WORKING PAPER 118

A Proposed Framework for Irrigation Management Transfer in Iran: Lessons from Asia and Iran

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International Water Management Institute

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IWMI receives its principal funding from 58 governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). Support is also given by the Governments of Ghana, Pakistan, South Africa, Sri Lanka and Thailand.

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Acknowledgements: The authors gratefully acknowledge the financial support of the Government of Islamic Republic of Iran that enabled this research. They also want to acknowledge the logistical support and guidance provided by the Vice Minister of the Bureau of Extension of the Ministry of Jihad-e-Agriculture during the field visit to Qazvin Province and the symposium on Water Users Associations held in Tehran during March, 2006. They also gratefully acknowledge the insights provided by Dr. Rajabi, Dr. Balan, and Mr. Yusufi of Bureau of Extension and their kind support for the visit and arranging participation in the WUA symposium as well as organizing the field trip to Qazvin. They are also thankful to Mr. Ali Ghasemi, Head of WMC of Qazvin Plains.

Ul Hassan, M.; Qureshi, A. S.; Heydari, N. 2007. *A proposed framework for irrigation management transfer in Iran: Lessons from Asia and Iran.* Colombo, Sri Lanka: International Water Management Institute. 37 pp. (IWMI Working Paper 118)

/ irrigation management / privatization / institutions / water resource management / water users' associations / irrigation systems / Asia / Iran /

ISBN 978-92-9090-660-5

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Acronyms and Abbreviations

APFMIS	Andhra Pradesh Farmers Management of Irrigation Systems
BoE	Bureau of Extension
DC	Distributary Committee (in India)
DSI	General Directorate of State Hydraulics (in Turkey)
DWMO	District Water Management Organizations (Central Asia)
FO	Farmer Organization (in Sri Lanka and Pakistan)
FSU	Former Soviet Union
FUWUA	Federation of Unionized Water Users Associations
GNP	Gross National Product
IA	Irrigation Associations (Turkey)
ID	Irrigation Department (Pakistan, India)
IMT	Irrigation Management Transfer
IWRM	Integrated Water Resources Management
MCM	Million Cubic Meters
MoC	Ministry of Cooperatives, Islamic Republic of Iran
MoJA	Ministry of Jihad-e-Agriculture, Islamic Republic of Iran
MoE	Ministry of Energy, Islamic Republic of Iran
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
JICA	Japan International Cooperation Agency
PC	Project Committee (in India)
PCI	Pacific Consultants International
PIDA	Provincial Irrigation and Drainage Authority (in Pakistan)
RCO	Rural Cooperative Organizations
RPC	Rural Production Cooperative
RWAO	Ravansar Water Affairs Organization
UWUA	Union of Water Users Associations
WMC	Water Management Company (responsible for main canal management)
WRWUDSC	Western Regional Water Utilization and Delivery Services Company
WUA	Water Users Association
WUCC	Water Users Cooperative Company (equivalent to WUA)
WUG	Water Users Group (at the watercourse level)

Abstract

Iran is facing a serious water scarcity and the Government of Iran is trying to implement technical and institutional measures to meet the challenge. One of the key strategies being persuaded by the Iranian authorities is the devolution of management responsibility to users. Thus, irrigation management transfer (IMT) has been adopted as a key strategy to improve the operation and maintenance, and thereby reduce losses, and enhance the sustainability of irrigation infrastructure. However, IMT efforts are at an inception stage and are largely happening in areas where infrastructure is under rehabilitation. The key objective of this paper, thus, was to review the ongoing IMT efforts in the two provinces of Iran, as well as the lessons from the neighboring countries, and propose a viable framework for implementing IMT. To get the first hand information of the IMT activities in Iran, field visits were carried out in the provinces of Qazvin and Kermanshah where two big pilot projects are being carried out. For comparative analysis of the IMT situation in neighboring countries, a comprehensive review of experiences in Sri Lanka, India, Pakistan, Turkey and Central Asia was carried out through literature survey. Based on the synthesis of lessons from this exercise, the paper proposes a framework for irrigation management transfer in Iran.

INTRODUCTION

The populations and governments of water scarce countries face the challenges of optimizing allocation and utilization of the limited water resources for food production, and rural livelihoods. The challenges are further compounded by the emerging competition from the non-agricultural uses, and the environment (Molden and Bos 2005). Governments tend to revisit their policies and introduce institutional reforms to re-allocate water and utilize it efficiently to optimize benefits and conserve the environment. Policy objectives of reforms differ greatly (Vermillion and Sagardoy 1999), and thus achieve varying outcomes. In addition, while considerable preparatory inputs are usually provided to prepare policies and legal frameworks, a necessary but not sufficient condition for achieving the desired objectives (Prathapar et al. 2001; Molle et al. 2004), the enforcement mechanisms generally receive less attention. Water reforms, if not conceived and implemented well, can lead to further deterioration of the situation rather than improving it (Kendy et al. 2003) and often might actually hit the poor hardest (van Koppen et al. 2002). Iran, an extremely water scarce country, in its intent to search for solutions for optimizing the use of water resources, intends to devolve water management to local level institutions, and some efforts have been piloted.

Iran is one of the most water scarce countries and faces the multiple challenges of a rapidly growing population, limited freshwater availability and over-exploitation of groundwater. In this context, the Iranian government has embarked upon various policies aimed at improving the productivity of land and water resources. One of such policies is devolving the responsibility and authority of irrigation management to users through irrigation management transfers. This paper documents the outcomes of the establishment of Water Users Associations (WUAs) in Iran, and the issues around these reforms, and proposes a framework based on the lessons learned from Iran and elsewhere in Asia.

The following section briefly describes the context in which IMT is taking place in Iran. The section *Key Elements of Iran's Water Policy for Agriculture* briefly presents the key priorities for agricultural water management and institutions managing water and efforts to improve institutions related to IMT. The section *Progress in IMTs: Experience from Two Irrigation Systems in Iran* summarizes the situation with regard to IMT in two provinces. The section *Lessons from Neighboring Countries of South, West and Central Asia* entails lessons from the neighboring countries. The section *Conclusion: Proposed IMT Framework for Iran* proposes an IMT framework for Iran based on experiences in Iran and neighboring countries, and concludes the discussion.

IRANIAN CONTEXT

Natural Conditions

Iran, one of the oldest civilizations of the world, is situated in the Middle East region of Southwestern Asia and is located between 25° and 40°N and 44° and 63°E. The national territory covers a total land area of about 1.65 million square kilometers(km^{2}). About 52 percent of the country consists of mountains and deserts and 16 percent of the area has an elevation of 2,000 meters(m) above mean sea level. Of the rest, about 11 percent is covered by forests, 8 percent is pastureland, and about 1.5 percent of the land is used for cities, villages, industrial centers, and related areas. In mountain valleys and in areas where rivers descending from the mountains have formed extensive alluvial plains, much of the soil is of medium to heavy texture and is suited to a variety of agricultural uses when brought under irrigation. Northern soils are the richest and the best watered.

Iran is the most populous country of the region, and the 16th most populous in the world. The total population is about 67.3 million (1995)[1], of which 41 percent is rural. The average population density is 41 inhabitants per kilometer (km), but varies considerably across various provinces (FAO 1997). The annual demographic growth rate was estimated at 3.4 percent over the period of 1980 to 1990 and at 2.6 percent between 1990 and 1994. The population living in urban areas has increased by 14 percent during the last three decades. Currently, 61 percent of the people are living in urban areas as compared to only 47 percent in 1976. This fast urbanization has increased the domestic and industrial demand for water, which has put enormous pressure on the agriculture sector to reduce its consumption of water and increase the productivity of available water resources. In order to sustain agriculture, serious efforts are needed to generate economic activity in the rural areas to restrict migration of rural population to cities.

Climate

Although climatic conditions of Iran are typically of an arid and semi-arid region, it enjoys a wide spectrum of hydrological conditions. Annual rainfall ranges from less than 50 millimeters (mm) in the deserts to more than 1,600 mm on the Caspian Plain. The average annual rainfall is 252 mm and approximately 90 percent of the country is arid or semi-arid. Overall, about two-thirds of the country receives less than 250 mm of rainfall per year.

The distribution of rainfall varies from region to region. The north, west and southwestern regions of Iran cover only 30 percent of the total land area whereas the amount of rainfall they receive is over 56 percent. For this reason, these areas are considered most suitable for rain-fed agriculture and dry farming. In other parts of the country, dry farming is also practiced but the yields are very limited. The central and eastern parts of the country cover about 70 percent of the total land area whereas their share of rainfall is only 43 percent. In these regions no crop production is possible without assured irrigation. This is mainly due to very low rainfall and high evaporation rates. In some low-lying plains of central plateau, the average annual rainfall is about 50 mm whereas the annual evaporation may exceed 4,000 mm.

Agriculture and Rural Economy

Agriculture accounts for about 25 percent of the country's GNP and employs about 27 percent of the workforce. It supports about 70 percent of the population, produces more than 80 percent of the total food requirements, produces 90 percent of the raw material and accounts for 33 percent of the non-oil exports. Over the recent years, the agriculture sector has achieved a growth rate of 5 percent with some fluctuations mainly due to changing climatic conditions.

Iran is a land abundant and water short country. The cultivable area is estimated at about 51 million hectares(ha), which is 31 percent of the total area. Of this, about 18.5 million ha (36% of the cultivable area) is considered usable for agriculture, while only 14.4 million ha is actually cultivated. Of this area, 12.8 million ha consisted of annual crops and 1.6 million ha of permanent crops. The potential of irrigable area has been estimated at more than 12 million hectares whereas

[1] According to the other literature, the population is 60 million based on 1996 statistics, of which 38 percent lives in rural areas. The average population density is also reported as 36 inhabitants per km^2 (Shiati 1999). The average rate of population growth is reported as 3.91 percent during 1976-1986, 2.46 percent over a period of 1986-1991 and only 1.47 percent from 1991-1996.

due to shortage of water only 7.3 million hectares is being irrigated (partially or fully). About 6 million hectares are rain-fed.

Wheat and barley are major crops and grown on more than 75 percent of the land area. Other important crops include cotton, rice, maize, dates, fruits, tea and tobacco. There have been significant increases in the gross production and yields of major crops over the last two decades. However, the overall yield per hectare of most of the crops is still far below than their demonstrated potential. The annual cropping intensities in Iran are about 95 percent as compared to over 100 percent in most of the regional countries. Table 1 gives the details of cultivated area, production, and yields per hectare of the major crops for both rain-fed and irrigated areas of Iran.

