IS PARTICIPATORY GROUNDWATER MANAGEMENT AN OPTION?

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ABSTRACT

In Iran as well as in the rest of the world, a large sector of the irrigated area is totally or partly dependent on groundwater. As such groundwater has become a cornerstone of many regional economies and societies. Yet contrary to surface water irrigation, where a lot of attention has been given to PIM, within the groundwater irrigation sector there has been very little attention for participatory management of groundwater resources even though in most places it is a very pressing issue. Dropping groundwater tables and pumps that run dry in many areas clearly show that often the present use of groundwater is unsustainable. In irrigation systems where conjunctive water management takes place combining groundwater and surface water management can offer an option for participatory groundwater management. This case study analyzes the situation of groundwater resource use in the Abshar irrigation system in the Zayandeh Rud Basin Iran and establishes the question if participatory management of groundwater and conjunctive use is a viable option for irrigation management in the present context.

GROUNDWATER USE IN THE ZAYANDEH RUD BASIN

The Zayandeh Rud basin is situated in the centre of Iran and covers an area of 41,500 km^2. The basin originates in the Zagros Mountains at altitudes of around 2300 m, where rainfall and snow are abundant[2], and closes in the Gavkhuni swamp at an altitude of 1466 m. The majority of the basin is a typical arid and semi-arid desert. The city of Esfahan, with almost two million inhabitants, and its fertile plains[3], form the main socio-economic area of the basin. Esfahan lies at an altitude of around 1800 m and has an average annual precipitation of 130 mm, concentrated in the November-April period. Temperatures are hot in the summer, reaching an average of 30^{o}C in July, but are cool in the winter dropping to an average minimum temperature of 3^{o}C in January. Annual potential evapo-transpiration is 1500 mm (Molle *et al.,* 2004).

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2- In the head of the basin at high altitudes precipitation averages at around 1700 mm a year.

3- The fertile plains are constituted by alluvial deposits flanking the Zayandeh Rud where slopes are gentle and soils have good soil moisture holding capacities (Salemi *et al.,* 2000).

In the lower and dryer parts of the basin, irrigation is a must for agricultural production. For centuries, water from the Zayandeh Rud River has been diverted to supply the city of Esfahan with water and to irrigate its gardens and neighboring areas. The peak flows from April to June provided the basis for widespread downstream irrigation using simple diversion structures, called *mahdis*, to make productive use of floodwaters (Salemi *et al.,* 2000). Beside surface water, most downstream areas have groundwater supplies close to the surface. The recharge of these is mostly direct recharge from the Zayandeh Rud River (idem, 2000).

Beside surface water, groundwater is one of the most reliable water sources in the Zayandeh Rud Basin. In the basin twenty unconfined and two confined aquifers have been identified. Presently about 21,200 tube wells, 1,726 qanats and 1,613 springs exploit a total of 3,619 MCM of groundwater a year. Studies conducted by the Esfahan Water Authority (EWA) in 2000 reveal that several aquifers are being over-exploited especially in some of the irrigated areas (Morid, 2004).

On basin level, 72% of total water use is groundwater with a total estimated use of 3500 MCM per year. The bulk of this water is used for agricultural production. In the irrigation districts groundwater use is high. In Nekuoabad and the areas of the Abshar and Rudasht irrigation districts that are near the Zayandeh Rud River have shallow aquifers of between 10-50 m. that are intensively exploited for agriculture. In these shallow aquifers there is a direct link between river flows, surface water irrigation in the systems and the level of the groundwater table (pers. com. Saberi). In general it is observed that the further form the river bed, the deeper the aquifers. These deeper aquifers respond much less to the fluctuations of surface water flows in the river and can be considered mainly as fossil water reserves (*idem*). The deep aquifer water reserves are used mostly in the Brokhar and Mahyar irrigation systems as well as the northern most edges of the Abshar Left Bank.

