21

Research Report

Need for Institutional Impact Assessment in Planning Irrigation System Modernization

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International Water Management Institute

Research Reports

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Contents

Summary

As opportunities for developing new irrigation systems are becoming rare, the emphasis has shifted to investment in rehabilitating and remodeling of existing systems. With the limited scope for irrigation expansion in the future, the need to ensure that these modernization efforts yield the expected performance improvements has become more important now than ever before. To be productive, the modernization process should necessarily include the matching of infrastructure with a suitable institutional framework.

This report cites a case study of the institutional implications of remodeling an old irrigation system in northern Pakistan. The process of planning and designing the Lower Swat Canal remodeling effort conspicuously left out the critically important consideration on institutional issues such as water allocation rules, operational procedures, and organizational capacity for post-construction system management. Consequently, the changes in physical infrastructure in the remodeled system did not accompany corresponding institutional changes to support the required operation and maintenance responsibilities.

Citing this example, the report draws the attention of the donors and the project planners to the institutional implications of current project preparation methods and concludes that the institutional constraints in modernizing old irrigation systems can be foreseen at the planning and design stages. The report advocates the need for an "institutional impact assessment" effort that assesses both the impact of infrastructure development design on the existing institutional framework and the related institutional improvements, as an essential component of project appraisal for irrigation system modernization in developing countries.

Need for Institutional Impact Assessment in Planning Irrigation System Modernization

D. J. Bandaragoda

Introduction

A growing concern exists among the donors, as well as among many others trying to foster improved performance, over the returns to investment on infrastructure development in developing countries. The reasons are attributed to problems of institutions[1] and management styles of these countries, which are often seen as having a significant impact on the standard of performance of the developed physical infrastructure (World Bank 1994).

Echoing this general concern on poor performance, a former Projects Policy Advisor to the World Bank declared that "many of the real problems with development programs and projects lay not so much in their design and planning as in their implementation" (Israel 1987). Based on a study of 222 World Bank-financed development projects in 36 countries, he further stated that "the real implementation problems were mostly institutional and managerial—in other words, they were rooted in the difficulties countries have in getting things done." The experience of recent development efforts in many regions of the world has made the latter part of his statement a truism, but its initial reference to the relative roles played by planning, design, and implementation deserves further consideration.

A more recent publication refers to three basic elements as being essential to developing functional irrigation projects: *water rights, infrastructure capable of delivering the service implied in the water right, and assigned operational responsibilities* (Perry 1995). The right combination of these basic elements, depending on the contextual situation, is necessary for systems to be fully functional. Essentially, the need for matching these prerequisites has to be considered at the planning stage itself, as any post-construction adjustments are extremely difficult to achieve.

Often, the planners tend to overlook the problems of implementation[2] when they are preoccupied with the designing of physical infrastructure for irrigation projects.[3] Current practices of project preparation and management are such that many project planners are compelled to focus on seeing a successful construction phase. In this process, the need to recognize that it is easier to identify the roots of some of the implementation problems during project preparation stages and to incorporate appropriate remedial action in the design itself escapes the attention of planners. Considering this possibility, this report attempts to highlight the need for assessing the institutional implications of irrigation infrastructure development projects, particularly the rehabilitation projects, at the time they are planned and designed.

The illustrative case material is from an evaluation of the "remodeling"[4] effort of the Lower Swat Canal (LSC) irrigation system. The project is located in the North-West Frontier Province of Pakistan. The study in-

[1] For the purpose of this report, the word "institutions" means a set of formal and informal rules used for collective action, and the organizations which are governed by such rules.

[2] The term "implementation" for the purpose of this report is not limited to the construction phase of a project. It necessarily includes the post-construction operation and maintenance activities, which are the more significant problem areas influenced by the projects' institutional and managerial contexts.

[3] A notable exception is reported by Beadle et al. (1988) who describe an integrated approach involving engineers and sociologists in a rehabilitation project in Nepal.

[4] Project documents have preferred to use the word "remodeling." instead of the more popularly used "rehabilitation." Some officials associated with the project have pointed out that since rehabilitation would mean restoration of original conditions, the term "remodeling" is preferable in this context.

cluded a review of planning documents, World Bank's project appraisal reports, subsequent feasibility reports, and aide-mémoire; a study of design concepts and their implied or suggested management plans; interviews with key officials in the planning and operating agencies relating to the LSC project and with farmers to assess their understanding on the implications of this new design and to obtain their perceptions of how the present situation is operationally handled; and an assessment of the remodeling effort and the current operation of the LSC system. The study focused on the circumstances under which some new design features aimed at demand-based irrigation operations were partially introduced and subsequently abandoned.[5]

The case study confirms a widely discussed development issue concerning weak institutions in developing countries (Hart 1978; Wade 1982; Israel 1987; Bromley 1987; Lusk and Parlin 1988; World Bank 1994). The main objective of this report by citing this case material is to illustrate and provide empirical evidence of the futility of pursuing infrastructure development interventions, particularly through system rehabilitation projects, without combining them with appropriate institutional development strategies. The case of the LSC modernization attempt needs to be viewed in the light of traditional canal irrigation that was pursued in this part of the world.

