ASIAN IRRIGATION IN TRANSITION - SERVICE ORIENTATION, INSTITUTIONAL ASPECTS AND DESIGN/OPERATION/INFRASTRUCTURE ISSUES

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INTRODUCTION

Participatory irrigation management and irrigation management transfer reforms often have the stated objectives of providing sustainable and adequate financing for operation and maintenance of irrigation and drainage services and of facilitating investment in the required rehabilitation or upgrading of irrigation systems. Overall reform of water resources management often encompasses these reforms. It often includes demand management to encourage efficient water allocation and imposes new externalities on irrigation systems in terms of environmental performance.

In Asia, where the older public schemes reach the age of 30-40 years in most countries, the issue of rehabilitation, which is related to those of operation and maintenance and modernization, is becoming increasingly important. While for some countries the extension of irrigated land still represents an important part of irrigation programmes, in most countries rehabilitation programmes are taking on increasing importance. The content and orientation of rehabilitation in a context of PIM/IMT will therefore be critical. This paper reviews the concepts of irrigation management transfer, modernization and service. The paper then examines IMT and PIM in the context of reforms towards integrated water resources management.

It is important to understand the actual characteristics and water management in the systems that are being transferred. Thus, the paper reviews the actual systems as they exist and impact and results of IMT and PIM programmes in the region and focuses more particularly on water management for rice, which is the most important crop in the region.

The paper then expands on the notion and consequences of service orientation in irrigation and drainage, and examines requirements in training and capacity building in the sector. In the conclusion, some general findings and recommendations are made on investment in irrigation and drainage systems in the context of water policy and institutional reform.

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A. SOME DEFINITIONS

Irrigation Management Transfer and Modernization

Irrigation management transfer (IMT) can be defined as the turning over of authority and responsibility to manage irrigation systems from government agencies to water user associations (Vermillion, 2000). This involves two key roles: the authority to define what the irrigation services will be and the authority to arrange for the provision of those services. After IMT, the water users, typically organized into a water users association (WUA) decide what services should be provided, what their objectives and target should be, what service performance standards are acceptable. Arranging for the provision of those services includes choosing service providers and collecting whatever resources are required to implement the desired services.

Modernization of an irrigation system could be defined as the act of upgrading or improving the system capacity to enable it to respond appropriately to the water service demands of the current times, keeping in perspective future needs (, or as a process of technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation schemes with the objective to improve resource utilization (labor, water, economics, environmental) and water delivery service to farms (FAO, 1997). The process involves institutional, organizational and technological changes. It implies changes at all operational levels of irrigation schemes from water supply and conveyance to the farm level. The objective is to improve irrigation services to farmers although improvements in canal operation will generally be a critical first step in the process. It is they who have to take the final decisions on the modernization programmes and improvements should not stop at the canal level. Modernization thus defined assumes that IMT has taken place and that farmers are in a position to decided on the level of service they want and are willing to pay for. The term "modernization" refers therefore not only to the rehabilitation, upgrading or transformation of physical infrastructure in irrigation systems but also to innovation or transformation in how irrigation systems are operated and managed.

IMT programs commonly include efforts to rehabilitate, upgrade or modify irrigation infrastructure. They also often include efforts to introduce new management systems or procedures that are consistent with the expectations and constraints which result from IMT, such as service agreements, management audits, asset management and information systems. In the context of IMT, modernization is related to the process of transformation from supply-driven to service-oriented water delivery and to changes in governance of the systems for goal setting, which includes the decision on the service to be provided by the system (Facon, 2001).

There is a general acceptance of the principle that water management institutions should be consistent with hydraulic management units, either at the basin, system levels or within the systems, and in practice the configuration of the irrigation systems has had a great influence on the design on PIM/IMT programs. Other important linkages are related to the setting of objectives for the irrigation systems. Relevant to IMT would be among others the determination of cropping patterns by a previously top-down institution and of the service to be delivered to farmers and on the other hand the necessity to manage water supply and drainage effluents in a river basin/integrated water resources management perspective rather than for the single purpose of irrigating crops.

Service

The notions of water delivery service and of generalized service-orientation of institutions in the irrigation sector, whether river basin agencies, reformed irrigation agencies, irrigation service providers or water users associations has become central in new concepts and definitions of participatory irrigation management and irrigation management transfer. Literature on the evaluation of impacts of on-going participatory irrigation management and irrigation management transfer programmes in terms of water service delivery, agricultural productivity and agricultural performance indicates that improved service is a problem area (Facon, 2000). The sustainability of the water users associations is however now seen to depend on their capacity to provide an adequate water delivery service and control and to allocate water and to provide an improved service to enable gains in agricultural productivity (Svendsen, 1997). This is essential for the capacity of farmers to pay water and for the water users associations to be financially viable. As a result, it is now recommended that strategies of gradual improvement of irrigation systems be adopted to support the transfer of water management responsibilities and associated rights (Vermillion et al., 2000).

The concept of irrigation service was introduced in the 1980s together with methods to evaluate service quality (Burt et al. 1996). Service is not an abstract or generic notion: it can be qualified precisely in terms of equity, reliability and flexibility as well as adequacy. The degree of flexibility in frequency, rate, duration is what distinguishes and characterizes classes of service quality from rotation to on-demand. Thus, the decision on the flexibility at all levels and ultimately at the farm is the most important decision as regards service. Flexibility is most closely related to improvements in agricultural performance, crop diversification, etc. The service definition will also specify the responsibilities of all parties (farmers, Water User Associations (WUAs), operators of the tertiary canal, operators of the secondary canals, operators of the main canals, and project authorities) in operating and maintaining all elements of the system. A main canal provides water, with a certain level of service, to secondary canals. Each upstream layer in a hydraulic distribution system provides service to the layer immediately downstream of it. The actual levels of service at each layer must be examined to understand the constraints behind the level of service that is provided to the field.

There is a wide range of levels of irrigation service, and the nature of the service may vary significantly from a highly flexible service differentiated at the farm level to an inflexible service provided on an undifferentiated basis to a large number of farmers. It is therefore important to qualify the level of service. The levels of service may be different at each layer. It is also important not only to identify what the existing level of service is, but also what the expectations are at each layer of operation. In service-oriented water management, the decision on the level of service against the cost for providing this service, from ISP to WUAs and WUAs to users, is expressed through service agreements which are the foundation of an asset management strategy and managerial capacity upgrading programs which are translated into financial plans (Malano and van Hofwegen, 1999). Service agreements may be a modality to force a negotiation on service levels and initiate a process towards a transformation of top-down irrigation agencies by providing accountability and transparency.

B. PIM/IMT, MODERNIZATION AND INTEGRATED WATER RESOURCES MANAGEMENT

Irrigation sector reform and water sector reform

Participatory irrigation management lies squarely within an integrated water resources management (IWRM) perspective and the policy and institutional changes that this new perspective demands. The growing understanding of the centrality of water rights and water allocation issues reinforces this integration. Clearer water rights and farmer participation in basin water resources management to facilitate more equitable, more efficient processes to improve water use efficiency and reallocate water among users become an important issue. The future role of existing public irrigation agencies or departments must be considered in the context of:

- reform towards IWRM with new institutions and apex bodies at the national level and river basin organizations;
- a move toward irrigation management transfer, participatory irrigation management, in some countries, privatization of service provision and more decentralized management.

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Irrigation agencies that already perform water resources management functions must adapt to a context where regulatory and governance functions are assumed by new institutions and where many O&M-related tasks will be performed by new operators. In Indonesia, local irrigation services are being re-oriented towards supports to river basin management and advisory services to farmers' organizations and local governments within the re-organization of the sector following the new water policy developed under WATSAL and decentralization. In Sri Lanka, irrigation institutions are redefining their roles and strengthening their skills in view of the new IWRM policies adopted by Government. In Cambodia, a new Ministry of Water Resources and Hydrology has been created as a successor to the irrigation department previously under the country's Ministry of Agriculture.

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Introducing reform in the irrigation sector only does not allow for a re-definition of the missions of the irrigation agency within a re-organization of the whole sector. This may induce blockages and resistance to reform in the sector if the only future offered to agency staff is seen to be redundancy or early retirement, as shown in Andhra Pradesh (Vermillion, 2000).

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Box 1: Possible new roles for irrigation agencies

- River basin planning
- Water resources allocation & monitoring
- Development of new policies and regulations
- Environmental monitoring and enforcement
- Groundwater monitoring and control
- Project planning, design and construction
- Technology transfer to IA
- Advisory services to associations
- Monitoring of association performance
- Arbitrating disputes

(from Svendsen et al., 1997)

The need for a long-term vision

Integrated water resources management is a continuing process that needs to be integrated into economic development processes. In this context, it is necessary to have a long-term vision of integrated water resources management and of the transformations that will be required in each sector. For this purpose, the validity of strategic planning approaches to identify actions that need to be taken by each actor in each sector by redefining missions, goals, objectives, strategies and priority plans for immediate action has been tested by FAO and ESCAP in four countries in the region: Malaysia, Philippines, Thailand and Vietnam in 2000 (LeHuu Ti and Facon, T., 2001). This project was coordinated with the global, regional and national visioning processes animated by the World Water Council and Global Water Partnership in preparation of and as a follow-up to the Second World Water Forum at the Hague, 2000.This international initiative was taken with the objective of averting the looming water crisis and foster immediate concerted action. At the occasion of national round tables organized that year, these four countries have reconfirmed their national water visions.

