Local Organizations for Social Development

Concepts and Cases of Irrigation Organization

David M. Freeman

with Vrinda Bhandarkar, Edwin Shinn, John Wilkins-Wells, and Patricia Wilkins-Wells

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To the farmers and irrigation managers
who made this book possible

CONTENTS

PREFACE

Much of the work reported here was accomplished as part of the Water Management Synthesis II (WMS II) Project at Colorado State University by the United States Agency for International Development under contract DAN-4127-C-00-2086-00. All reported opinions and conclusions are those of the author and not those of the funding agency or the United States Government.

The Water Management Synthesis II (WMS II) Project included as part of its mandate the establishment of a program of special studies. The purpose of this program was to increase the capacity of participant universities to serve USAID irrigation program objectives in technical assistance, training, and technology transfer globally and in specific Asian countries. During the course of deliberations with representatives of Cornell University, Utah State University, USAID/Washington, and USAID missions, Colorado State University (CSU) developed a program of special studies focusing on the following theme: interfacing farm water management with main system management through development of local command area irrigator organizations. This book presents the information, data, and analysis that developed as that theme was pursued. The larger body of work, from which this book has been drawn, was reported in *Linking Main and Farm Irrigation Systems in Order to Control Water,* WMS Report 69, Water Management Synthesis Project, Colorado State University, Fort Collins. This report series includes:

Volume 1: Designing local organizations for reconciling water supply and demand (D.M. Freeman).

Volume 2: A case study of the Niazbeg distributary in Punjab, Pakistan (Edwin Shinn and David M. Freeman).

Volume 3: A tank system in Madhya Pradesh, India (Vrinda Bhandarkar and David M. Freeman).

Volume 4: The case of Lam Chamuak, Thailand (Kanda Paranakian, W. Robert Laitos, and David M. Freeman)

Volume 5: Two tank systems in Polonnaruwa District, Sri Lanka (John Wilkens-Wells, Pat Wilkens-Wells, David M. Freeman).

David M. Freeman

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D.M.F.

PART ONE

Concepts

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1

INTRODUCTION

"...It must be stressed that irrigation is as much an expression of human organization and its adaptation to the physical environment as it is a technical achievement."

(Cantor 1967:62)

"The best structure will not guarantee results and performance, but the wrong structure is a guarantee of non-performance. All it produces is friction and frustration."

(Drucker 1974:519)

The idea of social development has been much confused, polemicized, and debated (Riggs 1984). Although the concept has not been defined to the satisfaction of even a substantial minority of scholars and practitioners, social development has generally been viewed as centering on the advancement and diffusion of new choice opportunities--permitting improved options regarding food, clothing, shelter, health care, transportation, educational and cultural experience, and social mobility. Furthermore, the idea of social development has also generally included some conception that people would meaningfully participate, individually and collectively, in making decisions about the patterns of choice available to them and affecting them.

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It is the purpose of this book to examine one aspect of the larger development effort in some detail and in one particular domain--the development of irrigated agriculture. The specific aspect being examined here is the development of local organizations which can link individuals to state bureaucracies. The central thesis is that properties of local organization, mediating between the agendas and resources of state bureaucracies and those of the local community, have everything to do with the ultimate productivity of the state supplied, and locally managed resources.

In the world of large-scale gravity-flow irrigation, it is the state bureaucracy which captures the water supply in remote watersheds and constructs, at great cost, the impressive engineering works to store and deliver water, but all this investment is exploited only to the degree permitted by local organizations which, at some point in the delivery system, must assume responsibility for delivering water to individual irrigators. The organizational conditions under which that water is, or is not, delivered have everything to do with the productivity of irrigation water. Yet, local organizations, interfacing local people and state bureaucracy, are frequently overlooked in development project planning.