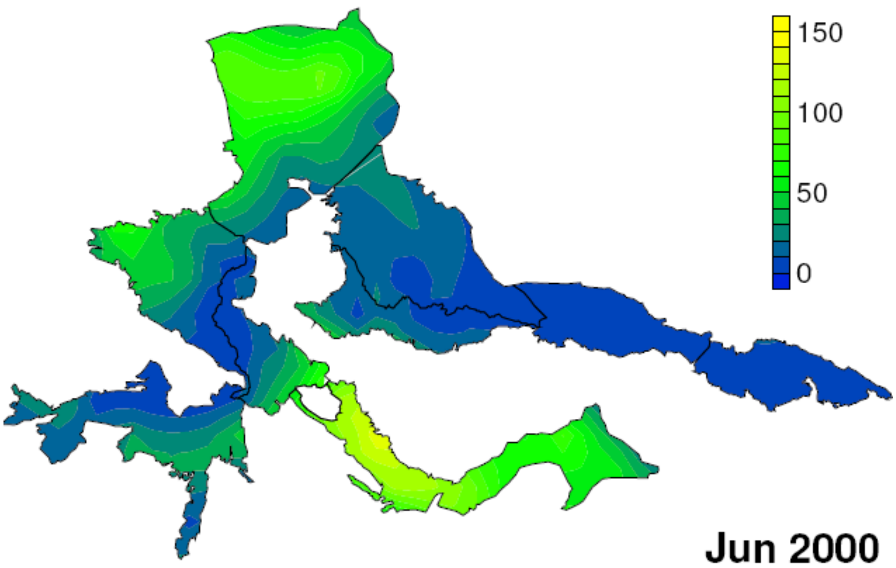

Figure 1: Groundwater levels in the main irrigation systems of the Zayandeh Rud basin in June 2000 (Droogers and Miranzadeh, 2000)

During the years of drought the shallow aquifers in the irrigation systems had a severe drop in groundwater levels as groundwater use increased while recharge was almost absent. Several farmers responded by deepening the existing wells. According to Saberi (pers. comm. and confirmed by farmers' interviews) the drop of groundwater levels in the deep aquifers also increased during the drought although in these deeper aquifers the drop of water level was less severe than in the shallow ones.

Groundwater resources are being overexploited in several areas of the basin with the associated water quality degradation (Salemi, 2003). This means that on the long run the exploitation of deep aquifers that have little direct recharge form surface water resources will exhaust the groundwater reserves. As control over groundwater, especially on the use of shallow aquifers, is very hard due to the fact that installing a shallow well is very easy, the EWA is limited in its management of groundwater to monitoring groundwater levels and limiting the construction of new deep wells.

GROUNDWATER USE IN THE ABSHAR IRRIGATION SYSTEM

In the Abshar system groundwater is, beside surface water, the most important and reliable source of water for irrigation. Most of the wells are owned individually or managed by a small group of farmers compromised by 2-15 users. Historically a couple of areas that lie within the irrigation system relied on qanats for their irrigation water. At present because of the large amount of tube wells, all qanats in the area have fallen dry, being replaced by either surface water irrigation or the use of wells (Hoogesteger van Dijk, 2005).

Groundwater management knows different forms of management but generally these are confined to a limited group of users in the field. The most common modes of groundwater management are:

- *Private well for private use*: This mode implies little organizational control as it is one user that has control over the water flows. In some cases the users use the surface water canals for transporting the water. In these cases it is only necessary to ensure that the use of these does not affect other users.
- *Private well for private use, selling excess water:* In some cases when farmers have a well, which exceeds their personal needs, they sell water to other users. In this case farmers have to organize to manage the water. In such cases, because of the high number of users, groundwater gets managed under the same rules as surface water. The only difference there is that the fees for the use of the water go to the owner of the well instead of the Mirhab. The fact that the well owner is also the outlet tender makes the management and regulation easy.
- *Private well owned by several users:* Often farmers do not have enough resources to invest in a well by themselves. In these cases, farmers often organize in groups of two to five users, mostly friends and family and jointly invest in the drilling and installation of a well. The most common arrangement for these wells is that farmers pay for the O&M of the well according to the amount of hours they make use of it. As in most cases it is friends and family that jointly invest in a well.

