

Chapter 1 - Introduction

Background

Agricultural irrigation utilizes some 80 to 90 percent of diverted water in developing countries. The World Bank, other development banks, and numerous countries have invested in large irrigation projects. There have been conflicting opinions about the wisdom of investing further in new irrigation projects, primarily due to questions about the performance of existing projects. Those who believe that further investment in irrigation projects is needed, whether it is for new projects, rehabilitation, or modernization, often have differing perceptions of how the investment funds should be spent.

Describing and quantifying the performance of irrigation projects is a relatively new idea if one goes beyond simplistic indicators, such as the total tons of grain produced with and without irrigation. This report pays considerable attention to the topic of describing irrigation project performance. To introduce the topic, it is sufficient to say that one single indicator, or even a small handful of indicators, cannot adequately meet the needs of all groups interested in irrigation projects. A river environmental specialist may be primarily interested in maintaining river flows and in preventing the degradation of return flows. A sociologist may have a strong interest in the level of social anarchy (or lack of it). An economist may be interested in the economic return on the Bank investment, while an agronomist may focus on the yield per hectare, and so on.

This research project was commissioned to answer a very fundamental question: Do modern water control and management practices in irrigation make a positive difference? Throughout this report, the reader will discover that the answer is a definite "yes".

In addition to the fundamental question addressed by this research is: Is it important to make a positive difference? Again, the answer is a very basic and resounding "yes". Irrigation projects have a large impact on the world food supply, country economies, and the environment - all of which can be quite fragile. Developing countries are experiencing high rates of population, urban, and income growth which is putting tremendous pressure on available water supplies. At the same time, growing populations make it necessary to ensure that crop yields continue to rise. Some predictions indicate a rise in world population from 5 billion in 1998 to 8 billion in 2020. Therefore, developing countries must find ways to grow more food with the same or less water consumption. There are three principal ways to do this:

- Improve water use efficiency (yield/water consumed);
- Reduce water quality degradation; and
- Reduce return flows into saline sinks

All three options require better on-farm water management, which depends upon improved quality and reliability of water delivery service to the field. One could logically assume that new and/or rehabilitation irrigation projects are designed and funded with the goals of improved water delivery service in mind. Because irrigation

projects are resource (capital, water, etc.) intensive, a second logical assumption is that project design and operation manuals should clearly define the service goals and should have clear guidelines as to how various project features will help to achieve the goals. Neither assumption matches reality.

In a parallel study of the strategy of Bank financed irrigation projects, none of the reviewers have been able to find any information about the quality of service with or without new Bank financed irrigation projects in the Bank Staff Appraisal Reports (SARs). Very few irrigation projects even have a modernization component. One regional exception is in western Africa, where projects in the Office du Niger and three very small projects in Niger, Senegal, and Madagascar address modernization.

Furthermore, there is no baseline information (indexes of reliability, timeliness, and flexibility) regarding levels of service to farmers and the factors which affect that service. One would expect that establishing baseline information regarding levels of service, determining standards, and then determining how to meet them, would be crucial for improving the design, upgrading, and management of irrigation projects.

This research project was funded to fill a major gap in Bank work by addressing these and other points related to irrigation project performance. The World Bank's Department of Agriculture and Natural Resources, in collaboration with the International Program for Technology Research in Irrigation and Drainage (IPTRID/AGR) and the International Water Management Institute (IWMI) received funding for this study from the World Bank research committee. Charles Burt and Stuart Styles of the Irrigation Training and Research Center (ITRC) at California Polytechnic State University, San Luis Obispo (Cal Poly), were the primary investigators.

Research Objectives

This project performed a rapid appraisal of 16 irrigation projects (described later) in 10 different developing countries. The stated objectives of the research were threefold:

1. Documentation of baseline data, including
 - a. Physical and institutional constraints. These can impact the effectiveness of the hardware and management used in the project.
 - b. Hardware and management factors which influence the quality of water delivery service and conveyance manageability.
 - c. The level of water delivery service which is declared and provided at various layers in the system.
 - d. Results such as cropping intensity.
 - e. Symptoms resulting from chaos and management problems. Chaos is defined in this project as a difference between declared levels of service and delivered service levels. (Perry, 1995)
2. Observations and Correlations. Relationships between the five preceding documented categories were to be examined.

