POLICY, SCIENCE AND SOCIETY INTERACTION

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ABSTRACT

Irrigated agriculture is undergoing rapid change and is facing issues related to climate change, population growth, consumption patterns, competition for resources and cost of development.The challenge is whether water availability for irrigation along with rainfed production will be sufficient to meet the growing food demand and improve global food security.Traditionally governments have been responsible for developments in the irrigation sector through planning, design and construction of projects.Trends toward decentralization, fiscal crisis and growth of the private sector have lead government to divest some of its role to user organizations and the private sector.This has been known as the participatory approach to irrigation management and has been adopted widely by many countries with a range of institutional arrangements. Many irrigation and drainage schemes worldwide perform below their capacity.To modernize and improve this capacity will require innovation and technical advancement but in addition issues of policy, governance, management and institution must also be addressed.

Key Words:irrigated agriculture, participatory management, modernize irrigation, innovation, policy, governance, institution, extension, drainage

INTRODUCTION

Governments are challenged by the need to provide food for their citizens, boost rural incomes, reduce poverty, while sustainably managing their natural resources along with water infrastructure (Merrey, 2007).These challenges are being managed in a rapidly changing world influenced by climate change, consumption patterns and demography.The management of water is not merely a technical issue but requires a mix of measures including changes in policies, prices and other incentives along with infrastructure and physical installations (Connor et al., 2012).Water management is unique and touches on every aspect of human wellbeing with links to socio-economic development, safety, human health, the environment and cultural and religious beliefs (Dalcanale et al., 2011).

Agriculture and particularly irrigated agriculture are undergoing changes and also facing challenges (Food and Agriculture Organization (FAO), 2012).Traditionally governments have been responsible for developments in the irrigation sector through planning, design and construction of projects.Decentralization, fiscal crisis in government, inadequate maintenance, growth of the private sector, etc. has lead government to divest most of its role to user organizations and the private sector (Peter, 2004).This is known as a participatory approach to irrigation management (PIM).The philosophy used is based upon developing co-operation with involvement of farmers in the operation, management and maintenance of the irrigation systems at the secondary and tertiary levels through water users associations (WUA).This

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involvement provides greater accountability, better service and increased productivity.It is also essential by need of government to reduce expenditures as part of economic reform (Hilland Tollefson, 1996). During the last three decades about 60 countries with significant irrigated areas have adopted PIM in varying degrees and ways and with mixed results (Kulkarni, 2012).Irrigation Management Transfer (IMT) is the full or partial transfer of responsibility and authority for the government, management and financing of irrigation systems from governments to WUA (Vermillion, 2003).

Irrigation is vital to food security.Increased growth of domestic and industrial water uses, growing environmental demands for water, along with the high cost of developing new water resources threatens the availability of irrigation water to meet the growing food demand.Water security and food security are intimately linked.The challenge is whether water availability for irrigation along with rainfed production will be sufficient to provide food to meet the growing demand and improve global food security.Climate change and bioenergy production further complicates the relationship between development and water demand (FAO, 2012).

Many irrigation schemes worldwide perform below their capacity.The low level of water productivity associated with their management results in lost opportunities for economic development and resource efficiency (FAO, 2011).

Modernization and improvement of irrigation systems is occurring throughout the world at varying rates.This is happening through improved infrastructure, water use efficiency and agricultural productivity. Much is being accomplished through scientific and technical advancement.There is acceptance however, that science and technology alone will not address the issues of food and water security (de Loéand Bjornlund 2010).It is also essential to address issues related to policy, management, institution and governance (Peter, 2004).

This paper will outline and discuss policy, science and societal interactions as they relate to irrigation and drainage challenges and opportunities in achieving global food security.It will address this subtheme through discussion under three topic areas:

- Policy requirements for better governance;
- Innovations, extension and improved irrigation and drainage services;
- Greater inaction among water users, agents, governmental organizations.

POLICY REQUIREMENTS FOR BETTER GOVERNANCE

Background

Water governance is a complex process as it combines several interrelated aspects: social, economic, environmental and political empowerment.In the absence of good and adequate policies, laws, institutions and governance, one would expect a serious negative impact on the sustainability of water resources.Improved governance, on the other hand, will lower operation costs and make a significant contribution to create a favorable environment to increase water investments and ensure that investment is used correctly and efficiently.

Shifting to a green economy requires careful management of all resources, especially water, which differs from other resources in some very important ways (United Nations Development Programme (UNDP)/Water Governance Facility (WGF) website).Increased demand for water combined with poor governance has resulted in intensified pressure on natural resources to serious levels.

Improved water governance and management are becoming imperative if the needs

of current and future generations are to be met in a sustainable manner and environmental protection is to be assured (Abdel Dayem and Odeh, 2009).
The term 'water governance' is relatively new in the global discourse on water management. Water governance was emphasized during the Second World Water Forum at The Hague when the Global Water Partnership (GWP) stated that 'the water crises are mainly crises of governance' (GWP, 2000).

The manner in which societies choose to govern their water resources and services has profound impacts on people's livelihood, opportunities and the sustainable development of water resources. Access to water is, for many people, a matter of daily survival or of breaking the vicious circle of poverty. Improving water governance will thus provide one cornerstone to alleviate poverty.

Defining water governance

Water governance refers to the range of political, social, economic, and administrative systems that are in place to regulate the development and management of water resources and the provision of water services at different levels of society' (GWP, 2002), while recognizing the role played by environmental services (Rogers and Hall, 2003).

Importantly, the water sector is a part of broader systems of social, political and economic developments and is thus also affected by decisions outside of the water sector.

Water governance addresses among other things:

1. Principles such as equity and efficiency in water resource and services allocation and distribution, water administration based on catchments, the need for integrated water management approaches and the need to balance water use between socio-economic activities and ecosystems.
2. The formulation, establishment and implementation of water policies, legislation and institutions.
3. Clarification of the roles of government, civil society and the private sector and their responsibilities regarding ownership, management and administration of water resources and services, for example:
    - Inter-sectoral dialogue and coordination;
    - Stakeholder participation and conflict resolution;
    - Water rights and permits;
    - The role of women in water management;
    - Water quantity and quality standards;
    - Bureaucratic obstacles and corruption;
    - Price regulation and subsidies;
    - Tax incentives and credits (Stockholm International Water Institute (SIWI), 2012).

The UNDP/WGF currently defines Water Governance as to comprise the mechanisms, processes, and institutions through which all involved stakeholders, including citizens and interest groups, articulate their interests, exercise their legal rights, meet their obligations and mediate their differences. Governance of water is understood in its broadest sense as entailing all social, political, and economic organizations and institutions, and their relationships, insofar as these are related to water development and management.

Differentiation between water governance, water use and water management

The meaning of water governance can be clarified by distinguishing it from water use and water management.
Water use is about the actual consumption or processing of water – or more abstractly, the practical realization of one or more of the ecosystem goods and services that water provides: irrigating a crop, watering cattle, consuming drinking water, generating hydropower, cooling a machine in a factory, dyeing fabrics, doing laundry, navigating a river, discharging dissolved chemicals as effluent, enjoying the sight of a fountain, etc.

Water management is the functional coordination of the human behavior that is necessary for realizing water use. The basic instruments of management are technologies (division structures in irrigation systems, community taps in water supply, a variety of measurement instruments and communication devices, etc.), institutions (distribution rules for rotation and queuing, staff roles and responsibilities, procedures for lodging complaints and imposing fines, etc.), money (water taxes/rates, subsidies, fines, bonuses, loans, etc.), and text/media (manuals, written orders, bills, maps, instruction videos, computer programs, etc.).