Despite the marked geographical differences in wealth generating capacities across the country, there is similarity to village society irrespective of location or agro-ecological zone. This cross-section covers small landholders, landowners, sharecroppers, absentee landlords and landless tenants. The distribution of rural population is largely determined by the availability of water, rainfall and arable lands. A high proportion of farms are considered small in size. About 70 percent of the landholders possess less than 5.5 ha (of which on average 2.13 ha are irrigated and 3.25 ha are rain-fed). These are generally subsistence farmers with no surplus products for sale. Their farm incomes are low because landowners exploit the labor of sharecroppers to earn more profit. But sharecroppers cannot afford to buy more than this land due to lack of capital and resources for inputs. Therefore, off-farm income generating activities, such as carpet weaving and other crafts, have evolved as a part of tradition and culture and remain crucial to household survival, and serve as an integral part of rural landscape to achieve modest living in many rural areas of Iran. The majority of women works in agriculture and constitutes a large portion of the agricultural labor force. Rural women play a very important role in animal husbandry. Women do more than 86 percent of the milking, and 42 percent of the feeding, watering and health care of animals. Women also carry out 90 percent of the milk processing, both for home consumption and for sale.

Table 1. Area, production and yields of major crops in rain-fed and irrigated areas of Iran.

Crop	Irrigated lands			Rain-fed		
	Area (million ha)	Yield (kg/ha)	Production (ton x 10^3)	Area (million ha)	Yield (kg/ha)	Production (ton x 10^3)
Wheat	2.27	3,145	7,141	4.23	720	10,044
Rice	0.56	3,253	2,350	-	-	-
Cotton	0.21	1,951	410	0.028	1,437	40
Barley	0.63	2,815	1,771	0.87	833	2,498
Forages	0.91	9,970	9,115	1.76	7,006	10,542
Sugar-beet	0.025	24,859	4,754	-	-	-
Fruit trees	1.70	6,670	11,249	0.15	2,000	300

Source: Shiati 1999

Socioeconomic Conditions

During the past two decades, Iran has continued to experience a slow transition from a traditional rural-based society to a semi-industrialized society. This has brought many challenges for the local people that include a high unemployment rate (presently estimated to be above 25%), distorted distribution of income and inequity in opportunities for growth. Although the official figure for

poverty in Iran is set at 18 percent of the population, more than 16 million people (about 25%) are estimated to be living under the poverty line.

Due to inadequate income distribution and poor caring practices, malnutrition is relatively high, especially in rural areas. Iran has made good progress in extending health and sanitation facilities to the people. Safe drinking water is available to 93 percent households and 73 percent have access to sanitation. Currently, over 85 percent of the population has access to health services and trained doctors attend 90 percent of the births. Average life expectancy and infant mortality rates have decreased remarkably over the recent years. Infant and under five mortalities are 28.6 and 35.6 per 1,000 live births, respectively. Disparities related to gender and areas are still considerable. For example, the literacy rate for men is 85 percent compared to 75 percent for women. Although the urban-rural gap has narrowed to about 14 percent (86% for urban population versus 72% of the rural), there are still noticeable differences among and within different provinces and cities. In most of the cities in Iran, the wastewater from the municipal areas, as well as the effluent from the industries, is disposed of untreated to natural surface bodies. This creates un-hygienic conditions for the inhabitants of these areas.

Water Resources of Iran

Iran can be divided into several basins and sub-basins. There are several large rivers. The Karun River, with a total length of 890 km is formed by the Euphrates and the Tigris after their confluence. The few streams that empty into the Central Plateau dissipate into the saline marshes. All streams are seasonal and variable. Spring floods cause enormous damage, while there is little water flow in summer when most streams disappear. Water is however stored naturally underground, finding its outlet in subterranean water canals (*qanats*) and springs. It can also be tapped by wells. The rainfall characteristics of the above basins are summarized in Table 2.

Table 2. Rainfall in major river basins of Iran.

Basin	Total area (km^2)	Percentage of total area (%)	Rainfall (mm/year)	Rainfall (km^3/year)	Percentage of total rainfall (%)
Central Plateau	832,000	51	165	138	33
Persian Gulf and Gulf of Oman	431,000	26	366	158	38
Caspian Sea	178,000	11	430	77	19
Lake Hamoun and Kara-Kum	150,000	9	142	21	5
Lake Orumie	57,000	3	370	21	5
Total	1,648,000	100	1473	415	100

Source: FAO AQUASTAT

Internal renewable water resources are estimated at 130 km^3/year. Surface runoff amounts to 97.3 km/year, of which 5.4 km^3/year comes from drainage from aquifers (spring flows), and groundwater recharge is estimated at about 49.3 km^3/year, of which 12.7 km^3/year is obtained from infiltration through riverbeds. Iran receives 6.7 km^3/year of surface water from Pakistan and some water from Afghanistan through the Helmand River. The flow of the Arax River, at the border with Azerbaijan, is estimated at 4.63 km^3/year. The surface runoff to the sea and to other countries is estimated at 55.9 km^3/year.

According to 1998 estimates, the total water consumption is approximately 88.5 cubic kilometers (km^3), out of which more than 93 percent is used for agriculture while less than 7 percent is allocated for domestic and industrial uses (Keshavarz et al. 2003). The existence and importance of groundwater has been known and understood for thousands of years. However, due to emerging water demands and shortage of surface water, farmers are tempted to use more and more groundwater to meet their crop water requirements. The use of groundwater for irrigation purposes is much higher in Iran when compared to many other countries of the world (Table 3). Presently, more than 50 percent of the water available at the farm gate comes from groundwater. The current estimated annual groundwater abstraction is about 55 billion cubic meters (BCM) compared to annual recharge of only 46 BCM. Due to this 9 BCM annual overdraft, groundwater tables are declining in many areas. Pumped groundwater is used for irrigation both in isolation and in conjunction with the surface water, which is creating serious salinity threats in the irrigated areas.

Table 3. Groundwater use for irrigation in selected countries.

Country	Irrigated area (million ha)	Irrigation use (km^3/year)	Proportion of groundwater (%)
India	50.1	460	53
China	48.0	408	18
Pakistan	14.3	151	34
Iran	7.3	64	50
Mexico	5.4	61	27
Bangladesh	3.8	13	69
Argentina	1.6	19	25
Morocco	1.1	10	31

Source: Qureshi 2004

Development of groundwater has been a key contributor in enhancing agricultural productivity and drought mitigation. In recent years, tube well development in Iran has taken a quantum leap. Current estimates show that there are about 470,000 tube wells in Iran as compared to only 230,000 in 1990 (Tamaab 2004). Most of the wells are owned by private farmers with no limits on groundwater abstraction. This unsystematic and un-regulated use of groundwater for agriculture is replete with serious consequences. Over-pumping is causing decline of groundwater tables in many areas, which is not only increasing the pumping cost but also deteriorating the quality of pumped water. The problem is much more severe in irrigated areas where large quantities of groundwater are annually pumped to get higher yields of crops. Although no detailed investigations about groundwater quality deterioration is available, there is evidence of arsenic contents in both surface water as well as groundwater. Mosaferi et al. (2003) have found six times higher values of arsenic in the water used for drinking and domestic purposes in the Kurdistan Province. However, no detailed studies are available to find out the cause of arsenic presence.

Irrigation Water Management

Despite the shortage of water, the over-use of water in irrigation is a major problem in Iran. At present, a big gap exists between water delivery from main canals and water application in the field. The emphasis has been much more on the water resources development and very little attention

is given to water resources management. The use of earth bunds, unlined canals, poor leveling of fields, combined with low water charges have resulted in low water use efficiencies and serious drainage problems in irrigated areas. The overall efficiency of irrigation systems ranges from 33 to 37 percent. In practical terms, therefore, much surface water is lost en-route, which, if salvaged, could be profitably used to bring more areas under irrigation.

On-farm water application rates are generally high in the country. Table 4 shows that the amount of water applied to different crops is two to three times higher than the world average (Keshavarz et al. 2003). Even though water requirements for different crops depend upon environmental conditions, soil types and other factors not equal across sites, there still appeared to be considerable scope for improving water use efficiencies by adopting improved and innovative water management technologies. Currently, only 2 percent of the cultivated area is equipped with pressurized irrigation systems and the remaining 98 percent is irrigated through traditional flood/basin methods of irrigation.

Table 4. Average amount of water applied to different crops for irrigation in Iran.

Crop	World average (m^3/ha)	Iran (m^3/ha)
Wheat	4,500-6,500	6,400
Melons	7,000-0,500	17,900
Sugar-beet	5,500-7,500	10,000-18,000
Rice	4,500-7,000	10,000-18,000
Sugarcane	15,000-25,000	20,000-30,000
Corn	5,000-8,000	10,000-13,000

Source: Keshavarz et al. 2003

KEY ELEMENTS OF IRAN'S WATER POLICY FOR AGRICULTURE

Iran's water policies can be understood by examining the following legal documents (Government of Islamic Republic of Iran 2003):

(a) The law of preservation and maintenance of groundwater resources of 1966;

(b) The law on water and its nationalization of 1968;

(c) The law on equitable distribution of water of 1982, that was subsequently amended in 1990;

(d) The law on maintenance and fixing of boundary of riverbeds of 1983; and

(e) The law of promotion of investment in water projects in Iran of 2003, and subsequent bylaws

These laws are complemented by "Long-Term Development Strategies for Iran's Water Resources" that was approved by the Cabinet of Ministers of Iran on October 19, 2003. Below is a brief account of the situation of water resources management and use.

Key Priorities of Iranian Water Resources Management

Water policies in Iran have undergone remarkable changes over the last century. In the major law approved in 1968, water was declared as "national wealth and belongs to everyone" (Marjanizadeh et al. 2007). This law recognized the earned water rights of the people and the government was made responsible for maintenance of water infrastructures. In 1983 the "Law of Fair Water Distribution" was introduced and all water resources of the country were declared as the property of the government, and the Ministry of Energy was made responsible for distribution of water to different sectors. This law was later modified to include certain other parameters such as optimization of available water resources.

The key objective of all these legislations was to improve water demand and allocation regulations, optimize agricultural water use, introduce water pricing for different sectors, improve repair and maintenance of irrigation structures and control environmental pollution. While doing so, very ambitious targets were set for the next 20 years. For each river basin, it advocates structural and non-structural actions to increase the proportion of surface water and reduce the proportion of groundwater in overall consumption in the coming 20 years. The share of surface water resources should be increased to 55 percent from the current level of 46 percent in the next 20 years and provisions should be made to allocate required baseflow for environmental sustainability. It proposes water reforms to reduce the agricultural share from 93 to 87 percent.

Achieving these targets require considerable efforts in improving water use efficiencies, modernization of irrigation infrastructure, prioritization of water use and enhancement in management capacity. This implies that institutional structure and procedures of water allocation and use in the agriculture sector should be modified. Over the last 10 years, the government has taken several steps to improve management of water resources. This includes determination of real water demands for different agro-ecological zones, rehabilitation and modernization of irrigation infrastructure, pricing of surface water and groundwater use, and introduction of high efficiency irrigation systems. However, all these efforts are still in the early stages and effectiveness of these measures still has to be seen for long-term sustainability of agriculture in the country.

