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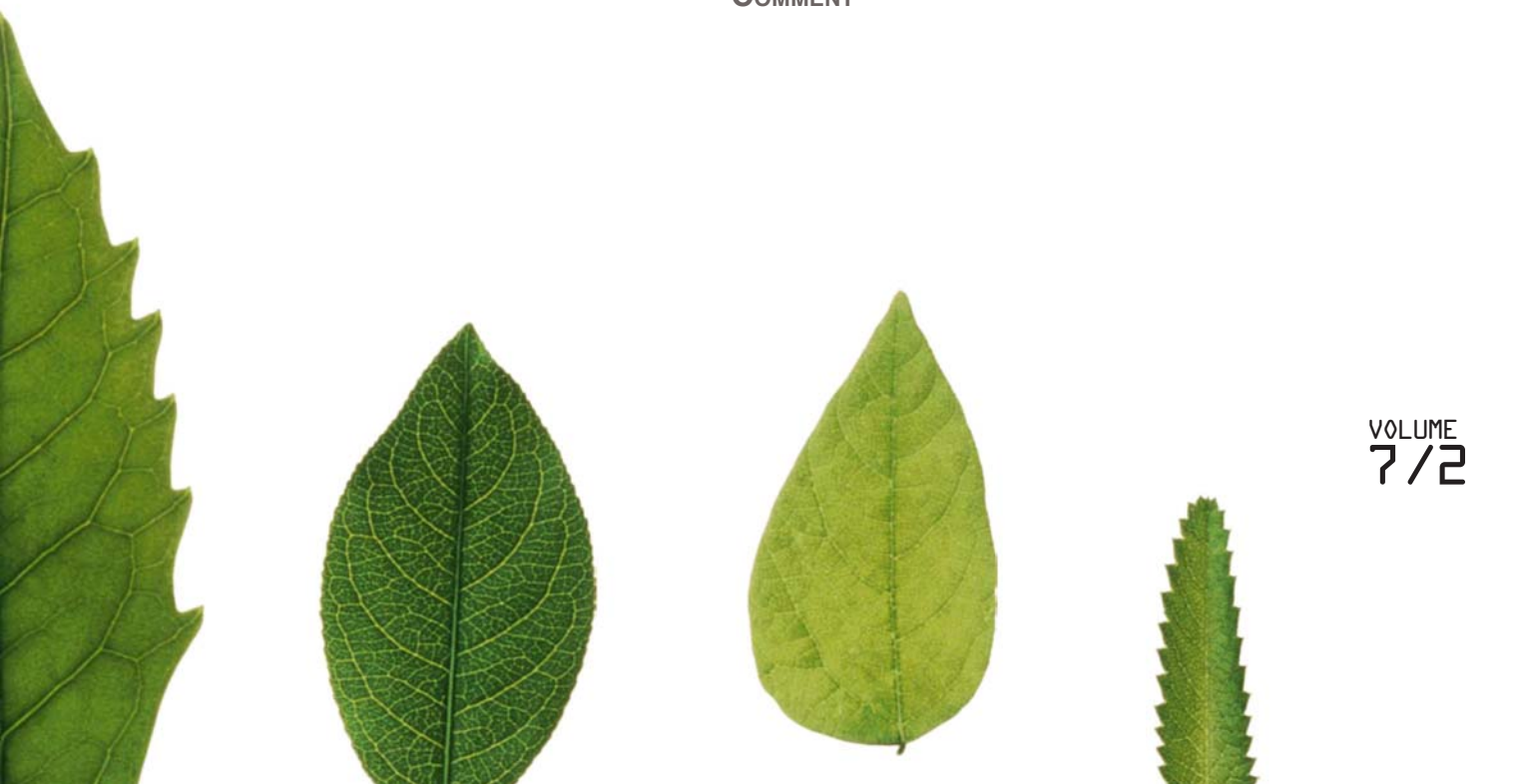
COMMENT



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Comment

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1 INTRODUCTION

Groundwater in Yemen is a byword for crisis and both the dwindling oil reserves and groundwater stocks are linked to the recent turmoil and large political and economic challenges ahead. Groundwater overuse was on the list of top ten priorities of the Ali Abdullah Saleh Government, but was also mentioned during the visit of the United States Secretary of State to Yemen in 2010. It is likely to remain a 'hot topic' in the next decade.

The development of groundwater use in Yemen in fact has been rapid and unprecedented. Groundwater-irrigated agriculture increased from 37,000 ha in 1970 to 400,000 ha in 2005. This is the equivalent of one-third of the national cropped area. Most of this is under high value crops: fruit, vegetables and *qat*, often mixed with timber and firewood trees. The groundwater boom has kept the rural economy vibrant. Agricultural employment increased by 25 percent between 1970 and1996, whereas agricultural net value of output quadrupled.[1]

Farmers in the irrigated areas are the 'haves'. Elsewhere in rural Yemen, food insecurity persists and since 2008 it is on the rise. Seven million people or 35 percent of the population are undernourished[2] – a number rising further during the 2011 political crisis. A categorization of those most vulnerable is: rural and rain-dependent farmers growing un-irrigated wheat and *qat*, with limited diversity in income sources, a large number of dependents, and generally far away from main facilities and without access to irrigation.