Some choice opportunities can be advanced and diffused by interaction in marketplaces where rational, self-seeking behavior is rewarded according to the extent to which people can produce goods and services which fulfill choice demands of exchange partners. Yet, other choice opportunities are not adequately supplied by the logic of individual self-interested behavior in marketplaces; these are choice opportunities which are produced by organized collective action in the realm of public goods. Examples abound--e.g., traffic control and street lighting, flood protection, police and fire protection, national defense, programs supplying public health and educational services. The particular example, central to this effort, is that of providing controlled supplies of irrigation water in large-scale gravity-flow systems.

An individual can go into the private marketplace and purchase seeds, fertilizer, herbicides, pesticides, and various agricultural implements with which to grow food and fiber. But, in no society or culture can an individual go into the private marketplace and purchase a unit of water control with which to irrigate the crop if local rainfall patterns are insufficient to sustain the plant population. Irrigation water, to be productive, must be controlled. Irrigation water control, in turn, is dependent upon the quality of collectively constructed human organizations. In large-scale gravity-flow systems, if irrigation water gets to the plant root zone at the proper time, and in the proper amounts, it is because people have organized collectively to perform tasks beyond the capacity of individuals.

Creating and operating organizations has always been a central concern of human beings who have recognized, for thousands of years, that they must make permanent arrangements to secure and collectively manage what they could not obtain individually. Irrigated agriculture, therefore, has always meant the organized collective attempt to control water to better fill crop consumptive needs. The progress of people in a diverse array of cultures has always depended on how they have organized their collective lives; the progress of irrigated agriculture depends upon the quality of irrigation organizations.

The analysis which follows is rooted in a fundamental proposition--social development requires effective local social organization productively linked to state bureaucracy such that people can collectively provide themselves essential choice opportunities not provided by markets. Effective local organizations, in turn, make possible both exploitation of private goods and services exchanged on marketplaces, state provided resources, and meaningful participation of citizens in social development. The objective is to carefully examine the manner in which individuals in several cultures organize, or fail to organize, to provide themselves with controllable irrigation water supplies. Lessons learned about effective irrigation organization may well instruct us not only about the nature of viable forms of water management, but also shed light on attributes of local organization effective in developing improved choice opportunities in other spheres of social life.

The objective of Part One is to present an analysis of organizational breakdown between main system bureaucracies and farmers, and to formulate strategic variables and relationships that contribute to improved design of local irrigation organizations. Part Two reports empirical case studies of middle-level irrigation organization in three nations--Pakistan, India, and Sri Lanka--and the impact of such organization on agricultural production. Part Three presents implications and conclusions.

The emergence of early civilization has been associated with the development of the more complex forms of human organizations necessary to settled irrigated agriculture (Fukuda 1976; Mann 1986; McNeill 1963). In river valleys such as the Tigris, Indus, Nile, Jordon, Ganges, and Yangtze, earliest forms of complex organization emerged as people organized to deal collectively with controlling irrigation water. Writing emerged to sustain joint agreements among people who required ways to record promises made regarding irrigation water, land, grain, and animals (Mann 1986). An article of irrigation practice traceable to the Code of Hammurabi read: "If anyone opens his irrigation canals to let in water, but is careless and the water floods the field of his neighbor, he shall measure out grain to the latter in proportion to the yield of the neighboring field" (Framji and Mahajan 1969:cxi). In India, by 300 B.C., the written record tells us that the state had established a standard practice of taking a 25 percent share of the produce of irrigated agriculture as a tax to support irrigation construction, operation, and maintenance beyond the capacity of local farmers to manage (Framji and Mahajan 1969).