Irrigation Tradition in Pakistan

The history of the Indus Basin irrigation system of Pakistan goes back to 125 years. Pakistan's canal irrigation, which was based on the original objective of irrigating the maximum area possible from the available water supplies, was characterized by the following features:

- run-of-river water supplies
- protective irrigation
- low water allocations of 0.21-0.28 l/s/ha (3-4 cusecs per 1,000 acres)
- low cropping intensity (annual average 75%)
- infrastructure designed for equity and reliability of supply
- few gated structures and minimal operational adjustment required
- all outlets to draw design discharge

Typical Field Management Structure

A hierarchy of organizational units is involved in the operation and maintenance of a typical canal system. An Executive Engineer is in charge of a canal Division under the administrative control of a Superintending Engineer, who is the head of a Circle consisting of two or three Divisions. The Division is the executive unit for operational activities, and the Executive Engineer has the pivotal role in the Irrigation Department, as the engineers above him are controlling and directing officers, while the engineers and staff under him are there to assist him in his field duties.

A Division is further subdivided into three or four subunits known as Subdivisions, each headed by a Subdivisional Officer (SDO), who is also a qualified engineer. A Subdivision, ordinarily, consists of three or four Engineering Sections and two to three *Zilladari* or Revenue Sections. The head of an Engineering Section is a Sub-Engineer, who is responsible for the distribution of supplies and the maintenance of distributaries/minors up to about 2 to 4

[5]This was part of a study on crop-based irrigation operations conducted by IWMI with support from the Asian Development Bank (Bandaragoda et al. 1993; Garcés-Restropo, Bandaragoda, and Strosser 1994).

cumecs (100 to 150 cusecs) discharge. The Sub-Engineer is assisted by Masons, Mistries, Mates, and Canal Patrols for maintenance and watching of channels, and there are also Gauge Readers for regulation and observation of water flow. A Zilladari Section is headed by a *Zilladar* who supervises the work of about 10 *Patwaris* (Irrigation Record Keepers), each Patwari being required to record the extent of irrigation of 1,200 to 2,000 hectares.

This typical pattern of staff required to operate a canal system under the traditional design has remained largely unchanged since the inception of the existing canal irrigation administration in the late 1800s.

The density of irrigation staff is substantially lower in the subcontinent than in many other irrigated areas. Similar to the low relative water supply in this region, the "relative bureaucratic supply" reflecting the average irrigation staff per 100 irrigated hectares is in the order of 0.3 to 0.5 in many Indian canals, compared to around 2.5 in South Korean canals (Wade 1988). The system was originally designed for a low management intensity.

Impacts of Changing Conditions

Most of the traditional design features have outlived their usefulness in the context of changed physical and social conditions. The ideas of "protective" irrigation and equitable water distribution embodied in the early design criteria are no longer readily applicable as many environmental conditions have changed. Some of these interacting changes in the operational environment are:

- increased indiscipline in the operation of the system
- cumulative effect of poor maintenance
- increase in the number of small farms

General deterioration of the physical infrastructure, coupled with operational irregularities, has adversely affected the reliability of irrigation water supplies, as well as the equity of water distribution within the system. As the number of small farms has increased due to subdivision and transfer of land, the emphasis of objectives in irrigated agriculture has started to shift from productivity per unit of water to productivity per unit of land.

The impact of these environmental changes was seen in the following:

- demand for more irrigation water and for its greater reliability
- advent of groundwater development
- increased water supply through reservoir storage
- increase in cropping intensities (over 100% in many systems)
- diversification in cropping patterns

A major environmental factor that had contributed to the earlier design for "protective irrigation" was the incompatibility between the streamflow in the major rivers and the pattern of water requirement of the main cropping seasons. The mismatch between average river flows and the crop water requirements in the Rechna doab (the area between the Ravi and Chenab rivers) is substantial as can be seen in figure 1. In recent years, the seasonal disparities between canal irrigation supplies and optimal crop water requirements have been reduced to a certain extent by the large regulatory reservoirs (Tarbella, Mangla, and Chashma) and the rapid growth of private tube wells. However, the demand for water continues to exceed the effects of these developments.

When and where the supply of surface water was not a major constraint, the difficulty remained to be the low water allowances in the traditional "protective" irrigation systems designed for extensive irrigation. In many locations, this situation could hardly be improved upon due to inadequate channel capacities in the conveyance system.

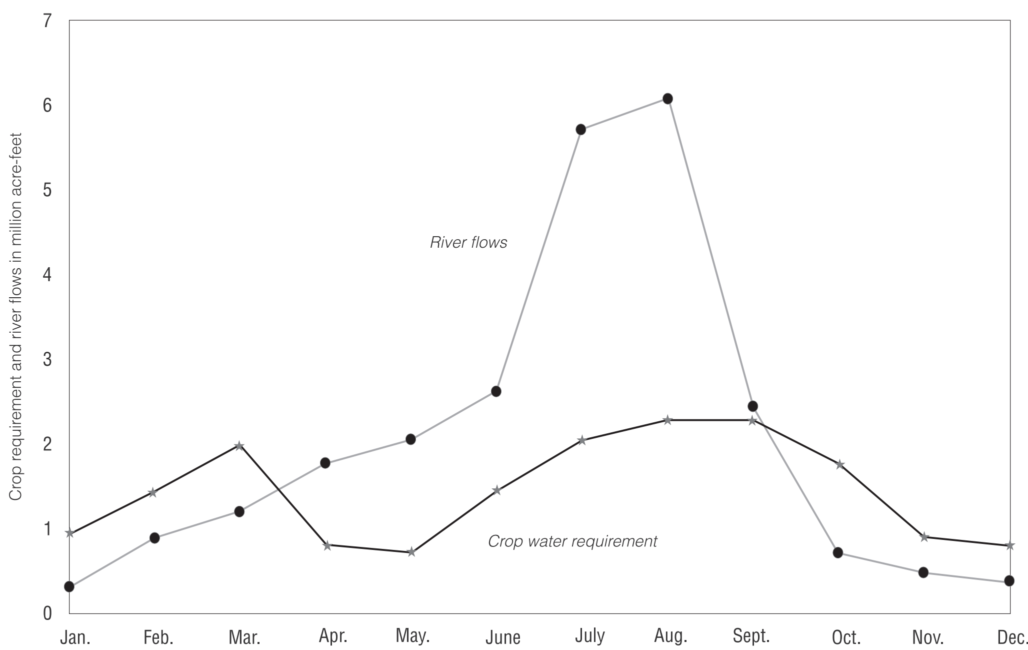
Initiatives for Modernization

The limitations of the country's traditional supply-based irrigation in the context of changed conditions was subject to intermittent policy considerations. Three such instances can be highlighted.

