the sustainability of the functional system requirements (e.g., the medium- and long-term peak irrigation requirements, the passive and active controllability of flow in case of system degradation, the long-term flexibility toward crop diversification) during the lifetime of the envisaged irrigation system will have to be considered. For an average level of perfection (40–60%), it is necessary to consider priorities with respect to the sustainability of the functional system requirements (e.g., in addition to the aforementioned, the managerial and hydraulic responsiveness, the required communications and the required organization of the water users).

Moreover, for a low level of perfection (20–40%), convincing subsidiary influences in terms of mutual influences of requirements like the rationalized turnout concept and organization of the water users, or limited peak canal capacities, improved water duties and envisaged command area, and other engineering and nonengineering preferences of system managers, farmers, the local community, politicians and national and local agricultural interests have to be considered. For an average level of perfection (40–60%), directly related plans of these groups have to be considered.

Managerial aspects. A more explicit determination of the implicit functional requirements of an irrigation system is required before and during the design and construction of a system. To that end, the related internal managerial processes in the Irrigation Department will have to incorporate the experiences of its own system managers. Moreover, the matching of engineering and nonengineering functional requirements requires more (40–60%) or less (20–40%) interaction with the local community, farmers, politicians, the Department of Agriculture and the Land Commissioner's Department at this stage.

Considering the hydraulic and structural engineering aspects involved, from these different interest groups, only the Irrigation Department staff can effectively incorporate functional requirements for its irrigation systems. A reassessment of the present rigid design concept seems unavoidable to develop a new design concept more appropriate to the Sri Lankan management environment in general. At the same time, a new design concept should not be another blueprint approach, but it should have the flexibility to incorporate requirements of location-specific physical, institutional and human environments.

Such a different attitude is unlikely to come about, if foreign funds continue to flow into Sri Lanka without the requirement that the Government of Sri Lanka and the Irrigation Department become more accountable toward their own design assumptions, by developing their own independent professionalism,

and determining appropriate functional system requirements for Sri Lankan irrigation. Such a requirement on the donor's side, instead of a systematic and detailed intervention in an — for Sri Lanka — inappropriate design concept, may lead to more sustainable irrigation systems and performance. Development of appropriate functional system requirements

for new or existing irrigation systems will only be possible, if the government and the donors will allow appropriate time and funds for the required managerial processes.

Opportunities for Improvement: Requirements with Respect to the Managerial Conditions

People. Achieving a low level or an average level of perfection of the determination of the functional system requirements and evolving design concept for Sri Lanka in general, and for location-specific systems in particular, will require a different attitude toward and awareness of "irrigation professionalism" by engineers of the Irrigation Department, foreign consultant companies and the donors, because of the necessity to open up the present dominant hydraulic and civil engineering orientation for other relevant functions of irrigation systems, like realistic irrigation requirements and related management inputs.

It will also require an increased awareness by staff of the managerial aspects of the design processes. Moreover, a change in communication capacities and attitudes is required of the Irrigation Department head office staff vis-a-vis its own lower hierarchical levels and the different interest groups in society that are affected or that benefit from their irrigation systems. As mentioned before, such major changes in professional attitudes will only come about, if the involved engineers are more accountable and responsible toward their design assumptions and evolving system performance.

Provision of information. For a low level of perfection (20–40%), information should be available regarding the most obvious experiences of system managers and beneficiaries in the utilization of existing irrigation systems (preferably with a similar design concept in terms of designed allocation), water flow regulation and maintenance processes. Such experiences refer to, for example, (peak) irrigation requirements, required controllability of head sluice and main system, communication requirements, system layout, drinking and bathing water requirements, and other important functions of existing village reservoirs. To achieve an average level of perfection (40–60%), information as to the most important experiences of system managers and beneficiaries will have to be available.

Moreover, for a low level of perfection (20–40%), information should be available regarding necessities for the sustainability of the functional system requirements during the lifetime of the envisaged irrigation system (e.g., the medium- and long-term [peak]irrigation requirements, the passive and active controllability of flow in case of system degradation, the long-term flexibility toward diversifying the cropping patterns). For an average level of perfection (40–60%), information will have to be available on priorities in the sustainability of the functional system requirements (e.g., in addition to the aforementioned, the managerial and hydraulic responsiveness, the required communications and the required organization of the water users).

Moreover, for a low level of perfection (20–40%), information should be available on convincing subsidiary influences in terms of mutual influences of requirements like the rationalized turnout concept and organization of the water users, or limited peak canal capacities, improved water duties and envisaged command area, and other engineering and nonengineering preferences of system managers, farmers, the local community, politicians, and national and local agricultural interests. For an average level of perfection (40–60%), information regarding such mutual influences of directly related requirements as unsteady flow conditions and management inputs, have to be available.

Systems and methods. The rigid Technical Guidelines should be adapted to more appropriate design concepts and, even then, the use of the evolving design concept will have to be restricted to purely design activities within an appropriate framework of functional system requirements.

Instead, systems directed at facilitating the integration of the point of view of the system managers, the local community and future settlers in the functional system requirements and the design concept will have to be introduced. Examples of such systems are checklists, priority lists, cost curves, planning systems, pilot studies, trial runs, questionnaires, attitude studies, field visits, rapid rural-appraisal techniques and hydraulic-simulation techniques to determine the appropriateness of design options. Such systems will have to be developed to test to what degree alternative design concepts fulfil these different functional requirements.

For a low level of perfection (20–40%), the operation and maintenance manuals will have to be written before the design and construction and it should be in line with the above explicit and consistent functional system

requirements and the related design concept. The latter will have to be defined before and during the design phase rather than "after the meal."

A more gradual development of irrigation infrastructure or its rehabilitation from the head end to the tail end of a main system or catchment area — like the more traditional Sri Lankan way of spontaneous extensions of command areas over time — will allow for field-testing, evaluation and possible improvement of the functionality of system requirements like layout, water duties and controllability. Such a gradual system development or rehabilitation based on feasibility assessment will provide for more flexibility in determining these functional system requirements, thus preventing costly investments serving no other purpose than the justification of the theoretical economical feasibility.

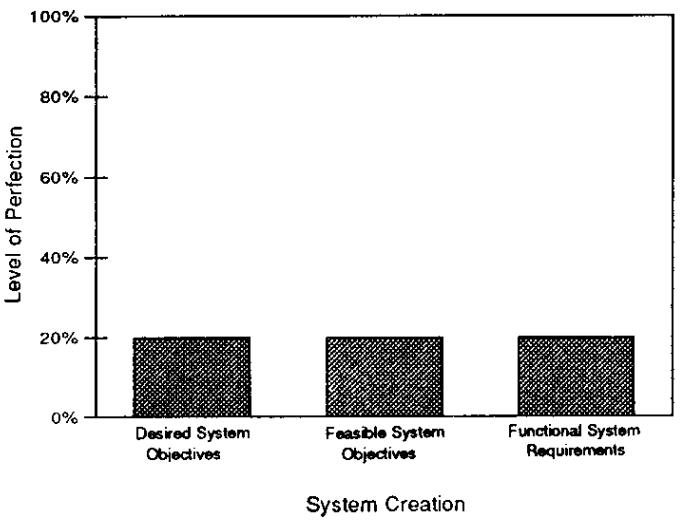
Provision of knowledge. The Irrigation Department should develop its own expertise on appropriate functional system requirements and evolving design concepts and managerial processes that would lead to these requirements. To allow the development of such expertise, donor organizations, foreign and, to a certain degree, local consultants, in their turn, will have to become aware of their limitations with respect to the determination of appropriate functional system requirements and design concepts in unfamiliar physical, institutional and human environments — especially if they have to assess them under time pressures. Politicians, who promote construction and visibility at the expense of sustainable and cost-effective processes and outcomes, should be made aware of their influence on these decision-making processes.

Organizational rules. Appropriate rules that bring about the incorporation of interests other than hydraulic engineering and civil engineering in the functional system requirements will have to be developed. For example, procedures to consult different levels of system managers, local communities, politicians and farmers about their preferences with regard to the system's functions, and the testing of the envisaged design concept on its compliance with these functional system requirements may be developed. In addition, more effective rules are required for river basin development or watershed management to prevent the recurrence of such grave mistakes as those that occurred in the Badagiriya system.

PRIORITIZING AMONG OPPORTUNITIES FOR IMPROVEMENT

The levels of perfection achieved in system creation processes in the Kirindi Oya system are graphically displayed in Figure 8. Higher levels of perfection are assumed to lead to higher system performance. However, it is yet unknown to what degree the different key decisions contribute to the system performance; the relative contributions of the different key decisions have to be determined through comparative research in different irrigation systems, before they can be used as normative indicators for the levels of perfection for the different key decisions to reach a certain performance level. Such comparative research will be undertaken in the near future by IIMI's performance research program. In the absence of such normative values, the given opportunities could be used by the Irrigation Department as a kind of a checklist.

Figure 8. Levels of perfection of system creation processes, Kirindi Oya.



CHAPTER 11

Conclusions and Recommendations

DECISION MAKING AND MANAGERIAL CONDITIONS: AN OVERALL PICTURE

THE FIRST SECTION of this chapter gives an analytical overall picture of the different key decision-making processes and their managerial conditions in the Kirindi Oya system, which will be valid to a certain degree in other irrigation systems of the managing agency with a similar design concept. This is done by comparing the decision-making processes and managerial conditions of different irrigation management concerns, which are described and analyzed in this paper. To that end the mutual adaptation of the technical and managerial aspects and the levels of perfection of different key decision-making processes will be compared. The managerial conditions of different key decision-making processes will be compared to the achieved levels of perfection. Finally, a judgement will be made regarding the contributions of different key decisions in the Kirindi Oya system toward the overall system performance.

The Decision-Making Processes

The mutual adaptation of the technical and managerial aspects. The allocation and water flow regulation concerns cover the *system utilization* in this paper.

The allocation decision making in the Kirindi Oya system was characterized by too little management effort to assess the water users' requirements, i.e., the demand side. Allocation decisions and their actual implementation did not relate to any demand assessment, except in a very broad and inaccurate way. In addition, there was a distinct divergence between the scheduled in-seasonal allocations and their implementation. At

the same time, a lack of motivation and willingness to put much effort into water flow regulation by higher-level staff had led to a complete delegation of this decision making to the gate tenders, and an increased allocation to the main canals to ensure conveyance to the tail end of the main canal.

There was a complex of reasons behind this lack of motivation and willingness to increase management inputs. An institutionalized priority for construction activities, and directly related lack of institutional support for improved water delivery performance by the managing agency were the most basic and crucial of these reasons.

System creation has been split up into three key decisions in this paper, namely, the determination of desired system objectives, feasible system objectives and functional system requirements.

The desired system objectives for the Kirindi Oya project were dominated by the government's requirement to use foreign funds for speedy and visible results and for large systems where many people could be settled in a short period. This priority led to a lack of representation of the desired objectives of local communities and future settlers in the project objectives. Representation of their preferences regarding the envisaged project objectives (e.g., irrigation requirements, cropping patterns, areas to be irrigated, preferences regarding existing and new small reservoirs) was needed, to a certain degree at least, to develop a sustainable system beyond the initial years after the investments. As national and local politicians were more interested in the short-term priority of settling people, and also that the managing agency was fascinated by the prospect of building the longest earth dam in Sri Lanka, such participatory processes did not take place. Given the size of this project compared to the traditional systems, these participatory processes to obtain an appropriate insight in the desired objectives of the local communities and settlers regarding the irrigation system would have been complicated and time-consuming.

Consequently, the identification of the agency staff and the water users with the objectives of the Kirindi Oya project and their commitment to these objectives remained limited in terms of the envisaged water duties, commanded extent, cropping intensities and cultivation of subsidiary field crops; these project objectives were desirable for the donor's EIRR rather than for the managing agency. However, without such commitment, the higher management efforts required by the staff of the head office and the

project-level agency and the water users to reduce water wastage in the system were unlikely to come about. Thus, this managerial approach to project identification did not stimulate a sustainable achievement of KOISP objectives.

Similar to the determination of desired objectives, the determination of feasible system objectives for the Kirindi Oya system were dominated by the political priority for a large system with speedy and visible results. In addition, agency priorities to build the longest earth dam in Sri Lanka and to obtain foreign funds for this project prevailed. Because of these priorities, the interaction between politicians, the Ministry of Lands and Land Development, the managing agency and the donor staff was less effective in assessing feasible system objectives than in adjusting the project objectives (i.e., irrigation requirements, command area, cropping patterns) to the requirements that make the project feasible in terms of the EIRR.

Apparently, the donor lacked technical and managerial techniques to prevent this type of dualistic decision-making processes, which obscured the real feasibility of the project objectives and the national or regional economic and social opportunities. For example, it was clear from the analysis that the use of major assumptions regarding irrigation requirements and cropping patterns could be manipulated freely by the donor staff and consultants; references to the magnitude of the assumptions made, the risks involved and their potential consequences for the EIRR were not required. The absence of such requirements suggests that the donor agency itself might have been less interested in the actual feasibility of a project.

The real feasibility issue, as can be derived from Chapters 3 to 5, i.e., the lack of managerial control to reduce water waste in the system had not been addressed in the feasibility assessment by the managing agency, the donor staff or the consultants. Instead, several perceived feasible objectives like the irrigation requirements, related command area and implementation schedule themselves were causes of unfeasibility, because they restricted flexibility in interactions with the managing agency, the local community and the water users during the determination of functional system requirements in later stages of the project.

Only the managing agency can determine cost-effective feasible solutions for sustainable river basin and system development and rehabilitation, and outsiders cannot play more than a facilitating role. A donor should not

become involved in designing the actual plan or its components, but should only judge a plan prepared and developed by the government and the managing agency. Criteria used by the donor staff and consultants should be used in a more objective way toward "selling" of the loan or grant. The then evident passive role of the managing agency did not build up a commitment for a sustainable achievement of project objectives. Checks and balances (e.g., Ministry of Planning) were required in this system development to ensure that all important interests were considered.

Lack of accountability allowed for a blueprint approach, i.e., a lack of any matching of the desirable objectives of different interest groups with the available resources to attain more sustainable and feasible project objectives.

The functional requirements for the Kirindi Oya system were, to a large extent, implicit and based mainly on assumptions. Because most functional requirements were implicit, the appropriateness of the underlying principles (e.g., controllability of water flow, disciplined water users, communication requirements, motivation of staff, managerial capabilities and attitudes) was never discussed. Important nonengineering functions of the layout (e.g., ecological effects on drinking water, groundwater table and fishing, and environmental and settlement aspects of existing and new tanks) were not considered. Apart from the lack of incorporation of experiences of system managers in the present design concept, no interaction with the local communities and the water users regarding functional requirements of system components occurred.

The functional system requirements were determined by means of scientific engineering concepts like theoretical water requirements, rationalization and turnout areas, which allowed project-level staff to make these "blueprint" decisions implicitly, without any reference to or assessment of the real-life requirements of managers of existing systems and the water users. In general, this lack of interaction was reinforced in construction projects of the managing agency by the feasibility-level requirements to realize low water duties in the maximum possible command area and with a maximum cropping intensity in a limited period of time.

The managerial requirements from system managers and the water users were thereby assumed at unfeasible levels (i.e., an average to very high level of perfection) without any commitment of the system managers and the water users themselves. None of the parties involved in these decision-making

processes were accountable to the achievement of the project objectives other than the targets of construction, settlement and organization of the water user group targets; while being aware of the unsustainability of the blueprint approach, they adhered rigidly to their formal terms of references and job descriptions.

In conclusion, the mutual adaptation of technical and managerial aspects in all the above key decision-making processes related to water delivery in the Kirindi Oya system were characterized by a lack of interaction between different agency levels, and between the agency and the water users. Top-down enforcement and little follow-up (i.e., monitoring and evaluation) in view of the consequent performance constituted the general managerial approach, which minimized the required management inputs of the managing agency and the donor staff. All decision-making processes were characterized by an almost complete absence of responsibility and accountability toward the system's water delivery performance. At the same time, the interaction between the donor staff and the consultants and the managing agency was ineffective and inclined toward "buying" and "selling" of the loans.

The levels of perfection of the different key decisions. Except for the seasonal and in-seasonal allocation processes with a low level of perfection (20–40%), all the other key decision-making processes had a very low level of perfection (0–20%). The main reasons were the priorities for obtaining foreign funds, speedy construction and visible results which affected the performance of all key decisions in the Kirindi Oya system. The level of perfection of the allocation concerns was somewhat higher, because of the basic necessity to deliver water for successful cultivation; there was constant pressure (complaints) from the water users. The system managers had to spend their time on complaints and also there was the risk of interference by politicians. The maintenance of a "no-complaint" situation apparently required a low level of perfection (20–40%). Water flow regulation was largely left to the gate tenders; a "no-complaint" situation with a very low level of water flow regulation could be reached by allocating more water to the system, which compensates for the lack of management input.

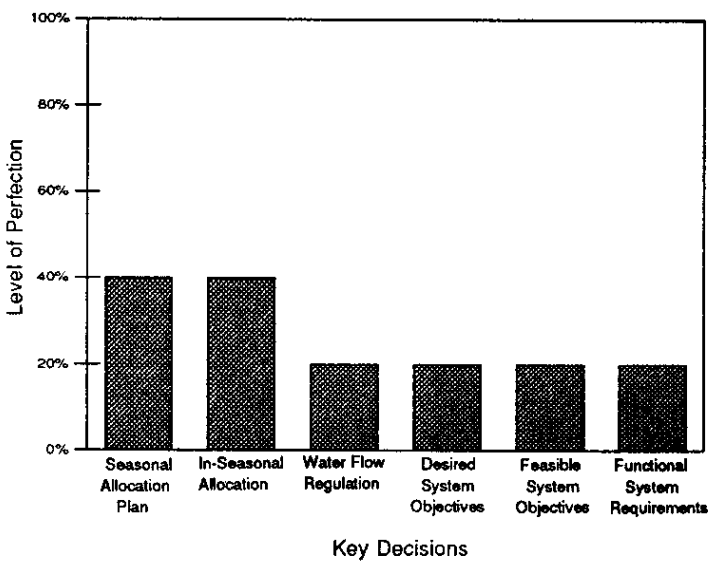
The level of perfection of all key decisions for system creation was very low (0–20%). Unlike for the system utilization decision-making processes, minimization of management inputs of all involved actors was not balanced

by complaints from any party during the time of project planning and design. Only during actual construction works and consequent utilization of the system, did complaints arise. This demonstrates again the complete absence of any accountability in the system creation decision-making processes. It is only during system utilization that the potential complaints by the water users and politicians have built some accountability, however passive these were.

