Working Paper No. 23

INTRODUCTION OF MONITORING ACTIVITIES AT THE MAIN-CANAL LEVEL

A Study of the Kirindi Oya Right Bank Main Canal -- Maha 1991/92

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Rey, J. ; Hemakumara, M. ; Mohanrajah, S. ; Junaid, M.H. 1993. Introduction of monitoring activities at the main-canal level: A study of the Kirindi Oya Right Bank Main Canal -- Maha 1991/92. Colombo, Sri Lanka: IIMI. x, 66p. (Working paper no. 23)

/ irrigation management / water management / canal irrigation / monitoring / decision making / water conveyance / indicators / Sri Lanka / Kirindi Oya /

DDC 631.7

ISBN 92-9090-190-x

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Contents

Figures

Tables

Preface

The research activity described in this working paper is a joint effort undertaken by the International Irrigation Management Institute (IIMI) and the Irrigation Department of Sri Lanka. Two of the authors, S. Mohanrajah (Resident Engineer, Irrigation Department) and M. H. Junaid (Additional Engineer, Irrigation Department), were responsible for the management of the Right Bank Main Canal (RBMC) in Kirindi Oya during the season, maha 1991/92. The monitoring network introduced under their supervision, with the active collaboration of the field staff, proved to be of significant benefit for the effective accomplishment of their day-to-day tasks of canal management. This led the authors to the conclusion that disseminating this experience even at an early stage could be of some interest to others seeking the improvement of the management of manually operated irrigation canals. Emphasis has deliberately been put on methods rather than on thorough, *a posteriori* analysis of data. Thus, ideas suggesting how to use simple flow data to compute indicators and derive management information has been preferred to the in-depth analysis of the data. The authors also hope to convey their intimate conviction of the usefulness of real collaborative action-research between "outside catalysts" and managers in charge of irrigation systems through this paper.

Introduction

Since its inception, the International Irrigation Management Institute (IIMI) has been studying the management of main canal systems. Several studies showed that due to the complexity of their hydraulic behavior these systems are often difficult to control and function under unsteady flow conditions which prevent the managers from achieving their water delivery targets. Seeking innovative ways for tackling these difficulties, IIMI embarked on a collaborative research project with CEMAGREF* to investigate the potential for using new decision-support tools like flow simulation models.

With a view to improve the management of manually operated main canals through the routine use of such tools, IIMI concentrated its efforts on a pilot study of the Kirindi Oya scheme in southern Sri Lanka.

It became clear while designing the framework of this study that the introduction of a simulation tool in this operational environment had important implications in terms of communication needs within the system and availability of real-time monitoring data.

A possible approach seemed to be to address the problem as rationalization of the canal management through the development of a simple Management Information System integrating the simulation tool for specific processing.

A generic methodology based on system analysis was adopted to diagnose the problems, leading to the formulation of an action plan to be implemented over two seasons of irrigation, maha 1991/92 and maha 1992/93.

The approach required putting some effort into understanding and controlling the information and data flows within the system. This was addressed by the introduction of a rationalized monitoring system (June/July 1991) and the storage of data in a computerized database.

It also required the introduction of some innovations in the decision-making process, based on the availability of real-time information and, progressively, the assistance of the simulation model of flow which permits a better understanding of hydraulic conditions.

The implementation program was designed as follows:

	Yala 1991	Maha 1991/92	Yala 1992	Maha 1992/93
Step 1: Information Communication	Design Training	Operational		Operational
Step 2: Processing Modelling	Design	Training	(Training)	Operational

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*French Institute of Agricultural and Environmental Engineering Research.

In this paper, we will mainly report the achievements of maha 1991/92 during which, Step 1 has been fully integrated into the Irrigation Department (ID) management process.

Monitoring Activities: A New Picture of the System

GENERIC PURPOSE

Using a simulation model, the manager of a complex physical system can obtain a holistic picture of his system. This representation, which can be either static or dynamic, can make a big difference in the way the manager conceptualizes his system and contribute to enhancing his confidence in making rational, planning or control decisions. The picture given by the use of a simulation model of flow is highly sophisticated; the manager can follow the likely evolution of levels and discharges at any interesting point of his canal over a period of time varying from a few hours to ten days while testing tentative operational plans. For the Kirindi Oya Right Bank Main Canal (RBMC), it has been decided to adopt a gradual approach and to build an "intermediate picture" first, based mainly on the real discharges measured at all the structures of the canal which are displayed daily on boards in the engineer's office as well as in the field offices. This important step helps to fulfil two objectives:

- Create the first "holistic real-time image" of the canal for all the people interested in its functioning.
- Provide the inputs required for building an operational database likely to assist the manager in making decisions (simulation model is fed in real time, regular statistical analysis is provided: See "Further Improvements" -- p. 19).

MONITORING NETWORK

The study focused on the management of the Right Bank Main Canal (RBMC) of the Kirindi Oya Scheme. This earthen canal is about 30 km long. Water levels are controlled by adjusting 19 cross structures (gated regulators) and water is issued all along its length through 42 offtakes. Its command area is divided into four subdivisions called "tracts" (see issue tree in Annex 1). Each tract covers an area ranging from 500 to 1,000 hectares (ha) and irrigation activities at this level are under the control of a Work Supervisor assisted by a team (4 to 6) of gate keepers. The overall management is guided by a Resident Engineer in charge of supervising the whole command area with the help of an additional irrigation engineer and Technical Assistants.

The basic activities involved in the data collection program are briefly detailed below and summarized in Table 1.1. A graphical representation of the system is given in Figure 1.1.

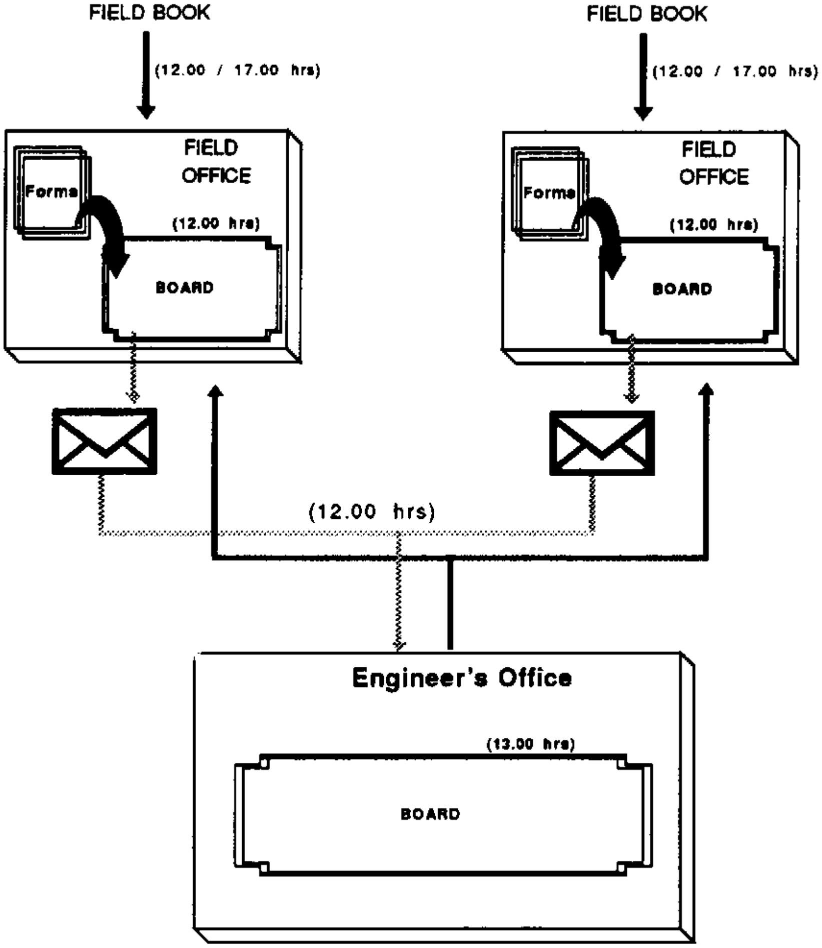
Table 1.1. Methodology for data collection at main-canal level.

NO.	TYPE OF ACTIVITY	PERSON	PLACE	FREQUENCY	SOURCE OF DATA	FORM USED	TYPE OF PROCESSING	OUTPUT	DESTINATION OF OUTPUT
1	Collection of gate readings	IL	Field	Daily * Twice a day 8.00 am / 16.00 pm * Every adjustment of gates	-	Form (i) and (ii) of booklet for field staff	No processing	Time and settings/levels of * Offtake spindle heights * Up/down stream water levels of offtakes * Spindle Heights of GRs * Up/down stream water levels of GRs	WS's Office
2	Preparation of Display Board	WS	WS's Office	Daily	Form (i)	Display Board at WS's office	Compute the discharges through offtakes (Not operational yet)	Evolution of water levels over 7 days	Display Board at WS's office
3	Preparation of Gate Setting Forms	WS	WS's Office	Daily	Form (ii) or Display Board Data	Gate Setting Table	Copying the GR gate settings and offtakes data from Form (i) or Display Board.	Time and settings of GR gates and up/down water levels Time and discharges to every offtake	WS's office
4	Sending data from WS's office to RE's office	WS	WS's Office	Daily After 12.00 Hrs	Gate Setting Table		One WS will be responsible for collecting Gate Setting Forms from two head-end tracts. Similarly, data from the tail-end tracts will be collected by one WS.	Time and settings of GR gates and up/down water levels Time and discharges to every offtake	RE's Office
5	Preparation of RB Display Board	Draughtman or any person assigned for this	RE's office	Daily 13.00 Hrs.	Gate Setting Table	RB Display Board	Computing the Flow data and water levels of different reaches from Gate Setting Forms.	Evolution daily discharges to offtakes over 7 days Feedback to WS's (messenger) 1. Computed discharges 2. Action plan if necessary to control flow	Display Board at RE's office Field
6	Filing of data to seasonal file Storage in database	Draughtman/ TA	RE's Office	Daily	Gate Setting Table	File Database	Filing and entering of data	Hard copy + database	RE's Office

Notes,:

IL = irrigation laborer	WS = work supervisor	TA = technical assistant
RB = right bank	RE = resident engineer	GR = gated regulator

Figure 1.1. Layout of the data collection and communication network.



Recording of Gate Openings and Water Levels

To facilitate the collection of data, the irrigation laborers were supplied with a specially designed field booklet (See Annex 2).

This field booklet consists of 2 types of forms:

a) Form (i) Daily Gate Settings:	These forms are designed to enter the normal, routine data twice a day (morning/ afternoon).
b) Form (ii) Daily Gate Operations:	These forms are designed to record all the gate adjustments done during the course of the day.

Preparation of Display Board (Work Supervisor's Office)

The data are displayed in the Work Supervisor's office to provide information direct to farmers or the Irrigation Department field staff. A sample format of the Display Board used in the Work Supervisors' office is shown in Annex 3 (evolution over 7 days).

Preparation of Gate Setting Forms

Special forms are used for sending data to the Resident Engineer's office. The Work Supervisor is responsible for filling the Gate Setting Form correctly by referring to the daily readings (routine data) entered in the folios of the field books of irrigation laborers. The sample form for Tract 2 is shown in Annex 4.

The morning data as well as the afternoon data of the previous day are ready by 12:00 noon.

Sending Data from the Work Supervisor's Office to the Resident Engineer's Office

Two solutions were envisaged:

1. Use of an external messenger.

2. Use of Work Supervisors.

After several discussions, it was decided to choose option 2 which dramatically improves the efficiency of the system. The Work Supervisors can get direct feedback from the Resident Engineer's office and then provide the operational instructions of the engineer to their respective field units.

A messenger is given on incentive payment of Rs1,500 (US$ 38.00) per month currently, with funds provided by IIMI.

Preparation of the Right Bank Display Board

The primary data to be displayed on this board are supplied daily by the Work Supervisors who gather the data through Gate Setting Forms. The processing is limited to the computation of discharges.

A partial sample format of the Display Board of the Right Bank Resident Engineer's office is shown in Annex 5.

Data Storage

At the computation stage, data are stored in a database. After the displaying of results, the Gate Setting Forms are filed in the seasonal file of the Resident Engineer's office.

PROCESS OF DESIGNING AND IMPLEMENTATION

The process of designing and implementing the monitoring activities was extensively discussed (five formal meetings between the Irrigation Department and IIMI) during June and July 1991. The final shape of the monitoring network was built on these discussions and the past experience of the Irrigation Department (ID) engineers in introducing such a data collection program. The key elements are:

- Provision of facilities for recording and displaying data. The Irrigation Department installed ceramic gauges on both the upstream and downstream sides of each structure of the canal where necessary. IIMI was in charge of designing and providing forms for data collection, four wooden boards for displaying data in the unit offices (field level) and one white board for displaying the whole set of daily data in the Resident Engineer's office. Wrist watches were also provided to the gate keepers, enabling them to precisely record the time of every operation performed along the canal.

- It was decided that IIMI would cover the cost of sending the data daily from the field units to the Resident Engineer's office. This measure which cannot guarantee the sustainability of the system was adopted transitorily, with a view to institutionalizing this task within the Irrigation Department once its efficiency had been clearly proved.

- In order to facilitate the daily computation of discharges at all the offtakes using the water levels (upstream, downstream) and the gate openings, a laptop computer was provided by IIMI to the Right Bank office. This computer contributed significantly to the efficiency of the system.

Training

Starting these new activities required training the key actors at the field level. This task has been achieved by the Irrigation Department (ID) with the support of IIMI. After a transition period of one week, during which the recording of levels from the top of gauges and the filling of forms remained problematic, the field staff progressively integrated these new tasks into their normal duties. IIMI and ID supported the training of the Resident Engineer's office staff in the routine use of the laptop computer. The data were first stored and processed using a Lotus spreadsheet prepared by ID engineers. This spreadsheet is now being replaced by a more systematic database (dBase III+) interfaced with the simulation model, and it provides a substantially increased storage capacity.

Canal Management: More Transparent, More Responsive

GENERIC APPROACH

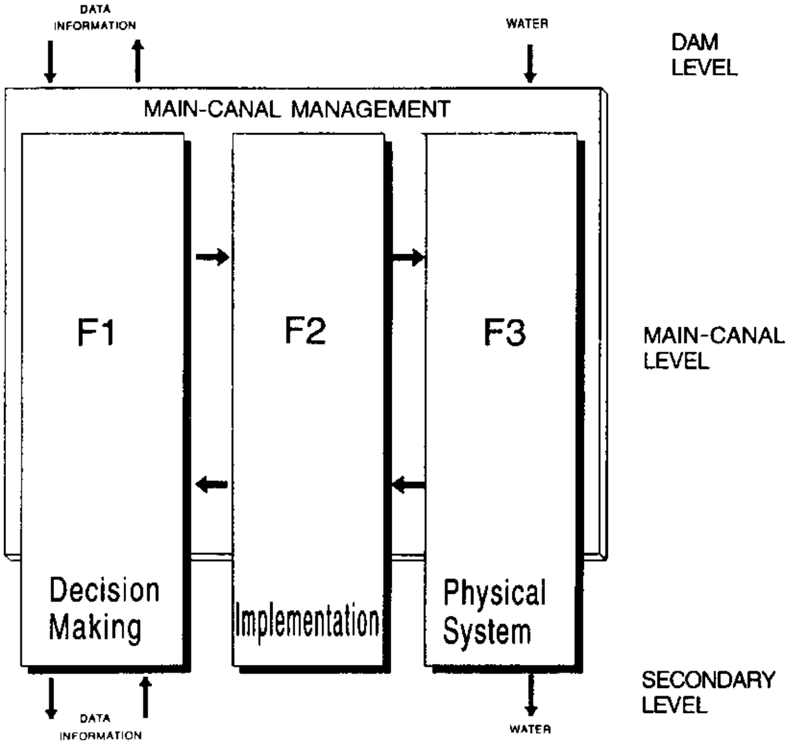
As mentioned earlier, simple system-analysis concepts were used for designing the framework of the intervention. A brief description of the management context resulting from this approach is summarized below.

Our attempt is limited to the presentation of generic "management processes" performed within a particular hydraulic subsystem (e.g., main canal) of an irrigation network with regard to water management activities. We believe that such a subsystem can be usefully described by three "components":

1. People in charge of the whole decision-making process and the analysis of data (F_1).
2. People in charge of the local implementation process and collection of data (F_2).
3. The physical system encompassing the canal, its structure and irrigation water (F_3).

The interconnections between different subsystems are not only achieved through hydraulic interdependency (water flow), but also through operational information regarding the water control strategies and regular flow of observation or evaluation data.

Figure 2.1. Simplified framework for main-canal management.



By dividing these components into specific activities and identifying the communication flows, we could clarify the management context in the particular subsystem of relevance to us, (i.e., the main canal). A schematic layout is given hereafter using two main entries:

- The three components earlier mentioned (decision making, implementation and physical system).
- Three main management processes: command, observation and evaluation.

The management of a main canal can thus be described as consisting of several activities distinguished below.

Process of Command

C_{11}: Decision-making process regarding operational strategies (short-term planning including target setting).

C_{12}: Decision-making process regarding real-time adjustment and refining of operational strategies (control).

C_{21}: Routine implementation of instructions.

C_{22}: Facing perturbations at the implementation stage (local analysis).

Process of Observation

O_2: Collection of data (water levels, structure state)
[Form (i), Gate Settings Table].

O_1: Observation of hydraulic state and behavior of the system
[Display Boards, database].

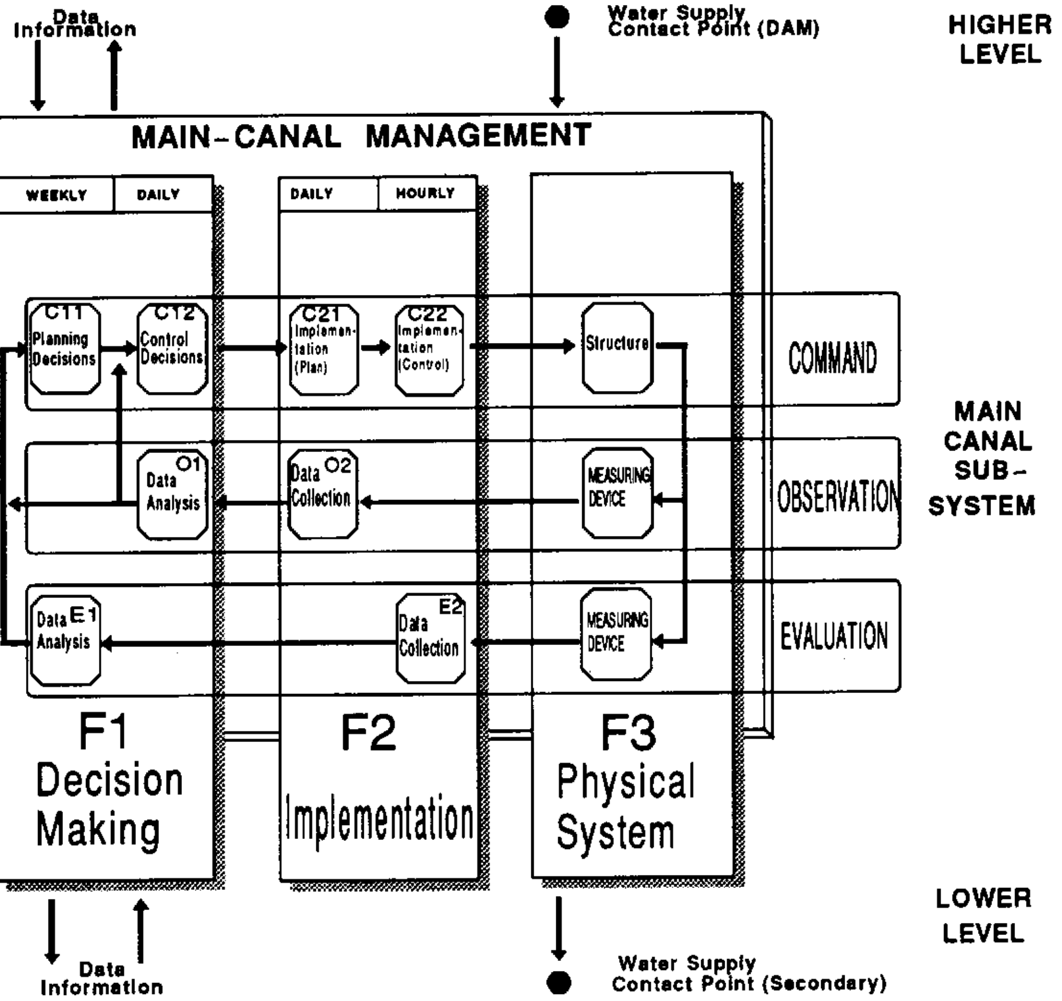
Process of Evaluation

E_2: Collection of data (operations implemented, time and amplitude)
[Form (ii)].

E_1: Analysis of the performances of the water delivery process performance, estimation of potential improvements [database].