Box 2: National water visions

Malaysia

In support of Vision 2020 (towards achieving developed nation status), Malaysia will conserve and manage its water resources to ensure adequate and safe water for all (including the environment).

Philippines

By the year 2025, water resources in the Philippines are being used efficiently, allocated equitably and managed sustainably with provisions for water-related disasters.

Thailand

By the year 2025, Thailand will have sufficient water of good quality for all users through an efficient management, organizational and legal system that would ensure equitable and sustainable utilization of its water resources with due consideration on the quality of life and the participation of all stakeholders.

Viet Nam

The Vietnamese Water Vision is the integrated and sustainable use of water resources, the effective prevention and mitigation of harms caused by water for a better future on water, life and the environment.

In these national vision statements, sustainability encompasses economic, financial, social and environmental dimensions and refers to the goal of meeting the needs of present and future generations within a framework of integrated water resources management as defined by the World Water Commission and the Global Water Partnership and collaborating institutions, building on previous definitions of CNUCED and the Dublin principles. Considering the national vision and specific considerations of food security, agricultural and rural development, the countries have defined sectoral visions that encapsulated integrated water resources management goals and developed priority action plans.

Significantly, irrigation management transfer and participatory irrigation management were high on the agenda in each country. By applying strategic planning approaches to the irrigation sector, Vietnam and the Philippines found that mere rehabilitation of irrigation infrastructure would not be sufficient to achieve the vision and the pilot introduction of modern water control and management concepts was identified among the main priority actions. Modernization of irrigation systems is already an integral part of Malaysia's water resources management strategies and is one of the measures being studied at present in Thailand. The study has shown that in practice several important issues need to be considered while one analyses organizational change for participatory irrigation management:

- Arrangements will need to take into account water rights and allocations in a river basin perspective;
- Modernization of irrigation systems can be understood as the combination of water management strategies and related institutional and technical solutions;
- An integrated water resources management perspective, even in the long term, requires changes now.

Environmental externalities

Historically, modifications to irrigation projects have not given thorough consideration to environmental consequences. But scarce water and concern for environmental impacts increase the need for improved on-farm irrigation management. Low irrigation efficiencies have been documented in various projects, and improved irrigation efficiencies are often listed as a major source of "new" water. However, it is now evident that return flows from an "inefficient" project are often the supply for downstream projects, in the form of surface flows or groundwater recharge (Seckler, 1996). Therefore, typical project irrigation efficiencies in the 20-30% range by themselves give no indication of the amount of conservable water within a hydrological basin unless that project is at the tail end of the basin. Conservation (i.e., less spill, deep percolation, and seepage) within one project may deprive a downstream project of part of its accustomed water supply (Burt, 1996).

Most "new" water for existing basins and projects will only appear if there is improved irrigation water manageability by farmers i.e. if the service delivered at farm level allows farmers to improve their on-farm irrigation practices. The potential sophistication of on-farm water management is highly dependent upon the level of water delivery service provided to individual fields, which in turn depends upon the conveyance manageability within the complete water distribution system.

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The critical importance of maintaining minimum flow rates and water qualities in natural drains and rivers is increasingly being understood. In the U.S.A. and Europe, for example, many of the recent irrigation system modernization efforts have stemmed from the need to reduce in-stream damage to endangered species of fish. In Malaysia, modernization strategies also incorporate similar environmental objectives for rivers. The quantities and timing of river diversions, and qualities and quantities of irrigation return flows, have a tremendous impact on the environment. Increasingly the issues will have to be explicitly dealt with by irrigation systems and farmers in the region. This is already the case in some of the most economically developed countries, and will be a future requirement in other countries, which must be anticipated now.

C. IRRIGATION SYSTEMS IN ASIA

The actual irrigation systems[2]

The concepts used for the development of irrigation by colonial powers were adapted to the conditions and to the objectives of irrigation in the past. Irrigation was extensive and the water resources were not regulated by large storage reservoirs. The design standards adopted in many developed and developing countries after the mid 1900s to deliver water according to crop demand were conceptually more advanced. However most of them fail to meet that objective because of the deficiencies of the water control technology and complexity of the operational procedures. Managing an irrigation system equipped with manually-operated gates at each branching point is a very complex task. In many cases, the systems were designed to be operated at full capacity without consideration for operation at less than full supply. The use of technology with continually adjustable structures which has been the norm during the three decades of intensive development of irrigation in developing countries from 1960 to 1990 has badly affected the performance of irrigated agriculture in many countries. Even the best qualified managers and operators would not be able to manage these systems to the highest standards. They simply cannot work. They are now impeding the transfer of management to user associations. They are being successfully automated in western countries but not in developing countries.

The farmers served by these systems responded to the economic changes and poor performance or inadequate service by tapping additional water resources to overcome the limitations of the existing systems, which were under sized for intensive irrigation such as the typical structured design systems or provided erratic water supply, to be able to adopt modern cultivation practices and diversified cropping patterns: tampering of control structures, pumping from canals, drains, borrow pits, replacing animal-driven pumps by motor-pumps and more recently tapping groundwater resources

[2] This section is further developed in a recent FAO publication: How Design, Policy, Management and Performance of Irrigation projects affect the performance of irrigation systems, FAO, Bangkok, 2002 (http://www.watercontrol.org/publications/publications.htm).

with a dense system of shallow wells or deep tubewells which provide the flexibility and reliability needed for modern irrigation at farm level. These responses from the farmers are inevitable.

If the water distribution rules define a pattern of water distribution that does not match technically feasible and desired goals of the water users, the users will subvert these rules (IWMI Research Paper 12). This will lead to poor water delivery performance and increases in the cost of irrigation to users. Inconsistency in the water distribution rules creates difficulties in system operations that are likely to lead to inefficient and inequitable water distribution performance. Especially inconsistency of rules between various levels: reservoir, main canal, channels is detrimental. Rules in channels cannot be followed if there is unpredictability of delivery by main canal.

Making water delivery match goals is important. The need for change in response to changing environment, changing agriculture, diversification, etc. requires adapting water distribution rules to changing demands. The users, on the other hand, must accept the limitations on uses imposed by water availability and the features of the system. These considerations call for a greater attention to an analysis of operational rules at all levels in the system and particularly to a proper articulation of operational rules at the interface between the future irrigation service providers and water user associations, to the necessity of improving operations in the upper levels of management if water users associations are to be in a position to develop applicable rules and procedures, and to the necessity of incorporating at all levels production objectives of the farmers.

Very few countries have adopted a full spectrum of modern irrigation concepts and standards consistent with service orientation. In a few cases, the design makes use of the most advanced technologies for water control but this is done to reinforce top-down management processes and the water distribution strategy lacks the flexibility required for a service oriented delivery. In other cases, the technology is inadequate to satisfy the stated objective of modern irrigation. This is partly due to resistance to change in irrigation agencies, which also concerns technical practices, but also often to a lack of knowledge of available options among the local professional communities. More frequently, neither the technology nor the strategy meets the definition of service orientation, including the projects with faulty designs, and operational procedures designed for the convenience of the operators, not of the users.

Initial system designs may represent a severe constraint to the adoption of new and more flexible operational procedures. Many problems related to inequity and unreliability of water service can be attributed to design and operational procedures, which, if left unchanged, will produce the same results whatever the governance setup. The question whether the technical/hydraulic dimension of irrigation can be brought under the control of agents focused on non-technical user-derived objectives is central as is this would characterize a service-oriented management. The case for reassessing the design standards, configuration and operational procedures at the moment of transfer as a result of a review or resetting of both internal objectives in terms of service with the water users and external objectives with water resources management institutions is therefore compelling.

An appraisal of initial conditions and performance of the systems to be transfer would allow both a better design and strategic planning of physical improvements together with a definition of the service to be provided both by the irrigation service provider to WUAs and by WUAs to their members, with indications on ways and means to achieve these service goals and improve them in the future, given the forces of change that effect the irrigated sector. To meet the conditions of the future, water delivery from irrigation projects should be more flexible and reliable. Operation rules should be transparent and understood by the users. As for requirements on system operations resulting from integrated water resources management, water rights and the necessity to satisfy different water uses with same primary infrastructure are not the only issue. Water obligations related to disposal and quality of effluents, other environmental requirements are or will be part of the externalities imposed on system managers in all countries.