This paper describes current groundwater security in Yemen. It focuses on two aspects: local management of groundwater by farmers themselves and the link between local management and the 2002 Water Law and other legislation. With respect to groundwater security, the paper particularly asks the question: who is accountable to whom?

In spite of the boom it has brought, Yemen's groundwater economy is a source of insecurity. Where water balances have been estimated – not easy in the absence of unified data - the scales are out of kilter. Most dramatic is the water balance for Sana'a Basin, which estimates abstraction to be five times the amount of recharge – 270 MCM against 51 MCM.[3] In other parts of the country, the disequilibrium is less severe but nevertheless worrying: 34 MCM against 18 MCM in Wadi Ahwar,[4] and 235 MCM against 115 MCM in Hadramawt.[5] More telling than these studies is the evidence in the real world. The General Authority for Rural Water Supply Projects reports that it is becoming increasingly difficult to drill wells that strike water for the national rural water supply program. The number of failed drillings stands at more than 40 percent. Falling water tables are reported from each Governorate. Severe disaster spots are found along the coast in Tihama where reduced supplies of surface water and overuse of groundwater have caused some coastal villages to fall prey to sand dune formation. Because of shortages, urban water delivery in several major cities is being provided at ever larger time intervals. The Government of Yemen estimates that violence accompanying land and water disputes results in the death of nearly 4,000 people each year.[6]

1 Abdurrahman al-Eryani et al., Water Problems in Yemen: Three Major Challenges (Paper presented at the National Conference for the Management and Development of Water Resources, Sheba Center for Strategic Studies, Sana'a, 15-17 January 2011).

2 *See* World Food Program/ VAM, Comprehensive Food Security Survey (Sana'a: WFP, 2010).

3 Earth System Science/ Japan Techno Co, *The Study for the Water Resources Management and Rural Water Supply Improvement in the Republic Of Yemen: Water Resources Management Action Plan for Sana'a Basin* (Sana'a: NWRA, Ministry Of Water And Environment/ JICA, 2007).

4 Hydrosult/ International Development Research Centre, *Water resources assessment and detail design of different components of Wadi Ahwar- Abyan* (Sana'a: Ministry of Agriculture, 2008).

5 Komex, *Water Resources Management Studies in the Hadramaut Region* (Sana'a: NWRA, 2002).

6 Gavin Hales, Under pressure: Social violence over land and water in Yemen, Issues Brief 2 (Sana'a: Armed Violence Assessment, 2010).

The question then is: what is the response of the state and communities to address the groundwater crisis. The paper answers this question based on documentation of a number of cases of local management collected during the period November 2010-February 2011. These cases were identified in a number of ways – but mainly through informal networks. One remarkable point was that it was relatively easy to identify examples, especially in the highland districts, suggesting that local regulation of groundwater is not exceptional. The message is that in many areas farmers have responded to the risk of falling groundwater tables, and in some cases deteriorating quality that followed the intense exploitation of groundwater, by making their own rules. In coastal areas where groundwater overuse issues are equally severe in places, there appeared to be fewer examples of local management, probably due to the larger complexity of the water systems (conjunctive use of spate irrigation and groundwater) and larger aquifer systems.

2 CASES OF LOCAL MANAGEMENT

The intense use of groundwater in Yemen's arid environment and the falling groundwater tables triggered several government and donor responses. These include the creation of a National Water Resources Authority (hereafter NWRA), the enactment of a Water Law; the sponsored creation of Water Users Associations (hereafter WUAs) and the implementation of subsidy programs aiming to introduce efficient irrigation techniques. Substantial effort has also gone into creating awareness on groundwater overuse.

The Water Law was accepted by the House of Representatives in July 2002. The Water Law is a major watershed in that it marked the beginning of the idea that groundwater is no longer for everybody to take. The Water Law describes a well licensing procedure – applicable to wells extending beyond 60 meters in depth. The National Water Resources Authority, established in 1995, and its branch offices that came into existence over time in some (not all) of the Governorates are the regulator in this respect. The Water Law provide the basis for setting up new organizations in water management as well: Water Basin Committees, Water Zone Committees (for parts of the basins) and WUAs as well as federations and unions of WUAs. The Water Law does not describe the powers and procedures for these new bodies but it refers to a bylaw that is to be developed later.

This did not prevent the development of irrigation-based WUAs in a large number of internationally funded investment programs, such as the Irrigation Improvement Project, the EU Food Security Program, the Land and Soil Conservation Project, the Groundwater and Soil Conservation Project, the Sana'a Basin Water Management Project, the Community Water Management Project, Abyan Water Management Project and under different activities of NGOs such as Care and Triangle. The best estimate is that 700 WUAs were formed – often registered under Law 39/ 1998 or Law 1/2001 on Cooperative Societies and Associations. This arrangement was not entirely appropriate as it defines the WUAs as membership organizations for agricultural improvement entitled to certain privileges but not as local management bodies with encompassing powers. The status of these 700 WUAs over the years is unknown but anecdotal evidence suggests that a large number of them have withered after intensive engagement in planning and implementation in the concerned projects was over. According to the Union of WUAs, around 200 'active' irrigation-based WUAs remain.[7] The seemingly lacklustre performance of the irrigation-based WUAs may be contrasted with the relatively good performance of water committees that were set up under drinking water programs. A total of 108 such committees under water supply projects were surveyed in 2007 in Dhamar and Hodeidah Governorate.[8] The survey found that 81 percent of these committees were still functioning. In most