Step 1 of our activities (data collection, communications) was intended to focus mainly on the improvement of the primary loop highlighted in Fig. 2.2, (C_{12}, C_{21}, C_{22}, O_2, O_1) and form the substance of this paper, while preparing the context for further action (step 2) likely to address the remaining identified activities. We will first discuss the changes that occurred at the manager's level (F_1), and then at the field level (F_2).

Figure 2.2. Complete framework for main-canal management.



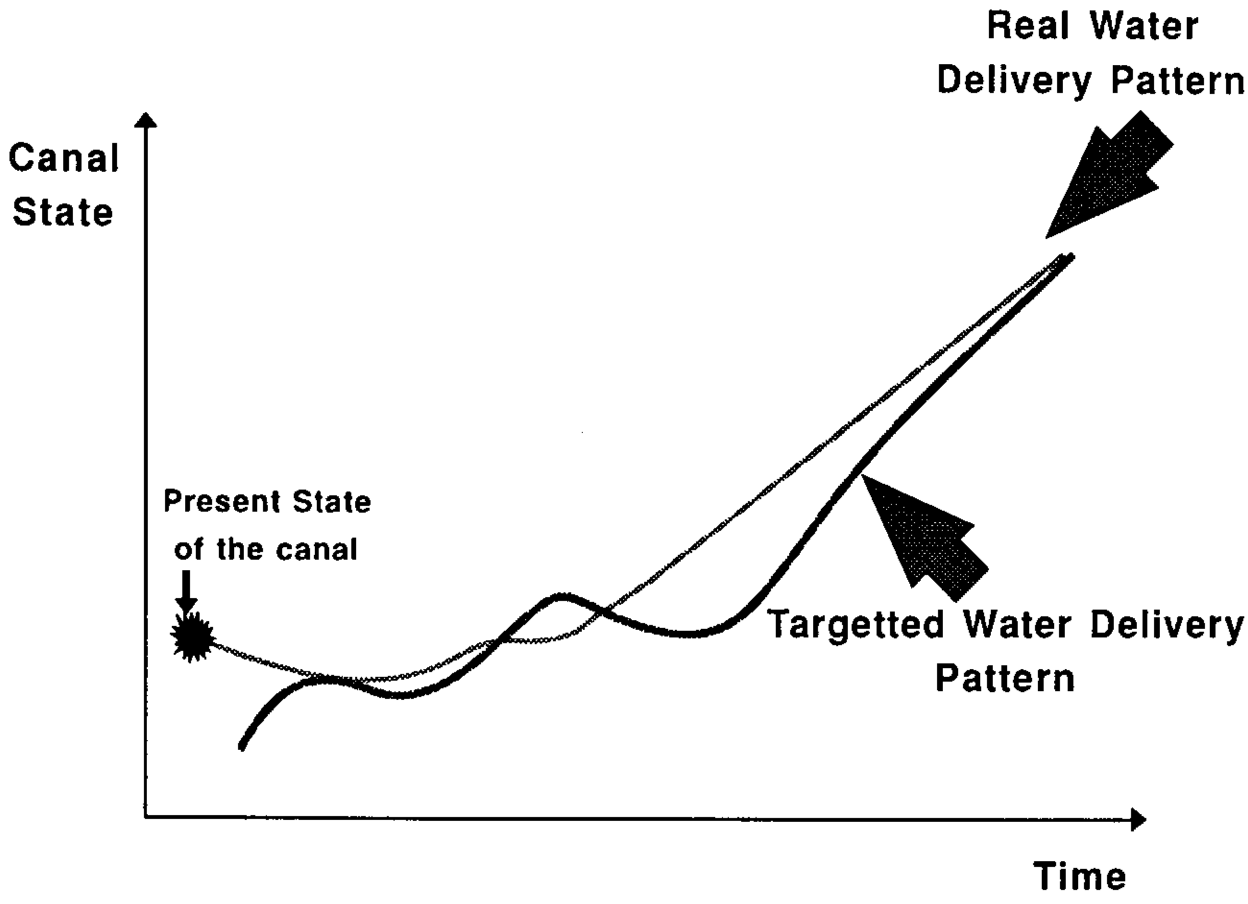
DECISION-MAKING PROCESS AT THE MANAGER LEVEL

The manager is responsible for commanding the system as a whole. At his level, an overall process of optimization can be envisaged to work out operational plans (C_{11}, C_{12}). His task lies mainly in:

- Formulating targeted "trajectories" for the system (e.g., water allocation plan).
- Assessing the actual system state.
- Making operational decisions (planning, control) for bringing or maintaining the system on the targeted trajectories.

At these 3 levels (Figure 2.3), better data flows and, consequently, more systematic ways of making decisions enhance the manager's capability to command the main canal system.

Figure 2.3. Manager's activities.



Fixing of Targets

During the maha 1991/92 season, the process of fixing targets moved from the consideration of theoretical water requirements (classical computation using Penman formula, soils characteristics and assumed network efficiency) to the practical adoption of "field-based" targets, taking into account, to some extent, the feedback of the farmers. The Canal Manager can at any time consult the display board in his office where the values of discharge for 7 days at all offtakes are displayed. These discharges represent the achievements of field staff in their process of implementing the resident engineer's instructions which are given for the first time on a regular, daily basis and which take into consideration the concern of saving water whenever possible. For example, during the month of March 1992, farmers of Tract 5 became aware of the serious problem of water scarcity and interacted with the Irrigation Department to reduce the issues at certain offtakes. By an iterative process, an acceptable pattern of water deliveries was stabilized and (as shown on the display board) this resulted in an overall issue of 140 cusecs instead of 180 as per the previously targeted requirements (for both Tracts 2 and 5).

The simple fact of having a series of daily, complete pictures of what is really happening in the field allows a convergent process towards more realistic targets.

Assessment of the Canal State

To be provided with a reliable and complete picture of the system in a timely fashion is a basic requirement for making coordinated decisions. This has been achieved satisfactorily during maha 1991/92. From the manager's point of view, one of the important consequences of his ability to display the daily status of the canal is the enhancement of clarity in the way different actors of the system communicate. For any control purpose or in response to complaints conveyed to him, reference can be made to the data, displayed in his office, to which everybody has access. The data can be discussed, analyzed and action taken if necessary.

Making Operational Decisions

Although the capacity for detecting the gaps between current targets and field achievements has been improved, and feedback and decisions are conveyed to the field in a more timely fashion than before, the way of making the decisions has still to be more rational and systematic. Gate-adjustment instructions are based on experience and knowledge gained by studying the previous records as far as the offtakes are concerned and no elaborate operational instructions are given concerning the cross structures. (The only instruction given is to maintain the target water level, knowing the approximate discharge being conveyed at this point.) The key element for improvement at this stage of this control activity (C_{12}) is a better responsiveness of the manager to the field conditions. There is no doubt that a great potential exists for refining the decisions taken by using more systematic tools and by integrating the analysis of past achievements through the evaluation process. (Activity E_2.)

Methods of refining decisions have been discussed throughout the season and a decision-support package integrating the simulation model of flow and computation of indicators (See "Further Improvements" -- p. 19) will be tested during maha 1992/93, to support both C_{11} and C_{12} activities.

CLARIFICATION OF RELATIONS: MANAGER/FIELD STAFF

The field staff (Work Supervisor and Gate Keepers) have positively reacted to the introduction of the monitoring activities.

As far as the routine control activity (C_{12}) is concerned, the instructions given by the Resident Engineer are now regular, based on more rational analysis and conveyed in real time to the field. This has led to:

* More accountability of the field staff, which now gets an early direct feedback and has to provide coherent values regarding the canal status.

* Formulation of more precise instructions and better guidance to the Gate Keepers by Work Supervisors.

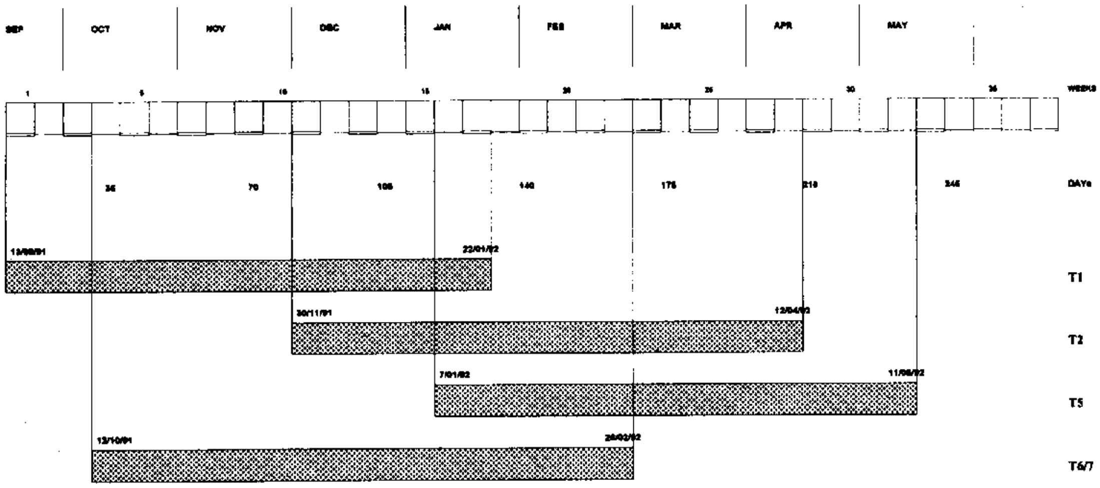
Elements have been indirectly introduced for improving the activity C_{22} concerning the ability of field staff to make local analysis and decisions. Each Gate Keeper carries a booklet with the complete "memory" of the local subsystem he is in charge of (offtakes or cross regulators). The availability of past records allows the introduction of simple operational rules like: while checking the status of one structure (levels, openings), if any strong discrepancy is detected between the actual value of one parameter and its previous recorded value, and if no instruction from the Work Supervisor or the Resident Engineer has been received in between (which means that the previous record was acceptable), the Gate Keeper takes action to bring the structure back to its previous state.

Impact During Maha 1991/92

IRRIGATION CALENDAR

The total extent of four Tracts (1, 2, 5, 6/7) has been cultivated during maha 1991/92 in the Right Bank Main Canal (RBMC) command area. The calendar of water issues is broadly shown in Figure 3.1.

Figure 3.1. Calendar of water issues during maha 1991/92.



The areas under cultivation as well as the targeted crop water requirements as used by the Irrigation Department are given in Annex 6.

ACHIEVEMENTS

Although all the information potentially available through the analysis of the raw data collected during the season has not been used by the manager during maha 1991/92, it is interesting to note that the preliminary changes which have occurred in the way of managing the system (See "Canal Management: More Transparent, More Responsive" -- p. 9), have contributed to improving the situation in two essential areas: water conservation and better water deliveries to farmers.

Water Conservation

As a result of new monitoring activities, the water allocations at the offtakes have been roughly looked into by the manager throughout the season and a control performed for conserving water whenever possible.

We can compare maha 1991/92 achievements with those of maha 1990/91. A brief summary of external conditions during both seasons (see below) suggests that the comparison makes sense and leads us to interpret the changes in duties essentially in terms of managerial improvement.

	MAHA 1990/91	MAHA 1991/92
Crop	Rice 3.5 months	Rice 3.5 months
Conditions		
Average duration of land preparation	6 weeks	6 weeks
Area cultivated (ha)	2530 (6260 ac)	2980 (7370 ac)
Target duty (m)	2.44 (8 ft)	2.44 (8 ft)
Rainfall (m)	1.01 (3.3 ft)	0.7 (2.3 ft)
Achievements		
Real duty (m)	2.53 (8.3 ft)	2.35 (7.7 ft)
Average yield (t/ha)	5.4 (100 bs/ac)	5.4 (100 bs/ac)

ha = hectares ac = acres
m = meters ft = feet
t = metric tons bs = bushels

Nevertheless, various reasons prevent us from making a classical cost-benefit analysis based on these data. First, the existence of an exclusive connection between the water saving during this season (0.18 m, without taking the rainfall into consideration) and the management intervention carried out during the same season cannot be blindly claimed, due to the complexity of the environment in an irrigation scheme and all the factors which affect its functioning. Second, in the present context, the benefits derived from water saving are not clearly gained by the people who bear the cost of the managerial improvements (Irrigation Department), so that this type of analysis cannot help in proving the sustainability of the intervention. However, it is interesting to compare the cost of such a managerial intervention with the potential price of water saved, at the overall level of the scheme. The opportunity cost of water in a water scarce environment is considered as equal to the benefit gained from additional cultivation. With an average yield of 5.4 t/ha (100 bs/ac) and a market price of Rs 8.00 per kg of which 25 percent is considered as benefit, we obtain the following figures:

Costs of managerial interventions (1 season, 4 tracts)		Value of benefits (1 season, 4 tracts)	
Messenger:	Rs 12,000	Water saved in comparison to previous season (Tracts 1,2,5 and 6/7)	
Boards, forms:	Rs 15,000	= 4.9 M m^3 (4,000 Ac-ft)	
Office (extra work):	Rs 3,000	Extra irrigation possible:	200 ha (500 acs)
Computer:	Rs 70,000	Extra rice production:	1,100 t (50,000 bs)
		Approximate net income: Rs 8.5 M	
Total:	**Rs 0.1 M** **(US$ 1,250)**	**Total (25% of net income):**	**Rs 2 M** **(US$ 50,000)**

With all the reservations mentioned above, it is probably worth noting that any attempt to promote water conservation practices through better control of the deliveries (or other methods) can, most of the time, in a water scarce environment where land is available, lead to a significant potential income at the level of the scheme.

Quality of Service Deliveries

Although difficult to assess, the benefits in terms of better working relationships gained at the interface of agency staff and farmers have to be mentioned. It is well known that the clients of any irrigation system need to be confident of the management of the system on which the main input to their activity (water) depends. Lack of confidence creates all types of individualistic reactions (overestimation of duties, illegal tapping of water, interventions at control structures) mostly caused by the absence of clarity concerning the water supply at the interface of agency staff and farmers. Our experience during this season indicates that the provision of Display Boards in both the Resident Engineer's and unit offices, has contributed to improving this situation. The availability of standardized, quantified figures which can be easily checked in the field makes everybody more comfortable in debates and discussions at the field level.

At the same time, interviews with the field staff have confirmed that a better awareness of the canal functioning at both Work-Supervisor and Engineer levels has contributed to minimizing the number of trial and error operations, thus reducing the water level fluctuations along the canal during this season.

As explained in the next section ("Further Information"), this parameter (level fluctuations) can be traced during the season; unfortunately the lack of corresponding data from the previous seasons prevents us from quantifying the impact of the intervention accurately. In any case, the number of complaints or requests made by the users has decreased in comparison with the previous season (Irrigation Department records).

Further Improvements

In this section, an attempt is made to present perspectives for further improvements in the decision-making process performed by the main canal manager. We will mainly emphasize the potentialities of a more systematic analysis of the flow data gathered through the monitoring network (activity E_3 of evaluation) and briefly point out the importance of strengthening the planning capability of the manager (activity C_{11}) through the use of a simulation model of flow.

FROM RAW DATA TO MANAGEMENT INFORMATION

Raw Data

The data on water levels and gate openings at all structures collected daily by the gate keepers were stored in a simple database. The first by-product of these data was a systematic computation of discharges. Thus, during the season, two essential data files comprising the following fields were built:

- Distribution: tract code, structure code, date, time, level upstream, level downstream, and discharge.
- Operation: tract code, structure code, device code, date, time, and gate opening.

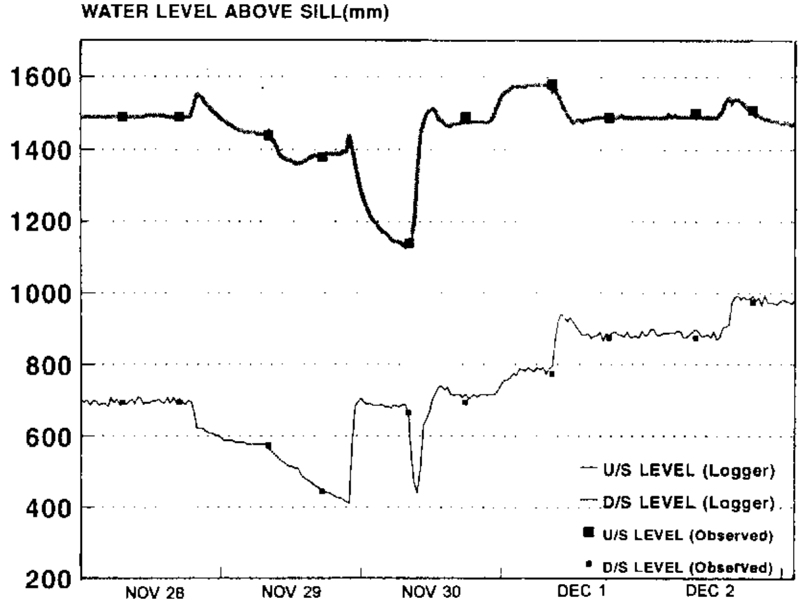
A *structure* is a cross regulator or an offtake. These structures are usually made of one or several gates which are called *devices.*

At the end of maha 1991/92, about 14,000 distribution records and 6,000 operation records were stored.

The computation of discharges is one of the difficult issues related to water flow monitoring. For this purpose, we used structure formulas as described in Annex 7 and CEMAGREF, France 1991. This implies an adequate survey of structure geometry and a reliable estimation of discharge coefficients (C_d) gained through calibration and insights into the accuracy of routine field measurements (water levels and gate opening). As far as this last aspect is concerned and for research purposes only, we made use of an automatic data logger to record water levels at regular intervals at a specific location of the canal (Cross Regulator Number 3); the graph (See Figure 4.1) compares the water levels recorded by the field staff with those recorded and stored in the automatic logger during a period of randomly selected 4 days.

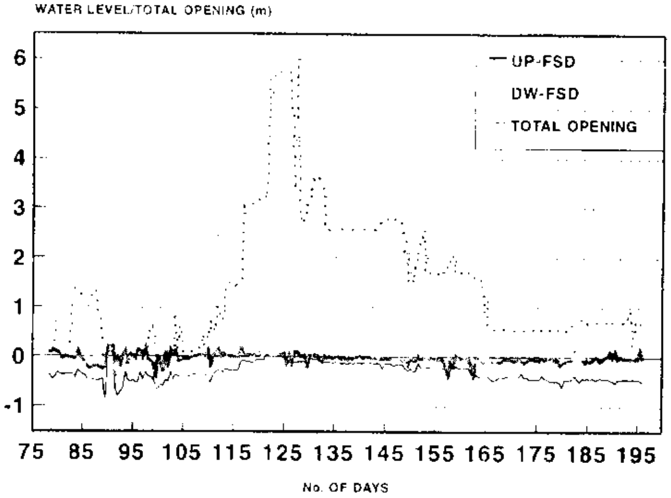
The quality of the data recorded by the field staff proved to be very satisfactory. In fact, a simple analysis (Malé 1992) shows that the accuracy of water-level measurements marginally affects the accuracy of the discharge computation, the main cause of error being the incertitude of discharge coefficients which, in our case, have not been calibrated for all the structures but for a limited sample of them. These incertitudes can explain some of the inconsistencies encountered while computing the flow through the cross regulators but the results obtained for the offtakes were considered as reasonably good and indicative of the real water issue pattern.

Figure 4.1. ***Comparison of water-level recordings: automatic data logger output vs. field measurements at GR3 (for the period 28 Nov -2 Dec 1991).***



The interest of the availability of this raw data for the manager is straightforward. As mentioned earlier, it forms the basis for building an on-line picture of what is happening all along the canal (Activity O_1). It also provides some interesting local information concerning the hydraulic functioning of structures. As an example, the water levels upstream and downstream of Cross Regulator Number 5 as well as its total gate opening (sum of the openings of its 5 gates) are plotted in Figure 4.2. Periods of high flow along the canal lead to a high degree of submergence of the structures thus rendering the various reaches strongly interdependent, hydraulically.

Figure 4.2. Levels and gate openings at Cross Regulator No.5.



Note: FSD = Full supply depth, considered as targeted water level.
High submergence during the period [120.150]
UP = upstream level DW = downstream level

Indicators

The bulk information conveyed by the raw data can be condensed and shaped into meaningful indicators likely to support the decision-making processes performed by the manager. For this purpose, we propose the systematic computation of eight indicators on a *weekly or monthly basis*:

Descriptive Indicators

This set of indicators aims at describing the hydraulic behavior at the structures without explicit reference to targets.

D1 : Total volume issued at the structure, in mm for the offtakes and in MCM for the cross regulators.

D2 : Total number of gate adjustments performed at the structure.

D3 : Average submergence at the structure (ratio: level downstream over level upstream).

D4 : Average level fluctuation upstream of the structure (standard deviation level upstream).

Performance Indicators

This set of indicators explicitly takes into account the targets formulated by the manager in terms of water deliveries. At this stage, we used four indicators developed by Molden and Gates (Molden and Gates 1990 and Annex 8).