Improvements in management inputs, managerial attitudes, interaction with the water users and subordinates, and information flows seemed to have depended on the more basic precondition of more commitment and accountability of all staff levels to the overall system performance. Priority for improvement lies thus with building up such an overall institutional support to the water delivery performance both during system creation and during system utilization. This will have to be initiated and developed by the managing agency's head office rather than at project level alone.

The levels of perfection achieved in the Kirindi Oya system are graphically displayed in Figure 9. Higher levels of perfection are assumed to lead to higher system performance. However, the degree to which the

Figure 9. The levels of perfection of the different key decisions in Kirindi Oya.



different key decisions contribute to the system performance is yet unknown; the relative contributions of the different key decisions have to be determined through comparative research, before they can be used as normative indicators for the levels of perfection for different key decisions to reach a certain performance. Such comparative research will be undertaken in the near future by IIMI's performance research program.

The Managerial Conditions as a Whole

People. Compared to the low level of perfection achieved, the managing agency possessed abundant expertise in all technical aspects of the allocation concern, other than the agricultural aspect. For the water flow regulation, awareness, expertise and experience of the managing agency were too limited (i.e., limited to the head sluice only) for even a very low level of perfection. Awareness of the managerial aspects of their jobs was also limited. Managerial techniques and skills were insufficient to interact effectively with colleagues, other agencies, the water users and politicians, even for the then existed low level of perfection. Training in these aspects may improve such awareness and related skills.

On the other hand, training in these aspects will be of limited avail without more — advance or simultaneous — structural changes to increase the managing agency staff's responsibility and accountability toward its water delivery performance. The motivation and willingness of the Irrigation Department staff in the Kirindi Oya system to improve its performance are low. Without any institutional support on the one hand, and amidst the opposition of colleagues due to conflicting construction and cultivation interests on the other hand, it needs an extraordinary individual motivation of the staff member to do a good job with water users who are hard to satisfy and with the politicians who intervene constantly. A more likely choice for a responsible decision maker is to maintain a low profile. Measures to improve the accountability and motivation toward water delivery may be the pricing of water, special career paths for system managers which also relate to job performance, incentive systems, performance evaluation concerning the water delivery for different subsystems, etc.

In the *system creation* decision-making processes, the technical professionalism of the irrigation engineers is rather one-dimensional in its

exclusive focus on the hydraulic engineering and civil engineering aspects. The managerial and real-life relevance of these approaches is resisted, because this would pollute their "pure" science. Implicitly, this is strongly related to managerial attitudes of other disciplines and the water users. Training will probably not increase the awareness in this respect, because many agency staff members are aware that the acceptance and use of the prevalent scientific approaches, which reduce the need to refer to real-life constraints, are directly linked to the preferences of the donors, the politicians and the agencies for foreign-funded large projects, which will deliver visible results in a limited period of time.

The development of a large-scale irrigation-cum-settlement system like the Kirindi Oya system within a limited time period is managerially of a far more complex nature than managerial problems experienced in the developed countries. For example, the number of settlers, the interests of the extant irrigation systems, the variable hydrological characteristics of the Kirindi Oya catchment, the number of agencies (17) involved and the different political interests in such a system create an almost unlimited managerial complexity. Trying to develop a sustainable large-scale system with all the complexities involved, in a short time frame, is surely too ambitious for a less-developed country where the managerial capabilities and motivation of involved actors are less well-organized than in developed countries. In short, the managerial conditions do not allow this type of "shortcuts to progress" to be sustainable.

Thus, it appears that the managerial attitudes of the agency, the government, the donor staff, consultants and politicians toward the assessment of the desired and feasible system objectives and functional system requirements are not objective. All of them have vested interests in the approval of the loans and tend to pay too little attention to the actual desirable and feasible project objectives or appropriate functional system requirements. A different attitude of agency staff in this respect requires the development of accountability toward the water delivery performance during the planning and design stages. As long as foreign funds for construction projects become available without any built-in accountability toward the sustainability of project objectives, nothing will change the present blueprint approach.

Provision of information. For the *system utilization* decision making, the technical and managerial aspects of the information provision were focused on a "no-complaint" situation of a very low to low level of perfection. For the seasonal and in-seasonal allocation decision making, no information was available regarding the demand side. Information provision focused on the head sluice and *ad hoc* instruction, monitoring and evaluation of staff. The intensity of *ad hoc* instruction, monitoring and evaluation increases when water is becoming scarce. The field staff were stimulated to lessen provision of information to their superiors and encouraged to solve problems by themselves.

Average levels of perfection (i.e., improved performance) will require more bottom-up information on the demand side, on realized water issues and operational methods. However, it will also require more top-down information provision to field staff and the water users about allocations and water flow regulation. This will require increased management inputs.

As has been mentioned before, increased management inputs can only be expected, if the managing agency expects its staff to improve its performance. The lack of any performance evaluation of the water delivery decision making below the main reservoir sluices is, in this respect a symptom of the lack of institutional support of the managing agency as a whole for the system management and water delivery performance. At the same time, it causes and reinforces lack of interest by different staff levels in improving water delivery performance.

The often heard argument that water delivery performance is considered situation specific and system specific is valid. However, the use of existing performance indicators (e.g., water duties, cropping intensities, rainfall utilization for different subsystems over different periods of time) by the managing agency in a systematic way is required for monitoring and appraisal of the performance of its staff.

The provision of information for assessing the *system creation* was defective; the same type of information mentioned above (i.e., information regarding the preferences, relevant experiences of and requirements from the existing local community, beneficiaries and system managers) was lacking. The lack of that type of information was compensated for by assumptions, which were not required to be justified. An average level of perfection will require such information provision on a more regular (40-60%) basis, while

a low level of perfection needs it on a less regular (20-40%) basis. Provision of this sort of information will require time and more gradual system development and rehabilitation, and a different professional and managerial attitude of agency staff. These are unlikely to come about without making agency staff more accountable toward the water delivery performance of irrigation investments.

Systems and methods. Most systems used for facilitating the technical and managerial aspects of the *system utilization* decision making were directed toward the head sluice of the reservoir. Allocation and water flow regulation below the head sluice were largely left to the gate tenders and no systems were used.

The method of monitoring and evaluating the allocations by means of theoretical water requirement calculations (i.e., the relative water allocation) was practised for the head sluice only. Rotational issues were practised in times of water shortage only, i.e., active control by necessity. Calibration was not practised at all. More sophisticated systems and methods regarding the technical aspects provided by the Operation and Maintenance Manual and the Water Management Strategy Plan were oriented toward a level of perfection higher than the level actually achieved; they could not compensate for an inappropriate design concept or a lack of management inputs by staff.

Similarly, the scientific engineering approaches used in the *system creation* decision-making processes (e.g., theoretical water requirements, rationalized layout, turnout areas, soil surveys, socioeconomic surveys) tried to simulate real-life situations and were in line with the earlier-mentioned minimization of management inputs by all involved parties. All could be and were used without interaction with the water users and different system managers, and without reference to related experiences. Systems which will incorporate real-life experiences and requirements will need more interaction with the water users and system managers, and will thus require more time and, probably, more gradual development of irrigation systems. This will not happen without the aforementioned increased accountability toward the water delivery performance during the time of planning and design of the irrigation investments.

Provision of knowledge. Little knowledge about experiences with different management techniques and approaches for *system utilization* in different Sri Lankan irrigation systems had been systematically built up.

Also, besides general truths like monitoring and evaluation, little systematic knowledge in decision-making process in allocation and water flow regulation has been built up internationally. Knowledge regarding managerial techniques and attitudes required for effective interaction with field staff, the water users, politicians and different agencies, and regarding allocation and water flow regulation processes was almost absent. The absence of this knowledge itself was again an indication of the weak commitment of the managing agency to improving its water delivery performance. Without improved commitment and motivation, the provision of additional knowledge will not necessarily lead to its utilization and consequent improved performance.

Knowledge regarding the *system creation* decision-making processes was adapted to a very low level of perfection due to the adoption of inappropriate and blueprint system development and design concepts. These concepts were based on desired and feasible system objectives and functional system requirements that might have been desired, feasible and functional generally in environments where the managerial conditions matched these objectives and requirements. This, however, was not the case in Sri Lanka.

More appropriate knowledge requires the building up and development of an appropriate engineering profession, which does not rely solely on international reference literature — whose design concepts are based on implicit functional requirements and assumptions — but which tests the design concepts for its feasibility in Sri Lanka and for its validity for the explicitly identified functional system requirements for Sri Lanka in general, and for specific systems in particular. This also requires knowledge on how the desired and feasible objectives and functional system requirements can be identified and tested for the Sri Lankan situation. Moreover, knowledge has to be developed as to how such processes can be integrated within the overall setup of lending agencies such as the ADB.

Organizational rules. Within the managing agency there were very few rules that guided the *system utilization* processes below the main reservoir sluices in terms of required decisions, hierarchical levels to be involved, required information flows, the role of water users and the required interaction with water users. Some organizational rules have been developed for the seasonal allocation processes; the requirement of interaction between the Government Agent, different agencies and the water users has been laid

down in official rules for institutions like the cultivation meeting, district agricultural committee meeting, etc. The presence of the Irrigation Management Division during the commissioning phase without any clear rules regarding its managerial role in the system has created a confusion in the Kirindi Oya system. For in-seasonal allocation and water flow regulation processes, appropriate rules were not developed upto that time. A lack of rules regarding the appropriate hierarchical and financial authority of the staff responsible for the allocation processes led to the *de facto* delegation of the allocation and water flow regulation to the gate tenders.

No water delivery performance indicators were used to assess staff performance. Thus, no formal rules for accountability in water delivery performance has been built up within the managing agency. As a result, the motivation and willingness to improve its performance were very low. The lack of these rules is a symptom of the lack of accountability of the managing agency as a whole toward the water delivery performance.

When compared, the rules for *system creation* gave a relatively large role to the managing agency, politicians and the donor than to other agencies and the beneficiaries. With the setting up of, among others, the Settlement Planning and Management Division (SPMD) under the Ministry of Lands and Land Development that situation was undergoing a change. However, clear rules about "who should do what" have not been developed; nor have any rules been developed regarding inputs from project beneficiaries during planning and design.

Unfortunately, the role of the national planning body was not formulated to ensure the dominance of the national interests and, consequently, these interests seemed to have been made subordinate to political and donor (i.e., the EIRR mainly) priorities. The heavy reliance on outsiders (i.e., the donor staff and consultants) for determination of feasible system objectives in a short time frame restricted the opportunities for real assessments of desirability, feasibility and functionality.

Rules that ensure the interaction between agencies at national level were limited to the rather "ritualized" and ineffective Central Coordinating Committee. Rules aimed at effective interaction for setting desired and feasible system objectives and functional system requirements between the water users, the local community, the local politicians, the donor and the agencies at project and national level were completely absent.

In conclusion, a prerequisite to all these different options for improvement of the managerial conditions is an increased accountability in all key decision-making processes to the water delivery performance. This accountability can probably be developed only when it is incorporated into the mechanisms of fund raising.

The Results: The Contributions of the Different Key Decisions

Seasonal allocation plan. The seasonal allocation plan seemed to be a very useful mechanism for obtaining clarity of the rights and entitlement of the different areas regarding water. Moreover, the staggering of deliveries over different subsystems facilitated the delivery of the required peak discharges during the land preparation. The usefulness of the theoretical water requirements for determining allocation plans was very doubtful; actual water flows and volumes, whether measured or not, and even if only from the head sluice, appeared to be more reliable guidelines than the theoretical values. In fact, the use of the theoretical requirements seemed to have provided an excuse to neglect the determination of the actual requirements of the water users, the staff and the local community, which seemed indispensable for more effective allocation processes. All in all, however, the seasonal allocation plans contributed to a basic water saving as well as a maintenance period through the intermediate seasons, during which no water issues were necessary from the head sluice.

In-seasonal allocation. The in-seasonal allocation decisions were made in a rather passive and implicit way and did not serve any clear purpose other than maintaining a no-complaint situation within the involved subsystem. No discipline was required from the water users and the field staff, except in connection with some distributary channels and field channels having difficulties in getting water to the tail enders. In exceptional situations like heavy rainfall, canal breakage and water shortage, this type of decision making led to much confusion, unclarity and even crisis situations for the field staff and the water users. The implicit and inappropriate way of determining conveyance targets (using the full supply depth which is an implicit design requirement assuming steady flow) led, even more regularly, to such unclarity and crisis situations.

Water flow regulation. Decision making about operational methods, which lead to localized water flow regulation for the main system, were largely left to the gate tenders. It meant that the water flow regulation was, to a large extent, passive and was replaced, to a certain extent, by larger allocations to the main canal. Within the distributary channel subsystem, the coordination of the water flow regulation had been done by these gate tenders and the water users. It seemed appropriate given the absence of a link between the water flow regulation decisions and the in-seasonal allocation decision-making processes of higher-level staff. Thus, the water flow regulation in the Kirindi Oya system could be considered as having an almost negative contribution to the overall system performance; as it had been hardly managed (i.e., management inputs minimized by higher-level staff) it was, to a large extent, replaced by a larger allocation to the main canals. Within the distributary channel subsystem, it contributed to a very flexible and responsive water delivery.

Desired system objectives. The decisions regarding the desired system objectives reflected only the perspective of national politicians, the donor, the managing agency, and to some degree the Land Commissioner's Department. Negative factors regarding the location of dam site and command areas from the point of view of the local community and local politicians were ignored. The preferences and requirements of directly related interest groups as the local community, settlers and local authorities, which seemed indispensable to determine the desirability of such project objectives as, for example, water duties, cropping intensities, cultivation of subsidiary field crops and related extension of the command area, were not considered. No commitment of the government, the agencies and the beneficiaries has been built up in this decision making toward the sustainable achievement of the project objectives. Thus, the decisions only served short-term political interests, the engineering prestige of the managing agency and the initiation of the loan acquisition by the Government of Sri Lanka.

Feasible system objectives. The decision making regarding the feasible system objectives did not assess the feasibility of the project objectives at all, but, instead, developed a plan which was feasible in terms of the EIRR. The use of unjustified assumptions for the calculation of the EIRR resulted in an incorrect picture of the economic feasibility of the Kirindi Oya project

at the Lunuganwehera site. In addition, the EIRR was used for internal donor decision-making processes only. The involved government and managing agency staffs were mainly interested in obtaining the loan and were rather indifferent toward the donor requirements with respect to the feasible system objectives. No effective evaluation of the economic and social opportunities of the system and evaluation of the national interest by, for example, a national planning body took place. The aforementioned factors made the application of the EIRR for assessing the economic feasibility for Sri Lanka's situation very doubtful; rather, it became a tool for justifying the desired system objectives and "buying" and "selling" of the loan. As a result, the feasibility assessment had led to several project objectives (e.g., water duties, command area, cropping pattern and intensity, and implementation schedule) which themselves were the major causes of unfeasibility of the project. The main purpose of the feasibility decisions was the donor's internal justification of the loan.

Functional system requirements. The design concept of the managing agency was implicitly based on functional system requirements which were inappropriate for the managerial conditions in Sri Lanka. Obvious experiences that influenced the functional system requirements (e.g., experiences in regard to managerial capacities and motivation of staff, drinking water requirements, medium- and long-term irrigation requirements, responsiveness, passive and active controllability of flow in case of system degradation, long-term flexibility for diversifying the cropping pattern), were not considered in the design concept. The decisions regarding the functional system requirements were made implicitly, to a large extent, and were in a way an immediate consequence of the desired system objective of building a large "one-off" system with minimum water duties, maximum cropping intensities, a maximum command area and a maximum number of settlers in a short period. The main contribution of this key decision was the *theoretical* achievement of those perceived, desired and feasible project objectives.

CONCLUSIONS: SYSTEM CREATION

Desired System Objectives

1. The desired system objectives were determined at the beginning of the Kirindi Oya project by national politicians, the managing agency and, to some degree, the Land Commissioner's Department. Preferences and directly related objectives of the local community and local authorities regarding, for example, the dam site and the demolishing of 50 existing small tanks were not considered.

2. Despite the availability of a more favorable alternative dam site, the donor did not intervene in these macro-level decisions, which were highly political.

3. The elaboration of the desirable project objectives in terms of the size of the command area, crops to be cultivated, number of people to be settled, cropping intensities and water duties for the Lunuganwehera dam site, however, were determined to a large extent by the donor staff and consultants. Because of the marginal EIRR at the initiation of the project, little flexibility existed to change or adjust these objectives if they appeared undesirable or unrealistic at later stages of the project. This led to "enforcement" (i.e., a less objective assessment by the agency staff in view of the related funding interests) of undesirable project objectives like the growing of subsidiary field crops during yala in all New Areas.

4. The lack of consideration of desirable project objectives from the point of view of the local community and the water users had serious consequences for their commitment to sustainable achievement. In addition, no commitment of the government and the managing agency toward the sustainable achievement of the project objectives had been developed during this decision making.