7 Personal communication, Board of Union of Water Users Associations Yemen.

8 IOB, *Support to rural water supply and sanitation in Dhamar and Hodeidah Governorates, Republic of Yemen* (The Hague: IOB Inspectie Ontwikkelingsbeleid, 2007).

cases the larger assembly is dormant but the core group of community members – involving pump operators, technical persons, meter readers and administrators - meets regularly. In two-third of the committees, there had been elections or replacement of leadership. Committee chairmen were paid in 40 percent of the cases.

The committee members received general support in institution building but committee members are largely self-trained in pump operation and repairs. All in all, of the 108 sampled systems, 85 percent was operational, which is high by international standards. There is a large capacity to self-organise in rural Yemen and the technical services for operating tubewells are amply available.

The responses to falling water table have not been limited to formal institutions only; rather the opposite. Over the last decade, in fact, a situation of new legal pluralism has developed. In a substantial number of communities, local informal rules have been developed among water users to regulate the use of groundwater. Table 1 lists cases of local groundwater management that were identified in the documentation and from other sources.[9] It appears that two new trends have emerged since 2000. First, where earlier local conflicts on groundwater development were exceptional, they became more common. Whereas Lichtenthaeller (2003) observed that there were no conflicts on water in spite of falling groundwater tables in Amran in 2000, in 2010 he describes that protests and blockages are common in Amran by the late 2010's.[10] Second, either triggered by conflict or heightened awareness, farmers have developed local rules and regulations in many areas. Increased extraction from the aquifers dried up springs and shallow wells. Many communities have sought to prevent further harm to existing users, for instance, by norms restricting well spacing and banning export of water from their area by tankers. In other cases, farmers closed disputed wells, invested in groundwater recharge or connected separate wells by a shared network of pipelines, allowing water to travel from one area to the other. In some cases, the agricultural wells doubled up as sources of domestic water supply and private village pipe networks were developed.

9 *See* Frank van Steenbergen, "Promoting local ground water management" 14 Hydrogeology Journal 380-391 (2006), Christopher Ward and Nasser Al-Aulaqi, *Yemen: Issues in Decentralized Water Management: A Wadi MENA Research Study* (Sana'a: International Development Research Centre/ International Fund for Agricultural Development, 2008) [hereafter 'Ward and Al-Aulaqi'], Bryan Bruns and Taha Taher, Yemen Water User Association Study: Findings and Recommendations for a Problem-Solving Approach (Sana'a: Groundwater and Soil Conservation Project, 2009), Laura Bonzanigo and Cecilia Borgia, *Tracing evolutions of water control in Wadi Siham, Yemen (MSc Thesis)* (Wageningen: WUR Irrigation and Water Engineering Group, 2009) [hereafter 'Bonzanigo and Borgia'], G. Lichtenthaeler, *Political Ecology and the Role of Water: Environment, Society and Economy in Northern Yemen* (Surrey: Ashgate Publication Ltd, 2003) and G. Lichtenthaeler, 'Water Conflict and Cooperation in Yemen' 254 *Middle East* 30-36 (2010) [hereafter 'Lichtenthaeler'].

10 G. Lichtenthaeler, *Political Ecology and the Role of Water: Environment, Society and Economy in Northern Yemen* (Surrey: Ashgate Publication Ltd, 2003) and Lichtenthaeler, note 9 above.

Table 1: Cases of local groundwater management

	Place	Type of local rule
1	Hejraht al-Asham, Jabal al-Sharq- Dhamar	Restrict well drilling
2	Wadi Khalaka, Sana'a	Restrict well drilling, ban on tankers, well depth
3	Khrabat Muhyab, Bani Matar, Sana'a	Restrict well drilling, well spacing
4	Qarwa Beshar, Jahanah, Khawlan, Sana'a	Restrict well drilling
5	Hijrat al-Muntasir, Amran	Ban on new drilling
6	Wadi al Qarada, Bani Hushaish, Sana'a	Restrict well drilling, recharge weirs in wadi bed, well sharing
7	Wadi Akarem, Dhamar	Restrict deep drilling in the main wadi
8	Bani Garban, al-Kafr District, Ibb	Protection zone
9	Al-Gawaref, Ibb	Ban on qat irrigation
10	Wa'alah, Amran	Ban on water transport by tankers
11	Bait Sarhan and Alhamrmaly, Amran	Ban on water transport by tankers
12	Al Ma'akhad, Amran	Ban on water transport by tankers
13	Qa'a Al-Shams, Amran	Ban on water transport by tankers
14	Bani Maymoun, Amran	Tankers only within village
15	Wadi Dhelaa, Hamdan, Sana'a	Well spacing, well sharing, dam development
16	Wadi Al Zabaira in Qadas, Al Mawasit District, Taiz	Restrict/ban well drilling, closing disputed wells
17	Al Aroosi, Mehan, Sana'a	Closure disputed wells, agreement on reservoir operation
18	Al Mashra, Damar	Ban on drilling
19	Wadi Al-Har, Anss, Dhamar	New agricultural wells only if they serve drinking water too
20	Mawia, Taiz	Joint WUA to regulate new well development, replacement of qat in some area