Water consumption, or demand by users, is determined by cropping patterns, prices of crops, volume and quality of irrigation service delivery, irrigation technology used by farmers, and the appropriate level and structure of irrigation service fee (ISF). Some of these elements, such as the quantum and quality of irrigation service delivery, water regulation and distribution practices, and organization of O&M, and levels and structure of ISF can be influenced through appropriate IMT designs. The strategy prioritizes water allocation as drinking, hygiene, industry and services, gardening and agriculture. Control of water pollution, enhancing water quality gradually by imposition of national quality standards for consumption, conservation and use are key priorities for Iran.

Determination of economic value for uses as well as its inherent value in the basin, fixing prices for various consumptive uses based on covering O&M, and investment and replacement costs are the key strategies to optimize water use in Iran (Government of Islamic Republic of Iran 2003). Some uses, like drinking and domestic, would consider the users' ability to pay and might, for example, only recover operation and maintenance costs (Government of Islamic Republic of Iran 2004). The long-term strategy is also to launch public awareness programs for conserving water quantity and quality, and to optimize consumption (Government of Islamic Republic of Iran 2003).

Another measure taken is to amend the "law of promotion of investments in water projects in Iran", to motivate farmers to invest in irrigation and drainage networks and water soil projects, which is enforced by a state level committee (Government of Islamic Republic of Iran 2004). This

bylaw enforcement committee comprises the Deputy Minister for Energy, and representatives from the Ministry of Agriculture, state management and planning organization, and consumers and producers support organization. This law allocates all the exploitable water to the investor, except for the water for which water rights already exist. In addition, all lands potentially irrigated by the new facilities will be transferred to the investors at the price of undeveloped land, and in case the investor is unable to use all the water, the government is bound to buy surplus water at agreed prices. However, the law puts such use in jeopardy when the investor is of foreign origin as such investments are subject to different conditions. Likewise, allocating all the exploitable water to the investor, in the absence of proper regulation and oversight by, or enforcement capacity of the public agencies, for example in extreme water short areas, might have implications for the poor in accessing this water. In addition, the investors might have incentives to seek enormously high profits if there would be no alternative source of supply, which might be the case in many drier parts of Iran.

Existing Institutional Arrangements for Agricultural Water Management

Ministry of Energy (MoE): The water resources development for various sectors falls under the responsibility of the Water Affairs Division of the Ministry of Energy (MoE). This division is responsible for planning, development, management and conservation of water resources. The MoE has constructed several irrigation and drainage schemes and systems including dams in various river basins of Iran. Surface irrigation and drainage systems, as well as large-scale groundwater projects, have also usually been constructed by the MoE through its national development program. The MoE, through its Regional Water Authorities (RWAs), has been responsible for the management and maintenance of major infrastructure (reservoirs, main canals, big groundwater schemes) and delivery of irrigation water to the farmers. The RWAs generally employ water masters (*mirabs*) to operate gates of secondary canals. The maintenance, though at a limited scale, is carried out through contractual arrangements with both public and private companies. However, in recent times, there has been a tendency to transfer part of the system management responsibility to groups of farmers.

Ministry of Cooperatives (MoC) has been responsible for organizing, facilitating, and monitoring various rural cooperatives, including those which are responsible for groundwater schemes, and cooperative farming. In several rehabilitation projects, where creation of user groups is a part of the project, the MoC is also engaged in organizing water users.

Ministry of Jihad-e-Agriculture (MoJA), is responsible for the management of rain-fed and irrigated agriculture in Iran. The MoJA also takes care of subsurface drains, secondary and tertiary canals and development and management of on-farm irrigation schemes. The MoJA runs its extension and research programs for improving agricultural productivity, and is responsible for supporting and promoting on-farm water management through its Bureau of Extension (BoE). The Bureau has its branches at the provincial level, and the extension agents are based at a sub-district level, for a group of villages. The extension agents visit the rural settlements and advise farmers on crop technology, as well as water management. In recent years, however, the BoE has also been made responsible for establishing and training Water Users Associations (WUAs).

Each of these ministries is extremely specialized with separate subdivisions for each task. Such intensive specialization has resulted in poor coordination amongst different ministries and line agencies involved in the management of water resources. The roles and responsibilities of these organizations are not clearly defined, which often results in ineffective management of water resources at all levels. Despite heavy risks of drought, no emergency plans are available for monitoring, planning, mitigation and preparedness for drought. At present, no appropriate institutional

arrangements are available for proper coordination between different agencies and ministries for drought management. Recently, a task force for drought has been established under the Ministry of Jihad-e-Agriculture. The objectives of this task force is to prepare a comprehensive drought management plan for the government to put appropriate institutional and legal structures in place prior to the onset of drought conditions to take necessary actions well in advance.

Since 1996, there is a joint committee comprising MoE, MoJA, and MoC which aims to consolidate and promote effective water utilization and management for agriculture. This committee meets periodically to review progress against the objectives set by various development plans.

Improving Institutions for Water Management

Until the early 1990s, water management for agriculture at the local level was part of communal responsibilities. The communities diverted the canal flows to earthen secondary and tertiary canals, and the silt clearance and strengthening the embankments were the only water management activities that were collaboratively performed through village organizational structures. These communal organizations were responsible not only for water management but also for other communal activities such as weddings, funerals, religious ceremonies, education, etc. Decision-making was undertaken at communal meetings that were chaired by the village elders and attended by heads of households. The most common criterion for water distribution was the equity in distribution as perceived by the community members, and water was distributed in rotational turns. The main canal was perceived to be the government's property and responsibility.

In the Third Five-Year Development Program (FYDP: 2000-2004), the government recognizes that the potential for water resources development in Iran is very limited and therefore more emphasis should be given to conserve water at all levels. For this purpose, effective policies and institutional arrangements need to be introduced to improve water management for agriculture. The traditional arrangements for agricultural water management at local level have been the informal community organizations in villages. In many irrigation systems, such organizations do not correspond to hydraulic boundaries, and thus the users of parts of the system located in one village need to coordinate their water distribution with the other village, which does not always happen, and might lead to inter-village conflicts over water distribution. The government, thus, encourages the promotion and creation of Water Users Associations (WUAs) to devolve irrigation system management responsibility and authority at the local level, whereby the traditional local authorities would be able to coordinate water management within their community and be part of the WUA at the (sub)system level. As a result, the process of creating WUAs along all tertiary canals and federating them up to the main canals for irrigation system management has started.

Over the last decade, many farms have fragmented due to social and cultural changes and Islamic inheritance laws. As a result, the same farmers now own land along several secondary and tertiary canals. While users do participate in the O&M activities below the main canal level, certain rules of participation have emerged. For example in Kermanshah Province, certain decisions require full participation by all the users, while for some other decisions, community elders can make decisions, that are perceived as binding for all members.

Apart from the informal collective action at the community level described above, a number of formal institutional structures exist, which are responsible for collective action at the village level. These include:

(a) ***Village Islamic Council*** is the smallest unit of governmental administration that was originally conceived as the core of the government to support the Islamic revolution. The

main task of such councils is to collaborate with governmental agents regarding social, economic and developmental aspects of villages. They also execute most development activities. Three-member councils are elected by the village residents every four years. The effectiveness of the performance of Islamic Councils in terms of water management is however not studied much.

(b) ***Rural Cooperative Organizations (RCOs) and Rural Production Cooperatives[2] (RPCs)*** are public organizations established, for improving the living standards of communities through the provision of cooperative services for agricultural businesses, since 1963 and 1971, respectively. The cooperatives can be production oriented, for example bee-keeping, or function oriented, such as marketing, input supply, and other needed articles of daily use (fuel, milk, sugar, rice, etc.). The RPCs were formerly called Agricultural Companies, and were initially established for rural development, including optimum use of soil and water resources. By the year 2000, there are about 800 RPCs in the country covering about 2.2 million hectares of land. However, there are plans to increase their number up to 1,700 with an overall coverage of 4.5 million hectares (PCI 2004). The main activities include land consolidation, irrigation and water management, cooperative use of farm machinery, distribution of inputs, extension activities, and cooperative marketing. These have been registered under the MoC. The most important function of RCOs is to distribute authorized agricultural inputs (e.g., fertilizer, seed and chemicals) to the farming community at the government fixed rates.

(c) ***Well Cooperatives*** are almost in all river basins where groundwater is used. These were established for the construction, operation and maintenance of deep wells. The number of members varies depending on the size of the well and the area irrigated by this well. Such cooperatives can take loans from banks to finance their activities.

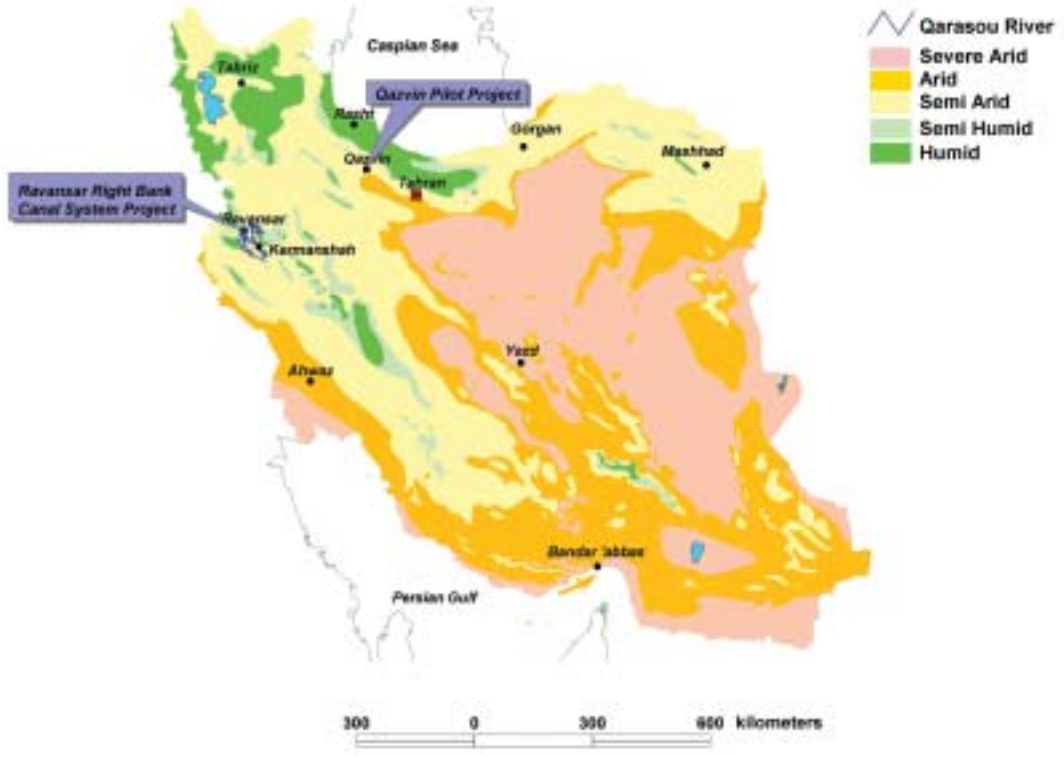
(d) ***Water Users Associations*** have been established in some surface irrigation schemes since the late 1990s and are registered by the MoJA. While the scope of some WUAs are limited only to O&M of tertiary systems, others might function at both tertiary and secondary level or even be federated up to the main canal system.

