



Review Paper

Review of Yemen's Control of Groundwater Extraction Regime: Situation and Options

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Abstract

Depletion of groundwater resources has become a major concern in many parts of Yemen today. The competitive overdraw of groundwater is compounded by the lack of governance and institutions. Under current lawless conditions, better off farmers have captured larger share of groundwater through uncontrolled deep well drilling, which had lead to both shallow groundwater and springs available to poorer farmers to be depleted or exhausted. Although groundwater use is driving rural growth, groundwater mining is not only unsustainable, it is also inequitable. Understanding interest and influential power between various stakeholders thus become critical to the task of interpreting resistance to change in ground water control policy/implementation. Each specific measure of controlling groundwater extraction tends to raise its own problems. Applying single measure alone cannot resolve the problem and other forms of interventions are also necessary. There are some high impact actions that can be started now, including intensive user involvement and organization, self-regulation by water user associations, monitoring and information sharing, tradable water rights, and improving incomes through technological improvements. Thus, the next phase of control extraction of groundwater will require mobilizing government commitment around this agenda, working on the governance system at the local level, and piloting high impact actions.

Keyword: Groundwater extraction, governance, regulations, arid, fragile state.

Introduction

The Middle East is an arid, water-scarce region. The Arabian Peninsula's first democracy stands at a crossroads¹. Yemen is one of the top world's water-stressed countries. Groundwater levels in its aquifers are falling at a rate of 3 to 6 meter annually, threatening agriculture and leaving major cities without adequate safe drinking water. In Sana'a basin, wells to supply domestic water for the people of Sana'a city will have to be drilled to depths of more than 1000m which are considered extremely deep by world standards.

Like other humans, the people of Yemen strongly resist regulations and laws imposed from the top down. Consequently, the Ministry of Water and Environment, has adopted a strategy of decentralized water resource management, by encouraging stakeholder and community participation. Governorates, water basins and villages have acted to conserve local supplies of the life-giving water, but it is uncertain how long these efforts can lead to avoid of the disaster.

Water crisis would cause unstable country. Framing policy or implementing laws in a fragile state is a problem: The organization for economic cooperation and development defines 'a fragile state as one that is unable or unwilling to 'provide physical security, legitimate political institutions, sound

economic management and social services for the benefit of its population'². Fragile states share a number of features: widespread poverty, low taxation and weak legislative assemblies. They are vulnerable to economic shocks and natural disasters. Military interference in politics is common, and there are likely to be areas where tribes and non-state actors wield more power than the official authorities'. As much as 90% of Yemen's groundwater is currently used for agriculture and a rising amount goes to irrigate high-value crops of qat³. Profits from qat sales sustain the rural economy and slow the process of urbanization but they also lead to over-exploitation of deeper aquifer. As water becomes scarce, water for domestic use is more or less prioritized over qat irrigation. However, eliminating qat consumption will have unpredictable consequences for settlement patterns and political stability.

Changing water practices to control groundwater extraction requires changes in the attitudes of individuals, institutions, professionals and social organizations. By definition, 'social change instruments are not neutral, one person's positive change is often seen as destructive by others. Therefore it is important to ask, 'change from what to what?' as well as 'how can changes take place?'. The key to control of groundwater extraction oriented civil society lies in the creation of shared visions. This means broad stakeholder participation in water planning and operating decisions is required.

'In every country there are some legal, administrative, or constitutional 'failures' and some inappropriate policies (from a water perspective) which are currently unchangeable'⁴. The most pressing water challenge in Yemen today is the persistent problem of unsustainable groundwater management. Groundwater use is driving rural growth, yet groundwater mining is both unsustainable and inequitable. Mining has to be reined in if the rural economy is to survive, but groundwater policy has to look not only at sustainability, but also at incomes and at the growing need for rural urban water transfer. International experience shows that recovering control of groundwater is difficult and Yemen does not have the essential governance and institutions⁵.

When start a reform process and choosing new management tools, it is necessary to select what problems are to be resolved. Within the water sector in Yemen the problems discussed in this paper are; water scarcity (insufficient water to maintain food security), and Over abstraction (mining of ground water). Hydrological models are well developed however, significant improvement is needed to models for aspects of economic, social, institutional and legal. The analysis searches to present model that integrate all these aspects of groundwater overdraft into a coherent framework. The purpose of the study is to describe the current state of groundwater extraction policy/regulation in Yemen; examine the implications of current groundwater regulation for people; and with reference to other regional and international works, to describe options available to the Government of Yemen to control groundwater extraction.

The study also seeks to determine how implementation varies with the characteristics of the area regulated, the responsible agency, and the use of complementary groundwater management measures.

