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Experiences with Local Water Governance and Outcomes for Vulnerable Communities in the Tihama Region of Yemen

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ABSTRACT: In communities that contend with low levels of human development in meeting basic needs, risks relating to groundwater overabstraction can enhance preexisting vulnerabilities. In Yemen, where per capita freshwater availability is amongst the lowest in the world, the most severe outcomes of water scarcity are felt at the local level, by the most marginalised. In addition to an analysis of available knowledge on norms and practices for community water management and the informal and formal networks that operate in rural Yemen, qualitative-based original research was undertaken in Hajjah and Al-Hodeidah governorates. The main objective of this research was to understand how improvements on management practices could lead to better outcomes for the poor.

The research demonstrates that community members in areas that are typified by water insecurity have a high degree of awareness of the different factors, both hydrological and political, that lead to groundwater depletion. Community members have a collective interest to build on existing practices that respond to risks in order to safeguard resources – particularly in addressing the stemming of water overabstraction through deep well drilling to develop cash crops. The research also highlights the difficulties communities face in overcoming power structures which inhibit their efforts in implementing water-related decision-making.

The paper argues that for improved water management practices to take place, the political nature of water management at the local level must be considered with a realistic identification of the stakeholders involved. Strengthening a formalised local government structure may have limited effectiveness if it is done without recognising the traditional and informal forms of leadership, and the existing patterns of power which drive local water governance. The paper concludes that there is an interest/demand for developing or further promoting allocation principles to promote equity amongst communities.

KEYWORDS: IWRM, water security, water scarcity, local water governance, groundwater management, Yemen

INTRODUCTION

Yemen's scarce available water resources do not meet current aggregated demand, with groundwater depletion exceeding annual recharge rates. The country's fast-growing population, lack of accountability in water management, and a challenging hydrological profile, are some of the factors that have led to a full-scale water shortage crisis. Having a semiarid to arid climate, and being vastly dependent on groundwater, agricultural water use is a major factor in the country's water overdraft with 90% of water withdrawals being used for agricultural purposes (FAO Aquastat Survey, 2009). It is estimated that one third of agricultural water is used to cultivate *khat* (Aldabashy, 2017).

A very large factor influencing water insecurity is the political and economic fragility experienced in Yemen, which includes limited fiscal and political decentralisation, and an institutional environment that must blend formal with informal political systems particularly at the local level. The current conflict

in Yemen which began in 2015 is making a challenging situation unendurable, and access to water supply services is deteriorating further. The humanitarian situation in Yemen is currently seen to be the worst in the world, and the continued need for international assistance will continue into the future even if parties agree to a peace settlement. An on-going decline in access to and standards of basic services, particularly water supply, has the potential to lead to further civil unrest. A lack of access to services has also led to the biggest outbreak of cholera in modern history, with more than one million suspected cases since the outbreak began in April 2017 (WHO, 2018). Currently, a total of 16 million Yemenis lack access to safe water and sanitation (OCHA website, 2018).

Despite previous governments having launched efforts to improve water access in Yemen through the development of a Water Law in 2002 (amended in 2006) which aims to reduce indiscriminate drilling of groundwater, the political turbulence which arose from political uprisings has pushed water down the new government's list of priorities (IRIN news, 2012). Previous reform efforts were constrained by low institutional capacity, and capture of benefits (Lerner et al., 2009). The *status quo* in accrual of benefits is facilitated by the continuation of attempted centralised decision-making in Sana'a (Al-Akhali, 2014) and "even in periods when centralisation was the *de jure* form of government, decentralised governance, local tribal heads, and customary laws were the *de facto* form of government" (ibid).

Water and poverty in Yemen are very closely linked, and much of this has to do with food production. In agriculture, ownership of a water source is correlated with higher income, and "development of groundwater resources in recent years has contributed to growing income disparities, as the better off have been able to capture the lion's share of the resource" (Ward et al., 2007). Groundwater use must drive rural growth, however groundwater mining is not only unsustainable, it is also inequitable (Alderwish et al., 2014; Zeitoun et al., 2012; Hellegers et al., 2008; Beddies, 2009; Beddies and Shahid, 2009). Competitive overdraw of groundwater is also compounded by poor governance which may further entrench inequality (The World Bank, 2007; Ward et al., 2007; Alderwish et al., 2014). The pattern of deep well irrigation also individualises water and further perpetuates the pattern of 'winners': large farmers capture benefits of water access through landownership and tubewell drilling, and tribal leaders who are charged with dispute resolution, are also often the largest users of water (Alderwish et al., 2014; van steenberg, 2011, Zeitoun et al., 2012).

Given the crucial importance of the water sector for poverty reduction and sustainable human development in Yemen, improvements hinge on addressing the obstacles which inhibit resolving the water crisis. The approach of influencing power can improve the situation – where the rule of law applies. The violations of policy and law seen in Yemen indicate that the local governance context is not adequately regulated to ensure that the law is working (Alderwish et al., 2014). The strength and reach of law and policy in both cases is generated by its concurrence with the interests of the powerful (ibid).

