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Redistribution of Groundwater Abstraction in Wadi As Ssirr:

A Task for the Local Water User Associations

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Abstract

The water resources situation in Wadi As Ssirr is typical to all Sana'a Basin, which is in a state of water crisis. Overexploitation of groundwater by more than 1359 wells within the Wadi catchment area of about 200 km² is the cause of the problem. It is one of the areas in the Basin with the highest well density. Proper perception of the severity of the problem might facilitate collective actions at the user level by accepting a viable institutional arrangement. This paper will discuss the involvement of Water User Associations (WUA's) in water resources management by promoting collective actions to redeem the effects of overexploitation of groundwater resources. By following an IWRM approach, WUA's should initiate a strategy with an action plan that will redistribute abstraction by retiring a substantial number of wells and will ultimately lead to a manageable abstraction pattern in the Wadi.

Keywords: wadi, IWRM, institutional arrangements, water user associations, collective action, groundwater abstraction, Sana'a Basin

Introduction

Wadi As Ssirr is located on the eastern part of Sana'a Basin (See Figure 1). It drains a catchment area of about 199 km². The topography of the Wadi is controlled by a mountainous relief with elevations that range from about 2200 masl, downstream at the outlet, to about 2600 masl at the furthest point on the catchment boundary. Climate is controlled by aridity. Average annual rainfall is about 200 mm, which yields an annual runoff of about 1 Mm³. Thus, groundwater recharge is extremely low.

Agriculture is the main economic activity in the Wadi. Irrigated agricultural, the main user of groundwater, covers an area of about 3600 hectares. Main crops are qat and

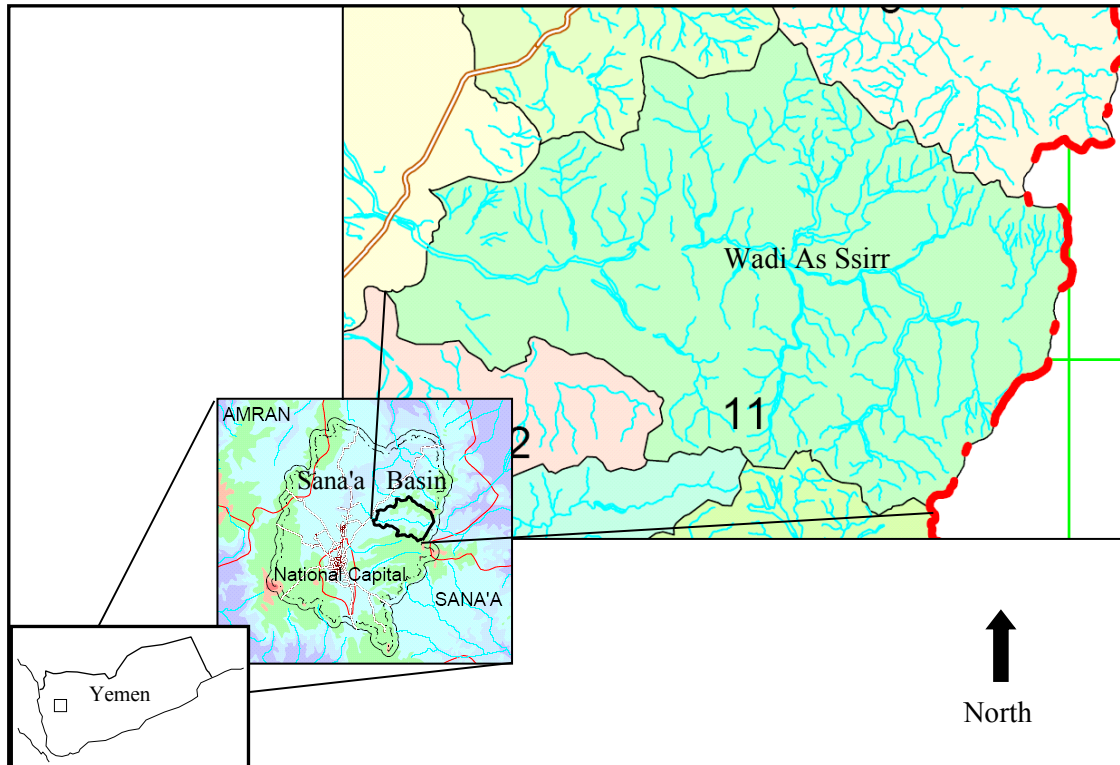


Figure 1 :Location of Wadi As Ssirr within Sana'a Basin

grapes. High demand on irrigation water is also provoked by the present consumptive cropping pattern. Most of the irrigation water is applied to qat farms.

The number of wells in the catchment area of the Wadi is about 1359 including dug wells and boreholes (See Figure 2), which abstract about 41 Mm³ annually. It is one of the catchments in the Basin with the highest well density. Among these wells, about 587 are operational boreholes which abstract about 34 Mm³ to irrigate about 2800 hectares (See Table 1). Well depths vary between 200 and 400 meters below ground level for most boreholes. Water levels vary between 100 and 150 meters. Most boreholes are tapping the sandstone aquifer (WEC, 2004).