Groundwater and IMT

In many parts of the world, groundwater is a major emerging problem. In some areas, overexploitation is posing a major threat to the environment, health and food security. The explosion of groundwater irrigation in some countries is a farmer response to the lack of flexibility and, in the worst cases, the unreliability of the canal irrigation systems. Water recycling and the conjunctive use of groundwater mostly happen as a desperate response from farmers who are unable to obtain their share of irrigation water from the canal or from systems managers as a way to rectify problems of management capacity and shortcomings of the original design. The benefits that the changes have brought to farmers include increased quantity of water, increased reliability of water and freedom for the families to choose their own crop strategies. Service requirements of the farmers are thus met, where possible, from other sources than the delivery of the main surface systems. It is therefore perplexing that, in spite of an affirmed service orientation, IMT or PIM programs often fail to take into account actual the service needs as expressed by farmers' actual practices and actual water management in the systems. New institutions appear to reflect the stated operations of the canal systems and not appear the need for combined management of water delivery, drainage, water recycling and conjunctive use. Whether this is a threat to the viability of the water users associations should perhaps be given more attention.

On-farm irrigation technology

The slow adoption of new on-farm irrigation technology is a perplexing issue. In addition to market and agricultural policy considerations, a principal reason is perhaps that the focus of attention in developing countries has occurred at the farm level, and not at the level of operation of the main and conveyance systems. Farmers will not invest in water saving technologies if the service of water is not reliable and if the economic incentives for saving on water, energy and labor are not strong enough. Many important management objectives can only be satisfactorily realized if the main water distribution system is well operated, and only then high returns can be obtained from agricultural extension advice and the increased application of other complementary inputs.

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Rehabilitation and upgrading

What are the practices through which physical works are planned in PIM/IMT programmes? Particularly in Asia, the most common planning tool is the walk-through. Lack of farmer participation in design and construction has been identified as a problem area and design processes are meant to be more demand-driven (Facon, 2000). The objective is to improve conveyance and reliability and reduce canal maintenance requirements (drop structures, etc.) (Vermillion, 2000, Bruns and Helmi, 1996, FAO, 1998). PRA mapping, transects, of land tenure, farming systems, ecosystems are also tools used on the field, mostly to prepare canal layout designs and identify objectives of rehabilitation/improvement. In practice, a diagnosis of operation procedures is not performed and operational rules and procedures are not really discussed or linked to identified works. Physical works are not related to service or performance goals. As a rule, expectations are low. The initial focus on upgrading is generally on reliability and equity, which are admittedly the first issues to address but there is generally no vision of future requirements. There is no discussion of flexibility, i.e. there is no discussion of the main aspect of service quality.

There is still a significant knowledge gap on the impact of IMT and PIM in general (Vermillion, 1997). However results of recent impact evaluations and efforts to synthesize existing literature allow us to draw some general conclusions on the impact of PIM/IMT programmes on the quality of water delivery service. However, as most of these programmes have included some measure of rehabilitation or upgrading or infrastructure or on-farm infrastructure development, it is often difficult to separate farmers' involvement benefits from other changes such as rehabilitation.

Quality of operations and maintenance is often a stated goal of programmes, but most of the evidence is qualitative statements. General impression is that after turnover, services have substantially improved in regard to timeliness, reliability, and equity. Increases in irrigated area and crop intensity are mentioned in many instances. Flexibility is not a service characteristic explicitly investigated but some results in terms of timeliness and adequacy are registered. Improvements in terms of water use efficiency are more uncertain.

In Asia, impacts are typically not noticeable in terms of agricultural performance: change in irrigated area, crop patterns, cropping intensity or yields, PIM has neither improved nor interfered with agricultural productivity (Vermillion, 1997, Svendsen te al., 1997, Rabi, 1998, Facon, 2000). The future of farming is seen to depend on diversification of crops and a more commercial orientation. Diversification makes irrigation management more complex. Irrigation systems may not have enough capacity to deliver water for other crops or irrigation practices or may need to be operated differently. Greater reliability may be required, through improved main system operation or through more flexibility for farmers to locally distribute water according to their needs. The necessity of reengineering irrigation, i.e. taking a fresh look at key processes and how they can best be carried out and of considering both hardware and software elements is emphasized as irrigation becomes more commercial (Bruns, 1996) but is in apparent sharp contrast with design processes and their outcomes.

Low productivity is also often but not always associated with small farm size, a subsistence orientation, production of low value crops such as grains, inappropriate agricultural policies, a poor natural resource base, and inadequate agricultural services. It is necessary to address these issues or provide assistance through other agencies for production increase, or to subsidize the association. For farmers, the second-generation IMT problem is to increase farm productivity to pay higher irrigation fees and to take advantage of possible improvement in irrigation service quality (Svendsen et al. 1997).

Type of investment projects

Lending for irrigation has progressively changed over time from a project-specific nature of investments to take the form of sector loans or national/regional in scope projects supporting the objectives of participation and capacity building. These projects often combine a mix of low cost rehabilitation projects and management reforms with attention to improved operation and maintenance and user participation. Low cost rehabilitation of irrigation infrastructure, in some cases an investment to catch up years of differed maintenance, cannot correct the deficiencies of the original design, if the causes of deficiencies are not identified through an in-depth diagnosis of the current system.

In Asia, where the older public schemes reach the age of 30-40 years in most countries, the issue of rehabilitation is becoming increasingly important. In theory, rehabilitation provide an opportunity to take into account the management patterns of operators and irrigators. In practice, however, rehabilitation simply re-establishes the physical configuration of the original system. The content and orientation of rehabilitation in a context of PIM/IMT will therefore be critical.

Towards gradual improvement strategies

PIM has generally led to modest efforts by farmers to improve management efficiencies and responsiveness. Significant future expenditures loom in the future unless observed under-investment in O&M is halted. It is therefore recommended to replace periodic rehabilitation with on-going infrastructure improvements jointly financed by government and the farmers, with the objective to improve performance and ensure financial viability and physical sustainability of irrigation.

An issue for the sustained success of participatory irrigation management is therefore the availability of financial instruments that allow farmers to invest in the upgrading of their irrigation systems. Decentralized irrigation improvement funds are increasing proposed in IMT programmes. Required support services could be: assessment of system facilities, credit, and design and construction assistance. The assessment can be done jointly by agency and WUA or contracted out: annual maintenance planning, selective improvement, planning whole-system rehabilitation.

Other regions have often adopted a radically different approach

In contrast with this model, IMT in other regions has often taken a very different shape, with a deliberate effort to change the control logic of the systems from the top down and the transfer of large units of the systems to large water users associations. IMT has been more engineering driven, and this is the main difference with Mexican, Turkish, US experience. The issue is whether basic flaws or constraints can be addressed with a light rehabilitation program and whether not doing so hampers IMT/PIM or jeopardizes the success of reform in terms of sustainability of institutions and financial sustainability.

D. RICE

Rice in Asia

In most of Asia, rice is not only the staple food, but also constitutes the major economic activity and a key source of employment and income for the rural population. Water is the single most important component of sustainable rice production, especially in the traditional rice-growing areas of the region. Reduced investments in irrigation infrastructure, increased competition for water and large or excessive water withdrawals from underground water (through drawdown, depletion, salinity build-up, salt-water intrusion or land subsidence) lower the sustainability of rice production. However, despite the constraints of water scarcity, rice production must rise dramatically over the next generation to meet the food needs of Asia's poor. By year 2025, rice production in Asia must increase by 67 percent from the 1995 production level in order to meet the increased demand for this cereal which is the staple for more than one-half of world's population. Producing more rice with less water is therefore a formidable challenge for the food, economic, social and water security of the region (Facon, 1999).

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About 80-90 percent of all freshwater resources used are for agricultural purposes and more than 80 percent of this water is used in irrigating rice. In other words, the efficiency of water use in irrigated rice production systems must be significantly increased. The existing strong interdependence between water use in the crop production subsystem and the operation of the irrigation facilities for water service elicits the need for pursuing a comprehensive agenda for improving the performance of rice irrigation systems (Bhuyan, 1996).

Diversification

Since no major net addition to currently irrigated rice areas is expected in the coming decades and major breakthroughs in raising yields of rainfed rice systems are unlikely to be available during this period, most of this additional rice will have to be produced in irrigated areas. In rice irrigation systems, rice monoculture is overwhelmingly the dominant practice. Diversification of the crop production system in these areas is desirable for several reasons. First, diversification will open opportunities for increasing farmers' income from their limited land resources. This is particularly important at the present time when profits from rice culture are very low and declining. Second, it is increasingly evident that, as productivity of the land under rice monoculture under wetland conditions is declining over time, a diversified agriculture will be more sustainable in the long run. Third, with increasing scarcity of water, irrigated agriculture will have to aim at maximizing return to water rather than return to land. Present rice culture systems require more water than most other food crops, both in terms of quantity of food and calorie produced. Therefore, a major scope exists for increasing returns from water by growing diversified crops, especially in areas of water shortage. To enable farmers to diversify their cropping pattern, they must be provided with facilities to exercize crop choice options, which is presently lacking in most rice irrigation systems.

