Design of Water Distribution Procedures in Irrigation Management Transfer: A Crucial Step

Has Willet[1]

INTRODUCTION

IRRIGATION DEVELOPMENT CAN be sponsored by external agents in a number of ways. Three forms are distinguished where Irrigation Management Transfer (IMT) is part of the intervention strategy:

1. Newly built schemes where water users are meant to become responsible for the management of the whole or part of the infrastructure.

2. Rehabilitation of public schemes with IMT included in the project objectives.

3. Assistance to existing communal irrigation systems.[2]

In all three cases, the water users are confronted with a changed hydraulic environment. Well established procedures for allocating and distributing the water may either be absent, as in the case of newly built schemes, or considered inadequate to reach the project's objectives, (eg., improved efficiency or reduced conflict). The introduction of newly designed procedures, reflected in infrastructural choices and organizational arrangements, is therefore a typical component of IMT.

Recent research has concentrated on the "design process": on the question how a good design can be arrived at. It is shown that by incorporating farmers' insights and existing indigenous knowledge and experience regarding water management as much as possible, familiarity of the irrigators with their system and sustainability of its use will be enhanced. Involving the water users in all stages of the project cycle is often seen as the key for success. Interesting views are being developed as to how this can be effectively realized. In a recent contribution, Ubels and Horst call for an iterative approach to irrigation design and development in Africa, implicating a more intensive and prolonged presence of the development agency in the project area than is usually the case (Ubels and Horst 1993). A similar idea is found in Vermillion's article on farmer contributions to irrigation design in Indonesia [(Vermillion 1989)].

Though probably a common feature of successful irrigation projects is indeed farmer participation, it is argued here that this might not be a sufficient condition. New ideas about possible arrangements may often be expected to be brought in by the intervening agent, as was seen in one of the two Ecuadorian cases outlined below. The validity of the proposals made determines the fluency with which the participatory design process takes place. An adequate design tool that helps to analyze the social, agricultural and hydrological environment and that provides a reference cadre of possible solutions, is then essential.

In spite of the growing interest of investigators for issues concerning the "design outcomes" and some promising research findings, the results are scattered, and still highly insufficient and unaccessible to the ones who are directly involved with the implementation of projects entailing IMT. If, for any reason, farmers lack the possibility to contribute substantially to the design of distribution procedures, project personnel will draw upon former experiences or regionally developed standards. In the worst case the design is bound to rely on some kind of a worn blueprint alternative, or otherwise turn into an experiment, with the farming community taking the risk of failure.

A cautious remark is made with respect to the trial-and-error- and iterative approaches to system design advocated by the authors cited above. The cost-aspect of "tuning" the design to the environment wherein the system has to operate, applies to both sides in the participatory process: intervening agent and water users. Just as it may be difficult to extend successful experiments to the national level because of the high cost of prolonged agency involvement, investments in the form of time dedicated by the farming community, participating in long discussions about what would be the best solution in their particular case, may also become a limiting factor.[3] It can further be argued that often weaker members of the community, in terms of productive resources, will see their

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[1]Consultant Natural Resources Management for SNV, a Dutch Development Foundation, Cajamarca National University, Peru.

[2]This is a somewhat atypical case of IMT, because the management is in the hands of the farming community before the intervention and will enerally remain there after completion of the project. Often, though, not only the infrastructure but also the management is affected by the intervention.

[3]This point can be attributed to the complex and conflictive nature of water allocation and distribution which makes a discussion of alternatives with the directly involved a very difficult and time consuming matter, especially if no references can be made to prior experiences with irrigation management.

time as being limited sooner than others, and therefore their disadvantageous position might become worse as a result of too long design processes, accompanied by subsequent alterations in the distribution procedures.

Summarizing, it is stated that initial choices concerning the water allocation and distribution methods to be applied, made by engineers, together with other professionals of a project team and with participation of representatives of the farming community, can be seen as greatly decisive for the impact of IMT, on the one hand, and that a sufficient knowledge base for making these decisions is frequently absent, on the other.[4]

In the following section, irrigation developments in the Ecuadorian highlands are outlined in order to illustrate these ideas. Then the available tools for making design choices are shortly explored. The paper concludes with the suggestion that efforts should be dedicated to the compilation of the scattered information on principles for water allocation and distribution into a comprehensive handbook.