21	Al-sinah, Almaafer, Taiz	Well distance, blocking out well development in sensitive areas, permission by NWRA only with consent of the cooperative
22	Wadi Sana'ah, Dhamar	Spring protection – zoning; distance rule
23	Hejrat al-a'asham, Jabal Al-sharq, Dhamar	Protection zone
24	Al-Wahda, Al-Maafir, Taiz	Ban on new wells, non-well owners to share in existing wells
25	Zubera, Wadi Siham, Hodeidah	Preventing new shallow development by referring cases to Local Council and NWRA

3 CASE STUDIES

This section describes a number of cases in more detail.

3.1 Wadi al Qarada, Bani Hushaish, Sana'a

One example of local management of groundwater concerns Qarada in Sana'a Basin. Qarada is a distributary of the Wadi El Sir. The short term floods in the wadi are diverted to spate irrigate the land but more importantly they recharge the shallow aquifers. Grapes – in different varieties - are the almost exclusive crop in the area. Because the area is open, it is prone to frost and growing *qat* is not an option.

There are over 100 wells in the area – typically these are 300 meters apart. Up to 2002/2003, well drilling continued unabated – with a fifteen meter decline a year till the water table reached 320 meters in 2008, the threat of sulphur and fluoride levels increasing with increased depth. In anticipation of the new Water Law, additional wells were developed that were subsequently covered and are not yet used.

The production of the wells over the years also dropped to less than 50 percent. For a long time the answer to water scarcity was to invest in new and deepened shared wells rather than in shared conveyance networks. However the cost of developing a well is considerable and can go up to YR 40 Million. Part of the resistance to investing in modernized irrigation systems was the partly well founded scepticism about the usefulness of drip systems as these would not work with the widely spread out root system of the old grape plants.

In 2003 two WUAs were established for the area – Al Qarada and Al Ashraf. This was triggered by the Sana'a Basin Water Management Project that also worked on creating awareness and increasing the interest in improved irrigation systems. Membership grew over the years. Al Qarada started with 70 members but now has 130 members. The WUAs regulate and monitor the drilling of wells. If unlicensed drilling is about to start in the area of the Al Qarada, a complaint will be lodged with the government by the Al Asharaf WUA. This is done to preserve harmony in the area of Al Qarada. The same process in reciprocity is initiated if unlicensed drilling is planned in Al Asharaf.

Recharge in the area greatly improved after the construction of 47 stone check dams in the riverbed under the Sana'a Basin Water Management Project. These structures slow down the speed of the floods and increase the infiltration rate. The speed of the water moreover ensures that the sediment is still removed. The investment in the structures including the stone bank protection amounted to USD one

Million. A comparison of these types of structures with recharge dams indicate that they are significantly more effective in recharging local aquifers particularly in comparison with large dams.[11]

There are several plans to improve water use in the area. One plan is to promote drip irrigation but use a storage tank to create enough pressure. The development of drip systems suitable for the wide-rooted crops is a special challenge. There are also requests for better support in marketing and extension: grapes suffer from pest attacks but there is no effective extension. Also there is a concern that the grapes may suffer from import of raisin from other countries.

3.2 Khrabat Muhyab, Bani Matar, Sana'a

The main water source of the Khrabat Muhyab area is the run-off from Jebel Mountains. The run-off feeds springs and the aquifers. Over the years farmers have moved to groundwater irrigation, typically pumping water from 150 to 180 meters deep. The wells – if only because of their cost – are shared by many families. A typical well may have seventeen shares (in the form of time slots) and ownership is between 25-30 families.

Following a violent conflict over the sharing of water from a dam that was to be built by the government in a nearby area, the farmers decided to regulate the use of water in their area. The establishment of the WUA called 'Bled Agustan' was triggered by seeing the conflict and hardship arising from overuse of groundwater in nearby areas. It was not set up by any project but created at the initiative of the concerned farmers.

The WUA initially regulated seven wells in Khrabat Muhyab village. Minimum rules were set on the distance between wells that irrigate 53 ha[12] under fruits and staple crops (not *qat*). Wells were to be at least 500 meters apart but the distance can be even larger dependent on the location. The minimum distance to a spring for instance is 2000 meters.

Whereas the WUA initially covered seven wells in two villages, its usefulness was recognized and it now covers the area of 58 wells in eight villages. The membership went up from 80 members to several hundred. The development of new wells in the area is not allowed unless a clear need for a new well (rather than getting water from an existing well) is proven and the minimum distance is observed. Improved irrigation techniques are relatively exceptional in the area and there still appears to be scope for improving water management on this front.