Water governance is the set of allocation, rule-making and public auditing activities that creates the frameworks and conditionalities for use and management.

Water governance challenges

The challenges of water governance are enormous when it comes to bureaucratic implementation, public participation, sustainable management of water resources, and the provision of water services. Varying interpretations of integrated water management, competing interests among different sectors stakeholders, power dynamics, and lack of capacity building are just some examples of the challenges involved.

It is worth noting that water decisions are anchored in governance systems across three levels: government, civil society and the private sector. Facilitating dynamic interactions – dialogues and partnerships – among them is critical for improving water governance reform and implementation. Since they are part of their national and international water agendas, many countries are currently responding to water governance challenges by developing and implementing national integrated water resources management (IWRM) plans and strategies (Hamdy, 2012).

A number of critical challenges to participatory water governance can be identified. These include (EMPOWERS, 2007):
- fragmented decision-making;
- lack of reliable information;
- poor access to information;
- focus on technological solutions;
- limited stakeholder participation or representation;
- lack of accountability and transparency.

Why is more effective water governance needed?

As unanimously agreed, the water crisis is mainly a crisis of water governance. Consequently, the Dialogue on Effective Water Governance aims at bringing together as many stakeholders as possible to examine water governance systems and, where required, plan action strategies to improve them (Integrated Risk Governance (IRG), 2008).Effective water governance is needed for numerous reasons:

Increasing demand

Rapid economic development and societal change are putting increasing pressure on water ecosystems and other natural resources. In a number of countries or regions, demand is outstripping supply to the extent that water resources are fully allocated in most of the years. Under such conditions, which are often referred to as river basin 'closure', available water resources are fully allocated and the political importance of effective water governance increases (Batchelor, 2009).

Access to water

Problems of access to water are a product of the social, economic and institutional context as they are of the technical factors governing water resource availability. Since water is a cornerstone for most economic activity, equitable distribution under changing patterns of supply and demand is often more of a challenge than absolute limitations on the available resource (Moench et al., 2003). Hence, systems of effective water governance are needed that ensure that all sectors of society have equitable, reliable and sustainable access to water.

Lack of accountability and transparency

Corruption remains one of the least addressed challenges in relation to water governance and water service delivery (UNDP, 2007). Corruption is a symptom of governance deficiencies in both the private and public spheres. In many countries, enforcement of legislation is weak and judicial systems are inadequate. When these are combined with, for example, shortcomings in accountability and transparency, personal economic gain becomes more attractive than concern for the well-being of citizens.

New research increasingly shows how corrupt practices are detrimental to sustainable water use and service provision. Corruption ultimately limits the scope for improving poor people's livelihood opportunities.

Sector reform

Decentralization and other aspects of integrated water resource management are considered to be important components of sector reform programs that, to be effective, require improvements in water governance systems (Moriarty et al., 2004). Many countries are currently moving away from conventional forms of water governance, which usually have been dominated by top-down supply-driven approaches, towards bottom-up demand-driven approaches, which combine the experience, knowledge and understanding of various local groups and people (UNDP, 2007a). These changes require improvements of the water governance systems that include: more effective stakeholder dialogue, better vertical and horizontal sharing of information amongst stakeholders, conflict resolution at a range of different scales and planning procedures that are based on a vision that is common to relevant stakeholders.

Water rights

Ownership, or the right to use a water resource or water supply infrastructure, means power and control (UNDP, 2007). The various roles and responsibilities, such as those encapsulated in legislation on water rights and ownership, have a complex relationship with water governance. How property rights are defined, who benefits from these rights and how they are enforced are all central issues that often require clarification as patterns of supply and demand change. Attempts to mitigate climate change impacts will, in many cases, require revisions to existing legislative frameworks and/or the enactment of radically new frameworks. Insecurity of water rights, mismatches between formal legislation and informal customary water rights, and an unequal distribution of water rights are frequent sources of conflict (UNDP, 2007; Hodgson, 2004). In contrast, the establishment of well-defined and coherent roles and responsibilities through legislation of formal and informal water rights may lead to numeroussocial, economic and environmental benefits.

Gender

Current literature ongovernance and particularly water governance tends to be gender-blind (Cleaver, 2007). It is clear that effective, efficient and equitable water resources management is only achieved when both women and men are involved in integrated water resource management (UNDP, 2006 and 2007). Gender mainstreaming is the process of assessing the implications for women and men of any planned action, including legislation, policies and programs in all areas and at all levels. It is a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programs in all political, economic and societal spheres, so that both women and men can benefit equally and inequality is not perpetuated. The ultimate goal is to achieve gender equality.

Principles for effective water governance

There is no single model of effective water governance; indeed to be effective governance systems must fit the social, economic and cultural particularities of each country (Rogers and Hall, 2003). Nevertheless, there are some basic principles or attributes that are considered essential for effective water governance:

Approaches

- open and transparent;
- inclusive and communicative;
- coherent and integrative;
- equitable and ethical.

Performance and operation

- accountable;
- efficient;
- responsive and sustainable.

How can water governance be improved?

Governance becomes 'effective' or 'good' when conditions of equity, accountability, participation, transparency, predictability, and responsiveness prevail. Governance is a complex product of social-political interactions in which various societal actors are involved at different levels. In the case of water governance, these interactions will directly generate policy outcomes affecting agriculture, food, health, education, economic development, and poverty alleviation. For these complex interrelationships to succeed, they have to take into consideration that they are interdependent and that no one agent, group, or sector has all the knowledgeand facts required to set policy, make decisions,or take actions. Because ofthis complexity, good governance does not justappear but is the culmination of multi-faceted,long-term processes that have to be carefullyplanned and nurtured. For good governanceto emerge, contextually appropriate conditionsmust exist and an enabling environment mustbe cultivated. Parties concerned must be opento committing to collective decision-making,effective and functional institutions need tobe developed, and policy, legal, and politicalframeworks must be suitable to the goals that arebeing pursued for the common good. Three major components of governance, namely, public sector reform, stakeholder participation, and public private partnerships,are being promoted to improve water management and governance (Abdel-Dayem and Odeh, 2009).

Governance Indicators

Governance indicators include, but are not restricted to:

Accountability of water service providers/Transparency of water service provision

- availability of government water budget and expenditure information;
- availability of private sector water budget and expenditure information;
- effectiveness of complaints procedures of water service providers;
- representation of users in decision-making (management and governance);
- existence of non-governmental organisations (social auditors) in the water sector and types of public action.

Public availability of water information

- existence of 'public right to information' legislation;
- accessibility of government water information;
- accessibility of private sector water information.

Quality of water service provision (performance)

- coverage of water services (all sectors) (WR);
- water quality measures (all sectors) (WR);
- cost recovery measures (all sectors) (WR);
- consumption levels (all sectors) (WR/PEWM);
- percentage of non-revenue water(drinking water supply);
- distribution/equity measure (irrigation);
- incidence of water related diseases (general);
- yields and water productivity of irrigated crops (agriculture/irrigation).

Policy requirements for better water governance

According to Rogers and Hall (2003), the concept of water governance, *'encompasses laws, regulations, and institutions but it also relates to government policies and actions, to domestic activities, and to networks of influence, including international market forces, the private sector and civil society*. These, in turn, are affected by the political systems within which they function.National sovereignty, social values or political ideology may have a strong impact on attempts to change governance arrangements related to the water sector, as is the case for example, with land and water rights.' (Saleth, 2011).