Developing an understanding of how communities manage their resources in situations of severe resource scarcity and of what elements ensure that power over this resource is maintained, are useful in determining how more sustainable practices in water resource management can be established for the future. In a complex political environment, and where hydrological challenges mean that important trade-offs in water supply need to be made day-to-day at the local level, local management of water can be seen as an important step and perhaps the only feasible way of dramatically improving water security for the most poor and marginalised.

To this end, original research and an analysis of available knowledge was conducted on the potential for management of water resources at the community level in rural Yemen. The original research builds on a previous body of evidence that has uncovered traditions and community practices in water management in Yemen (Taher et al., 2010; Taher et al., 2012; van steenberg, 2012; van Steenberg, 2011; Zeitoun et al., 2012). The aim is to contribute to a better understanding of both the visible (in the form of laws and regulations) and the invisible (in the form of norms and practices) means of

governance related to water supply in the region of Tihama, and to understand the potential for improved local water management that could lead to better outcomes for the poor.

METHODOLOGY

To address the research question identified above, desk study and qualitative research was conducted with individuals and stakeholder groups who perform a role in local water management from September 2014 to January 2015. It should be noted that the qualitative field based research took place in the lead-up to the current conflict, which has severely affected the study areas. The period of desk research and analysis was undertaken again between December 2017 and February 2018. The objective of the desk research was to understand what previous efforts have been identified, at the community level in Yemen and to support the outcomes of the qualitative research.

The study areas are located within Hajjah and Hodeidah Governorates (Figure 1) with eight randomly selected villages, four in each Governorate, shown in Figure 2. A random sampling procedure using the 'RAND' function in Excel functions was used to select the eight villages to be covered in the study.

Figure 1. Geographic location of study governorates (marked with star).



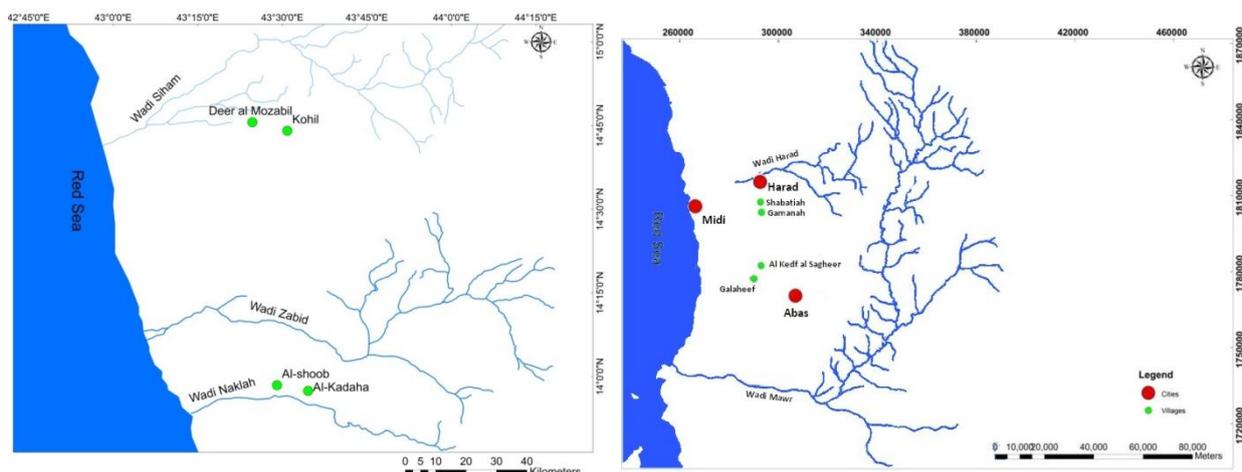
For all field research, survey tools were developed including the use of a master research questionnaire and templates developed according to the data collection method. The qualitative data collection included a total of 16 focus group (FG) discussions with community members held in the eight sample villages in both Al Hodeidah and Hajjah governorates. Two focus groups were held in each village, segregated by sex, so that unique experiences of men and women could be analysed separately. Approximately six to ten community members participated in each focus group discussion.

The researchers took the approach to hold focus groups with women and men separately, as women and girls are generally direct stakeholders in managing water at the household level in Yemen, and are therefore hampered by unequal norms and practices which lead to reduced water security. Participants of the focus groups represented views as members of their community, expressing how water management occurs at the local level and how community members cope with and manage in the face of extreme water scarcity. Analysis was done through development of research matrices in Excel, where summaries of discussion points were charted against the evaluation question, according to the unit of

analysis (i.e. by village, by focus group, or by key informant). This enabled the researchers to pick out themes and highlight areas of emphasis. The interviews were conducted by the Yemen-based researcher (co-author) and women's interviews conducted by a woman PhD candidate at University of Sana'a.