P1 : Measure of adequacy, indicative of the notion "enough supply."

P2 : Measure of efficiency, indicative of the notion "no waste."

P3 : Dependability, indicative of the notion "timeliness of the deliveries."

P4 : Equity, indicative of the notion "equitable water distribution among a set of structures."

The computation of these indicators for a cross regulator relates to the performance achieved by the offtakes commanded by this cross structure (taking off from the reach immediately upstream) weighted by their respective command areas.

The complete set of indicators is given in Annex 9 (Tables D1 to P4) for the Kirindi Oya Right Bank Main Canal (RBMC) during the season maha 1991/92. This computation has been done only at the end of the season but the interest of performing intermediate computations during the next season is pointed out below.

Management Information

Having worked out systematic procedures for providing the manager with a set of standard indicators, an essential step is then to "extract" the information contained by these and convert it into operational decision support. We think that three main operational areas could be covered by analyzing our indicators.

1. Progress in water conservation through analysis of water allocation.
2. Improvement of the service to the farmers through detection of weaknesses in the delivery process.
3. Improvement in manageability of the structure by the field staff through analysis of hydraulic flow conditions.

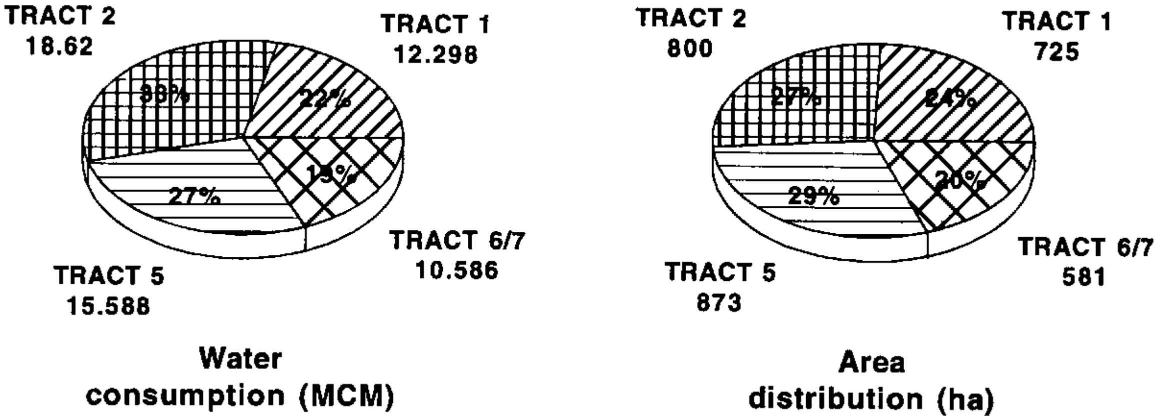
Analysis of Water Issues

A large amount of information can be derived from the water-issue analysis during the season, in terms of spatial distribution among tracts and secondaries as well as temporal distribution during land preparation periods or rainy periods.

This information can stimulate the manager's ability to reconsider his procedures and improve them, if necessary as explicated below through a few examples.

WATER ISSUES IN THE DIFFERENT TRACTS

Figure 4.3. Water issues tractwise.

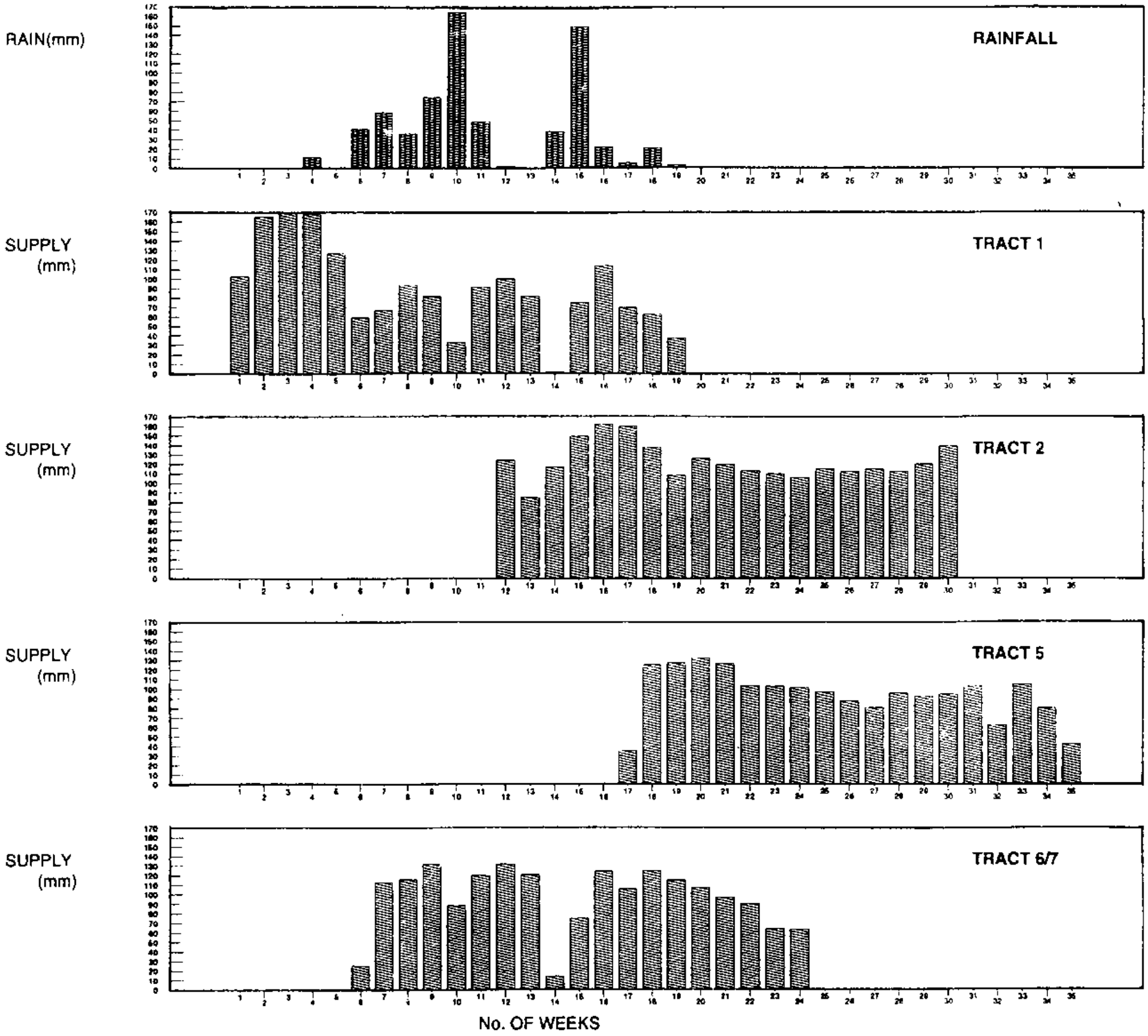


Tract 1 - 15,182 ac-ft
Tract 2 - 22,986 ac-ft
Tract 5 - 19,244 ac-ft
Tract 6/7 - 13,069 ac-ft

This type of output monitoring, if completed by incorporating the rainfall contribution (if reliable figures are available), enables the manager to critically review the distribution of water among the different parts of the command area and it forms the basis for analyzing any discrepancies in water consumption between tracts.

USE OF WATER DURING THE SEASON

Figure 4.4. Weekly pattern of water issues.



With reference to Figure 4.4, it is worth mentioning that the rainfall pattern is only indicative. The data have been collected by the Irrigation Department using a single rain gauge located relatively far away from a significant part of the command area. Because, in Kirindi Oya, rainfall quite often leads to a very scattered distribution of the inflow all over the command area, only a careful study would yield a strict correlation between the water delivery patterns in the different tracts and the rainfall measurements. An upgrading of the rainfall measuring network would obviously help in adopting more responsive practices. However, a few observations can be made on the weekly patterns of water issues shown in Figure 4.4:

- As water issues for Tract 1 commenced before the seasonal rains, weekly issues during the initial period were nearly double the normal issues. (High consumption during land soaking and other land preparation activities.)
- Water supplies in Tracts 2 and 5 are quite stable during all phases of the season. This reflects to, some extent, the controlling capacity of the field staff in maintaining the water level in the corresponding reaches of the main canal (see hydraulic indicators in Annex 10).
- The pattern of water issue to different tracts also shows some interesting features. For example, the recorded water issues in Tract 2 do not reflect a good response to rainfall (with all the reservations explained above) and do not clearly account for changes in crop water requirements in the latter stages of cultivation. The relatively long period devoted to land preparation (weeks 12 to 18) in this tract was due to the delay experienced by the farmers in getting loans for starting the season. Most of the first water issues were not used and thus led to a significant wastage.
- As far as both these aspects are concerned (rain and cropping stages), there is probably room for improvement by adopting more responsive management practices.

CONVEYANCE LOSSES

As mentioned earlier, the uncertainties in the computation of the discharges through the cross regulators prevented us from getting accurate results and our tentative ranking of reaches in regard to overall seepage during the season reveal too many inconsistencies for the estimated losses to be considered reliable. A simple approximate value has been obtained for the losses along the whole extent of the canal.

Table 4.1. Conveyance losses.

RBMC		
	Area (ha)	2,980
	Weeks	1-35
	Reach	[DAM-GR18]
With GR data	Head (MCM)	77.1
	Tail (MCM)	7.3
	Delta	69.8
	Duty (ft)	7.7
	Duty (m)	2.3
With offtake data	Duty (ft)	6.3
	Duty (m)	1.9
10% < Losses < 20%		

In addition, a systematic study of all steady flow periods which occurred in the different reaches along the season has been done. (A reach is considered to be under steady flow conditions if there is no significant changes in its inflow and outflow discharges, as well as in the water levels at its upstream and downstream ends during a hydraulically representative period of time. See Malé 1992 for more details).

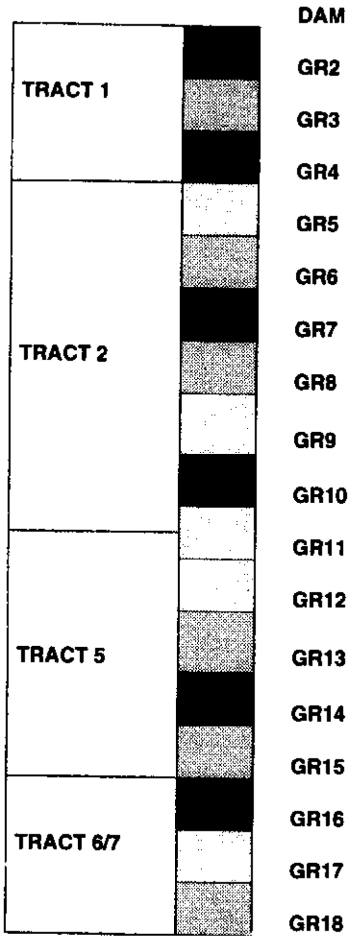
Table 4.2. Summary of steady flow periods.

REACH	NUMBER OF STEADY FLOW PERIODS (During 19 weeks)	TOTAL DURATION OF STEADY FLOW PERIODS (hrs)	% TIME OF STEADY FLOW
DAM / GR2	12	357	12
GR2 / GR3	28	801	27
GR3 / GR4	26	559	19
GR4 / GR5	6	136	12
GR5 / GR6	24	441	15
GR6 / GR7	21	410	14
GR7 / GR8	18	297	10
GR8 / GR9	13	265	9
GR9 / GR10	10	167	6
GR10/ GR11	7	159	7
GR11/ GR12	33	835	29
GR12/ GR13	21	325	11
GR13/ GR14	24	392	14
GR14/ GR15	12	167	6
GR15/ GR16	2	39	3
GR16/ GR17	13	179	6
GR17/ GR18	10	155	5

Simple water balances have been worked out for these steady flow periods. But, for the same reasons, the absolute results are difficult to interpret. We tentatively ranked the various reaches into three groups: high, average and low seepage. We believe that, subject to accurate calibration of the cross regulators, this type of analysis would enable the manager to systematically locate leakages or water tapping spots along the canal.

Table 4.3. Losses by reach.

REACH	LOSSES IN THE REACH
GR8 / GR9 GR4 / GR5 GR10/ GR11 GR16/ GR17 GR11/ GR12	LOW ░
GR5 / GR6 GR2 / GR3 GR7 / GR8 GR17/ GR18 GR12/ GR13 GR14/ GR15	MEDIUM ▒
GR6 / GR7 GR3 / GR4 GR13/ GR14 DAM / GR2 GR9 / GR10 GR15/ GR16	HIGH █



Detection of Weaknesses in the Water Delivery Process: (P_1, P_2, P_3, P_4)

The quality of water deliveries at one structure is highly dependent on the location of the structure along the canal and on the capabilities of the field staff in charge of operating it. It is of great importance for ensuring a proper management control to be able to discriminate the different structures according to their achievements with regard to common objectives such as adequacy, efficiency or reliability of water deliveries.

Through the regular study of the four performance indicators, chronic weaknesses can be identified and analyzed to find out whether the cause of induced sub-optimal performances lie in managerial or technical problems.

For example, an analysis has been worked out for the whole season for all the structures of the RBMC. For each of the four performance indicators, the structures have been ranged in three groups: indicator below average (33%), average (33%) and above average (33%). In Table 4.4 and 4:5, the structures considered as functioning below average have been given the flag, -1; those functions at average level the flag, 0; and those above average, +1. To allow comparison, the structures have been again ranged into three main groups according to the value of the sum of the flags, which permits us to separate structures presenting a good water delivery profile from those having faced problems in meeting the targets during the season. This discrimination can be done systematically on a shorter time scale (weekly) and compared with the feedback from users and field staff. In case remedial action has to be taken for improving the deliveries, the descriptive indicators (see next paragraph) can help in pointing out the nature of likely hydraulic problems.

Table 4.4. Analysis of performance indicators.

TRACT	CANAL	FLAGS ACCORDING TO PERFORMANCE INDICATORS				
		P1 (Adequacy)	P2 (Efficiency)	P3 (Dependability)	P4 (Equity)	SUMMARY
5	FC 55	1	-1	-1		-1
6	FC 37	0	0	-1		-1
2	FC 68	1	-1	0		0
5	DC 1A	1	-1	0		0
6	FC 25	1	-1	0		0
1	D5	-1	1	1		1
1	F58	-1	1	1		1
1	F57	-1	1	1		1
2	FC 34	1	0	0		1
2	DC 9	-1	1	1		1
2	DC 4	0	0	1		1
5	FC 54	1	0	0		1
5	DC 13	-1	1	1		1
5	DC 11	-1	1	1		1
5	DC 12	0	0	1		1
5	FC 54A	1	0	0		1
5	DC 1B	-1	1	1		1
7	DC1	-1	1	1		1
1	F56	0	1	1		2
1	F55	0	1	1		2
1	DC 3A	0	1	1		2
1	D4	0	1	1		2
2	DC 6	0	1	1		2
2	DC 7	0	1	1		2
2	DC 1	0	1	1		2
2	DC 8	0	1	1		2
2	DC 5	1	0	1		2
5	DC 1	0	1	1		2
5	FC 48	1	0	1		2
5	BC 2	0	1	1		2
6	FC 24	1	0	1		2
6	DC 2	0	1	1		2
6	DC 1	0	1	1		2
1	FC 6	1	1	1		3
1	DC 2	1	1	1		3
1	DC 3B	1	1	1		3
2	DC 2	1	1	1		3
2	DC 3	1	1	1		3
5	DC 9	1	1	1		3
5	FC 49	1	1	1		3

Table 4.5 Analysis of performance indicators.

TRACT	GR	FLAGS ACCORDING TO PERFORMANCE INDICATORS				
		P1 (Adequacy)	P2 (Efficiency)	P3 (Dependability)	P4 (Equity)	SUMMARY
1	GR 2	1	0	-1	-1	-1
2	GR 10	0	0	0	-1	-1
2	GR 8	1	-1	-1	1	0
5	GR 14	-1	1	1	-1	0
6	GR 17	0	1	0	-1	0
1	GR 4	-1	1	0	1	1
5	GR 15	-1	1	1	1	2
5	GR 11	-1	1	1	1	2
5	GR 13	1	0	1	0	2
6	GR 18	-1	1	1	1	2
1	GR 3	0	1	1	1	3
2	GR 5	0	1	1	1	3
2	GR 7	1	0	1	1	3
2	GR 9	0	1	1	1	3
5	GR 12	0	1	1	1	3
6	GR 16	0	1	1	1	3
2	GR 6	1	1	1	1	4

Analysis of Hydraulic Flow Conditions: (D_2, D_3, D_4)

In the process of diagnosing the potential difficulties faced by the field staff at the implementation stage (C_{21}, C_{22}), it is quite important that they be provided with simple information concerning the hydraulic conditions at the structures.

The same approach has been used for classifying the structures according to their hydraulic functioning. A structure is considered as behaving well if few operations are done, the degree of submergence is low, and few fluctuations of upstream water level occur.

Table 4.6. Analysis of descriptive indicators.

TRACT	CANAL	FLAGS ACCORDING TO DESCRIPTIVE INDICATORS			
		D2 (No. operations)	D3 (submergence)	D4 (level fluctuations)	SUMMARY
6	FC 37	-1	-1	-1	-3
6	DC 2	-1	-1	-1	-3
1	D4	-1	-1	0	-2
1	D5	-1	-1	0	-2
1	F57	-1	-1	0	-2
1	F58	-1	-1	0	-2
6	DC 1	-1	-1	0	-2
1	F56	0	-1	0	-1
1	DC 3B	-1	1	-1	-1
1	F55	0	0	-1	-1
6	FC 25	0	0	-1	-1
1	DC 3A	0	1	-1	0
1	FC 6	0	0	0	0
1	DC 2	0	0	0	0
2	DC 2	0	-1	1	0
5	FC 54	0	-1	1	0
5	DC 1A	0	-1	1	0
5	DC 1	0	-1	1	0
5	DC 13	0	-1	1	0
6	FC 24	0	0	0	0
7	DC1	1	0	-1	0
2	DC 9	1	-1	1	1
2	FC 34	1	-1	1	1
2	DC 4	1	-1	1	1
2	DC 8	1	-1	1	1
2	FC 68	1	-1	1	1
2	DC 1	1	-1	1	1
2	DC 7	1	-1	1	1
5	DC 11	1	-1	1	1
5	BC 2	1	-1	1	1
2	DC 6	1	0	1	2
2	DC 5	1	0	1	2
2	DC 3	1	0	1	2
5	FC 49	1	0	1	2
5	FC 48	1	0	1	2
5	FC 54A	1	0	1	2
5	DC 12	1	0	1	2
5	DC 1B	1	0	1	2
5	DC 9	1	0	1	2
5	FC 55	1	0	1	2

Table 4.7. Analysis of descriptive indicators.

TRACT	GR	FLAGS ACCORDING TO DESCRIPTIVE INDICATORS			SUMMARY
		D2 (No. operations)	D3 (submergence)	D4 (level fluctuations)	
6	GR 17	-1	-1	-1	-3
6	GR 16	-1	-1	0	-2
1	GR 3	-1	1	-1	-1
2	GR 5	-1	-1	1	-1
5	GR 13	0	-1	0	-1
1	GR 2	0	1	-1	0
1	GR 4	0	1	-1	0
2	GR 10	0	-1	1	0
2	GR 8	-1	0	1	0
2	GR 6	-1	0	1	0
5	GR 14	0	-1	1	0
5	GR 15	0	-1	1	0
5	GR 11	1	-1	1	1
6	GR 18	1	1	-1	1
2	GR 7	0	1	1	2
2	GR 9	1	0	1	2
5	GR 12	0	1	1	2

For the first time in Kirindi Oya, the whole extent of the four tracts was irrigated at the same time during January 1992. As complementary information, the peak discharges as well as the average submergence (Indicator D3) at the regulators during the corresponding week are recorded in Table 4.8.

The peak issue of the dam was 9.1 m^3/s. These values have of course to be considered as indicative with full awareness of the uncertainties of discharge computations at the cross regulators mentioned previously.

Once again, our objective in this paper is not to carefully analyze what has happened in RBMC during maha 1991/92 but rather to suggest methods for better management in the future. Nevertheless, a brief analysis of the Tables 4.4 to 4.7 is given in Annex 10.