1. An early government report (Water and Power Development Authority 1979) linked the prevailing mismatch between water supplies and crop water requirements mainly to two factors:
   - inadequate water supplies throughout the year
   - limitations of the design canal capacities
2. More recently, the National Commission on Agriculture (Ministry of Food and Agriculture 1988) identified two factors as the most adverse effects of the seasonal variability of water supplies:
   - the chronic inequity affecting the tail enders
   - shortages during critical periods of the crop growth cycle

   These factors in turn would contribute to lower yields in large areas.
3. Similarly, in a series of deliberations that took place in finalizing the Water

FIGURE 1.
Comparison of crop water requirement of Rechna doab and average flows of the Chenab river.



Sector Investment Plan (WSIP) for Pakistan, a working paper on policy and management issues (Kirmani 1990) saw two major factors depressing crop yields:

- inequitable distribution of water
- lack of adequate matching of water supplies with crop requirements

The Working Paper concluded: *More water can be made available for productive use by changing the historic withdrawal pattern to a crop needs pattern, by ensuring equitable distribution and by conjunctive use of surface and groundwater storages. These management methods will not affect the water rights of the canal commands....*

While the policy concerns were focused on several limitations of the traditional modes of supply-based irrigation, the "irrigation culture" that was imbued over such a long period of time acted as an impediment to consideration of broad-based changes, and the policy interests had to be content with remodeling the systems wherever possible to have increased system capacity. Recognizing these developments, the donors showed an interest to steer the policies towards a more marked change from the traditional supply-oriented irrigation operations. Consequently, the project planners associated with the LSC remodeling effort decided to explore the introduction of demand-based irrigation operations in the remodeled system, as the system was to be given a substantially increased water allowance.

Modernization of Lower Swat Canal

Summary of the LSC Project

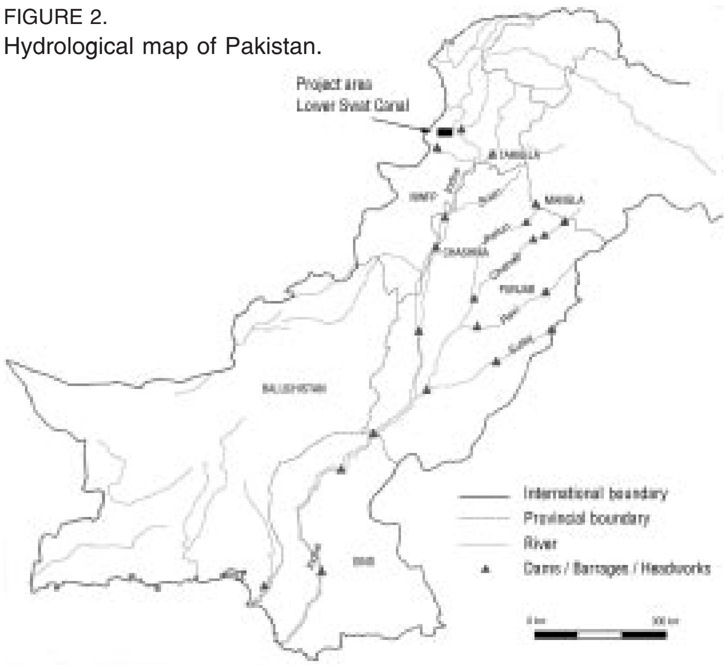
The LSC is located in the Mardan district of the North-West Frontier Province (NWFP) of Pakistan, the northwestern part of the Vale of Peshawar on the left bank of the Kabul river plain (see figure 2). The main canal, which offtakes from the Swat river at Munda, conveys water for a distance of 40 kilometers to serve a command area of 54,430 hectares.

Irrigation is not new to this area. Historically, the Swat river had a number of small diversions to irrigate some 17,600 hectares of land before the LSC was constructed by the colonial administration in 1885.

The first improvement to the system was effected during 1915–1918 when a gated diversion weir was installed at the Munda headworks. A second level of improvement was effected in 1935 raising the canal's authorized full supply discharge to 23.5 cubic meters per second (830 cusecs) for a culturable command area (CCA) of 54,430 hectares. The average irrigation allowance of the LSC during this period, which was around 0.43 liters per second per hectare (6 cusecs per 1,000 acres), was in the upper range of allowances of the canal systems in Pakistan. By the early 1970s, the LSC system command area, like many others elsewhere in Pakistan, was already experiencing a shortage of water due to increased cropping intensities.

The location of the project in the upper reaches of the Indus river system provides for a relatively secure supply of irrigation water compared with downstream areas. Thus, the designing for a higher water

FIGURE 2.
Hydrological map of Pakistan.



allowance, which could well have been supported by this location, was meant to address the issue of the existing mismatch between canal water supplies and average crop water requirements (see figure 3). The designs for remodeling the LSC were based on canal capacities to provide 0.77 l/s/ha (11 cusecs per 1,000 acres). An adequate supply was considered a prerequisite for a shift from the traditional approach of "protective" irrigation towards that of "productive" irrigation.