3.3 Dhelaa, Hamdan, Sana'a

Dhelaa is located at relatively close proximity to Sana'a and has a long history of irrigated agriculture. The area is supplied surface water from the Matba tributary of the Wadi Dhelaa. Water used to come both as surface flows from the river bed and as groundwater supplies from ancient *qanats* or horizontal wells. Sabean inscriptions inside the tunnel of the *qanats* suggest that they were developed at least two thousand years ago. Over the years the tunnel was gradually deepened to keep up with fluctuating water tables. Land levels also increased over time with sediment from the adjacent hills causing land levels to rise. Fifty years ago dugwells were developed – initially operated by animals but as water tables became deeper, the wells were deepened and diesel pumps were increasingly resorted to. At this time, grapes, apricots and maize were the main crops mixed with *qat* and fuel wood.

As the *qanat* ran dry from 1982 onwards and as shallow wells started to fail around 1990, farmers shifted to using deep wells – drilling over the years up to 300 meters deep with water tables between 150 to 200 meters. The transition to deep wells coincided with a transition to growing *qat* and fuel wood trees mainly: the more costly operation of deep wells required a higher value crop. In Dhelaa five wells have been developed – all under shared ownership. Ownership in the wells is divided in shares – corresponding to half day's water supplies

11 Ahmed Mohammed Alderwish and Wael Ishaq Mohamed Alderwish, *Integrated Water Management for Small Catchments in Arid Mountain Regions* (Sana'a: Sana'a Basin Water Management Project, 2009).

12 12000 lebba (= 44 sqm).

(contingent on availability of high voltage electricity). The shares, which can amount to sixteen per well, may be owned by more than family. This can bring well ownership up to thirty families per well. All wells are shared and families have shares in more than one well. Moreover the five wells in Dhelaa are connected through a pipeline system. This makes it possible to irrigate the entire area from different wells and to compensate for the temporary breakdown of one deep well by sourcing water from another well. In Dhelaa, a minimum distance on new wells has been imposed as well. This used to be 500 meters from an existing well but has now increased to 700 meters.

Within these distances, it is not allowed to develop a new well but one can always buy water from one of the existing wells. Because all landowners are interconnected and because everybody has a share in at least one well, enforcement of this rule has not been problematic. Farmers in Dhelaa agreed on the regulated and shared system after seeing the severe decline in groundwater in nearby Shamlan where many wells were developed in a very short timeframe. The rule was introduced gradually – in this case under the leadership of the local sheikh family. There is a WUA in Dhelaa but it plays no role in groundwater management. If there is a conflict in the local regulations, the local council, security forces or members of parliament can be called upon. In fact if there are conflicts at all, it concerns the joint running of the shared wells and not the regulation of groundwater use: who is first, how to compensate for power outages and how to pay for the cost of maintenance and repairs.

The wells in Dhelaa are not only used for agriculture but they are used for drinking water supply as well. The community has built their own water supply system from the same wells. Special pipes connect different sections of the small town. This has developed over the years. The wells were initially mainly for irrigation but they were next connected to the mosques and then to individual households and public water points. YR 2000/month (nearly USD 10) is paid per month for a house connection.

The water table has more or less stabilized; more or less because some wells still need to be deepened though not as much as before. The main drinking water well for instance had to be deepened another six meters over the last three years but other wells are stable. The seeming balance is also attributed to the construction of a recharge dam at Al Merbaha, one of the two sources of Wadi Madla. The work was initiated by the sheikh family who invested YR 6 Million (USD 30,000) in the construction of the dam at the end of the 1990s. The dam was subsequently upgraded in 2002 to a 25 meters high structure with a sand core and riprap covering at a cost of YR 150 Million. The dam is over dimensioned – even in the recent wet year the dam was not filled to more than one-third of its capacity. The dam however is reportedly successfully contributing to recharge in the area and has influenced the availability of water in the nearby wells.

3.4 Wadi Ghulaka, Nahem, Sana'a

The area of Wadi Ghulaka still has sufficient groundwater and carefully guards it. The construction of the Arisha Dam was initiated to improve recharge to the mainly shallow wells in the area. There is in fact a ban on drilling wells beyond a certain depth with the upper limit set at 200 meters. The quality of the deeper groundwater which is expected to be saline is a concern. Another local rule is a strict ban on selling water outside the area. Tankers are not allowed into the area either to collect water from the shallow wells or from the dam reservoir. The local rules were initiated by the chairman of the WUA that was established for the Arisha Dam.

3.5 Al-sinah, Almaafer, Taiz

Al-sinah area is located in Wadi Al-asloom, Almaafer District, Taiz Governorate. This is 30 km west of Taiz. The area consists of 12 groups of villages with a total population of approximately 18000 (2004 Census). It is well-known for its cooperative society, which dates back to the late 1960s when the community decided to establish this organization to nurse water and electricity projects but also to facilitate education and health improvements. Al-sinah and its cooperative society stand out as a single example of long-term institutionalised local development and resource management.

Al-sinah basin contains 35 agricultural bore wells, owned by farmers, either individually or shared. Most of these wells were developed in the 1970s. The average depth of wells is 260 metres but the water table is found at 96 metres. The water table is declining continuously: a decline of six metres was observed in the year 2010. Groundwater is used for irrigation of a number of cash crops mainly *qat* and vegetables. No modern irrigation systems are in use except for conveyance pipes to deliver water to the plots.