[2] A cooperative can be a small group of people with a minimum membership of seven people. There is no limitation of maximum membership. A cooperative normally comprised of three to five board members (managing director, deputy director, secretary and members). The cooperatives can be established for all sectors. In Iran, the cooperatives established for the agricultural sector involve agriculture (both greenhouse and field crops), animal husbandry, agro-industry (shoe making, carpet making, etc.), processing and facilities, and operation and maintenance of irrigation infrastructure.

PROGRESS IN IMTs: EXPERIENCE FROM TWO IRRIGATION SYSTEMS IN IRAN

For the limited scope of this study, the experience of WUAs in two different basins is reviewed below. The WUA in Kermanshah Province (Gharasu tributary located in the upper reach of the Karkheh Basin, and organized along the territorial principles of villages) was studied by PCI (PCI 2004) and the one in the Qazvin Province (Qazvin Pilot Project organized along hydrologic boundaries of Qazvin canal) was visited by the authors together with a study team from Bureau of Extension of the MoJA. The irrigation systems in Kermanshah Province are under rehabilitation, while those in the Qazvin Province were rehabilitated some 20 years ago. Location of study sites is shown in Figure 1. The key findings of these assessments are given in the following section.

Figure 1. Map of Iran showing locations of two IMT pilot projects.



Ravansar Right Bank Canal Irrigation System in Kermanshah Province[3]

Irrigated agriculture is generally managed through Rural Production Cooperatives (RPCs). There are 18 RPCs in Kermanshah Province including one Union of RPCs. In comparison to other provinces, the formation of RPCs had lagged due to post-war reconstruction after the Iran-Iraq

[3] The information presented in this section is extracted from a recent JICA Study (PCI 2004).

war in the 1990s (PCI 2004). There were some 110 Rural Cooperative Organizations (RCOs) at the village level, but mostly dealing with cooperative shops for daily needs.

The study area is located in the center of *Sanjbi* Plain, which is surrounded by mountains and has mountain climatic conditions. The rainfall in Ravansar is about 527 mm of which 90 percent occurs during November and April (PCI 2004). The water resources used for irrigation are derived from surface sources, springs and groundwater. However, the main source is the *Gharasu* River, especially during the dry season. Additionally, the two seasonal rivers, *Gharab* and *Kilanba*r only provide water during the rainy season (Figure 1). The *Gharasu* River receives an important part of its flow during the dry season from the Ravansar Spring, along with *Jaberi*, *Ghar Daneh* and *Mir Azizi* Springs.

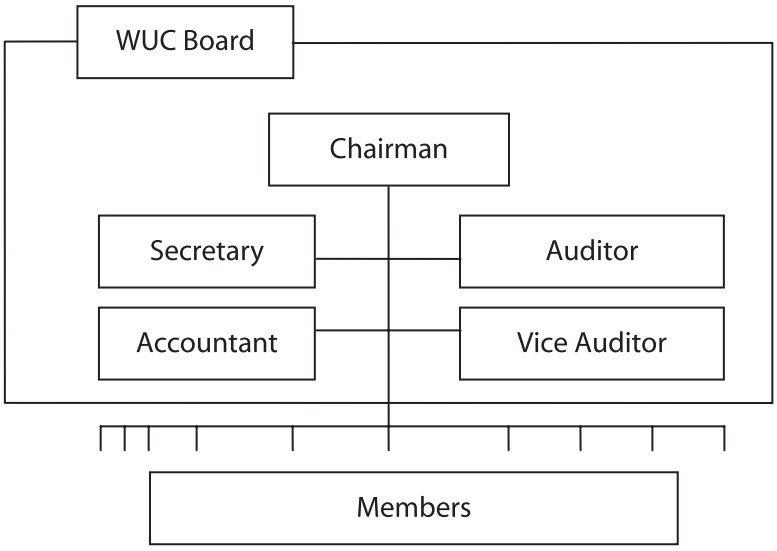
There are 352 registered wells in the Ravansar command area and the amount of approved groundwater extraction is 45.24 MCM sufficient for about 5,000 ha. However, there are a number of unauthorized wells too causing a depletion of groundwater that has been rapidly falling since 1999 (PCI 2004).

Most of the irrigation systems are multipurpose in nature and serve irrigation, flood control, improving inundation and groundwater recharge purposes. Average land holdings are generally smaller than 5ha, and due to absentee landlordism, a number of holdings are cultivated through sharecropping arrangements causing fragmentation of operational holdings. In 2003, there were some 1,140 farm households. Irrigated agriculture was practiced on one-third of the command area. PCI (2004) found that 74 percent of the farm households had debts, which is relatively high according to Iranian cultural norms of "*not being under debt*". The Ravansar Irrigation System comprised Ravansar Right Bank Canal with a 700 ha command area and Ravansar Left Bank Canal with a command area of 2,000 ha. In addition, some 175 pump owners had been allowed to extract water directly from the river to irrigate about 1,000 ha. Some 20 un-licensed pumps were also operating in 2003 (PCI 2004: 3-34). The operation of the Ravansar diversion gates are carried out by the Ravansar Water Affairs Organization (RWAO), while the on-farm activities are done by the provincial branch of the agricultural ministry.

The water users of secondary canals are more or less the same farmers, whose lands might be located along several watercourses. Two IMT models had been tried out. In 2000, O&M of the irrigation system was initially transferred to a semi-government company (Western Regional Water Utilization and Delivery Services Company (WRWUDSC)) for water fee collection and O&M of the canal. However, no maintenance was ever carried out by the company. The contractual arrangements had several weaknesses, such as poor definition of roles of the company, the MoE, and the farmers. Later, in 2003, a Water Users Cooperative Company (WUCC) was formed in a single meeting of 20 minutes for the Ravansar Right Bank Canal, without even a proper briefing to the farmers (PCI 2004:3-41). The organizational structure (in Figure 2) was imposed, with the MoC responsible for establishing the WUA.

The governance and management functions have been fused into the WUCC Board, which comprised of Chairman (also as General Manager), Secretary, Auditor, Vice Auditor and Accountant. The members of the WUCC are the farmers who own land in the command area. The WUCC was given the responsibility for O&M of the canal as a contractor to the MoE and also to collect water fees from farmers and deposit them into the MoE account.

Figure 2. Organizational structure of Water Users Cooperative for the Ravansar Right Bank Canal.



According to the charter, the rights of the WUCC comprise:

(a) to accept (or reject) the maintenance responsibility for water infrastructure;

(b) to receive subsidies and assistance offered by the government on stipulated conditions;

(c) to run a business based on its own assets and resources; and

(d) to receive benefits generated by its own business.

On the other hand, the responsibilities or obligations of the WUCC include:

(a) to agree to O&M initiatives for infrastructure through contracts with MoE;

(b) to implement O&M activities under contract with MoE;

(c) to collect water fee from members and transmit to the MoE;

(d) to conduct activities declared in the article of association as social responsibility; and

(e) abide by the bylaws (internal rules) declared at registration.

The rights and responsibilities specified above clearly indicate that the WUAs were largely perceived as the O&M contractors to the MoE, rather than independent local organizations managing water on behalf of the water users.

PCI (2004) found that the WUAs in the Ravansar irrigation system were not clear about the respective roles of the MoE as “water supplier” and the MoJA as responsible for provision of advice on crops. Thus, the farmers remained uncertain about where to go for the solution of their problems. Due to lack of clarity about the objective of WUAs amongst the local government staff, the central government’s intentions of improving water management through the participation of local farmers has not been properly communicated. As a result, true participation of farmers has not happened to support successful WUAs. Another reason for the lack of cooperation of farmers is the lack of reliable water supply by the MoE. Therefore, before involving farmers in water management, the

MoE needs to ensure reliable water supply in the canal systems, so that the users have enough incentives to participate in their WUAs.

The whole program of WUAs is a very new subject for both government and farmers. From the government's side, many organizations are working together in the field to make WUAs. However, due to lack of proper training, experience of working with grassroot level farmers, and clear direction, concerted efforts will be needed to sensitize and train government agents in IMT. They should get more experience for internalizing the objectives, concepts and methodologies of participation and devolution, so that they can be more instrumental in training rural communities about cost sharing, self-reliance and sustainability concepts.

Irrigation Systems in the Qazvin Province

In Qazvin Province, IMTs were planned in 2002 after consultations between the MoE, BoE and MoC. In Qazvin, 860 kilometers of tertiary canals were transferred in 2003, 250 kilometers of secondary canals in 2004 and 94 kilometers of main canal in 2005. In total some 158 WUAs have been formed so far in Qazvin Province alone. During the WUA formation, all stakeholders were consulted in brief meetings. According to the Head of Water Management Company, the groundwater forms a significant proportion (50% or more) of water resources available and used for agriculture. Though agriculture is the main water user, the surface water systems also serve municipal and environmental uses.

The WUAs are mandated to either manage surface water or groundwater, and the conjunctive management is currently not a WUA responsibility. The older canal systems are in serious need of rehabilitation and maintenance. The main and secondary canals are equipped with hydraulic gates. The canals are operated for only 12 hours per day, and only in summertime (April-October). The system of water supply has been a demand based one - each farmer needing water has to submit his demand, get a pay slip either from WUA or from WMC, if WUA is not operational, pay the charge in advance at the bank, and return payment receipt to canal office, which will then issue a water release slip specifying time, date, discharge and duration of water supply. This on-demand system was quite sophisticated, but had a lot of transaction costs for farmers. Both WMC and the WUAs have been operating the irrigation systems using this design approach, with one key difference of local water ordering system pursued by WUAs versus the centralized order system followed by WMC. Before the emergence of WUAs, the main issue farmers faced was related to the time and effort each farmer had to spend in traveling to submit his demand almost once every ten days during the cropping season, and paying the charges and then again providing the proof of payment for water release. Thus, the **main incentive** why farmers supported the management transfer was so that many of them could reduce transaction costs by saving on the time and effort they would otherwise spend in ordering water, as through WUAs ordering water and paying for it was to be localized. The creation of WUAs has thus enabled farmers to use a more grassroots oriented system of locally ordering water than a cumbersome and centralized one.

The efforts to form WUAs have thus been quite timely in Qazvin, and the speed of management turn over has been comparable to that of Turkey in the mid 1990s. The main driving force behind the effort has been the interest and leadership provided by the head of WMC in Qazvin. This effort clearly highlights the role of a **reform Champion** in moving the IMTs forward in Qazvin, by providing enabling conditions for WUAs at the local level, and encouraging them to take over system management. The Qazvin WMC followed a systematic organizational design aimed at reducing the transaction costs for farmers at the grassroot level, and have thus assisted the water users at the

quaternary canal level to form informal Water User Groups (WUGs), as the areas of operation at this level are fairly small. Keeping this level informal, does not require them to keep minutes of meetings, and other operational records of canals. The WUGs meet once before the cropping season to discuss the seasonal cropping plan, and submit this to next level, and once during the off-season to discuss and address the maintenance needs for their respective canal. The disputes related to water distribution amongst the farmers are also resolved here informally. These WUGs are the members of Water Users Associations (WUAs) at the tertiary canal level. These WUAs have been unionized at the secondary canals and formed Unions of Water Users Associations (UWUAs), which have then been federated at the main canal level to form one Federation of Unionized Water Users Associations (FUWUA).