The government's role should be that of an*activator and facilitator*, rather than a top-down manager. Important aspects of the government's role include formulating national water policies and legislation, enacting and enforcing the legislation, and encouraging and scrutinizing the private sector. The rules may be formal (codified and legally adopted) or informal (traditionally, locally agreed and non-codified) (UNDP website).

There is a growing perception that the governance of water resources and water servicesfunction more effectively within an *open social structure* which enables broader participation by civil society, private enterprises and the media, all networking to support and influence government. The trend now is for *distributed water governance systems* to supplement formal authority by an increasing reliance on informal authority, for example, through genuine public-private coordination and co-operation. This can avoid governments being caught up in the contradictory roles of being both a provider and regulator of services (Batchelor, 2009).

To establish effective water governance systems and put integrated water management (IWRM) into practice,the following are determined as important needs:

- establishing an effective information system and training people to run it;
- regulating the interactions between public policies (governance) and property rights on the use of natural resources;
- setting an appropriate water resources regime that can take account of the various heterogeneous demands;
- building a coherent, legal framework with a strong and autonomous regulatory regime.

There is a range of tools available to policy-makers and practitioners. The Global Water Partnership Toolbox for IWRM brings together an array of over fifty tools and references that can be used by policy-makers and practitioners to improve water management (GWP, 2001). Different countries need to identify which management tools or instruments are most relevant to their given circumstances.

An example of available links to guidelines or toolboxes that can be helpful in improving different aspects of water governanceis mentioned:

- guidelines for improved local water governance: http://www.empowers.info/page/2850;
- sustainable livelihoods toolbox: http://www.livelihoods.org/info/info_toolbox.html#1;
- GWP IWRM toolbox: http://www.gwpforum.org/servlet/PSP?chStartupName=_water;
- tools to support transparency in local governance: http://www.transparency.org/toolkits/index.html.

The challenge, however, is to adapt, pilot and mainstream these tools such that that they are brought into everyday use.

Finally, achieving good water governance cannot be undertaken hastily using blueprints from outside any given county or region. Good governance needs to be developed to suit local conditions. Incremental improvement and flexibility are keys. New reforms do not have to be implemented in a comprehensive or fully integrated way. However, they do have to be workable to demonstrate that new approaches are both pragmatic and likely to generate public and political support (EFID).

Lessons Learned from the Regional Cooperation to Achieve Water Governance

InWent / Arab Water Council (AWC) four-year joint program

It is a fact that water availability is extremely scarce in the Middle East and North Africa (MENA) Region. Thus, water resources must be managed efficiently. Sincethe governmental institutions are responsible for water management, they must improve very significantly their governance and management practices. A major constraint for this has been the availability of trained and experienced personnel at all levels in the water sector. Accordingly, education, capacity building, training and organizational developments constitute an essential cornerstone to pursue good management and governance-related practices for the water sector in the MENA Region.

A four-year Program on Capacity Building in the Water Sector for the MENA region, focusing on eight countries (Egypt, Morocco, Algeria, Tunisia, Jordan, Palestine, Syria and Yemen) was formulated by InWent-Capacity Building International, on behalf of the German Federal Ministry for Economic Cooperation and Development, together with the Arab Water Council as the Regional Partner for the program (InWent website).

The main objectives of the overall program included strengthening regional co-operation; facilitating the development of management strategies for the water sector in selected countries within the MENA Region in order to formulate and implement appropriate water sector reforms; establish a functional partner network; and promote awareness of policymakers and the general public on water-related issues.

The outputs of the program included: improving the institutional performance, increasing the awareness of policy-makers of the priority issues involved, and supporting the development of a functional network on water issues within the Region.

The InWent approach was focused on the implementation of a series of activities such as dissemination of regionally-relevant and up-to-date professional knowledge and methodical competence; capacity building needs assessment and how they can be met in a cost-effective and timely manner; and periodic monitoring and evaluation of the progress made. It also included public relations, public awareness, and promotion of best practices in communities, and overall, regional co-operation through internal funds, third-party funds, and partner projects.

The four-year program consisted of a number of training events and seminars as well as three interrelated International Partner Fora on Water Governance in the MENA Region: The Current Situation, the Critical Issues, the Way Forward, and the Water Future to 2025 for the MENA Region.

Water Governance Program for Arab States (WGP-AS)

Launched in 2009, the goal of the Water Governance Program for Arab States is to improve the effective use and management of scarce water resources in Arab countries. It aims at supporting the achievements of the Millennium Development Goal (MDG) 7 particularly with respect to improved water supply and sanitation, by promoting an integrated approach to water resources management in the Arab Region. It is envisaged to act as a catalyst for effective water governance through the provision of technical and policy support, capacity building and seed funding for activities in the areas of:

- Integrated Water Resources Management;
- local management of water resources, water supply and sanitation;
- capacity building and institutional strengthening;
- MDG7 water targets monitoring and State of the Water Report for the Arab Region.

In addition, the project addresses cross-cutting dimensions such as adaptation to climate change, transboundary water management, gender mainstreaming and awareness-raising(Water Governance Program for Arab States(WGPAS) website).

In order to overcome the array of challenges that face them, the Arab States are in need of concerted efforts to improve water governance. UNDP assists countries across the Arab region to build and share their own solutions to development challenges within UNDP's four main focus areas: Poverty Reduction and Achievement of the Millennium Development Goals, Democratic Governance, Crisis Prevention and Recovery, and Environment and Sustainable Development. WGP-AS provides the required support to the above focus areas from water governance prospective as follows:

- proper access to water, for many people in the Arab region, is required for daily

survival and breaking the vicious circle of poverty;
- water supply and sanitation is a main component in the WGP-AS for assisting in the achievement and progress monitoring of the Millennium Development Goals in the Arab region;
- the WGP-AS promotes participation, accountability, rules of law, ethics, transparency and information sharing as building blocks for water governance;
- proper IWRM development and implementation in the region assists in preventing water related crisis given the limited shared water resources and potential adverse impacts of climate change on the Arab countries.

Regional Project on Public Engagement in Water Management Project (PEWM) in the MENA Region

In December 2009, the PEWM Project was launched in Cairo, Egypt, with the aim of strengthening the Arab Water Council's capacity for assisting water stakeholders improve the monitoring and evaluation capacity as a tool for strengthening water governance in the Arab World. Six Arab countries are involved in the project, namely Jordan, Palestine, Lebanon, Egypt, Tunisia and Morocco (AWC website).The PEWM Project has two main components:

- *Component 1.*Baseline Diagnosis of Water Governance Indicators;
- *Component 2.* Strengthening Civil Society Involvement in assessing their Country's water service performance.

The project aims at strengthening stakeholders' participation in water management through improving their capacity for Monitoring & Evaluation, as well as strengthening the Arab Water Council capacity to support public engagement in water management.

INNOVATIONS, EXTENSION AND IMPROVED IRRIGATION AND DRAINAGE SERVICES

Background

There is a consensus that the irrigation and drainage sector requires substantial transformation to meet the challenges of food security and improve its social, economic and environmental performance in a context of dynamic socio-economic and agricultural transformation processes.These are driven by demography and changes in food demand and increased land and water scarcity requiring substantial increases in water and land productivity. The sector needs to increase its resilience and sustainability, adapting to climate change, supporting climate-smart agriculture and ecological or sustainable crop intensification, to adapt to water sector reforms and solve intractable internal problems related to financing and governance.

In short, there is a general understanding of the need for forward-looking innovation in technology, institutions, policy and governance. Indonesia is a typical example, 'key pressures on the sector from outside forces of change and key challenges that the sector faces in terms of its efficiency, equity, productivity and sustainability' require ' pro-active initiatives to prepare farmers and other stakeholders for the changes coming'(Vermillion et al., 2011).