5. There were no requirements of the government, the managing agency and the donor with respect to the sustainability of the desired system objectives.

6. Environmental sustainability was not a serious requirement.

Feasible System Objectives

1. Given the average water requirements of the Sri Lankan irrigation systems, the 75 percent dependable regulated water resources of the Kirindi Oya project were sufficient to reach a cropping intensity of 200 percent in the Ellagala system only, i.e., no water resources were available for any extension of the command area. This water-short situation of the Kirindi Oya project was the result of serious flaws in the method used for assessing the feasible system objectives by the managing agency, the government and the donor.

2. A very expensive and unfeasible system had been considered feasible and it has been implemented while a far more feasible alternative was available. This alternative was far cheaper, because a smaller dam would have commanded the same area, required only one main canal and would not have inundated irrigable areas (the present reservoir inundates 4,050 ha of previously developed lowland). Feasibility and appraisal studies of the donor did not consider this obviously better alternative, because the choice for the dam site was considered a political decision.

3. In addition, through improper use of the EIRR for feasibility assessment, the actual economic, technical and managerial feasibility of the Kirindi Oya project at the Lunuganwehera site has not been determined. The economic consequences of the political choice for this site has thus not been made explicit in any way.

4. The estimated EIRR of the Kirindi Oya system was based on optimistic assumptions regarding water duties and managerial inputs of the agency staff and the water users. These assumptions were not based

on real-life experiences and requirements of the agency staff and the water users in similar irrigation systems in Sri Lanka. It implied that related assumptions of project benefits in terms of the size of the command area and cropping intensities also remained unjustified, except for theoretical justifications.

5. Other serious bottlenecks for project feasibility like feasible levels of maintenance funds, cost recovery and organization of the water users were made loan covenants, while the donor and the government staff were well aware of the ritualistic nature of these covenants.

6. The EIRR was used for internal decision-making processes of the donor only. The Government of Sri Lanka and the agencies did not use it for determining the feasibility or opportunities of the investments.

7. The government, the agency as well as the donor staff and consultants were not objective in assessing the feasibility of possible system objectives. A political priority existed for fast and visible project results. The agency did have an interest to get this major construction project funded in view of the additional funds, and also that the construction of the longest earth dam in Sri Lanka would boost the prestige of its engineers. The donor staff appeared to be biased for approving the loan without assessing its real feasibility. Consultants were biased because they were hired to develop a feasible plan and not to assess the actual feasibility. On account of these biases the interaction between the donor staff and consultants, and the government officials and the agency staff appeared less effective for assessing the feasible system objectives than for adjusting project objectives (i.e., irrigation requirements, command area, cropping patterns and intensities, implementation schedule and organization of the water users) to make the project feasible in terms of the EIRR.

8. Vested interests of the government, the agencies, the local community and the water users in obtaining outside financial assistance made it extremely difficult for outside consultants to assess feasible project objectives in a reliable way.

9. In contrast to these constraints, the donor staff and consultants appeared to have a very large influence on these decision-making processes due to the leverage used by the donor to enforce certain aspects, which it considered essential for ensuring project feasibility, as for example the double-bank canal, cultivation of subsidiary field crops and cost recovery. However, this type of "remote-control" project management by the donor staff and their consultants led to very unfeasible project objectives. The leverage used by the donor made an effective interaction between it, the government and the agency staff even more unlikely given the priorities of the government and the agency for obtaining the loan funds.

10. In addition, the present large role for outsiders (i.e., the donor staff and consultants) reinforces the lack of commitment and accountability of these groups to the sustainable achievement of the established project objectives. If the recruitment of more consultants is considered a solution for insufficient capacity of the managing agency, it is an unsustainable solution, for the chances that the managing agency will perform better in system utilization than during the feasibility assessment are extremely low.

11. The risks implied in the optimistic assumptions were acknowledged to some degree by the donor, but were not incorporated in the sensitivity analysis of the EIRR.

12. National or regional economic or social opportunities of the donor loan were not assessed. They appeared to be near zero; whatever the donor was willing to fund was considered a gain to the government, the agency, involved individuals and the project beneficiaries. Their attitude to the funds favored short-term objectives.

13. In Chapters 3 to 5, the crucial role of the level of managerial inputs and motivation of the managing agency in the water delivery performance was discussed. However, during feasibility assessment, this management factor was considered a variable parameter.

14. Instead of using the EIRR for assessing the economic feasibility of a technically and managerially feasible plan of the Kirindi Oya project, it had been used for prioritizing among different objectives for the project. This adjustment of project objectives to make the project feasible in terms of the EIRR resulted in project objectives that in themselves had become major factors of unfeasibility of the proposed project (e.g., low water duties and extension of command area in a short period of time without sufficient time and resources for organization of the water users, introduction of subsidiary field crops in all New Areas during yala).

15. The use by different actors of major assumptions regarding feasible irrigation requirements, cropping patterns, managerial capabilities and motivation of managing agency staff was very inconsistent and it led to inconsistent outcomes. No justifications for the assumptions through experiences or real-life situations were apparently required by any party. Consequently, the outcomes of different donor feasibilities and appraisals (e.g., the crucial irrigation requirements) varied up to 100 percent.

16. The use of theoretical water requirement calculations during the feasibility assessments for estimation of irrigation requirements, instead of the earlier practice of using an average water duty based on experience, allowed for these highly variable outcomes and seemed irrelevant and even misleading in view of the high variability of underlying assumptions.

17. The donor and the government did not maintain explicit criteria regarding the reliability of the available regulated water resources (e.g., the 75 percent dependable annual regulated volume) for assessing the feasibility of large irrigation investments. The consequences of this lack of criteria could be enormous; the difference between the 75 percent and 50 percent inflow figures and the present regulated volume figures were considerable, and that difference was a major cause for the present water-short nature of the Kirindi Oya system.

18. Other major factors such as soil suitabilities, reliability of hydrological and geologic data, motivation and managerial capabilities of staff, feasible maintenance levels and life span of the project were not considered in the feasibility assessments.

19. Proper assessment of the feasible system objectives requires comprehensive decision-making processes by the Sri Lankan authorities to incorporate a matching of desired objectives of different interest groups with available resources. This implies that the domination of short-term political priorities prevented an appropriate determination of feasible system objectives.

Functional System Requirements

1. The design concept of rationalized system layout, turnout areas, and high density of flow and measurement structures used by the Sri Lankan agencies was inappropriate for the Sri Lankan situation, because it implicitly assumed an increase of the managerial level of perfection from a low (20–40%) level to an average to very high (40–100%) level. The motivation and willingness of agency staff to increase its management inputs correspondingly were absent. Without specific commitments of the managing agency head office to improve to an average level of perfection, functional requirement for an appropriate design concept should have been oriented to the existing low level of perfection (20–40%).

2. Functional system requirements were kept implicit. Many design options had been copied from international reference books on irrigation design, without considering the underlying functional requirements. This has resulted in structures and operational practices which would have facilitated controllability over water flow. Justifications regarding the degree to which measurement structures at the head of distributary and field channels would be more appropriate than staff gauges, the long-term utility and cost-effectiveness of the large number of control structures, the utility of the chosen number of cross-regulators and their location in main and branch canals were

neither given nor required, but were apparently part of a "rational" engineering approach. Making the underlying functional system requirements explicit was, however, not in the interest of the managing agency or the government because of their priority for obtaining foreign funding.

3. The utility of writing up such requirements in an Operation and Maintenance Manual after the design and construction of a system seems questionable. Only before and during the actual design and construction, can the different functional requirements be matched into a feasible and functional overall design concept. The practice of preparing such manuals after project construction even justified, to a certain degree, the lack of consideration of this issue by the managing agency and the donor, before and during design and construction.

4. To a certain extent, this design concept has evolved directly from the priority of the donor, the politicians and the agency for the use of foreign funds for major irrigation investments. The donor stimulated and pushed the introduction of this design concept, because it theoretically provided for more control over water flow. The institutional constraints were acknowledged in broad ways, but were not linked to the design concept and underlying functional requirements. Agency staff tend to accept requirements of the donor staff in this respect, even if they are less appropriate, because of the political priorities for the acquisition or continuation of the loan.

5. The present general practice of irrigation engineers in keeping the underlying functional requirements implicit, when proposing design criteria and writing operation and maintenance manuals impedes discussion, evaluation and adjustment of these requirements. No learning processes can evolve and all kinds of myths about the functionality of control and measurement structures persist. The persistence of this kind of "conventional engineering wisdom" allows the determination of most functional system requirements by engineers on their drawing tables — whether in Sri Lanka or abroad — instead of relating them to real-life requirements.

6. The determination of the irrigation requirements of a turnout area requires very accurate estimates of the different proportions of lowland and upland soils, during the design stage. However, an accurate assessment appears difficult in Sri Lanka due to the difficulty in obtaining reliable survey and field-measurement data. Furthermore, accurate measurement of lateral seepage can probably be determined only during system utilization, which requires more gradual system development and rehabilitation.

7. The managing agency and consultants were not made accountable for the sustainability and actual functionality of their assumptions. Instead, the managing agency and consultants adhered themselves strictly to their terms of reference.

8. Despite the awareness among agency staff during construction of Phase I that the plans to introduce subsidiary field crops and to achieve very low water duties were unfeasible, the related assumptions regarding the feasible command area were not changed for Phase II. The related feasibility-level requirements to maximize the command area and cropping intensities did not allow for such adjustments. Thus, these very basic functions of the irrigation system were adapted to the overall feasibility-level project decisions, even if unsustainable in view of real-life requirements.

9. While many managing agency staff members were aware of the theoretical nature of envisaged irrigation requirements and rationalized design concept, this did not lead to major adjustments in the design concept, unless the donor intervened. The ultimate responsibility for providing these engineering solutions to managerial problems was thus left to the donor.

10. In Kirindi Oya, all development works of the system were planned to be implemented simultaneously without any assessment of real-life irrigation requirements. Designs of large parts of the command area were completed without prior serious field-testing of these assumptions. Even during Phase II, while the assumed water duties

were increased, the actual irrigation requirements in Phase I areas were not used as a reference. This led to many inappropriate canal and structure capacities, consequent overloading and erosion of canals, and breaking of control and measurement structures.

11. The donors' practice of hiring outside consultants "to get the job done" may have some validity for construction targets. However, outside consultants cannot ensure the required performance during system utilization, because this is not their responsibility and is beyond their control. Disappointing performance due to inadequate management cannot be solved by outside consultants, whatever organizational structures, manuals or training are provided to them.

12. In contrast to the crucial responsibilities implicitly left to the donor staff, their monitoring and supervision of the project were limited and similar to interventions of a rather *ad hoc* nature.

13. The operation and maintenance manual envisaged the introduction of fixed rotations to all canals and even to individual allotments in the whole command area under water abundant situations. Such a strategy attributed much weight to equity and water efficiency criteria, which were not traditional in the allocation processes of the Sri Lankan irrigation systems.

14. The indifference of many engineers, institutionalized priority for construction and other influences like seniority, unwillingness to discuss their own profession or criticize colleagues, prevent an active discussion and improvement of the present inappropriate design concept, though many engineers are aware of its inappropriateness. Thus, innovation and professionalization of appropriate irrigation engineering do not take place.

15. The concept of the theoretical water requirements is usually not considered separately from irrigation requirements. From the moment water was released from the head sluice upto its application by the water user to his crop, a complex of internal agency processes and

interaction between the agency and the water users create irrigation requirements that appear to be quite different from those theoretical water requirements. This difference is caused to a large extent by managerial losses or requirements. It strongly suggests that the use of the theoretical crop water requirements for assessment of system feasibility and for the determination of functional system requirements should better be abolished.

16. The turnout concept is inconsistent with traditional and present water management practices at tertiary level. It assumes that the water users in a turnout will cooperate in sharing water and saving water for other subsystems. Instead, one often discovers that these water users working together only to get more water to their own turnout. The organization requires of the water users to cooperate in the envisaged way and it also requires more management inputs by the managing agency staff to limit water issues to these turnouts. As described in Chapters 3 to 5, these inputs seem unfeasible in the Sri Lankan managerial context without increased institutional support of the managing agency as a whole. Another related inconsistency in the Kirindi Oya system was that the improved water duties were to a large extent based on this turnout concept, but only limited funds for organizing the water users were made available.

CONCLUSIONS: SYSTEM UTILIZATION

The above section on system creation and maintenance has argued against the prevailing design concept of the managing agency. However, many systems have been built in Sri Lanka following this design concept and are being utilized. As is shown by this case study of the Kirindi Oya system, the motivation and managerial capabilities of the staff of the managing agency did not correspond to the underlying functional requirements and design assumptions. This was aggravated in the Kirindi Oya, system because most staff members were involved in construction activities which, in general, received more interest and priority within the managing agency. On the other

hand, several staff members of the Water Management Feedback Center were well-motivated and could enforce at least some attention to the allocation and water flow regulation processes. Without exceptional efforts, substantial improvements of the existing system management cannot be expected in the future, except for some increase in the on-the-job experience of some gate tenders, and more attention to conveyance through the main system. Therefore, the conclusions below are not specific to the Kirindi Oya system in its commissioning stage, but have more general value, i.e., for the utilization of all systems with a similar design concept in Sri Lanka.

Seasonal Allocation Plan

1. The seasonal planning of the managing agency in the Kirindi Oya system did not assess the demand side in terms of the preferences and requirements of the water user representatives of the Irrigation Management Division and the other agencies until the formal precultivation meeting, the Project Coordinating Committee meeting and the cultivation meeting.

2. The lack of mutual adjustment of the parallel planning processes by the Irrigation Department and the Irrigation Management Division in the early stages led to divergent expectations toward the season before the first interactions in the precultivation meeting and the Project Coordinating Committee meeting.

3. Effective exchange of views between the Irrigation Department, the water users and their representatives during the precultivation and the cultivation meetings appeared impossible. Therefore, the divergent expectations led to clashes during these meetings and frustrations on both sides. Thus, the function of the cultivation meeting as a decision-*taking* body (i.e., its legal status) was confused with that of a decision-*preparation* body — decision making involves decision taking as well as decision preparation — which created problems and frustrations for all parties.

4. The present seasonal and in-seasonal allocation processes were more oriented to construction and maintenance priorities than to building confidence, credibility and trust of the water users and the other agencies in the Irrigation Department. An attitude of delivering water as a service did not exist.

5. The seasonal allocation was approached more as a technical issue (i.e., matching supply with theoretical water requirements), and much less as a managerial challenge. No active managerial approach regarding the necessary interaction of the Irrigation Department with different relevant agencies, the water users and politicians has been pursued. Such an approach could have improved mutual understanding and made priorities and criteria of different parties more explicit.

6. Through this passive and technically oriented approach, the Irrigation Department alone was responsible for the success of the season. But, when the involved risks were explicit and accepted before the season by these different parties and they compromised to some degree, less conservative allocations might have become possible. (This does not mean, however, that the Irrigation Department would not be responsible for delivering the water according to the agreed plan.) Moreover, experience should be built up by all parties and not by the responsible engineer alone, whose experience might be lost after his transfer.

7. Staff members of all involved agencies were not accountable toward the water delivery performance in terms of seasonal water duties, cropping intensities and achieved yields. Neither did staff members get any institutional support from the national-level officials in their agencies to improve their performance in the seasonal planning. Without such accountability and related institutional support, no improvements of the seasonal allocation processes could be expected through increased willingness and motivation of involved staff members to seriously increase their efforts to augment interaction with water users and coordination with other agencies.

In-seasonal Allocation

1. Despite the use of a design concept that provided for many decision points between head sluice and the field channel, only the gate tenders were involved in the consequent decision-making processes. Higher-level staff members were only involved in allocation decision making from the head sluice and in interventions in case of complaints.

2. Demand assessment and matching of supply and demand were left to the gate tenders. It had led to an on-demand mode of in-seasonal allocation. The preferred method of allocation was a continuous supply to subsystems if enough water was available. If water was limited in certain locations, an on-demand rotation was implemented.

3. Staff members at levels higher than field-staff level seldom guided, monitored, evaluated and stimulated the gate tenders in in-seasonal allocation and water flow regulation processes.

4. Nobody was really responsible for reducing or limiting water waste within the distributary channel or field channel or on-farm. Gate tenders were involved, to some degree, in coping with the total allocation within their subsystems, but it was not their responsibility. Staff members at higher levels seldom intervened in the allocation at field level, unless specific problems had arisen. They also were not responsible for reducing water wastage.

5. Consequently, a lack of pressure by higher-level staff to economize on water use in the system was prevalent in water abundant years. The only pressure available in this respect was the short-term availability of water at a specific location; for head enders this pressure usually did not exist and it resulted in water wastage.

6. The very localized matching of supply and demand by the gate tenders led to oversupply at the head and perhaps might have led to undersupply at the tail of a system or subsystem, even in water-abundant situations as in the Kirindi Oya system. The only way

to resolve this problem was through the involvement of higher-level staff members in this matching of supply and demand to make it less localized.

7. Separate organizational structures for conveyance and distribution along the main system (e.g., the project-level Water Management Feedback Center and the Resident Engineer's office) were often perceived as a solution to reduce localized favoring of demand at the expense of conveyance to the tail. However, this appeared to be untrue in the absence of any accountability of these organizational structures toward the related water delivery performance.

8. The official rotational allocations were determined by higher-level staff members by means of the theoretical water requirements. These rotational allocations were laid down in water schedules that were fixed for the whole season. In the absence of any information on the actual irrigation requirements, these water schedules were of academic value only, and might have deviated attention from the need to determine the actual irrigation requirements.

9. Implementation of the scheduled rotational issues was not in the interest of the individual water users, gate tenders and their supervisors. It, therefore, required the strong hand of the Irrigation Department to enforce them. Such enforcement occurred only in case of water scarcity.