The main effort behind all the mobilization, organization, and capacity-building work has been from the Water Management Company (WMC) of Qazvin Plains, in collaboration with the BoE. The WMC took the lead in almost all spheres of IMT. The inputs by the BoE were largely in the shape of consultation on how to involve farmers, and advice on the organizational design for WUA.

The FUWUA in Qazvin is a fairly large organization, as it employs about 200 staff, mostly salaried, but some positions are based on commissions. Interestingly, almost all the engineers were females. The FUWUA was responsible for maintenance, collection of payments and water delivery and distribution at the main canal. It has established branch offices for facilitation of farmers, who now do not have to travel long distances to order water. The FUWUA gives a high priority to equitable water distribution amongst the FUWUAs, WUAs, and the farmers. Since the overall water supply is less than the potential demand, the water is only supplied during the period April to October. There is an elaborate system of water demand planning which is initiated at the WUG level and aggregated up to the main canal level. The volumes of water supply are discussed between the FUWUA and the WMC on a 10-day daily basis.

The fee collection rates were low initially, but the FUWUA had taken steps and issued sanctions, and now the collection of Irrigation Service Fee (ISF) is almost 100 percent, which is deposited to Ministry of Energy, which is supposed to return 25 percent[4] of the collection to FUWUA for operation and maintenance costs. In accordance with the contract, the FUWUA is obliged to deposit all collected ISF to the MoE account, which on complete receipt of the ISF is supposed to return 25 percent of the collected ISF back to the FUWUA for its operations. During the past three years, the FUWUA, despite achieving a 100 percent ISF collection rate, has not received its 25 percent share from the Ministry. This shows the prevalent one-way and top-down accountability of FUWUA to MoE. To mobilize some funds for its operations, the FUWUA has collected an additional 7 percent annually from the users. Despite such setbacks and prevalent issues, the farmers and leaders of FUWUA seem enthusiastic to make this experience a success.

The key constraints include lack of start-up capital, availability of credit for maintenance, lack of coordination between MoJA, MoC and MoE, as well as within different branches of Ministry of Energy. Overall, the farmers still have complaints about WUAs regarding the quality of service

[4] It is not clear how the shares of government and FUWUA were defined in Service Fee. The ideal principle for fixing the ISF in Iranian conditions would be to allocate all operation and maintenance costs PLUS a discounted amount of infrastructure replacement costs. The system being described here originates from a river, and thus the FUWUA should only be paying the infrastructure replacement cost to the government while keeping the balance for meeting its operation and maintenance and rehabilitation costs. It is thus proposed to conduct a detailed investigation on this to help policymakers develop a transparent ISF charging system. In addition, how the charges are to be levied and collected from farmers, should be internal FUWUA business, which is largely dependant upon its infrastructure. For example in the system visited, charges are levied volumetrically, but if the water volume upstream varies, the theoretical discharges are not guaranteed. Thus, a farmer might end up paying for less or more water than planned and received (this is not a proper volumetric system if it relies on correct operation to deliver a nominal rather than an actual volume).

and the maintenance of infrastructure. The WUAs have received quite old and dilapidated canals, some parts of which are in serious need of rehabilitation.

The FUWUA leadership (General Manager, Treasurer, Deputy General Manager) perceive that policymaking regarding WUAs has not proceeded well, as the visions and efforts of the two ministries are not alike. Even within the Ministry of Energy, the WMC's hard efforts to transfer management to FUWUA have received resistance from the other divisions of the same ministry.

Rehabilitation and maintenance costs are rather high due to lined channels, as the system receives a high load of stones which require mechanized cleaning annually. These costs are high due to financial difficulties faced by the FUWUA due to non-provision of their share in the ISF. If there are operational faults in the sophisticated hydraulic gate structures, the skilled labor force to repair these is only available with WMC at the provincial capital, and involves complicated bureaucratic procedures to call upon, and might cause delays. Due to delays in payments of ISF share to FUWUA from the MoE, the FUWUA has inadequate operational funds, for which it collects in the form of an additional levy from the farmers above the ISF. According to farmers, the delayed or non-payment of the agreed ISF share from the MoE to FUWUA were largely the result of poor coordination between various branches of the MoE.

There are some issues regarding the release of timely water supplies from upstream, at the headworks/diversion of the river where the canal off-take is located. This is under the authority of the Ministry of Energy. Thus, the accountability is only one way.

COMPARING NOTES: LESSONS FROM SOUTH, WEST AND CENTRAL ASIA

This section presents a brief summary of progress and issues in IMT programs in India, Sri Lanka, Pakistan, Turkey, and the Central Asian Fergana Valley shared by Kyrgyzstan, Tajikistan and Uzbekistan.

IMT in India: Andhra Pradesh[5] and Gujarat States

In India, provincial governments have been responsible for developing and managing irrigation systems. Andhra Pradesh has a population of over 75 million, 70 percent of which is rural. Irrigated farm sizes are small, around 0.88 ha per farm on average. Poor financing over time led to poor performance of irrigation systems, deteriorating infrastructure, declining yields and rural incomes and declining irrigated areas. The governments of Andhra Pradesh and Gujarat states embarked on Irrigation Management Transfer (IMT) in the mid-1990s through legislative acts. The government of Andhra Pradesh followed a Mexico-Style 'big-bang' approach, whereby the Provincial Chief Minister himself championed the reforms and went on to mobilize communities to take over the responsibilities of O&M of tertiary and secondary level canals. In contrast, the Gujarat government decided to adopt a more conventional "step-by-step" pilot approach, which is applied in many parts of India and other Asian countries (Parthasarathy 2000; Brewer et al. 1999). Both programs are less than 10 years old.

[5] Various aspects of reforms in Andhra Pradesh have been very well documented. See for instance, Hooja et al. 2002; Mollinga et al. 2001; Peter 2002; Reddy 2002; Sivamohan and Scott 2003; Svendsen and Huppert 2000; and Wood 2000.

The main objective of the reforms in Andhra Pradesh was to make irrigation schemes self-financing autonomous irrigation systems managed by WUAs, and provide a state level farmers' forum for governance to reduce the government's role as technical assistance provider. Since the promulgation of the 1997 Andhra Pradesh Farmers Management of Irrigation Systems (APFMIS) Act, almost all the tertiary level irrigation systems, and over 174 secondary systems have been transferred to farmer management, while the main systems remain under governmental control, with hypothetical representation by users in the governance mechanisms.

The organizational structure of WUAs was dictated from the top. Within the first two years of formation of WUAs, training was provided, with the most emphasis on WUA presidents (Raju 2000). While the APFMIS Act has been quoted as a good example of IMT legislation, its on-ground implementation has been less than perfect. For example, prior to the 2005 elections, the legality and status of the WUAs fell into question, and the whole program seemed to be stalled (Turral pers. comm. 10 December 2006).

The role of mobilizing communities to take over management was assigned to the irrigation officials, who remained less enthusiastic due to the vested interests of irrigation officials in rent-seeking and related to maintenance contracts. The elections were held quickly for 7,750 WUAs without adequate awareness building at the grassroots level, and were not held at all for 495 WUAs for various reasons. The program created 10,292 Water Users Associations (WUAs) and federated many of them into 174 Distributary Committees (DCs) within almost a year, whereby WUAs were responsible for the lowest tiers (tertiary canals) of the irrigation system, with joint management by DCs comprising state representatives and federated WUAs at the secondary level and Project Committees (PCs) at the main canal level.

The membership of WUAs comprised all users and owners who could prove their title to land, thus initially excluding a large majority of tenants, which led to a later revision of the Act to include the tenants (Rao et al. 1999). The committees and presidents could be elected or chosen by consensus, and majority of members could deselect a president, if so desired. In many instances, in an estimated 30-40 percent of WUAs, the old Irrigation Department contractors became the presidents, who later colluded with officials and subcontracted work to their own companies (Raju 2000), further proving the nature of political economy and rent-seeking behavior prevalent in the irrigation management in the subcontinent in general.

The impetus for the 'big-bang' IMT came through a World Bank loan, whereby the Bank provided funds for a rehabilitation project and attached conditionality of handing over the systems to water user organizations. The subsidies were funded by the Andhra Pradesh Government who took the loan, but would pay it back from sources other than the beneficiaries. The WUAs participated in joint surveys, but the Irrigation Department had to authorize and disburse the funds. WUAs had to implement the repairs themselves through their own staff or labor sharing. Some argue (see for instance, Rao et al. 1999) that the total quantum of subsidies in the form of rehabilitation grants to WUAs increased by fivefolds compared to the past. Irrigation revenue tripled, but WUAs were neither allowed to set the charges nor collect them, an essential condition leading to greater sustainability elsewhere. Water allocation and distribution to WUAs still remain in the hands of the Irrigation Department.

In Gujarat, NGOs and Irrigation Officials were responsible for mobilizing the farmers. Through these reforms, pilot WUAs were set up on small areas at the lower tier only. The landowners could voluntarily buy shares at nominal rates, and WUAs function under the existing Cooperative Law. The formation of WUAs remained voluntary. Need based grants could be allocated by the government to WUAs, who would participate in joint surveys and ID would approve and allocate grants, and WUAs would implement the repairs and rehabilitation. WUAs were allowed to set and collect the

water fees and had to hand over 50 percent of the collected fee to ID. WUAs were allowed to participate in higher-level decision-making on water distribution with ID and were responsible for distribution themselves within WUA territory.

The WUAs were required to maintain 12 types of registers, whereas most WUAs have been reported to maintain only three to four - pertaining to meetings, payment of bills, cash register, and physical works, and that too with the help of irrigation department staff (van Koppen et al. 2002). Some argue that the irrigated area went up by 20-40 percent and the statewide benefits of IMT were expansion of irrigation to an additional 200,000 ha, and increased rice yields in costal areas worth 153 million US Dollars (Rao et al. 1999), while others (for example, Raju 2000) argue that this was more on account of correction of records than addition of new lands and increased productivity.

As a result, later studies (Raju 2000; van Koppen et al. 2002) found that "WUAs in practice were a handful of local elites" and "around half of the supposed constituencies of WUAs were unaware of the existence and the purpose of WUAs". The participation rates of members in decision-making for both the states were found to be low, around 20-50 percent and those for small farmers and landless tenants even lower (Raju 2000). While formal and informal meetings have become more frequent, the WUAs and DCs have been unable to focus on timely acquiring of water from the upstream agency in the agreed volumes, and distributing it equitably amongst their members and efficient water use by members (Raju 2000). This situation has led to a growing dissent amongst some traditional local institutions, like *Punchayats*, which feel there are too many organizations, or their importance has been undermined. Likewise, the traditional labor sharing maintenance has reduced. Some progress has, however, been made in improving the infrastructure, but mainly due to the subsidies. At other places, water distribution has been reported to have improved or been made more user-oriented (Raju 2000).