There is also a need for improving the productivity of rainfed agriculture and a change in paradigm to broaden governance, planning and management from irrigation and drainage to encompass the whole spectrum of agricultural water management.This is to improve overall rainfed water and land productivity, (supplementary irrigation, water harvesting, soil and water conservation, etc.) to full irrigation and drainage in river basins or meso scale watershed (Rockström et al., 2009). Ample evidence indicates that rain-fed crop yields can be doubled through innovations in soil, crop, and water management (Falkenmark et al., 2006).

To narrow the often wide gap between actual and attainable yield per unit water consumption, 'improvements in grain yield and crop water productivity arise from breeding for superior varieties, better agronomic and water management practices and the synergy between breeding and agronomy. While further genetic enhancement can contribute in the medium- and long-term, on-farm best management practices will provide the most immediate and effective way to increase crop water productivity'.Agronomic practices that narrow the yield gap per unit water useareoften a more effective investment of scarce financial resources, particularly for smallholder farmers. Practices required to close this gap areknown for many crops and cropping systems.Solutions involve efforts to modernize services to farmers (e.g. irrigation delivery systems, extension, etc.) and policy and institutional development to remove the barriers to their adoption. It must berecognized that beyond water management, non-water related agronomic practices also play an important role in increasing crop water productivity (Sadras et al., 2011).

We will therefore discuss extension of available good management practices and types and levels of innovation: crop husbandry, germplasm, value chains, on-farm water management, irrigation technology, irrigation and drainage system design and operation, social, institutional, and policy; sources of innovation: farmers, research and development, private sector, irrigation institutions,policy, innovation external to the sector; upscaling and diffusion of good practices and innovation among farmers for on-farm water management and agricultural practices, examining the role of extension and incentives; and upscaling and diffusion of innovation among irrigation and drainage practitioners.

For irrigation and drainage systems, service relationships provide a framework to discuss: 1) how changes in farm-level practices require changes in the irrigation and drainage service received by the farmers, 2) how these require changes at higher levels of management, 3) what type of management is responsive to changes in service demand and 4) what types of hardware and software changes are needed to adjust operation to meet service demand. Irrigation and drainage systems however, do not provide irrigation and drainage services to farmers only.They also provide multiple goods and services that can be optimized and managed. This recognition will be an additional driver for innovation.

Innovation in the irrigation and drainage sector

Irrigation and drainage have a very long history. Focusing on the second half of the 20th century, which witnessed the rapid expansion of irrigation and drainage, publicirrigation went through an initial phase of supply-driven, top-down irrigation development. This was controlled by powerful irrigation agencies and focused on the production of staples which supported the green revolution. It is during this period that the main design and operational features of irrigation systemswere developed. Progressively, the focus switched to a more demand-driven irrigation development that supported agricultural diversification or water conservation, with reforms in management. During the 1980s, based on an understanding that irrigation problems were management problems, the main emphasis was on institutional reformie: participatory irrigation management and irrigation management transfer.As a result, design and operation were somewhat neglected and did not evolve, even though water control principles were a major cause for poor performance.There was a call for simpler systems based on proportional distribution that could be operated by farmers.

Innovation in water control technology in developed countries, supported primarily by public investment in research and development (control structures, downstream control, SCADA, automation, canal lining techniques, etc.) was promoted in developing countries. This transfer of technology however, met with a number of difficulties ie: costs, poor adaptation, complexity, insufficient capacity development,proprietary technology, etc. to the extent that a number of these promising innovations are now frequently resisted. These technical innovations were used to strengthen rather than transform top-down, bureaucratic styles of management. The slow pace of innovation in irrigation and drainage is well documented. Adoption of technology and innovation does not only lag behind other sectors of the economy but more importantly it lags behind technological advances in production agriculture (Plusquellec,2002).

However, that period also witnessed the utilization of technological revolution that profoundly changed the irrigation landscape. The availability of cheap and efficient pumping and drilling technology, together with increased availability of energy, have resulted in the explosion of groundwater pumping and atomistic irrigation. Groundwater irrigation now dominates irrigated agricultural production in major irrigation countries including India and China. Farmers were also enabled to invest in pumping and free themselves from irrigation agencies' whose operation did not evolve to meet the changing demand for irrigation services. This revolution wasprimed by public investment programs and is now dominated by farmer/private investment and private suppliers. A consequence is the depletion of aquifers and the emergence of conjunctive use.

The development of pressurized pipe networks and irrigation technology ie: sprinkler and drip irrigation systems has transformed irrigation practices in arid areas and regions with market demand for diversified cash crops, fruits and vegetables. Supply is now dominated by the private sector but the dissemination of these technologies is still supported by public agencies or subsidy programs in a number of countries. An important form of public supportis laboratories that develop and ensure technical standards and test equipment.

These technologies are widely promoted as 'water saving technologies'. The reasons farmers adopt or invest in themare varied: increased income: if yield tonnage, quality, or alternative, high value crops will pay for investment; risk aversion/food security: shift from rainfed agriculture to irrigation to reduce the uncertainties associated with variable rainfall patternsor from public, surface-delivery systems to well water if surface water is delivered in an inflexible and unreliable manner; convenience: freedom from fixed schedules to receive project water deliveries, or delivering fertilizers more precisely and cheaply through 'fertigation' systems; reduced costs: pumping, labour. 'Not all of these motives are water-related.These factors, together with cost, credit availability, extension advice, technical support, etc. influence a farmer's selection of technology (Perry et al., 2009). The 'water saving' objective of these technologies may be fallacious. Perceptions of farmers as inefficient and wasteful users are often erroneous and the introduction of these technologies may generate little or no 'new water' to be made available to other sectors. Wide scale adoption of these technologies may in fact result in increased water consumption, reduced water availability for cities and downstream (Centre for Irrigation Technology, 2011). The objectives for supporting these technologies must therefore be clear, analyzed and monitored by sound water accounting and usually accompanied by associated measures: tariffs, quotas, allocation (FAO, 2012).

To a large extent, the information technology revolution has not yet fully reached the irrigation and drainage sector. This is however, changing rapidly. Typical irrigation and drainage management often make limited and ineffective use of information technology.However, the general spread, decreasing costs and increased availability of information and communication technology throughout society (managers and farmers) and development in modeling, sensors and remote sensing are beginning to make an impact. Advances in crop modeling have a very significant potential to support precision irrigation and application of fertilizers and other inputs (FAO, 2012).

Remote sensing allows the estimation and monitoring of ET.It opens new avenues for effective water conservation programs and water allocation.

Research, development and technology transfer for technological innovation or institutional innovation have been primarily dominated by the public sector.This has more recently been changing.Farmers, civil society and the private sector are increasingly recognized as important innovators. Conservation agriculture was developed by farmers together with problem-solving support from input supply companies, and public research and extension organizations (Kassam et al., 2008). Institutional reform was dominated by donor-driven support and the importation of reform models.An important source of institutional innovation can be found in the informal water economy: the groundwater recharge and water harvesting movements in India have been supported by social reform movements (Mukherji et al., 2011). In India, farmers and water user organizations have innovated and invested in pipe distribution to individual farms and for intermediate storage facilities. Increasingly, these innovations inspire innovative government public policies, as evidenced in the new India 5-year Development Plan, or public irrigation development projects (Facon, 2010). This recognition has led to important innovations in knowledge management systems.