Irrigation systems have been built for many reasons--to provide insurance against drought, to suppress rebellion (which tended to flare after bad harvests), to increase tax revenues, to fulfill ritual obligations of monarchs, to obtain goods for foreign exchange, to settle the landless, to secure loyalty of groups close at hand or on the frontier, and to enhance voter prosperity. Within the last 200 years, another motive has emerged--a vision of steering societies toward economic and social development by transforming low input/low output agriculture into high input/high output agriculture. This involves:

1. Producing agricultural surpluses so that farmers can sell, rather than consume, most of their output.
2. Increasing livestock numbers to provide increased draft power, hide, and meat protein.
3. Obtaining greater productivity per person per hour, liberating increasing numbers of people from the soil to move to industry and to provide services.
4. Making food and fibre a smaller part of household budgets, and thereby leave resources available for obtaining products and services of a technologically more advanced society.

This vision has everywhere rested on newer technologies and organizational arrangements to harness and manage technology in agriculture--especially irrigated agriculture.

The earliest recorded dams were constructed a little over 5,000 years ago, and it has been estimated that by 1800 A.D., worldwide irrigation was about 8 million hectares (19.8 million acres). Irrigated agriculture rapidly expanded during the nineteenth century, pushing global irrigated acreage to about 48 million hectares (118.6 million acres) by 1900. Expansion of irrigated land during the twentieth century proceeded at an even greater pace. By 1969, total global irrigated area was roughly 200 million hectares (494.21 million acres) (Framji and Mahajan 1969). From 1950 to 1970, the gross irrigated area of the world doubled. By the 1970s, the rate of increase had declined to about 5 million hectares per year, and due to constraints associated with cost, decline in suitable acreage, and adverse terms of trade for agriculture, the rate of growth in the mid-1980s fell off to approximately 4 million hectares per year (Rangeley 1987).

Irrigated agriculture has been disproportionately productive (Table 1). Only about 18 percent of the world's cultivated land is irrigated, but it produces roughly 33 percent of the planet's human food supply. However, the fact that many landscapes of the world are dominated by dams, reservoirs, and canals cannot hide a disquieting fact: many irrigation projects in many nations and cultures have not served the needs of farmers and agricultural production as planners have hoped.

Table 1. Contribution of irrigated acreage to food production.

Country	% Cultivated Area Irrigated	% Contribution to Total Food Production
India	30	55
Pakistan	65	80
China	50	70
Indonesia	40	50
Chile	35	55
Peru	35	55

Source: Rangeley 1987:30.

The story of the typical irrigation project is one of failure to fulfill projected economic returns to investment. It is also a story of farmers who fail to exploit their relatively expensive water supplies to the degree planned, and who frequently exhibit irrigation behavior viewed by main system managers as detrimental to the functioning of the systems. Montague Yudelman (1987), reflecting on World Bank experience, has suggested that Bank irrigation projects seldom have met expectations. Expressions of disappointment have been many (Bottrall 1978, 1981, 1981b; Chakravarty and Das 1982; Levine, Capener, and Gore 1972; Lowdermilk, Early, and Freeman 1978; Pant and Verna 1983; Posz, Raj, and Peterson 1981; Reidinger 1974; Sharma 1980; Steinberg 1984; White 1984). Everywhere, the picture of poor irrigation water management unfolds around low levels of water use efficiency marked by inequities in distribution, disappointing cropping intensities and yields, and irrigation bureaucracies which perform with insufficient regard to the needs of farmers to control water to produce food and fibre. The three case studies which constitute Part Two of this volume add to this literature by documenting specific problems on irrigation projects in Pakistan, India, and Sri Lanka.

Given a projected decline in rates of expansion in irrigated acreage and the widely observed disappointment with the performance of irrigation projects, attention has shifted to rehabilitating existing works. Only about 28 percent of the desired increase in agricultural output in the next few decades is expected to come from increasing the quantity of cropped area (FAO 1979). Qualitative irrigation improvement must play a significant part in increasing the capacity of poor nations to feed their growing populations. A dollar or rupee invested in rehabilitating existing systems promises to provide a better return than investing in a new system. However, whether constructing a new system or rehabilitating older works, irrigation development efforts will be doomed if proper attention is not given to the social organization(s) necessary to operate and maintain the works (Bromley 1987; Freeman and Lowdermilk 1985).