Table 4.8. ***Peak discharge and average submergence.***

REGULATOR	MAXIMUM DISCHARGE	SUBMERGENCE
GR2	8.5	0.78
GR3	8.5	0.86
GR4	8.0	0.94
GR5	7.0	0.91
GR6	7.0	0.81
GR7	7.5	0.71
GR8	7.0	0.79
GR9	9.0 *	0.76
GR10	5.0	0.87
GR11	6.5	0.80
GR12	5.5	0.79
GR13	6.5	0.86
GR14	6.0	0.89
GR15	3.5	0.80
GR16	3.5	0.93
GR17	3.0	0.91
GR18	2.5	0.37

* Probably overestimated

TOWARD BETTER CANAL OPERATIONS

As mentioned earlier, the next step after knowing more accurately and in a timely fashion the functioning of the canal system, is to work out operational decisions for commanding it (activities C_{11}, C_{12}). Several approaches can be used: trial and error, direct empirical experience, rules of thumb, or rules based on optimization procedures. The objective pursued in Kirindi Oya is to test and gradually introduce optimization procedures supported by the use of a simulation model of flow. This second step is justified by the difficulties still faced by the manager during specific phases of management of his canal such as the starting of cultivation in one tract, rainy periods, or the routine implementation of more sophisticated water delivery patterns required in case of nonrice crops (intermittent irrigation). An enhanced understanding of the water propagation lagtimes, and of the hydraulic interdependency between the reaches due to cross-regulator adjustments, then becomes essential to work out coordinated operational plans minimizing the waste of water and perturbations along the canal. The maha 1992/93 season should enable us to show that a simulation model of flow interfaced with a computerized data- base and simple additional optimization modules is an adequate answer to most of the operational questions facing an irrigation canal manager.

Conclusion

The problems faced during operational water management are relatively well-known and various tools can be designed for assisting managers of irrigation systems. Technical improvements have to be introduced with a full awareness of the existing management context. This involves a careful diagnosis of the ground situation and usually leads to the design of a management intervention package instead of the introduction of a single, isolated tool. A real problem remains: the gap which usually exists between the communication and measurement facilities of a system and the data requirements of many decision support tools.

In the Kirindi Oya Project, IIMI, CEMAGREF and the Irrigation Department of Sri Lanka, have opted for a gradual approach to achieve success in the introduction of the simulation model of flow into the day-to-day decision-making processes. In the first phase, as described in this paper, a simple management information system has been developed and implemented. This step alone permits an interesting evolution of the management practices and provides a fairly large amount of new information to the manager about the functioning of his system. In the second phase, the model which can now be fed with reliable and timely data is to be progressively utilized for real-time application to solve routine operational problems still faced by the manager at the planning and control stages.

References

Malé, J.M. 1992. The roughness coefficient: An indirect witness to observe a canal? A methodology based on the use of a simulation model of flow in irrigation canals. (IIMI Internal Report.)

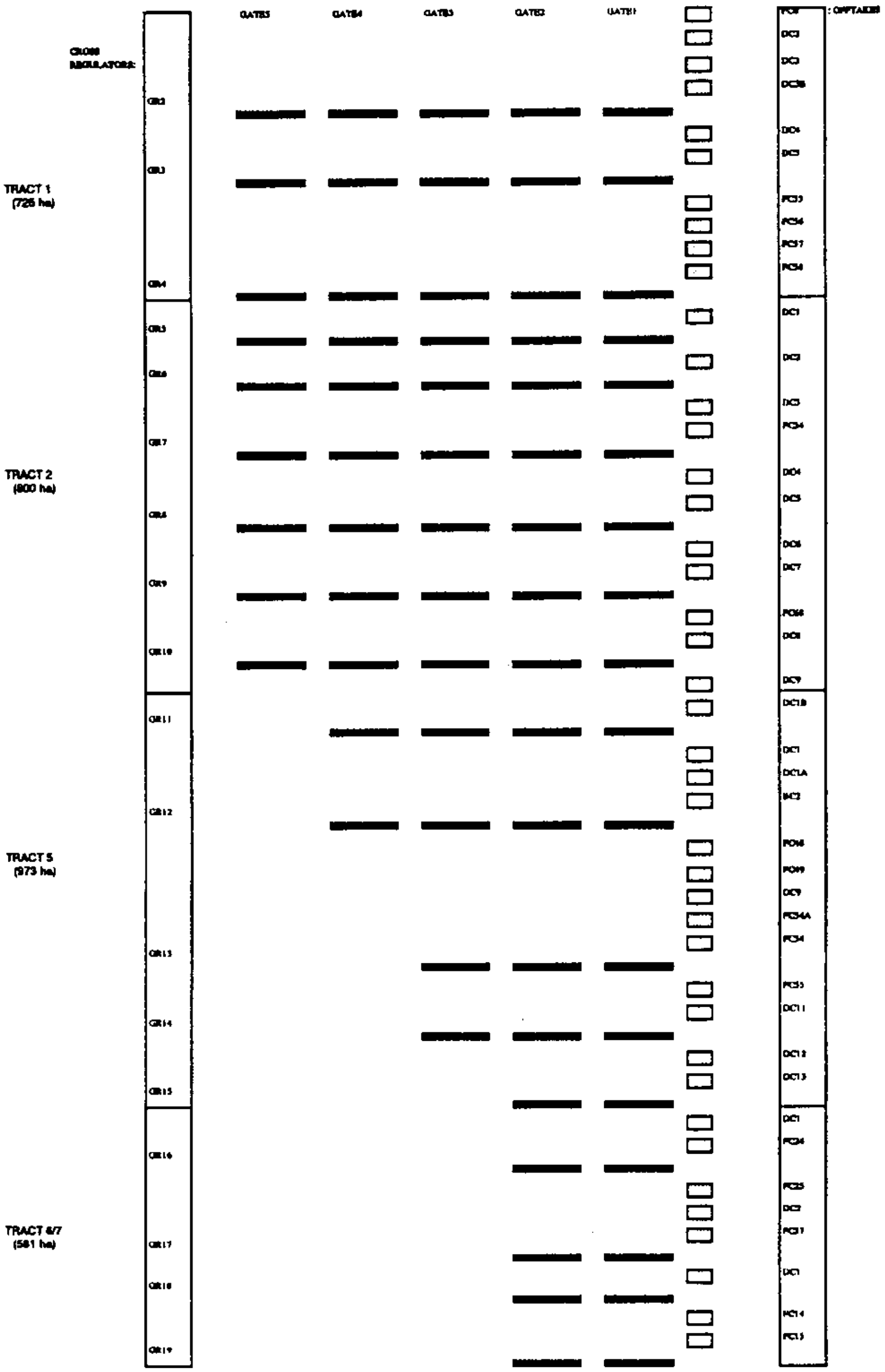
CEMAGREF, France 1991. SIC: Simulation of irrigation canals. Theoretical concepts. (Software Manual).

Molden, David J. and Timothy K. Gates. 1990. Performance measures for evaluation of irrigation-water-delivery systems. pp.804-803 in Journal of Irrigation and Drainage Engineering, Vol.116, No.6, November/December, 1990.

ANNEXES

Annex 1

Issue tree diagram of Kirindi Oya Right Bank Main Canal



Annex 2

Form (i) and (ii) of Booklet for Field Staff

Form (i)

දිනපතා ගේට්ටු සැකසුම්

යාය

ජල බෙදුම්කරු

දිනය

ගේට්ටු අංකය	වේලාව	ස්පින්ඩල් උස	ජල මට්ටම	
			ඉහළ	පහළ/වියරය

Form (ii)

දිනපතා ගේට්ටු මෙහෙයුම

ජල බෙදුම්කරු

යාය

දිනය

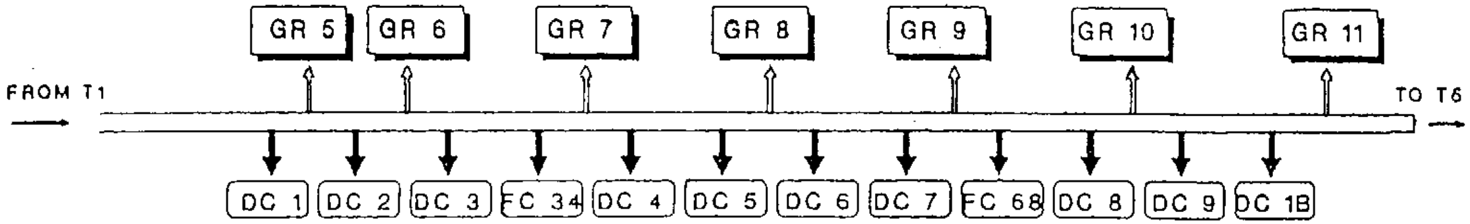
ගේට්ටු අංකය	මෙහෙයුම 1				මෙහෙයුම 2				මෙහෙයුම 3				මෙහෙයුම 4			
	වේලාව	ස්පින්ඩල් උස	ජල මට්ටම		වේලාව	ස්පින්ඩල් උස	ජල මට්ටම		වේලාව	ස්පින්ඩල් උස	ජල මට්ටම		වේලාව	ස්පින්ඩල් උස	ජල මට්ටම	
			ඉහළ	පහළ/වියරය			ඉහළ	පහළ/වියරය			ඉහළ	පහළ/වියරය			ඉහළ	පහළ/වියරය

Annex 3

Display Board in Work Supervisor's office

RBMC WATER ISSUES - TRACT 2

SEASON :



COMMAND AREA(Ha)												
APPROVED FLOW (CUSECS)												
DAY												
DAY												
DAY												
DAY												
DAY												
DAY												
DAY												
DAY												

Annex 4

Form to Record Gate Settings

දකුණු ඉවුර - ගේට්ටු සැකසුම යාය 2

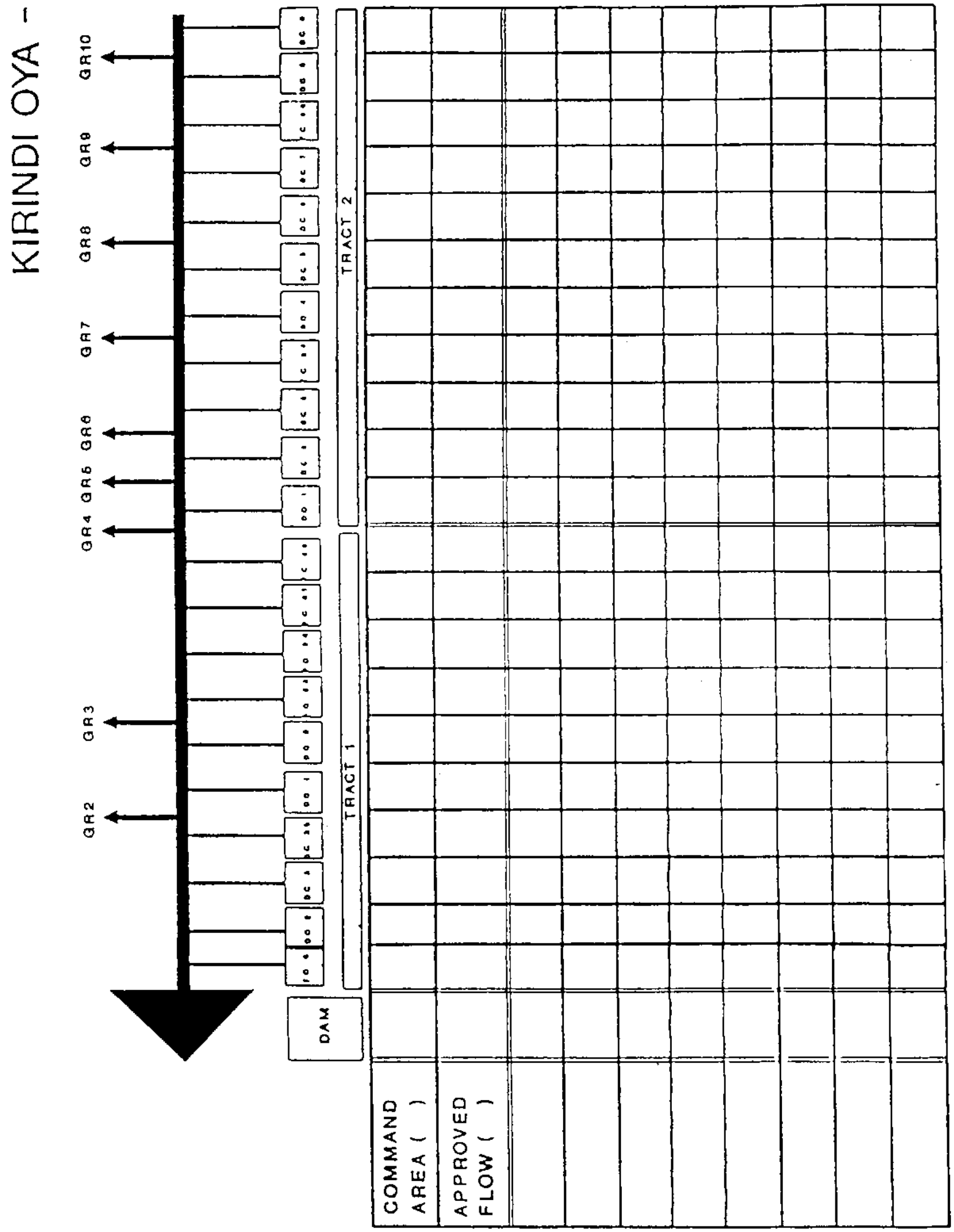
කන්නය:
දිනය:

දත්ත රැස් කලේ :
දත්ත සටහන් කලේ :

Off-takes/Gated Regulators	Time	Water Level (cm)		Head Over Weir (cm)	GATE – Sp Hts (cms)					Computed Discharge (cusecs)
		Up	Down		G1	G2	G3	G4	G5	
DC 01										
GR 5										
DC 02										
GR 6										
DC 03										
FC 34										
GR 7										
DC 04										
DC 05										
GR 8										
DC 06										
DC 07										
GR 9										
FC 68										
DC 08										
GR 10										
DC 09										

Annex 5

Display Board in Resident Engineer's office



Annex 6

Areas Under Cultivation and Crop Water Requirements

The basic assumptions used by the Irrigation Department for estimation of crop water requirements lead to the following targets in terms of water supply:

- At the field level:

Land preparation:	3 weeks	2.05 l/s/ha
Growing stage :	13 weeks	1.85 l/s/ha

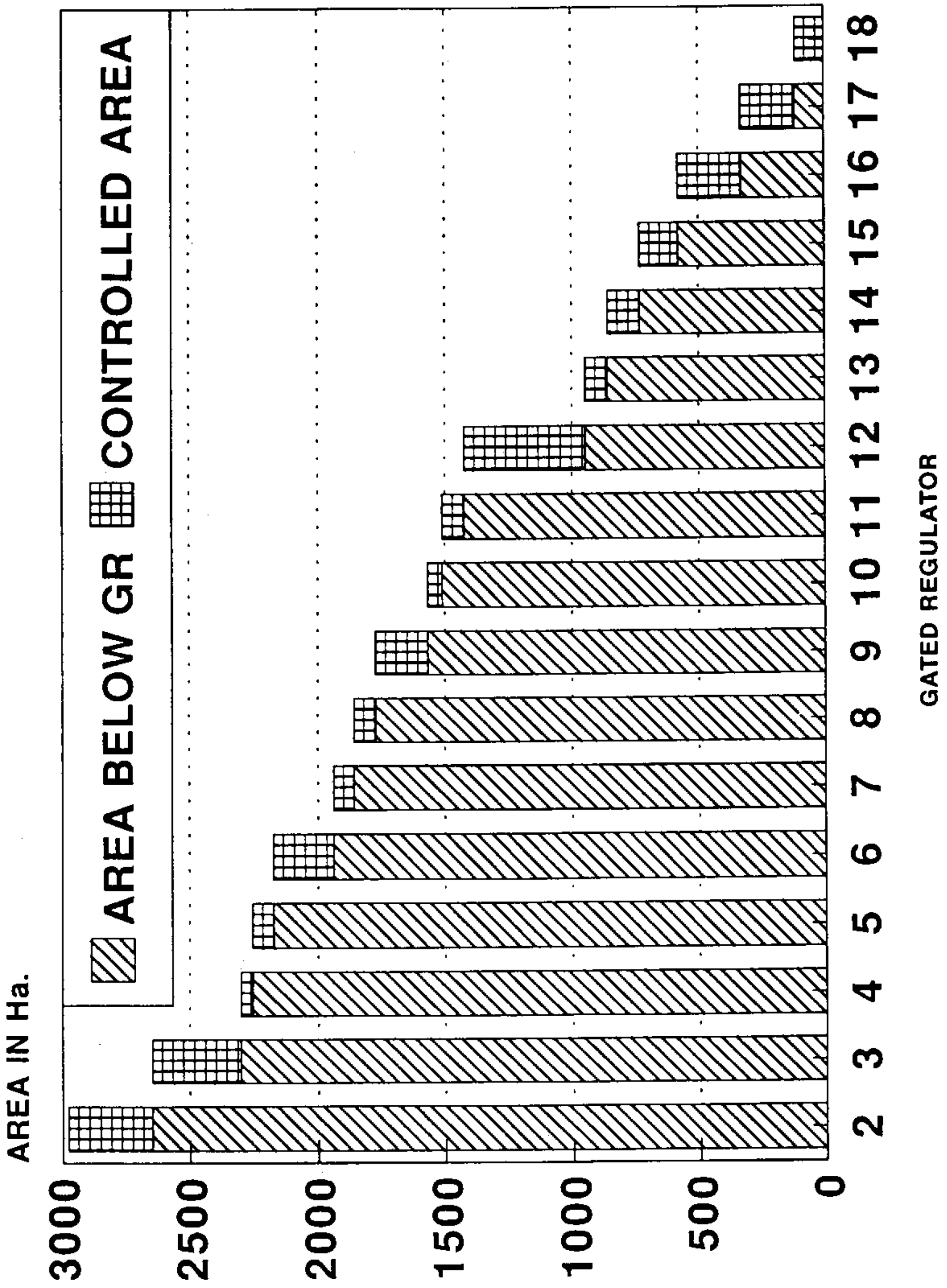
- Assuming an average efficiency of 85 percent at the tertiary level and 90 percent at the secondary level, the total average duty at the head of the distributaries becomes:
  (0.37 + 1.45)/0.85/0.90 = 2.4 m
  (1.22 + 4.77)/0.85/0.90 = 7.8 feet

- As a rough assumption, 8 feet is used as target duty at the main sluice level.

KIRINDI OYA RBMC MAHA 1991/92:
AREA UNDER DIFFERENT CANALS (in ha).

TRACT	1		2		5		6/7	
	CANAL	AREA	CANAL	AREA	CANAL	AREA	CANAL	AREA
	F6	10.0	D1	80.0	D1B	30.4	D1	236.0
	D2	51.6	D2	234.8	D1	22.3	F24	14.0
	D3A	180.0	D3	68.8	BC2	436.4	F25	15.0
	D3B	88.2	F34	10.0	D1A	17.2	D2	192.0
	D4	163.0	D4	27.3	F48	8.1	F37	8.0
	D5	185.2	D5	58.7	F49	16.2	D17	116.0
	F55	11.1	D6	140.7	D9	47.6		
	F56	9.1	D7	65.8	F54A	7.1		
	F57	13.2	F68	8.1	F54	9.1		
	F58	13.2	D8	48.6	F55	7.1		
			D9	56.7	D11	118.4		
					D12	31.4		
					D13	121.5		
TOTAL		724.6		799.5		872.8		581.0

AREA CONTROLLED BY DIFFERENT GRS,
KIRINDI OYA RBMC.

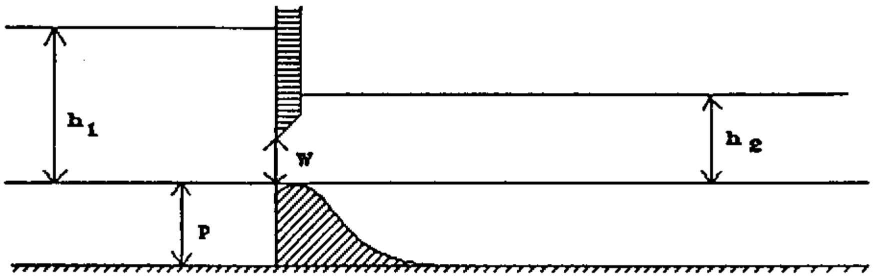


Annex 7

Structure Formulas.

WEIR/UNDERSHOT GATE (small sill elevation)

Figure A.



Weir — Free Flow

$$Q = \mu_F L \sqrt{2g}\, h_1^{3/2}$$

Weir — Submerged

$$Q = k_F \mu_F L \sqrt{2g}\, h_1^{3/2}$$

with k_F = coefficient of reduction for submerged flow.

The flow reduction coefficient is a function of $\frac{h_2}{h_1}$ and of the value α of this ratio at the instant of the free flow/submerged transition. The submerged conditions are obtained when $\frac{h_2}{h_1} > \alpha$. The law of variation of the k_F coefficient has been derived from experimental results.

Let $x = \sqrt{1 - \frac{h_2}{h_1}}$

If $x > 0.2 \Rightarrow k_F = 1 - (1 - \frac{x}{\sqrt{1-\alpha}})^{\beta}$

If $x \leq 0.2 \Rightarrow k_F = 5x(1 - (1 - \frac{0.2}{\sqrt{1-\alpha}})^{\beta})$

with $\beta = -2\alpha + 2.6$

One calculates an equivalent coefficient for free flow conditions as before.