3. Findings. The research was to develop a systematic method of project appraisal which will provide transferable information about conveyance manageability and levels of service, as well as the factors affecting them.

This research builds upon previous work presented in the World Bank Technical Paper No. 246 (Plusquellec et al., 1994). That publication, Modern Water Control in Irrigation, provided a conceptual framework for the concepts, issues, and applications of irrigation modernization efforts. It lacked the detailed field baseline information and correlations which this report now provides.

Project Appraisals

A key item addressed by this research is the development of appropriate procedures to evaluate irrigation projects before and after investment. Appraisals (evaluations) of irrigation projects often only look at the "big picture", as illustrated in Figure 1-1, without examining internal processes. The "In" may include dollars, water, labor, fertilizer, etc. The "Out" may include dollars, water, tons of rice, etc.



Figure 1-1. The "big picture" view of irrigation projects (also known as the "black box" approach).

Conceptually, the approach of Figure 1-1 is simple - does an irrigation project pay for itself, or doesn't it? But the use of Figure 1-1 to analyze and explain irrigation project performance should be considered the "black box" approach. It gives no information about the internal processes which affect the output, and provides no solid basis for determining what internal factors must be modified to improve output. Figure 1-1 is also inadequately simplistic to address environmental issues associated with irrigation projects, which can be strongly dependent on internal processes.

Irrigation projects are very complex, and might be compared to a human body as illustrated in Table 1-1. Numerous factors affect output.

Table 1-1. Comparison of irrigation projects with a complex human body.

	<u>Human Body</u>	<u>Irrigation Project Equivalents</u>
Output	Work or Movement	Crop Yields, Financial Self-Sufficiency
External factors influencing output	Heredity	Topography, Soils
	Surrounding Environment, Background	Rainfall patterns, crop prices, national water rights policies
Internal factors influencing output	Training, conditioning, diet	Physical infrastructure design, operation rules, management

Figure 1-2 shows some of the major inter-relationships which affect outputs from irrigation projects. "Results" are easy to confuse with "causes" and "symptoms"; indeed, in some cases the relationships can be switched. It may be thought that strong water user associations (WUAs) will eliminate most, if not all, of the myriad of problems in irrigation projects. However, Figure 1-2 shows strong WUAs as a result, not as a cause. Figure 1-2 shows that numerous factors will impact project outputs, and the strength of a WUA is dependent on both institutional and water delivery service factors.

A classic scenario for the existence of a weak WUA is one in which the irrigation project authorities expect the WUA to collect water fees, distribute water, and maintain a water distribution network - yet the WUA has little or no say in how the fees are spent, and the water arrives at the WUA area in an undependable manner (i.e., poor water delivery service). In this scenario, the weak WUA is a symptom, not a cause, of poor water delivery service.

A secondary objective of this project was to develop a rapid appraisal process which would examine the factors in Figure 1-2. This rapid appraisal process is described in more detail in the methodology section below, and in subsequent chapters.

