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Approaches and Impacts of Participatory Irrigation Management (PIM) in Complex, Centralized Irrigation Systems – Experiences and Results from the Jordan Valley

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Abstract

Participatory Irrigation Management (PIM) is a key term in the toolbox of current approaches to improve the efficiency and performance of water resource management. Experiences from several countries indicate that introducing participatory elements in the relationship between – mostly governmental - decision makers on water resources and end users of water is an essential, but neither detached nor standardized process in the complex set-up of successful water resources management. The differences between the applied participatory approaches support the assumption that PIM cannot be transferred from one situation to another without modifications. Published guidelines on elements and procedures in participation put their focus on general applicability, but the successful implementation of PIM in a specific case crucially depends on its sensible adaptation to the local situation.

Water resource management in the Jordan River's east bank underwent significant changes since the 1960s and became a highly centralized irrigation system under the control of the governmental Jordan Valley Authority (JVA). The social structure of the farming population developed alongside the reorganization, but weakened tribal bonds in favour of the economic independence of individual families. Efforts towards an improved utilization of water by introducing participatory elements in water resources management thus have to cope with complex incentive structures of individuals on the level of farmers' communities and within the administration. The implementation of a concept, which relies on four years of analyses on socially acceptable mechanisms in the Jordanian context and the evaluation of former - less successful - approaches, now yield its first positive results. Major economic effects are decreasing maintenance costs of the pressurized conveyance system, a higher security of water supply through the therewith improved reliability of the system and the increase of cultivated areas due to a lower share of buffer zones within irrigation plots, which were a part of farmers' reaction against the risk in water supply. Major social effects originate from the improved and more transparent communication structures, which reduce the number of conflicts between farmers and the need for interventions of governmental authorities in local disputes.

1 Introduction

Participatory Irrigation Management (PIM) is a key element in the toolbox of approaches to improve efficiency and performance of water resources management. Such improvements are of primary importance in countries that have to cope with water scarcity or, with regard to expected impacts from global and climate change, are likely to face such problems in the foreseeable future. Experience from several countries indicates that introducing participatory elements in the relationship between – mostly governmental – decision makers on water resources and end users of water is an essential, but neither detached nor standardized, process in the complex set-up of successful water resources management. Several countries, such as Mexico, Turkey, Indonesia, the Philippines, Colombia, India, Sri Lanka, and Nepal, adopted policies to encourage greater management participation by water users since the mid-1980s (WORLD BANK, 2002.). The differences between the applied approaches support the assumption that PIM cannot be transferred from one situation to another without modifications. Guidelines and elements in participation may be of general validity, but the successful implementation of PIM depends crucially on its sensible adaptation to the initial situation in a given case. The documentation of empirical sequences in the development and implementation of approaches as well as the evaluation of achieved results is thus critical for the completion of the existing toolbox for PIM.

2 Water and irrigated agriculture in the Jordan Valley

Irrigated agriculture in the Jordan Valley covers with approximately 30.000 ha about one-third of Jordan's total irrigated areas. Water for irrigation stems from the tributaries to the Jordan River, side valleys on the east bank and from the treated wastewater from urban areas in the Jordanian highlands. Large-scale development of the water resources started in the 1960s and led to a centralized water distribution scheme under the management of the Jordan Valley Authority (JVA) which works under the auspices of Jordan's Ministry of Water and Irrigation (MWI).

The backbone of the irrigation scheme is the open King Abdullah Canal (KAC), which delivers water via pumping stations and attached, pressurized conveyance systems to the individual irrigation perimeters. A total of 35 irrigation perimeters depend each on one common source of water. Sources are either one of the 28 pumping station along the KAC or an inflow from a side valley, a so-called Wadi. Water is conveyed from the source to farmers' fields through pressurized irrigation pipelines and distributed to each cultivation unit (35 dunum = 3,5 ha) by an end user outlet (DOPPLER *et al*., 2002, HADDADIN, 2006). The cultivation units are technical and administrative units due to their common water outlet. Farming systems, i.e. farming families or enterprises, may possess, rent or cultivate any amount of land, from parts of a cultivation unit up to a number of cultivation units, at a time.