IRRIGATION DEVELOPMENT IN HIGHLAND ECUADOR

An important, but decreasing share of the national food is produced in the *sierra* (highland) on small and fragmented landholdings by the *indigena* and *mestizo* inhabitants, totalling 20 percent of the Ecuadorian population. Agricultural productivity is low due to climatological constraints, poor soils, rough topography and low input of labor and cash. Through migration of male adults to urban centers and to plantations in the coastal lowlands, most of the rural families obtain a large part of their monetary income, while agricultural production is mainly destined for consumption within the household. A number of factors lead to the deterioration of the resource base and of the subsistence level of the population.

Water deficit is a restricting factor in the lower valleys of the sierra where the temperature is favorable for two main food crops, maize and beans. In the highest parts, above 3,500 meters (m) altitude, a slightly better rainfall regime and lower temperatures are encountered. Here, root crops and barley dominate the cropping pattern.

A big number of communal and private irrigation systems, some of them constructed more than a century ago, cover over 200,000 hectares (ha[5]) of farmland in the sierra, complemented with some 70,000 ha of public irrigation schemes.

Many existing irrigation channels in the private sector (communal and private) were build and managed under the "hacienda" form of agricultural production that predominated until the beginning of the sixties. With the fragmentation of the big landholdings, the authoritarian force that structured the management of these systems disintegrated and today many of them have fallen into disrepair. A few communal systems were recently built or rehabilitated with help of non governmental organizations (NGOs).

A national irrigation institute within the Ministry of Agriculture is since 1972 legally responsible for the development and management of all water resources in the country. In the public irrigation schemes, a rigid 7½-day-interval rotational water supply within the tertiary units, and a continuous water supply at the tertiary inlet, constitute the basic water distribution principle. Water is allocated in accordance with the cultivable surface of the individual plot and an annual fee is charged correspondingly. In the private and communal systems, state interference is generally limited to the raising of a water tax at the system level. A chronic lack of funds is the main cause of the low coverage of the institutes' services and the poor performance of the public schemes.

Latacunga-Salcedo-Ambato Scheme

In a major public scheme in the central sierra, named Latacunga-Salcedo-Ambato, the water distribution practices in four tertiary units (round 12 ha each) were studied during two months in 1986. The strict rotation of 7½ days imposed by the authority turned out to be ignored by the water users. Instead of rotating the tertiary flow (8 liters per second [l/s]), many parcels within a tertiary unit were being irrigated at the same time, dividing the stream into extremely small flows varying between 0.1 and 4 l/s, under a kind of free demand principle with the law of the strongest as, apparently, the only regulating force.

Some reasons for the rejection of the imposed rotational supply system could easily be discerned. The irrigation schedule, with turns calculated in quarters of an hour precisely, completing 24 hours a day, turned out to be quite unmanageable for the illiterate majority of the irrigators. More than half of them are women cultivating tiny plots, combining agricultural labor with other tasks. Migrating male heads of households appear only once or twice a month to take care of the bigger parcels and would not be bothered by the official timing of their turns. Many parcels remain fallow or are cultivated only part of the year so that a lot of turns would have to be rescheduled anyway.

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[4]Water allocation and distribution procedures are treated herein as a single subject because both are often closely interrelated. Sometimes external (political or legal) institutions define water allocation criteria, and thereby exclude allocation from the realm of participatory decision making. This exclusion greatly reduces the chances of getting a design adapted to the social environment and ought to be reconsidered when formulating an IMT policy.

[5]This figure is a rough estimate as very little is known about private sector irrigation. The figure about public sector irrigation may have to be actualyzed.

Conflicts over the distribution of water frequently arise because formal water distribution rules that fit the farmer community are lacking. As a result, potential benefits for especially the resident female water users are not realized and the water distribution efficiency remains low (below 50 percent, Jeldres and Willet 1986).