10. Superiors at the project site and headquarters seldom guided, monitored, evaluated or stimulated their subordinates in in-seasonal allocation and water flow regulation processes. It demonstrated the weak institutional support or institutional disinterest in the performance of staff members and in the resultant actual water delivery performance. Performance of staff members in this area of concern depended mainly on their individual motivation.

11. Motivation to do a good job without this institutional support and with opposition of colleagues (when construction and cultivation interests

conflict, with the water users who are seldom satisfied whatever the performance), and the constant possibility of interventions by politicians, requires an unlikely individual motivation of the staff member. A more likely choice for a responsible decision maker is to maintain a low profile. Such an attitude will be stronger during the construction of the system, but will continue after the construction is completed, on account of other reasons mentioned before.

12. There was little awareness among the Irrigation Department staff regarding the managerial aspects of the allocation processes. The managerial capacities in terms of specific managerial techniques and attitudes were specially suboptimal in view of the complexity of these processes for less motivated subordinates, the multitude of interests of the individual farmers and the interference of politicians.

13. The water user groups can be viable, only if they play a meaningful role in the allocation decision-making processes. This required increased management inputs from the staff to interact with these groups, which is unlikely to come about without more accountability of the staff toward the water delivery performance. Enforcement of this accountability by organizing the water users into groups is unlikely to be successful, because of the inaccessibility of the daily allocation and water flow regulation processes between different levels of staff to people outside the managing agency. This inaccessibility makes it easier for the agency staff to thwart the accountability toward the water users.

Water Flow Regulation

1. Experience with operational methods and water flow regulation below the head sluice was found mainly in gate tenders. Gate tenders were expected to gain experience on-the-job.

2. No coordination of water flow regulation took place in the main system of Kirindi Oya.

3. The operational methods were determined mainly by the priority given by the gate tenders and water users to the distribution of sufficient water through distributary channels. Conveyance along the main canal had to be covered by extra allocations through the head sluice and by incidental interventions of higher-level staff following complaints.

4. Effective monitoring of actual water flows and water levels by higher-level staff, for example, in case of water scarcity, was complicated in most cases by water level fluctuations, unfamiliarity with actual operational methods, broken measurement weirs and backwater effects.

5. As for the in-seasonal allocation, institutional disinterest at all levels in the water delivery performance led to an absence of technical and managerial expertise in actual and more appropriate operational methods and related managerial techniques and processes.

6. As in the allocation concern, the water flow regulation decision making was characterized by a minimization of management inputs by the responsible staff.

RECOMMENDATIONS FOR DIFFERENT MANAGEMENT CONCERNS

Opportunities for improvement of the managerial levels of perfection have been indicated for all management concerns in the respective chapters in terms of requirements concerning processes and their managerial conditions. In this section, specific recommendations for the different key decision-making processes for all involved actors (i.e., the government, the agencies and the donor), are added to the opportunities for improvement given in different chapters. These recommendations evolve from the conclusions given above.

Desired System Objectives

1. Fixing of project objectives in terms of irrigated extent, cropping intensities, water duties, cropping patterns and time required to realize these objectives at an early stage seems undesirable in general, especially without an assessment of the sustainability and feasibility of these objectives at the time they are fixed. An EIRR just above the cutoff (i.e., 10% for the donor) for a large irrigation investment causes such inflexibility and therefore seems undesirable. Flexibility toward all these project objectives should be maintained during design and construction, and actual utilization of an irrigation system.

2. The EIRR should not be used for determining desirable project objectives such as the cultivation of subsidiary field crops, but should be used only for judging their feasibility.

3. The donor should not play any influential role in this decision making, but leave it to the national government, the agencies and the public. Without an active role of these parties, no commitment or accountability toward the project objectives is developed in them. Making accountability toward project objectives in the medium term and long term, a requirement of the loan agreement should become a major area of concern for the donor in general. The donor should limit its role to judging the feasibility within a framework of its other funding criteria (e.g., economic and environmental criteria).

4. Desirability of the system objectives or project objectives in view of the relevant interests of the local community, local authorities and the water users should be considered in this decision making to increase their commitment and identification with project objectives.

5. Environmental sustainability should also be considered in this decision making, especially for irrigation-cum-settlement systems in the dry zone.

Feasible System Objectives

1. Conditions have to be created for the donor staff and consultants to be more objective about the approval of a loan, if a project is unfeasible. Staff and consultants should focus on the quality of their feasibility and appraisal assessments, and long-term feasibility of approved loans, rather than on the quantity of loans and adherence to loan targets.

2. Outsiders should not play an influential role in the decision preparation of the feasibility level decision making. Instead, the national government and the agencies should determine and develop complete plans and, if required, submit these to the funding agencies. Distrust of the objectivity of this assessment by these national parties — reflected also in the reduced opportunities attributed by them to the loan funds — is probably justified, but the funding agencies and their consultants cannot play any other role for sustainable project development and implementation than assessing locally developed plans in a way which is objective toward actual "selling" of the loan or grant. Influencing of project components by outsiders has high risks of leading to unfeasible project objectives. It also reduces the identification and commitment of the national government and the agencies with the project objectives.

3. Accountability and commitment of the national government and the agencies should be built into feasibility and appraisal processes for future loans, because so far these new investment opportunities have been given priority by managing agencies at the expense of sustainable project achievement. This can be done, for example, through comparing the water duties proposed in funding requests with water duties actually achieved by the same agency, and limiting improvement assumptions to 10 percent at most, unless past performance of the agency allows for more. Because of their crucial importance, the data on achieved performance should be cross-checked by specially assigned objective consultants or "water budget accountants" (e.g., checking of flow and yield measurements, calibrations of measurement structures and remote sensing of irrigated

areas). Similarly, all other assumptions involved in the feasibility assessment (i.e., implementation schedule, cropping intensities, yields, maintenance levels) can be related to past performances of the same agency with, for example, 10 percent improvement margins. It is only through such a link between project funding and project performance that at least some value can be attributed to water by the managing agency and the donor, which is a basic prerequisite for improved management inputs by the managing agency during system utilization.

4. The donor's leverage should not be used for pushing certain projects, project components or project concepts, — which have led only to less appropriate objectives and less commitment. It should be used for making the government and the agencies accountable toward sustainable achievement of project objectives.

5. Requirements should be developed for the use of the most important assumptions underlying the EIRR (e.g., water duties, cropping patterns, cropping intensities, command area, agricultural prices, yields and implementation schedule) to reduce their potential manipulation and resultant inconsistencies between different assessments. Examples of the most obvious requirements in this respect are explicit statements regarding the size of assumed improvements of water duties, cropping intensities and yields, as well as a sensitivity analysis of the EIRR, which reflects all explicitly stated performance improvements and involved risks (e.g., reduced or delayed levels of water saving, reduced or delayed benefits, lack of maintenance funds, shorter life span, delays in implementation schedule and cost overruns), as well as the quantified combined effects of optimistic assumptions (e.g., Table 5.21 in IIMI 1990, 174). Justifications and references to earlier real-life experiences with respect to their feasibilities should be explicitly stated in Feasibility and Appraisal Reports. Risks used in the sensitivity analysis should represent all similar experiences of other donors in the same country or region.

6. The donor should develop internal quality control mechanisms for feasibility assessments along the lines mentioned under item 3 (e.g., separate divisions or staff members in the Operations and Evaluation division, who also become accountable for the quality of the involved assessments). Also, the donor should develop internal mechanisms to evaluate the consistency in sequential feasibility, appraisal, monitoring and evaluation assessments regarding key parameters like "with" and "without" management inputs and capacities of agencies, water delivery performance, command areas, cropping patterns and intensities, implementation schedules, etc.

7. The EIRR should not be used as the only indicator for assessing the feasibility of project objectives, because this allows for unfeasibility and manipulation of the underlying assumptions. Instead, the feasibility of, for example, availability of water resources, improved water duties, envisaged cropping patterns and intensities, area to be commanded, agricultural prices, maintenance funds, life span of the project, the "with" and "without" yields, should be carefully assessed.

8. The EIRR should not be used as a major guideline for the identification of feasible project components, which allows for making any project proposal economically feasible. Instead, it should be used only for the assessment of the economic feasibility of a plan, which is feasible in other aspects.

9. Theoretical water requirements should be replaced by gross water duties for specific locations. This also makes it easier to recognize the size of the assumed improvements compared to achieved gross values in the region or country. The theoretical water requirements should not be used for assessment of feasible improvements of water duties without very explicit justifications and references (e.g., gross water duties achieved by same agency) to all involved assumptions.

10. The reliability of data used (e.g., data of soil, topographic and other surveys, hydrological and climatological data, water and soil

suitabilities) should be assessed and stated in Feasibility and Appraisal Reports.

11. If more than one option exists for a specific project, the economic feasibility and other advantages and disadvantages of these options should be reflected and a rude estimate of their EIRR quantified in the feasibility and appraisal assessments. Though it does not mean that the donor should interfere in political choices by the national governments, this procedure at least would permit that "politically-inspired decisions should only be taken up in full knowledge of its economic consequences" (ADB 1979, 79).

12. A mechanism should be developed by the donor or the national government to determine if the 10 percent cutoff rate really represents the opportunities of the investments in the country at the time of major investment decisions.

13. The use of loan covenants by the donor for a "ritual" allocation of responsibility to the national government to solve major constraints in project feasibility should be abandoned.

14. Feasibility assessments should make explicit statements as to what degree proposed project objectives have been discussed and are supported by the local community and the water users.

15. The reliability of the assessment of water resources should get priority for assessing the feasibility of an irrigation system. For example, the 75 percent, rather than the 50 percent, dependable regulated volume (i.e., not inflow) should be used. The functionality of these water resources in terms of the related cultivation risks should be made explicit and incorporated in the economic feasibility of the system. To achieve this, the feasibility assessments should explicitly state the cultivation risks incorporated in the operational studies and the water resources available in view of the achieved and assumed water duties and cropping patterns. Different situations as well as their economic

feasibility should be calculated. The outcomes of such calculations should be presented in the Feasibility or Appraisal Reports.

16. Sensitivity analyses should reflect all risks implied in the assumptions.

Functional System Requirements

1. The managerial requirements should not be considered a variable, but should form an integral part of the other perceived system functions. The envisaged managerial inputs should be explicitly related to the required commitment, motivation and willingness of the agency at head-office, project and field levels. Similarly, assumed management or labor inputs by the water users and assumed irrigation requirements should be related to their acceptability to the water users. All these perceived management requirements should be established prior to and parallel to the establishment of other functional system requirements and evolving design concepts and criteria.

2. The feasibility-level estimate of the irrigation requirements, command area and cropping pattern and intensities should not influence the decision making about the corresponding design-level values, if these do not correspond to realistic requirements. More conservative feasibility-level estimates are required to allow more flexibility during system design, development and rehabilitation.

3. "Blueprint" type approaches (i.e., theoretical water requirements, rationalized layout, turnout areas, increased densities of flow control and measurement structures) to establish functional system requirements and design criteria should be abandoned, because they do not reflect the system and subsystem specific requirements of the local communities, the agency staff and the water users. Neither should design criteria be copied from international text books or "conventional engineering wisdom" without explicit reference to their functionality within the Sri Lankan context in general, and in the envisaged system or subsystem in particular. More explicit references should be made to the subsystem specific requirements, and envisaged

design solutions, in view of the requirements of different staff levels of the managing agency, the local community and the water users.

4. The donor staff and consultants can and should play a facilitating role only in the decision-making processes about the functional system requirements (e.g., irrigation requirements, feasible level of control over water flows, cropping patterns, related managerial capabilities and motivation, system layout, functions of existing and new intermediate tanks and nonengineering functions like bathing and drinking water). To increase the functionality and sustainability of the perceived requirements as well as the related feeling of responsibility and accountability of this agency, the managing agency itself should take the lead and play the major role in this decision making. Inability of the agency to play such roles should be considered a priority of the government and the agency for outside project funding at the expense of project functionality and sustainability.

5. The government, the Irrigation Department and the relevant agencies should make the functional system requirements explicit. If they lack specific expertise, they should initiate the hiring of outside assistance for the identified functional system requirements. These requirements should be translated into clear responsibilities of the Irrigation Department and other relevant actors.

6. The preparation of an Operation and Maintenance manual with guidelines for utilization of an irrigation system after construction is completed means that the functional system requirements are determined "after the meal." This seems to be a waste of money. The different functional system requirements should be matched into a feasible overall design concept before and during design and construction.

7. In the establishment of appropriate functional system requirements the system requirements and preferences from the point of view of the local and farming community and local politicians (e.g., irrigation requirements, cropping pattern, bathing and drinking water,

groundwater table, other functions of existing or new intermediate tanks and system layout) have to be considered to a certain extent. This would require more comprehensive and complex decision-making processes, which in turn requires a more gradual development of the system.

8. Functional system requirements and design criteria should be determined on a representative pilot basis, and adjusted to these experiences or, even better, should be related to real-life requirements while gradual development or rehabilitation of the command area takes place.

9. Time pressures will favor "blueprint approaches" and will reduce the need and utility of interactive processes required for assessing the system's required functions.

10. Accountability toward the sustainability and functionality of the system requirements should be built into these decision-making processes. This requires more explicit references to the functional requirements behind design concepts and criteria, related past experiences, acceptability of functional requirements, feasibility and sustainability for the local community, the system managers and the water users.

11. The donor should not enforce anything on the government or the agency (e.g., cost recovery, cultivation of subsidiary field crops), if they have no time to monitor and evaluate these activities. Instead, they should leave the determination of functional requirements to the agencies themselves and limit their own involvement to an unbiased feasibility assessment.

12. The lack of consideration of the human factor in the theoretical water requirements makes them an inappropriate concept for the determination of the irrigation requirements in small-holder irrigation systems. As for the determination of the feasible system objectives, the use of feasible system objectives without explicit justifications and

references (e.g., achieved gross water duties) to all involved assumptions should be abandoned.

13. The Technical Guidelines of the Irrigation Department should be improved in line with more appropriate design concepts and should be used for the pure design processes only. Design processes have to occur in line with already defined system-specific functional requirements.

Seasonal Allocation Plan

1. Seasonal planning requires the assessment of the demand, i.e., the preferences and requirements of the water users and the relevant agencies, by the managing agency at an early stage of this planning to enable early adjustment of expectations and plans to what is feasible. To this end the Irrigation Department should determine the degree to which it wants to use the initiative of the Irrigation Management Division for this purpose or whether to start on its own initiative.

2. The "myth" that the cultivation meeting is a decision-*preparation* instead of a decision-*taking* body, should be exposed to all involved parties. The persistence of this myth leads to confusion about the degree to which water users are involved in the seasonal allocation planning. The meeting should be formalized as an extension meeting and decision-taking body with an additional function to hear remaining (i.e., unrepresented in the final decisions) water user discontent, which may be fed back to the Ministry of Lands and Land Development and relevant Departments through the minutes or other means.

3. The Irrigation Department staff should be made aware of and stimulated to consider the seasonal allocation planning a managerial challenge rather than a technical problem.

4. While the Irrigation Department will always have to be responsible for the delivery of water, it does not necessarily have to be solely responsible for the seasonal allocation decisions and the consequent success or failure of the season. The other interested parties could be

involved in the determination of acceptable risks and compromises achieved.

5. Improvements in management inputs, managerial attitudes, interaction with the water users and subordinates, information flows and allocation strategies — all these seem to depend on the more basic precondition of more commitment and accountability of the staff members of the Irrigation Department, the Irrigation Management Division and the Department of Agriculture for their contributions toward seasonal water duties, cropping intensities and yields. Priority for improvement lies with building up such an overall institutional support to the seasonal allocation performance. This will have to be initiated and developed by the respective head offices or the government rather than at project level.

In-seasonal Allocation

1. Economizing on water use and improvement of the water delivery service would only be possible, if higher-level staff members of the Irrigation Department will get themselves involved in the in-seasonal allocation and water flow regulation processes below the head sluice. Their involvement would improve the coordination of these decisions over the system, and also would lead to improvement of these decisions themselves. Further, it would stimulate the field-level staff as well.

2. Improvements in water delivery will require regular demand assessment during the season. This requires more management inputs and more interaction with the water users. As there is a large number of water users in a small- holder system like Kirindi Oya, the Irrigation Department should support and strengthen the organization of the water users into viable groups with representative group leaders.

3. Improvement of these processes will require a change of the present institutional support by the Irrigation Department for staff members at different levels involved in in-seasonal allocation and water flow regulation. Moreover, accountability and responsibility of these staff

members at different levels toward the water delivery performance have to be built up within the managing agency. This improved institutional support and accountability should be initiated at head-office level rather than at project level.

4. The present organizational structure with localized water delivery responsibility for the Resident Engineer's office facilitates the lack of representation of system-wide interests to save water at the subsystem level. This is reinforced by the absence of any accountability to the water delivery performance. Therefore, sufficient financial and hierarchical authority should be allocated to the Water Management Feedback Center, which represents system-wide interests in comparison to more localized interests.

5. The use of the theoretical water requirements for in-seasonal allocation decision making should be made subordinate to the assessment of the actual demand.

6. The implementation of rotational water deliveries should be envisaged, only if the agency has a commitment toward its enforcement. At present, this commitment does not exist and enforcement of rotations occurs, only if physical constraints (e.g., canal capacities, water scarcity) impede on-demand delivery.

7. As for the seasonal allocation planning, the Irrigation Department staff should be made more aware of the managerial aspects of their jobs regarding the in-seasonal allocation and water flow regulation. A Training Needs Exercise may help improve this awareness, as well as the awareness about the required managerial techniques and attitudes.

Water Flow Regulation

1. Improvement of the water flow regulation requires the involvement of staff of levels higher than field staff to guide, monitor and evaluate field staff in this area of concern.