The JVA is in charge of the maintenance of the conveyance system and bears responsibility for the water distribution. It employs on that behalf about 800 workers who operate, amongst others, the valves of the end user outlets and read off the water meters that count individual water consumption. Valves from the pressurized conveyance system, meters and depressurization units are placed in locked concrete boxes. The JVA agents hold the keys to these boxes. The amount and timing of water attributed to individual farmers from the system depends on the decision of the responsible local JVA office. The JVA bases its decisions on the one hand on the cropping plans that each farmer is supposed to submit at the beginning of the vegetation period and on the other on the available water in the JVAs storage facilities. Special permits for particular cultures are possible. JVA employees pass by at the irrigation plots and open the valves in the concrete boxes for a certain time. This time corresponds to the water quantity that would be delivered by the known diameter of the valve and the assumed standard pressure of the water supply system.

The social and economic context of the rural population in the irrigation scheme developed alongside the reorganization of water resources by the JVA since the 1960s. Migrants from

different parts of Jordan moved to the new attractive area of production and settled there. This process weakened tribal bonds in favor of the economic independence of individual families an nearly eradicated communities who share water according to common traditional concepts of water rights (GHNEIM *et al*., 2005):

3 Challenges to the irrigation water management

The current, technically sound approach of management in water distribution faces serious problems within the social and economic context, since it allows for significant incentives from illicit action by all concerned parties. Reported incidents range from deliberate damage of water meters to circumvent regular billing of water charges and temporary depressurization of the conveyance system by perforation of tubes for illegal water extraction up to informal lobbying that obstructs the performance of the administrative system.

Economic and social consequences are

- *Increased maintenance costs* for the JVA due to manipulations of water meters and valves, the therewith connected destruction of concrete boxes and illegal tapping of the pressurized pipes.
- *Loss of public funds* through unaccounted water extraction by manipulated or destroyed water meters and uncontrolled water extraction of surface water from the King Abdullah Canal via the illegal use of mobile pumps,
- *Elevated risk and costs for farmers* from illegal tapping by perforating pressurized tubes. The entailed temporary depressurization of the system interferes with the delivery of water according to the agreed-upon water supply plan.
- *Additional investments by farmers* in private ponds and pumping equipment arise from the necessity of private water storage in order to counteract potential disruptions of the regular water supply by the system of the JVA. The construction of such storage facilities also comes with opportunity costs for its demand in area on the irrigation plots.
- *Further additional costs for farmers* trough *a)* opportunity costs from crop combinations, that renounce on parts of profit margins in favor of risk reduction and b) the introduction of uncultivated buffer zones in the irrigation plots in order to cope with unreliable water supply.
- *Increased social costs* due to social strife in the farming community as well as between aggrieved farmers and the administrative authorities that are responsible for the timely provision of water.

These problems in irrigation management add up to a significant scale with regard to the already tense water situation in the Jordan Valley. As a result, irrigation efficiency is far below its potential and cost recovery for the services of the JVA by farmgate prices of about 0.015 €/m3 does not even cover the Authority's expenses for labor and maintenance of pumping (AL-WESHAH,1996). The Jordanian government decided in 2001, to counteract these problems by gradually introducing participatory elements into the water management of the Jordan Valley irrigation scheme. The decision relied on previous experience with participatory approaches in irrigation management from other countries that lead to demonstrable improvements in economic water use efficiency, sustainability and cost-reduction with regard to conveyance systems and a more responsible handling of water resources and public funded installations by (*cf.* WORLD BANK, 2002). First attempts of participatory solutions were based on general guidelines provided by the World Bank but yielded little success (*cf.* MAZAREH *et al.,* 2004). Subsequent surveys and analyses of traditional management models within irrigation communities throughout Jordan provided the basic knowledge on more suitable starting points for participatory approaches in the Jordanian context (*cf.* GHNEIM *et al.,* 2005). One major finding of this research was that situations and indigenous solutions differ - even within Jordan - in a way that may call for more than one

single, standardized approach towards the introduction of water users' participation in management decision making.