Undershot Gate — Free Flow

$$Q = L\sqrt{2g}(\mu.h_1^{3/2} - \mu_1.(h_1 - W)^{3/2}) \qquad [7]$$

It has been established experimentally that the undershot gate discharge coefficient increases with $\frac{h_1}{W}$. A law of variation of μ of the following form is adopted

$$\mu = \mu_o - \frac{0.08}{h_1/W} \textit{ with } \mu_o \approx 0.4$$

$$\textit{Hence, } \mu_1 = \mu_o - \frac{0.08}{\frac{h_1}{W} - 1}$$

In order to ensure the continuity with the open channel free flow conditions for $\frac{h_1}{W} = 1$ it must have: $\mu_F = \mu_o - 0.08$.

Hence, $\mu_F = 0.32$ for $\mu_o = 0.4$

Undershot Gate — Submerged

Partially submerged flow:

$$Q = L\sqrt{2g}[k_F.\mu.h_1^{3/2} - \mu_1(h_1 - W)^{3/2}] \qquad [8]$$

k_F being the same as for open-channel flow.

The following free flow/submerged transition law has been derived on the basis of experimental results:

$$\alpha = 1 - 0.14\frac{h_2}{W}$$

$$0.4 \leq \alpha \leq 0.75$$

In order to ensure continuity with the open-channel flow conditions, the free flow/submerged transition under open-channel conditions has to be realized for $\alpha = 0.75$ instead of $\frac{2}{3}$ in the weir/orifice formulation.

Totally submerged flow:

$$Q = L\sqrt{2g}\,(k_F.\mu.h_1^{3/2} - k_{F1}.\mu_1.(h_1-W)^{3/2}) \qquad [9]$$

The k_{F1} equation is the same as the one for k_F where h_2 is replaced by h_2-W (and h_1 by h_1-W) for the calculation of the x coefficient (and therefore for the calculation of k_{F1}).

The transition to totally submerged flow occurs for:

$$h_2 > \alpha_1.h_1 + (1-\alpha_1).W$$

with:

$$\alpha_1 = 1 - 0.14\,\frac{h_2-W}{W}$$

$$(\alpha_1 = \alpha(h_2-W)\,)$$

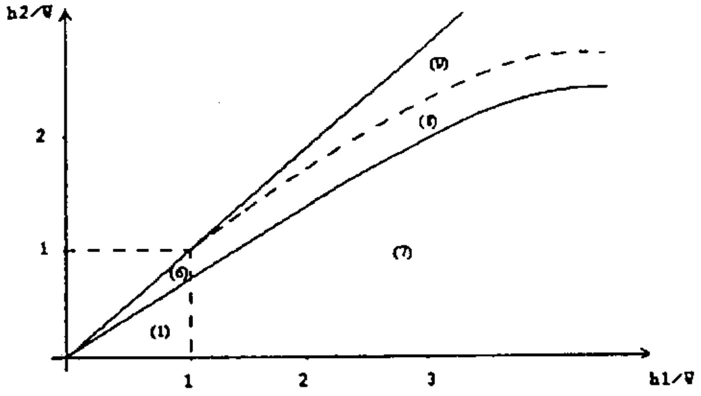
The functioning of the weir/undershot gate device is represented in Figure A1.2. Whatever the conditions of the pipe flow, one calculates an equivalent free flow discharge coefficient, corresponding to the classical equation for the free flow undershot gate.

$$C_F = \frac{Q}{L\sqrt{2g}\,W\sqrt{h_1}}$$

The reference coefficient introduced for the device is the classic C_G coefficient of the free flow undershot gate. It is then transformed to $\mu_o = \frac{2}{3}C_G$.

It is possible to get $C_F \neq C_G$, even under free flow conditions, since the discharge coefficient increases with the $\frac{h_1}{W}$ ratio.

Figure B.



WEIR / UNDERSHOT GATE

1: Weir — Free flow
6: Weir — Submerged
7: Undershot gate — Free flow
8: Undershot gate — Partially submerged
9: Undershot gate — Totally submerged

OVERFLOW

One takes into account the fact that the undershot gate has a certain height and if the water level rises upstream of the gate, water can flow over the gate. The flow overtopping the gate is then added to the flow resulting from the previous pipe flow computations. The overflow Qs is expressed as follows, under free flow conditions:

$$Q_S = 0.4L\sqrt{2g.}(h_1 - W - h_s)^{3/2} \qquad [10]$$

h_s being the gate height.

The weir is thus considered as having a discharge coefficient of 0.4 decided *a priori*. One uses the equivalent formula in the case of submerged overflow conditions:

$$Q_S = \mu' L\sqrt{2g}(h_1 - h_2)^{1/2}.(h_2 - W - h_s) \qquad [11]$$

$$\textit{with:}\quad \mu' = \frac{3\sqrt{3}}{2}\,\mu = 1.04$$

Annex 8

Performance Indicators Developed by Molden and Gates.

We note Q_D, the water delivered at a considered point of the irrigation network (discharge) and Q_T, the targeted water delivery at the same point. These two variables are thus functions of time and space:

Q_D (x, t) and Q_T (x, t).

The computation of Molten and Gates indicators requires the use of three basic mathematical notions:

- The notion of sill function:
  $Y(x) = x$ if $x < 1$, 1, otherwise
- The notion of average of a function F during a period of time $[t_1, t_2]$, within a certain spacial range $[x_1, x_2]$:
  $<F (x, t)> [x_1, x_2] [t_1, t_2]$
- The notion of standard deviation of a function F regarding its temporal or spacial fluctuations:
  $S_{t \text{ or } x} (F(x,t))$ x or t

Then we have:

Adequacy : $P_1 = <Y (Q_D/Q_T) >$ x, t

Efficiency : $P_2 = <Y (Q_T/Q_D) >$ x, t

Dependability : $P_3 = <S_t (Q_D/Q_T) >$ x

Equity : $P_4 = <S_x (Q_D/Q_T) >$ t

Annex 9

Indicators Computed During Maha 1991/92

D1, D2, D3, D4: P1, P2, P3, and P4.

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR D1 (offtake allocation in mm)

TRACT	CANAL	WEEK NUMBER																																			TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
1	FC 6	141	186	204	183	117	42	49	80	56	49	73	89	67	0	84	97	73	63	39																	1693
	DC 2	85	176	132	145	106	78	94	121	100	32	114	140	99	0	86	118	80	61	45																	1812
	DC 3A	99	198	215	196	150	45	64	82	79	30	69	84	78	7	64	91	55	58	36																	1702
	DC 3B	139	192	184	166	124	134	105	177	93	36	127	136	87	0	116	145	81	74	56																	2172
	D4	110	176	180	173	131	44	72	81	102	31	112	123	105	0	77	141	89	69	40																	1857
	D5	83	111	116	118	101	42	42	63	53	25	71	74	64	0	57	94	61	57	33																	1266
	F55	134	186	184	325	159	145	63	135	76	110	72	55	50	0	80	89	79	40	0																	1984
	F56	48	101	153	111	69	15	52	49	4	14	38	81	33	0	13	70	45	46	0																	941
	F57	132	192	174	363	223	59	31	147	220	126	119	83	65	0	99	176	89	120	0																	2417
	F58	109	93	123	210	113	67	81	111	44	40	147	85	66	0	137	152	22	47	0																	1647
	TRACT 1	103	165	168	168	126	59	67	94	81	33	92	100	82	2	75	114	70	63	37																	1697
2	DC 1												107	34	72	66	100	94	88	73	92	93	85	70	69	80	83	80	90	87	105						1569
	DC 2												128	38	120	125	138	136	119	112	137	131	127	128	117	136	124	131	110	137	165						2359
	DC 3												100	35	117	156	165	143	137	143	144	141	137	133	124	137	134	136	131	137	169						2520
	FC 34												27	182	87	89	125	97	31	48	57	52	16	105	42	71	28	72	45	5	151						1332
	DC 4												245	47	156	308	365	319	160	81	91	96	67	63	52	50	48	52	57	77	129						2459
	DC 5												150	25	52	152	166	172	101	31	35	36	26	25	24	25	25	26	27	59	168						1324
	DC 6												146	153	139	173	171	183	169	127	183	178	154	160	160	153	158	157	164	164	155						3047
	DC 7												69	88	125	126	137	135	127	127	114	72	91	81	105	112	104	104	115	117	88						2037
	FC 68												149	159	182	180	284	427	294	52	46	38	29	27	8	24	27	18	29	13	23						2011
	DC 8												142	222	168	227	217	208	210	158	149	144	147	126	151	160	157	156	152	161	163						3217
	DC 9												89	173	104	193	192	186	184	100	98	93	101	76	50	65	86	78	98	54	38						2059
	TRACT 2												124	85	117	150	162	160	138	108	126	119	113	109	106	115	112	114	112	120	139						2329
5	DC 1B																	127	123	68	53	49	44	41	46	43	42	46	47	44	39	35	31	41	36	8	963
	DC 1																	54	63	77	67	60	55	46	39	24	27	14	23	41	31	53	56	49	33	3	817
	DC 1A																	304	456	444	431	267	317	228	271	354	288	249	306	276	199	304	323	303	317	51	5688
	BC 2																	19	94	91	94	91	84	75	80	84	74	77	77	71	77	94	37	86	78	9	1392
	FC 48																	74	193	186	178	160	158	170	166	116	114	68	117	125	137	262	703	705	479	298	4408
	FC 49																	125	184	172	165	177	140	95	105	66	129	80	156	152	178	168	140	175	150	94	2652
	DC 9																	112	153	144	132	150	105	107	78	65	122	92	111	120	141	123	131	144	125	21	2176
	FC 54A																	274	361	334	309	351	260	152	129	65	55	121	207	284	375	309	360	393	301	263	4905
	FC 54																	190	225	152	137	125	97	76	67	81	93	29	62	93	71	77	107	121	85	8	1897
	FC 55																	0	184	274	248	274	220	208	300	246	154	251	126	277	144	241	133	167	73	231	3750
	DC 11																	0	176	171	180	207	124	160	167	148	123	89	152	133	128	105	84	134	76	105	2461
	DC 12																	9	129	148	147	149	142	153	55	46	44	39	40	46	53	48	30	29	3	106	1417
	DC 13																	0	104	150	184	136	108	127	118	100	92	76	89	95	91	92	73	83	29	58	1805
	TRACT 5																	35	125	127	132	126	103	102	101	96	87	80	95	92	94	102	62	105	80	42	1786
6	DC 1						18	80	91	94	79	87	111	85	0	57	108	104	117	97	104	75	62	42	47												1460
	FC 24						15	202	218	259	172	91	71	114	0	79	17	114	164	115	100	63	60	59	33												1945
	FC 25						107	335	265	308	252	232	224	291	158	118	211	172	188	196	149	160	195	145	87												3792
	DC 2						37	128	123	143	83	145	148	135	4	86	134	103	111	110	98	101	107	82	61												1939
	FC 37						0	0	0	0	209	96	166	224	81	110	103	84	196	156	71	90	80	80	366												2112
7	DC1						12	119	127	157	77	135	139	142	36	86	143	107	146	147	124	130	107	64	80												2075
	TRACT 6/7						25	112	115	131	88	120	132	121	14	75	124	106	125	115	107	96	90	63	63												1822

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR D2 (Number of gate operations)

TRACT	CANAL	WEEK NUMBER																																		Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
	DAM	5	2	3	3	7	3	5	4	8	9	4	4	3	5	0	1	5	3	4	1	0	3	3	1	0	1	2	0	2	5	2	3	1	1	2	105
1	FC 6	7	0	0	0	4	3	6	3	3	1	2	1	7	0	4	1	2	3	3																	50
	DC 2	5	0	6	0	4	5	3	0	3	2	2	0	3	0	4	1	2	2	2																	44
	DC 3A	12	5	5	4	2	6	3	2	6	13	12	0	3	1	18	4	8	3	7																	114
	DC 3B	4	2	3	2	2	5	5	6	8	7	5	1	3	0	13	4	5	4	4																	83
	D4	4	0	0	0	2	5	3	5	4	6	8	5	4	1	3	3	3	4	2																	62
	D5	7	3	1	0	5	7	7	3	7	7	3	1	1	0	6	4	4	2	3																	71
	F55	6	3	3	2	3	1	2	2	2	1	1	2	3	0	2	2	2	3	0																	40
	F56	7	0	3	6	3	1	2	0	2	4	5	1	2	0	1	1	3	1	0																	42
	F57	7	16	1	4	4	1	1	2	4	2	7	4	3	0	3	0	4	2	0																	65
	F58	9	14	10	7	6	5	4	4	5	6	5	2	3	0	1	0	2	3	1																	87
	GR 2	19	21	4	13	16	16	14	15	18	15	12	10	8	7	24	12	6	10	4																	244
	GR 3	22	17	10	9	16	9	13	13	13	24	20	12	13	9	28	14	10	24	14																	290
	GR 4	16	22	14	24	30	10	8	11	9	11	13	14	12	2	12	7	12	7	2																	236
	TRACT 1	125	103	60	71	97	74	71	66	84	99	95	53	65	20	119	53	63	68	42																	1428
2	DC 1												7	3	3	1	5	2	5	1	0	1	0	0	0	0	0	0	0	0	2						30
	DC 2												7	4	4	2	4	4	3	5	0	3	1	0	2	0	1	0	2	0	3						45
	DC 3												4	3	2	0	0	2	2	0	0	0	0	0	0	0	0	0	0	1	2						16
	FC 34												1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0						3
	DC 4												2	3	2	0	0	1	3	0	0	1	0	0	0	0	0	0	0	1	2						15
	DC 5												4	5	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	2						16
	DC 6												4	2	0	0	2	2	4	5	0	1	3	1	0	4	0	2	0	0	0						30
	DC 7												3	2	0	0	2	2	1	4	2	1	8	1	0	0	0	0	0	0	2						28
	FC 68												3	10	3	0	1	0	1	0	0	0	0	0	3	0	0	0	0	0	2						23
	DC 8												6	7	5	0	0	4	2	0	0	1	0	0	0	0	0	0	0	1	2						28
	DC 9												5	7	2	2	0	0	2	0	0	0	2	0	2	0	0	0	0	0	2						24
	GR 5												55	8	32	34	17	26	26	4	6	1	12	10	5	0	0	10	10	0	17						273
	GR 6												47	15	33	26	19	30	23	0	6	0	9	9	6	0	0	12	10	0	14						259
	GR 7												27	12	8	11	5	9	34	24	3	1	23	21	20	0	19	12	0	3	11						243
	GR 8												42	11	25	35	5	12	13	25	3	1	19	17	12	0	14	13	0	3	4						254
	GR 9												7	8	3	11	6	6	10	5	4	3	8	7	4	0	0	4	0	0	3						89
	GR 10												16	25	4	30	11	14	18	11	4	1	13	28	9	0	0	9	0	15	9						217
	TRACT 2												240	125	127	153	77	115	148	85	28	16	98	94	63	4	34	62	22	25	77						1593

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR D2 (Number of gate operations)

TRACT	CANAL	WEEK NUMBER																																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	Total
5	DC 1B																	2	0	1	0	2	7	5	2	2	2	0	0	0	0	0	0	0	0	0	23
	DC 1																	3	5	3	2	4	0	1	5	4	2	4	4	4	0	0	2	0	0	0	43
	DC 1A																	3	3	0	1	0	9	10	8	0	2	2	0	0	0	0	2	0	0	0	40
	BC 2																	1	6	2	0	4	1	3	2	0	2	1	0	0	3	2	0	0	0	1	28
	FC 48																	1	3	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	8
	FC 49																	1	1	1	0	0	1	2	0	0	1	0	2	0	0	0	0	0	0	0	9
	DC 9																	2	0	3	4	2	2	2	1	0	3	0	3	1	0	0	0	0	0	1	24
	FC 54A																	1	0	0	2	0	1	1	2	2	4	1	1	1	0	0	0	0	0	0	16
	FC 54																	2	0	3	3	0	1	2	3	0	5	6	3	4	2	0	0	0	0	1	35
	FC 55																	1	3	2	0	0	1	0	2	1	2	4	1	1	0	0	2	0	0	0	20
	DC 11																	1	1	1	3	2	4	2	0	0	1	3	1	0	0	0	0	1	1	0	21
	DC 12																	4	2	0	0	0	0	0	2	1	2	2	0	0	1	1	0	2	0	1	18
	DC 13																	1	3	2	4	8	1	0	2	3	2	0	1	1	2	3	0	0	0	1	34
	GR 11																	7	7	9	4	1	10	6	8	0	4	13	0	3	8	0	0	0	0	0	80
	GR 12																	7	14	20	11	9	12	12	11	0	7	6	3	5	2	4	2	4	0	0	129
	GR 13																	9	15	11	9	5	14	11	6	0	9	6	2	1	2	0	0	0	1	0	101
	GR 14																	8	16	10	2	4	11	11	8	2	4	4	1	1	2	0	2	1	1	0	88
	GR 15																	5	11	7	5	6	9	7	5	1	0	4	0	0	2	6	0	0	0	0	68
	TRACT 5																	59	90	76	51	47	84	75	67	16	52	56	22	22	24	17	10	8	4	5	785
6	DC 1					6	11	13	13	6	11	10	6	7	0	6	6	17	10	8	19	11	8	10	5												183
	FC 24					1	6	1	3	1	3	3	0	1	0	2	1	3	2	2	4	4	5	3	2												47
	FC 25					1	1	0	0	3	0	0	0	0	1	1	2	4	2	3	2	3	2	5	4												34
	DC 2					10	9	3	3	1	1	4	4	5	0	5	0	4	2	2	4	4	5	5	4												75
	FC 37					1	1	2	0	0	4	3	0	1	3	1	0	4	3	2	2	2	3	6	6												44
7	DC1					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0												0
	GR 16					12	21	11	5	9	7	8	3	2	0	7	1	4	12	15	4	14	4	11	0												150
	GR 17					6	2	7	5	0	6	0	0	1	0	3	0	8	20	11	10	14	4	4	8												109
	GR 18					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0												0
	TRACT 6/7					37	51	37	29	20	32	28	13	17	4	25	10	44	51	43	45	52	31	44	29												642

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR D2 (Number of gate operations)

TRACT	CANAL	WEEK NUMBER																																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	Total
1	OFFTAKES	68	43	32	25	35	39	36	27	44	49	50	17	32	2	55	20	35	27	22																	658
	GRS	57	60	28	46	62	35	35	39	40	50	45	36	33	18	64	33	28	41	20																	770
	AVG.	4.8	4.0	2.3	2.7	3.7	2.8	2.7	2.5	3.2	3.8	3.7	2.0	2.5	0.8	4.6	2.0	2.4	2.6	1.6																	2.9
2	OFFTAKES												46	46	22	6	14	18	24	16	2	9	14	2	7	4	1	2	2	4	19						258
	GRS												194	79	105	147	63	97	124	69	26	7	84	92	56	0	33	60	20	21	58						1335
	AVG.												5.9	3.0	3.1	3.7	1.9	2.8	3.6	2.1	0.7	0.4	2.4	2.3	1.5	0.1	0.8	1.5	0.5	0.6	1.9						2.0
5	OFFTAKES																	23	27	19	20	22	28	28	29	13	28	23	16	12	8	7	6	3	2	5	319
	GRS																	36	63	57	31	25	56	47	38	3	24	33	6	10	16	10	4	5	2	0	466
	AVG.																	2.0	3.1	2.6	1.8	1.6	2.9	2.6	2.3	0.6	1.8	1.9	0.8	0.8	0.8	0.6	0.3	0.3	0.1	0.2	1.4
6/7	OFFTAKES					19	28	19	19	11	19	20	10	14	4	15	9	32	19	17	31	24	23	29	21												383
	GRS					18	23	18	10	9	13	8	3	3	0	10	1	12	32	26	14	28	8	15	8												259
	AVG.					2.6	3.6	2.6	2.1	1.4	2.3	2.0	0.9	1.2	0.3	1.8	0.7	3.1	3.6	3.1	3.2	3.7	2.2	3.1	2.1												2.3

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR D3 (Ratio of level d/s over level u/s)