Key issues to be addressed in Indian IMT programs are:

1. Information asymmetries between large and small farmers, and high transaction costs for small farmers to participate, thus poor participation of and accountability to smaller farmers;

2. One-way accountability of WUAs to ID, poor acquisition and allocation, no DCs for all areas, the umbrella governance bodies could not be set-up;

3. Provision of subsidies as incentive to drive reforms has led to physical capital building in most parts, and in some instances weakened the social capital by creating a conflict between old institutions and new organizations;

4. Reforming the bureaucracy still remains the biggest challenge.

IMT in Sri Lanka

In 1988, after some successful experiments, the Government of Sri Lanka adopted a policy of transferring full responsibility for the operation and maintenance (O&M) of small irrigation schemes to farmer organizations (FOs). In the medium and major schemes, farmers and agency personnel were made jointly responsible for the management of the systems: FOs taking charge of O&M of irrigation facilities below the distributary channel head, and the irrigation agency retaining its control of the headworks and the main canal system. The objectives of the program were to (a) relieve the government of the financial burden of funding recurrent expenditures for irrigation; (b) improve the maintenance of irrigation facilities and the irrigation service; (c) enhance the productivity of irrigated land and water; and (d) promote a spirit of self-reliance among farmers in irrigation schemes (Samad and Vermillion 1999).

The FOs were the central piece of the programme, whose main function was to deal with irrigation matters, but legal provisions permitted them to be multi-functional. Owner cultivators and occupiers of land in the designated areas were eligible members. Only one person per plot of land was conferred membership. In most localities, cultivating a plot of land irrigated by a particular distributary channel, regardless of the tenure pattern, had been a sufficient qualification for membership. FOs could become legal entities if they registered with the Department of Agrarian Services and the Commissioner approved the registration. After registration, FOs could formulate rules on maintenance, conservation, and management of irrigation infrastructure under their jurisdiction, to devise procedures for distributing water within the area under their command, and to impose and levy fees to recover the costs of O&M.

Transfer of responsibilities from the government to FOs could take place informally or formally in the beginning. For example, initially, an informal transfer could be a verbal agreement between the agency and the FOs for management of the system. Once FOs were established and considered capable of handling responsibilities, the irrigation agency formally 'handed over' the O&M of distributary channels to FOs. An agreement would be signed between the FOs and the agency stipulating the responsibilities of each party.

The reported evidence from 199 systems (Samad and Vermillion 1999) suggests that the IMT entailed a partial devolution of decision-making authority to farmers. The main thrust of the government had been on the setting up of farmer organizations. The creation of farmer-agency joint project management committees improved communication between farmers and agency personnel, and fostered greater farmer participation in decision-making. However, the agency intervention at the level of the transfer unit remained strong. The performance of these jointly managed systems provided a mixed picture of IMT in Sri Lanka (Merrey 1996). In one project area, all schemes in the sample were reported to have project management committees, about 88 percent of the distributaries had organizations, and considerable progress had been made in the 'turnover' of distributaries to farmers. However, most farmer organizations remained dependent on the department to give them funds for maintenance. The concept of turnover was not precisely defined. It was not ownership and did not include enforceable water rights. Distributary canal organizations could take contracts for O&M from the Irrigation Department, and the government paid the farmers without collecting irrigation fees.

Overall, the government expenditure on irrigation after IMT in Sri Lanka declined, and the costs of irrigation to farmers remained almost the same. Farmers generally made fewer direct payments, however, and contributed more labor for canal maintenance. While the maintenance was largely neglected before IMT, the increased labor contributions by FOs resulted in some physical improvements, and FOs kept on deferring the major maintenance. The quality of irrigation services did not improve much due to IMT in systems which badly needed rehabilitation. However, in schemes where both management transfer and rehabilitation have occurred, significant effects on agricultural productivity levels and economic returns were observed, but not only due to IMT. The infrastructure inspections revealed a serious underinvestment in maintenance. Serious concerns about sustainability of the turned over schemes remain.

IMT in Pakistan

In Pakistan, users have managed the tertiary level irrigation infrastructure since the first development of irrigation. However, owing to concerns about sustainability of the secondary and main system, reforms were introduced in 1997 through the promulgation of Provincial Irrigation and Drainage Authority (PIDA) Acts. The reform acts were largely pushed by the World Bank with a sector loan to the Government of Pakistan at a time when it had enormous balance of payment problems, without

adequate commitment or understanding of the reforms by the governmental officials (Ul-Hassan 2002). The legal enactments are thorough and even rules of business have been drafted for both PIDAs and FOs. The reforms were piloted at one main canal in each of the four provinces. The reforms intended to create autonomous authorities on main canals and Farmer Organizations at the secondary canals, and transfer all O&M responsibilities.

By the procedures, each tertiary canal elects one member to the General Assembly of FOs, and the FO members elect an executive council headed by the President. Each of the FOs recruits technical staff accountable to FO management, which meets once or twice a month, and more frequently during irrigation season. The bulk water rights are defined by the design discharge of the main and secondary canals, which, in theory, has to be proportionally shared by water users regardless of their cropping choice.

While the legal enactments have been adequate, the implementation has been far from perfect. For example, the ID staff in the Punjab Province opposed IMT, whose staff used to earn handsome "rents" before reforms (Ul-Hassan 2002). Part of the problem also remains to contact and inform the large numbers of mostly illiterate farmers involved, whose levels of awareness need to be built. The numbers of potential FO members of the secondary canals might be in the tens of thousands, but not everyone knows about the purpose and modalities of reforms. For example, an average distributary canal of 17,000 ha might have more than 5,000 farmers (Bandaragoda 1999).

The land tenure systems pose another enormous challenge, as lessees to absentee landlords cultivate large tracts of land. While the absentee landlords residing in urban areas remain uninformed, their lessees have no stake in long-term institutional development, as they keep on changing their operational areas with different landlords at different canals.

The mobilization of communities for participation in O&M and governance through electing the leadership has been one of the major challenges. In some parts, like in Sindh Province of Pakistan, NGOs had been deployed to carry out social mobilization and capacity building, while in the biggest province of the Punjab, the task was carried out by the ID staff, which were directly threatened by the reforms. Though social mobilizers were also recruited by the PIDAs, but in very small numbers, they could not counterbalance the rumors spread by the ID staff. Therefore, the PIDA in Punjab had to reduce the number of O&M responsibilities initially vested with FOs to only 'reporting offenders'. This role, however, is perceived to be very bad socially. The Baluchistan Province was still looking for consultants to implement the reform till 2004, even after seven years of passage of the enabling legislation. In the North-West Frontier Province (NWFP), the initial actions only started in 2003, when the consultants were commissioned through the agricultural department as well as directly by a World Bank project in 2004, where the DHV International Inc. undertook community mobilization, but with little content and coverage. For example, the International Water Management Institute (IWMI) tried to use the FOs as a basis for training and extension on Crop Based Irrigation Operations, but in the end ran a separate program directly at village level, covering all the villages in Maira Branch Canal (Upper Swat/Pehur High-Level Canal system), where no FOs had been formed, and only existed on paper (Turral pers. comm. 10 December 2006).

At whatever limited scale these reforms have been implemented, it is clear that these have been successful in areas wherever NGOs have mobilized and trained FOs, and have almost failed or drifted from the original intent in areas where ID staff alone or with government recruited mobilizers have mobilized communities. There is documented evidence that returns to mobilization efforts are high in terms of improving participation and governance by the users (Ul-Hassan et al. 1999; Wahid and Ul-Hassan 2000). While FOs have to maintain more than 20 sets of registers for state inspection of their performance, the state is not obliged to be answerable to the FOs for anything.

Some lessons from Pakistan's reform in relation to water resource governance can be summarized as:

(a) There is a strong need to translate policy statements presented in media and press to actions on the ground to show that the commitments are serious;

(b) While the legal frameworks are in place, the enforcement mechanisms are weak, and the reform efforts have been largely impeded by the inadequate support by the implementing agencies;

(c) In larger canal systems with a large number of farmers involved, such as those in Pakistan, the reforms cannot be implemented without an appropriate change agent (NGOs, community mobilizers);

(d) While the major thrust has been on creating users organizations to improve management, little attention has been paid to improve governance; and

(e) The accountability mechanisms are only top-down.

IMT in Turkey[6]

Turkey followed an accelerated IMT program since 1993, and within three years was able to transfer one million ha to WUAs. The reasons for implementing IMT were three-fold, (a) escalating labor costs due to high inflation, (b) a hiring freeze in government agencies, and (c) the consequent concern over the agency's ability to operate and maintain systems serving the expanding irrigated area for which it was responsible. The impetus for the program came partly from the World Bank's pressure for cost recovery, but also due to internal fiscal pressure (Svendsen and Nott 2000).

The Bank funded study tours to Mexico and elsewhere, which gave managers a vision of what it could achieve through IMT. The program was undertaken entirely with the staff of the General Directorate of State Hydraulics (DSI), who were extensively trained and oriented to the program well in advance, and a sense of competition was instilled amongst the field staff for championing the change. A distinctive feature of the program was its entire reliance for implementation by its own staff rather than grassroot NGOs. Another distinctive feature was to transfer the management to existing locally controlled organizations, such as municipalities. While common farmers were initially opposed to the reforms before 1980, both the farmers and municipal governments supported IMT later (Scheumann et al. 2002). The design of organizational structures is somewhat similar to irrigation districts in industrialized countries, although municipality leaders in most cases still lead these even after more than a decade. Another distinct feature was the size of the irrigation units, which averaged 6,500 ha per association.

The ownership of the infrastructure remains with the state, but O&M functions are vested with IAs through a formal annual contractual mechanism between DSI and IAs. The contracts do not define the obligations of, and can be unilaterally cancelled by, DSI. In effect, the municipality leaders execute the contract on behalf of the state, and not the users.

[6] For a more detailed account of IMT in Turkey, the reader is referred to Huppert and Urban 1998; Scheumann 1997; Scheumann et al. 2002; Scheumann and Ul-Hassan 2001; Scheumann and Vallentin 1999; and Svendsen and Huppet 2000.

The IMT in Turkey has demonstrated that:

(a) the process has evolved and has taken a program approach with strong political backing;

(b) the demand for change emerged internally due to fiscal crises and was not dictated by donors;

(c) the process was initiated from areas where the farmers already had some collective action experience for O&M; this initial momentum was used to create a competition amongst DSI regional staff to upscale, and they did not see emerging IAs as a threat to their jobs. The DSI has redefined its role from a direct service provider to catalyzer and support service provider;

(d) the IAs were not overloaded with functions right from the start, and had lot of assistance from DSI;

(e) the fee collection for O&M improved considerably; and

(f) the conflict resolution mechanisms are in place and seem to function well.