Planning Process

Three main planning documents[6] served to conceptualize the design basis for remodeling of the LSC. A fourth,[7] closely following on the first three, was used to present the case for obtaining the necessary government approval. A fifth document[8] was generated when the project consultants were required to prepare a manual of procedure for operating and maintaining the systems to be rehabilitated.

Each of the five documents tended to progressively narrow the project's design focus. However, the five planning documents, taken together, provide a story about an unclear picture of the project's main design objectives, as their emphases changed during the overall planning and design process. At least four different design emphases at different stages are discernible in this process:

1. To increase diversion capacity;
2. To install surface and sub-surface drainage;
3. To shift from restrictive supply-based irrigation; and
4. To provide for demand-based irrigation to be conveniently introduced at a later date.

According to initial plans, the LSC was to be remodeled for an increased diversion capacity of 55 cumecs (1,940 cusecs). The design was intended primarily to overcome channel capacity constraints to enable an increase in cropping intensity from 100 percent to 180 percent. The remodeling of the LSC, however, was taken up as a component of the Salinity Control and Reclamation Project (SCARP)[9] in Mardan (popularly known as "Mardan SCARP"). Mardan SCARP included an extensive program of civil works including construction of surface and subsurface drains, irrigation canal remodeling, road improvements, and land reclamation. The project also included some activities relating to agriculture development.

Apparently, the primacy of the drainage component of Mardan SCARP had a significant effect on the project

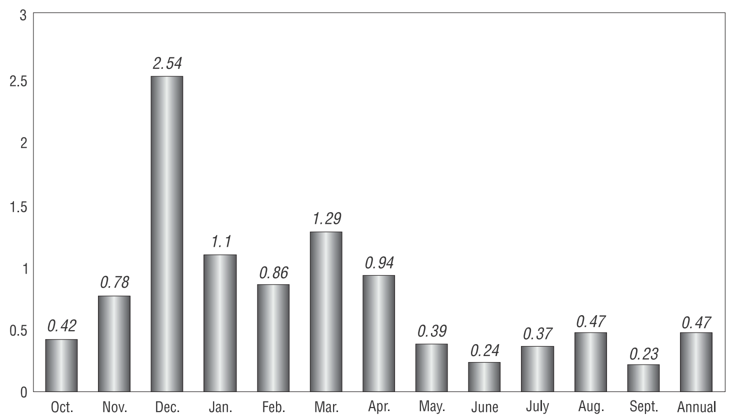
[6] (1) *Project Planning Report (PPR)* of Mardan Salinity Control and Reclamation Project - Phase one, prepared by Water and Power Development Authority (WAPDA), dated December 1977; (2) *Staff Appraisal Report (SAR)*, Salinity Control and Reclamation Project (SCARP) Mardan, January 11, 1979, of the World Bank; and (3) *Final Project Plan (FPP)*, SCARP Mardan, June 1981, prepared by the Consultants.

[7] *Planning Commission Proforma for Mardan SCARP (PC-I)*, February 1982, prepared by WAPDA.

[8] *Operation and Maintenance Manual, Mardan SCARP (O&M Manual)*, prepared by the Consultants in April 1985.

[9] The SCARP program had been launched basically as a measure to reduce the effects of waterlogging and salinity. With an emphasis on drainage, it covered a number of selected salt-affected and waterlogged areas throughout the country.

FIGURE 3.
Ratio of water supply to crop water requirements in the old LSC irrigation system.



design.[10] Based on 1981 estimates, about 50 percent of the project cost was for drainage work, 40 percent for engineering, administration, interest, and O&M during construction, whereas only 10 percent was for canal remodeling (WSIP 1990). In many respects, this cost pattern reflected the relative importance attached to the various components of the project, and remodeling of the canal system attracted less attention at all stages of the project's development. It appears that, during the iterative planning and design process, the modernization of irrigation operations shifted downwards in the order of priorities of the design objectives.

While the government's concern in the initial stages of project planning was limited to increasing the system capacity, subsequent planning documents for SCARP Mardan indicate that the introduction of demand-based irrigation operations in the remodeled LSC system was foremost among the later-stage design intentions. For this purpose, some structures necessary for a demand irrigation system (canal head regulators, wasteways, flow and discharge controls, and gated outlets) were provided. However, recognizing the possible constraints on the acceptance of a demand system by farmers and agency staff, the 1981 Final Project Plan (FPP) advocated a cautious approach. The FPP recommended that general designs should be developed in such a way that structures could be conveniently and economically adapted by addition of gates and control devices at a future date enabling the adaptation to a demand system. Meanwhile, all canal sections were to be enlarged according to the requirements for demand irrigation.

Main Design Criteria

In general, the design criteria for the project included:

- remodeling of watercourses and supply channels to an initial capacity of 0.77 l/s/ha (11 cusecs per 1,000 acres) with provisions for increasing to an ultimate capacity of 1.33 l/s/ha (19 cusecs per 1,000 acres)

- designing of all outlets as proportional modules, but providing for the installation of a gate at a future date when demand for regulation of the watercourse flow occurs

- designing supply channels with check structures and wasteways so that water can be delivered under fluctuating crop water requirements

Thus, the design at this stage clearly aimed at shifting away from the traditional supply-oriented irrigation, though not completely, and not necessarily soon after the project was completed.