	CANAL	WEEK NUMBER																																	AVG
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
1	FC 6	0.71	0.58	0.55	0.59	0.57	0.69	0.62	0.61	1.00	1.00	0.87	0.58	0.61	1.00	0.72	0.57	0.68	0.46	0.53																0.68
	DC 2	0.62	0.49	0.47	0.49	0.51	0.58	0.78	0.51	0.97	1.00	0.67	0.51	0.50	1.00	0.64	0.49	0.62	0.47	0.56																0.63
	DC 3A	0.12	0.35	0.32	0.35	0.32	0.13	·	0.27	·	·	0.21	0.10	0.34	·	0.25	0.34	0.67	0.38	0.59																0.32
	DC 3B	0.37	0.16	0.15	0.16	0.19	0.17	0.48	0.16	0.93	0.83	0.18	0.18	0.18	1.00	0.48	0.15	0.41	0.20	0.39																0.36
	D4	0.95	0.78	0.75	0.79	0.80	0.87	0.98	1.00	0.92	0.84	0.85	0.90	0.92	1.00	1.00	0.77	0.93	0.69	0.82																0.87
	D5	0.74	0.69	0.69	0.70	0.74	0.72	1.87	0.81	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.70	0.88	0.72	0.90																0.89
	F55	0.69	0.59	0.61	0.55	0.73	0.87	0.74	0.68	0.96	0.63	0.56	0.75	0.79	0.49	0.31	0.55	0.59	0.41	0.68																0.64
	F56	0.92	0.70	0.74	0.67	0.92	0.82	1.00	0.73	0.64	0.74	0.79	0.98	0.93	0.55	1.00	0.74	0.74	0.46	0.73																0.78
	F57	0.67	0.68	0.66	0.67	0.72	0.59	1.00	0.99	0.71	0.93	0.73	0.94	0.91	0.56	0.97	0.67	0.78	0.54	0.78																0.76
	F58	0.83	0.78	0.71	0.72	0.82	0.68	1.00	1.00	0.84	0.89	0.82	1.00	0.93	0.56	0.86	0.81	1.00	0.77	1.00																0.84
	TRACT 1	0.66	0.58	0.57	0.57	0.63	0.61	0.83	0.69	0.80	0.79	0.67	0.67	0.71	0.80	0.70	0.58	0.73	0.51	0.70																0.67
2	DC 1												0.65	0.77	0.76	0.79	0.69	0.71	0.64	0.67	0.71	0.69	0.71	0.97	0.91	0.75	0.73	0.75	0.68	0.69	0.68					0.73
	DC 2												0.78	0.90	0.79	0.81	0.79	0.79	0.76	0.78	0.81	0.80	0.83	0.81	0.83	0.80	0.83	0.81	0.83	0.82	0.72					0.80
	DC 3												0.72	0.81	0.75	0.70	0.86	0.66	0.89	0.62	0.61	0.62	0.61	0.64	0.69	0.63	0.63	0.64	0.62	0.68	0.61					0.67
	FC 34												0.91	1.00	0.91	0.91	0.87	0.91	0.94	0.96	0.96	0.96	1.00	0.91	0.99	0.95	0.99	0.96	0.98	1.00	0.87					0.95
	DC 4												0.72	0.86	0.84	0.76	0.70	0.63	0.66	0.70	0.68	0.66	0.69	0.70	0.74	0.75	0.75	0.74	0.72	0.72	0.70					0.72
	DC 5												0.65	0.71	0.69	0.67	0.60	0.59	0.59	0.63	0.60	0.59	0.62	0.61	0.64	0.63	0.63	0.62	0.61	0.62	0.58					0.63
	DC 6												0.56	0.50	0.64	0.55	0.53	0.50	0.46	0.53	0.32	0.50	0.48	0.50	0.54	0.55	0.55	0.56	0.49	0.53	0.57					0.52
	DC 7												0.79	0.71	0.73	0.71	0.70	0.66	0.65	0.68	0.65	0.66	0.66	0.71	0.75	0.74	0.76	0.76	0.73	0.72	0.79					0.71
	FC 68												0.86	0.62	0.70	0.79	0.78	0.67	0.55	0.63	0.66	0.74	0.78	0.85	0.94	0.82	0.76	0.83	0.76	0.83	1.00					0.77
	DC 8												0.77	0.67	1.00	0.72	0.70	0.70	0.66	0.70	0.72	0.75	0.72	0.88	0.70	0.62	0.65	0.66	0.66	0.72	0.79					0.73
	DC 9												0.92	0.83	0.84	0.82	0.82	0.83	0.75	0.74	0.74	0.75	0.75	0.79	0.84	0.85	0.82	0.82	0.80	0.85	1.00					0.82
	TRACT 2												0.76	0.76	0.79	0.75	0.71	0.70	0.69	0.69	0.68	0.70	0.71	0.76	0.78	0.74	0.74	0.74	0.72	0.76	0.76					0.73
5	DC 1B																	0.47	0.47	0.44	0.42	0.45	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.49	0.55	0.61	0.65	0.54	0.63	0.50
	DC 1																	0.78	0.60	0.63	0.64	0.66	0.68	0.69	0.71	0.79	0.79	0.91	0.80	0.91	1.00	0.96	1.00	0.83	0.94	0.80
	DC 1A																	0.76	0.67	0.69	0.68	0.68	0.70	0.69	0.70	0.72	0.74	0.69	0.76	0.83	1.00	0.67	0.90	0.83	0.78	0.77
	BC 2																	0.96	0.91	0.95	0.95	0.93	0.94	0.88	0.89	0.88	0.89	0.92	0.92	0.97	0.94	0.86	0.88	0.88	0.92	0.91
	FC 48																	0.74	0.44	0.46	0.41	0.44	0.43	0.42	0.45	0.58	0.58	0.74	0.58	0.56	0.52	0.59	0.59	0.52	0.48	0.53
	FC 49																	0.77	0.58	0.58	0.61	0.58	0.57	0.61	0.56	0.68	0.68	0.88	0.66	0.64	0.57	0.59	0.65	0.56	0.56	0.63
	DC 9																	0.74	0.59	0.59	0.66	0.61	0.56	0.56	0.57	0.61	0.66	0.88	0.67	0.66	0.69	0.73	0.73	0.58	0.58	0.65
	FC 54A																	0.75	0.57	0.63	0.65	0.59	0.57	0.64	0.53	0.60	0.80	0.99	0.72	0.70	0.64	0.75	0.70	0.56	0.57	0.66
	FC 54																	0.85	0.68	0.72	0.71	0.67	0.64	0.64	0.65	0.65	0.69	1.00	0.78	0.77	0.73	0.79	0.74	0.63	0.61	0.72
	FC 55																	1.00	0.67	0.62	0.64	0.62	0.60	0.55	0.56	0.68	0.71	0.80	0.68	0.58	0.59	0.66	1.00	0.71	0.67	0.69
	DC 11																	1.00	0.77	0.78	0.78	0.74	0.75	0.74	0.69	0.76	0.75	0.86	0.77	0.78	0.79	0.83	1.00	0.72	0.79	0.79
	DC 12																	0.96	0.64	0.60	0.60	0.59	0.61	0.57	0.54	0.70	0.58	0.64	0.65	0.60	0.56	0.56	0.71	0.73	0.83	0.65
	DC 13																	1.00	0.76	0.75	0.78	0.76	0.75	0.70	0.70	0.83	0.70	0.75	0.77	0.74	0.69	0.72	0.79	0.75	0.86	0.77
	TRACT 5																	0.83	0.64	0.65	0.66	0.64	0.63	0.63	0.62	0.69	0.69	0.82	0.71	0.71	0.71	0.73	0.80	0.68	0.71	0.70
6	DC 1					0.60	0.77	0.75	0.78	0.70	0.79	0.73	0.67	0.99	1.00	0.76	0.65	0.61	0.64	0.63	0.66	0.69	0.66	0.67	0.58											0.72
	FC 24					0.58	0.67	0.73	0.82	0.59	0.85	1.00	0.81	0.57	1.00	0.19	0.88	0.67	0.88	0.81	0.67	0.67	0.64	0.63	0.59											0.70
	FC 25					0.62	0.73	0.68	0.78	0.54	0.67	0.69	0.70	0.56	0.60	0.75	0.70	0.64	0.59	0.59	0.54	0.52	0.53	0.55	0.45											0.62
	DC 2					0.63	0.67	0.72	0.81	0.65	0.80	0.78	0.76	0.67	0.72	0.77	0.74	0.73	0.70	0.70	0.69	0.67	0.68	0.68	0.58											0.72
	FC 37					0.87	0.61	0.81	0.60	0.64	0.69	0.65	0.81	0.70	0.60	0.88	0.83	0.73	0.72	0.71	0.74	0.71	0.74	0.69	0.64											0.73
7	DC1					0.69	0.92	0.71	0.79	0.61	0.75	0.66	0.70	0.64	0.52	0.65	0.64	0.74	0.66	0.67	0.64	0.67	0.61	0.59	0.64											0.68
	TR. 6/7					0.67	0.76	0.73	0.76	0.62	0.76	0.79	0.74	0.69	0.74	0.67	0.74	0.69	0.66	0.69	0.66	0.66	0.64	0.64	0.58											0.69

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR D3 (Ratio of level d/s over level u/s)

CANAL	WEEK NUMBER																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	AVG
GR 2	0.65	0.61	0.60	0.60	0.59	0.55	0.57	0.54	0.67	0.73	0.61	0.63	0.67	0.86	0.71	0.69	0.73	0.78	0.79																0.66
GR 3	0.49	0.38	0.39	0.41	0.48	0.51	0.58	0.45	0.56	0.53	0.47	0.61	0.64	0.86	0.68	0.62	0.76	0.86	0.88																0.59
GR 4	0.39	0.28	0.29	0.31	0.44	0.43	0.54	0.35	0.51	0.39	0.33	0.69	0.69	0.90	0.71	0.67	0.83	0.94	0.98																0.56
GR 5												0.71	0.75	0.68	0.68	0.71	0.75	0.91	0.94	0.93	0.91	0.89	0.88	0.83	0.74	0.69	0.69	0.67	0.67	0.76					0.78
GR 6												0.57	0.73	0.64	0.65	0.63	0.68	0.81	0.84	0.82	0.81	0.80	0.78	0.70	0.63	0.64	0.63	0.64	0.60	0.65					0.70
GR 7												0.64	0.70	0.58	0.55	0.60	0.65	0.71	0.69	0.72	0.70	0.69	0.66	0.64	0.56	0.58	0.58	0.59	0.61	0.60					0.63
GR 8												0.60	0.90	0.80	0.74	0.72	0.77	0.85	0.83	0.79	0.77	0.77	0.75	0.69	0.67	0.69	0.69	0.68	0.69	0.65					0.74
GR 9												0.69	0.79	0.68	0.63	0.65	0.69	0.82	0.76	0.66	0.60	0.61	0.60	0.65	0.62	0.61	0.62	0.63	0.60	0.62					0.66
GR 10												0.72	0.88	0.87	0.67	0.76	0.83	0.95	0.96	0.97	0.91	0.87	0.85	0.73	0.67	0.70	0.70	0.76	0.87	0.83					0.82
GR 11																	0.73	0.87	0.85	0.80	0.77	0.77	0.77	0.74	0.63	0.62	0.64	0.65	0.69	0.81	0.86	0.88	0.86	0.87	0.77
GR 12																	0.59	0.79	0.84	0.73	0.76	0.78	0.72	0.66	0.50	0.51	0.45	0.52	0.57	0.61	0.56	0.72	0.70	0.62	0.65
GR 13																	0.72	0.86	0.87	0.90	0.86	0.85	0.86	0.83	0.75	0.76	0.78	0.79	0.79	0.80	0.77	0.78	0.77	0.82	0.81
GR 14																	0.80	0.88	0.89	0.88	0.86	0.88	0.88	0.84	0.71	0.81	0.85	0.79	0.79	0.86	0.83	0.89	0.77	0.81	0.83
GR 15																	0.91	0.80	0.80	0.81	0.78	0.84	0.78	0.66	0.68	0.79	0.80	0.91	0.76	0.70	0.85	0.95	0.68	1.00	0.81
GR 16					0.79	0.75	0.82	0.76	0.86	0.73	0.77	0.72	0.87	1.00	0.89	0.75	0.81	0.93	0.91	0.88	0.90	0.94	0.91	0.93											0.85
GR 17					0.78	0.75	0.87	0.78	0.89	0.83	0.85	0.85	0.90	0.99	0.94	0.85	0.83	0.90	0.92	0.91	0.88	0.97	0.97	1.00											0.88
GR 18					0.36		1.00		0.71	2.32	0.44	0.69	0.53	0.99	0.93	0.75		0.33	0.37	0.28	0.18	0.29	0.29	0.63											0.65

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR D4 (Standard deviation of up stream water level)

TRACT	CANAL	WEEK NUMBER																																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	AVG
1	FC 6	0.10	0.02	0.05	0.04	0.08	0.12	0.12	0.04	0.24	0.29	0.15	0.03	0.06	0.35	0.17	0.02	0.15	0.02	0.02																0.11
	DC 2	0.12	0.02	0.03	0.04	0.08	0.12	0.24	0.04	0.29	0.29	0.17	0.03	0.07	0.27	0.18	0.02	0.14	0.02	0.02																0.12
	DC 3A	0.17	0.01	0.02	0.03	0.08	0.11	0.25	0.04	0.33	0.36	0.21	0.16	0.11	0.53	0.24	0.02	0.12	0.03	0.03																0.15
	DC 3B	0.18	0.04	0.01	0.04	0.08	0.11	0.24	0.04	0.34	0.32	0.19	0.18	0.08	0.47	0.23	0.02	0.15	0.03	0.02																0.15
	D4	0.10	0.02	0.05	0.02	0.08	0.09	0.32	0.11	0.27	0.31	0.16	0.11	0.13	0.41	0.25	0.01	0.18	0.03	0.04																0.14
	D5	0.12	0.01	0.02	0.03	0.06	0.16	0.29	0.11	0.29	0.27	0.17	0.09	0.19	0.34	0.24	0.03	0.19	0.04	0.03																0.14
	F55	0.16	0.08	0.08	0.09	0.11	0.29	0.32	0.23	0.26	0.33	0.17	0.15	0.08	0.05	0.22	0.03	0.14	0.07	0.02																0.15
	F56	0.15	0.09	0.08	0.10	0.07	0.24	0.27	0.20	0.23	0.27	0.16	0.09	0.06	0.04	0.20	0.03	0.13	0.05	0.03																0.13
	F57	0.15	0.09	0.08	0.07	0.07	0.20	0.24	0.16	0.20	0.24	0.12	0.09	0.06	0.03	0.20	0.04	0.13	0.07	0.03																0.12
	F58	0.17	0.10	0.09	0.08	0.08	0.19	0.24	0.16	0.21	0.24	0.12	0.08	0.06	0.03	0.23	0.05	0.16	0.08	0.04																0.13
	TRACT 1	0.15	0.04	0.05	0.05	0.07	0.17	0.25	0.10	0.25	0.27	0.15	0.10	0.10	0.21	0.22	0.03	0.13	0.04	0.03																0.13
2	DC 1												0.11	0.21	0.27	0.17	0.06	0.10	0.05	0.12	0.03	0.08	0.07	0.10	0.10	0.02	0.03	0.07	0.05	0.08	0.07					0.09
	DC 2												0.05	0.30	0.30	0.13	0.05	0.07	0.05	0.10	0.03	0.03	0.04	0.11	0.11	0.02	0.04	0.04	0.05	0.02	0.05					0.08
	DC 3												0.13	0.23	0.23	0.10	0.04	0.06	0.17	0.09	0.05	0.02	0.05	0.11	0.10	0.02	0.04	0.04	0.04	0.05	0.08					0.09
	FC 34												0.04	0.32	0.25	0.11	0.09	0.07	0.06	0.11	0.06	0.04	0.06	0.15	0.16	0.02	0.06	0.07	0.05	0.04	0.08					0.10
	DC 4												0.04	0.22	0.25	0.09	0.06	0.04	0.06	0.09	0.05	0.02	0.05	0.11	0.10	0.02	0.04	0.07	0.04	0.04	0.05					0.08
	DC 5												0.11	0.21	0.27	0.09	0.06	0.04	0.06	0.09	0.06	0.02	0.05	0.11	0.10	0.02	0.05	0.07	0.04	0.04	0.05					0.08
	DC 6												0.09	0.16	0.19	0.08	0.06	0.06	0.05	0.11	0.03	0.02	0.05	0.11	0.06	0.01	0.05	0.06	0.02	0.03	0.09					0.07
	DC 7												0.09	0.16	0.21	0.08	0.07	0.06	0.05	0.11	0.05	0.02	0.06	0.11	0.07	0.01	0.06	0.06	0.03	0.03	0.09					0.07
	FC 68												0.03	0.19	0.27	0.06	0.05	0.06	0.04	0.07	0.04	0.01	0.03	0.06	0.06	0.04	0.04	0.04	0.03	0.02	0.08					0.06
	DC 8												0.10	0.22	0.40	0.07	0.06	0.09	0.05	0.06	0.03	0.01	0.03	0.08	0.04	0.01	0.03	0.05	0.02	0.02	0.09					0.08
	DC 9												0.11	0.20	0.22	0.10	0.06	0.07	0.06	0.06	0.02	0.01	0.02	0.10	0.09	0.01	0.04	0.08	0.01	0.04	0.10					0.07
	TRACT 2												0.09	0.21	0.24	0.10	0.06	0.07	0.06	0.09	0.05	0.03	0.05	0.11	0.09	0.02	0.04	0.06	0.04	0.04	0.08					0.08
5	DC 1B																	0.02	0.06	0.05	0.02	0.01	0.09	0.09	0.08	0.01	0.03	0.08	0.01	0.14	0.17	0.19	0.24	0.11	0.01	0.08
	DC 1																	0.08	0.07	0.04	0.03	0.02	0.05	0.05	0.05	0.01	0.03	0.06	0.01	0.09	0.17	0.17	0.32	0.16	0.07	0.08
	DC 1A																	0.04	0.06	0.04	0.02	0.03	0.05	0.04	0.04	0.01	0.03	0.06	0.01	0.08	0.18	0.16	0.34	0.17	0.05	0.08
	BC 2																	0.02	0.06	0.05	0.02	0.03	0.06	0.05	0.05	0.01	0.03	0.06	0.01	0.09	0.16	0.15	0.31	0.15	0.06	0.08
	FC 48																	0.06	0.15	0.15	0.07	0.02	0.07	0.08	0.10	0.01	0.07	0.08	0.02	0.06	0.09	0.08	0.13	0.10	0.02	0.08
	FC 49																	0.11	0.09	0.12	0.08	0.02	0.06	0.07	0.07	0.02	0.06	0.10	0.02	0.05	0.07	0.09	0.15	0.09	0.03	0.07
	DC 9																	0.11	0.07	0.11	0.08	0.02	0.06	0.08	0.06	0.01	0.07	0.11	0.03	0.05	0.08	0.11	0.22	0.09	0.02	0.08
	FC 54A																	0.12	0.07	0.11	0.08	0.03	0.06	0.08	0.07	0.03	0.06	0.10	0.03	0.05	0.08	0.10	0.19	0.09	0.03	0.08
	FC 54																	0.12	0.07	0.12	0.08	0.02	0.07	0.09	0.06	0.02	0.06	0.11	0.03	0.05	0.08	0.09	0.20	0.09	0.03	0.08
	FC 55																	0.06	0.08	0.08	0.07	0.04	0.09	0.07	0.06	0.05	0.08	0.06	0.04	0.03	0.06	0.04	0.22	0.07	0.15	0.08
	DC 11																	0.06	0.06	0.08	0.07	0.02	0.25	0.07	0.08	0.06	0.06	0.07	0.03	0.04	0.05	0.04	0.21	0.10	0.14	0.08
	DC 12																	0.10	0.07	0.09	0.06	0.03	0.07	0.05	0.05	0.08	0.05	0.06	0.04	0.06	0.05	0.04	0.16	0.08	0.17	0.07
	DC 13																	0.10	0.08	0.10	0.06	0.03	0.07	0.05	0.06	0.08	0.05	0.06	0.04	0.06	0.05	0.04	0.16	0.08	0.18	0.08
	TRACT 5																	0.07	0.08	0.09	0.06	0.03	0.08	0.07	0.06	0.03	0.05	0.08	0.03	0.07	0.10	0.10	0.23	0.12	0.11	0.08
6	DC 1					0.12	0.20	0.10	0.09	0.14	0.16	0.17	0.15	0.28	0.28	0.27	0.04	0.08	0.09	0.14	0.06	0.04	0.05	0.10	0.05											0.13
	FC 24					0.17	0.21	0.11	0.10	0.17	0.18	0.17	0.21	0.07	0.32	0.24	0.04	0.11	0.09	0.14	0.05	0.04	0.05	0.08	0.05											0.13
	FC 25					0.14	0.29	0.20	0.21	0.11	0.27	0.20	0.19	0.13	0.14	0.26	0.09	0.22	0.15	0.14	0.17	0.14	0.11	0.14	0.04											0.17
	DC 2					0.16	0.18	0.23	0.13	0.16	0.25	0.18	0.19	0.14	0.00	0.31	0.09	0.22	0.18	0.16	0.16	0.14	0.15	0.16	0.03											0.16
	FC 37					0.21	0.07	0.24	0.06	0.14	0.25	0.22	0.24	0.17	0.15	0.29	0.08	0.25	0.20	0.22	0.20	0.19	0.21	0.22	0.08											0.18
7	DC1					0.19	0.24	0.23	0.16	0.15	0.22	0.16	0.17	0.17	0.04	0.23	0.07	0.25	0.19	0.19	0.18	0.17	0.17	0.17	0.05											0.17
	TR.6/7					0.15	0.20	0.19	0.13	0.15	0.22	0.17	0.18	0.18	0.13	0.26	0.07	0.16	0.13	0.15	0.12	0.10	0.11	0.13	0.06											0.15