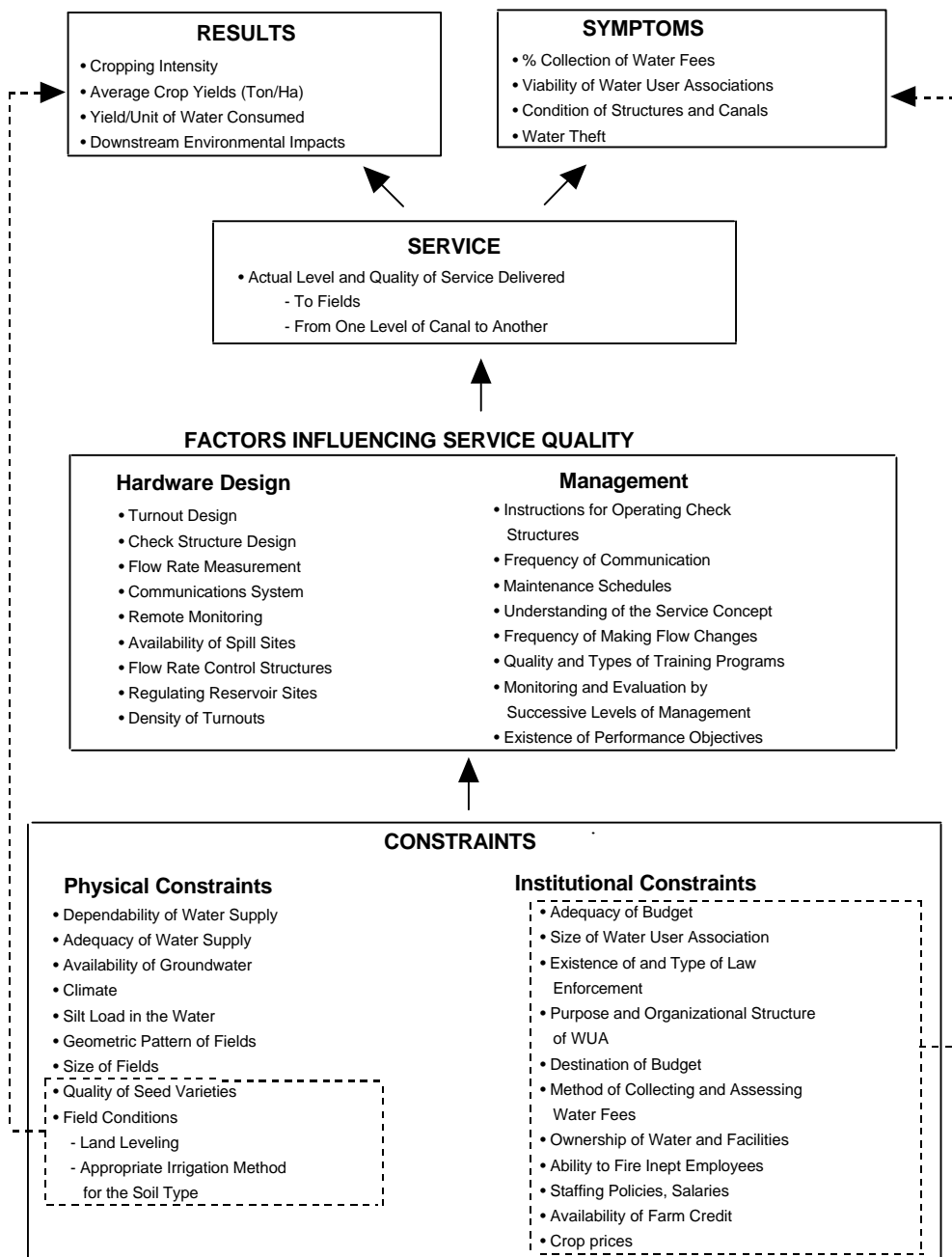


Figure 1-2. Factors affecting output (results) and symptoms from irrigation projects.

Internal process indicators and external performance indicators were developed for the 16 irrigation projects which were evaluated. The development of the internal process indicators and some external performance indicators was based on standards of the principal authors. They have extensive experience in irrigation modernization programs - a key factor to understand when examining the standards. To illustrate this point, one might consider 3 different perspectives of irrigation performance:

- The traditional farmer with a traditional (and typically inefficient) method of field irrigation.
- The traditional engineer and economist, who look at present inputs and outputs.
- Persons with a vision of how irrigation systems will need to perform when there are 3 billion more people on this earth by the year 2020, resulting in increased competition for water from the urban and environmental sectors.

The traditional farmer with no knowledge of advanced irrigation methods, nor knowledge of the pressures on the total water supply, will have a completely different perception of "satisfactory service" than the visionary. The traditional project operation engineer may be so immersed in the daily struggles of administration and avoiding major spills that he may consider anything that works with a minimum of personal (to himself) hassle to be "satisfactory".