Some have envisaged a "water revolution" brought about by rehabilitated irrigation systems and reformed administrative structures that would be analogous to the "green revolution" (Bottrall 1981b; Chambers 1980a). A "water revolution" promises to increase productivity at favorable cost-benefit ratios. Many new crop varieties need controllable irrigation water and would benefit from a "water revolution." Furthermore, a "water revolution" promises increased social justice, since benefits could be delivered to least advantaged farmers. Water control is critical to farmers in determining what crops to grow and whether or not to adopt new technologies such as fertilizers, pesticides, and high-yielding varieties. Since least advantaged farmers must pay the highest prices for insecure water in high demand periods, and because the poor and powerless are least able to influence water distribution, an increase in irrigation water control is a potentially powerful tool in the policy maker's kit for promoting agricultural development with social justice.

2

ORGANIZING FOR WATER CONTROL

Reconciling Main System Supply with Farmer Demand

Water control by farmers, defined as the capacity to apply the proper quantity and quality of water at the optimum time to the crop root zone to meet crop consumptive needs and soil leaching requirements, is a fundamental yardstick used to measure the effectiveness of irrigation systems. Water control is a function of the manner in which people organize at several levels--the main system and one or more tiers of middle-level organization between main system management and individual water users (Figure 1).

Water control for main system management means something different than water control at the farm level. This shift in meaning necessitates the existence of effective middle-level irrigation organizations to provide an interface for the different, even incompatible, requirements of main and farm systems.

Water control is critical, not only to improving production in any given season, but also to sustaining the production environment across seasons. Greater water control permits less water to be used per unit of production, which translates into reduced energy consumption, soil erosion, waterlogging, and salinity (Mathur 1984; J. Mohan Reddy 1986). Because high-yielding plant varieties demand adequate, timely water applications, farmers with inadequate water control will refrain from investing in such varieties and associated costly inputs of fertilizers and pesticides. As control over water diminishes, it becomes necessary to apply increasing quantities of water whenever available to attempt to ensure the survival of at least a portion of the plant population. Over-irrigation, even in the context of general water scarcity, can lead to erosion, waterlogging, and salinity.

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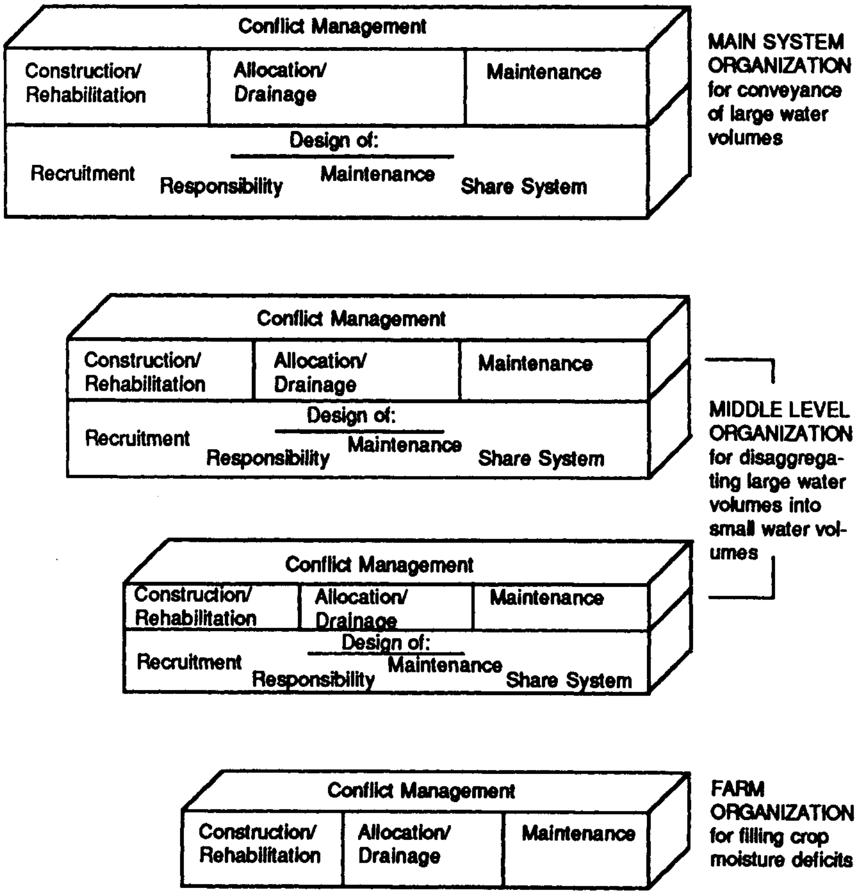