[10]The emphasis on the drainage component also reflected on implementation processes of the LSC remodeling effort. As summarized in the Water Sector Investment Plan, by 1989, the canal remodeling was among the most delayed components of the main project items of Mardan SCARP.

Implementation of Canal Remodeling

In actual construction, instead of the proposed modified Adjustable Proportional Module (APM)[11] with provision for subsequent installation of a gate, an entirely different design was adopted. The new design was for an over-sized concrete pipe outlet, acting as a submerged orifice, equipped with a vertical slide gate at the entrance. Stilling wells were provided, in which measurements of the upstream and downstream heads could be made for calculating the discharge. The reason for this mid-course design change is not clear. However, the change in design seems to have taken place after the planning stage, as no planning document refers to this outlet, or to the possibility of implementing a demand-based system with such gated outlets replacing the traditional APMs immediately.

These new gated outlets were first installed in the upper reaches of the LSC system. During the protracted construction phase, the project authorities confronted field difficulties in continuing with the installation of gated outlets. Farmers in the upper reaches, who had to use these new outlets before the whole system was remodeled, started to damage the gates in the absence of any institutional arrangement for operating these structures. Realizing these difficulties, the project had to fall back on its earlier design strategy, and started to install the modified APMs in the remaining command area.

The system's discharge capacity was to be enhanced according to peak crop water requirements. However, considering the variations in cropping that could be anticipated, the operational capabilities for coping with the seasonally variable crop water requirements and the implied variations in the channel flows were not given sufficient consideration in the design, mostly because an operational plan was not considered at that stage. Although an operational plan was developed later (Operation and Maintenance Manual, April 1985), which recognized the need for a progressive shift to demand-based operations, it did not sufficiently describe the options for systems operation in the interim. Nor did it consider fully the institutional implications of the transition.

[11]The Adjustable Proportional Module is an outlet design, which can be adjusted and then fixed in place to supply a stipulated design discharge in relation to downstream command area.

Impact of Remodeling on Post-Construction System Management

After a prolonged period of infrastructure development, the remodeled LSC was characterized by the following:

- an increased water supply
- various types of distributary outlets
- a physical system which required a dynamic management system
- inadequate system management staff
- disrupted *warabandi* (rotational water allocation) schedules
- warabandi being made partly redundant due to increased water supplies
- no clear rules for water allocation and system operation

Immediately after the completion of the project, the remodeled LSC system required a fairly concentrated management effort. The operating agency had not only to cope with the problems of a physical system which was still in a confused state due to "last-minute" acceleration of construction work, but also to work out an appropriate operational plan in the context of new operational requirements. No clearly detailed operational plan had been developed during design that provided the necessary decision rules for the various control structures, or diversion points.

The lack of operational guidance placed a heavy strain on the institutional capacity of the system, which was not changed in any way to correspond to the physical changes. The lack of institutional preparedness was a major impediment to the full realization of the project modernization design objectives. The impacts of three important aspects are outlined below.

Impact of Remodeling to Water Resource Allocation

The remodeling exercise has clearly brought about an increase in supplies within the system. Field measurements and interviews with farmers confirmed this situation. Information presented in the following paragraphs is based on a field study conducted in a sample secondary canal command area of the LSC system.

The average 10-day flow data at the head of the Lower Swat Canal, kept by the Irrigation Department for the period 1988 to 1992, show that the supplies gradually increased during this period. In 1992, the supplies at the head of the LSC were about 60 percent more than that of 1988. The maximum 10-day average discharge in 1992 was 39.2 cumecs (1,383 cusecs) as compared with 24.3 cumecs (858 cusecs) in 1988. This increase in water supplies does not reflect the full supply discharge of the canal system, as the construction of the aqueduct in the main canal was completed only in late 1992. The supply at the head of the LSC was expected to increase further to reach the new design values.

However, increased supplies coincided with a decline in control over the water distribution in the system. This situation was caused by a combination of factors:

- lack of management capacity to cope with the operation of the remodeled system
- lack of morale among the personnel, mostly due to unclear operational rules after remodeling the system
- lack of consistency of the control structures in the physical system (for instance, three different types of outlets, various drop structures, and radial gates)
- absence of adequate operational instructions (none of the structures had been provided with rating curves, without which it was difficult to ascertain the quantities of water delivered at various points in the system on a regular basis)

Daily discharge measurements taken in June 1993 also showed that the Sheikh Yusuf Minor, located towards the tail end of the main canal, was drawing more than its design capacity (108% to 129 % of the remodeled design capacity), whereas the discharges entering Distributary No.3, located at the head of the system, were only 83 percent to 87 percent of the design. This rather unusual discrepancy favoring the tail area of the system reflects the inconsistent infrastructure features within the system. The absence of adequate control on the operation of the distributary outlets was confirmed by the finding that there was no consistent trend in the outlet discharge in relation to the inflows of the distributary channels. Some outlets were drawing much more than the design discharge; one outlet in Sheik Yusuf Minor was getting more than three times its design discharge, demonstrating that the system could be arbitrarily used.

In the absence of a disciplined water distribution system, farmers responded to increased supplies in a haphazard way. Interviews with the sample of farmers representing head, middle, and tail reaches of the two channels indicated that, in general, the remodeling had provided them with increased water supplies, and helped them to increase cropping intensities. On average, cropping intensity in the LSC had increased from 160 percent before remodeling to almost 200 percent. Important changes included increased mixed cropping (crops grown within the orchards) and intercropping (two crops sown together). Some farmers also reported an increase in the cropping intensity with three crops instead of two during each year as a result of remodeling.