Methodology

The steps for gathering data and the initial data organization are shown in Table 1-2. At first glance, the methodology described in Table 1-2 is typical of any similar research project. However, there are significant differences between this methodology and the ones used in prior international irrigation project research.

Table 1-2. Project tasks.

<u>Task</u>	<u>Comments</u>
Develop initial draft of internal process indicators and external indicators	
Develop data collection forms	About 600 questions were developed. Beta tests were conducted in Mexicali, Mexico and Lam Pao, Thailand.
Selection of projects	
Contact local irrigation specialists and the projects	Where possible, local irrigation experts were involved in organizing preliminary data prior to the visit, and assisted in arranging the visit.
Project visits	
Compute indicators	The computation of external indicators was very time consuming.
Write up project descriptions	

A fundamental feature of this research is that it relied upon a Rapid Appraisal Process (RAP) which only required a 3-5 day visit to any single irrigation project. The data and results contained within this report demonstrate that a RAP, if developed and conducted properly, is a valuable diagnostic tool. A more detailed description of the RAP is found in the next chapter.

Develop internal process indicators and external indicators. The details of this step are covered in Chapter 6. The computation of internal process indicators requires

information listed in the "Constraints", "Factors Influencing Service Quality", "Service", and "Symptoms" sections of Figure 1-2. External indicators require some of the information contained under "Physical Constraints" (water supply, climate) and "Results".

Develop data collection forms. The questionnaire can be found in Attachment A. It contains approximately 600 questions, and was designed to collect information in the following categories:

1. Typical baseline data, such as:
 - a. Total area served
 - b. Budgets
 - c. Climate
 - d. Crop areas and yields
 - e. Water supply
 - f. Number and size of water user associations
 - g. Total length of canals and pipelines
 - h. Field sizes

This type of information is standard data collected in irrigation project evaluations, with perhaps some extra attention paid to certain details in this research project.
2. Non-typical data, such as:
 - a. Various institutional constraints
 - * Methods of collecting and assessing water fees
 - * Existence and type of law enforcement (as related to water conflicts)
 - * Strength of WUAs
 - * Wages of operators as compared to typical laborers
 - * Organizational charts of management, employee, and farmer responsibilities
 - b. The physical infrastructure for moving and controlling water flow rates and depths
 - * Designs of turnouts and check structures
 - * Number and locations of spill sites
 - * Canal capacities
 - * Flow rate measurement and control structures
 - * Communication system
 - * Density of turnouts
 - c. The operation of physical infrastructure
 - * Frequency of communications
 - * Promptness of repairs
 - * Instructions for operating check structures
 - * Frequency of checking and adjusting flows and water levels
 - * Number of farmers who must cooperate in the final distribution of water
 - * Water travel time through the system
 - d. Service of water delivery at all levels throughout the system, including
 - * Service to the main canal from the reservoir or river
 - Reliability. Does it come when guaranteed and at the proper flow rate?

- Consistency. Does the assigned flow rate stay constant for the period of time it is supposed to remain constant?
- Flexibility. Is the flow the right frequency, rate, and duration?
- Accuracy. Are the flow rates and/or volumes known?
- * Main canal service to secondary canals
- * Secondary canals service to tertiary canals
- * Service to the point where control is turned over to farmers
- * Service to individual fields

Contact local irrigation specialists and the projects. Some typical baseline data requires several weeks to organize. In some cases, good typical baseline data is simply not available, no matter how much time is spent looking for it. A Rapid Appraisal Process (RAP) is most efficient if the typical baseline data is organized prior to the visit. The gathering of typical data requires cooperative project staff and government agencies. It also requires an individual who is both knowledgeable in irrigation and skilled in obtaining information from the project and agencies. The gathering of typical data organization does not require unusual skills for the synthesis or analysis of the data. A request list of typical data was prepared (see Attachment B) and sent to each project prior to the site visits - allowing for sufficient time to collect the typical data.