Upgrading rice schemes

The task of upgrading or modernizing an irrigation system for rice cropping in the wet season and for diversified cropping in the dry season is complex. It requires that any permanent structural or physical upgrading to be done for rice must also conform to the requirements of the diversified crops to be grown in the dry season. It is therefore logical to assume that the upgrading of common denominator factors, i.e. factors that are relevant for both seasons, could be upgraded permanently and these should be handled by the main irrigation system. Examples of these would include upgrading of water control, drainage, reliable schedule of water delivery, etc. at the main system. The on-farm, crop-specific factors could be handled seasonally by the farmers themselves as individuals or as groups. Examples of this type of upgrade would include the same items, as above, but at the farm level. Provision of flexibility will become an additional requirement.

Reliable water supply is critically important for diversified cropping, as farmers have to invest much more for these crops compared to rice. Areas that are far from the irrigation source generally suffer more water shortage in the dry season compared to near-by areas. Means of augmenting water supply in these areas, if they are suitable for diversified cropping, have to be found. Shallow groundwater development through the private sector is often the most reliable and affordable water source for this purpose. Groundwater has the advantage of being available on demand at the farm and able to avoid major water distribution problems.

Suitable methods of water application to the crop (e.g., basin, furrow or basin-cum-furrow), methods of controlling seepage from canals or neighboring rice areas (e.g., dikes, interceptor channel, dike-cum-interceptor channel), or means of drainage enhancement (e.g., collector gravity drain, pumping, collector-cum-pumping) will be required. Diversified cropping requirements must be thoroughly considered in pursuing the modernization process, with the objective of raising farmers' incomes through provision of flexibility and option to choose crops in the dry season.

Water management for rice

As far as rice water management itself is concerned, whether one aims at raising water productivity or water use efficiency, it is now widely accepted that a river basin perspective should be adopted with much more attention being paid to defining the boundaries of intervention (farm, system, basin). Substantial progress has been made in defining concepts and methodologies (water accounting, modeling, etc.) but available data, which are already woefully inadequate to assess the merit of interventions at the farm or system level, water abstraction and even cultivated and irrigated areas, are even more lacking for the adoption of integrated river basin approaches. More attention must also be paid to water quality issues and particularly the release of pollutants (fertilizers and other agro-chemicals) and salt concentration.

Nevertheless, practices which minimize irrigation inflow are of a direct interest to farmers who see their water supply rationed and have to pay an increasing share of its cost, for managers and developers who also face rationing because of degradation of water resources, dam siltation, transfer to other sectors, etc. and have an interest in minimizing pumping costs, and operation and maintenance as well as development costs, and indeed for water resources managers who need to plan future irrigation developments with minimum environmental impact from withdrawals or reservoirs.

In addition, many major rice-growing areas are located in coastal plains. Furthermore, water saving practices, which require greater water control, typically are associated with or part of packages to improve agronomic practices and the efficiency of use of other inputs, and therefore play an important role in total factor productivity. They therefore contribute to increasing not only water use or irrigation efficiency but also to improving or sustaining water productivity.

Indeed, water management methods, which improve water use efficiency, have been developed with a view to maintain crop yields and actually, when implemented properly, lead to yield increases (in the range of 15-20% in China for intermittent flooding and other methods). It follows that, although it is correct and necessary to use rigorous concepts for efficiency and performance at system and basin levels, and to determine under various conditions the optimum combination of improved technologies and water management practices that can meet water demand with least water consumed and managing return flows to ensure system and basin level efficiency, in practice it is difficult to find water management techniques proposed for adoption at the farm level which do not simultaneously raise irrigation efficiency and water productivity. The acceptance by farmers of these strategies and practices will of course depend on economic factors (Klemm, 1998). Furthermore, they depend on improved water control and management of water at the system level, as well as adequate irrigation (in particular a reticulated irrigation distribution system) and drainage facilities. Their availability in China has allowed farmers to adopt the water savings techniques. However, typically, at that level, conveyance, field canal and distribution efficiencies are particularly sensitive to the quality of management, communication and technical control. When water supply within the system is unreliable, farmers try to store more water than is needed. In many large irrigation systems, few control structures at any level and poor drainage structures and poor drainage networks contribute to a waste of water.

Being confronted with this rather large number of problems, it is not surprising that farmers are reluctant to shift to more demanding water management techniques than flooding. However, considering the growing water scarcity and pressure on the irrigated sub-sector within the water sector and on agriculture by other sectors of society and overall economic development policies described in previous sections, there is not much choice and farmers must be provided both with a conducive environment and a proper production tool, i.e. better performing irrigation services.

Improvements in the operation and maintenance of rice irrigation schemes through rehabilitation of the deteriorated systems, improvement of irrigation infrastructure for surface irrigation, irrigation management transfer, modernization, combining to various degrees institutional, organizational and technical changes, have been attempted in the region with mitigated degrees of success. Studies undertaken by the World Bank in recent years have evaluated the impact of irrigation projects. A study of 1995 evaluated the design of rice project in the humid tropics and concluded, from the strong degree of resistance of farmers to new design standards and the level of anarchy and chaos observed on the schemes, that the more reticulated systems, capable of supporting on-demand water delivery, were not appropriate under these climates. A more recent study (1997) assessed the agro-economic impacts of investments in gravity-fed irrigation schemes in the paddy lands of Southeast Asia, to determine whether and how the quality of O&M services influences the sustainability of those impacts.

At four of the six sites, the areas supplied by the irrigation systems were significantly less than planned. Cropping intensities were also substantially lower than expected at three sites and falling at a fourth. Only one scheme had attained both its area and intensity targets. Paddy yields varied widely —between schemes and in comparison with expectations— but a weighted average for the wet and dry seasons at all the schemes was about 3.3 tons, or 85 percent of appraisal projections. However, farmers had not diversified out of paddy. Indeed, the concentration on paddy had increased. Output was between 32 and 73 percent of appraisal estimates for five schemes. The returns had also been driven down by the decline of the international price of rice.

Overall, agency and irrigator performance appeared to be substantially better than expected. Farmers cooperated to achieve at least basic O&M objectives regardless of the level of maturity of the formal organization. There were no substantial negative constraints on irrigated production attributable to poor performance in O&M. Those O&M operations that are essential to keep sufficient supplies of water flowing to the great majority of the fields were adequately carried out. The study also noted the dismantling of complex technological control systems installed in the 1980s in favor of fixed structures that have no adjustments and structures that adjust automatically to changes in water levels; the rejection by farmers of both rotations and gates. Rotations do occur, but they tend to break down under conditions of shortage, which is when they are most needed. The main finding was that given that they offered poor economics and low incomes, these paddy irrigation schemes faced an uncertain future. Small-holder irrigated paddy could no longer provide the basis for a growing, or even stable, household economy, driving younger family members off the farms while older members who stayed behind concentrated on basic subsistence crops, social capital would erode and O&M standards were likely to suffer. As economies expanded, irrigated paddy would not be able to compete with the incomes to be had from other employment opportunities. Improved O&M performance would not rescue them.

The study made these recommendations:

- Sharpen the response to O&M failures by disaggregating O&M; identifying the poorly performing components; and dealing with disincentives specific to each, such as the tertiary gates that farmers below consider unfriendly.
- Simplify the infrastructure and operations technology by converting to fixed and automatic controls that need less human intervention and by supporting authorities that plan with the farmers to abandon equitable rotations by rationing water during emergencies.
- Promote the transfer of management to farmers and their WUGs judiciously by recognizing that organizing user groups pays off, but also accepting that immature WUGs cannot handle some management responsibilities.
- Improve household earnings by diversifying cropping systems and supporting research, extension, and marketing services keyed to specialty crops and integrated, high-value farming.

The findings and conclusions of these two studies, combined with the results of the evaluation of modernization projects conducted by IPTRID in 1998, seem to be rather pessimistic and contradictory. However, put together, they tend to indicate that present project designs or operations are not capable of supporting both economically and technically the intensified, diversified and more water efficient and productive rice production systems which will be required in the future. They also seem to indicate that purely software solutions or mere improvement of operation and maintenance do not deliver the expected results in terms of improvements in performance and yields. They also reveal that many modernization or improvement efforts have been inappropriate, poorly adapted to local circumstances and the specific character of rice-based production systems, and incomplete or fragmentary. Conjunctive is practiced within "modern" irrigation schemes: it may provide a solution but is not available in all places.

E. TOWARD SERVICE ORIENTATION

Key elements of sustainable service oriented I&D management

Sustainable service oriented irrigation and drainage management can be characterized by the following (Malano and van Hofwegen, 1999):

- It is output-oriented: the cost of the service provision is based on well developed operation and asset management programs
- It involves users to determine levels of service and the associated cost of service

- The irrigation and drainage organization should be able to recover the cost of service provision either from direct consumers or from subsidies
- It relies on an appropriate legal framework that provides protection for users, the organization providing service and the general interest of society

The following paragraphs review key strategies, processes and issues that need to be addressed in the transition towards service provision, i.e. modernization as previously defined in this paper.