The increase in cropping intensity was accompanied by a change in the cropping pattern. The trend for cultivating cash crops, like tobacco and potato, was significant in the head reaches of the LSC. The cropping pattern during the period from 1980 to 1991 reveals that the area sown under high water requirement crops, such as sugarcane, had gradually increased during the period.

Irrigation with fixed time turn rotation (warabandi) schedules for distribution below the outlet was the normal practice in the LSC before remodeling. With increased water supplies, the time required to irrigate a given plot of land had significantly decreased. This provided some flexibility to the farmers and resulted in deviating from a strict warabandi practice. Farmers tended to irrigate mostly during daytime, except during the peak demand period. Only 28 percent of the farmers interviewed reported the need for night irrigation. In a warabandi schedule, this proportion should have been closer to 50 percent.

The project's civil work had clearly helped to improve drainage in the command area. In part of the command area, where waterlogging was becoming an irrigation hazard, farmers tended to value the contribution of the improved drainage system more than that of the increased water supplies in their perceived economic benefits of the project. The new tile drainage system was perceived as having helped in the removal of excess water and salts from the soil. However, according to some farmers, this improved drainage had also abetted the rapid percolation of water, thus necessitating more frequent irrigation of some crops, like sugarcane. However, the impact of the absence of an appropriate institutional setup to maintain this expensive subsurface drainage system is not yet appreciated.

Impact of Remodeling to Water Control Systems

The design of the distributary outlet that delivers water to a watercourse can determine, besides the quantity of water to be delivered, the scope and nature of interactions between the operating personnel and the water users, and the interactions amongst the users themselves. The outlet design can also reflect the type of procedures and rules that would guide these interactions. In this sense, the design can decide whether the institutional arrangement at this agency-user interface is to be agency-dominated or user-oriented.

The design of the gated outlet for the LSC had been decided without a full consideration of such institutional implications, as apparently, the focus was on the immediate need to shift towards demand-based irrigation operations. With the gated outlets, as provided in the design, constant adjustment of the gates would be an important operational requirement as the outlet discharge would vary with fluctuating upstream head. However, a lack of preparedness in this regard resulted in not having in place either the necessary operating staff, an operational plan, or the organized water user groups.

The new design which incorporated gates in the outlets resulted in widespread tampering of the gates wherever they were first installed. The farmers in this area, especially in the head reaches of the distributaries, quickly started to use the maximum openings of the structures, thereby availing full irrigation supplies at their convenience. Consequently, tail-end farmers were not receiving enough water during the peak demand period and were compelled to irrigate at night when head-end farmers were not irrigating anymore. Subsequently, the authorities intervened to take control over the situation, and introduced locking devices to the gates.

With the LSC remodeling work nearing completion, the Irrigation Department, while taking over the remodeled system from the construction authorities, started to install yet another outlet, a different version of the original APM. This version is an improvisation by changing the traditional APM with the addition of a gate instead of the roof-block, and it appears to be a much simpler structure than any of the outlet structures designed by the project.

Midcourse design changes and inordinate construction delays have finally left the farmers with three different types of distributary outlets: the gated type constructed by the project, the modified APM put in by the Irrigation Department, and the original APMs remaining in some places. The confusion arising as a result of these differing distributary outlets clearly illustrates the lack of design attention on institutional aspects.

Similar to the design emphasis given to constructing the physical structure of the outlet without sufficient consideration of its institutional implications, control structures were designed and constructed at all diversion points and at drop structures, also without considering the specific operational requirements (Horst 1998). These control structures are hardly used. The main reason is the absence of a system of operational rules and the lack of required operational staff or users' involvement. The other reason is that, instead of the intended flexibility in water delivery, the same traditional supply-oriented system of uniform flows is still the preferred practice, despite the increased water supplies.

Institutional Response to Design

Irrespective of what the project documents conveyed, the behavioral response of the project's intended beneficiaries to project design was, at best, a passive one. The operating agencies, the farmers, and even the policy level officials were very slow in adopting the operational changes intended in the new design.

The general understanding among the users was that the initial remodeling objective was to enhance the LSC system's capacity to meet the requirements of an increased cropping intensity. However, whilst the capacity enhancement was meant to meet the peak water requirements, it was an extrapolation of this initial objective by the project planners, which also established the concept that the remodeled irrigation system should be operated according to crop water requirements. This concept implied a demand-based irrigation system. At a late stage of the planning process, there were doubts about the prevailing management and institutional conditions, and it was decided to plan a gradual change from the present operational mode to a demand system over a period of time. All the interviewees from the operating agency acknowledged this initial understanding. Clearly, the decision to install part of the physical infrastructure (cross-regulators in the distributaries and gated outlets) that was meant for immediate demand-based operations was a deviation from the common understanding, and was taken without consultation, or appreciation of the full implications.

Evidence of disinterest in the new system emerged from amongst both the operating staff and the water users. In the head reaches of the canal, where the gated outlets and radial gates for distributary regulation were first installed, the water users wasted little time in damaging the new infrastructure. The agency staff quickly pointed out how infeasible the design was in the light of this immediate rejection by the farmers, and saw the system as a waste of resources. This event illustrates the deficiency in coordination between design and management groups, and reflects a common attitude towards innovations funded by external aid.