Altogether 31 key informant interviews and three round-table meetings (two in Al-Hodeidah and one in Hajjah) were held with local government staff in the eight villages. Resume Round table meetings were held with representatives from government line departments and included tribe leaders such as *Sheikh*, religious/influential leaders, farmer association representatives, and water user representatives. The round-table meetings were an opportunity to understand how more influential representatives and community leaders work together (or separately) and view water resources problems. Key informant interviews were held with representatives from government line departments including the National Water Resources Authority (NWRA), the representative *Sheik* of surveyed villages, local council members, farmer association representatives and Water User Committee (WUCs), community representatives (male and female) and NGO personnel. The interviews were an opportunity to understand in-depth how representatives from different stakeholder groups perceive local water management.

Figure 2. Surveyed villages in Hajjah (left) and Hodeidah (right).



Source: surveying by research team

Profile of Hajjah and Hodeidah Governorates

The two study governorates selected are highly vulnerable, and affected by chronic crises which include drought, floods and conflict. Hajjah and Al-Hodeidah governorates lie in the Tihama Region, on the Western coast of Yemen. The Tihama Plain is hot, windy and semi-arid. The mean annual rainfall varies from about 50 to 100 mm along the coast to about 300 mm (occasionally 400 mm in the southern reaches) along the foothills at the lower end of the catchments. Potential evapotranspiration in the 20-30 km fringe closest to the sea is in the range of 2000-2200 mm (TSHWC, 1992).

Although traditional rain-fed crops such as sorghum and maize are still dominant in the study area, there has been an earlier shift since the 1980s to more remunerative cash crops such as banana, vegetables and fruit trees in newly irrigated areas. The shift from traditional rain-fed agriculture to cash crops came as a result of the high demand for these crops that accompanied the rapid population increase. It was encouraged via government policy to develop agriculture, through programmes that provided encouraging incentives to investors, which led wealthy people and senior officials to invest in agriculture in Tihama. This was facilitated by a lack of control in practice over the drilling of new wells (Zeitoun et al., 2012).

During the last 20 years groundwater abstraction in Tihama has grown enormously due to the widespread and unrestricted introduction of well-drilling equipment and motorised pumps and the attractiveness of a permanent, secure and apparently limitless source of water, in comparison to the limitations of *wadi* flow or flood water. Agricultural production in Tihama depends largely on spate irrigation – a system of harvesting and managing flood waters. Drilled wells are being constructed at an increasing rate. Dug wells, previously the most common form of water supply infrastructure, are now typically being deepened by drilling. It is estimated that nearly 70% of wells are pumped wells. The greatest rate of growth of pumped wells is shown in the mid-Tihama groundwater provinces including the district of Hays (NWRA, 2009). The average depth of groundwater wells in the northern part of Tihama is 80 m, and can range in depth to 120 m, with the average abstraction rate at about 8 l/s, operating 12 hours/day, 24 days/month which is the annual average (ibid).

COMMUNITY WATER MANAGEMENT IN YEMEN: BACKGROUND AND CONTEXT

The village as a participatory institution

Yemen has a tradition of managing agricultural water involving comprehensive hydraulic structures, and for centuries there has been a successful balance between delicate environmental equilibrium and available water resources (Negeneman, 1997). The application of collaborative approaches in groundwater management at the community level has traditionally been in practice in Yemen over centuries. Literature sources emphasise that communities have acted collectively in an attempt to safeguard their resources through traditional arrangements (Taher et al., 2012; Lichtenthäler and Turton, 1999; Ward et al., 2007). Existing literature also indicates that in developing new solutions for managing water, local action can be supported, but probably not initiated, by outside agencies, and planning has to be built with the local level and public agencies in parallel (Ward et al., 2007).

In Yemen, the village is a participatory institution in which virtually all of the community components have reciprocal relations. Following the tribal ethic, in a balanced situation a village can be considered as a 'family' in which all members take care of the common interest. Village difficulties, opportunities and conflicts among the village members or with external elements should be discussed during *ad hoc* meetings attended by all family heads. Village meetings, formal and informal, are frequent and constitute occasions to debate questions, and to propose resolutions to conflicts. Women are not represented in these traditional arrangements in a direct sense. In taking decisions at the village level, there are generally three points of reference: the first is the *Sharia'h*, the Islamic law; the second is the *Urf*, or the traditional norms, and the third is the agreement of the majority of the family heads.

The local policy context

The overarching policy setting out conditions for preserving water resources and water management at the local level is the national Water Law (2002) and its amendment (2006) which aims to control groundwater abstraction rates through setting out a licensing procedure for deep wells, identified as being wells with a depth greater than 60 meters. The Water Law also sets out the governance of water resources at the local level through Water User Organisations (WUOs) and defines the National Water and Sewerage Authority (NWSA) and branch offices as regulators for urban supply.