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR D4 (Standard deviation of up stream water level)

CANAL	WEEK NUMBER																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	AVG
GR 2	0.26	0.01	0.02	0.04	0.08	0.13	0.25	0.04	0.35	0.36	0.20	0.17	0.28	0.10	0.34	0.03	0.12	0.03	0.04																0.15
GR 3	0.18	0.02	0.02	0.04	0.06	0.29	0.33	0.11	0.27	0.29	0.18	0.10	0.18	0.11	0.29	0.01	0.12	0.05	0.03																0.14
GR 4	0.18	0.10	0.09	0.10	0.10	0.34	0.36	0.15	0.21	0.28	0.12	0.07	0.06	0.15	0.20	0.05	0.09	0.10	0.04																0.15
GR 5												0.06	0.15	0.19	0.17	0.06	0.09	0.06	0.10	0.03	0.02	0.03	0.11	0.10	0.02	0.03	0.07	0.05	0.07	0.07					0.08
GR 6												0.05	0.21	0.18	0.13	0.05	0.08	0.06	0.09	0.03	0.03	0.05	0.10	0.11	0.02	0.04	0.04	0.04	0.02	0.06					0.07
GR 7												0.17	0.26	0.18	0.12	0.04	0.05	0.06	0.10	0.06	0.04	0.06	0.17	0.14	0.02	0.06	0.07	0.04	0.04	0.08					0.09
GR 8												0.12	0.17	0.21	0.09	0.07	0.04	0.06	0.10	0.06	0.02	0.05	0.11	0.10	0.02	0.06	0.08	0.04	0.04	0.07					0.08
GR 9												0.13	0.16	0.19	0.09	0.08	0.09	0.06	0.09	0.06	0.02	0.06	0.12	0.10	0.01	0.06	0.07	0.03	0.03	0.10					0.08
GR 10												0.13	0.16	0.31	0.07	0.06	0.09	0.07	0.06	0.11	0.02	0.03	0.10	0.05	0.01	0.03	0.05	0.03	0.07	0.11					0.08
GR 11																	0.01	0.06	0.06	0.06	0.01	0.03	0.09	0.09	0.01	0.03	0.08	0.02	0.15	0.17	0.20	0.31	0.20	0.02	0.09
GR 12																	0.03	0.06	0.06	0.03	0.03	0.07	0.05	0.05	0.01	0.04	0.06	0.01	0.10	0.17	0.15	0.30	0.23	0.05	0.08
GR 13																	0.08	0.09	0.12	0.09	0.03	0.07	0.08	0.06	0.02	0.06	0.11	0.04	0.05	0.08	0.09	0.26	0.09	0.41	0.10
GR 14																	0.06	0.06	0.08	0.07	0.03	0.08	0.07	0.06	0.06	0.06	0.07	0.03	0.04	0.05	0.04	0.21	0.07	0.36	0.08
GR 15																	0.10	0.09	0.08	0.06	0.03	0.07	0.05	0.05	0.08	0.05	0.05	0.06	0.07	0.05	0.07	0.14	0.17	0.18	0.08
GR 16					0.08	0.14	0.14	0.11	0.17	0.22	0.15	0.14	0.26	0.10	0.33	0.04	0.08	0.08	0.15	0.05	0.04	0.05	0.07	0.05											0.12
GR 17					0.13	0.18	0.23	0.15	0.16	0.23	0.17	0.20	0.19	0.07	0.22	0.08	0.12	0.10	0.12	0.09	0.06	0.07	0.10	0.11											0.14
GR 18					0.17	0.28	0.22	0.15	0.13	0.21	0.15	0.17	0.17	0.04	0.15	0.06	0.14	0.13	0.11	0.08	0.05	0.09	0.09	0.05											0.13

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR P1 (adequacy)

TRACT	CANAL	WEEK NUMBER																																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	AVG.
1	FC 6	0.8	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.5	0.8	0.9	0.9	0.4	0.8	1.0	0.7	0.7	0.6																	0.8
	DC 2	0.6	1.0	0.8	1.0	0.8	0.8	0.6	0.9	0.9	0.5	0.9	1.0	0.7	0.0	0.8	1.0	0.7	0.5	0.6																	0.7
	DC 3A	0.8	1.0	1.0	1.0	0.9	0.4	0.5	0.7	0.6	0.2	0.5	0.6	0.5	0.0	0.5	0.7	0.4	0.4	0.5																	0.6
	DC 3B	0.8	1.0	1.0	1.0	0.8	0.7	0.6	0.9	0.6	0.3	0.8	0.9	0.7	0.0	0.8	1.0	0.6	0.6	0.6																	0.7
	D4	0.7	1.0	1.0	1.0	0.9	0.3	0.5	0.6	0.7	0.2	0.1	0.7	0.7	0.0	0.6	1.0	0.7	0.5	0.6																	0.6
	D5	0.8	0.8	0.8	0.9	0.7	0.2	0.2	0.4	0.4	0.2	0.0	0.0	0.4	0.0	0.3	0.7	0.4	0.3	0.4																	0.4
	F55	0.1	0.9	0.9	1.0	0.8	0.4	0.3	0.4	0.7	0.4	0.0	0.7	0.6	0.0	0.7	0.9	0.7	0.5	0.0																	0.5
	F56	0.1	0.8	0.7	0.8	0.7	0.2	0.2	0.2	0.5	0.2	0.0	0.9	0.7	0.0	0.5	0.8	0.4	0.5	0.0																	0.4
	F57	0.4	0.9	0.8	0.9	0.5	0.2	0.0	0.0	0.1	0.2	0.0	0.4	0.1	0.0	0.3	0.9	0.6	0.5	0.0																	0.4
	F58	0.2	0.5	0.6	0.8	0.5	0.2	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.2	0.6	0.1	0.2	0.0																	0.2
	TRACT 1	0.7	0.9	0.9	1.0	0.8	0.4	0.4	0.6	0.6	0.2	0.3	0.5	0.6	0.0	0.5	0.8	0.5	0.5	0.5																	0.6
2	DC 1												0.6	0.2	0.5	0.6	0.8	0.8	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.6	0.7	0.7	0.7						0.6
	DC 2												0.7	0.1	0.8	0.9	1.0	1.0	0.9	0.8	1.0	1.0	1.0	0.9	0.9	1.0	0.9	1.0	0.9	1.0	1.0						0.9
	DC 3												0.7	0.6	0.7	0.9	1.0	0.9	0.9	1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	0.9	1.0	1.0						0.9
	FC 34												0.6	0.9	1.0	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.6	0.8	0.8	0.8	0.9	0.9						0.9
	DC 4												0.6	0.7	0.9	1.0	1.0	1.0	1.0	0.6	0.7	0.7	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.5						0.6
	DC 5												0.6	0.7	1.0	1.0	1.0	0.9	1.0	0.8	0.6	0.6	0.8	0.5	0.7	0.2	0.7	0.5	0.6	0.8	0.8						0.7
	DC 6												0.3	0.1	0.5	0.8	0.9	0.2	0.2	0.5	0.8	0.8	0.5	0.6	0.6	1.0	0.6	0.7	0.7	0.6	0.6						0.6
	DC 7												0.2	0.0	0.3	0.4	0.9	1.0	1.0	0.3	0.6	0.6	0.4	0.6	0.7	0.9	0.8	0.8	0.9	0.8	0.8						0.6
	FC 68												0.4	0.0	1.0	0.4	1.0	0.9	1.0	0.9	0.7	0.7	0.9	0.9	0.6	0.9	1.0	0.9	0.9	1.0	1.0						0.8
	DC 8												0.4	0.0	0.6	0.0	1.0	0.3	0.5	0.9	0.9	0.9	0.6	0.5	0.2	0.6	0.4	0.6	0.4	0.1	0.1						0.5
	DC 9												0.2	0.0	0.0	0.0	0.9	0.1	0.2	0.2	0.5	0.5	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0						0.2
	TRACT 2												0.5	0.2	0.6	0.7	0.9	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7						0.7
5	DC 1B																	0.8	0.9	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
	DC 1																	0.4	0.5	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.6	0.2	0.4	0.4	0.5	0.6	1.0	0.4	0.9	0.5
	DC 1A																	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0
	BC 2																	0.2	0.7	0.7	0.8	0.8	0.7	0.6	0.6	0.6	0.6	0.3	0.6	0.6	0.6	0.7	0.5	0.1	0.6	0.1	0.5
	FC 48																	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9
	FC 49																	0.6	1.0	0.9	1.0	1.0	0.8	0.7	0.7	0.7	0.8	0.7	1.0	0.9	0.9	1.0	0.8	1.0	1.0	1.0	0.9
	DC 9																	0.4	0.9	0.4	0.9	0.9	0.8	0.7	0.6	0.5	0.9	0.5	0.9	0.8	0.8	0.9	0.7	0.7	0.9	0.8	0.7
	FC 54A																	0.4	1.0	0.9	0.9	0.9	1.0	0.9	0.8	0.6	0.8	0.7	0.9	1.0	1.0	1.0	1.0	0.0	1.0	1.0	0.8
	FC 54																	0.3	1.0	1.0	0.9	0.9	0.7	0.7	0.9	0.9	1.0	0.6	0.8	1.0	1.0	0.6	0.9	0.0	1.0	0.2	0.8
	FC 55																	0.3	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	1.0	1.0	1.0	0.9	0.8	0.0	1.0	0.2	0.8
	DC 11																	0.0	0.6	0.3	0.9	0.9	0.8	0.8	0.2	0.3	0.3	0.3	0.2	0.4	0.4	0.7	0.5	0.0	0.0	0.1	0.4
	DC 12																	0.0	0.8	0.9	1.0	1.0	0.9	0.9	0.9	0.7	0.6	0.3	0.9	0.7	0.7	0.3	0.1	0.0	0.1	0.1	0.6
	DC 13																	0.0	0.3	0.8	0.8	0.8	0.7	0.6	0.1	0.1	0.0	0.1	0.1	0.3	0.3	0.7	0.3	0.0	0.0	0.0	0.3
	TRACT 5																	0.2	0.7	0.6	0.8	0.8	0.7	0.6	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.7	0.5	0.2	0.5	0.2	0.5
6	DC 1					0.0	0.1	0.5	0.7	0.7	0.6	0.7	0.8	0.7	0.1	0.4	0.8	0.8	0.9	0.7	0.8	0.8	0.5	0.4	0.5												0.6
	FC 24					0.0	0.2	1.0	1.0	1.0	0.9	0.7	0.7	1.0	0.5	0.6	1.0	1.0	1.0	0.9	0.8	0.6	0.6	0.5	0.4												0.7
	FC 25					0.0	0.3	1.0	1.0	1.0	0.9	1.0	1.0	0.8	0.5	0.4	1.0	0.8	0.8	0.8	0.7	0.7	0.8	0.7	0.9												0.8
	DC 2					0.0	0.2	0.5	0.8	0.9	0.5	0.9	0.8	0.0	0.1	0.0	0.2	0.6	0.7	0.6	0.7	0.7	0.8	0.6	0.3												0.5
	FC 37					0.0	0.1	0.0	0.6	0.7	0.8	0.9	0.9	0.0	0.0	0.0	0.9	0.6	0.7	0.7	0.8	0.8	0.6	0.5	0.9												0.5
7	DC1					0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.5	0.0	0.0	0.0	0.1	0.5	0.7	0.6	0.0	0.0	0.7	0.5	0.4												0.2
	TRACT 6/7					0.0	0.1	0.4	0.6	0.6	0.5	0.7	0.7	0.3	0.1	0.2	0.5	0.6	0.7	0.7	0.6	0.6	0.6	0.4	0.4												0.5

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR P1 (adequacy)

REACH	WEEK NUMBER																																			AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
GR 2	0.8	1.0	1.0	1.0	0.8	0.6	0.5	0.8	0.7	0.3	0.6	0.8	0.6	0.0	0.6	0.8	0.5	0.5	0.6																	0.7
GR 3	0.7	0.9	0.9	1.0	0.8	0.3	0.4	0.5	0.6	0.2	0.0	0.3	0.5	0.0	0.4	0.8	0.5	0.4	0.5																	0.5
GR 4	0.2	0.8	0.7	0.9	0.6	0.2	0.1	0.1	0.3	0.2	0.0	0.5	0.3	0.0	0.4	0.8	0.4	0.4	0.0																	0.4
GR 5												0.6	0.2	0.5	0.6	0.8	0.8	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.6	0.7	0.7	0.7						0.6
GR 6												0.7	0.1	0.8	0.9	1.0	1.0	0.9	0.8	1.0	1.0	1.0	0.9	0.9	1.0	0.9	1.0	0.9	1.0	1.0						0.9
GR 7												0.7	0.7	0.8	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	0.9	1.0	1.0						0.9
GR 8												0.6	0.7	0.9	1.0	1.0	1.0	1.0	0.7	0.6	0.6	0.7	0.5	0.6	0.3	0.6	0.5	0.6	0.7	0.7						0.7
GR 9												0.3	0.1	0.4	0.7	0.9	0.5	0.4	0.4	0.7	0.7	0.5	0.6	0.6	0.9	0.7	0.8	0.7	0.6	0.6						0.6
GR 10												0.4	0.0	0.7	0.1	1.0	0.4	0.6	0.9	0.9	0.9	0.7	0.5	0.3	0.6	0.5	0.6	0.5	0.2	0.2						0.5
GR 11												0.2	0.0	0.0	0.0	0.9	0.3	0.4	0.3	0.5	0.5	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.3	0.3	0.3	0.3	0.3	0.2
GR 12																	0.3	0.7	0.7	0.8	0.8	0.7	0.6	0.6	0.6	0.6	0.4	0.6	0.6	0.6	0.7	0.5	0.2	0.6	0.1	0.6
GR 13																	0.5	1.0	0.6	0.9	0.9	0.8	0.8	0.7	0.6	0.9	0.6	0.9	0.9	0.9	0.9	0.8	0.7	0.9	0.8	0.8
GR 14																	0.0	0.6	0.4	0.9	0.9	0.9	0.8	0.3	0.4	0.4	0.3	0.2	0.4	0.4	0.7	0.5	0.0	0.1	0.1	0.4
GR 15																	0.0	0.4	0.8	0.9	0.9	0.7	0.7	0.3	0.3	0.1	0.2	0.2	0.4	0.4	0.6	0.2	0.0	0.0	0.0	0.4
GR 16					0.0	0.1	0.6	0.7	0.7	0.6	0.7	0.8	0.7	0.1	0.4	0.8	0.8	0.9	0.8	0.8	0.8	0.5	0.4	0.5												0.6
GR 17					0.0	0.2	0.5	0.8	0.9	0.5	0.9	0.8	0.1	0.1	0.0	0.3	0.6	0.7	0.6	0.7	0.7	0.7	0.6	0.4												0.5
GR 18					0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.5	0.0	0.0	0.0	0.1	0.5	0.7	0.6	0.0	0.0	0.7	0.5	0.4												0.2

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR P2 (Efficiency)

TRACT	CANAL	WEEK NUMBER																																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	AVG
1	FC 6	0.7	0.7	0.6	0.7	0.9	0.7	0.7	0.9	0.9	0.9	0.9	1.0	0.8	0.8	1.0	0.9	0.9	0.9	1.0																	0.8
	DC 2	1.0	0.9	0.9	0.9	1.0	0.9	0.9	1.0	0.9	0.9	0.5	0.9	0.9	1.0	0.9	0.9	1.0	0.9	1.0																	0.9
	DC 3A	0.3	0.8	0.7	0.7	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																	0.9
	DC 3B	0.6	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.9	0.9	0.8	0.6	0.9	1.0	0.8	0.9	1.0	1.0	0.9																	0.8
	D4	1.0	0.8	0.8	0.8	0.9	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0																	1.0
	D5	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																	1.0
	F55	1.0	0.9	0.9	0.3	0.6	0.9	1.0	0.9	0.7	0.9	1.0	0.9	0.9	1.0	0.9	0.9	1.0	1.0	1.0																	0.9
	F56	1.0	1.0	0.8	0.8	0.9	1.0	0.9	0.9	0.8	1.0	1.0	0.5	0.8	1.0	0.9	0.9	1.0	0.9	1.0																	0.9
	F57	0.9	0.8	0.8	0.4	0.8	1.0	1.0	1.0	1.0	1.0	1.0	0.8	1.0	1.0	0.9	0.8	1.0	0.9	1.0																	0.9
	F58	0.9	0.9	0.9	0.7	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	0.9	1.0	1.0	1.0																	1.0
	TRACT 1	0.7	0.8	0.8	0.8	0.9	1.0	1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0																	0.9
2	DC 1												1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0							1.0
	DC 2												1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0							1.0
	DC 3												1.0	0.7	1.0	0.9	0.8	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0							0.9
	FC 34												0.6	0.3	0.4	0.6	0.7	0.2	0.3	0.6	0.8	0.8	0.7	0.8	0.8	1.0	0.9	0.9	0.9	0.8	0.8							0.7
	DC 4												0.7	0.6	0.9	0.4	0.4	0.2	0.2	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0							0.8
	DC 5												0.8	0.8	0.5	0.7	0.8	0.9	0.9	0.6	0.7	0.7	0.5	0.7	0.6	1.0	0.6	0.8	0.6	0.5	0.5							0.7
	DC 6												1.0	1.0	1.0	0.8	0.8	1.0	1.0	1.0	0.8	0.8	1.0	0.9	0.9	0.8	0.9	0.9	0.9	1.0	1.0							0.9
	DC 7												1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0							1.0
	FC 68												0.8	1.0	0.2	0.7	0.5	0.2	0.1	0.4	0.7	0.7	0.3	0.4	0.5	0.3	0.2	0.3	0.3	0.3	0.3							0.4
	DC 8												0.9	1.0	1.0	1.0	0.6	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0							1.0
	DC 9												0.9	1.0	1.0	1.0	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0							1.0
	TRACT 2												0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9							0.9
5	DC 1B																	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	DC 1																	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.7	1.0	1.0	1.0	0.9	0.8	0.6	1.0	0.8	0.9
	DC 1A																	0.5	0.3	0.3	0.3	0.3	0.5	0.6	0.6	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.7	0.5
	BC 2																	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	FC 48																	0.8	0.8	0.8	0.8	0.8	1.0	0.9	0.8	1.0	1.0	0.9	1.0	0.9	0.9	0.8	0.3	0.9	0.3	0.4	0.8
	FC 49																	1.0	0.8	0.8	0.9	0.9	0.9	1.0	1.0	0.9	1.0	0.8	0.9	0.9	0.9	0.8	0.9	0.2	0.9	0.2	0.8
	DC 9																	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.7	1.0	1.0	1.0
	FC 54A																	0.9	0.5	0.8	0.6	0.6	0.7	0.8	0.8	0.9	0.9	0.7	0.7	0.5	0.5	0.5	0.5	1.0	0.7	0.2	0.7
	FC 54																	1.0	0.6	0.6	0.9	0.9	1.0	0.9	0.7	0.6	0.5	0.9	1.0	0.8	0.8	0.9	0.8	1.0	0.2	0.9	0.8
	FC 55																	1.0	0.4	0.1	0.5	0.5	0.8	0.5	0.2	0.4	0.4	0.4	0.1	0.2	0.2	0.7	0.7	1.0	0.4	0.8	0.5
	DC 11																	1.0	0.9	1.0	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	DC 12																	1.0	0.7	0.3	0.8	0.8	0.9	0.8	0.4	0.6	0.6	0.9	0.5	0.6	0.6	1.0	1.0	1.0	1.0	0.9	0.8
	DC 13																	1.0	1.0	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	TRACT 5																	1.0	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0
6	DC 1					1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0												0.8
	FC 24					1.0	0.9	0.4	0.4	0.4	0.5	0.9	0.9	0.5	0.8	0.8	0.6	0.7	0.7	0.8	1.0	1.0	0.9	1.0	1.0												0.8
	FC 25					1.0	0.8	0.1	0.4	0.3	0.5	0.5	0.4	0.9	0.9	0.9	0.1	0.6	0.5	0.5	0.7	0.7	0.6	0.7	0.4												0.6
	DC 2					1.0	1.0	1.0	1.0	0.9	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0												1.0
	FC 37					1.0	0.9	1.0	0.4	0.3	0.5	0.5	0.5	1.0	1.0	1.0	0.3	0.7	0.7	0.7	0.3	0.3	1.0	1.0	0.3												0.7
7	DC1					1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0												1.0
	TRACT 6/7					1.0	1.0	1.0	1.0	0.9	1.0	0.9	0.9	1.0	1.0	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0												1.0

Table : KIRINDI OYA RBMC MAHA 1991/92 - INDICATOR P2 (Efficiency)