Whenever possible, a local irrigation expert was included in the research process at this initial step. The local expert participation was intended to increase local awareness and capacity. In some cases, the local irrigation expert worked with the irrigation project staff to collect typical baseline data prior to the RAP. In other cases, the local irrigation expert only participated in the RAP. For example, in the Rio Mayo project in Mexico, the irrigation project staff was able to organize all of the data, but an irrigation specialist from the Mexico Institute of Water Technology (IMTA) in Cuernavaca participated in the RAP itself.

Project visits. A typical visit took the following form:

1. One of the ITRC authors would arrive at the project on Day 1. In some cases, he was accompanied by a local irrigation expert and/or a representative of IWMI. In other instances, he would arrive alone.
2. A half-day was spent at the project offices examining the typical baseline data which had been collected in advance by the project authorities or local irrigation expert. At this time, gaps in the data were noted and project authorities requested their staff to provide specific information. The gaps were generally due to a misunderstanding of details in the request for information which had been sent to the irrigation project prior to the visit of the ITRC author.
3. A half-day was spent at the project offices becoming more familiar with the general project layout and in interviews with various staff members to answer other parts of the questionnaire.

4. Two - three days were spent traveling down the canal system. The goal was to drive from the water source, down the complete length of the main canal. Information was obtained about the release of water into the main canal. During the trip down the main canal, the design and operation of each structure along the length of the main canal was noted. Operators and supervisors on this level were interviewed. Every attempt was made to talk to individual operators and supervisors, rather than receive answers from the project office personnel (who generally accompanied the authors on this trip). This was not always easy; in projects with the lowest performance, the office personnel tended to try to answer all questions. However, the field staff typically had different answers. In many projects the gate and turnout operators had field books in which they recorded such items as cross regulator position, water levels, or flow rates. These books were an excellent source of information and often illustrated differences between the stated service and the actual service.

Once the main canal design and operation was understood, the focus shifted toward the secondary canals. The process of the main canal was repeated. Structure designs, operation procedures, and controllability issues were addressed for each structure along a single secondary canal. Several secondary canals were visited. Following this, the same procedure was followed on the next "layer" or level of canals. Eventually, the path led to the point at which the operation was handed over to farmers, and finally down to individual farms.

5. A half-day to one day was spent talking with farmers and water user associations. Short conversations with individual farmers occurred throughout the travels along the various layers of the water distribution network. Again, every attempt was made to have spontaneous conversations with farmers, as opposed to conversations with farmers who had been selected by the project authorities. Farmers from the head and tail sections of the network were sought out.

If water user associations (WUAs) existed, short meetings with several WUAs were typically organized. These meetings served to answer questions about water rates, budgets, and responsibilities of the WUAs. The meetings also served as forums to ask questions about the quality of water delivery service to the fields.

Computation of indicators. This will be discussed in more detail in the chapter dealing with indicators. The Internal Process Indicators were computed rapidly. The External Indicators required the most amount of time to compute - typically 3-4 days/project.

Written project summaries. In the original scope of work it was not envisioned that a report would be written for each individual project. However, the authors found that by writing the individual project summaries, many ideas could be organized. The 16 project summaries can be found in a separate report titled "Project Summary Reports".

Results

The contributions (results) of this research are:

1. A Rapid Appraisal Process (RAP). This was developed and proven to provide a uniform and comprehensive field data in irrigation projects for developing countries.
2. A set of Internal Process Indicators. The indicators and corresponding rating scales were developed to evaluate the internal workings of irrigation projects. The indicators also assess the ease with which existing irrigation projects will be able to provide the levels of water delivery service needed by the field irrigation technologies 30 years from now.
3. External performance indicators, both established by IWMI and ITRC, and newly developed ones.
4. Correlations between data and indicators, and between various types of field data.
5. The introduction of the use of confidence intervals in describing irrigation project data and indicators.
6. Discussion of various observations
7. Lessons learned, which can be applied to other projects.
8. Recommendations for the Bank and other agencies which invest in new irrigation projects and irrigation project modernization.