At national and local levels through their branches, the National Water Resources Authority (NWRA), is in charge of: 1) water resource planning and monitoring (i.e. the formulation of a National Water Plan, which is to be further developed into a water basin and water zone plans, which integrate all water management issues); 2) legislation (registrations of water rights and licensing of water wells) and 3) public awareness (of groundwater mining and pollution). Staff of the NWRA have the status of judicial enforcement officers and report violations of the Water Law to the police. Local Corporations for Water Supply and Sanitation (LCWSS) are responsible for the implementation, construction and

operation of water supply and sewerage systems in urban areas while the General Authority of Rural Water Supply Projects (GARWSP) is responsible for the planning of water supply in rural areas of Yemen and for keeping track of the performance of the local councils¹ in implementing water supply. Local councils are tasked to follow up and supervise all governmental water projects in their area. They may look at operation problems of water supply projects, as well as water deficiency in wells.

Large irrigation schemes are overseen by Tihama Development Authority (TDA). The TDA is administratively and technically answerable to the Minister of the Ministry of Agriculture and Irrigation (MAI). The TDA is endowed with wide-ranging and fairly autonomous authority to act in the Hodeidah governorate and five major *wadis* (Mawr, Surdud, Siham, Rima, Zabid and Hays), covering the full range of agricultural programmes, including irrigation and community development.

RESULTS AND DISCUSSION

The following analysis has resulted from the original field results including the focus group discussions, key informant interviews and roundtable meetings. Where this analysis is supported by the literature review, an indication has been made by referencing.

Local water access and management

In the areas surveyed, there is a strong reliance on deeply accessed groundwater, with predominantly more boreholes in northern areas, and more dug wells in the southern areas of Tihama. The situation in the study areas mirrors the wider context in Yemen where 70.5% of water withdrawn throughout the country is from groundwater (FAO Aquastat Survey, 2009). The most common form of direct access to water for households was through boreholes/dug wells with varying forms of ownership (i.e. privately or publicly owned), with two villages having household connections provided through an international development cooperation. Pumping water from boreholes using diesel pumps is common. Sustainability of water supply is a considerable challenge, and maintaining sustainable infrastructure comes at a high cost, with financial and material resources for machinery, repairs, and fuel to run diesel pumps all being necessary to ensure functioning of infrastructure. The inability of the poor to pay for water consumption also inhibits sustainability and operation and maintenance (O&M) of water supply projects.

In order to compensate for poor access in household water supply, supplemental water tankering is common in all of the surveyed areas, particularly during drought times, in order to meet household demands. Water tankering is provided by the informal private sector, and is largely unregulated by local government. Poor households also depend on women and children to fetch their domestic water needs from agricultural boreholes, with the water quality in these boreholes being described as very poor. Access to agricultural water follows similar forms of access. Small-scale farmers in villages surveyed where a private well owner was present, stated that they irrigate crops with groundwater using diesel pumped boreholes, with supplemental use of rainwater and floodwater. A barrier in access to irrigation is that wells are owned privately, and typically the farmer who has ownership will decide on the terms for access on a case-by-case basis. There are no examples of long-term formal agreement in this sense, and agreements are insecure and rarely serve the long-term needs of small-scale farmers. Tihama differs from areas of the highlands where most boreholes are shared by more than one farmer. In Hajjah, at a roundtable meeting attendees estimated that 10% of water supply projects are government-owned, and 90% are privately owned and have no organisational structure. A similar figure was estimated in focus groups where the participants analysed ownership of local boreholes and approximated 75% of water sources to be privately owned. A trend towards private ownership of water

¹ Local authority.

sources has had a profound effect on the politics of local water management in the areas surveyed, and has been shown to restrict small-scale farmers from participating in the planning of local water resources, and are similarly unable to represent their needs in developing infrastructure solutions.

Community members demonstrated some awareness of the Water Law through FGs, and its provisions for licensing of private wells. Discussions yielded both the presence and the absence of knowledge, making it difficult to generalise an outcome. For instance, in four FGs in Hajjah (including one women's FG), between 20-60% of the participants stated that they had an awareness of the Water Law and its licensing procedures. In three FGs in Hodeidah (all male), it was stated there was an awareness of the Water Law, but followed up with a statement that there is no implementation or regulation of the Water Law. In one village in Hodeidah, an FG stated that when the Water Law came into force, the local branch of NWRA used it as a way of "getting money out of locals".

In terms of local governance structures, decisions are overseen by a locally determined mix of traditional or informal actors including *Sheiks*, *Aquil* (defined as local 'wise' elders), private well owners, elders; as well as formal institutions, WUAs with no set understanding on the responsibilities and accountabilities these actors have in making decisions. Interviews with formal institution representatives determined a strong sense of oversight in community water management, although there were no clear hierarchies for communication between institutions and communities, and communications tend to be *ad-hoc*.

It is evident that gender inequalities persist and can manifest in a system that is reliant on traditional or informal forms of governance, and that women's input into decisions can be limited. Discussions over community water management are held in mosques or other gatherings which exclude women's views and experiences. All informal/traditional leaders interviewed in this research could not convey one example of women's views being represented in decision-making.

Water User Organisations (WUO) in practice

Following the introduction of the Water Law, different levels/categories of Water User Groups, most notably Water User Associations (WUAs), which manage and monitor public agricultural wells, and Basin Councils were established to transfer operation and maintenance (O&M) functions of the spate irrigation and groundwater irrigation schemes from the Ministry to the user organisations (Taher et al., 2012). WUAs are formed to oversee spate or groundwater irrigation projects. Water User Committees (WUCs) in turn have been typically formed through development of drinking water supply projects and consist of 10-12 elected community members, who may also be members of WUAs.