The designers of this scheme obviously didn't consult the future users upon the water allocation and distribution procedures, as these are laid down in a national irrigation water management manual. The rotational water delivery system is adhered to because no awareness exists of possible alternatives, but clearly doesn't fit this social and agricultural environment.

Patococha Scheme

In the southern province of Cañar, some 1,200 ha were recently brought under irrigation through a joint effort of the national irrigation institute, an NGO and a farmers association. In contrast to the Latacunga-Salcedo-Ambato Project, farmers participated in all stages, from the project's conception to the operation, mainly as a result of the unusual mix of executing agents and the decisive vote of their representatives in the project committee (CESA 1990).

In view of the scarce and uncertain managerial support from the national irrigation institute, and the negative experience with the standard rotational supply at the tertiary level applied elsewhere in public schemes, an alternative water allocation and distribution principle was sought for in coordination with the future water users. The management at the secondary and tertiary level was thought to be transferred to the farmers association. Some of the major challenges encountered were the following:

* A flexible distribution procedure had to be devised that would allow for the varying needs of different crops to be satisfied, from grain crops that are only irrigated once or twice in their production cycle, to vegetables that have to be irrigated at least once a week.

* As water is scarce in certain periods due to a variable river flow at the source, an efficient distribution was needed.

* Because of the differential advantage drawn from the use of the irrigation system within the community, with some members owning less than a few hundred square meters of irrigable land, others over 5 ha, and cropping intensities being highly variable, no agreement could be arrived at upon the creation of the role of a paid water guard. Thus arrangements were needed to enable the water users to coordinate the distribution among themselves.

* Routines had to be designed that would make possible an effective coordination between the government agency personnel, at the main channel level, and the water users in order to achieve an adjustment between the flows diverted to the secondary channels and the water used at the community level, to avoid damage to the infrastructure and to optimize the use of the scarce resource.

Several factors hampered the attempt to establish in Patococha an improved water management, geared to the specific needs of the marginalized Andean smallholders. Local customary arrangements of water management were minimal and inadequate to serve as a mould for a mixed (government/farmers) organization of water distribution for the new system. No other guiding principles for the design of suitable arrangements were available from the literature that would have allowed the project team the introduction of new elements that had proven to be successful elsewhere. Finally, a lack of institutional commitment, combined with certain legal impediments, discouraged the set up of a controlled experiment that could have eventually indicated new ways towards an effective IMT in government-run schemes.

Expectations were high because of the relatively strong farmers association and their involvement during the whole process of project implementation. Nevertheless, this advantage didn't materialize in a well functioning water distribution, partly because good alternatives to the rotational delivery were hard to formulate under the adverse socioeconomic conditions.

THE ENGINEER'S TOOLBOX

In this section, types of knowledge relevant to the design of water management procedures in IMT are reviewed. As engineers are shaped within many different backgrounds it is hard to do this in an objective manner, and neither is it tried here. Nor are the four categories given below intended to have any broader scope than strictly the argument of this paper.

Thus, the irrigation engineer's toolbox is seen as consisting of the following elements:

1. Technical knowledge of **plant-water-soil relationships** and of **hydraulic structures**, their hydraulic characteristics, functions and design. This first category of knowledge is typically acquired through formal education, and normally constitutes the gross contents of it.

2. The available choice of **water distribution methods** is generally acknowledged through descriptive classifications, of which the most widely known is probably the one given by FAO (1982).[6] As pointed out by Jurriens and de Jong, this one and others lack completeness and consistency (Jurriens and de Jong 1989). Except for this, two more reasons make the existing classifications of little practical use to designers. First, no implications of the social, agricultural and hydrological environments on the choice of distribution method are presented anywhere in a systematical way. Furthermore, guidelines for the implementation of different methods are hard to find, except for the rotational system that most authors seem to consider superior for smallholder irrigation in developing countries, probably because of its supposed efficiency.