However, a few governance issues remain yet to be addressed:

(a) The legal basis is perceived to be inadequate;

(b) The operations and decision-making within IAs are dominated by a few influential personalities and not by common farmers; there is a need for more direct farmer participation;

(c) The accountability is still top-down; and

(d) The transaction costs for obtaining information, monitoring and enforcement remain high.

IMT in Central Asia's Fergana Valley

Central Asian countries are in transition from being centrally planned to market economies. Gradual land privatization is in progress, as is IMT. Kyrgyzstan has a fairly elaborate legal framework, and most of the secondary canals are operated by WUAs. On the other hand, there is no clear legal framework in both Tajikistan and Uzbekistan, and WUAs, wherever these exist, operate under laws pertaining to non-governmental organizations (NGOs) (Ul-Hassan 2004).

WUAs, in theory, based on the cropping plans of their members, prepare seasonal water demands and submit to district water management organizations (DWMOs), who adjust their demands according to predicted water availability. WUAs are responsible for O&M of secondary and tertiary systems, while the DWMOs are responsible for main canals. In practice, however, the data about crops are not collected and therefore all such planning remains on paper.

All the farmers with land titles are potential members of a WUA, which can be formed by consensus of the founding committee. The founding committee, in practice, is a group from the local elite that files papers for registration of WUAs with the law department (Ul-Hassan et al. 2005). The organs of WUAs are: (a) WUA General Assembly comprising all members; (b) WUA Council comprising elected or nominated members out of all members; (c) Dispute Resolution or Revision Commission; and (d) WUA Directorate appointed by and accountable to the WUA Council. WUA councils meet every fortnight or at least every month, while general assemblies meet twice every year, during the growing season and the off-season.

The WUA councils are required to adopt, and in most cases they only copy, the byelaws stipulated by the state. The WUAs are accountable to several state agencies, such as taxation, land and water authorities, justice department, state environmental organs, and municipalities. Hence, for most of their time, WUA directors are responding to questions raised by inspectors of most of these agencies.

In general, the state commanded the DWMOs or local governments to mobilze farmers, with the exception of projects funded by donors (Yakubov 2004). In most cases, the common farmers remain un-informed even about the existence of WUAs (Ul-Hassan 2003), and wherever they are aware, they consider WUAs to be agents and representatives of the state and not of their communities (Ul-Hassan and Nizamedinkhodjaeva 2003).

Amongst the key issues facing WUAs, the nature of property rights to land (Ul-Hassan et al. 2005) is the most important. Since the dissolution of Former Soviet Union (FSU), private property rights are only gradually evolving. Within the command of a single WUA, one may find private or quasi-private farms, (parts of) state or collective farms and leased lands from the state or private persons. In addition, the village residences do fall within irrigation systems, and each household has a backyard garden, which is supplied water from the main irrigation system. In addition, in Tajikistan and Uzbekistan, the cropping patterns are dictated by the state formally or informally. As a result of these complications, most WUAs remain underfunded. Farmers have no ownership of WUAs in most parts, and the infrastructure remains in serious need of repair and rehabilitation.

Second Generation Problems in Early IMT Programs[7]

Insecure water rights were reported to be the most frequent second-generation problems affecting WUAs in Philippines, Turkey, Mexico, Colombia and Argentina. So were the financial shortfalls, lack of rehabilitation and lack of capacity amongst WUAs for effective financial and administrative management. Though most farmers have managed their water for many many years at their fields, they lack knowledge and experience of managing systems. While taking on new roles of governance, they need basic knowledge across several disciplines in order to keep their hired staff accountable. Thus, there is a need for capacity-building and support services mechanism for reliable legal and technical advice. Also, there is a need for either a support service for lobbying in governmental policy forums, or apex level WUA bodies that can present and argue for WUA rights at higher policy forums.

Most WUAs have faced **financial shortfalls** for various reasons. As reported by Vermillion (1997), the WUA managements tend to charge less from their members, and adopted several corollary cost-cutting measures in order to be popular. This has resulted in ignoring necessary maintenance and repair work. Several reasons contribute to low fee setting and poor recovery; including lack of authority to set fees and apply appropriate collection measures (Pakistan); lack of metering devices to charge by volume (Tajikistan, Uzbekistan and Kyrgyzstan), where the state policy is to charge by volume; not keeping promises on provision of subsidies from the state (Uzbekistan); and lack of conformance to agreements by state bodies; and farmers' ability to pay (Sri Lanka, Nepal, Iran, and Central Asia).

[7] This section is based upon the findings of Svendsen et al. 2000.

Most IMT programs tend to turn over systems that are in serious need of rehabilitation, and the IMTs are attached to the donor conditionality rather than an internally felt need. Besides, the maintenance needs of such systems are not carefully assessed and diagnosed. Some Southeast Asian countries like Vietnam, Indonesia, Thailand, and to an extent the Philippines, have made an industry out of rehabilitation for IMT. The Ravansar case in Iran exhibits as if Iran is also embarking on the same path. While the WUAs take over the management due to state inefficiency, many systems are not easy to operate and maintain due to technology or seriously and continuously deferred maintenance. In many other systems, the system designs might be outdated to cater to more recent needs. Even in systems that are attached to a donor-funded maintenance and rehabilitation program, WUAs lack capacity to prepare proposals and mobilize co-financing. WUAs do not find enough incentives not to defer maintenance.

Lack of financial and administrative management expertise amongst users often becomes a major problem. While farmers do manage resources and staff individually for their farming, they have relatively less experience in doing so in an organized fashion. In many instances, the WUA management could make decisions that are contradictory to their set policies or objectives. In many WUAs, lack of will to apply sanctions has resulted in poor resource mobilization for maintenance. In addition, identifying and recruiting appropriate staff becomes a major headache in many countries like Central Asia, where irrigation system management is a rather unique expertise available only to state employees, and the experts and staff WUAs get had never worked with private organizations.

Irrigation agencies face problems of dislocation/shortfall of staff, erosion of technical capacity and need to define and assimilate the new role for the agency in the changing context. Besides, in many water scarce countries, there is a lack of will on the part of the state agencies to step away from rent-seeking (as explained earlier for the Indian case), which can frustrate the IMT efforts.

Farmers generally face challenges of increased water fees, additional physical participation in O&M, and additional transaction costs of acquiring and using information. In addition, they also have to bear the additional burden of adjusting to the new institutions.

CONCLUSION: PROPOSED IMT FRAMEWORK FOR IRAN

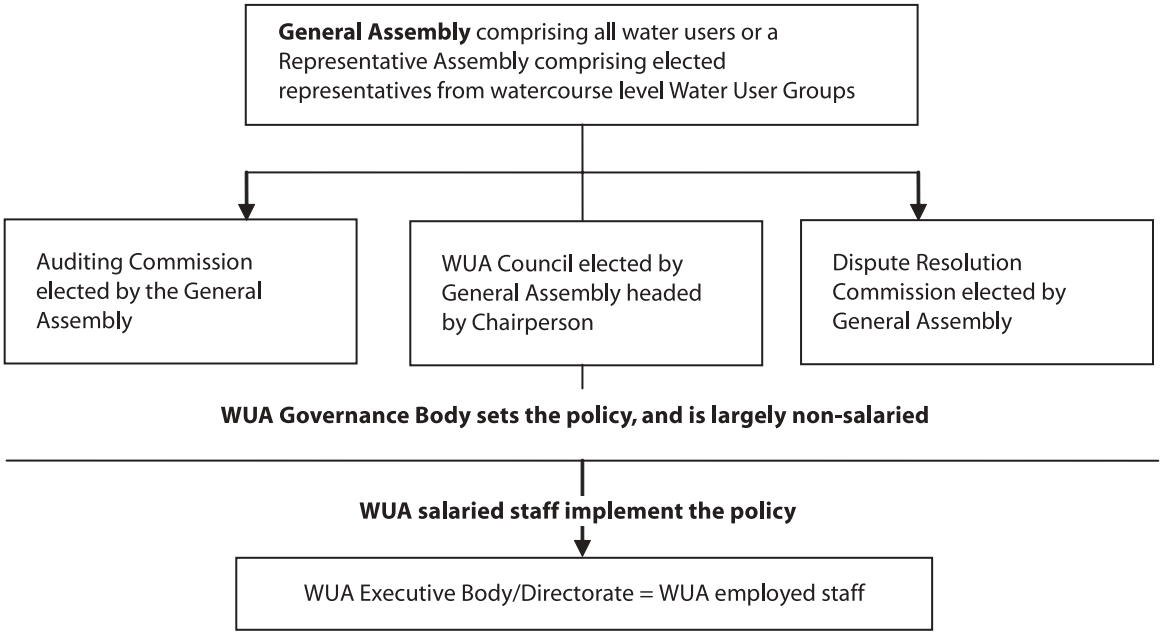
Iran has already identified IMT as a policy for future water resources development and management, and is encouraging transfer of irrigation systems to local level organizations. The objectives of such efforts remain vaguely defined in terms of efficient water resources management, improved farm income and reduced government spending. Most of these objectives cannot be achieved simultaneously and need compromise. The objectives might also vary for different levels of an irrigation system. Thus, there is a need to clearly set policy objectives, and define a clear strategy for how to design, implement, and monitor IMT in various river basins and agro-ecological settings to meet those objectives. An IMT strategy should clearly spell out the roles and responsibilities of the MoE, BoE, and MoC in relation to the new organizations emerging for water management, and the IMT should be piloted in a few selected canal commands and then out-scaled to larger areas. The mandate of the current collaborative committee of the three ministries can be expanded to formulate such a strategy, and make arrangements for its implementation, monitoring and periodic review.

The most recently introduced legislation on irrigation improvements might bring more investments, but could lead to greater inequality amongst water users and put the access to water by poor people in jeopardy. In addition, WUAs are currently organized under cooperative law, which applies to business cooperatives. WUAs manage a common pool resource in the public

interest and, thus, are not strictly business cooperatives. A serious review of all applicable laws for agricultural water management, including laws related to land rights, is essential to remove inconsistencies amongst various laws. Many countries have resolved for special laws relating to IMTs that override the existing laws wherever there is a conflict. This might be the path for Iran to follow.