In relation to water management the formation of WUAs has also been encouraged at micro level. WUAs are customarily responsible for O&M of water management infrastructure. Several water user groups can be combined to form a WUA, which can regulate and coordinate O&M at a higher local level. The interviews found that membership of the WUA resulted from varying means. WUAs which were formed as a result of development cooperation and that were being supported by externally led projects, had an elected membership of 10-12 farmers. These WUAs also had a more active link to Water Basin and zone committees and the local NWRA branch. The WUAs for the purposes of this research were concerned with groundwater governance, and not spate irrigation.

The WUA itself is a well-recognised unit of local governance with a high level of acceptance in the study area by community members; however, many believed that the WUA, in terms of its ability to represent community needs, required improvement. In most cases, the WUA, in addition to dealing with well management, discusses access to water, and rules surrounding a water source, but did not facilitate forward planning around water resources. In one situation, the head of a WUA was a powerful private well owner who benefited from irrigation through his own farming operations. This highlights the potential conflict of interest that can occur when WUAs lack an accountable governance structure.

Community focus groups revealed that WUCs set up through donor programmes were highly effective but when financial assistance ceased many WUAs ceased operation. Although WUCs aim to collect fees from households to support their operation and for improvements on access to water, they had concerns on the practicality of collecting fees due to the poverty of the households served. Despite this, out of the seven WUCs interviewed, two were found to be self-sustaining in the sense that they were still operating at the time of interview, despite stopping of donor project funding. Both of these WUCs stated that they were sustained as they were still able to collect some limited user fees; therefore, they continued to hold meetings to discuss continued O&M of the drinking water supply. Of the WUCs interviewed, two were formed by the local GARWSP branch (likely through donor cooperation), two were formed by an INGO, one by the local council and one was formed by the *Sheikh* (there was no response for one WUC).

Of the seven WUCs interviewed, all but one stated their top challenge was a collection of user fees and inability of community members to pay due to poverty, with the remaining single WUC stating that incomplete infrastructure completion was the main challenge facing the WUC. Other challenges faced by WUCs include: limited overview of responsibilities, lack of sustainability of water supply resulting in inability of WUC to make decisions on access, and difficulty in securing accountable leadership as WUC members are voluntary and unpaid. WUCs that are initiated through international donor support can have limited successes locally, although scaling up can be arduous, as observed with little or no effect at the national level (Alderwish et al., 2014). In terms of monitoring, there were few examples of WUCs being able to systematically collect information. Six of seven WUCs reported not monitoring water resources that affect water supply side issues in any way.

Local power structures

Local power dynamics are highly influential in determining the groups that benefit the most from more secure access to water resources. In roundtable meetings, discussing future possibilities for reform, there was a more pronounced resistance to change in forms of groundwater management procedures amongst current well owners (i.e. traditional leadership). The management procedures discussed were typically a series of local decisions that would inhibit or limit the use of groundwater through adjusted availability options (e.g. limiting distances between wells and licences for well drilling and access, and pricing options). It was observed that the groups who have access to capital gained from unregulated groundwater development and cash crop production did not see the possibility of shifting existing forms of power as an agreeable option.

In the agricultural water sector in the Jordan and Yemen context, Zeitoun et al. (2012) contend that the centre of influence stems from the relationships between traditional tribal leaders and highest echelons of the government. As a result, the 'winners' are groups that benefit from current patterns of water use which have resulted from unregulated groundwater drilling such as farmer *Sheiks* and large landowners, and the 'losers' are the poor farmers and rural landless, while the Ministry of Water and Environment opposes this alliance (ibid). Lichtenthäler and Turton (1999) also drew the 'winners' into the traders and importers of pumps and irrigation equipment, who are often the same families that own drilling rigs. Zeitoun et al. (2012) conclude that water use patterns are established by the interests of, and power asymmetry between, stakeholder groups.

Perceptions of how decisions are made over groundwater in the study areas vary according to the different stakeholder groups interviewed. *Sheiks* who were also private well owners were identified by stakeholders as being the *de facto* management authority for decisions around access to scarce water resources. The idea that private well owners have management authority is expected as they would provide (or exclude) access for community members and the rules generated by them would have a huge impact on those seeking access. In community focus group discussions, participants were requested to detail the role of *Sheiks* in local water resources management, with varying responses

given: controlling drilling, supervision and monitoring of improvements, looking for new water sources, ensuring that households pay water fees and settling disputes.

In contrast, altogether eight *Sheiks* were interviewed and requested to describe their role in local water resources management. Five of the eight *Sheiks* interviewed perceived their role to be in local regulation and water resources allocation (i.e. of groundwater), which several defined as determining length of time (i.e. number of hours) of access to community members and the hours for pumping water from boreholes.