The main activities of the cooperative society are water and electricity. The cooperative society owns three wells. Water is pumped to four elevated tanks perched on top of the mountain and then distributed to homes via a network of pipelines. 1900 homes are subscribed to the network. The water is provided for drinking and domestic purposes only. It is prohibited to use water for agriculture. Al-sinah cooperative society has few remarkable features that earmark it as a special case:

- democratic structure: The management is elected every three years with an elaborate structure of twelve election assemblies. There is no traditional local leader. The preference is for people of high integrity. There are no big social and income differences in the community and education is widespread even among women.

- conditional partnership with public agencies: The Al-sinah cooperative society systematically liaises with public agencies and has sought specific support for parts of its investment program from different development programs. However, the association has refrained from automatic involvement in projects.

The association also plays a role in local groundwater management. Within the area a distance between wells in the range of 500 meter is observed. One striking example of the application of this rule was in the mid 1990s, when well drilling in a neighbouring hamlet threatened the sustainability of the Al-Sinah water supply well field. The association bought some scattered fields in this neighbouring hamlet, then drilled wells there – and subsequently capped the wells. Because local people respect the "500 meters between wells" rule, the capped wells prevented any other water development in the area and the Al-Sinah water supply was protected.[13]

The Al-sinah association also works together with the Taiz branch of the NWRA. NWRA does not issue any well drilling permit without consulting the association and obtaining a written consent from the association. Since two years no more well drilling permits have been issued. The association is trying to affirm this rule by declaring the area as a protected zone. A study has been completed and it is now being considered for approval by NWRA. Farmers are not allowed to dig open shallow wells without obtaining consent from the association.

Al-sinah is hence a case of local and central regulations reinforcing each others. Two years ago NWRA issued a well drilling permit to farmers without consulting the association. The association objected to the drilling. The disputed well was located outside the Al-sinah basin but at a 1000 metre distance from a well owned by the association. However, NWRA gave an undertaking that the new well would not have negative effects on the Al-sinah well. In case of any interference, the new well would be closed and handed over to the Al-sinah association.

3.6 Alkadarah, Qadas, Taiz

Alkadarah consists of a number of villages and isolated homes scattered over several mountains and valleys. Agricultural lands are located in the lower section of the valleys or on the mountains as terraces. Due to the geology of the area, no deep groundwater is found in Alkadarah. Shallow groundwater is available in some of the valleys but yields are low and unreliable. Rain-fed farming of sorghum and vegetables predominates. The shallow groundwater is used for *qat* irrigation.

The main concern is that drinking water is under threat. Traditionally the community depended on

13 Ward and Al-Aulaqi, note 9 above.

shallow dug wells, springs or cisterns meet their domestic and drinking water needs. The communities decided in the 1980s to construct drinking water networks entirely using their own resources. They formed committees for managing water projects and four projects were implemented. The water project at Hanhan, Bani Mansoor is one of these projects. It was constructed in 1982. The project committee drilled the well, and constructed the water tank and pipelines. Later, the Hanhan system was merged with another water system, the Wadi Aljannat project. The latter facility was supplied by two wells. However, due to low well production, water is provided to homes once every three days. The depth of the wells ranges between 50-90 metres. A standard rate of 200 YR per cubic meter is collected from subscribers. A third system, the Algobua-Aldho'uf project, was also established in 1982, but was abandoned for a long time due to differences between stakeholders.

A few village clusters in Alkadarah still do not have piped water supply. Some of these approached the Algobua and Aldho'uf project committee for permission to drill a new well. The response was guarded for fear that this new well may negatively affect the water resource. Negotiation and mediation between the two parties is in progress. The Algobua and Aldho'uf project committee had earlier prevented the drilling of new agricultural wells in their valley on the basis that the 10 existing private wells are enough.

3.7 Wadi Sana'ah, Dhamar

Wadi Sana'ah is located 15 km west of Dhamar city. The catchment area of the wadi lies within the larger Ga'a Jahran plateau. A number of old dams existed in the area and the remains of some of them are still in place, for example the Al-dheeb dam and the Al-gash'goosh dam. Wadi Sana'ah is characterized by fertile soil and good availability of groundwater. A variety of crops can be grown in the plateau but not *qat*: frost formation prevents this. The density of wells in the plateau is comparatively low with only 12 wells at distances varying between 500 to 1000 metres. The depth of wells varies between 25 – 220 metres and most of wells have a depth between 70-120 metres. The farmers respect the 500 metres rule, which is also the norm adopted by the NWRA branch in Dhamar for resolving disputes between farmers.

Wadi Sana'ah contains many springs but several springs disappeared after the earthquake that hit the Dhamar area in 1982. Only few springs are still perennial and many of them only appear in the summer. The location of springs is identified by the light blue colour of soil (called *sa'a*) indicating that it was frequently waterlogged. To protect the springs, the farmers do not allow the drilling of tube wells in the wadi. However, shallow dug wells (at a depth of 2-4 meters) are permitted.

3.8 Hejrat al-a'asham, Jabal Al-sharq, Dhamar

Jabal Al-sharq consists of many small valleys and mountains that mark the beginning of the western mountainous slopes. The area is located about 20 km north of Al-sharq town, Dhamar Governorate, and includes historical villages and castles.