Since the 1990s, the main innovation in water resources management has been the introduction and uptake of Integrated Water Resources Management. The introduction of blueprint integrated water resources management in developing countries however, has led to minimal ameliorations in water resources management and has represented amissed opportunity: typically supporting a focus on improving irrigation efficiency rather than water productivity, standard (and poorly effective) PIM, water demand management through water pricing (not feasible) and canal lining and modern irrigation technology to reduce 'water losses' and save water , and imported tools and instruments from formal water economies of developed countries to informal water economies of developing countries that are not applicable.(Facon, 2010).

Extension

In general, Total Factor Productivity growth (TFP) accounts for a higher share of agricultural output growth as agricultural economies develop. TFP growth was responsible for half of the output growth after 1960 in China and India, and 30–40 percent of the increased output in Indonesia and Thailand. TFP growth is a result of investments in research, extension, education, irrigation, and roads along with policy and institutional changes. Evaluation of productivity gains consistently points to investment in research often associated with extension as the most important source of growth. Improved varieties alone contributed nearly half of the total factor productivity gains in Pakistan and China during the post Green Revolution period (Fischer et al., 2009).

Thereductionof increases in productivityhas been associated with 'under-investment' in agricultural research and development (R&D) both in terms of benefits and preparedness to meet established political commitments to reduce poverty and hunger. New global challenges require additional research investments that will only occur if adequate attention is given to the information, basic studies and human resources in national institutions of research and higher education (Beintema et al., 2009). Public investment in research, development and technology transfer in land and water management practices represent efficient means for governments to promote sustainable land and water management. One key role of government is to invest in pilot programs that demonstrate the technology requirements and economics of sustainable agriculture (FAO, 2011).

There is however an extensive research basis for most land and water systems, but research and extension need to be equipped to offer adapted technology on demand. Outreach programsie: Farmer Field Schools, in partnership with local farmer groups, non governmental organizations (NGO) and the private sector have proven successful in promoting a range of sustainable technologies and practices, including pressurized irrigation systems. Ministries of agriculture or rural development often have the primary responsibility for guiding land and water management. The role of these agencies in delivering technical and support services to rural communities or to individual farmers has been to encourage the uptake of inputs and the adoption of improved agronomic practice. It has become increasingly common for services such as extension to decline precisely where they are most needed (FAO, 2011). In some cases, the role of the private sector and equipment suppliers has been important, particularly in the application of precision irrigation.

A key to successful innovation adoption is to enable farmers to grow crops profitably. Extension workers however, only reach a small portion of communities, and seldom have a background in water management, irrigation equipment, horticulture or dry-season cultivation. They are often trained to support farmers in staple crop production but lack the skill and experience required to support irrigated, market-oriented crop production and sales (Giordano et al., 2012).It is therefore argued that wise investment in technology transfer should include improving the information farmers receive on market-oriented farming; making more information available to farmers on marketing; promoting 'try-before-you-buy' schemes established by dealers who could also be provided with credit from wholesalers and manufacturers; and using existing and expanding the use of the mobile phone, internet and radio networks to disseminate information (Giordano et al., 20012). Advisory services to farmers can now include a broader range of information 'push', and even credit services through mobile technology. The adoption of information kiosks based on ATM models in rural India has been demonstrated together with dissemination of near-real-time remote-sensing products. These types of innovation go beyond the conventional 'extension service' models used by agricultural and rural development agencies (FAO. 2011).

Extension systems were originally designed at a time when extension was the only way farmers received information. However, improvements in education, the spread of new communication technologies, and the growth of the private sector have all created a situation that is profoundly different from that which existed when extension organizations were first established. It is therefore suggested that the objective of extension should be empowerment rather than adoption, with farmers recognized as experts and having networked farmers (Bartlett, 2010). Sustainable crop intensification is very knowledge intensive and cannot be supported by traditional extension. In addition,production systems for Sustainable Crop Production Intensification (SCPI) are knowledge-intensive and relatively complex to learn and implement. It follows that SCPI will require significant strengthening of extension services, from both traditional and non-traditional sources, to support its adoption by farmers. One of the most successful approaches for training farmers to incorporate sustainable natural resource management practices into their farming systems is the extension methodology known as farmer field schools (FAO, 2011).FFS and other forms of participatory adult education have also been adapted to water farmer schools and now climate farmer schools with success in promoting participatory groundwater management (World Bank, 2011).The success of Brazil's Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) program demonstrates how innovation diffusion can be done by institutions through informed agricultural services (FAO, 2011).

However, too little research and development regarding the special needs of smallholder farmers, which are often not reached by private sector extension, and the logistics of reaching a greater number of small farmers in remote areas, with shrinking budgets for extension services will result in a slower adoption rate of new knowledge-intensive systems in smallholder farming systems (Kassam et al.,2008).This is unless significant resources are allocated from the public and civil society sectors. There is clearly a role for both the public and the private sector for research and extension particularly as related to irrigation.The needs of the developed and developing countries are often different.Increasing involvement of the private sector has often resulted in more rapid acceptance, higher efficiency and increased profitability.The public sector however, needs to be involved to ensure the service is extended to smaller farmers (Tollefson, 1996).Innovative market approaches have been successfully utilized to reach poor farmers. However, resources required toexpose farmers to the technology, followed by active extension with adopting farmers and subsequent follow up for complex systems such as drip are considerable and cannot be supported by the dealer network. The degree of sustainability of technical and financial benefits, in common with most irrigation systems, will depend on the availability of spare parts, technical and agronomic support from the supply chain, availability of the minimum water requirements,viable market for produce, the ability to access that market, and the effectiveness and efficiency of the supply chain. The lack of any of these can negate the viability of the sustained extension of the technology using a market approach' (DFID, 2003). Innovative processes have been successfully tested in the Philippines for empowering the poor to invest in shallow tubewells through FFS and adapted financing mechanisms (Facon, 2010).

Nevertheless, extension systems have been successful in introducing modernized on-farm irrigation technology, particularly in Mediterranean countries. In Morocco and Tunisia, where modernizing on-farm irrigation was more effective than investment in large-scale infrastructure,assistance of extension services is the key to achieving sustainable modernization. Extension services created by the local water management company help farmers' decision-making on project dimensioning. They validate dealers' sales propositions, suggest changes in system design and participate in project inception. Their agreement is required before subsidy allocation and activities, together with the development of irrigation testing laboratories, should be recognized and financed within modernization programs (Molle, 2007).

In conclusion, there is a consensus that there is a need for pluralistic, demand-driven, decentralized and innovative advisory services together with strong research-extension-farmer linkages. International Rice Research Institute's (IRRI)'magic pipe' which supports a simple way to conduct safe alternate wet and dry irrigation for rice paddy fields provides an example of such successful new approaches. *Learning Alliances*can help leverage cross-sector resources, strengthen capacity, and plan, generate, and document development outcomes. A Learning Alliance can be seen as a process undertaken jointly by research organizations, donors, development agencies, policymakers, and private businesses (Pandey et al., 2010).

Irrigation and drainage services

The concept of service in irrigation and drainage is relatively new. In the 1980s, discussion on irrigation project improvements emphasized entirely management improvementsover better hardware selection and design. At that time, the concept that irrigation projects must provide service to customers was also introduced from other utilities and sectors such as electrical supply, communications and transport. In the early 1990's, the International Water Management Institute (IWMI) began to develop 'Performance Indices' for international projects, documented significant differences between promised versus delivered flow rates at various offtakes.They provided a narrative discussion of factors, which they felt influenced the level of service, emphasizing management improvements. Plusquellec et al. (1994) re-emphasized the importance of proper hardware selection and articulated the need for an approach to modernization based on the service concept.The International Commission on Irrigation and Drainage (ICID) Working Group on Irrigation and Drainage Performance (ICID, 1995) published a list and description of currently used performance indicators (ratios of volumes of water delivered, lost, and consumed at various times and locations, dependability of supply and regularity of water deliveries).