Design processes

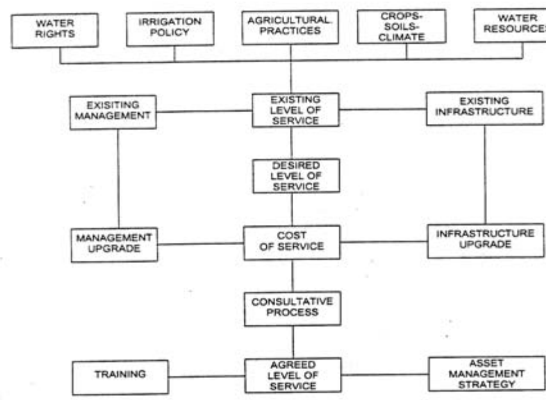
Performance of irrigation projects is determined by a combination of physical, institutional and policy factors. The gap between potential and actual outcome is strongly related to over-optimistic assumptions of the hydraulic performance at planning stage, and in a number of cases to faulty and unrealistic designs as well as construction. The performance of operation of irrigation systems is influenced by the capacity of the management agency to apply the operational rules defined by the designer. Many designs are difficult to manage under real field conditions. The professional context explains why design irrigation engineers know little about actual distribution processes.

Some of the reasons lie in administrative and behavioral reasons, mostly associated with the lack of experience, effective accountability and feed-back from operation of design engineers, whether in irrigation agencies or in local and foreign consulting firms, in lending policies of financial institutions, in lack of accountability of operators and managers to the users. In countries with large development of irrigation, the state officials have often entrenched engineering practices. The planning, design and construction process must produce a system and conditions capable of accommodating effective management practices. IMT provides an opportunity to correct the administrative and behavioral reasons at the stages of design, construction and operation.

Modern design is the result of a process that selects the configuration and the physical components in light of a well- defined and realistic operational plan, which is based on the service concept. It is not defined by specific hardware components and control logic, but use of advanced concepts of hydraulic engineering, agronomy and social science should be made to arrive at the most simple and workable solution. The most important issue is the system ability to achieve a specific level of operational performance at all levels within the system. A proper operational plan is the instrument that combines the various perspectives and helps reconcile conflicting expectations between the users, the project manager, the field operators and the country policy objectives. The second step is the planning of an irrigation project is the decision about water deliveries i.e. the frequency, rate and duration of water deliveries at all levels of an irrigation system. A water delivery schedule does not necessarily imply a specific design. A rigid schedule of water deliveries to the farm turnouts may use modern irrigation hardware and computerized decision support systems to make the water deliveries reliable and equitable, but a project designed for rigid rotation through simple non-adjustable structures or for proportional distribution cannot be operated for flexible water distribution. To a large extent, the layout, original design criteria and standards used for an irrigation project limit the options for its rehabilitation and modernization. In extensive irrigation projects with the objective of thinly spreading water, the design capacity decreases from upstream to downstream. Traditional delivery systems have no or little flexibility built into them and do not attempt to match water deliveries to crop needs. In responsive irrigation projects, the design capacity increases when moving downstream to accommodate the need for flexibility.

The decision on level of service

The level of service consists in a set of operational standards set by the irrigation and drainage organization in consultation with irrigators and the government and other affected parties to manage an irrigation and drainage system. It must emerge from an extensive consultation process. It should become a series of norms (targets) against which operational performance is measured, be revised on an on-going basis to respond to changes in irrigated agriculture and requires careful consideration of the cost associated with specific levels of service. A strategic planning and management approach is recommended. The formulation of level of service specifications is the central decision for strategic planning and future operation and management. For existing irrigation and drainage schemes, Malano and van Hofwegen recommend that the following process could be applied:



<u>Service agreement</u>

It is necessary for all service relationships to define services (transactions) and the conditions attached to them, and payment required for obtaining these services. These must be stated in quantifiable and measurable terms that are easily monitored and controlled. These can be formulated in service agreements in the form of contracts that contain details on the level of service to be provided by the organization, the obligations of customers and the organization and the process for resolution of conflict should these arise. Service agreements are being introduced in several countries in the region: Thailand, Indonesia as well as several Central Asian Republics. A service agreement consists of two main elements (Malano and van Hofwegen, 1999): transactions and accountability. The service agreement should therefore contain details on:

- Specification of service to be provided;
- Amount and form of payment of service by users;
- Monitoring procedures to verify whether services are provided as agreed;
- Liability to both parties for not fulfilling the agreement;
- Relevant authority to settle conflicts;
- Procedure for reviewing and updating the service agreement.

Accountability mechanisms defined through the service agreement provide:

- Operational accountability: monitoring, evaluating, controlling and enforcing;
- Strategic accountability: mechanisms that users have to control the formulation of the service agreement;
- Constitutional accountability: mechanisms by which users can influence the strategic decision making process of the organization.

<u>Management of irrigation systems</u>

Each level of service, to be achieved, depends on operational parameters. Requirements in terms of flow control systems and human resources must be clearly understood and planned for. It is also necessary to understand the internal mechanisms of irrigation systems, and to provide selective enhancement of those internal mechanisms, if irrigation project performance is to be improved. These "details" are so important that it has been argued that investments must be based around specific actions to improve them, rather than deciding on the framework for detail improvement only after the investment is approved (FAO, 1998).

Management of irrigation systems in a business and service oriented mode is also a complex operation. It requires advanced managerial skills and the ability to process and interpret large amounts of data. A feature of modern design and operation is often the minimization of the collection of large amounts of data for statistics while information needed for operation increases. For example water requests and water deliveries have to be recorded and matched with conveyance capacity, seasonal water allocation and total water availability. Water deliveries have to be converted into financial transactions. Payrolls and financial assets have to be managed as well as stocks, spare parts, vehicles and construction equipment. Maintenance programs have to be implemented and closely followed (Facon, 1997). Modern information and management systems are imperative to assist managers in performing efficiently their tasks. These tools can be used irrespective of changes in management structure, but the needs will also be felt by WUAs. The availability of management support tools can be seen as a means to facilitate their taking over their new managerial responsibilities.

Strengthening the management capacity and skills of WUAs is imperative to enhance the performance of irrigation systems. Approaches based on the irrigation agencies as sole capacity builders tend not to produce strong WUA institutions while approaches based on social organizers tend to neglect the upgrading of the necessary technical and managerial skills of the WUAS. Recent debates and conferences suggest that a polycentric approach where WUAs can elect to receive support from different operators, for the various skills that they need to acquire could be more effective:

- NGOs, local governments, consulting firms, federation of WUAs or river basin organizations, for building them as viable and independent institutions with good governance;
- the irrigation agency/services (reformed and strengthened on technical aspects and as a capacity builders) on aspects related to operation and maintenance at their level;
- agricultural extension, irrigation advisory services, etc.

Monitoring and evaluation

The effects of any program that modifies the organizational arrangements for providing the service must be evaluated in terms of the quality of that service (Svendsen, 1997). In a typical IMT monitoring and evaluation system, key issues about outcomes and impact include as potential immediate outcomes the quality of the water delivery service. Possible eventual impacts are related to socio-economics and productivity. Potential areas of interest for water users are estimated to be the quality of O&M, the cost of O&M, the use of funds collected, agricultural and economic productivity. Impacts, which are the indirect or ultimate effects of an intervention, include cropping intensity, number of crops grown, if design and operational rules are performance-oriented. M&E is meant to provide information but also to strengthen local management capacity, enhance skills and support problem solving by WUAs. Standard tools are: walk-through and inspection of irrigation systems, planning maintenance or rehabilitation priorities, preparing O&M plan, supervising field staff, conducting technical audits.

In the service concept, the outcome and impact indicators listed above are actually the specific objectives of service-oriented management. Indicators can be classified as indicators for comparing the performance of irrigated agricultural systems, or external performance indicators, and internal process indicators. External indicators examine values such as economic output, efficiency, and relative water supply (i.e., ratios of outputs and/or inputs). Targets are set relative to objectives of system management, and performance measures tell how well the system is performing relative to these targets. These performance indicators are primarily applicable to compare actual results with what was planned – say, to compare outputs from a project before and after. The objective of internal indicators is to assist managers to improve water delivery service to users. Internal indicators include indicators to concretely measure service at all levels and could be very useful in M&E systems as service is generally assessed simply by sampling or polling.

Irrigation management audits, asset assessment and management, benchmarking

Benchmarking, which uses primarily external performance indicators, could be introduced as a way for continuously assessing management performance before, during and after IMT and maintaining a dynamic of improvement. Irrigation management audits can be used to assess performance according to key indicators listed in a service agreement.

Where infrastructure is still owned by the government after IMT, they can be a joint exercise between the irrigation agency, WUA and local government to assess governance and service provision, including technical, financial and organizational aspects. A prerequisite for management audits is a detailed initial assessment of assets to be transferred with their condition and functionality, and systematic monitoring of assets through detailed survey and monitoring.

Design and operation for IMT.