According to farmers, they had very little knowledge of a demand-based irrigation system. This is understandable as the fixed time turn warabandi rotation system of water distribution is deeply embedded in the social norms associated with irrigation. It has been practiced for more than a century in the LSC system. In the absence of any formal organized group behavior, the farmers were perplexed as to how control could be effected. Should the control of gated outlets be taken over by the Irrigation Department staff, then, such an arrangement would offer them the least flexibility in making optimum use of irrigation allocations, thereby resulting in situations that had existed prior to the system remodeling. This, in their opinion, could not justify the expenditure towards purported improvements in the physical system. Farmers perceived the gated outlet as an opportunity for the officials to advance to this additional point of control and add to the existing official pressure on them, with all its accompanying social ramifications.

Even the designers' plans for management appear to have been neglected by policy. The design stage intentions regarding short- and long-term operation and management were discussed in the 1985 O&M Manual. These recommendations had not been developed through any consultation process during design, and also not seriously pursued during remodeling. During this period, the idea of institutional adaptations to improve agency resource capacity, or to establish water user associations did not attract policy attention. Consequently, the same organizational structure that existed before the remodeling exercise remained unaltered, but was entrusted with additional responsibilities.

An effort to correct this situation was made by the initial interventions of the donor missions. The donor's intentions, at that stage, were to pursue a shift from the traditional supply-oriented irrigation operation to a new and more flexible system taking into account the increased water supplies and the related need to make the system more responsive to crop water requirements. However, this idea seems to have been abandoned when project implementation delays were starting to exert a greater pressure than the good intentions. The project fell back to the usual confluence of interests, comprising those of the donor, the executing agency, and the consultant to place emphasis on completing the infrastructure components of the project. In the final analysis, there has been an inadequate policy consideration on the post-remodeling institutional requirements.

Thus, overall, the present operational conditions in the system reflect the effects of a lack of design-management interaction in the remodeling exercise, which has led to the institutional unpreparedness for the intended changes. The major reason for this negative institutional response can be seen in the rather misplaced overreliance on a number of broad design assumptions.

The O&M Manual is conspicuous in relying on broad assumptions for suggesting demand-based irrigation in the LSC. One assumption is the adaptability of the present institutional framework to undertake a swift shift to demand-based operations. For instance, the "demands" of the individual farmers were to be aggregated by a designated representative of the "Water User Association" (an organization which does not exist) in the form of a demand water order, which is supposed to specify the timing when the supply to the watercourse is to be turned on and off (i.e., the supply period) and the varied flow rates to be allowed for discrete time intervals during the supply period. Considering the poor level of education among the farmers in this area, it would be unrealistic to expect that they would be in a position to determine with any exactitude their periodic water requirements.

A second assumption was that the users were ready to introduce immediate flexibility in their daily or weekly irrigation practices, and in their related habits and customs. For example, the demand water order implies that irrigation supplies to the watercourses would be intermittent, and presumably during each supply period, the demands of all the irrigators on the watercourse would be met.

A third assumption was that the social background in the LSC area was harmonious, or at least self-sustaining, in the resolution of disputes. There was no mention of how the adjustments were to be made in the individual demands to make them realistic, nor of the procedures to be followed to resolve competing demands. For the distribution of the irrigation supply to the different farms at the watercourse level, and again between different watercourses, no methodology had been developed. The operation of the system with widely varying crop water requirements during the cropping seasons was another subject which had not been treated comprehensively.

Need for a Pre-Project Institutional Impact Assessment

Following the definition given by Perry (1995) of a functional irrigation system (referred to in the introductory sections of this report), the remodeled LSC can be described as a dysfunctional irrigation system. The new infrastructure has provided for increased water delivery, but is not fully geared to serve a clear set of water rights. The management structure in place does not have the full capacity to handle either of these two elements (water rights and infrastructure) in a satisfactory manner. The system does not satisfy the condition for being functional, in that the system's three critical elements, *water rights, infrastructure, and management responsibilities*, are not compatible with one another.

The case of the LSC illustrates many instances of project planning, where the designs are focused on establishing a physical system. Particularly in developing countries, when modern designs are imposed on social environments which are often unable to cope with their intended operational requirements, the lack of consideration on institutional implications of the design becomes a major issue. When modernizing an existing system, the problem is accentuated by the fact that the system is already having an established institutional framework. Some formal rules may only notionally exist, but the rules-in-use are fairly well established in a deep-rooted cultural background. The operating agencies and other related organizations have their own stable organizational cultures, determining the way the individuals and groups handle their responsibilities and manage resources. The major reason for modernizing an existing irrigation system should be that the system has ceased to be functional. If, as a result of the modernizing effort, the system continues to have, or newly acquires, dysfunctional features, the investment on system modernization is wasted and farmers' confidence in government and donor agencies gets eroded.

Therefore, in planning for modernization of existing irrigation systems, the design should also consider the institutional implications of changing the existing design. The main features of this required pre-project institutional impact assessment are outlined below (also see figure 4).