Discussions about informal/traditional governance, influential private well owners and water management during roundtable meetings and key informant interviews with local government representatives alluded to concerns over potential conflicts of interest that could arise. The role in particular of the authority of the *Sheik* as settler of groundwater disputes, yet also as a 'high water user' was highlighted in that *Sheiks* would make decisions that favour a continuation of their decision-making power over water resources. Marginally less than half (5 out of 13) of the local institutions interviewed (which included government line ministries and WUAs) confirmed they faced resistance in implementing WRM-related measures. A borehole siting being taken over by a rich investor was an example related by an interviewee of a challenge that they faced, as well as problems with overcoming illegal drilling by "powerful *Sheiks* and investors or landowners". Some other problems arising from the *Sheik's* decision-making authority were documented including problems related to lack of technical knowledge related to groundwater and hydrological processes, which should inform their decisions on locations of infrastructure and distances between boreholes. A government stakeholder stated that project failures have occurred due to the "unscientific interventions of *Sheiks* in the selection of tanks, boreholes and pipes near his house, and his biased intervention in the selection of Water User Committee members". In one example, a private well owner was able to influence a planned water project to being relocated to a different village, so that the recharge levels of his well were not affected. Questioning confirmed that in Abbs and Hays districts, private well owners exhibit strong opposition to any public water supply projects being planned, to safeguard the recharge of their wells.

Despite these experiences related during FG discussions with community members, the perception that the communities see informal/traditional governance or high water users as having an adverse impact on water resources is not always the case. Community members, both men and women, held different views on whether high water users should be held accountable for their water usage patterns in relation to availability of the resource. When locals were asked if there are ways to confront private well owners who use a lot of groundwater, some participants stated that they did not see the large water users as a wrongdoer; moreover, as locals are permitted to use domestic water from these boreholes, they did not feel they should be in a position to negotiate around water management. It is accepted however that some community members may not feel empowered to speak against such authorities that grant access to a valuable resource.

Decentralised government bodies would be a more directly recognised authority in local water management, if they were more empowered to demonstrate practices that allow for greater accountability and citizen engagement in local water resources management. It is generally viewed that decentralised water management, a stakeholder partnership approach and secure water rights may gradually reduce the rate of groundwater overdraft (Ward et al., 2007). The World Bank Poverty and Social Impact Analysis (ibid) argues that where this approach is being implemented on a small-scale, there is an improvement in water governance. The components of this approach include increased awareness and cooperation of the population, basin committees and plans, the beginning of regulation, and a growing WUA movement (ibid).

Water-related decision-making at the community level

In Hajjah District, one of eight villages felt they work together on water-related risks (defined as the majority of participants in each village focus group discussion) whereas in Hodeidah six of eight villages felt they work together on water-related risks. In Hodeidah, detailed examples of making cooperative arrangements included working together to reduce adverse impacts during flood events (two villages), as a group asking farmers to reduce their irrigation during drought (one village), and collectively deciding to prioritise drinking water over irrigation during drought (one village). Half of the eight village-level focus group discussions were able to relate examples of rules where the community collectively made restrictions over water-supply access. For instance, in the village Deer al Mozabil in Hodeidah, a WUC decided on timed rationing of water for each housing cluster and then developed a system to oversee the water storage devices during filling. Some examples of rules developed by communities over water management, included in Hajjah, in Al-Kedf Village, members collectively decided a ban on local water trucks selling water outside of the area. In Hodeidah, in Al-Kadaha Village it was decided that during periods of drought, domestic water supply is given priority over agricultural water supply and farmers were asked to reduce their use of irrigation water. A village in Hajjah advocated through the WUA to recognise customs to protect the water catchment, including controlling grazing activity on recharge areas. Notably, in Al-Kedh Village, Hajjah District, members of the village collectively decided to stage a demonstration to protest against over-abstraction of groundwater by high water users. Despite there being limitations for communities to participate in decision-making over the drilling of new boreholes, communities have collectively shown their interest in creating rules which safeguard water resources.

In turn, WUCs also indicated interest in further developing or building on principles and norms that allow for improved community decision-making. One WUC in Hajjah District related a wide range of ideas including: building on existing local regulation in use and allocation of water, controlling drilling of boreholes, restricting banana cultivation, restricting selling water to irrigate *qat*, developing awareness campaigns for water use, developing equity allocation principles and improving legal enforcement of the Water Law.

The above examples represent inventive and pragmatic ways that communities may be able to address promoting equity in groundwater abstraction and safeguarding resources. In further discussions around motivating factors behind these rules the participants highlighted interest in following equity principles as a key motivating factor. A WUC member highlighted the importance of equity in management decisions, particularly in relation to cost: "the network was complete but there were no rules to allocate water. The one with the large tank collects more water and pays the same as others because there were no flow meters".

Despite these examples of collective decision-making over water access being related in half of the surveyed villages, there still remain many stakeholders (related in focus groups, key informant interviews and roundtables) who believe that there are "no rules" over drilling. One focus group participant determined that "anyone who is capable" can drill and extract water from farms at no cost.