First steps in the adaptation of the ways for introducing PIM to a specific situation in Jordan – i.e. the Jordan Valley irrigation scheme - were implemented by the project on Water Management in Irrigated Agriculture (WMIA) under the umbrella of the Jordanian-German technical cooperation. The following overview on the situation and problems of irrigation in Jordan provides the background for understanding the starting point of changing a top-down oriented water management towards PIM. The subsequent detailed analysis highlights the elements of the underlying concept and explains the already achieved success, even if it may be premature to state a general breakthrough.

4 Basic reflections on PIM in the Jordan Valley

The first, basic question to address was - and to some extend still is - the identification of suitable types of farmers' organization. Formal water users associations (WUA) did not exist in Jordan. An analysis of traditional types of farmers' cooperation in Jordan identified informal management approaches that are still applied in traditional settlement schemes around springs. These traditional forms of participatory irrigation management rely on water allocation in relation to the size of irrigation plots. The strict irrigation schedules and the laws on how to handle violations and solve conflicts are enforced by the farmers themselves under the advice of the mostly tribal authorities (GHNEIM *et al.,* 2005).

A direct transfer of these traditional approaches to the Jordan Valley was, however, judged to be not suitable. Major obstacles in this regard where *(a)* the ownership of water resources in the Jordan Valley by the Jordanian instead of possession by tribes or villages, *(b)* the relatively new social fabric of settlements of the Jordan Valley, which developed alongside the reorganization of water resources by the JVA since the 1960s and *(c)* the complex and large-scale irrigation system of the Jordan Valley, which involves substantial public investments and requires advanced technical management. Introducing PIM into the irrigation scheme of the Jordan Valley thus required the development of new participatory structures, which are based on both, methodological knowledge on participation and the specific Jordanian background of social interactions.

5 Participatory Irrigation Management in the Jordanian context

Attempts to consider end users' demands in irrigation management in the Jordan Valley allow for a distinction into two branches. The first branch started in 1998 with the so-called TO2 Pilot project in the area of Adyasseh and focused on the improvement of technical premises in on-farm water distribution. The direct incorporation of farmers' views was restricted to a consultation via a rapid rural appraisal in 2000. Elements of the project were changes in the management of the water network by the JVA as well as in the technical set-up of irrigation within the farms. The JVA contributed to the project by increasing the capacity of flow limiters, by improving its management of pumping stations, distribution interfaces on the farm gate and by a more efficient control of irrigation orders. Farmers profited by subsidized, improved irrigation equipment and additional training. Results were, however, not satisfactory with the regard to the social and economic problems that occurred under the former irrigation regime. Officially registered Water Users Associations (WUA), which did not exist in Jordan to that date, were considered as a potential structural add-in for improving the situation, but the majority of farmers in the pilot area seemed "to rejected the transfer of the management to a farmer's organization" (*cf.* MAZAREH *et al.*, 2004).

The second branch of Jordan's attempts to involve farmers in irrigation management focuses on a participation that exceeds the role of information delivery and the reception of extension

messages on improved irrigation methods. The project on "Water Resource Management in Irrigated Agriculture" (WMIA), which started in 2001, supports the creation of farmer-owned WUAs in the Jordan Valley by building on knowledge about traditional and informal cooperation structures in rural societies in Jordan. The so far attained results support the expectation that the applied approach may bridge the predominantly technical improvements in water resource management that are further on pursued by the TO2 project and which are the basis of the additional Kafa'h project.

Gained knowledge on traditional farmers' associations in irrigation management allowed for the identification of three core elements, which characterize successful WUAs in the Jordanian context:

a) Farmers participate actively in traditional bodies for water management, which settle final decisions in water management, but are hesistant to participate in purely consultative organisations,
b) Farmers' incentives for cooperation, i.e. investing time and money, in those bodies are intimately linked to the individual benefits which originate from the bodies decisions. A precondition seems to be the assessability of resulting benefits by the farmer in advance, either by experience or by credible accord with the respective authorities.
c) A formal, transparent management system reduces or at least clarifies the impacts of informal power structures and relationships between individuals on the management of water resources.

Formal mechanisms had to replace the missing traditional social bonds in the set-up of the Jordan Valley's irrigation system. Jordanian law demands for the placement of a bank deposit for registering farmers' associations, which posed simultaneously a major initial challenge for the introduction of WUAs but also a scale for the interest and commitment of farmers in relation to the arbitrament that Jordanian authorities are willing to assign to their WUAs.