2. More attention of the Irrigation Department is required in systems with similar design concepts like the Kirindi Oya system for the conveyance through the main system, especially with respect to the stabilizing of water flows. This can be done, for example, by means of strict separation of staff responsible for conveyance and distribution from staff responsible for regular monitoring and evaluation of the separate contributions to the resulting actual water levels in the main canal.

3. More accurate water flow regulation will require more accurate discharge measurements, which necessitates staff gauges or measurement structures that are calibrated more regularly.

4. An increased level of perfection of the water flow regulation seems unlikely without better overall institutional support and accountability to the water flow regulation performance of the Irrigation Department staff. As for the seasonal and in-seasonal allocation concerns, this accountability should be initiated and developed by the Irrigation Department head office or the highest-level policymakers rather than by the project-level management.

RECOMMENDATIONS FOR RESPONSIBLE ORGANIZATIONS

Priorities for Improvements in Irrigation Management

Prioritizing among the areas of concern and the given opportunities for improvement should evolve from internal decision-making processes, strategic exercises or the like, within and between the managing agency and the Government of Sri Lanka rather than from outside. In addition, the donor could derive some opportunities for improvement with respect to its role in these decision-making processes.

The earlier section of this chapter on the overall picture of irrigation management disclosed the inconsistencies between different key decisions

in irrigation management. That these inconsistencies are so excessive has been possible through the almost complete absence of any accountability toward the water delivery performance in all the key areas of concern. This lack of accountability and responsibility in system creation and utilization concerning the water delivery performance is the crux of the whole irrigation management problem; it dominates all key decision making with respect to the water delivery.

The lack of motivation and willingness of the agency staff to increase their management efforts in the water delivery aspects of system utilization and creation is due ultimately to this lack of accountability and responsibility of the managing agency as a whole toward its water delivery performance.

The agency-wide priorities for construction activities and related funding make these system creation and rehabilitation processes the most, if not the only, likely starting point for building such accountability through the leverage provided by these funds. A more objective assessment of the *potential* irrigation management performance during the system creation and rehabilitation processes can be a first step in giving some value to the only resource which is not attributed any value in irrigation at present, i.e., water.

Involved agencies, the donors and politicians should develop more long-term commitment to improve the contribution of the system creation decision-making processes to the long-term system performance and sustainability. The present decision-making processes attribute very little value to system sustainability and performance, and this method has to be changed by the involved parties. This last section gives recommendations for the different actors involved.

Managing Agency

In all cases, it will be the Irrigation Department that has to play a major role in improving processes of all management concerns. This should also include possible improvements in the level of perfection of the determination of feasible system objectives and functional system requirements, on account of its familiarity with the managerial situation in its own irrigation systems. It should also be the leading agency for prioritizing among the given opportunities for improvement of the different areas of concern as described in chapters 6 and 10.

If the managing agency itself would initiate such processes, many chances of success exist to make its feasibility assessments and design concepts more appropriate, which may require strategic planning exercises of different levels of staff, and possibly other relevant actors, to evaluate the appropriateness of many internationally accepted techniques (e.g., EIRR, theoretical water requirements, operational studies, rationalized layouts, parallel field channels and "one-off" concept) for the Sri Lankan situation. System creation and rehabilitation should become more appropriate and cost-effective, for example, by approaching it on a smaller, less capital-intensive and more gradual scale; integrated river basin development and management (e.g., reuse of drainage water, suitable command areas and smaller dams) should replace capital-intensive large-scale blueprint approaches which are based on unfeasible management requirements. The required management inputs should be matched with feasible levels and opportunities for investments assessed in a more objective way.

At the same time, improvements in the utilization of existing systems may be initiated and it may require a similar, and partly overlapping, strategic exercise by different levels of staff, and possibly by other relevant actors. Or, working groups may be started to deal with specific management concerns like the system creation concepts, the seasonal allocation, the in-seasonal allocation and water flow regulation.

Thus, more explicit definitions of generalized functional system requirements for the Sri Lanka situation will be required (e.g., motivation and managerial capabilities of staff, management intensiveness, desired degree of controllability over water flow and related costs, vulnerability to political intervention, and ecological, cultural and other functions of the system, etc.).

The Government of Sri Lanka

It seems, however, that improved performance and related increased management inputs during system utilization are hard to achieve within the present managerial situation in Sri Lanka, and without more political priority for structurally improved water delivery performance.

Therefore, the managing agency may not be willing to initiate the aforementioned processes without specific requirements of the Government

of Sri Lanka for it to become more accountable to the water delivery performance of the system, especially at the time of investments. The aforementioned recommendations for the desired and feasible system objectives and functional system requirements may be picked up by the government to make the managing agency more accountable. The government may focus in this respect on the more explicit definition of the desirability, feasibility and functionality of a specific system development and design concept by the managing agency and other relevant agencies before approving it to be submitted to external funding agencies. If the government does not require such explicit statements, it will be very difficult to judge the desirability, feasibility and functionality of a proposed investment in this professional domain of the engineers.

In addition, the government might consider it desirable to implement changes in the organizational setup of the agencies through, for example, privatization to make the agencies more directly accountable to investments and the evolving of water delivery performance.

As regards existing systems, the government may want to develop accountability toward the investments made within the managing agency by requiring changes from the managing agency to develop responsibility, accountability and institutional support for staff involved in allocation and water flow regulation processes.

The Donor

Because of the major opportunities presently provided by the donor funds for politicians and involved agencies, it is not unlikely that politicians, the government and the agencies lack the will to initiate such required processes as long as these funds continue to be available in an unconditional mode. In that situation, the donor has a major responsibility in enforcing more accountability of the agencies toward their irrigation investments.

Political priorities in all countries are often oriented to the short term. The donor funds allow the politicians to start up projects that have high viability and prestige in the short run, despite reduced opportunities in the short, medium and long term, as has been the case for the Kirindi Oya project. The donor bears a responsibility in this respect as far as it provides an external assessment of the economic feasibility of the envisaged irrigation

investments. Given the short-term political and agency priorities to obtain these funds, it seems to be of utmost importance that the donor should give an objective and reliable picture of this feasibility. It will be only in that way the donor allows itself, the politicians and agencies to make decisions on irrigation investments, which are essentially always politically inspired, in full knowledge of their economic consequences. Several ways to improve the present feasibility assessments by the donor have been described earlier in this chapter.

This paper strongly suggests that the donor itself cannot be involved in the design of system objectives and requirements, which are so detailed that desirability, feasibility and functionality assessments and their monitoring and evaluation would become a major problem. Rather, it should restrict itself to general, but very clear and explicit performance objectives and requirements, and use these to assess the feasibility of proposed projects and their performance.

Specific requirements for the donor to use indicators can be derived from the aforementioned recommendations for the desired and feasible system objectives and functional system requirements. As long as the donors will fund irrigation investments without such requirements, the required responsibility and accountability processes within the government, the irrigation and the other agencies seem less likely to occur, because of the very limited value attributed to water by any of the involved parties. Different attempts of the donors to improve the water delivery performance by way of provision of water management consultants, writing of Operation and Maintenance Manuals or supporting IIMI research projects are acknowledged; but they will have limited effect without an increased value attributed to water by the managing agencies.

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ANNEX I

Levels of Perfection of the Irrigation Management Concerns

THE ANALYSIS OF an irrigation organization with respect to irrigation management concerns or key decision-making processes, will probably lead to the conclusion that conditioning is required for improvement of the mutual adaptation of their technical and managerial aspects. However, these concepts do not provide for criteria to choose among different conditioning alternatives. Kampfraath and Marcelis (1981) have identified four criteria for that purpose that together form the basis for the concept of "levels of perfection."

These criteria are derived from the decision-making processes: systematics, feedback, foreseeing and integration. Decision-making processes are essentially processes of transformation of the "resource" information into decisions. The quality of the decision is then determined by two dimensions, namely 1) what information is taken into account, and 2) how that information is processed. The first dimension can be split up into three criteria:

* In fact, a decision is a position with respect to future action, so that for making that decision "foreseeing" (i.e., the degree to which decision making foresee the scope of the decision) influences the quality of the decision.

* Another element is the influencing through and of other processes. A position in the area of seasonal planning has consequences for the area of maintenance, for example. "Integration" (i.e., the degree to which problems are seen in a wider perspective before the decision is made) is used as a criterion for this aspect.

* The position will only have actual consequences, if the *de facto* action has commenced. Up to that moment the position can be revised based

on information of the past; the quality of the position depends on the level of "feedback" (i.e., the degree to which the decisions made are tested continuously for their appropriateness).

The second dimension refers to the first criterion, "systematics" (i.e., the degree to which decisions are made following a more or less fixed pattern).

These criteria can be used for describing the quality of decisions and thus of the management concerns. The level of perfection is derived from those four criteria through the attachment of an estimated quantitative label to different qualitative levels of those four criteria, as shown in Table 1 on page 13 of Chapter 1. The levels of perfection of different irrigation management concerns and key decisions used in this paper have been derived from Table 1 and are listed in this Annex.

STRATEGIC CONCERN: DESIRED SYSTEM OBJECTIVES

0–20%/VERY LOW: The establishment of the desired system objectives is *ad hoc* without considering the likely sustainability of these objectives during the lifetime of the envisaged investments. No feedback from the existing local community, the future beneficiaries, the separate agencies and individuals in those agencies, the local and national politicians, the consultants and donors with respect to the desirability and acceptability of the identified desirable system objectives takes place. No rules support this decision making, but a certain routine may exist.

20–40%/LOW: Necessities for short-term sustainability of the desired system objectives during the life-time of the envisaged investments are incorporated. Irregular feedback from the existing local community, the future beneficiaries, the separate agencies and individuals in those agencies, the local and national politicians, the consultants and donors with respect to the desirability and acceptability of the most important desirable system objectives takes place. Broad rules support this decision making.

40–60%/AVERAGE: Priorities for the short- and long-term sustainability of the desired system objectives during the lifetime of the envisaged investments are considered. Regular feedback from relevant parties like the existing local community, the future beneficiaries, the separate agencies and individuals in those agencies, the local and national politicians, the consultants and donors with respect to the desirability and acceptability of (for them) relevant system objectives takes place. The preferences and requirements of these groups with respect to the system

objectives are considered. Rules support important aspects of this decision making, e.g., the determination of the district and national, social and economic opportunities for the investments.

60–80%/HIGH: Foreseen developments that will affect the short- and long-term sustainability of the desired system objectives during the lifetime of the envisaged investments are considered. Frequent feedback from relevant parties like the existing local community, the future beneficiaries, the separate agencies and individuals in those agencies, the local and national politicians, the consultants and donors with respect to the desirability and acceptability of (for them) relevant system objectives takes place. Important preferences and requirements of these groups with respect to the system objectives are incorporated. Procedures in terms of combinations of mutually attuned rules support this decision making.

80–100%/VERY HIGH: Expected developments that will affect the short- and long-term sustainability of the desired system objectives during the lifetime of the envisaged investments are reviewed and considered. Continuous feedback from relevant parties like the existing local community, the future beneficiaries, the separate agencies and individuals in those agencies, the local and national politicians, the consultants and donors with respect to the desirability and acceptability of (for them) relevant system objectives takes place. All relevant preferences and requirements of these groups with respect to the system objectives are incorporated. Balanced systems of mutually attuned procedures support this decision making.

STRATEGIC CONCERN: FEASIBLE SYSTEM OBJECTIVES

0–20%/VERY LOW: The assessment of the feasible system objectives is *ad hoc* without considering their likely sustainability during the lifetime of the investments. No feedback is obtained from relevant agencies, publications, local communities or beneficiaries regarding the appropriateness of the feasible objectives. The mutual influences between different feasible objectives as watershed management, dam sites, command area, suitability of soils, water delivery concept, water duties, cropping patterns and intensities, maintenance, settlement and environment are not considered; mono-disciplinary feasibilities dominate the decision making. No rules exist regarding the determination of the feasible objectives but a certain routine may exist.

20–40%/LOW: Necessities for the short-term sustainability of the feasible system objectives during the life-time of the envisaged investments are incorporated. Obvious experiences of relevant agencies, publications, local communities or beneficiaries regarding the appropriateness and the feasible objectives are processed.

Convincing mutual influences between different feasible objectives such as watershed management, dam sites, command area, suitability of soils, water delivery concept, water duties, cropping patterns and intensities, maintenance, settlement, environment, etc., are incorporated. Broad rules (e.g., steps to be taken, criteria to be used, consultations required, level of agreement of different groups) support the decision making.

40–60%/AVERAGE: Priorities for the short- and long-term sustainability of the feasible system objectives during the lifetime of the envisaged investments are considered. Regular feedback of important information regarding the appropriateness the feasible objectives is considered. Directly related mutual influences between the different feasible objectives as watershed management, dam sites, command area, suitability of soils, water delivery concept, water duties, cropping patterns and intensities, maintenance, settlement, environment, etc., are considered. Rules (e.g., steps to be taken, criteria to be used, consultations required, level of agreement of different groups) support important decision-making processes regarding the feasible objectives. 60–80%/HIGH: Foreseen developments that will affect the short- and long-term sustainability of the feasible system objectives during the lifetime of the envisaged investments are considered. Frequent feedback of most relevant information regarding the appropriateness of the feasible objectives is considered. Important mutual influences between such different feasible objectives as watershed management, dam sites, command area, suitability of soils, water delivery concept, water duties, cropping patterns and intensities, maintenance, settlement, environment, etc., are incorporated. Procedures in terms of combination of mutually attuned rules support important decision-making processes regarding the feasible objectives.

80–100%/VERY HIGH: Expected developments that will affect the short- and long-term sustainability of the feasible system objectives during the lifetime of the envisaged investments are reviewed and considered. Continuous feedback of all relevant information regarding the appropriateness of the feasible objectives is considered. All mutual influences between such different feasible objectives as watershed management, dam sites, command area, suitability of soils, water delivery concept, water duties, cropping patterns and intensities, maintenance, settlement, environment, etc., are incorporated. Balanced systems of mutually attuned procedures support important decision-making processes regarding the feasible objectives.

STRATEGIC CONCERN: FUNCTIONAL SYSTEM REQUIREMENTS

0–20%/VERY LOW: The decision making about the functional requirements is *ad hoc* and does not foresee the sustainability of these requirements (e.g., in case of crop

diversification, after degradation of parts of the system because of lack of maintenance) during the lifetime of the envisaged irrigation system or the involved components. No feedback of the local community and system managers regarding the appropriateness of the functional system requirements takes place. The decision making about the functional requirements does not try to integrate the irrigation and nonirrigation preferences and requirements of local community, water-management staff, politicians, future settlers, and (national or regional) agricultural interests together with the engineering interests. No rules exist regarding the determination of the functional requirements. A certain routine may exist.

20–40%/LOW: The decision making about the functional requirements considers necessities regarding the sustainability of these requirements (e.g., in case of crop diversification, after degradation of parts of the system because of lack of maintenance) during the lifetime of the envisaged irrigation system or the involved components. Feedback of obvious experiences of the local community and system managers regarding the appropriateness of the functional system requirements takes place. The decision making about the functional requirements considers convincing subsidiary influences in terms of irrigation and nonirrigation preferences and requirements of local community, water management staff, politicians, future settlers, (national or regional) agricultural interests and engineering interests. Broad rules exist regarding the determination of the functional requirements.

40–60%/AVERAGE: The decision making about the functional requirements considers priorities regarding the sustainability of these requirements (e.g., in case of crop diversification, after degradation of parts of the system because of lack of maintenance) during the lifetime of the envisaged irrigation system or the involved components. Most important experiences of the local community and the managing agency regarding the functional system requirements are considered. The decision making about the functional requirements considers directly related influences in terms of irrigation and nonirrigation preferences and requirements of local community, water management staff, politicians, future settlers, (national or regional) agricultural interests and engineering interests. Important decision-making processes regarding the functional requirements like the number and sites of intermediate reservoirs, the determination of peak irrigation requirements to certain subsystems, the required controllability over water flow, etc., are supported with rules.

60–80%/HIGH: The decision making about the functional requirements considers foreseen developments regarding the sustainability of these requirements (e.g., in case of crop diversification, after degradation of parts of the system because of lack of maintenance) during the lifetime of the envisaged irrigation system or the involved components. Most experiences of the local community and the managing agency

regarding the functional system requirements are considered. The decision making about the functional requirements incorporates important influencing factors in terms of irrigation and nonirrigation preferences and requirements of local community, water management staff, politicians, future settlers, (national or regional) agricultural interests as well as the engineering interests. Most decision-making processes regarding the functional requirements like the number and sites of intermediate reservoirs, the determination of design and peak irrigation requirements to certain subsystems, the required controllability over water flow, etc., are supported with combinations of mutually attuned rules.

80–100%/VERY HIGH: The decision making about the functional requirements considers and reviews expected developments regarding the sustainability of these requirements (e.g., in case of crop diversification, after degradation of parts of the system because of lack of maintenance) during the lifetime of the envisaged irrigation system or the involved components. All relevant experiences of the local community and managing agency regarding the functional system requirements are considered. The decision making about the functional requirements incorporates all influencing factors in terms of irrigation and nonirrigation preferences and requirements of local community, water management staff, politicians, future settlers, (national or regional) agricultural interests and the engineering interests. Decision-making processes regarding the functional requirements are supported by balanced systems of mutually attuned procedures.

ALLOCATION CONCERN: SEASONAL ALLOCATION PLAN

0–20%/VERY LOW: Seasonal allocation planning regarding water duties, cropping pattern, cultivation calendar, irrigable area and cultivation risks for different subsystems takes place ad hoc. A certain routine may exist. Few rules guide this planning. Related decision making by the Department of Agriculture, the water users and the maintenance planners is not considered. Performance evaluation through complaints.