Figure 1. Organizational levels of irrigation systems.

Irrigation water management in large-scale gravity flow systems is the process by which bureaucracies capture and control water in central irrigation works and pass it on to local command areas, which divide and control it further. In turn, local organizations (Figure 1) pass the water on to farmers, who must place it in crop root zones at times and in amounts which make it most productive and least damaging to the production environment.

Years of careful experimentation have established that applying the right amount of water to crops at the right time, as defined by properties of the plant, soils, and climate, is critical to crop productivity. Doorenbos and Kassam (1979:2) have plainly stated the problem in its technical aspects:

> The upper limit of crop production is set by the climatic conditions and the genetic potential of the crop. The extent to which this limit can be reached will always depend on how finely the engineering aspects of water supply are in tune with the biological needs for water in crop production. Therefore, efficient use of water in crop production can only be attained when the planning, design and operation of the water supply and distribution system is geared toward meeting in quantity and time...the crop water needs required for optimum growth and high yields.

The extent to which the water supply can be tuned to crop biological requirements is a function of the organizational operations conducted at the several levels (Figure 1).

At the farm level, water control is fundamentally determined by the operation of organizational networks established to operate upstream physical structures. How effectively irrigation water reaches the root zone is a function of an organization's ability to rehabilitate, operate, and maintain works, and to manage conflict. Farmer control over water in the field is critical. Only the farmer combines the factors of production in a particular field to bring in a crop. If water comes too soon, too late, in amounts too much or too little, the productivity of that water is sharply reduced. Because different plants exert different consumptive demands in varying stages of growth and in varying soil and climatic conditions, irrigation water can fulfill consumptive demand only if it is subject to precise control that allows farmers to be rapidly adaptive in managing it.

A rice cultivator in Southeast Asia working in an irrigation system designed to deliver continuous simultaneous water supplies to hundreds of farmers in a given command faces different water control problems than does a farmer in northern India or in Pakistan who works within a rotational delivery system to serve the consumptive requirements of wheat or cotton. Even within a given irrigation system, the consumptive demand of crops can be expected to be highly varied. A farmer growing shallow-rooted vegetables on lighter soils faces different water application requirements than a neighbor who grows deeply rooted crops in heavier soils. Furthermore, a rain which delivers two inches of water to a particular site may deliver only a fraction of an inch to another farm site only a few miles away.

Farmers in irrigation systems around the world are faced with the common task of hitting a moving target--a varying moisture deficit in the crop root zone--within irrigation systems which typically have been designed by remote engineers, managers, and politicians whose professional responsibilities were to aim a quantity of water in the general direction of a command area. In most large-scale systems, especially in Asia, the upstream control systems have been designed without adequate regard to the problems faced by farmers in securing local control (Bottrall 1981b, 1985; Bromley 1982; Freeman and Lowdermilk 1985; Kathpalia 1981; Lowdermilk 1986; Wade 1979, 1980, 1982a, 1982b, 1987).