Management of a relatively large system is generally divided between various units. The locations of the interfaces between these levels have an important influence on the way the system is operated and its hydraulic performance. If management of the main system has to be divided between units, the interface should be located at hydraulic "breakdowns" such as reservoirs. The trend is to transfer the management of large sections of irrigation systems to large user associations, such as Turkey and Mexico. The contractual approach to bulk supply provision or irrigation service provision may require changes in hardware and operational rules at the interface between the management levels.

Precise, but user-friendly, control of flows and measurements of volumes is needed. Reforms often include the establishment of water rights and trade of these rights, and the pricing of water on a volumetric basis. The design of irrigation projects should take these reforms into consideration. A rigid system with fixed distribution structures is not compatible with water trading. Measurement and control are required where trading is expected to occur. The layout of the canal network should also be designed so as to be integrated with not only the roads and drainage system, but also with the multi-level of management, whether from the agency or user associations.

Economic evaluation.

Conventional economics use a high discount rate for future costs and benefits and fail to show the importance of maintenance in sustaining the life of a system and the livelihood of farmers. The result is a that a project with a low initial cost, which deteriorates quickly and is dependent for continued survival on timely and properly funded maintenance, or with high operation costs (pumping schemes) is preferred to one that is constructed to need less maintenance or lower operation costs because it appears cheaper. Such a project may not sustainable without government subsidies, and will have to be abandoned unless governments keep a policy of subsidizing irrigated agriculture. Governments must therefore carefully consider the potentisl impacts of new financing policies for the sector.

Subsidies do leak to non-poor. But lack of subsidies (or too low) may mean farmers – especially poor farmers – become unable to pay the full cost of water fees (especially if for example, prices fall as they have done for staples) and so unable to support private sector involvement. On the other hand,

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too much subsidization may mean investments are made in poor-quality projects, with low rates of return. Local irrigation improvement funds can represent a viable option if allocation of subsidies in the form of matching grants is made according to transparent criteria and decided through a process where the central and local governments as well as WUAS are represented. Pro-poor water management is a developing field of research and experimentation that hopefully will provide indications on financial mechanisms that do not disadvantage or exclude the poor, including pro-poor targeted subsidy schemes.

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The case for a massive re-training of engineers and managers in irrigation agencies, consulting firms and Irrigation Service Providers

Intensified and on-going training programmes for both professionals in the reformed irrigation agencies, consulting firms who will provide advisory services to water users associations and to the managers of water users associations and the technical staff that they may employ for operation and maintenance of their irrigation schemes are understood as one of the conditions for sustained success of the transfer programmes (see for instance the FAO-INPIM email conference on IMT).

It is therefore essential that these programmes introduce and provide knowledge on ways and means to design and operate irrigation systems cheaply for good performance and adequate service to farmers as they evolve toward more commercial forms of agriculture. An appraisal of initial conditions and performance of the systems to be transfer would allow both a better design and strategic planning of physical improvements together with a definition of the service to be provided both by the irrigation service provider to WUAs and by WUAs to their members, with indications on ways and means to achieve these service goals and improve them in the future. It is suggested that the Rapid Appraisal Process[3] developed and used in the evaluation of modernization programmes of IPTRID could be used for this purpose at programme appraisal stage and for individual irrigation systems. Internal process indicators would be useful in monitoring and evaluation systems.

A pilot training programme on modernization concepts and application of the Rapid Appraisal Procedure, which builds on the knowledge synthesis acquired in recent years on modern design principles and participatory irrigation management shows promising results. Its application to a system in Thailand by staff of the Royal Irrigation Department gave very promising results (see Appendix 1). A concept for a more ambitious re-training programme based on the same concepts and tools has been developed and could be supported in the context of efforts to improve the performance of programs to transfer the management of irrigation systems to the users (Burt and Facon, 1999).

F. CONCLUSION

The notion of water delivery service and of generalized service-orientation of institutions in the irrigation sector, whether river basin agencies, reformed irrigation agencies, irrigation service providers, water users associations has become central in new concepts and definitions of participatory irrigation management and irrigation management transfer. The evaluation of impacts of on-going participatory irrigation management and irrigation management transfer programmes is one of the reasons of this evolution.

Literature on the evaluation of impacts of on-going participatory irrigation management and irrigation management transfer programmes in terms of water service delivery, agricultural productivity and agricultural performance indicates that improved service is a problem area.

[3] The manual and files for the RAP can be downloaded from: http://www.watercontrol.org/tools/tools.htm

The service orientation of irrigation water delivery doers not appear to be sufficiently taken into account in processes and tools for design and preparation of operation and maintenance plans infrastructure rehabilitation works, monitoring and evaluation systems. For the large systems, partial or gradual transfer may not provide explicit steps for a real decision on service and the gradual building upstream of governance structures by federation a constraint to address the central strategic questions of service at the beginning of the transfer process. For small or traditional schemes, the question of future needs of irrigated agriculture is often not asked. IMT has rarely affected the design processes. The sustainability of the water users associations is however now seen to depend on their capacity to provide an adequate water delivery service and control and to allocate water and to provide an improved service to enable gains in agricultural productivity.

In the context of Asia, diversification of rice crops is a major issue for increased income by farmers and improved agricultural and water productivity. This in turn is essential for the capacity of farmers to pay water and the water users associations to e financially viable. A more forward-looking strategy anticipating these future needs is therefore required.

As a result, it is now recommended that strategies of gradual improvement of irrigation systems be adopted to support the transfer of water management responsibilities and associated rights. Concepts of irrigation management transfer/participatory irrigation management transfer and modernization are therefore converging. However, there are still some substantial differences: modernization stresses that the infrastructure/physical improvements which must be supported must be designed with a view to improve equity and reliability of water delivery service and evolve towards increasing levels of flexibility. Operational and technical details become very significant. Environmental considerations need to be better taken into account in a perspective of integrated water resources management.

A more forward-looking strategy anticipating these future needs is required. Recent visioning processes in the water sector provide a good condition for strategically planning organizational and technical changes in participatory and irrigation management. This in turn is essential for the capacity of farmers to pay water and for the water users associations to be financially viable. An appraisal of initial conditions and performance of the systems to be transfer would allow both a better design and strategic planning of physical improvements together with a definition of the service to be provided both by the irrigation service provider to WUAs and by WUAs to their members, with indications on ways and means to achieve these service goals and improve them in the future.

Although the relationship between design and operation is not univocal, initial system designs may represent a severe constraint to the adoption of new and more flexible operational procedures. Many problems related to inequity and unreliability of water service can be attributed to design and operational procedures, which, if left unchanged, will produce the same results whatever the governance setup. Many of the transferred systems cannot effectively provide needed or a reasonable level of service, now and in the future, with a limited program of repairs or with rehabilitation. This threatens the capacity of the water users associations to carry the costs of operation and maintenance of the systems unless service is improved significantly and unless they are in a position to improve agricultural performance.

Knowledge in the field on how to design and implement service-oriented water control and management is lacking but capacity building components for agency decision makers and field staff, ISP/project operators and managers, consulting firms, water users associations do not address sufficiently the practicalities of design, operation etc. on top of governance aspects and advisory services. Even if conjunctive use and recirculation are practiced in many cases, PIM/IMT often only concerns surface water systems and their management. This may be a problem for the viability of the newly created institutions.

Delivering an improved service, securing a water right, charging a water fee may require improved water control and measurement of discharges at all levels of the irrigation system. One can therefore argue that there is a case for reassessing the design, configuration and operational procedures at the moment of transfer as a result of a review or resetting of both internal objectives in terms of service with the water users and external objectives with water resources management institutions.

Another serious issue is to ensure that rehabilitation, modernization do not increase farmer dependence on the government, In particular, it is now thought that irrigation system improvement works should be planned and implemented after transfer. Subsidies may still be required but they should be smart. The new ideas about decentralized irrigation improvement funds are an example of these “smart” subsidy systems that encourage investment of the users in the maintenance and upgrading of their schemes.

The required transformation of irrigated agriculture will not take place just as a result of transfer and demand for improved services. Technical advisory services, financing arrangements, and other agricultural support services will be required.

Therefore, concerning the financing of irrigation and drainage systems in the context of water sector and institutional reform, the following conclusions can be made:

1. The IMT and PIM reforms do present good opportunities to redress the present under-investment in operation and maintenance or upgrading of the irrigation and drainage systems;

2. The service-orientation of irrigation and drainage service providers represents a new model for financing of irrigation and drainage services;

3. A condition for the success of these reforms is that farmers be provided with a good service: this may entail a significant departure from the mere cosmetic or light rehabilitation or upgrading which is typically financed in the context of IMT/PIM programmes in the region;

4. A second condition for the sustained success of participatory irrigation management is the availability of financial instruments that allow farmers to invest in the upgrading of their irrigation systems;

5. A third condition is a substantial increase in the training and capacity building components of these programmes;

6. A fourth condition seems to be that irrigation sector reforms should be part and parcel of a more general reform of water resources management, in which issues of water allocation, water rights, ownership of transferred assets and the future of the irrigation agencies are addressed;

7. Another condition for the sustainability of the reforms is the development of a suitable service environmental to assist farmers in increasing the productivity of agriculture.