Wadi Alwa'ad has relatively flat lands that were covered with coffee plantations in the past. Now *qat* is the dominant crop in addition to sorghum, corn and some vegetables but all crops are rain-fed. Shallow dug wells are the main source for groundwater. Only a few wells have water throughout the year especially wells that are located in the downstream of the wadi. The water table of shallow wells is at 10-15 metres. Some of these open wells are common *waqaf* and are used for drinking water supply. An open well called *alnazool* is believed to be 500 years old and has water throughout the year. However, the springs are the preferred source for drinking water in the area. The yield of the springs varies in time and locations. Some springs can be found only in the rainy season. At one of the most yielding springs, a 20 litre container was filled in about 14 minutes. Villagers will queue day and night for getting their share. As in many other places, springs are regarded as sacred common property which should be preserved. No well drilling is allowed near springs. As an alternative for the water demanding qat, new plantation of coffee is developed. Some of these new coffee plantations also replace old coffee trees which reportedly require more water.

4 OBSERVATIONS

There are several observations to be made from these cases.

First, groundwater is surprisingly collective. This is different from the perception that groundwater is exploited mainly by individual large farmers. Wells in many cases are shared between a large number of shareholders and they are not the property of a single person. In some cases wells are connected by a shared pipeline. In several cases – Alkadarah, Al-sinah and Dhelaa - there has been collective investment in community drinking water supply.

Second, there is a high level of local management in several cases, which has often been introduced recently. The local rules consist of measures such as well spacing, closure of disputed wells, zoning and bans on sales to water tankers. There is often considerable local effort to improve groundwater recharge. A common feature of these pragmatic local regulations (bans, minimum distances and zoning) is their visibility. Consequently it is easy for everyone to observe whether rules are applied or not and no special organizations are required to enforce them.

Third, local management is in some cases encouraged by projects, such as the awareness and social mobilization activities under the Sana'a Basin Water Management Project or the Groundwater and Soil Conservation Project. In other cases communities come together after having seen disaster striking nearby areas or after having been faced with conflicts in their own area. In general such conflicts are 'functional': they trigger a response, as in the case of Hijrat-al-Muntasir. They are preferable to the default situation where wells continue to be developed unabatedly and the 'race to the bottom' is unchecked.

Fourth, the Water Law and the licensing procedures embedded in it are important though not necessarily in a direct way. The Water Law is generally taken seriously. A testimony to this is that in several areas in Bani Husheish, farmers had developed new wells prior to the enactment of the Water Law, then closed and hid these wells, so they could be utilized sometime in the future. The fact that in principle wells need to be licensed signalled that groundwater is no longer an open access resource and restrictions should apply. This has given impetus and strength to local groundwater management. Invoking the licensing procedures under the Water Law is one of the instruments in local water management as illustrated in the case of Al Qarada. From the Sana'a Basin Water Management Project, there are examples of villages pressurising local councils and the NWRA for more effective regulation and licensing. In an essentially tribal society, this demand for regulation by the government – local and central - is remarkable. In Al-sinah, the local cooperative cooperated with NWRA by recommending licensing of wells. There is mutual reinforcement of local rules and national law in several cases, effectively legal pluralism in action. A remarkable strategy of enforcing the licensing of drilling is from Qarada where the issue is not raised among close neighbours but an outsider WUA is expected to make the case to avoid conflict between close neighbours. The same point has been made in other interviews where WUA Union members preferred a sub-basin group to undertake the sensitive work of regulating groundwater use within member communities. There appears to be a need for an effective second or third party to avoid direct conflict.

Fifth, where local groundwater management is in place, a local sheikh or *aqil*, another respected leader or a WUA may have taken the initiative, as in Wadi Al Zabaira or cooperative as in Al-sinah. There may be many sources of local leadership – not necessarily the traditional sheikh. In Khrabat, the farmers themselves established a WUA and this WUA subsequently attracted more members. Some rules may be explicit and are enforced by local organizations but other rules exist as norms and expected practices and do not require a specific organization to support them.

Water Users Associations have also been created under a large number of projects. In some cases this has triggered local initiatives towards better groundwater management; in other cases local rules were in place and the WUA did not add value. The

main message is that WUAs are not the only route to promote local groundwater management but that they can play a long lasting role if properly encouraged. This is, for instance, part of the mandate of the Union of Water Users Associations that coordinates the activities of 120 active WUAs. There is a need to support these long lasting functions. At present engagement between the Government and WUAs ends with project closure in almost all cases. WUA are often established in anticipation of gaining access to government or donor support.[14]

Sixth, the local rules and regulations concern a broad range of measures such as location and depth of wells, recharge measures, management of reservoirs and in some exceptional cases cropping bans. Their impact can be large and they are an important component in managing local water resources. It is in fact hard to see how groundwater use in Yemen can be regulated without a foundation of local acceptance and initiative.

Seventh, local management has not been able to reverse the tide in all cases. In Qarada and Al-sinah, depletion was slowed down but not stopped. Farmers operate on the basis of best guesses and local practices. Providing information to water users would make a large difference in local management. Nowadays, unfortunately, the practice is for hydrogeological studies to be large, inaccessible and not shared by the government sponsors of these studies with other potential users.