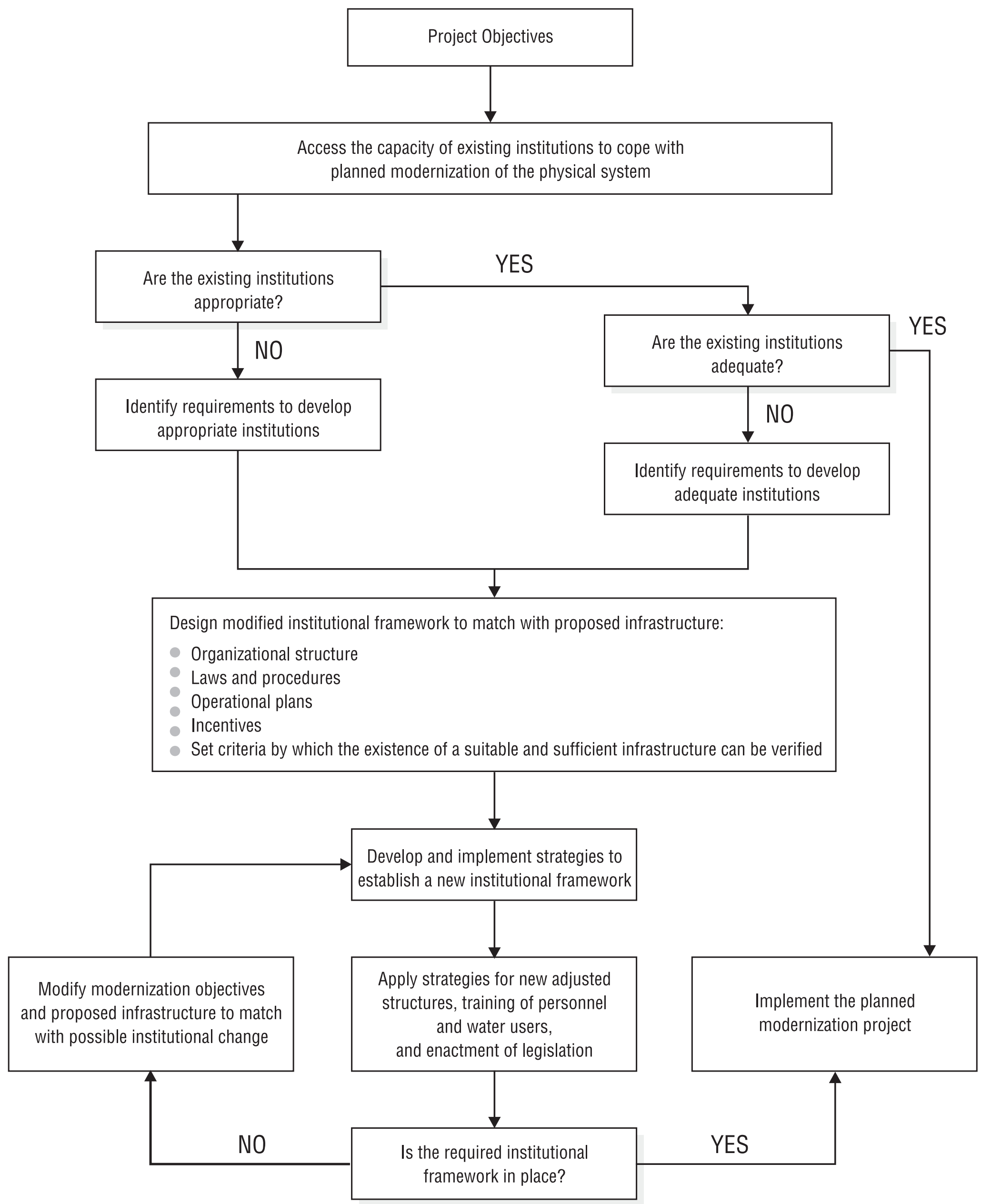
The procedure starts with a review of the existing institutional framework (including laws, rules and regulations, rules-in-use, organizations, and arbitration and accountability mechanisms) of the irrigation system to be modernized. During this review, the institutional capacity to absorb the changes in the physical infrastructure intended through the modernization effort is to be assessed.

The ability of the society and the economy to provide an adequate legal framework to effectively absorb the planned changes would largely determine the return on investment in modernizing the system.

Often, the modernization of physical systems in developing countries requires major changes in the existing institutions associated with them. An important design task is to identify the required institutional changes to match the intended changes in the physical system. A participatory approach to accomplish this task, involving the users, operators, and the policy makers, is most likely to generate the desired results. Changes in the infrastructure need to be compatible with the water rights, allocation rules, as well as the most appropriate and adequate management structures that can be developed in a reasonable period of time.

In some instances, the socioeconomic context may not allow a substantial change in the existing institutional framework in a reasonable period of time. Under such circumstances, the planners may have to reconsider their intended modernization designs and modify it if possible to suit the institutional changes that are possible. On rare occasions, no changes are possible in the existing institutional framework to absorb even the modified designs for system modernization. In such cases, the donors and policy makers should be able to take a bold decision to abandon the modernization plans and avoid a situation of wasted efforts.

FIGURE 4.
Institutional impact assessment process.



Conclusions

Lessons from the LSC remodeling experience point towards the important need for matching physical infrastructure improvements with corresponding improvements in the institutional framework.

In systems where management and physical conditions require improvement, a comprehensive "system renewal" is needed. Present day "modernization" attempts partly fulfill this requirement, in that they examine constraints in the physical system and try to find solutions in improving only the physical conditions. Constraints are systemic in nature and transcend the physical conditions to include the need to improve conditions related to manpower and social relationships. In this sense, the concept of "modernization" includes a review and improvement of four aspects: overall system objectives, and the physical, human, and social capital needed to realize the newly identified objectives.

The main reason for unfortunate missed opportunities in trying out something new and useful can be attributed to the failure during planning stages to plan the institutional changes required to achieve specified project objectives. The planning and designing of infrastructure modernization projects in developing countries must assess, as a criterion of project appraisal, the existing and the potential institutional capacity for post-construction operations of the facilities to be developed.

Finally, attention is drawn again to the valuable thoughts embodied in the earlier quoted words of Arturo Israel: "the real implementation problems (are) mostly institutional and managerial—in other words, they (are) rooted in the difficulties countries have in getting things done."

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