20–40%/LOW: Seasonal allocation planning considers, to some degree, the available supply during the season for the different subsystems. Cultivation risks are not quantified. Rules of thumb are used for the seasonal assessment of supply and demand, and allocation planning. Convincing influences of decision making by the Department of Agriculture, the water users, the politicians and the maintenance planners are incorporated. Performance evaluation through complaints and registration of final seasonal plans.

40–60%/AVERAGE: The available supply during the season for different subsystems is assessed and priorities are made regarding the allocation parameters (i.e., irrigable areas, cropping pattern, cultivation calendar, water duties and cultivation risks). Cultivation risks are quantified. The consequences of this season's allocation decisions on future expectations are, to a certain extent, considered a more active allocation strategy. Rules support this decision making. Directly related decision making by the Department of Agriculture, the water users, the politicians and the maintenance planners are considered for the matching of supply and demand. Performance evaluation through registration of final plans and comparison with important earlier experiences, and regular monitoring of actual implementation.

60–80%/HIGH: The available supply during the season for different subsystems is assessed and priorities are made regarding the allocation parameters, considering their consequences for future expectations, for important subsystems in view of the allocation strategy for these subsystems and the overall system. Cultivation risks and water duties for subsystems are quantified. Procedures of mutually attuned rules support this decision making. Important influences of decision making by the agricultural department, the water users, the politicians and the maintenance planners regarding different subsystems are incorporated in the matching of supply and demand. Performance evaluation through comparison of final plan with earlier experiences for different subsystems, and frequent monitoring and evaluation of actual implementation.

80–100%/VERY HIGH: The available supply during the season for different subsystems is assessed and priorities are made regarding the allocation parameters, considering and reviewing expected developments during the season and their consequences for future expectations in view of the allocation strategies. Balanced systems of mutually attuned procedures support this decision making. All relevant decision making by the agricultural department, the water users, the politicians and the maintenance planners regarding different subsystems are incorporated in the allocation decisions. Performance evaluation through comparison of final plan with earlier experiences for all subsystems, and continuous monitoring and evaluation of actual implementation.

ALLOCATION CONCERN: IN-SEASONAL ALLOCATION

0–20%/VERY LOW: Little effective planning of the in-seasonal allocation is done; actual in-seasonal allocation with respect to operational targets for conveyance and distribution, cropping pattern, cultivation calendar, irrigable area and cultivation risks for different subsystems takes place *ad hoc*, while incorporating urgencies. A certain

routine may exist. Few rules guide this planning. Decision making by the water users and the Department of Agriculture is not considered in the official allocation decisions, if any. Gate tenders determine, to a large degree, the actual allocations, whereby often the conveyance along the main system is neglected. Performance evaluation through complaints. No reliable or effective feedback to higher hierarchical levels on the actual realization of the operational targets for distribution and conveyance for different subsystems.

20–40%/LOW: Short-term planning of in-seasonal allocation considering necessities and urgencies. Rules of thumb are used for the in-seasonal assessment of supply and demand, and allocation planning. Convincing influences of decision making by the water users, the Department of Agriculture and the politicians for different subsystems are incorporated. Gate tenders take allocation decisions partly independently, and partly on instructions. Operational targets for distribution and conveyance only for urgencies separately considered. Performance evaluation through complaints and registration of final allocation plans (i.e., water schedules). Feedback on realization of the operational targets for distribution and conveyance for different subsystems takes place for obvious points in the (sub)system.

40–60%/AVERAGE: Regular (e.g., weekly or biweekly) planning of in-seasonal allocations. The consequences of allocation decisions on future expectations are, to some degree, considered. Foreseen supply and demand changes during realization of the operational targets for distribution and conveyance for the different subsystems are considered in the allocations. Rules support this decision making. Important targets for conveyance to the tail end of the main canal and other important subsystems are incorporated in the matching of supply and demand. Directly related decision making by the water users, the Department of Agriculture and the politicians are considered for the matching of supply and demand. Gate tenders take allocation decisions which conform to water schedules and related instructions. Performance evaluation through the registration of water schedules and comparison with important earlier experiences, and regular monitoring of actual implementation of most important operational targets. Regular feedback of effective rainfall for most important subsystems is considered in allocation schedules. Experience with allocations is laid down in records (e.g., database and seasonal reports).

60–80%/HIGH: Planning through frequent scheduling of allocations to different subsystems. The consequences of allocation decisions on future expectations are considered. Foreseen supply and demand (e.g., probable effective rainfall) changes during realization of the operational targets for distribution and conveyance for different subsystems are considered in the allocations. Combinations of mutually attuned rules support this decision making. Most relevant decision making by the

water users, the Department of Agriculture and the politicians are incorporated for the matching of supply and demand. Gate tenders take allocation decisions, which conform to water schedules and related instructions. Part of the instructions include standard practices in terms of operational methods and procedures. Operational targets for distribution and conveyance are considered separately. Performance evaluation through frequent comparison of actual implementation with the scheduled operational targets for conveyance and distribution for different subsystems. Frequent feedback regarding demand includes effective rainfall for all important subsystems.

80–100%/VERY HIGH: The actual allocation is laid down in the water scnedules. The gate tenders allocate accordingly, which conform to standard practices. Expected developments regarding supply and demand for different subsystems during the actual realization of the operational targets for distribution and conveyance for different subsystems are reviewed and considered. Most sudden demand changes are thus covered in a consistent and reliable manner. Balanced systems of mutually attuned procedures support this decision making. All relevant decision making by the water users, the Department of Agriculture and the politicians are incorporated in the matching of supply and demand. Performance evaluation through continuous comparison of actual implementation with the water schedules for conveyance and distribution. Deviations and delays are reported and registered.

WATER FLOW REGULATION CONCERN

0–20%/VERY LOW: Hardly any preparation and calculation with respect to operational methods and plans take place; they are established *ad hoc* and hardly foresee the consequences for upstream and downstream water levels in the main system. No rules support this decision making, but a certain routine developed through on-the-job experience may exist. No feedback takes place regarding operational methods used. Any coordination of the operations of different structures hardly exists along the main system. Time required for the operations is not determined in advance. Division of work is done by gate tenders themselves. Performance evaluation by complaints and by some monitoring of time spent.

20–40%/LOW: Some preparation and calculation with respect to operational methods and plans are done by supervisors (e.g., determination of approximate time and size of flow variations along the main system). Necessities with respect to the conveyance of resulting upstream and downstream water levels are considered in the operational methods and plans. Irregular feedback takes place regarding the most obvious experiences with operational methods and stabilization. Convincing influences of the operations of different structures along the main system on the stability of the water

levels are incorporated in the different operational methods. Broad rules support this decision making. Time required for the operations is estimated in advance. Division of work is done partly by gate tenders themselves and partly by their supervisor. Performance evaluation by complaints and by monitoring of time spent by supervisor.

40–60%/AVERAGE: Part of the preparation and calculation with respect to operational methods and plans is done by special staff of higher hierarchical levels. Priorities with respect to the conveyance of resulting upstream and downstream water levels are considered in the operational methods and plans. Regular feedback takes place regarding the important experiences with operational methods. Relevant influences of the operations of different structures along the main system on the water levels are incorporated in an operational plan. Rules support this decision making. Time required for the operations is calculated by means of historical data. Division of work is done through tasks and instructions. Performance evaluation by regular monitoring of actually implemented operational methods and time spent by supervisor.

60–80%/HIGH: Systematic preparation and calculation of operational methods and plans by special staff. Frequent feedback takes place regarding practised operational methods and resulting water flow regulation. The operational plan incorporates all control structures that influence water flow regulation along the main system. Combinations of mutually balanced rules support this decision making in all subsystems. Time required for the operations is calculated, partly by means of calibrated norms. Division of work is done through tasks and instructions. Part of the instructions constitutes standard operational methods. Performance evaluation by monitoring and evaluation of actually implemented operational methods and comparison of time spent with norms.

80–100%/VERY HIGH: Complete systematic preparation and calculation of operational methods and plans by special staff. Most operational methods have been standardized. Expected developments regarding upstream and downstream water levels are reviewed, evaluated and incorporated in the operational methods. Continuous feedback takes place regarding practised operational methods and resulting water flows and levels. Balanced systems with mutually attuned procedures support this decision making in all subsystems. Calculation of time required for the operations is based on unit time calculations (e.g., UMS). Performance evaluation by monitoring and evaluation of actually implemented operational methods and time spent.

ANNEX 2

Assumptions Made in the Calculation of Theoretical Water Requirements

THIS ANNEX LISTS the assumptions made in the calculations of the theoretical crop water requirements, and the aggregation of these into theoretical tract and system requirements. The assumptions described were used by the Water Management Feedback Center for the seasonal and in-seasonal allocation decision-making processes during the period covered by this paper.

* The actual area under rice cultivation in each subsystem is assumed to be 100 percent of the potential as the Technical Assistants of the Resident Engineer's offices did not have time to make better estimates and also the error involved is considered to be of minor importance compared to other inaccuracies in the assessment of the water requirements. The water users are assumed to grow a three-and-a-half-month variety of rice, which they generally do in practice.

* The land preparation in a tract is assumed to take three weeks; one week of land soaking and two weeks of puddling. The water issues during land preparation to the three tracts of the Phase I area along the Right Bank main canal are staggered[21] with a time lag of one week between the start of each successive stagger. Accordingly, it led to a total land preparation period of five weeks for the Right Bank command area. The actual period of land preparation for this area is usually about eight weeks (Sri Lanka Field Operations 1989, VII.6).

* The relative water requirements during the land preparation have been assumed to be 20 percent in the first week, 80 percent in the second,

21 Staggering is necessary along the Right Bank main canal, because the discharge needed to supply all tracts at the same time for land soaking is larger than the main canal capacity.

and 100 percent in the third week for each tract of the Right Bank area. These figures deviate from the 33,33,33 percent for successive 10-day periods as given by the Technical Guidelines of the Irrigation Department, as it is assumed that in the Kirindi Oya system many water users start cultivation relatively late, because many of them stay in their original villages till they get the news that the water issues have been started.

* During land soaking and puddling the average water requirements, in the absence of reliable field measurements, were assumed to be 125 mm and 200 mm for lowland and upland soils, respectively. However, IIMI measurements have shown that total water requirements for the land preparation in tract 5 of the Right Bank of the Kirindi Oya system were as high as 880 mm/ha (ibid.).

* After the land preparation, the season was initially divided in four broad growth phases of the crop in order to reduce the frequency of operations of the structures — compared to the weekly growth phases that were advised by the Water Management Consultants. However, later, the Water management Feedback Center again adopted the weekly adjustment.

* The 75 percent probability evaporation figures have been taken from the pan evaporation data of the Regional Research Station in Angunukolapelessa, as the most reliable in the neighborhood. The data from Tissamaharama and Hambantota evaporation pans were considered too unreliable.[22] However, it must be noted that the climate in Angunukolapelessa is quite different from that in the Kirindi Oya scheme.

* No rain was envisaged to be used effectively as there was no reliable system to adjust the water schedules to rainfall, and the prevalent on-farm methods did not tend to conserve rainwater. In the calculation

22 Ironically, in the Uda Walawe system which is climatologically similar to Angunukolapelessa, other consultants used Hambantota evaporation data, because according to one of the consultants, "they provided a more complete set for the Penman formula."

of the crop water requirements rainfall has been completely overlooked.

* The on-farm seepage and percolation losses are assumed to be 3 mm/day and 6 mm/day for lowland and upland soils, respectively, in the absence of reliable field measurements. IIMI research in tract 5 of the Right Bank found average values that varied between 4.7 and 10.8 mm/day (ibid.). The Water Management Consultants also have done field tests on seepage and percolation rates, but their results were considered inconclusive. The error that might be involved in this assumption could be rather important for these seepage and percolation figures were rather high compared to the total crop water requirement.

* As there were no accurate soil maps for the command area, the percentages of lowland and upland in field canal areas have not been reliably assessed.

The above assumptions of the Water Management Feedback Center for maha 1987/89 resulted in theoretical peak land preparation requirements of 2.55 and 1.70 l/s/ha at the farm turnout for upland and lowland soils, respectively. The computed peak crop water requirements at the farm turnout during crop growth period were 2.1 and 1.6 l/s/ha, respectively for upland and lowland (IIMI 1988, 18).

In addition, some other assumptions had to be made to derive the theoretical irrigation requirements for field channels, distributary channels, branch canals and main canals, from the crop water requirements at field level and from these the theoretical irrigation requirements of all New Areas.

* The total losses in the canals are assumed to be 93 percent for the field channels, distributary channels and branch canals. For tract 1 and tract 2 of the Right Bank, the total losses in the main canal have been estimated at 90 percent, and for tract 5 at 85 percent. These estimated conveyance values were found to be unrealistic by IIMI research (ibid., 25). The Water Management Consultants stated they had done some research in sample distributary channels to get an idea of the actual seepage losses, but considered their results very heterogenous and inconclusive. The average field application efficiency has been assumed to be 70 percent.

* During land preparation the water is scheduled to be delivered continuously and after the land preparation it is assumed to have rotational delivery among and within field channels and continuous delivery in distributary channels. A rotation interval of 7 days within a field channel has been assumed. The discharge in field channels has been assumed to be variable in quantity during different crop growth phases or rainfall, but to be of constant duration of delivery to and within field channels (i.e., fixed time and variable discharge). However, more informal and *ad hoc* rotations are practised usually.

* The time required to deliver the peak weekly — which conform to the 7-day interval — crop water requirement during the crop growth period to a 1-ha allotment was calculated to be 12.5 hours for upland soils and 9 hours for lowland soils.

* In case a field channel would need irrigation for six days out of seven, which was the case for many field channels in tract five, the field channel would be closed for one day a week. In June 1988, however, the Senior Irrigation Engineer changed his mind and neglected this one-day closure in further water schedules.

* In assessing the water requirements for different subsystems, it has been assumed that the canal was always under steady state conditions, and time of conveyance of water along the main canal and distributary channels is assumed to be zero.

* No assumptions were made regarding operational and managerial losses by the water users and the Irrigation Department staff.

The above list of assumptions shows the constraints one faces in making a reliable estimate of the actual water requirements at field level and overall system level. This is the case pertaining not only to the Kirindi Oya system, but also to other systems in general, because, except for the soil maps, most other parameters used for the calculation of water requirements have to be based on assumptions.

It makes these calculations no more than unreliable estimates of the average water requirements of canals and overall system, and especially of the water requirements at field level. Only if these estimates are adjusted to correspond to actually experienced water duties, can they be reliable.

However, in such a case the actually experienced water duties make the theoretical calculations redundant.

ANNEX 3

The Seasonal Allocation Plan

PLANNING FOR YALA 1988 AND MAHA 1988/89

Yala 1988

AT FIRST, ENOUGH water was not available for cultivating rice in the whole system for yala 1988. At the Project Coordinating Committee meeting of 7 April 1988, the Chief Resident Engineer told the other officers that he could issue water to all tracts for short-term other field crops (OFCs) till 15 July 1988. Until then no precultivation meetings had been held. The Project Manager of the Irrigation Management Division said that the water users could grow OFCs, if they would be allocated water till 30 August 1988. No conclusive decision evolved from this discussion.

Heavy rainfall during April caused abundant water availability. The Senior Irrigation Engineer informed the Chief Resident Engineer that enough water was available for growing rice in the whole scheme. At this moment, however, an unusual move was made by the Project Manager of the Irrigation Management Division for the New Areas.

Without consulting the other agencies first, the Project Manager of the Irrigation Management Division for the New Areas requested the Government Agent to authorize cultivation for tract 1 of the Right Bank. The Government Agent agreed to do this — he is empowered to do so according to the Irrigation Ordinance — and he sent a letter to the Chief Resident Engineer instructing him to issue water to tract 1 of the Right Bank. The letter also stated that the decision about the crop to be grown had to be taken at the cultivation meeting, which actually meant that rice would be grown, because the water users strongly preferred rice to OFCs.

Naturally, officers of all other agencies were very annoyed that they were not consulted by the Project Manager and the Government Agent. The Project Manager defended his position by saying that it was the decision of

the water users, and that he only did what they wanted. The result of this unusual procedure was that the Department of Agriculture did not have seeds available; the already-arranged other field crop demonstrations of the Department of Agriculture (Extension) were abandoned by the contracted water users, and the Agrarian Services Department was not able to supply many inputs to the water users, because that decision was taken hastily.

The Chief Resident Engineer was also in a difficult position, for it would mean that the yala season would continue till the end September 1988 and there would be little time for the required additional excavations in the main canal, and other repairs to Phase I construction. As 1988 was the last year that the ADB would reimburse expenses on these repairs, the Chief Resident Engineer consulted the Director of Irrigation on the strategy to be followed.

Cultivation of rice in tract 1 of the Right Bank and tracts 1 and 2 of the Left Bank — tracts 2 and 5 of the Right Bank had not finished maha cultivation then — meant that these repairs would have to be postponed; most staff of the Irrigation Department did not like this postponement, given their interests in construction works.

A side argument was that it would demotivate the water users to grow subsidiary field crops in future yala seasons. On the other hand, it was hard to imagine that no rice would be grown while the Lunuganwehera Reservoir would be spilling, given the two earlier drought seasons and one crop failure in the Kirindi Oya system and the existing political unrest in the area. The Director of Irrigation decided to allow rice cultivation in the abovementioned tracts.

No precultivation meeting was held. At the cultivation meeting for tract 1 of the Right Bank on 9 May 1988, the Resident Engineer (Right Bank) asked the water users to grow a short-term rice variety (i.e., the three-month variety) in order to enable him to attend to necessary repairs from 15 August 1988. Little discussion took place at this meeting about the consequences for maintenance, because the officers present felt that the decision was already made according to the wishes of the water users and could not be changed.