The American Society of Civil Engineers defined and described the various aspects of water delivery service in the context of the irrigation project as consisting of distribution system layers. Each layer provides a water delivery service to the next lower layer. The definition of water delivery service at any layer in the distribution system includes specification of the water right of the beneficiary; flexibility in rate, duration and frequency of delivery and the responsibilities of all parties in operating and maintaining all elements of the system. In (FAO. 1997), equity and reliability were also introduced. The point of differentiation within an irrigation system is the location for which upstream water deliveries can be deliberately and effectively manipulated separately with time. For all systems in which there iswater management by the individual farmer, the point of differentiation must be at the individual field scale. The actual levels of service at each layer must be examined to understand the constraints behind the level of service that is provided to the field. Malano and van Hofwegen (1999) also described service quality by equity, reliability, flexibility, and adequacy.They described equivalent indicators for drainage. The Rapid Appraisal Procedure for irrigation performance assessment and benchmarking (Burt, 2003) proposed a range of indicators for system outputs and symptoms.This included service quality at all levels, hardware and software elements that influence service quality, and system constraints.

It is now recognized that the level of service is the key decision for irrigation planning and management,It can be defined by 'a set of operational standards set by the irrigation and drainage organization in consultation with irrigators and the government and other affected parties to manage an irrigation and drainage system'. To be successfully achieved, it depends on operational parameters. Requirements in terms of flow control systems and human resources must be clearly understood and planned (Malano et al., 1999).

The improvement in performance of irrigation and drainage systems required to raise irrigated water productivity demands a shift in paradigm towards service orientation. The links between reliability and flexibility of water delivery service are now well established (FAO, 2011). The service approach to the management of irrigation and drainage is to ensure the supply of irrigation water and the removal of excess water is more responsive to customer needs.

A technologically driven hardware approach is likely to fall short of the attempted aims particularly if it is not accompanied by a fundamental shift to the management of irrigation and drainage systems. This shift must be towards management systems with a well-defined service orientation ie: the provision of an agreed or declared level of service that must be achieved at an agreed level of cost with customers. This is a critical element in creating an environment that encourages technology innovation both at the farm level and by the managing organization. The failure of many on-farm water management improvement programs is due to the failure in improving service to farmers so that they can adopt the recommended on-farm water management (OFWM) practices. Much of the technology available for on-farm water management has been developed and used in developed countries. These countries have one thing in common ie: the provision of a higher level of service by irrigation management agencies which are able to respond to their customer demands (Plusquellec, 2002). These technologies are spreading rapidly in developing countries but are usually adopted in groundwater systems or by farmers who pump independently, including within canal irrigation commands.This allows them to obtain the required flexibility and reliability of service.

This 'service revolution' is the essence of irrigation modernization. Modernization should include both physical as well as institutional and management changes. The lack of emphasis on any of these aspects will not allow the potential improvements in productivity to be achieved. Traditional bureaucratic management stifles innovation (Doan The Loi, 2012).

Irrigation modernization has made in-roads in countries ie: Mexico, Turkey and Brazil where IMT/PIM emphasizing service improvement is an objective. There is now widespread recognition of the need for irrigation modernization at the policy or strategic level. Therefore wholesale modernization of irrigation schemes is likely to be central to national strategies aiming to increase the performance of crop production. Combined with soil fertility management and plant protection, modernization has the potential to substantially reduce yield gaps in irrigated production.

In practice however, 'modernization' too often consists of traditional engineering improvement approaches. Nevertheless, success in developing 'pure' service-oriented management models and achieved performance levels such as the Jiamakou Irrigation district in China (Facon, 2013) have attracted the attention of policy makers.There, the key driver for the system's evolution to its outstanding level of performance is the manager. However, through institutional design, capacity building, empowerment and a system of meaningful incentives for performance and innovation reaching all levels of operation down to the farm, the system's management culture has been adopted by all staff.

It is expected that, increasingly, modernization will focus on improving the environmental performance of the irrigation systems.This includes elements of environmental engineering, conjunctive management of surface and groundwater resources and support of the adoption of pressurized irrigation.This often represents a step towards better control, flexibility and accountability of irrigation water delivery.It allows for transformation from low-return to high-return agriculture (FAO, 2012).

Modernization of irrigation systems is not, however, related solely to improving irrigation and drainage services to farmers. Multiple-use services (MUS) have emerged as an alternative approach to providing water services, aiming to meet people's multiple water needs in an integrated manner (Smits et al., 2008). The majority of medium and large-scale irrigation and drainage systems provide support and multiple uses and services (agriculture, water supply, industries, flood mitigation, groundwater recharge,ecosystemservices). Optimizing and managing these multiple uses and services represent new opportunities for engaging stakeholders, increasing the financial basis for the systems, and improving overall and landscape water productivity.

A major area for service improvement is drainage services. Investment in drainage has been neglected for years, despite the negative impacts on agricultural production.Due to neglect, drainage requirements have been developed for 10-15 million hectares in arid and semi-arid countries and the humid tropics. Data on land with high salinity levels, land removed from production, yield depression, and waterlogged and flooded land indicate that drainage problems are severe. The irrigation system management has undergone significant change in many countries but drainage has notbeen carefully considered (Scheumann et al., 2001). The need for drainage will increase with mechanization of agriculture and precision farming, together with climate change.

Obstacles to changing the outlook of the sector must not be underestimated. Policies and reforms imposed from the outside have not lived up to expectations, and the capacity of external development partners to impose them will continue to erode.Capacity building and practice change on the ground can serve as a basis for developing a broad constituency to effect the changes in governance and policy and the fundamental sectoral reforms that are required.This will entail overhauling educational establishments and their curricula in order that new generations of decision makers, experts, consultants, managers, operators and farmers are equipped with the knowledge to embrace, support and implement a change agenda.This change agenda must be clarified to ensure that present opportunities for investment allow this change agenda to be possible, rather than more difficult.

GREATER INTERACTION AMONG WATER USERS, AGENTS AND GOVERNMENTAL ORGANIZATIONS

Background

It is widely accepted that climate change has become a prominent concern of our planet and that its significant effect on water resources necessitates improved water governance, including better irrigation management. Uneven distribution of water resources, floods and droughts, increasedsoil erosion, runoff of agricultural chemicals, etc. are some of the related problems that affect agriculture. In Organization for Economic Co-operation and Development's (OECD) Horizontal Water Program, water security and its management are evaluated in a risk based approach. Therefore, water users, agents and governmental organizations are valued in a new mannerregarding the future perspective of water. The participatory approach has been adopted widely in the water management field in many countries including Americas, South Asia, Europe and Africa. Similar discourses of decentralization and participatory governance are occurring in multiple locations around the globe concurrently (Goldin, 2013). Major national and international policy documents require stakeholder participation in the water management field. Greater interaction among the water users, governmental institutions and civil society promote a collaborative decision making process. Today not only water management administrations and governmental institutions but all the affected and interested parties have input on how and where to use the water (von Korff et al., 2012).