Community perceptions around groundwater depletion

Community perceptions around the factors which contribute to groundwater depletion is important in looking at the reasons for prevailing management approaches that persist in the study regions. Specifically, questions were developed to understand the factors that may affect the reasons for maintaining power amongst power holders, and what actions would be necessary to reverse adverse practices. The focus groups provided an opportunity to explore these topics in-depth and gain insight into the reasoning that underlies people's beliefs regarding groundwater depletion.

Through the FGs held at village level, a set of questions were devised to probe what the community believes to be the main factors behind depleting groundwater levels. The most common factors

included: drought or lack of rain (majority of responses in six village focus groups), over-abstraction from high water users for irrigation (two focus groups), absence of a dam at upstream *wadis* (one focus group) and there were no ideas related in four focus group discussions.

Governance aspects around groundwater withdrawal were also a topic discussed with the focus groups. There is a strong consensus that 'high water users' are believed to be a significant factor in groundwater depletion, being identified as the second most significant reason for groundwater depletion after drought. The nuances of the following discussion in the FGs suggested that the high water users have the ability to circumvent policies which aim to stem groundwater overabstraction. There was a general sense that despite the existence of the Water Law, which has the purpose of stemming abstraction, that regulation and enforcement do not occur, paving the way for powerful local elites to capture scarce water resources for agricultural production. The impacts of water scarcity are felt the most by the poorest, who need to employ a range of innovations to access water for small-scale water production, and for their own domestic purposes. At the same time, the same groups must employ a range of increasingly severe coping mechanisms to allow their families to survive in times when water is scarce.

The FG discussions uncovered the range of ways that people cope with water insecurity, both directly and indirectly. The men's and women's focus groups yielded distinctly different responses and are therefore represented separately. In a direct sense, in 10 of the 16 focus groups (FGs) the practice of well deepening in the last decade as a response to lowering groundwater tables was mentioned. The men's FGs outlined the direct reliance on piped water networks through external donor-financed projects instead of using traditional boreholes, with mention of supplementary water tankering. In four out of eight men's FGs, participants mentioned selling their assets (including livestock) and arranging for migration of family members in search of work abroad. In two men's FGs there was mention of selling assets and reducing agricultural output, and in one FG there was mention of selling assets and migrating, respectively.

Women's FGs detailed the intricate set of efforts and increased time and effort taken to meet household water needs, when water is scarce. Some of these coping mechanisms include: prioritising water for instance from tankers for drinking, searching for water from irrigation boreholes (which are far away and unprotected), borrowing and bartering for small amounts of water at different points of the day from neighbours to get chores done, borrowing money to collect water from tankers, delaying washing of clothes, and skipping bathing children and reducing attention to hygiene.

Participants were also asked what they believed was the biggest barrier for improved agricultural production. Again, drought and resulting water scarcity were mentioned by the largest number of participants as the biggest constraint. A smaller number of participants mentioned locusts or lack of diesel for water pumps as a main barrier.

From a hydrological perspective, the semiarid to arid climate as well as more frequent drought conditions is very much a high factor contributing to shocks in groundwater. In the focus group discussions, around 60% of the participants stated that more than half of the year was drought-affected. Drought is strongly associated with food insecurity globally, and also significantly affects access to water, which in turn has a significant effect on livelihoods as outlined in a report by British Geological Survey (BGS) (Calow et al., 2002). Households depend on water for earning opportunities, such as garden irrigation, and livestock watering. Low to no yield of wells and boreholes during drought is a function of both increased demand on low-yielding sources and reduced recharge to the aquifer (ibid). It is generally accepted that an arid climate and drought in Yemen is most strongly associated with poor rainfall, which leads to failure in wells during the drought period. However, localised depletion, resulting from overpumping in the immediate vicinity of the well or borehole could also be a factor.

CONCLUSION

The research demonstrates that community members in areas typified by severe water scarcity i.e. areas where people are unable to meet their water needs due to lack of available water resources for the greater part of the year, have a high degree of awareness of the different factors, both hydrological and political, that lead to groundwater depletion. Community members also have an interest to collectively implement practices that respond to risks in order to safeguard resources based on principles of equity – particularly addressing the stemming of water overabstraction through drilling to develop cash crops. The research also highlights the difficulties communities face in overcoming power structures which inhibit their efforts in implementing water-related decision-making. The ability of 'formal' water governance institutions to support communities is limited in the face of powerful actors who are able to gain control of scarce water resources due to their ability to invest in the infrastructure, equipment and fuel needed to expand on water supply, largely for agricultural purposes. In such a system where formal governance is weak, a continuation of the *status quo* further entrenches poverty, especially where access to natural resources is highly correlated with the accrual of power, and there are strong linkages between poverty and lack of access to water.