The Agricultural Officer of the Department of Agriculture made the same request, because the yala season was already half gone and the risks of crop failure due to pests or diseases were increased. A cropping calendar was proposed by a representative of all distributary channel-level water user groups, according to which water would be issued between 10 May and 20

September. After some discussion, however, the representatives changed this proposal to the period from 10 May to 28 August 1988, which dates were agreed upon by the other water users. The water users of some field channels requested the Resident Engineer to repair their field channels instead of issuing water for yala, which the Resident Engineer agreed to do.

Maha 1988/89

The precultivation meeting for maha 1988/89 for tracts 2 and 5 was held on 12 August 1988. Before this meeting, the Project Coordinating Committee had already decided that they would issue water on 15 October 1988. The Chief Resident Engineer had written a letter to the Government Agent, advising him to issue water by the end of October 1988 in order to allow time for repairs to the main canal.

Before the precultivation meeting, the Resident Engineer of the Right Bank sent his Irrigation Engineer to the Chief Resident Engineer to inquire about the exact date when water issues would be made. The Senior Irrigation Engineer had informed the Chief Resident Engineer that water issues could be made on 15 September 1988; the Resident Engineer of the Right Bank did not agree to this date, because it would obstruct the maintenance activities.

At the precultivation meeting, the Resident Engineer (Right Bank) pleaded that he should be given one month for maintenance activities between the yala (which would end mid-September) and maha seasons. However, the water users of tract 2 and 5, who did not have a very good crop in the late maha 1988/89 season insisted that they did not want to do a late cultivation again and went as far as to threaten that they would not cultivate at all, if they could not get water in early September; in the Project Committee Meeting of the Irrigation Management Division they had decided to propose 5 September as the date for first water issues. The water user representatives added that they had lost confidence in the Irrigation Department as they had been requesting for specific maintenance activities since 1986, and that the Irrigation Department did not keep their promises.

The Resident Engineer (Right Bank) then proposed to issue water between 20 September and 1 October 1988, pending the decision by the Project Coordinating Committee of 15 August 1988. The water users agreed

to this on the assurance of the Resident Engineer (Right Bank) that he would do his utmost to solve their irrigation problems during this short period.

The Project Coordinating Committee decided that a Subcommittee was needed to "rationalize" the complex seasonal decision making, instead of letting the water users to decide. This Subcommittee decided to hold cultivation meetings and arrive at a decision after explaining the problems to the water users. The cultivation meeting decided to issue water from 20 September.

After all, The Irrigation Department could start its anticipated excavation of the main canal. Unfortunately, the Irrigation Department had not completed their maintenance activities in time and consequently they did not start water issues for the season until 25 September. On 20 September, many water users had come to the project expecting water issues, completely unaware as to why there was no water as agreed upon at the cultivation meeting. Many water users were angry not only about the fact that the date was delayed, but also due to the fact that the Irrigation Department did not inform anybody about the delay, not even the Government Agent or the Project Manager of the Irrigation Management Division.

STEPS IN THE SEASONAL ALLOCATION PLANNING

The *first step* in the seasonal matching of supply and demand is the preparation of a proposal for the seasonal allocation plan by the Senior Irrigation Engineer. The Senior Irrigation Engineer used the following implicit or explicit criteria for prioritizing among proposed areas to be cultivated, cropping pattern, cultivation calendar with staggers, assumed water requirements and related cultivation risks for different subsystems:

* At the time the decision was made to construct the New Areas, farmers of the Old Areas except the Badagiriya system were promised an explicit priority in cultivation rights. Farmers of the Old Areas would receive irrigation water first — even during times of water shortage — and they would be allowed to grow rice in both maha and yala seasons. Farmers of the New Areas would grow rice in maha, but were supposed to grow subsidiary field crops in yala. In the absence of additional support for introducing subsidiary field crops, in practice only rice was grown in the New Areas. The Badagiriya system would receive water,

only if the water supply for the Ellagala system and the New Areas was abundant.

* As described earlier, the water duties allocated to all areas were abundant, because they were based on realized, demand-driven gross water duties of earlier seasons. These duties represented a striving for minimization of cultivation risks and a minimization of complaints by the water users.

* A conservative estimate of the total area to be cultivated was made on the basis of these abundant water duties. Minimization of cultivation risks of the individual water users, rather than optimization of the productivity of the overall system, was the objective in the proposals of the Senior Irrigation Engineer. This priority was reinforced by the crop failure during the water-scarce season of maha 1986/87, which led to reduced confidence of the water users in the competence and credibility of the staff of the Irrigation Department. This resulted in complaints from the highest political levels in the country to the Irrigation Department. To restore confidence and prevent such high-level complaints, the Irrigation Department became more conservative in determining the area that could be cultivated.

* Long-term equity among different tracts in the New Areas was pursued. If water shortage at the start of a certain season forced cultivation in a limited number of tracts only, the tracts left dry would get priority for water in the next cultivation season.

* The proposed starting dates for different subsystems have to match the maintenance activities planned by the Resident Engineers' office for the off-seasons as well as the time needed by the water users to clean their field channels, get their cultivation credits, inputs, etc.

Conservative estimates for the irrigation requirements were justified because prioritizing during water-shortage situations of the cultivation season was considered unrealistic. The Water Management Consultants, using the results of a computer simulation, recommended a strategy for maximizing the water efficiency and cultivated areas by assuming low irrigation requirements and reducing the cultivated area at certain reservoir levels of Lunuganwehera (AHT/SCG 1987a, III.5). The Senior Irrigation

Engineer considered this to be unrealistic given the likely pressures that would be exerted on the staff of the different agencies and the Government Agent by the water users and politicians in response to such decisions. In his view, the cultivated area could be reduced, only if the minimum operating level of the reservoir (i.e., a physical control) would prevent further water issues to such subsystems.

The main criterion used by the consultants for the operation of the Kirindi Oya system was the maximization of productivity per quantity of water (AHT/SCG 1987b, 134). The Senior Irrigation Engineer tried to minimize the cultivation risks. At a later stage, the Water Management Consultants in their final operation and maintenance manual accepted the necessity of a "somewhat conservative planning at the onset of the season" (AHT/SCG 1989, IV.5). However, to prevent too conservative planning, they still recommended a fixed time schedule for adjustments in the cultivated area (ibid.), which remained unrealistic for the Irrigation Department in view of the above arguments.

In the *second step* of the preparation phase of the seasonal allocation decision making, the Senior Irrigation Engineer forwards his proposed seasonal allocation plan to the Chief Resident Engineer. This proposed seasonal allocation plan explicitly states the areas to be cultivated, the cultivation calendar with staggers, the crops to be cultivated, assumed water duties and involved cultivation risks. The Chief Resident Engineer in his turn matches these plans with the maintenance plans of the Resident Engineers (if the Senior Irrigation Engineer has not done so already).

In the planning for yala 1988, this matching led to conflicts between the Senior Irrigation Engineer and the Chief Resident Engineer, because the Chief Resident Engineer wanted to maximize the maintenance activities in the Phase I areas between yala 1988 and maha 1988/89. The reason for this priority for maintenance was that it was the last year that repairs of Phase I construction would be funded by the ADB.

Instead of making this priority explicit, the Chief Resident Engineer insisted on the introduction of short-term varieties of subsidiary field crops during that season in the New Areas, lest he would have to reduce the cultivated area due to the existing water shortage. The Senior Irrigation Engineer did not agree to it, because no plans were made for the introduction of these subsidiary field crops.

However, heavy rainfall occurred and the water users pressed for rice cultivation even when it was already late for starting the yala cultivation. The priority for maintenance activities of the Irrigation Department was thus severely threatened. Because donor funds were involved, the final decision regarding the cultivation calendar for yala 1988 was made by the Director of Irrigation himself.

However, in other seasons, all staff members of the Irrigation Department in the Kirindi Oya system agreed to the proposals that evolved from the office of the Senior Irrigation Engineer and the Chief Resident Engineer. As in the preceding stage of the preparation of the seasonal plan, an implicit criterion in this step of the seasonal planning was the restoration of confidence of the water users in the Irrigation Department after two water-scarce years, which meant that more weight was given to pressures from the side of the water users regarding the cultivation calendar. This criterion was implicit, because the Chief Resident Engineer at this stage gave priority to maintenance interests, while being aware that he would have to give in to likely pressures from the water users.

In the *third step* of the seasonal allocation planning, the Chief Resident Engineer informs the Government Agent of the availability of water for cultivation, the proposed areas to be cultivated and the cultivation risks involved. Consequently, the Government Agent organizes precultivation meetings for every tract (for the New Areas) or reservoir (for the Old Areas). However, in case of sudden heavy rainfall as in the aforementioned yala season, the water users or the Project Manager of the Irrigation Management Division react faster and request the Government Agent to organize the cultivation meeting before he receives such a proposal from the Irrigation Department.

The function of the *precultivation meeting* is to get an idea of the requirements of the water users regarding the seasonal allocation plan. Till this precultivation meeting the seasonal allocation planning by the Irrigation Department and the Irrigation Management Division had been largely separated. Before the precultivation meeting the demand assessment regarding the cultivation calendar and cropping pattern had been done only by the Irrigation Management Division, through their distributary-channel level and project level meetings as described on page xx. In the absence of any interaction at this stage, the seasonal planning by the water user

representatives and the Project Manager had little influence on the plans of the Irrigation Department in these preparatory stages.

The decisions that have evolved from these two isolated decision-making processes came together in the precultivation meeting for the first time and if they did not match — in practice, this applies mainly to the cultivation calendar — the proposals of the Irrigation Department were, in general, pushed by the attending officers for a number of reasons: 1) the Irrigation Department would be responsible for successful implementation of the plans; and 2) most agency staff did not like the rather political role of the Project Manager of the Irrigation Management Division for the New Areas as he would always support the water user demands, even if they are unreasonable or insulting to the agency staff. The water users, in their turn, can discuss and make tentative decisions on the proposed areas to be cultivated, the crop varieties to be cultivated and the cultivation calendar.

The outcome of the precultivation meeting was consequently discussed at the *Project Coordinating Committee* with the officers of the different line agencies and with the Project Managers of the Irrigation Management Division. In this meeting, the officers agreed on a proposed plan for the season which, according to the Sri Lankan law, would have to be authorized by the water users at the cultivation meeting.

This Project Coordinating Committee meeting was dominated by the water availability and the related proposed plan of the Irrigation Department. Until this meeting the agricultural aspects of the seasonal allocation plan were not discussed between the Irrigation Department and the staff of the Department of Agriculture, while at this meeting the agricultural arguments do not bear any weight anymore in view of the ready-made seasonal plan of the Irrigation Department. During maha 1987/88, at the Project Coordinating Committee meeting, the Department of Agriculture warned that the cultivation of rice in tract 5 during the intermediate season (i.e., between maha and yala) would lead to many pest attacks and diseases. The other officers ignored this warning. Later, at the cultivation meeting, the water users of tract 5 also ignored it. However, mainly due to these pest attacks the crop in tract 5 was very low in that intermediate season.

The Project Coordinating Committee was generally more oriented toward the implementation progress of the construction project than toward the agricultural implementation in the already constructed areas. Because of the

agency-wide priorities for these construction targets in the Irrigation and Land Commissioner's Departments, little detailed attention was paid to the agricultural implementation at the Project Coordinating Committee meeting.

Interaction between the agency staff and the water user representatives of the Irrigation Management Division. Efforts by the Project Manager of the Irrigation Management Division to have a separate District Agricultural Subcommittee for the New Areas that would pay more attention to the seasonal allocation decision making, and that would conform to the setup of the INMAS program (MLLD 1984a) were unsuccessful till 1989. The other agencies and the Government Agent resisted this. They argued that this decision making could be covered by the Project Coordinating Committee.

The function of this subcommittee would be to discuss with the officers of all the involved line agencies the decisions that will have to be made at the cultivation meeting and thus "guide the farmers to take a rational decision" (MLLD 1982a, 2). Indeed, the advantage of separating the seasonal allocation decision making from the Project Coordinating Committee is in the first instance not very clear, except for the important fact that more specific attention may be paid to the seasonal agricultural planning.

The Project Manager of the Irrigation Management Division for the New Areas consequently tried to get the water users to participate at the Project Coordinating Committee meeting, where he felt that their interests could be better served than in the cultivation or precultivation meetings. This was refused by the chairman, the Project Manager (Settlement), who was also the Additional Government Agent. His decision was supported by other line agency officers and the foremost local politician, the District Minister of Hambantota District.[23]

An important reason for most officers to resist the attendance of the water users in the Project Coordinating Committee was the fear that they would concentrate on criticizing their construction activities. Also, they did not like the aforementioned unconditional, and sometimes unreasonable support for the water users by this Project Manager who, in the absence of any formal role in the decision making, tried to give some meaning to his organization and the water user groups by stimulating the water users to channel all their

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23 An important fact in this respect was that the Project Manager of the Irrigation Management Division for the New Areas did not have a good relationship with the District Minister.

complaints through the formal Irrigation Management Division meetings. "No problems, no Irrigation Management Division" was his attitude, which was much resented by most officers.

Despite the resistance of other officers, it was agreed after one year of persistence of the Project Manager that from January 1988 the water user representatives would be allowed to discuss their problems with the officers of the different agencies, but only after the Project Coordinating Committee meeting was over. This meant that the water user representatives were still not able to influence the seasonal decision making about the cultivation calendar at the Project Coordinating Committee meeting.

Apart from the above short-term consequences for the cooperation of other agencies, the political role of the Project Manager had also implications for the internal organization of the Irrigation Management Division in the New Areas in the development of a patron-client relationship between the Project Manager and the water user representatives. For the organization as such, this relationship was rather unsustainable, as it totally depended on the presence of this Project Manager and his personal relationships with the staff members of other agencies.

This patron-client relationship created expectations from the side of the clients, which, combined with the lack of cooperation from the other agencies, led to the chaotic and *ad hoc* interventions in the seasonal decision-making processes as described earlier in this annex.

Although it was successful at times, it usually led to conflicts with the other agencies and created an even more hostile attitude of the agency staff toward the Irrigation Management Division. However, due to better personal relations of the Project Manager with the Resident Engineer of the Left Bank, this setup worked somewhat better on the Left Bank than on the Right Bank.

In August 1988, the Project Coordinating Committee decided to form a *Project Coordinating Committee Subcommittee* to discuss the seasonal allocation plans in more detail. This decision was made after a long period of unwillingness of the staff officers of the Irrigation Department and the Land Commissioner's Department to pay much attention to the seasonal planning. It was only after the conflicts described earlier in this annex that these officers accepted the complexity of different interests in the seasonal allocation planning, especially in view of the future necessity to introduce

subsidiary field crops, and delegated this seasonal planning to a special subcommittee.

Like the Project Coordinating Committee, this subcommittee was chaired by the Project Manager (Settlement). The Chief Resident Engineer, the Project Managers of the Irrigation Management Division and the representatives of the Department of Agriculture (Extension) and the Agrarian Services were members of this committee. The efforts of the Project Manager of the Irrigation Management Division for the New Areas to let the water user representatives participate in this meeting were again opposed by most officers. The Project Managers of the Irrigation Management Division were expected to sufficiently represent the opinions and preferences of the water users. Thus, while this subcommittee provided for a more careful preparation of the seasonal planning between the agencies, the divergence of expectations of the water users were not tackled at all.

During 1989, the *Subcommittee of the District Agricultural Committee* had become operational. This subcommittee is a decision-making body provided for by the INMAS program for the agricultural programming and implementation in the district. In principle, the same officers who attended the Project Coordinating Committee meeting, attended this meeting as well. Farmer representatives from all projects in the district also attended this meeting. However, the Chief Resident Engineer and the Project Manager (Settlement), did not attend this meeting, because they did not have any formal relation to the district administration.

As the Kirindi Oya system was still under construction, the agricultural planning could not be considered separately from the ongoing construction activities by the same staff. Without a complete separation of these activities, the Subcommittee of the Project Coordinating Committee seemed more useful than the Subcommittee of the District Agricultural Committee. However, an advantage of the Subcommittee of the District Agricultural Committee for the water users was its legal basis in the Irrigation Ordinance. For the agencies involved in construction this legal nature was a disadvantage, because without it their construction priorities would be better represented.

An improvement of correspondence of the planning in the Subcommittee of the Project Coordinating Committee with the planning in the Irrigation Management Division has been tried later after the personal intervention of

the Director of the Irrigation Management Division. This led finally to the attendance of the water user representatives in the subcommittee meeting. Despite this improvement the subcommittees alone appeared to be unable to tackle the problem of the divergent expectations of the water users and the agencies (IIMI 1990, 54).

The aforementioned problems of lack of coordination were, to a large extent, due to personal conflicts between the Project Manager of the Irrigation Management Division and the Project Manager (Settlement); with the arrival of a new Project Manager (Settlement) the situation improved (ibid., 51).

The Irrigation Ordinance provides for the legal framework, by which the decisions with respect to the seasonal allocation in terms of the cultivation calendar are taken by the water users at the *cultivation meeting*. It also provides for the possibility that the Government Agent can overrule these decisions, or make these decisions without holding a cultivation meeting (Government of Sri Lanka 1968, 5).

In small village reservoirs, the cultivation meetings allowed for discussion among farmers regarding priorities among the possible options. Due to the sheer number of water users in major systems like the Kirindi Oya such discussions have become ineffective. The main function of the meeting in the Kirindi Oya system is the authorization of the proposed seasonal decisions, whereby some modifications of the agency plans may occur as already described in this annex.

Though the Ministry of Lands and Land Development (MLLD) required "rational" seasonal allocation decisions, no criteria for this purpose were provided for use in the precultivation and cultivation meetings (MLLD 1982a, 3). The only criterion available for this decision making was the maximum periods allowed for issuing water for maha and yala seasons, i.e., five and four months, respectively (MLLD 1985b, 1985c, 1985d; Irrigation Department 1985). As there were no official criteria (regarding water delivery performance, cultivated extents, staggering, cropping intensity and long-term equity), the individual and conflicting criteria of the staff of the Irrigation Department and the Land Commissioner's Department and the water users were used. This led to the dominance of construction interests and the neglect of detailed attention to the seasonal allocation processes.