3. In contrast to the scarce information on distribution methods, relatively abundant are **methodological recommendations concerning the design process.** Many useful suggestions can be read on the ways to collect relevant information and effectively incorporate criteria of the farming community in the design of irrigation systems to be operated and maintained by the water users ([Yoder and Thurston 1989;] Ubels and Horst 1993).

4. **Experience** is probably the most important tool to engineers in making recommendations on system design and management. A disadvantage of relying too much on highly experienced engineers in IMT [is though that these are scarce and rarely available] for time consuming, field based, interactive design processes.

This evaluation suggests that an important shortcoming is the unavailability of an instrument to device suitable distribution arrangements. This conclusion is not a new one. The discussion goes back to the early 80s when a debate over "conceptual design" was made public by Jurriens et al. (1984). At that time though, the idea of IMT was not yet widely accepted and the main concern was for the physical layout of watercourses and hydraulic structures. A wider range of elements can now be recognized as relevant choices in design.

Progress is being made with the identification of factors that may influence the choice of management procedures through careful analysis of indigenous irrigation systems. An example is the relationship observed by John S. Ambler between the relative scarcity of water, water rights and the occurrence of proportional diversion structures or rotational supply systems [(Ambler 1989)]. The acquisition of water rights through participation in construction and maintenance of irrigation infrastructure as a main steering principle in water allocation and distribution is the theme of an article by Gerbrandy and Hoogendam (Gerbrandy and Hoogendam, forthcoming). These and other research findings will contribute to improve designs and enhance sustainability of irrigation systems transferred to their users, if they can be turned into a design tool in the hands of farmers and intervening agents looking together for solutions.

CONCLUSION: TOWARDS A DESIGN TOOL FOR DISTRIBUTION PROCEDURES

Information on the relationships between the social, agricultural and hydrological environment, and the organizational and technical design of irrigation systems, is poorly available to project designers. Engineers and other agency personnel could use this type of information in making participatory design processes run more smoothly by proposing adequate solutions that fit well into the environment.

The type of information especially needed are not prescriptions, based on theoretical parameters, but descriptions of real situations that give enough relevant information about the environmental context for the designer to be able to assess the validity of those solutions for the project s/he is working on. On the other hand, the description of management arrangements must be detailed enough so that solutions may be picked up and reconstructed. A drawback of various interesting studies is that many questions remain open. Questions such as the following:

- By what mechanisms do water users obtain rights to water, how are these rights expressed in daily water distribution routines?
- What arrangements are made to respond to fluctuations in water availability and demand?
- What communication patterns exist, what type of information is communicated and how is information processed by each party?
- How do water users become aware that they receive their fair share of water and what arrangements are made to minimize the need for mutual control? How effective are these?

[6] This classification distinguishes, "on-demand; semi-demand; canal rotation/free demand; rotational system and continuous flow."

* What agreements exist with non-participants in the water users' organization and with other irrigation organizations to regulate the use of the water sources?

This list is not intended to cover all aspects. More important than extensive checklists of questions is the development of a suitable language to describe irrigation situations in an unambiguous manner.

In order to make the numerous descriptions, spread-over reports, dissertations, congress proceedings, journals and papers, accessible to designers, a collection of cases could be brought together in a handbook and made available to a broader public. The proposed compilation would show a wide range of arrangements that irrigators are able and liable to make and maintain to operate their own irrigation systems, under different circumstances and applying different principles. Also, the outcomes of action research directed to IMT could be included.

Notwithstanding the considerable amount of difficulties, both theoretical and financial, that will have to be resolved before a handbook on water distribution principles can be published, it is hoped that some renowned institute will take up the challenge of bringing scientific achievements back to the field level.

A compilation and systematization of irrigation principles will be essentially a useful reservoir of ideas to broaden the horizon of thought of intervening agents who are assisting farmers' groups in developing sustainable irrigation organizations. A successful attempt might play a role in the construct of a comprehensive theoretical model wherein the findings of a variety of investigations into communal and farmer-bureaucracy managed irrigation can be framed. This model may evolve through time when new insights become available, contradictions get resolved, and existing gaps get filled up.

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