The physical subdivision of the Jordan Valley irrigation scheme into irrigation areas, which rely on one source for water each constituted an obvious structure for the delimitation of the new WUAs. Responsibilities transferred to the associations comprised in the first step the self-administration of water distribution within the respective irrigation area and the hand over of the keys to the concrete boxes, which contain meters and valves of each farm outlet to the farmers' fields. The distribution of water between the different irrigation areas remains – tentatively - in the hands of the JVA..

The WMIA project started negotiations with the farmers in 14 pilot plots in 2002 and supported them in establishing their formal WUAs until the end of 2003. The outline of the WUAs is based on the principles of

a) One voice per field with irrigation outlet: This does not coincide with the principle of "one man, one vote" since farmers may cultivate any possible area from fractions of one field up to a significant number of fields, but corresponds to the traditional, well understood and accepted principle of a connection between land and water rights. Farmers, who cultivate only a fraction of a field, select a representative.
b) The election of a directorate for each WUA: The elected body organizes the WUA meetings and negotiates with governmental authorities, which adds significantly to the transparency of decision processes and reduces social frictions due to informal linkages.
c) The official registration of the WUA with the MOI, which guarantees the sustainability of the WUAs by embedding them in the legal framework and anchors the compliance of the process of the participatory elements within Jordan's development plans.

The fact that farmers volunteered to place the required bank deposit for the registration was a first indicator for farmers' commitment, interest and trust in the negotiated results between governmental and private stakeholders.

6 Preliminary impacts from introducing PIM

In all fourteen pilot areas both, farmers and JVA, state a considerable improvement of the situation. Farmers are satisfied with a better water distribution and JVA generally claims that their duty has become much easier. The increasing number of WUAs and the related expansion of irrigated area under their management prove the progress of communities and the sincerity of the development.

Indicators for the improvement of water services are *(a)* the percentage of operational water meters, *(b)* the joint control of water consumption by farmers and the JVA, *(c)* the number of farm units, where water consumption deviates from target volumes and *(d)* the number of repair and maintenance incidents in the pressurized water conveyance system per year. 3 years of first experiences with WUAs and the attained level of PIM yielded the following state of these indicators:

a) Regular water distribution depends on an internal control of flow and allocations to the agricultural units. A visual control of flowing water like in ordinary irrigation systems is not possible due to the installed pressurized pipes. The volumetric control is achieved cumulatively with bulk water meters on the level of pumping stations and water meters at the farm outlets. These farm outlets formerly have been the location of extensive manipulation and destruction of water meters. A first activity in the northern areas is the rehabilitation of water meters following the request of farmers and their declared commitment to protect them. Indicators are on this level. The percentage of operational water meters remains at least in the north close to 100%. Only one community has a longer history of 3 years; others are more recent and may not yet be considered for evaluation.
b) Farmers in areas under the management of WUAs control their water meters at regular intervals - usually biweekly - in all communities. The announced water consumption is in line with the expectations for the relevant community areas by the JVA.
c) The JVA uses - among other criteria - target values of water consumption as a criterion for imposing penalties. If a water meter shows excessive values, penalties are issued and made public within the community. The establishment of WUAs largely reduced the number of penalties in most of the. Occasional relapses of penalties are subject to discussions in meetings between the WUAs and the JVA.
d) Areas under the joint management of WUAs and the JVA show a significant drop in the cases of destruction of water meters, valves and pipes. Causes for flaws in the water distribution are subject to discussions in the regular joint meetings, which provide useful information of technical problems in the local water distribution network to the JVA and allows for reduced maintenance frequencies and costs through immediate repair. The registered maintenance cases in the community area TO 28 area were on a level of about 425 cases per year until 2002. With an increasingly efficient cooperation between the JVA and the local water user cooperative the number dropped to about 200 cases annually, i.e. a drop of more than 50%. In area TO 50, the rate of 175 maintenance cases in 2003 dropped to a mere 60 in 2004.