ANNEX 4

Implementation Processes of the In-Seasonal Allocation Schedules

THE OFFICIAL IN-SEASONAL allocations, in terms of discharges for the whole season from the moment of completion of the land preparation, are entered in a special form. These forms are sent by the staff of the Senior Irrigation Engineer to the office of the Resident Engineer (Right Bank). During maha 1987/88 they were sent direct to the water user representatives.

In the office of the Resident Engineer, the conversion of the scheduled discharges into the target water levels over the measuring weirs is done by the Irrigation Engineer and the Technical Assistants by means of a theoretical weir equation. The rationale behind this work division is that the staff of the Resident Engineer is responsible for the actual gate settings and has to maintain these structures, and this experience enables them to determine the appropriate water levels to attain the operational targets.

The staff of the Resident Engineer (Right Bank) enters these calculated water levels in the forms against the corresponding scheduled discharges and distributes them to the water user representatives. The implementation of these schedules can be demonstrated with the following case for maha 1987/88.

During maha 1987/88, this conversion of discharges into water levels was done in a very unmotivated way; many of the notifications to the water user representatives did not show the water level, but gave scheduled discharges, which were incomprehensible to them.

At the beginning of the cultivation season, the actual in-seasonal matching of supply and demand starts without any assessment of the demand. Therefore, the first allocation to the Right Bank main canal is arbitrarily fixed at 30 percent of the design discharge. After this first issue, the allocation is increased whenever the actual matching of supply and demand in the Right Bank command area requires a higher allocation through the head sluice.

The actual matching of supply and demand starts at the level of the field-channel subsystem. The allocation to a field channel is estimated through experience in terms of a certain water level and is increased whenever requested by the water users. An increased allocation to one field channel is compensated for by a reduced allocation to another to maintain the required water levels along the distributary channel. If reduction to other field channels is not possible, and the water levels along the distributary channel become too low, the allocation to the distributary channel, as a whole, is increased. Thus, the actual method of allocating water to field channels and distributary channels is quite different from the scheduled rotational allocations. The demand for the main canal as a whole is assessed by the water levels along the main canal. If these levels are too low — usually at the tail end — and this cannot be rectified by reduction of the allocations to branch canals and distributary channels, the allocations through the head sluice will be increased.

The feedback requirements of this localized matching of supply and demand are less. The only feedback on the actual allocations to branch canals and distributary and field channels, during the observation period, to the Resident Engineer's office and the Water Management Feedback Center was through field visits or through irregular requests of the water users and the different hierarchical levels of the Resident Engineer's staff.

Extension of the water schedules and their implementation. The distribution of the water schedule forms takes place at the end of the land preparation, because up to that time the canals were overloaded to get the maximum quantity of water to the different subsystems and scheduled issues were still irrelevant. During maha 1987/88, at the end of the land preparation of tract 5, the office of the Resident Engineer (Right Bank) implemented the proposed water schedules directly after the distribution of the forms. No meetings were held to explain to the water users and its own gate tenders the content of the new forms and the way to use them.

As graphics were used to represent some values, the water users and field staff did not understand the contents of the forms. As a result, the implementation of the rotational deliveries after the end of the land preparation was completely chaotic.

Gate tenders closed offtakes that should have been opened, and *vice versa*. Because the water users were not properly informed about the actual

implementation of the rotation, some "water users that had sprayed weedicide and were waiting to irrigate land" faced serious difficulties (IIMI 1988, 70). This situation continued for two days, until the Senior Irrigation Engineer learnt about the early implementation. He instructed the Resident Engineer (Right Bank) to stop the rotations and give farmers training classes about the rotations first. The staff of the Resident Engineer responsible for the actual allocations and implementation did not monitor and intervene at all during this chaotic situation.

After this incident, the Senior Irrigation Engineer "claimed he had instructed the Resident Engineer (Right Bank) not to implement rotations until classes were held, and said there was supposed to be continuous issue until 28 March" (ibid., 70). However, it was only after the rotations were stopped, that the Technical Assistant of the office of the Resident Engineer (Right Bank) together with the Irrigation Engineer of the Water Management Feedback Center started up these classes for the water users and the field-level staff.

It is difficult to find the exact cause of the chaotic implementation of the rotational issues in tract 5, but the following facts form the background to the incident. The office of the Resident Engineer (Right Bank) had a lot of design and construction work to do and traditionally, these construction-related targets got priority over water delivery targets at all levels of the Irrigation Department.[24]

Somewhat similar to what Moore described as "negative incentives" for effective interaction with the water users (Moore 1980b, 106), the working atmosphere of the Irrigation Department staff in the Kirindi Oya system was such that activities like farm training classes were considered the "dirty work" by many officers. The attitude of the staff of the Resident Engineer (Right Bank) regarding the calculation of the water levels and the implementation of the training classes could be characterized as something like, "We are instructed to do this, but we do not like this and we are not going to implement these rotations anyway; so what a waste of time."

In short, the responsible staff of the office of the Resident Engineer (Right Bank) translated their priority for construction into a minimization of their

24 The motivations and attitude that underlie this priority are extensively described by Moore (1980b, 106).

management input as their main criterion with respect to the in-seasonal allocation processes, and regarding the calculation of the water levels and the introduction of the rotational issues.

Another reason that helped to create the chaos during maha 1987/88 was the continuous conflicts between the staff of the Water Management Feedback Center and the other officers. The other officers felt that the lack of administrative and financial authority of the Senior Irrigation Engineer, apart from the inferior status it gave him, made it easy to ignore instructions of the Senior Irrigation Engineer regarding a "minor" issue like in-seasonal allocation. This created an atmosphere in which both parties were harassing each other's professional domain.[25]

In addition, the unwillingness of the Resident Engineer to follow the instructions of, or make requests to, the Senior Irrigation Engineer (whose seniority of service in the Irrigation Department was slightly less than that of the Resident Engineer), played an important role. The Chief Resident Engineer and the Project Director were not able or willing — given the existing priority of the construction targets — to effectively control these conflicts and their consequences.

In June 1988, the Chief Resident Engineer made an effort to improve the allocation processes by the establishment of job descriptions for all project staff. In this exercise, the Senior Irrigation Engineer was made "fully responsible for the operation." The exact meaning of this responsibility was never specified, however. He was not given any financial or administrative responsibility, which was considered to be essential by his colleagues to maintain the areas under his responsibility. Moreover, while the Senior Irrigation Engineer was one of the most senior project officers, and his new designation should have been listed at the top of the list of designations and job descriptions, it was ironically put at the bottom .

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25 This conflict was of a type similar to the frequent harassments of the Irrigation Engineer and Technical Assistants (who are interested and motivated to deliver a good irrigation service in construction or rehabilitation projects) by other staff, who were more interested in the construction targets. As a result of these harassments, most "service delivery friendly" Technical Assistants were based in the head office in Colombo and did not get anymore promotions. For similar reasons, a Senior Irrigation Engineer in the Kirindi Oya system has been transferred to another duty station.

After the farmer-training classes were held, however, the scheduled allocations were still not adhered to. A successful implementation which conformed to the calculated water levels was, of course, impossible because of the malfunctioning of the measuring structures. However, despite this incapability to measure discharge and water level reliably, it would have been still possible to allocate water on a rotational basis to save water. These allocations had to be realized by the gate tenders through the assessment of water levels and the additional demand taking requests from the water users or their representatives into consideration.

These allocations would have to be made under the guidance of the Work Supervisor, Technical Assistants and Engineers, and not under the guidance of the Water Management Feedback Center as it was impossible for them to systematically monitor the actual issues without feedback on measurements or the water user complaints. Several officers of the Irrigation Department have stated that the implementation of such rotational deliveries would not have been a problem in the Right Bank, provided the motivation to do so existed. In practice, the rotational deliveries were not implemented, because of the aforementioned priority for the construction targets.

The Resident Engineer (Right Bank) recognized that the combination of construction and water-delivery activities of his staff would lead to neglect the latter. Therefore, he made one Technical Assistant fully responsible for the water-delivery activities of one tract, in contrast to the earlier arrangement where each tract was managed by three Technical Assistants.

Actual operational targets for distribution below the head sluice. Nevertheless, these Technical Assistants did not visit their tracts regularly. They instructed the gate tenders to allocate as much water as requested by the water users. Because the water users preferred continuous water issues, the gate tenders allocated them continuous issues as far as it was possible. The Work Supervisors of the office of the Resident Engineer (Right Bank) were not assigned the water-delivery responsibilities, because they were needed for construction activities.

Thus, instead of a rotational water-delivery method, a combination of continuous and on-demand delivery was practised despite their qualification as "unsuitable" by the Technical Guidelines (Ponrajah 1988, 244). Below the head sluice, there was no systematic monitoring and evaluation of these

actual allocation processes of the gate tenders by the Resident Engineer's staff.

For the staff of the Water Management Feedback Center the complete delegation of the allocation of water below the head sluice to the gate tenders with very little guidance from the staff of the other Resident Engineer (Right Bank) was very frustrating. In order to save the name of the Irrigation Department in the Kirindi Oya system, they started to monitor the actual water allocations through daily visits to the field.

They even instructed the water users to change gate settings in accordance with the scheduled water levels in order to enforce the rotational issues. The Resident Engineer (Right Bank) officially agreed with these instructions; however, his staff refused to follow them, and consequently it led now and then to conflicts in the field between the staff of the Resident Engineer (Right Bank) and the staff of the Senior Irrigation Engineer.

This refusal of the gate tenders must be seen in the light of the fact that for them the scheduled water levels were just theoretical values, because the allocations that they implemented were completely different (i.e., on-demand rather than supply-driven) and, in line with the instructions of their own administrative superiors.

At a later stage, the staff of the Water Management Feedback Center realized the impossibility of enforcing rotational allocations in this way. Consequently, it restricted its interventions in the actual allocation processes to the allocations to the Right Bank main canal from the head sluice.

Actual allocations from the head sluice to the Right Bank main canal. The allocations to the main canals were controlled by the staff of the Resident Engineer (Head Works) on the instructions of the Senior Irrigation Engineer who was responding to requests from the Resident Engineers of the Right Bank and the Left Bank.

In this respect, the Senior Irrigation Engineer has complained that the Resident Engineers were *ad hoc* in their decision making. For example, after rainfall, they often requested that the water issues be reduced by ten cusecs (about 10% of the average discharge in the Right Bank main canal), and two days later they would request an increase of 25 cusecs because of complaints from the water users. Thus, the discharge to the main canal had to be changed unnecessarily and frequently.

Another, even stronger example of the *ad hoc* decision making by the Resident Engineer is the following case. It started with a written request on 18 May 1988 by the Resident Engineer (Right Bank) to allocate 5.4 m^3/s to the Right Bank main canal. The Senior Irrigation Engineer issued only 5.1 m^3/s on 18 May arguing that the theoretical crop water requirements were only 4.5 m^3/s and that the Resident Engineer (Right Bank) should improve his water-delivery performance.

On 19 May, the Senior Irrigation Engineer made a field inspection and found that the cofferdam across the main canal (situated just below distributary channel 19) had been broken and that the whole main canal discharge was drained through branch canal 2. All gates to the offtaking field channels of distributary channel 2 (which itself was an offtake of branch canal 2) were fully open, while at the same time branch canal 2 was overflowing downstream of the offtake to distributary channel 2. Ironically, the water users in distributary channel 2 were not irrigating at the time on the instructions of the Department of Agriculture to control a brown hopper attack.

The responsible gate tenders stated on 19 May, that they had already warned the Irrigation Engineer of the office of the Resident Engineer (Right Bank) about the excess discharge in the main canal. On 19 May, the Senior Irrigation Engineer reduced the discharge in the main canal by 0.3 m^3/s on his own initiative. On 23 May he reduced it by another 0.3 m^3/s which brought the discharge back to the theoretical requirement. However, even on 23 May the water level in branch canal 2 was very high.

Regarding these allocations to the Right Bank main canal, the Resident Engineer (Right Bank) complained that making his requests to the Senior Irrigation Engineer caused unnecessary delays. In his opinion, it would be much simpler and faster to make requests directly to the Resident Engineer (Head Works) who was responsible for the operation of the head sluice. However, this argument of the Resident Engineer (Right Bank) seems less valid in the light of the admission by the Resident Engineer (Left Bank) that he did not experience this problem.

The advantage of that procedure, however, was that it enabled the Senior Irrigation Engineer of the Water Management Feedback Center to exercise some "macro-control" on the allocations to the main canals. He did so by using a comparison of the actual water allocations with the theoretical (i.e.,

a relative water allocation ratio which conformed to the relative water supply definition of Levine, 1982) as a performance measure for judging the correctness of the requests by the Resident Engineer (Right Bank).

Even if the required allocation was remarkably higher than the theoretical, the Senior Irrigation Engineer still authorized in writing the allocation of (almost) the same increase of discharge requested; but he made reference to this difference and encouraged the Resident Engineer (Right Bank) to improve his allocation performance. To increase the pressure, in his letter, he compared the allocation performance of the office of the Resident Engineer (Right Bank) with that of the office of the Resident Engineer (Left Bank), which was a little better, i.e., water duties of approximately 2,300 mm and 2,000 mm, respectively.

Moreover, the Senior Irrigation Engineer did not hesitate to comment, in black-and-white, on the quality of the construction works, if he deemed it necessary, which gave more weight to some form of "macro-control" with respect to the allocation processes. By these means the Senior Irrigation Engineer assured that his position in the allocation meant a little more than reporting only.

However, refusal of requests for more water to the Right Bank main canal was impossible, because the Water Management Feedback Center could not deny that there were water shortages in specific locations. Moreover, if it was refused, the Resident Engineers would hold it responsible for such shortages.

In case of heavy rainfall, the Senior Irrigation Engineer would decrease the discharge to the main canal by up to 5 percent without a request from the Resident Engineer to save water. In case the rainfall was more than 75 mm, he would close the main canal for seven days. Many complaints were heard about such a closure of the Right Bank main canal during 10-18 April due to different reasons. Two reasons were of a more technical nature: 1) Many farmers thought that the rainfall was not sufficient enough. This may have been true for certain parts of the command area as the Water Management Feedback Center gets rainfall data only from the Lunuganwehera Reservoir and the office of the Resident Engineer (Right Bank), while the rainfall could be distributed very heterogeneously. 2) The water users on the upland soils complained that water did not remain longer than four hours in their fields anyway. On the other hand, the Senior Irrigation Engineer and the Water

Management Consultants were of the opinion that the water users practised inappropriate on-farm water management, which was sufficient justification, in their opinion, to implement this procedure.

Apart from these technical arguments, the water users complained that they were not informed about the closure of the canal and many staff members of the Irrigation Department were on leave for the Sinhala and Tamil New Year. Another argument, from a managerial point of view, against this procedure was the assumption that the water users would practise good on-farm water management without being, at least, informed of or requested to follow such procedure.

Actual operational targets for conveyance through the main canal. Whereas gate tenders who were responsible for field channels and distributary channels could coordinate and balance the water levels in their channels by varying the allocations to the different offtakes and turnouts, such a coordination did not exist for the main canal for nobody was responsible for it. The Resident Engineer (Right Bank) was aware of this gap, but could not make a Technical Assistant available who could regularly monitor and adjust the operational targets for the conveyance along the main canal.

As a result, *ad hoc* measures to store, drain or "push" water in the main canal were adopted. Moreover, the lack of management of the conveyance was partly solved by keeping the allocation to the main canal higher. In case of sudden increases in water level in the main canal, the excess water was drained through the spillways to Weerawila tank — this happened even when the Weerawila tank itself was spilling — or through branch canal 2, instead of reducing the discharge to the main canal (this happened, in the case described on page 31).

The protection of the cofferdam erected at the tail end of the main canal to issue enough water to the upstream distributary channels got the utmost priority from the gate tenders. When the cofferdam was damaged for the first time, the Irrigation Engineer threatened the gate tenders that they would be fined two days' salary if it happened again. This resulted in remarkable good coordination between the gate tenders who were responsible for the water levels in the distributary channels downstream of branch canal 2, and the gate tenders who had to drain water through branch canal 2.

The aforementioned reluctance of the Resident Engineer (Right Bank) to request the Senior Irrigation Engineer for allocations once caused the spilling of water more than ten kilometers upstream of the siphon to protect the cofferdam, rather than reducing the discharge to the main canal.

Overall, the minimization of management input by the staff of the Resident Engineer (Right Bank) seemed to be the most important criterion in the above-described actual allocation processes and consequent operational targets for conveyance and distribution below the head sluice. Less important was the reduction of cultivation risks, by passively striving for a no-complaint situation. Only the Water Management Feedback Center used the criterion of economizing on water use for the system as a whole, through its "macro-control" on the allocations through the head sluice.

The allocation strategy. The Water Management Strategy Plan that was prepared by the Water Management Consultants (AHT/SCG 1987b) did envisage situations to reduce the cultivated area during the season, if the Lunuganwehera Reservoir level dropped below certain arbitrary levels. These levels were determined by running a simulation program several times at certain points: weeks 1,5,9, and 14 of the season (AHT/SCG 1989, IV.6). In Sri Lanka, the reduction of the cultivated area during the season is considered unfeasible by the officers of the Irrigation Department; hence this strategy is not used.

The passive allocation strategy adopted by the staff of the Irrigation Department allocates as much as possible on-demand (i.e. a combination of continuous and rotational deliveries) to the water users in water-abundant situations. However, it was only when water became tight or scarce that they contemplated more management inputs on the part of the staff and the water users by way of enforcing the rotational deliveries more strictly.