Who are the water users – interested and affected parties

Since it is a necessity to involve all the interested and affected parties in the water management processes from planning to decision making,'Participatory Water Management' and 'Integrated Water Resource Management (IWRM)' have become the main paradigms of the water sector globally. Studies throughout the world have demonstrated that user participation in irrigation services improves access to information, reduces monitoring costs, establishes a sense of ownership among farmers and increases transparency and accountability in decision making. The concept of interaction includesplayers in the various sectors. The interaction among food, energy and water has been on the agenda of the global water community. This interaction has gained attention and offered a new approach to water studies. However, more recently, it is understood that a sectoral approach would cease unless the role of ecology is included as the 'inclusive' fourth dimension. The interaction among water users is meaningful provided the role of ecology is considered.

Particularly when evaluating water management in the agricultural sector, the interacting parties can be included by referring to the distinction between the supply and demand sides. By limiting the actors in the agriculture sector to three groups, ie: government, farmers and regular consumers of agricultural output, each actor can be categorized as suppliers and demanders. In addition, the fourth actor, ecology, is a constant supplier that demands responsibility from the other three agents. In order to understand the demands of each party, interaction is a primary concern. By rationalizing the demand of every actor through interaction, exchange of information can be achieved and the awareness raised.

History

Water management has historically involvedthe concepts of participation and interaction among parties. Not surprisingly'responsible farmers' existed in pre-modern times of agrarian societies, when farmers were largely self-sufficient and a strong central authority was not present.It was with the triumph of modernization, that is accompanied by nation states' centralist bureaucracy and technocratic supremacy, expert knowledge was believed to be sufficient for management and distribution of water. However, in the age of the 'risk society' socially constructed threats, i.e. human impact on nature, are threatening nature's suitability for human security. It becomes important to account for the human factor as the lead actor of nature.

Participatory water management is not a novel concept. History records many instances of participatory water management. The Middle East region, covering Egypt and Mesopotamia host the most ancient remnants of civilization including water management technologies. Irrigation and water diversion structures date back to 5000 BC (Bazza, 2006). In addition to being a pioneer in water technologies, the Mesopotamia region was also the birth place of water regulations possessing the first signs of participatory water management. It was Babylonian King Hammurabi (1792-1750 BC) enacting the code of law that compelled farmers to cooperate in the distribution of water. The code forced farmers to view irrigation practice as a collective responsibility for the interest of the general public. Accordingly, a farmer was obliged to maintain the proper functioning of public canals that were located on his property (Bazza, 2006). Likewise, one of the historically acclaimed books of statecraft dating back to the 4thcentury in India, *Arthashastra,* counsels the statesman to assist farmers in the construction of irrigation projects (Chandrasekan et al., 1995). Contemporary China's ancestors, the Han Dynasty (206 BC-220) had a dual system of water management that resembles modern day approaches. The central authority was responsible for overall planning of water resources including flood control and transport, whereas local agencies were responsible for financing and management of irrigation projects (Greer, 1979). Centuries later this local management trend complimented the model of large-scale and capital intensive water management in the People's Republic of China (Giardano et al., 2004).

Although some early instances of water management utilize the 'Water Users Associations' (WUA) model, the concept itself is a creation of the twentieth century. One of the earliest cases of modern WUAs of the 20th century took place in Klamath, California in 1905. Establishment of WUAs in Klamath was originally a part of the greater socio-economic reclamation project for the indigenous people of the region. The stakeholders of the Klamath WUA were local farmers, businessmen, attorneys and community leaders who paid taxes for the construction of irrigation systems that are vital for the subsistence of the inherent beneficiaries of the land. By the 1950's the cost of the irrigation systems were reimbursed by the state. Today KWUA has become a professional organization, representing the interest of over 5,000 water users on 1,400 family farms (Keppen, 2004).

During the second half of the twentieth century, the gradual acceptance of democracy was occurring. Participation in water management became more commonplace.The participatory principle was considered to be successful in two types of stateswhich share the common characteristic of being open for institutional reform. The first group is well institutionalized democracies where institutional conditions allow and encourage the grassroots involvement of stakeholders having cross-cutting interests. The European Union (EU) Water Framework Directive (WFD) and the Aarhus Convention (1998) are two of the overarching regulatory frameworks that set the general norms of participatory water management, while allowing space for the creativity of direct users. The secondgroupofstatesarethosedesiring institutional reform including democratization, economic development and/or transformation of the elite class. Such periods of institutional reform allow change in managerial models, including water. It is not coincidental that South Africa has been one of the pioneers of participatory water management with the implementation of the 1998 National Water Act.This followed the end of apartheid rule (Brown, 2010). Likewise, Turkey and other developing countries have significantly accelerated the formation of irrigation associations and cooperatives during the 1980s and early 1990s in line with the global transformation. The World Bank has promoted the establishment of water user associations through financial assistance.This has been for more than three decades. Prior tothe 1980s, establishment of water user groups was not as widely promoted. Rather, individual initiatives of the states determined their level of participation. In the early 1960s, State Hydraulic Works (DSI) of Turkey encouraged farmers to establish irrigator groups to conduct operation and maintenance activities in large scale irrigation schemes (Topcu, 2009). Despite problems that have reduced the interactive potential of water management models in varying phases of history and geographical location, there is much to expect from the concept of public participation.

State of the Art

Post 1990, the IWRM paradigm gained momentum in the water sector.IWRM is defined as a process that promotes the co-ordinated development and management of land, water and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of the ecosystems (GWP-TAC, 2000).The purpose of IWRM is to manage water effectively and efficiently.It entails co-ordination of policies, institutions, regulatory framework planning, etc. of various agencies and departments responsible for aspects of water and natural resource management.This ensures coherent policy making related to all sectors ie:decision makers concerned with national water security, national food security and national energy security.Competing user groups influence strategies for water resource development and management (Phillips et al., 2008).Water users are now expected to participate in water resource planning, irrigation planning, flood management, climate change adaptation and mitigation for their own benefit and also for purposes of environmental sustainability (Goldin, 2013).

Participation has led to better governance practices ie: governmental institutions have been re-structured and water management decentralized in many countries. Non-governmental platforms such as the WUAs, irrigation organizations, local boards and regional water councils/committees have been formed in many countries.These bodies are included in water management processes beside the individual water users. In addition being a democratic representation model, public participation in the water management field also initiates social interaction and learning among water users (Muro and Jeffrey, 2012). The increasing interaction among the players results in better, more rapid decision making and enables the acceptance of decisions (von Korff et al., 2012).

Water management institutions, the included players and the level of interaction among these players vary across countries. Participatory water management practices have been developed within the EU during the last decades and gained momentum from 2000 onward. When Member States and the European Parliament reached an agreement on the WFD, they also agreed to inform and consult the public. The main objective of the WFD was to achieve the good status of water by 2015.The EU urges all interested parties to become involved in the basin management planning processes to reach this objective.The participatory approach has been widely adopted in Europe along with other developed parts of the world.It has been implemented with a high level of success.

The irrigation sector is recognized as a pioneer in participatory water management.Participatory Irrigation Management (PIM) refers to the participation of farmers in all aspects of irrigation management and at all levels.Irrigation management transfer (IMT) is the full or partial transfer of responsibility and authority for governance, management and financing of irrigation systems from the government to water use associations (Vermillion, 2003).Participatory irrigation management through WUAs has involved farmers in the management processes at the local level. This management model transfers the responsibility to the farmers regarding water distribution/allocation, crop pattern planning and financing of irrigation infrastructure (Bhatt, 2013). This model has been successful in many countries ie: Turkey, India, Brazil, and South Africa through promoting local governance and developing representation of water users in rural areas.