Water resources situation in the Wadi is typical for the rest of Sana'a Basin, which is in a grave water crisis. Problems are, to list a few, excessive groundwater abstraction, low groundwater recharge, low irrigation efficiency, highly consumptive cropping pattern and other institutional deficiencies. It is not clear yet how the water crisis in Sana'a Basin will come to an end. Nonetheless efforts to approach the matter on non-structural measures seem to be more viable. Approaching the issues at the local level

has been adopted lately by the concerned authorities and encouraged by the international donors.

To manage the resources and alleviate the negative impacts of the water crisis, an integrated management approach should be adopted. Integrated water resources management (IWRM) is an approach that takes into consideration socio-economic aspects and ventures beyond the traditional supply oriented solutions. It deals with issues of demand management and community participation, among others. One way of applying IWRM is to look for solutions at the non-technical domain of the problem.

Looking at the user side of the issue would lead to solutions that might prove viable. Local conflicts are serious matters that interfere with many projects that are related to water allocation and use. Other than that, it is the influential land owners that set trends, rather than the small holders who usually follow them.

Table 1: Groundwater abstraction and use in Wadi As Sirr

Well type	Total number of wells	Operational wells	Average well yield (l/s)	Irrigated area (ha)	Total abstraction (m ³ /year)	Operational well density (well/km ²)
Dug	1470	742	-	704.00	6,452,339	3.7
Borehole	753	587	5	2,815.00	33,829,487	2.9
Dug/Bore	37	30	5	77.00	609,304	0.2
	2260	1359			40,891,130	

Common pool resources problems are manifested here at their worst stage. Abstraction is not controlled, neither monitored. Competition on groundwater is apparent by the large number of wells within the small catchment area. The high well density causes interference and inefficiency of wells. Properties are small and spread over distant geographical locations, which make monitoring very difficult and costly. Legally binding regulations are not specific nor reinforced, which adds another dimension to the problem.

Estimation of Groundwater Abstraction

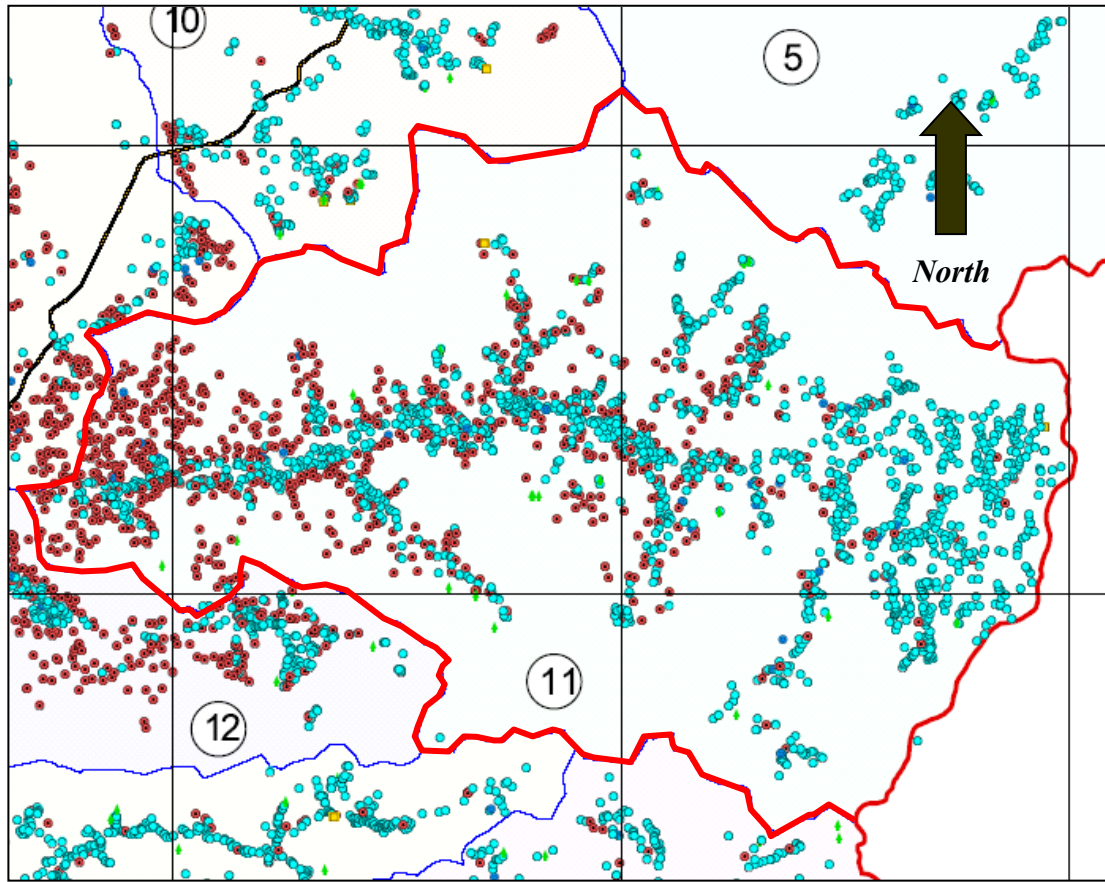


Figure 2: Location of wells within Wadi As Sirr Catchment area (Dark spots designate dug wells)