REACH	WEEK NUMBER																																			AVG
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
GR 2	0.5	0.8	0.8	0.7	0.8	0.9	0.9	0.9	1.0	1.0	0.9	0.9	1.0	1.0	0.9	0.9	1.0	1.0	1.0																	0.9
GR 3	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																	1.0
GR 4	0.9	0.9	0.9	0.6	0.8	1.0	1.0	1.0	0.9	1.0	1.0	0.8	0.9	1.0	0.9	0.9	1.0	0.9	1.0																	0.9
GR 5												1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0
GR 6												1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0
GR 7												0.9	0.7	0.9	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0						0.9
GR 8												0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.7	0.8	0.7	1.0	0.7	0.8	0.8	0.6	0.6						0.7
GR 9												1.0	1.0	1.0	0.9	0.8	0.9	0.9	1.0	0.9	0.9	1.0	0.9	1.0	0.9	0.9	0.9	0.9	1.0	1.0						0.9
GR 10												0.9	1.0	0.9	1.0	0.6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9						0.9
GR 11												0.9	1.0	1.0	1.0	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
GR 12																	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
GR 13																	1.0	0.8	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.7	0.8	0.7	0.9
GR 14																	1.0	0.8	0.9	0.8	0.8	0.9	0.8	0.9	0.9	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.9
GR 15																	1.0	0.9	0.7	0.8	0.8	1.0	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.9
GR 16					1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0												1.0
GR 17					1.0	1.0	0.9	0.9	0.9	0.9	0.8	0.8	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9												0.9
GR 18					1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0												1.0

Table : KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR P3 (Dependability)

TRACT	CANAL	WEEK NUMBER																																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	AVG
1	FC 6	2.8	0.0	0.2	0.1	3.1	1.5	2.2	1.1	0.4	1.4	1.4	0.2	2.0	1.1	0.9	0.5	0.7	1.1	0.5																	1.1
	DC 2	0.5	0.0	0.3	0.0	0.3	0.7	1.0	0.3	0.3	0.8	0.8	0.0	0.8	0.1	0.6	0.5	0.6	0.7	0.5																	0.5
	DC 3A	9.6	0.1	0.1	0.1	0.4	0.3	0.4	0.2	0.4	0.3	0.2	0.2	0.3	0.1	0.3	0.1	0.3	0.3	0.4																	0.7
	DC 3B	0.8	0.0	0.1	0.0	0.4	0.5	0.7	0.4	0.5	0.7	0.5	0.6	0.6	0.1	0.6	0.2	0.5	0.5	0.6																	0.4
	D4	0.4	0.0	0.1	0.0	0.3	0.3	0.5	0.5	0.4	0.3	0.1	0.2	0.4	0.1	0.4	0.1	0.5	0.4	0.4																	0.3
	D5	0.6	0.0	0.0	0.0	0.2	0.3	0.3	0.3	0.3	0.2	0.1	0.1	0.3	0.1	0.3	0.2	0.3	0.3	0.3																	0.2
	F55	0.1	0.3	0.5	0.4	1.2	0.7	0.7	0.9	1.1	0.8	0.1	0.6	0.6	0.1	0.6	0.4	0.5	0.5	0.1																	0.5
	F56	0.1	0.3	1.1	1.0	1.0	0.4	1.3	0.7	1.1	0.7	0.1	3.3	0.7	0.1	1.1	0.6	0.4	0.8	0.1																	0.8
	F57	0.9	0.6	0.9	1.0	1.1	0.6	0.1	0.1	0.5	0.6	0.1	1.8	0.4	0.1	0.6	0.4	0.5	0.7	0.1																	0.6
	F58	1.2	0.5	0.7	1.1	0.8	0.5	0.1	0.1	0.1	0.3	0.1	1.8	0.1	0.1	0.5	0.6	0.2	0.3	0.1																	0.5
	TRACT 1	2.7	0.1	0.1	0.1	0.3	0.3	0.4	0.3	0.3	0.3	0.1	0.2	0.3	0.0	0.3	0.1	0.4	0.3	0.4																	0.4
2	DC 1												0.3	0.2	0.2	0.7	0.1	0.4	0.2	0.2	0.0	0.0	0.1	0.5	0.2	0.0	0.0	0.1	0.0	0.1	0.1						0.1
	DC 2												0.4	0.2	0.3	0.3	0.0	0.2	0.2	0.2	0.0	0.0	0.1	0.3	0.3	0.0	0.1	0.1	0.2	0.0	0.0						0.1
	DC 3												0.4	1.0	0.3	0.4	0.1	0.2	0.2	0.1	0.1	0.1	0.0	0.3	0.3	0.0	0.0	0.0	0.2	0.0	0.0						0.2
	FC 34												2.6	7.4	1.3	3.1	2.0	3.5	4.1	0.7	0.6	0.6	0.4	3.5	1.2	0.4	0.4	0.5	0.5	0.5	0.5						1.8
	DC 4												1.3	1.2	0.4	0.8	0.2	1.2	1.0	0.2	0.1	0.1	0.1	0.5	1.7	0.1	0.1	0.1	0.1	0.1	0.1						0.5
	DC 5												0.9	0.7	0.7	1.0	0.5	0.2	0.2	1.0	1.4	1.4	1.1	1.3	1.3	0.5	1.2	1.2	1.4	1.1	1.1						1.0
	DC 6												0.4	0.2	0.2	0.5	0.3	0.1	0.1	0.4	0.5	0.5	0.4	0.6	0.4	0.2	0.4	0.4	0.4	0.3	0.3						0.3
	DC 7												0.4	0.1	0.2	0.6	0.3	0.2	0.1	0.6	0.4	0.4	0.3	0.3	0.3	0.1	0.3	0.3	0.2	0.1	0.1						0.3
	FC 68												2.9	0.1	3.3	4.8	1.8	2.7	2.3	2.6	2.6	2.6	2.0	2.0	2.9	2.3	1.5	2.2	1.6	1.1	1.1						2.2
	DC 8												0.7	0.1	0.5	0.1	0.1	0.3	0.1	0.2	0.2	0.2	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.2	0.2						0.3
	DC 9												0.7	0.1	0.2	0.1	0.5	0.1	0.1	0.4	0.4	0.4	0.4	0.2	0.1	0.2	0.1	0.1	0.2	0.1	0.1						0.2
	TRACT 2												0.4	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0						0.1
5	DC 1B																	0.2	0.0	0.2	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.1	0.1
	DC 1																	0.3	0.5	0.1	0.1	0.1	0.1	0.3	0.1	0.5	0.1	3.4	0.0	0.9	0.9	2.6	2.7	0.5	0.4	0.3	0.7
	DC 1A																	1.4	2.8	0.2	0.3	0.3	0.9	2.6	0.7	3.7	0.3	5.8	0.1	2.3	2.3	0.8	5.7	0.2	2.8	3.1	1.9
	BC 2																	0.3	0.2	0.1	0.2	0.2	0.3	0.4	0.3	0.3	0.3	0.4	0.3	0.2	0.2	0.6	0.4	0.1	0.2	0.1	0.3
	FC 48																	1.5	0.6	0.2	0.3	0.3	0.0	0.7	0.2	0.2	0.2	0.8	0.2	0.5	0.5	1.2	1.4	4.1	0.3	0.4	0.7
	FC 49																	0.3	0.4	0.2	0.4	0.4	0.3	0.4	0.1	0.3	0.2	1.2	0.3	0.3	0.3	0.9	0.5	1.8	0.6	2.4	0.6
	DC 9																	0.4	0.2	0.1	0.3	0.3	0.1	0.3	0.1	0.1	0.2	0.5	0.1	0.2	0.2	0.3	0.5	0.8	0.2	0.2	0.3
	FC 54A																	0.8	0.3	4.1	0.6	0.6	0.4	3.1	0.6	0.4	0.4	3.2	0.6	2.7	2.7	1.2	2.7	0.1	0.5	3.2	1.5
	FC 54																	0.5	0.3	0.8	0.8	0.8	0.3	3.8	0.6	4.5	6.1	2.5	0.3	0.8	0.8	1.7	3.5	0.1	1.7	4.8	1.8
	FC 55																	0.5	8.4	2.5	5.1	5.1	0.6	5.1	5.4	6.7	5.2	5.2	4.5	5.2	5.2	0.6	3.0	0.1	3.4	4.8	4.0
	DC 11																	0.1	0.6	0.2	0.5	0.5	0.4	0.5	0.4	0.4	0.3	0.4	0.3	0.5	0.5	0.3	0.5	0.1	0.1	0.2	0.4
	DC 12																	0.1	1.4	1.3	1.5	1.5	0.8	1.2	1.2	1.4	1.2	0.9	0.7	1.2	1.2	0.1	0.2	0.1	0.5	0.8	0.9
	DC 13																	0.1	0.5	0.6	0.6	0.6	0.3	0.5	0.3	0.3	0.1	0.2	0.2	0.3	0.3	0.2	0.3	0.1	0.1	0.1	0.3
	TRACT 5																	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.1
6	DC 1					0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.1	0.3	0.1	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.1												1.0
	FC 24					0.1	1.1	1.4	0.9	0.8	0.8	0.8	0.6	0.6	0.9	0.8	0.4	2.3	2.0	1.9	0.4	0.4	2.5	0.4	3.1												1.1
	FC 25					0.1	2.6	3.6	5.2	5.6	3.2	1.5	5.8	0.5	0.8	0.6	4.8	2.2	3.3	4.7	0.8	0.8	1.0	0.9	3.7												2.6
	DC 2					0.1	0.4	0.2	0.3	0.2	0.4	0.3	0.5	0.1	0.1	0.1	0.3	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.2												0.3
	FC 37					0.1	2.7	0.1	7.0	7.1	5.2	6.2	6.1	0.1	0.1	0.1	6.0	4.7	3.2	5.5	7.1	7.1	0.4	0.7	3.0												3.6
7	DC1					0.1	0.1	0.1	0.1	0.1	0.4	0.5	0.6	0.1	0.1	0.1	0.3	0.6	0.6	0.6	0.1	0.1	0.4	0.4	0.5												0.3
	TRACT 6/7					0.0	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.0	0.1	0.1	0.4	0.4	0.3	0.4	0.4	0.3	0.3	0.1												0.2

Table : KIRINDI OYA RBMC MAHA 1991/92 - INDICATOR P3 (Dependability)

REACH	WEEK NUMBER																																			AVG
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
GR 2	5.5	0.1	0.1	0.1	0.3	0.3	0.5	0.2	0.3	0.4	0.3	0.3	0.4	0.0	0.4	0.1	0.4	0.4	0.5																	0.6
GR 3	0.5	0.1	0.1	0.1	0.3	0.3	0.3	0.4	0.3	0.2	0.0	0.1	0.3	0.0	0.3	0.2	0.4	0.3	0.4																	0.2
GR 4	0.5	0.4	0.7	0.5	0.7	0.4	0.3	0.2	0.5	0.4	0.0	0.7	0.3	0.0	0.4	0.2	0.3	0.4	0.0																	0.4
GR 5												0.3	0.2	0.2	0.7	0.1	0.4	0.2	0.2	0.0	0.0	0.1	0.5	0.2	0.1	0.0	0.1	0.1	0.1	0.1						0.2
GR 6												0.4	0.2	0.3	0.3	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.3	0.3	0.1	0.1	0.1	0.2	0.1	0.1						0.2
GR 7												0.6	0.5	0.3	0.4	0.3	0.6	0.5	0.2	0.1	0.1	0.1	0.4	0.3	0.1	0.1	0.1	0.2	0.1	0.1						0.3
GR 8												1.0	0.6	0.4	0.7	0.4	0.5	0.4	0.7	1.0	1.0	0.7	0.9	0.9	0.4	0.8	0.8	0.9	0.8	0.8						0.7
GR 9												0.4	0.1	0.2	0.4	0.3	0.1	0.1	0.4	0.5	0.5	0.3	0.4	0.3	0.2	0.3	0.4	0.3	0.2	0.2						0.3
GR 10												0.8	0.0	0.7	0.7	0.3	0.5	0.4	0.3	0.3	0.3	0.4	0.6	0.6	0.3	0.6	0.5	0.4	0.3	0.3						0.4
GR 11												0.7	0.0	0.2	0.0	0.5	0.2	0.1	0.3	0.3	0.3	0.3	0.1	0.0	0.2	0.0	0.1	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.1	0.2
GR 12																	0.3	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.5	0.4	0.1	0.1	0.1	0.2
GR 13																	0.4	0.1	0.4	0.2	0.2	0.1	0.5	0.1	0.5	0.7	0.4	0.1	0.2	0.2	0.3	0.4	0.7	0.3	0.5	0.3
GR 14																	0.0	0.3	0.3	0.2	0.2	0.4	0.2	0.1	0.1	0.1	0.4	0.1	0.2	0.2	0.3	0.4	0.0	0.2	0.4	0.2
GR 15																	0.0	0.3	0.7	0.2	0.2	0.3	0.3	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.3	0.0	0.1	0.2	0.2
GR 16					0.0	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.3	0.1	0.3	0.1	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2												0.2
GR 17					0.0	0.5	0.5	0.3	0.3	0.4	0.3	0.3	0.0	0.1	0.0	0.3	0.5	0.5	0.6	0.7	0.7	0.4	0.5	0.3												0.4
GR 18					0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.6	0.0	0.0	0.0	0.3	0.6	0.6	0.6	0.0	0.0	0.5	0.4	0.5												0.3

Table : **KIRINDI OYA RBMC MAHA 1991/92 – INDICATOR P4 (Equity of supply)**

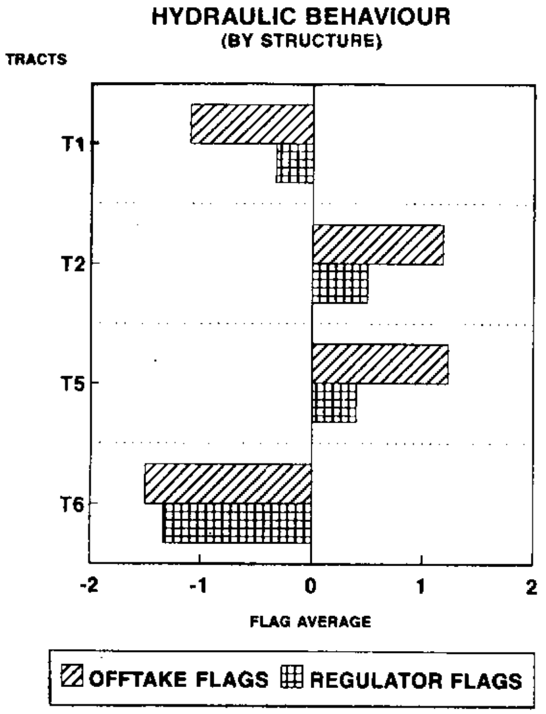
REACH	No of offtakes commanded	WEEK NUMBER																																		AVG
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
GR 2	4	•	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.3	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0																	0.1
GR 3	2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0																	0.0
GR 4	4	0.1	0.1	0.0	0.4	0.2	0.0	0.1	0.1	0.3	0.0	0.0	1.5	0.2	0.0	0.1	0.0	0.1	0.0	0.0																	0.2
GR 5	1												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0
GR 6	1												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0
GR 7	2												0.3	8.5	0.7	0.6	0.0	5.0	1.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.9
GR 8	2												0.0	0.1	0.3	0.1	0.4	7.3	6.0	0.3	0.1	0.1	0.6	0.1	0.1	0.0	0.4	0.1	0.4	0.8	0.8						0.9
GR 9	2												0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0
GR 10	2												0.1	0.0	5.1	1.6	0.1	8.0	7.4	1.7	0.3	0.3	2.1	1.6	1.1	2.8	2.6	2.3	2.5	1.5	1.5						2.2
GR 11	2												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GR 12	3																	0.2	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.3	0.1	1.1	0.1	0.1	0.1	0.1	0.6	0.3	0.3	0.2	0.3
GR 13	5																	0.1	0.1	0.5	0.0	0.0	0.0	0.2	0.1	0.7	2.5	0.3	0.0	0.2	0.2	0.1	1.3	4.3	2.8	7.8	1.1
GR 14	2																	0.0	3.3	15	0.4	0.4	0.0	0.9	10	5.2	2.5	1.6	9.7	3.6	3.6	0.0	0.2	0.0	0.6	0.2	3.0
GR 15	2																	0.0	0.3	0.8	0.1	0.1	0.0	0.1	1.2	0.6	0.4	0.0	0.9	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.3
GR 16	2					0.0	0.0	0.4	0.2	0.2	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0												0.1
GR 17	3					0.0	0.1	5.8	3.4	5.0	1.4	1.4	2.0	0.1	0.0	0.0	14	0.3	0.3	0.9	4.5	4.5	0.1	0.0	2.2												2.3
GR 18	1					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0												0.0
Tract 1	10	*	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.3	0.4	0.1	0.0	0.1	0.0	0.0	0.0	0.0																	0.1
Tract 2	11												0.1	1.4	0.7	0.4	0.1	2.5	1.8	0.3	0.1	0.1	0.4	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4						0.5
Tract 5	13																	0.1	0.8	2.6	0.2	0.2	0.1	0.3	1.8	1.1	0.8	0.9	1.6	0.7	0.7	0.1	0.6	1.0	0.8	1.6	0.8
Tract 6/7	6					0.0	0.1	2.4	1.6	2.3	0.6	0.6	0.8	0.2	0.0	0.1	5.3	0.2	0.2	0.4	1.8	1.8	0.1	0.0	0.9												1.0

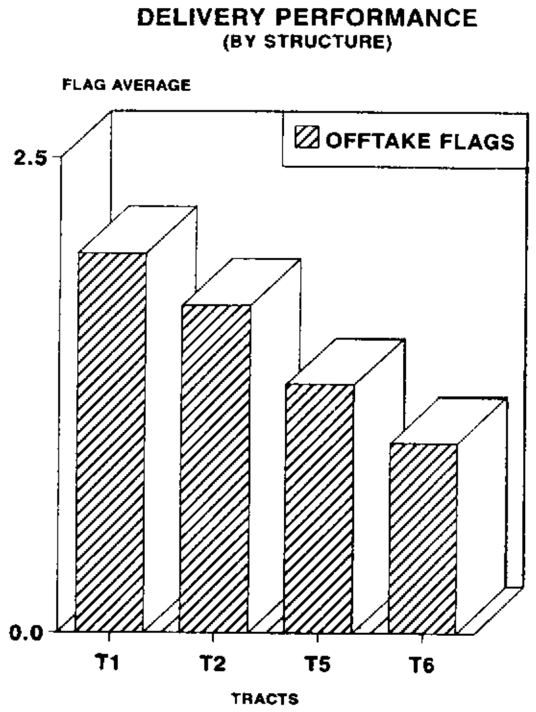
Annex 10

Analysis of the flags derived from indicators.

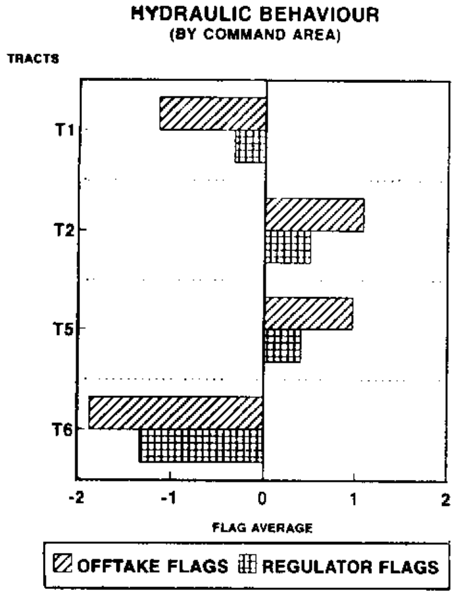
By analyzing the indicator summaries (Table 4.4 to 4.7) different observations can be made:

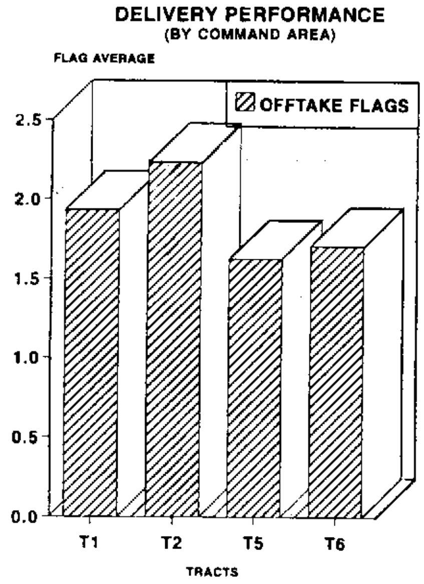
- * If the analysis is done in terms of structures (without weighing the offtake results by the command areas), we observe





- * If we weigh the flags with the respective command areas of the offtakes, we get:





- A general observation concerns the hydraulic functioning of the structures tractwise: T2, 5, functioned under more stable conditions than the two tail-end tracts 1 and 6.

- As far as the performance of deliveries is concerned, an interesting head-tail trend can be observed for the structures but weighed by the command areas tract, 2 ensured the better deliveries.

- There is no general correlation between the delivery performance and the hydraulic functioning. An accurate diagnosis, structure by structure, needs study of the 8 indicators individually.