Turkey's experience with irrigation groups dates back to the 1960's, when these groups were encouraged to become involved in the operation and maintenance (O&M) activities of large scale irrigation schemes.Since 1993 the process has been accelerated with the support of the World Bank.They established numerous irrigation associations and cooperatives gradually. The O&M responsibility of all irrigable land was given to the irrigation associations, cooperatives, village authorities and municipalities. The financial success of the process is apparent since the O&M expenditure decreased from 100% (1991) to 16% (2005). Despite the transfer of the O&M responsibilities to the water users, the interaction among interested stakeholders hasintensified. Among those stakeholders, DSI is a major participant providing workshops, seminars and training programs for the technicians and the secretariat of irrigation associations. In addition to DSI,the efforts of non-governmental organizations collaborating with farmers, municipalities, academia and other provincial organizations further enhances the opportunity for interaction.

A project conducted by WWF Turkey is an example of these activities. Since 2008, WWF Turkey has been working on one of the most vulnerable closed water basins in Konya. Turkey is conducting a project to mitigate the impact of climate change on water resources. The project includes training programs, pilot applications, climate modeling and potential agricultural scenarios. To date, pilot projects have demonstrated up to a 50% water saving, reduction in energy consumption and an increase in the overall productivity. Another example of stakeholder interaction is a study from the same region. In May, 2013 the regional development agency of Konya hosted a workshop bringingtogether members of irrigation associations, cooperatives, government and academia. It was an open forum whereby farmers could communicate directly with government and technical experts to express their concern and provide suggestions regarding topics of irrigation and energy; climate change and water management; irrigation infrastructure and pricing. Farmers had the opportunity to help shape the irrigation agenda of the region and interact with experts on a non-hierarchical basis. This type of interaction is invaluable considering the opportunity for transparency and the grassroots participation ofstakeholders.

Basic Components of a Successful Participatory Irrigation Management Model/ Benefits of Participatory Irrigation Management

It is widely accepted that improved irrigation management is required worldwideto improve the efficient use of water resources and to deal with the associated financial problems. Utilization of the participatory management approach enables thedirect involvementofstakeholders in the political, economic and technical decision making.This process increases the acceptance and quality of the overall work. Dynamic dialogue among the stakeholders is a basic criterion for the success of participatory water management. The involvement of stakeholders is not only limited to decision making but also has the benefit of responsibility sharing.
Participatory management has been applied through local organizations, WUAs, cooperatives successfully in many countries. Some of the positive outcomes of this model are: increased legitimacy of decisions, rapid response to technical problems,

transparent pricing, price monitoring, financial sustainability, development of social capital, ease of access to information, integration of diverse knowledge and capacity building.

Training is another key aspect of participatory management for the efficient involvement of all the participants. Scientific research related to participatory irrigation management is an important tool for dissemination and better functioning of the model. Tohelp shape the research agenda, it is important to bring all thestakeholders together in common discussion platforms. More recently there was been an increased effort to bring together policy makers, water users, producers, industry, infrastructure companies and academic researchers to help identify the emerging research needs.This holds great promise in direction setting and overcoming the gap between parties.

Future outlook

Climate change is impacting and reshaping the future for freshwater resources. It complicates planning, management and investment in water infrastructure. Reducing the cost of climate change adaptation on water systems requires progressive administrative bodies that follow the principles of durable peace, social welfare, rule of law and good governance. Action plans designed to mitigate the present effects of climate change are predictinga future water management scenario in line with the UN Sustainable Development Goals (2015).Risk of food security, demand for more productive agricultural systems, improved land and water management, drought and flood risks are issues that will continue to be included on the agenda of the irrigation sector.It will become critical to expand the irrigatedacreage and input from all stakeholders will be required. In the 2nd Istanbul International Water Forum,the WUAs system was discussed in detail. It was emphasized that a well-functioning WUAs network will relieve part of the burden from the agricultural sector. State and society are brought closer through the process and the social problems become more evident. These problems become easier to handle throughthe increasing economic prosperity that is occurring at the grassroots level (5th World Water Forum Secretariat, 2011). Dissemination of the participatory irrigation management model will help reduce the management and funding responsibility of governments.

Although it is difficult to measure the operational success of the participatory water management system, the ongoing criticisms are related to the inefficiency of the system and the inequity in developing countries (Ribeiro and Vieira, 2012). The success of IWRM and the participation relies on adequate distribution of power across governmental, political and public levels.This distribution requires a healthy social system (Molle and Hoanh, 2011). The lessons learned from the European experienceare valuable for other regions of the world.These regions however, need to develop their own specific system of participation and interaction. Policy developed regarding participatory water management must be sensitive to local conditions, adaptive to users' needs, have a flexible institutional structure, and allow for institutional learning and change (Kadirbeyoglu and Ozertan, 2011). All stakeholders must be supported to provide their perspective of the problems, solutions, interests and preferences during participative decision making (van Eeten et al., 2002). The need is to form actively operating systems and institutions rather than non-functional generic ones.

Conclusion

Irrigation and drainage face many challenges but also provide opportunities to assist global food security.Modernization and improvement of irrigation is occurring worldwide at varying rates and degrees.Much is being accomplished through innovation and technical advancement.This alone will not address the issues of water and food security.Policy, management, institution and governance are also key areas which need to be considered and addressed.

Improved water governance and management are imperative if the needs of current and future generations are to be met in a sustainable fashion.Good water governance cannot be hastily undertaken or achieved using blueprints developed outside the region.Good governance must be developed to suit local conditions and fit the social, economic and cultural particularities of the region.The government role should be that of a facilitator or activator rather than a top down manager.It is responsible to formulate national water policies and legislation, enact and enforce the legislation and encourage and scrutinize the private sector.Conditions of equity, accountability, participation, transparency and responsibility must prevail.Parties concerned must be open to committing to collective decision making, effective and functional institutions must be developed and policy, legal and political frameworks must be suitable to the goals that are being pursued.To strengthen governance and management of water requires education, capacity building, organizational development, etc.These are critical to the sector.

The innovation-extension-irrigation and drainage services nexus is also essential in allowing the sector to achieve economic, social and environmental sustainability along with food security.This encompasses the whole range of agricultural water management practices including genetics and agronomy, technological, institutional and policy innovation along with innovation in knowledge, management and diffusion systems.These will address the adaptation and diffusion of best management practices, and recognize farmers as innovators and experts but also encourage adoption of a multiple uses and a service perspective.In many countries irrigation and drainage agencies and agricultural support systems have been slow to adapt to the utilization of technology and the transformation of farming systems.Critical for irrigation and drainage management to enable adoption of farmlevel innovation is the adoption of serviceoriented management, together with incentives for innovation and performance for irrigation and drainage staff. Capacity building can serve as the basis for developing a broad constituency to effect the changes in governance and policy and the sectoral reforms that are required.

Agricultural water management related policies, strategies and investment programs must include incentives and support for dynamic innovation and knowledge management systems. These systems should be pluralistic and include government institutions, civil society and private sector organizations. Substantial public investment will be needed for these systems to respond to the needs of and reach smallholder and poorer farmers.

Greater interaction among users and organizations is also essential to help impact these challenges and opportunities.A well-functioning WUA network is an important aspect.Participatory management enables direct involvement of stakeholders in the political, economic and technical decision making.This increases the acceptance and quality of the work. Participation has led to better governance.Varying levels of operational success has occurred with the participatory system.Lessons learned from the European experience for example are valuable, however, other regions must develop their own specific systems of participation and interaction.Policy developed must be sensitive to local conditions, adaptive to user needs, have a flexible institution structure and allow for institutional learning and change.Stakeholders must be supported to provide their perspective of problems, solutions, interests and preferences during participative decision making.

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