5 CONCLUSIONS: WHO IS ACCOUNTABLE TO WHOM? REVERSING THE CRISIS?

The central question in this paper was: in groundwater security, who is accountable to whom? It appears that at least in several areas there are mechanisms whereby water users are accountable to one another and that groundwater management is not a 'free for all'. There are a substantial number of cases where farmers have established local rules to regulate groundwater use and new well development. The arrangements vary. In some cases this was by mutual understanding and commonly accepted norms; in some other cases farmers created their own organization to do so. In a few cases WUA created by projects served to catalyze restrictions on groundwater use. Though not directly enforced, the fact that there is a Water Law and a regulating body – NWRA and its branch offices – has strengthened the hands of local initiatives. In some cases the relation goes further. In Al-sinah, the cooperative society is consulted before drilling licenses are issued. In other areas water users have made arrangement for third parties to oversee local regulation so as to minimize local tensions on these sensitive issues. The Water Law and the public have been instrumental in creating the framework for local accountability- a contribution probably more effective and politically acceptable than the unilateral intervention as often called for in 'enforcing the law'.

This leads to another important question: to what extent can the current crisis be reversed with more local management and are the doomsday projections inevitable. It is beyond the scope of this paper to quantify this and the situation varies from basin to basin. For instance, the Sana'a basin is in greater dire straits than others. Yet what can be said is that there are still unused opportunities to utilize water better and much more can be done to strengthen local initiatives and promote efficient water use and productive agriculture.

That local groundwater management is an essential building block of groundwater security in Yemen is now more and more accepted. For instance, it is the first principle in the recent Sana'a Declaration for a Yemeni Partnership, endorsed by the Cabinet in 2011. Article 6 of the new bylaw to the Water Law makes the same point. There is a need, however, to go beyond these principles and to strengthen local groundwater management throughout the country. Some possible steps and adjustment would go a long way:

First, it is important to promote local groundwater management on the basis of good practices –

14 Bonzanigo and Borgia, note 9 above.

preferably from farmer to farmer and from community to community. This has been done before and consists of bringing different communities together, exchanging ideas and creating mild competition. Some mechanisms are in place for this but they are not fully engaged at present. For instance, the national Union of Water Users Associations that has a membership of 120 WUAs can also be organized at the basin level and it can play a role in a farmer movement to promote better water management.

A second opportunity missed out so far is to ensure the availability of basic information to farmers so that they can understand local hydrogeology and groundwater availability. Over the years a large number of studies have been undertaken – some concerning the entire country, others dealing with a specific basin or sub-basin. Despite the often substantial effort that goes into data collection and analysis, the results have not reached those most immediately concerned, that is, farmers.

Third, a related issue is the need to strengthen linkages between water users and local councils and the branch offices of NWRA. This has happened with good results in Sana'a and Taiz but it should be systematically upscaled. There is also a long history of local councils acting as an arbitrator of last resort in case of water issues and this can be further strengthened.

While the promotion of local groundwater management is one side of the story, the second part is the promotion of water productivity and better agriculture in general. There is room for improvement here. Ward and Naif (2011) quoting figures from AREA make the point that there is a considerable yield gap in Yemen agriculture.[15] The actual crop yield for the main irrigated crops is only 20-40 percent of the optimum. The largest gap is for alfafa (19 percent of optimum), followed by *qat* (27 percent). For grapes, bananas, oranges and mangoes, the yield is 40 percent, 42 percent, 46 percent and 51 percent respectively of the optimum. In addition there is much to gain in post harvest handling. In many areas faced with declining groundwater tables, even basic field water management practices – such as levelling – are not in place. In other words there are still untapped opportunities – making it possible to sustain and increase yields while reducing water consumption under better local management.

There is a need to streamline groundwater management and improved agriculture in different water-related programs, such as the drinking water programs, and irrigation efficiency and watershed programs. Under all these investments, Water User Groups, Water User Association or Water Committees are formed – creating the basis for discussing local management. The long awaited and recently finalized new bylaw of the Water Law provides openings. For instance, it describes the advisory functions of the WUAs to NWRA and provides for WUAs – provided they represent two-thirds of the water users – to make mandatory rules. Other clauses make the 500 meters distance rule[16] and spring protection zones compulsory. There is however still a degree of ambiguity in this new legislation on who is doing what and some clauses appear one-sided: one clause describes a main function of the WUA as 'to assist NWRA in implementing water rules through dealing with a single community based organization'. This does injustice to the self-organizing power of local communities and their accountability for their own sustainable future.

Finally, it is important not to equate local groundwater management with WUA formation and to assume that local groundwater management can only be channelized through formal WUAs. This would do injustice to the many examples of self-organization discussed in this paper. Another pitfall to be avoided is to view WUAs or informal local organizations as an extension of higher water authorities and to place them at the lower end of the hierarchy. Rather, activities at different levels can in the best of circumstances reinforce one another. In local groundwater management, the role of the State is relevant but not necessarily leading.

15 Christopher Ward and Naif, 'If we don't act - Implications of continuing as at present', Paper presented at the National Conference for the Management and Development of Water Resources in Sana'a,Yemen, 15-17 January 2011.

16 This rule actually dates back to the *harim* (border) rule from early Islamic legislation.

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