Identifying how the community perceives local water governance and how they currently work together to address water-related risks is a useful step towards identifying strategies which aim to overcome poor implementation of the Water Law. New strategies need to be able to fully identify the more hidden power structures that persist and the unequal power relations that, at local levels, inhibit community members from having a greater influence over the structures and social norms that affect their ability to safeguard scarce water resources. Identification of power structures may facilitate a process which addresses balancing the power relationships which influence how water resources are developed, to improve transparency around water governance. Gender inequality is a major factor in the context, as women are not represented in the governance structures (most significantly, traditional or informal governance structures), yet suffer the most acute consequences of the *status quo*.

Despite intense challenges in accessing water, community water management practices and agreements are implemented in some form in all of the areas surveyed, and the idea of managing water, based on local risks, is a major consideration amongst many stakeholders interviewed. There appears to be a high level of amenability for more formalised WRM programming to take place in the study areas amongst community members and formal government representatives. The different examples of arrangements for cooperation enacted within communities through WUCs are likely to have some improved effect on water management, where the state's ability to resolve such issues has been traditionally weak. Given the associated constraints, water supply improvement planning needs to be undertaken in a flexible and adaptive manner. A focus on managing water supply locally is considered to be a pragmatic approach and can be implemented alongside wider government-led initiatives.

There are many limitations, not only addressing the power dynamics that maintain poverty and inequality. Basic access to an improved water source and sustainability of water supply are major obstacles that communities face and take precedence over management of scarce resources. Access and sustainability have emerged mainly from the inability of households to pay their water consumption bills due to poverty, and at the time of the research, in six of the eight villages (i.e. 75% of villages surveyed) relied on a water source that was not functioning due to lack of ability to pay bills, inhibiting O&M of water supply. The sustainability of WUCs cannot be assumed unless financial support, which has been largely received in the past through project-based donor funding, continues.

The dual trends of communities needing to secure access to water through informal and often insecure agreements with private well owners, and the reliance on supplementary access to water through private water tanking has had a profound effect on the poor, who depend on rules and access considerations generated by private service providers, which is tenuous in an unregulated environment.

The trend towards privatisation of public land further restricts water access for the poor who depend on common wells. The extreme vulnerability of the communities surveyed is further entrenched by these patterns and has been demonstrated through the identification of the wide-ranging coping mechanisms employed by households when water is scarce including migration to Gulf countries and selling of household assets including livestock. The case in Yemen perhaps has similarities to other situations where governance is weak or where there is a lack of political will to provide adequate water supply to citizens.

The extent to which community management of water is affected by the conflict has not been reviewed in this study, as the survey took place in the months before the crises began to heighten in March 2015. Both of the study districts are very heavily affected by the crisis and experience frequent air strikes, displacements and general economic decline placing more pressure on basic essential services such as drinking water supply. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) states that the "collapse in the public sector is increasingly pressuring humanitarian organisations to compensate for the absence of government spending... This sets a potentially problematic precedent by stretching scarce humanitarian resources beyond their mandate and into the public sector to compensate for the failing social services" (OCHA website, 2018). Although the humanitarian response to the ongoing conflict is of critical priority, further research may uncover how basic crisis modalities or resilience approaches collectively employed by communities may improve a perilous situation in access to safe water.

As an outcome of the research, based on the acceptance of water user groups amongst communities and the limited success they have had in implementing management measures that promote intercommunity equity, it can be concluded that decentralised water management which support such institutions to manage through the principles of representativeness, accountability and equitable management will lead to an improvement in water governance, in some form. Incorporating women's views in these groups will be important as women hold a high responsibility for household-level access to water. The ability of the local branches of NWRA and GARWSP to link to water users through WUCs is an important step towards stemming inequitable well drilling. This should however be combined with a better understanding of local interpretations of the Water Law and the challenges in enforcement, with a stronger connection of water resources management to drinking water supply.

In the absence of strong local regulation of the Water Law, and with a multiplicity of stakeholders with some say in water management, there is likely to be no 'one size fits all' approach to improving management methods. Building the capacity of local groups, most pragmatically through WUAs/WUCs will likely be the most appropriate method of collectively determining challenges, for representation to authorities who are more open to change. However, a key finding of the research is the ability of communities to pay, while financial sustainability of WUCs is a criterion in catalysing more sustainable community involvement and management. With the current crises in Yemen, including the Tihama Region, there is a strong likelihood that a reliance on donor funds for reconstruction and development will be needed for generations to come to overcome the current gaps in service provision.

Improved data collection is needed that empowers local communities to highlight inequities and which allow groups to approach authorities and better convince them for improvements in local regulation of groundwater that would address inequalities. Donors, NGOs and even local government branches should assess what exists first, before deciding to bring in programme approaches as there are clear strong traditions and interests in self-organisation and collective management of water, if even many communities may not presently be empowered to do so. Strong perceptions of equity exist in communities in relation to water supply stemming from people's concern of the scarcity of the resource and poor access.

However, for improved water management practices to take place, the political nature of water management at the local level must be taken into account with a realistic identification of the

stakeholders involved, and their current roles in water management including making access and management rules. Strengthening a formalised local government structure may have limited effectiveness if it is done without recognising existing, informal forms of leadership, and the patterns which exist in local water management.

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