THE NEED FOR GROUNDWATER MANAGEMENT

In view of these developments there is a pressing need for groundwater management. Governmental control seems very difficult all around the world because of:

- The individualized character of groundwater technology (individual pumps) coupled to easy access to it and low use requirements. This makes it very hard for institutions to control the development and use of groundwater in areas where groundwater is readily available in economically exploitable aquifers. Users operate independently and are therefore hard to control.
- An institutional history based on the development and not the control of groundwater: throughout the twentieth century most water management institutions either promoted the development of groundwater use as a way to promote economic development and alleviate poverty, or left it to an uncontrolled lassie-faire development. Because of this there is neither a groundwater management culture nor control over the use and exploitation of this resource.
- A lack of funds and resources to implement a strict control on pumping: this is coupled mainly to the history of the institutions which have historically spent most of their resources and personnel on water development; the construction of infrastructural surface water management projects, subsidies for groundwater development and their management. Groundwater management has up until now not been a major priority of water management authorities.
- The social implications of restricting groundwater use. A great part of the agricultural production has become dependent on groundwater utilization. Restricting the use of groundwater has great impact on this agricultural sector and the livelihoods that depend upon it.

In view of this absence of governmental control and the importance of groundwater in the local economies and the increasing perception that users should become the managers of their resources participatory groundwater management has been seen in some places in the world as the key to the groundwater management problem. Mexico has for almost a decade promoted different projects that are based on participatory groundwater management with mixed results (Wester ,*et al.,* 1999; Marañon-Pimentel, 2000a, 2000b; , Hoogesteger-van Dijk, 2004).

Participatory groundwater management has proven to be a challenge, which has many hurdles on the way but some experiences show that with collective action for groundwater management it is possible to reach better groundwater management. Some of the key issues in such processes are: user awareness of the problem, its consequences and available management strategies; commitment on the part of the users; visible results for the users; strong collective commitment to work together on the management of groundwater. Whether these elements come together or not depends a lot on the boundaries of the institutions for groundwater management, the characteristics of the aquifers and the social and institutional structures existing in place.

IS CONJUNTIVE WATER MANAGEMENT FEASIBLE IN SURFACE IRRIGATION SYSTEMS?

Surface water irrigation systems, through their infrastructure usually create social relations of dependence needed to manage the system and get water from the sources, in this case the Zayandeh River to the fields. At primary and secondary system water management is agency managed until now. At tertiary level, water management becomes the responsibility of the users. These organize to manage the water based on long established customs and rules of water, labor and responsibility division. These systems have proven to be very effective in the management of water.

A question that arises here is whether these social structures could be used for the management of groundwater resources. There are no clear cut answers to this, but conjunctive water management could be a very feasible option for water management. In California some modeling experiences show that conjunctive water management can enhance an economically more viable resource management (Harou and Lund, 2006) especially where the surface-groundwater links are very strong and visible such as in the Abshar irrigation system. Of course here the challenge remains being how can it be implemented. Should there be a top down approach in which the state regulates and dictates, or should the effort and insights come from the water users, or should both work together? If so how should such a management system be crafted?

This paper does not want to give answers or guidelines, it rather wants to trigger the thought on whether through participatory groundwater (or conjunctive water) management it is possible to establish control measures for groundwater management in a case such as the Abshar Irrigation System or any other area where groundwater exploitation levels form a threat for the sustainable use of groundwater. So the first question to be established is:

Is participatory groundwater management within and outside of surface water irrigation systems a feasible solution?

If so....

- What knowledge is needed?
- What social structures are needed and at what scale?
- How should responsibilities be established and who should be responsible for what?
  - What role should be delegated to the state?
  - What role should be delegated to the water management agencies?
  - What responsibilities should go to user organizations and how do you organize these?
- Is there a need for institutional engineering?

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