Performance Evaluation of Makhamtao-Uthong Project with a Rapid Appraisal Procedure

The Makhamtao-Uthong project performance appraisal: context

Thailand has invested in the past large amounts of capitals for the development of new water resources. There is now however very little scope for further expansion of water supplies. Increased competition from industrial and urban consumption and explosive growth of rice cultivation during the dry season over the last three decades raise a new challenge for the government of that country.

At the request of the Royal Irrigation Department of Thailand (RID), FAO has recently organized a training workshop on irrigation project modernization, in March 2000, with support from the World Bank Research Committee. This workshop was organized in the context of the preparation of the irrigation management modernization component of the Natural Resources Management Project, which Government of Thailand would submit to the World Bank for funding. Twenty-two staff and consultants were trained in modern irrigation and management concepts and developed a priority modernization plan, which will be used for the detailed preparation of the modernization component.

The two-week workshop included a three day course to present modern concepts in water control and management, a Rapid Appraisal Procedure (RAP) using a field questionnaire to compute internal and external performance indicators, a five-day field visit to assess the Makhamtao-Uthong project, a sub-project of the Chao Phraya project, and three day to evaluate the results of the field evaluation and formulate proposals for the modernization of management of that project. During the last day, the trainees developed their own conclusions and recommendations and presented them to RID Management and consultants in charge of preparation of the World Bank proposed project.

The training programme used extensively the tools and findings of a major and unique study funded by the World Bank Research Committee and implemented by IPTRID on the evaluation of the impact on performance of the introduction of modern water control and management concepts on 16 irrigation modernization projects including 6 rice irrigation schemes. This study has been published by FAO as Water Paper Series 19.

The RAP quickly (within a week) evaluates an irrigation project to assess what type of modernization is needed. External performance indicators are also quantified. These characterize the inputs and outputs of irrigation projects, including amounts of water, yield, and economics. A detailed questionnaire is developed to obtain information needed for external performance indicators and internal process indicators. A list of baseline project data (acreage, budgets, crops, climate, water availability) is requested from project authorities prior to the visit. Typical baseline data is either available or it isn't. If the data does not already exist, spending an additional 3 months on the site will not create the data. Baseline project data is needed to quantify external performance indicators. A 5-day visit is made to the project. Ideally, only 1 day is spent in the office to examine system maps and to review the baseline project data that has been prepared in advance. The majority of time is spent in the field with field engineers/operators, making observations and collecting the data needed for internal process indicators. Substantial lengths of the main canal, some secondary canals, tertiary canals, etc. are visited. Observations are made regarding the types of structures, general conditions, operator instructions, quality of flow and water level control, and other operational points. Impromptu conversations are held with farmers and operators. Short visits are made to any water user associations that may exist.

Internal indices provide ratings to hardware, management, and service throughout the whole system at all levels, an approach which has not been used in the past. The complete picture enables one to visualize where changes are needed, and what impact the changes would have at various levels.

When the internal indicators are examined together and also combined with some of the external indicators, a clear image emerges about the design, operation, and management of an irrigation project.

The table below provides information on one of the internal process indicators, including weighting factors of the sub-indicators. The final weighted scores of the internal process indicators were always adjusted so that the maximum (best) indicator value is 10.0, and the lowest value is 0.0.

Sub-indicators for Indicator I-1 (Actual service to individual fields, based upon traditional field irrigation methods).

No.	Sub-Indicator	Ranking Criteria	Wt
I-1A	Measurement of volumes to field	4 - Excellent measurement and control devices properly operated and recorded. 3 - Reasonable meas. & control devices, average operation. 2 - Meas. of volumes and flows - useful but poor. 1 - Meas. of flows, reasonably well. 0 - No measurement of volumes or flows.	1
I-1B	Flexibility to field	4 - Unlimited freq., rate, duration, but arranged by farmer within a few days. 3 - Fixed freq., rate, or duration, but arranged. 2 - Dictated rotation, but matches approx. crop need. 1 - Rotation, but uncertain. 0 - No rules.	2
I-1C	Reliability to field (incl. weeks avail. vs. week needed)	4 - Water always arrives with freq., rate, and duration promised. Volume is known. 3 - A few days delay occasionally, but very reliable in rate and duration. Volume is known. 2 - Volume is unknown at field, but water arrives when about as needed and in the right amounts. 1 - Volume is unknown at field. Deliveries are fairly unreliable < 50% of the time. 0 - Unreliable freq., rate, duration, more than 50% of the time; volume is unknown.	4
I-1D	Apparent equity	4 - It appears that fields throughout the project and within tertiary units all receive the same type of water. 3 - Areas of the project receive the same amounts, but within an area it is somewhat inequitable. 2 - Areas of the project receive somewhat different amounts (unintentionally), but within an area it is equitable. 1 - It appears to be somewhat inequitable both between areas and within areas. 0 - Appears to be quite inequitable (differences more than 100%) throughout project.	4

The Makhamtao-Uthong canal system

The Royal Irrigation Department (RID) of Thailand selected the Makhamtao-Uthong (MU) canal system in the Chao Phraya basin for the field exercise included in the schedule of the training workshop. The Lower Chao Phraya Project, a nearly one million ha project, is served by 5 main canals diverting the Chao Phraya water from Chainat diversion dam. The Lower Chao Phraya Project is divided in 26 Operation and Maintenance Areas. The boundaries of O&M areas were defined for limiting the distances from area headquarters but are not based on hydraulic considerations. Each canal system is under the responsibility of several O&M areas. Each area is responsible for sections of several main canals. Consequently it is very difficult to get the basic data to calculate the external performance indicators of individual canal system. The Project is under the management of RID Region VII on the Right Bank and Region VIII on the left bank. The Northern part of the Lower Chao Phraya project is a typical conventional gravity gated system. The Southern part, south of Ayutthaya, is a typical delta irrigation system where the navigation channels play the role of irrigation, drainage, flood and pollution control canals.

Each dry season, the RID Office of Hydrology and Water Management allocates the volumes available from the two main storage reservoirs of the river basin for municipal and industrial supply, irrigation, navigation and pollution control and determines the areas of the Lower Chao Phraya that would be irrigated. RID records indicate that areas irrigated during the dry season exceeded planned areas by about 20 to 35 % during the years 1995 to 1998 (Table 1). In 1999, under the pressure of farmers' complaints, RID increased the volumes of water released from Bhumipol and Sirikit dams by about 15 to 20 % while water was available till the reservoirs were nearly drained. Exceptional rains in spring 1999 saved the dry season paddy crop.

Table 1: Planned and Actual volumes of water released from Bhumipol and Sirikit reservoirs (MCM) for dry season and planned and actual paddy areas (ha)

Year	**1995**	**1996**	**1997**	**1998**	**1999**
Water availability in both dams (MCM)	12733	14582	12107	6200	3879
Domestic water supply	1100	1800	1650	1600	650
Dry season crop: Phitsanulok	300	800	500	500	150
Dry season crop: Chao Phraya	3000	4150	3700	2900	1900
Navigation	300	400	300	300	0
Water supply Bangkok	700	750	750	750	650
Salinity control	600	600	500	450	350
Total planned (MCM)	6000	8500	7400	6500	3600
Total actual (MCM)	7216	9643	8556	6656	2575
Area planned (ha)	448,000	560,000	528,000	432,000	304,000
Area actual (ha)	512,000	669,000	649,600	606,000	538,000
Actual volume (m3/ha)	7366	8839	7954	7870	6743

Use of groundwater for irrigation has exploded during the last 5 years. It is reported that 28,000 tubewells are now in use in region VII. The MU canal is the most western system on the Right Bank of the river. The MU canal system consists of a 104 km long canal with a design capacity of 35 m3/s and twenty-four lateral canals serving about 44,500 ha on the left bank. Only the last 15 km of the main canal are concrete-lined. Lands on the Right Bank of the main canal are also irrigated by illegal pumping from the main canal and by drainage inlets. However no systematic monitoring of the illegally irrigated areas and volumes diverted has been made. The guess-estimates vary from to 2,800 to 8,000 ha. The MU canal system was designed for supplemental irrigation during the wet season (0.78 to 0.82 l/s/ha).

Responsibility for the management of the MU system is shared between three O&M area projects: Poniathep, Thabothe and Don Chedi. Don Chedi is only responsible for the last 47 km of the main canal and lateral canals serving 23,700 ha. RID Office of Hydrology and Water Management prepare a seasonal delivery schedule in advance. The MU main canal diverts water from a branch of the Chao Phraya River about 15 km upstream of Chainat diversion dam. The design of the intake affects the delivery of water to the MU project area. The intake was designed for delivering the design capacity flow when the water level is at (or about) normal full level. A pumping station was constructed in 1998 to supply water when the level drops below that level. Upstream weekly variations of water level in Chainat reservoir, of about half meter, are due to the reduced power generation at Bhumipol and Sirikit plants and the reduced water released during weekends. The MU main canal is operated on rotational basis during the dry season: Water is delivered for 10 days to the lateral canals upstream of km 57 and for 12 days to the downstream lateral canals. A second 6-day upstream /downstream rotation was established between the lateral canals of Don Chedi. Finally water is delivered on rotation basis to the farm outlets.