The experience of devolving management to companies in Kermanshah instead of WUAs has already proved that such arrangements are neither efficient nor sustainable. Thus, commercialization of irrigation management does not seem to be working in an Iranian context. On the other hand, the experience in the Qazvin Province of establishing tiered users organizations seems quite successful, despite several constraints faced by the WUAs. Collective action for water management has a long history in Iran, where tribes and communities have been self-managing qanat systems for centuries. Thus, mobilizing farmers to form tiered WUAs with the government moving its role to facilitation and regulation could lead to viable WUAs. The organizational model of WUAs followed in Qazvin Province, with some modifications might be adopted and tested out. For example, the watercourse level WUAs might be too small to be financially and technically viable. Instead, informal water user groups could be organized along quaternary and tertiary canals along the same lines as in Qazvin for preparing cropping plans and assessing water demand, as well as distributing water amongst their group members, undertaking maintenance and conflict resolution at the local level. The formal WUAs at the secondary canal level might be more suitable. The secondary canal WUAs can then be federated at the main canals and take O&M responsibility for the entire system (see Figure 3 for illustration). The qanat systems have complex and detailed operational rules and procedures, detailed memberships, rights, obligations and often hereditary water masters. Such systems need to be understood well before any careful intervention is aimed at enhancing the operational performance.

Figure 3. Organs of a Water Users Association.



Source: Adapted from Ul-Hassan 2004.

One cautionary point relates to the clarity in land and water rights. As there are growing trends of sharecropping, absentee landlordism, and land fragmentation, it is important that the mobilization models ensure inclusion of smallholders and leaseholders in the WUA formation processes. A good practice is to allocate leadership quotas for various landholding categories, with majority to the smallholders and farmers from the tail-ends of canals.

There is a clear need for institutionalized arrangements for social mobilization and capacity-building, as well as strategies to achieve higher awareness and participation in both organizational development as well as organizational action. A social mobilization and capacity-building action program might be needed. Indian examples clearly demonstrate that in the capacity-building programs, it needs to be ensured that the capacity-building efforts take care of needs of the future organizational leaders as well as the current leaders. While the MoC has the mandate to organize agricultural cooperatives, water management is a much more specialized task. The BoE and MoC should pool their resources and come up with a WUA mobilization and capacity-building strategy and a pool of WUA mobilizers and trainers. This pool can later provide backstopping and support services to WUAs. A more rigorous and well structured social mobilization approach would help speedup organizational building. Such an approach comprises of identifying and deputing Social Mobilizers from provincial extension staff, training them in social mobilization and capacity-building of WUAs, and then starting the social mobilization process simultaneously at several locations. The mobilization process needs to be carefully designed and implemented with a rigorous and robust monitoring component to regularly advise on the needed changes in content, design and strategies.

At the pilot sites, it appears that governance and management has been fused together. Governance bodies are farmer representatives elected out of farmers for WUA level policy formulation and implementation oversight. These positions are generally not paid salaries or commissions, but when they spend time on WUA supervision, etc., their time and other costs are then compensated through payment of a daily allowance, travel costs, accommodation, etc. The management (staff) positions are fully or partially paid, but they should not have the right to represent water users. It is important to keep management and governance separate (see Table 5 and Figure 4 for illustration). When governance and management are not separate, there is a chance to induce corruption in the organization.

Setting and collecting the water charges appropriately is an important issue for Iran. Presently, water charges are set at 3 percent of the gross farm incomes. However, considering the differences in water resource availability and agro-ecological zoning, the infrastructure for irrigated agriculture might be more expensive in some areas than in others, due to, for example, differences in water source, irrigation technology, etc. In such situations, the present rule of thumb will make O&M financing extremely unreliable. In most countries, water for agricultural use has no price as a resource. What farmers pay is generally the cost of water delivery services, including operation, maintenance, and governance costs, and occasionally infrastructure replacement costs. The most transparent way of doing it is to establish these costs for the irrigation system managed by WUAs, and adding proportionate costs for upstream system (main canals, diversion system, etc.). The reservoir operation and maintenance costs are generally not charged to farmers, but are recovered from other sectors and uses (municipal, environmental and power). Since the water charging policy of Iran is unclear, it is proposed that such a study be commissioned as early as possible, and the water pricing policies be then adjusted based on the recommendations of the study. In addition, the fee charging mechanisms within the WUAs should be left to WUAs and not imposed from above. The current practice of charging a fixed proportion of agricultural income as a water fee is neither transparent, nor efficient in encouraging water conservation.

Table 5. Proposed governance and management functions in an Iranian WUA.

WUA Governance	WUA Management
1. Approval of WUA status and bylaws	1. Preparation and finalizing of seasonal water requirement and distribution plan
2. Approval of membership and new members	2. Fair water provision to all water users
3. Election and appointment of executive bodies including leaders	3. O&M of infrastructure
4. Approval of rules and fees for water services	4. Environmental Protection Plans
5. Approval of plan for water distribution and its control	5. Organization of water accounting
6. Approval of budget	6. Data collection and database management
7. Addressing WUA development questions	7. Assisting WUA to improve financial potential
8. Monitor the performance of WUA management by selecting performance and service delivery standards	8. Organization of financial and audits
9. Approval of audit	9. Assistance to farmers to increase water productivity and conservation
10. Dispute resolution	

Source: Adapted from Ul-Hassan 2004

The day-to-day functions of a WUA include:

a) Distribution of water, according to agreed schedule and prevailing water rights/allocation.

b) Operation of hydraulic infrastructure – head gate, regulating structures and farm turnouts (unless the farmer does this).

c) Resolution of disputes over distribution and allocation.

d) Setting and agreeing the level of water fees.

e) Assessment and collection of fees.

f) Account keeping for costs and income to the WUA and presentation of accounts in public meetings, at least once a year; record keeping and maintaining a bank account.

g) Optionally, the provision of input and marketing services for specified items.

h) Organization and payment for maintenance of channels, structures, and public access (roads, bridges, tracks, etc.); the same for any costs involving pumping, fuel, etc.

i) Organization and payment for upgrading (modernization or improvement) of the system, to better meet the operational needs of farmers.

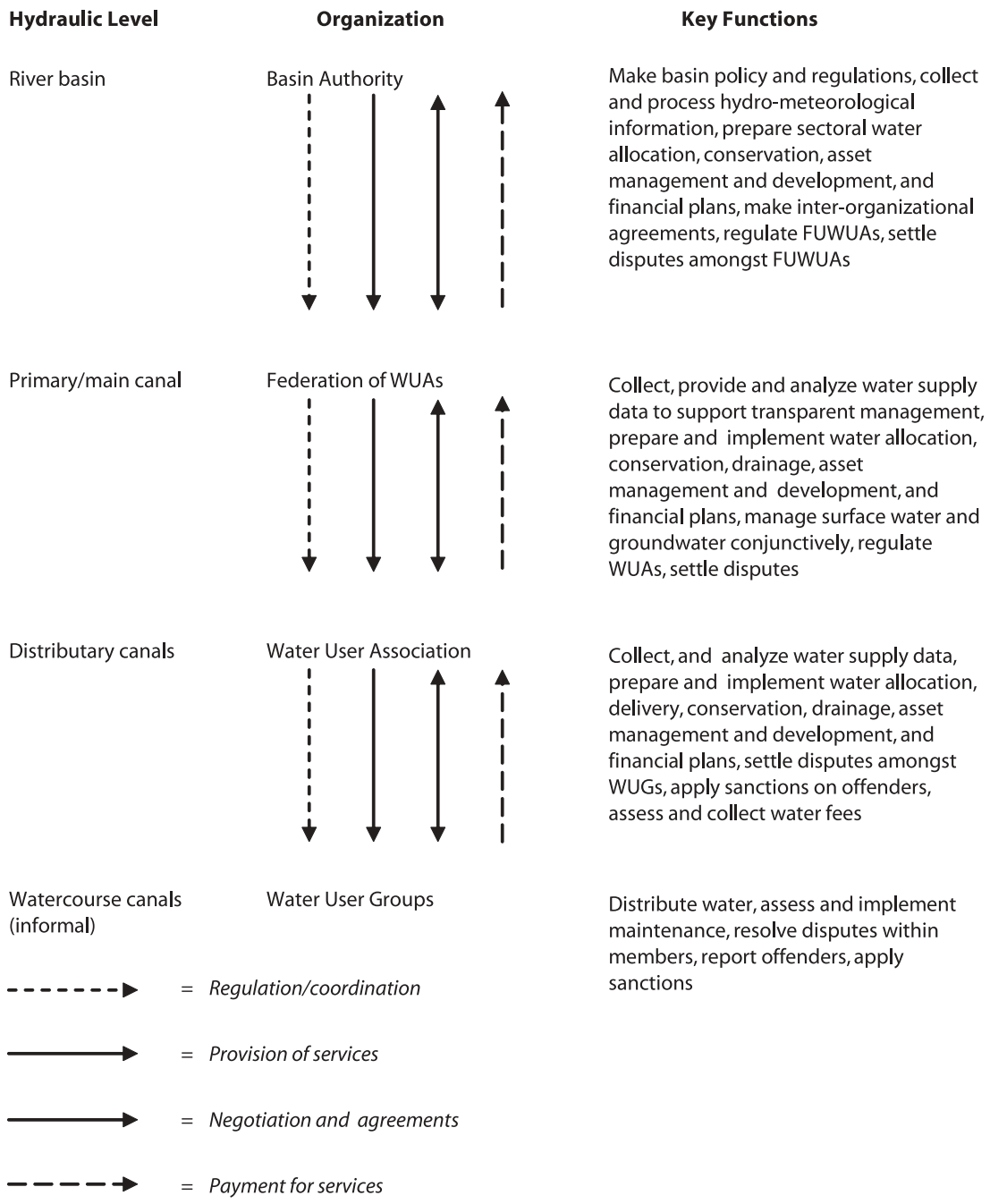
j) Monitoring of canal and drain flows, rainfall and groundwater use.

The arrangement for resolving water-related conflicts between WUA members, amongst WUA members and WUAs, among WUAs and the water service provider are not clearly defined, and need to be identified. For example, the disputes within an organizational tier could be resolved internally, and in case there are disagreements, the affected party could appeal at the next higher tier. The disputes between the WUAs and the state agencies might be resolved by independent courts or arbitration commissions.

Transparency and accountability are two key pillars of participation. The situation with regard to overall water rights for FUWUA in Qazvin is not clear. Likewise, as was explained by farmers, while FUWUA is fully accountable to state (depositing ISF to state fully), the state is not accountable to FUWUA (untimely water release, non-provision of FUWUA share of ISF). These issues need to be resolved through the IMT agreement to be signed by the FUWUA and the water service provider.

The ultimate objective of handing over the management of irrigation water to farmers is to introduce efficiency, discipline, and conservation for enhancing water productivity. However, as was the case in Qazvin, the pioneering WUAs are facing problems due to state agencies. While the WUAs might be able to meet the challenge in the short run, continued disincentives might affect negatively on their ambitions and enthusiasm. Thus, it is of paramount importance that the incentive

Figure 4. A schematic diagram of hydraulic infrastructure and proposed management organization.



structures and policies are set in a way that encourage water users and their associations, as well as the other water managing entities to manage it better. For example, soft loans or small matching grants for maintenance might encourage WUAs to improve maintenance, and thus reduce conveyance losses. Similar loans for water application technology might help water users to reduce consumption.

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IWMI is a Future Harvest Center supported by the CGIAR

ISBN: 978-92-9090-660-5