The fundamental problem is that main system managers cannot control the strategic variables that determine water demand and water productivity farm by farm and field by field: site specific variations in soil moisture holding capacity, soil moisture availability, planting times, crop variety, root zone depth, daily crop moisture depletion, specific evapotranspiration rates, and margins to the permanent wilting point. Such matters are known to main system managers as general tendencies, not as field-by-field particularities.

On the other hand, individual farm operators cannot adequately control variables that establish the pattern of main system water supply, such as watershed yield and distribution, storage and canal capacity, intra- and inter-state (provincial) allocation, river and canal hydraulics, regional or district strategies for conjunctive use of surface water and groundwater, and the management of large main system storage, canal, and drainage structures. Therefore, main system supply and farmer demands must be matched. In gravity-flow surface irrigation systems, the best way to make this match is to create an intermediate tier of organizations which accept main system water deliveries within the constraints which the main system must impose, control such water, and disaggregate water flows to fit the unique demands of individual farmers.

Reconciling the Knowledge Held by Main System Managers and Farmers

At least two general, but very different, formats exist for knowing about the world--a particularizing mode emphasizing the uniqueness of events, and a generalizing mode extracting larger similarities and arriving at abstracted patterns of relationships. One can distinguish between *idiographic*, or unique, knowledge of substantive content and *nomothetic*, or generalizing, kinds of knowledge (Nagel 1961). Distinguishing between nomothetic and idiographic knowledge is helpful in viewing differences between the central bureaucracy and farmers.

The knowledge of irrigation officials educated in the professions depends heavily upon generalized principles abstracted from the rich flow of natural and social processes (i.e., nomothetic knowledge). Highly-processed, abstract, organizing principles have pride of place in science and in the training of irrigation engineers and managers who possess formalized knowledge of other disciplines. This general, cross-culturally viable, scientific knowledge renders propositional knowledge out of particular facets of the whole system, but does not comprehend the richness of the whole. It is limited to shedding light on particular, abstracted slices of reality in the form of economic supply and demand curves, cost-benefit ratios, bars of tension, pounds of pressure per square inch, yield responses to fertilizer, thermodynamic behavior, channel hydraulics, sedimentation and scouring, capillary action, soil intake dynamics, evapotranspiration processes, and administrative notions of span and control. Sciences abstract general rules to construct logically connected sets of propositions about relationships among phenomena. These abstracted propositions are employed in central planning units to design and operate those parts of the irrigation system under the management of the central bureaucracy.

On the other hand, local people possess extensive idiographic knowledge, built through long experience and encoded in tradition and custom. Their knowledge is of unique, site-specific circumstances and their particular situation relative to those circumstances. Whereas the bureaucratic analyst must grasp general tendencies across broad systems, the individual farmer is intensely interested in the specific outcomes of his or her particular situation. Whereas the central manager obtains knowledge to make decisions by employing methodological devices to control extraneous variables that might confuse the analysis of central tendencies in the system, the individual farmer responds to factors excluded by central management because they are important in local contexts.

Irrigation is practiced in a great variety of conditions (e.g., social, economic, topographic, soils, climatic, and crop). These vary within a farm, and they vary widely among farms and among command areas within an irrigation system. Given that each setting represents a unique arrangement of the generalizable properties known by central management, a condition that seems to exist across the whole system does not necessarily exist in any specific subset of that system. Farmers, who are employers of rich idiographic knowledge, have much reason to distrust the nomothetic understandings of main system managers.

The problem is that the generalizations of irrigation managers in large, remote bureaucracies are not legitimate where farmers' individual and unique settings are concerned. The lack of mutual understanding is rooted in differences in types of knowledge and experience. There need be no hypothesis of irrationality or ill will on the part of any party to account for fundamental differences in orientation.

Reconciling the Logic of Public Goods with Individual Rationality

Main system managers control water by providing a transport system for water using rivers, canals, reservoirs, and diversion structures. They have assumed that if water is moved in the direction of targeted cultivable command areas, water control at the local level will automatically evolve because it is needed. In the light of history, this optimism is known to have been