The main canal is equipped with 6 gated cross-regulators, none of them with a weir section. All the gates are manually operated. The operation concept is based on delivering target flow downstream of each cross-regulator, particularly at the interface between O&M areas. The offtakes of lateral canals are either equipped of single gates or constant orifice gates (one of the gates frequently being not installed). All the field operators of cross regulators and lateral offtakes are supposed to and apply strictly the instructions given to them by the Operation chief of their O&M area. None of them is expected to take any initiative in adjusting the gates. A considerable volume of information is transmitted from the field to higher level for statistical purposes.

Flows in the main canal are calculated by the orifice formula with a low degree of confidence; and flows diverted to the lateral canals are determined by "experience". All the farmers interviewed during the field visit reported having an individual pumping equipment used to pump from any possible source of water: Main or lateral canals if gravity supply is insufficient, main and tertiary drains, borrow pits along the main canal, and groundwater. Farmers interviewed are hardly aware of RID plans to match the irrigated areas in the Chao Phraya basin with the water available in storage dams. All of them admit that they take risk, maximize pumping and eventually would request RID to increase water releases through political channels. Rice is the main crop during dry and wet season. Average annual cropping intensity is about 170-180 %. Sugarcane is cultivated in Don Chedi area and fishponds are also important. Average farm size is about 2.5 ha with a maximum of 15 ha. Average yields during the last five years in Don Chedi area were about 4.05 and 4.80 tons/ha. The volumes of water delivered at the head of Don Chedi area during the dry season 1996-98 range from 7900 to 8700 m3/ha. The Don Chedi O&M project has 155 employees of which 12 officers. (Administration section: 11; engineering section: 7; mechanical section:8; operation: 100+ of which water masters: 2; zonemen: 12; gate tenders: 38; canal tenders: 37). This staffing is rather high (150 ha per O&M staff). No water charges are collected from the farmers. However farmers spend between 10 to 35 US$/ha in pumping costs per dry season. The annual budget of Don Chedi area is about US$ 27.5/ha for O&M (excluding improvement works), of which about 66 % is for staff salaries (US$ 18.2/ha).

External performance and internal process indicators
Some external indicators required for giving a score to some internal sub-indicators have been estimated. The values of indicators of outputs/unit areas of the MU Project are in a good average, given the high cropping intensity and crop yields. Water indicators (relative water supply and relative irrigation supply) are certainly on the high side compared with other projects. The canal system is just able to pass the peak evapotranspiration requirements for a 100 % cropping intensity (cropping intensity is about 75% for the authorized irrigable area, but additional irrigated area on the right bank pushes the "legal" cropping intensity close to 100 %.). The volumes delivered to Don Chedi area (8,500 m3/ha) for the dry season are far below the volumes reported in other performance studies and even in feasibility studies. Obviously the main reason is the high level of recovery of drainage water within and on the boundaries of the project, combined with the use of groundwater. The average values of internal indicators as rated by the trainees for the project were:

I -1	Actual service to individual fields, based on traditional on-farm irrigation methods	4.1
I- 2	Actual Service to avg. point of Effective Differentiation based on Traditional On-Farm Methods	2.6
I -4	Actual Service by main canal to its subcanals	3.7
I- 5	STATED service to fields.	3.4
I- 6	STATED service to avg. point of EFFECTIVE differentiation.	4.1
I- 8	Stated Service by main canals	6.9
I- 9	Evidence of Lack of Anarchy in Canal System u/s of ownership change	4.8
I- 10	Cross-Regulator Hardware (Main Canal)	2.3
I -11	Capacities (Main Canal)	5.7
I- 12	Turnouts (from Main Canals)	5.1
I- 13	Regulating Reservoirs	0
I- 14	Communications (Main Canal)	4.7
I -15	General Conditions (Main Canal)	7
I -16	Operation (Main Canal)	0.5
I -28	Number of Turnouts/(operator, gate oper., supervisor)	0.5
I -29	Feedback Information	0.5
I -30	Computers for billing/record management	2
I -31	Computers for Canal Control	0
I-32	Effectiveness of water supply releases from reservoir	3
I-33	Effectiveness of main system operation	5
I-34	How closely are instructions followed?	10

The analysis of the internal indicators and sub-indicators reveals that:

- The main canal provides a very poor and inequitable service to the secondary canals and sub-projects
- The reason lies not in poor maintenance nor in the cross-regulators but how they are operated
- Secondaries provide a very poor service to the points of effective differentiation (irrigation blocks
- Poor performance at the farm level is compensated by pumping and conjunctive use
- There is a water supply problem which cannot be solved overnight (linked to water level at the Chao Phraya dam on the Chao Phraya River)
- As instructions are followed, the solution lies in changing the instructions to gate operators. Some minor adaptation of cross-regulators would provide much more flexible and equitable distribution
- Communications and procedures can be drastically improved
- Staff density is very high and can be reduced
- There is no reliable measurement at any level

In addition:

- A transfer of the canal as it is presently operated would create problems of inequity between secondaries and sub-projects that cannot be solved by institutional measures alone.
- Rules established by WUAs equivalent to present rules would be subverted by farmers, as they are at present, for the same reasons.
- Shallow water tables are not available everywhere.
- The canals do not dominate some areas.
- Establishment of WUAs at the level of secondaries would allow controlling the problem of illegal turnouts and implementing a different operation strategy negotiated with the main canal ISP. Upstream and downstream areas have different cropping patterns that could be accommodated by a different service.
- Problems of inequity between upstream and downstream require a re-centralization of operational responsibilities for water dispatching in the main canal.

Priority Action Plan

The recommendations presented by the trainees during the closing session derived from the assessment of the external and internal indicators included:

Priority	Cost (Million Baht)	Action
1	0	Change instructions: water level control and empower operator to make adjustments
2	0	Establish a single operation unit for the main canal
3	5	Flow measurement at the head of the canal and each project
4	1.2	Flow measurement at the head of each secondary (flumes)
5	5	Long-crested weirs at cross regulators
6	0	Better transfer of data on turnouts
6	0.1	Walkie talkies for zonemen and gate operators
6	0.4/year	Improved mobility/transport
7	6	Motorize cross-regulator gates
8	0	Control or eliminate illegal turnouts

Longer-term measures identified were:

- Management of water recirculation within the project
- Management of conjunctive use
- Development of tertiary network
- Improve water supply to the main canal

Conclusions
The MU project is performing well in terms of productivity and water use despite the low capacity delivery of the canal system. Farmers have invested in individual farm pumps that have allowed secondary water sources to be tapped, the development of conjunctive use, increased reliability in water supply and to some extend in crop diversification and fishponds. The importance of individual pumping is overwhelming but has an economic impact on farmers' income. An evaluation limited to external indicators of the Makhamtao-Uthong system would have concluded that the project compares well with the best performing rice projects of the IPTRID study. Obvious recommendations would have been to establish water user associations and a system of water charges. The internal indicators provided the basis for a rational program of improvement that will enhance the operation, management and outputs of the project.

Benefits expected from a modernization program are expected to be a reduction in pumping costs and a reduction in O&M staff. Given the present efficiency of the project and of the Lower Chao Phraya Project it is doubtful that a modernization program could generate some water savings. However the improved reliability associated with a better discipline in water allocation should have a positive impact on crop productivity.

Proposed changes would enable a transfer of water management to users in good conditions of equity between different areas with the possibility to implement rules at the level of the secondaries, and to apply and enforce a water allocation and water charging system. Most of the actions identified are of the software type and require training only. The physical upgrading identified is minimal and costs less than the upgrading budgets currently spent on the system.

The RAP procedure, which has been defined in the course of the IPTRID study, is rapid and comprehensive enough to give good indications of the critical internal links of an irrigation system. The complete picture provided by external and internal indicators enables one to visualize where changes are needed.

More generally, this training workshop has confirmed the efficacy of the modernization concept and tools such as the RAP for rapidly designing suitable irrigation modernization strategies. It is suggested that conducting a similar training programme for national officers and consulting firms including a RAP of selected representative schemes at early stages of project appraisal could lead to improvements in project scoping, design and strategy.

This is the approach followed with the World Bank in the context of the preparation of the Vietnam Water Resources Assistance Project: a first training workshop was conducted in March 2002 with the Rapid appraisal of the Cam Son- Cau Son irrigation system. Another workhsop is planned in May 2002 for the staff of the Dau Tieng irrigation scheme. Subsequently, during the implementation of an irrigation modernization programme, carrying out a Rapid appraisal of each scheme to be modernized by trained local staff and consultants could lead to similar improvements. Indeed, re-training of staff at all levels should be considered an essential component of an irrigation modernization programme.

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