A comprehensive quantitative evaluation of contributions to the second objective, i.e. the water distribution according to the demand of individual farms, is not possible yet due to the missing representative and quantitative information on farming systems before and after the introduction of the participatory elements in irrigation management. Observations on the changes in decision-making by farmers, however, may be regarded as indirect indications. Farmers compensate risks in water supply, as given under the earlier management set-up by the JVA, by

a) the construction of water ponds for intermediate water storage of water, which does not only reduce the available area for cultivation, but is also a source for secondary pollution that has an impact on filter and irrigation systems
b) over-irrigation, i.e. the attempt to store as much as possible water in the soil, which causes not only excessive water consumption but also negatively affects plant development and thus yields and
c) refraining from investments that would be profitable under a reliable water supply .

Observations from the pilot TO 28 show that about 50% of the farms abandoned ponds and connected their field irrigation system (FTA) directly to the outlet from the pressurized pipes within 2 years after the establishment of their WUA. The already stated decrease of cases of excessive water use compared to the JVA's target values of water consumption point to the decrease of over irrigation. An example from two further selected pilot areas shows that the number of greenhouses, which are a typical investment in irrigated agriculture, increased significantly in the years after the introduction of participatory elements to water management (table 1).

Table 1: Number of greenhouses in selected pilot areas of the Jordan Valley

	Number of greenhouses in areas with water user communities		
Area	**2003**	**2004**	**2005**
TO 50	3245 (100%)	3850 (119%)	4459 (137%)
TO 55	1678 (100%)	1962 (117%)	2067 (123%)

Two additional reactions of farmers to counteract risk from water supply are the introduction of fallow as a buffer zone on parts of their fields and the choice of crops that are less profitable, but also less sensitive to periods of draught. A quantification of effects from participatory water management is also not possible yet due to the lack of representative data on the pilot areas, but a exemplary calculation, based on a linear programming model about an irrigation area in the southern Jordan Valley, helps to emphasize the implications.

The calculation compared the optimal use of water and irrigated area under the assumption of *(a)* the water supply under full control of the JVA and *(b)* the steering of water supply by a farmers' committee, which considers individual farm demands. The model-based analyses considered the observed cropping patterns before the introduction of WUAs as the basis for the first assumption and allowed for optimal cropping patterns for the second. Results anticipated a significant increase in crop intensity and cultivated area (*cf.* table 2).

Table 2: Model-based estimations of impacts from Participatory Irrigation Management (case study from the southern Jordan Valley)

Indicators	**Before PIM**	**With PIM**
Price elasticity	1.3	1.7
Total cultivated area (ha)	268.6	388.3
Crop intensity	82%	118%
Total revenue	597929JD 423334 $	806397.18JD 570929 $

A further important effect was the change in the elasticity of water prices. Model results and the consequential functions of water demand indicated that participatory irrigation management substantially increased the profitability of sensitive reactions to changes water prices (*cf.* table 2). This implies that PIM does not only contribute to improved incomes from agricultural production

but also supports the market-driven optimal allocation of the scarce water resources throughout the Jordanian economy.

7 Lessons learned from introducing PIM in Jordanian irrigated agriculture

The successful and promising process of introducing participatory structures into the irrigation scheme of the JVA allows for some useful suggestions on required elements in the management of respective changes, even if the process in Jordan has not reached its final state yet. Experience of the WMIA project pointed out the following cornerstones:

- Promotional programs for explaining the advantages of participatory irrigation management are essential initial activities for successful transfer programs. This can be done through meetings, workshops, and the distribution of pamphlets.
- The election of a WUAs first set of directors is a critical action for the future of the association. When the directors are representative of the membership and have leadership capacity and managerial spirit, the WUA will likely be successful.
- Successful transfer requires an appropriate legal framework. This framework must clearly define the rights to water, forms of organization, the responsibilities of each party, and the manner in which activities should be regulated. Fiscal benefits must also be considered for companies that manage the irrigation and drainage infrastructure.
- A transfer program should be accompanied by continuous training for both WUA directors and their operating staff.
- The transfer of responsibilities and tasks from governmental organizations - like the JVA in Jordan - to WUAs requires a simultaneous restructuring of the public agency. Staff, skills and management structures will have to be redirected to the new fields of services, which comprise the solution of operational problems, negotiations on questions of water management between WUAs, the technical and organizational support of WUAs and the enforcement of national water laws.

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