Groundwater abstraction fluctuates during the year. The total annual abstraction volume is about 41 Mm³ as shown in Table 1. Two distinct seasons can be observed; the dry season and the wet season. The dry season extends over a 35 weeks period, and the wet season covers the rest of the year. The number of annual pumping hours have been estimated by the WEC (2004) report on well inventory. On average the annual hours sum up to 2250 according to the WEC report. While during the wet season the pumping duration falls to 630 hours as shown in Table 2. The average daily pumping hours during the dry season were reported to be 10, 3, and 8 hours for boreholes, dug wells, and dug/bore, respectively. Regarding the wet season, the average daily pumping hours were reported to be 8, 4, and 6 for boreholes, dug wells, and dug/bore, respectively (WEC 2004).

Proper Institutional Arrangements

A rational response to the issues of groundwater is to deal with the problem at the user level, by introducing institutional arrangements that can develop and employ effective

management instruments (Frederiksen, 1991). For example, gentleman agreements among influential owners and local dignitaries might be a management instrument in some cases. Conflicts over local common pool resources tend to become less intense as the beneficiaries expect smaller future revenues and cooperation becomes more likely. Access to proper information is the key to this level of homogeneous perception of the severity of the situation (Libecap, 1995).

For the case in hand the Water User Associations can play a role. These organizations are meant to formulate community participation within a legal framework. WUA's should extend their role to IWRM issues. WUA's have been encouraged lately by the authorities and seen as a possible institutional arrangement to address the problems at the local level.

Authorities and donors support the WUA's in various ways. One aspect of support, is that beneficiaries of irrigation support projects must apply through their local WUA. Another is the publicity that these WUA's get by the official media. Thus, WUA's are fostering institutional changes by community support and acceptance. They have enjoyed favorable reception so far in various locations in Sana'a Basin. Success of such organizations is linked to the level of reliance of the local communities on them. The issue here is the enforcement by social pressure rather than by legal instruments. WUA's are supposed to be the "elder" that users turn to for helping solve water problems, similar to the tribal traditions in other facets of life. Customary law should incorporate these entities as part of the institutions of the traditional community.

Proposed Redistribution of Abstraction

By calculating the irrigation water requirements it is possible to estimate the required groundwater abstraction volumes. However, it is assumed that the required annual demand is 41 Mm³ as reported by WEC (2004). This demand can be satisfied by 587 operational borehole wells, if the pumping hours during the dry and wet seasons are increased proportionally (See Table 2). In other words, the other wells will have to retire and farmers, the Wadi catchment will rely on these 587 operational borehole wells. Consequently, redistribution of groundwater abstraction will be accomplished. In addition, well interference and inefficiency might be prevented.

It is common practice within the Basin that a number of farmers share ownership of a well. Collective ownership of wells, and water rights per se, is separate from land ownership. As such this practice signifies the understanding by farmers of the fact that the aquifer they tap is common property. Based on this understanding, it becomes possible to promote a voluntary action of sharing wells rather than constructing new ones. Further, it is more efficient to share existing wells among farmers rather than operating wells individually. Successful sharing arrangements will lead to voluntary well retirement at the foreseeable future. At the short term it will facilitate monitoring and control. The task is to be accomplished by WUA's. Initially, the groundwater abstraction volumes should not change and voluntary retirement of wells will suffice. The task is not effortless, but definitely helpful in controlling groundwater depletion.

Table 2: Proposed and reported estimation of groundwater abstraction pattern

Abstraction pattern	Total number of wells	Average well yield (l/s)	No. hours dry season (35 weeks, 14/day)	No. hours wet season (17 weeks, 8/day)	Total annual abstraction volume (m ³)
Proposed	587 (operational)	5	2520	816	39,685,896
Reported (WEC 2004)	1359	varies	2250	630	40,891,130

This pattern of abstraction requires institutional arrangements that should be initiated by the Water Users Associations. Since these associations can provide the incentives and can become a guarantor for the owners of the retired wells. WUA's can devise practical incentives to retire wells that are in excess of the operating wells. It might be the first task toward a long term strategy for achieving well retirement that might lead to controlled groundwater abstraction.

Concluding Remarks

To mitigate the severity of groundwater overexploitation in Wadi As Ssir, a proper institutional arrangement and abstraction pattern are proposed. WUA's should get involved in IWRM activities. In addition, a system of incentives is to be devised by WUA's to facilitate collective actions. WUA's should undertake the task to initiate a collective action for retiring wells that will ultimately direct to a manageable groundwater abstraction pattern. An abstraction pattern that might help prevent well interference and inefficiency. Based on available data, the water demand was calculated and could be satisfied by a modified abstraction pattern. Conflicts might be

resolved by the mediation of the WUA's that should be a reliable performer at the local level. Cooperation rather than discord among users is expected when thorough information and a reasonable perception of the severity of the problem occurs among users. Customary law and community pressures might serve as effective management instruments.

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