Methodology

The irrigated sector in Yemen is similar to that of other countries of the Middle East. In all, the sector is characterized by high consumption of water and production of high quantity of waste water, socio-economical constraints, and competition between users. A method is used to determine the extent to which the implementation of groundwater control mechanisms reflects key principles of modern integrated water resources management, such as restricting extraction to sustainable levels, and involving stakeholders in setting limits on extraction. It proceeds from a review of challenges and problems to the comparative advantage of Yemeni engagement.

The work deals with the legislative, administrative and technical basis of groundwater control policies. It includes an extensive discussion of the requirements and options in respect to control overdraft of groundwater exploitation. This includes review of water relating laws, strategies, and policies in Yemen that focuses in control of groundwater extraction and result in describing the challenges of the water resources. The study measures the characteristics of the context to which each option relates.

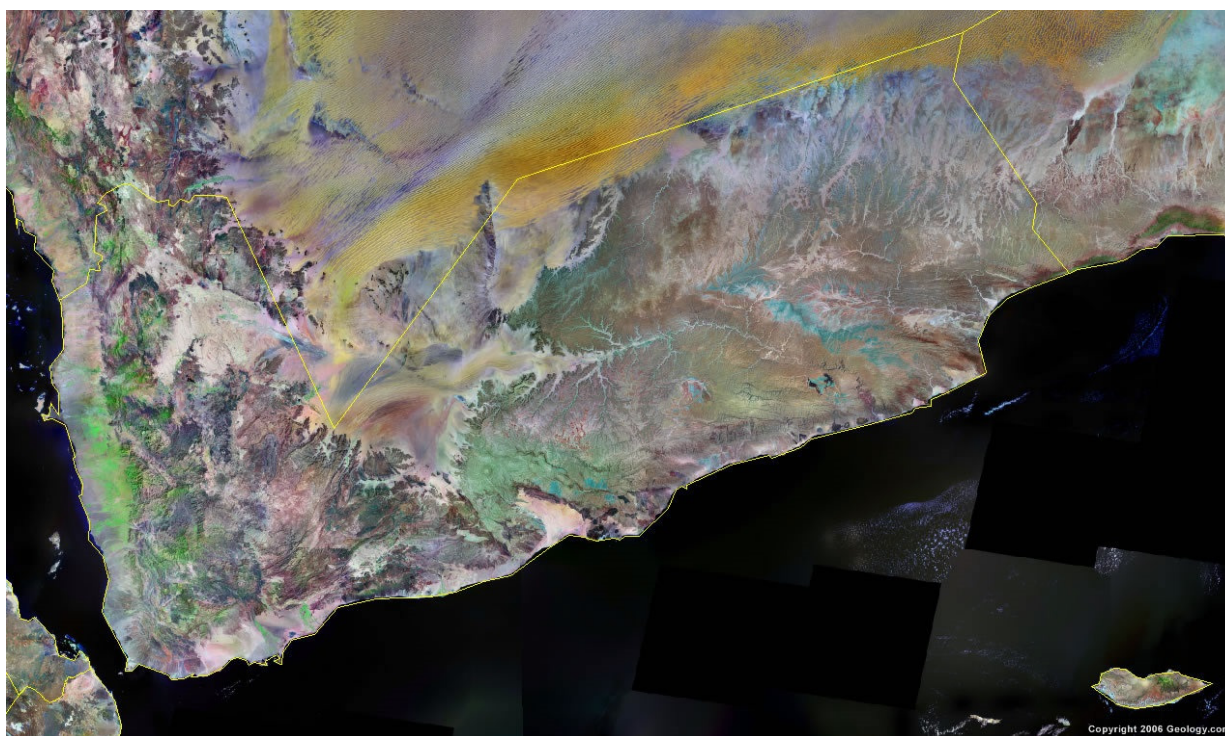


Figure-1
Location Map (source: UN Cartographic Section)

Options include: direct regulations, indirect regulations, whereby government introduces rules or incentives that influence the extraction behavior of individual well owners. Interventions through active involvement of government/public and community involvement in introducing conservations measures through irrigation efficiency, the complex redefining the structure of property rights within which private sector, the state and the community operate. Assessment of improvement of elements of good groundwater governance, through understanding of stakeholders interest and influence (power) distribution in water sector of Yemen.

Interviews/consultations with key stakeholders are carried out in relation to options/key patterns revealed by the content analysis. The options/ areas were analyzed by taking a critical look at current and past experience, projects and programs. The objective of the analysis was to identify the most promising options to deal with the major water challenges of protecting water sources and quality, and sector governance. Increase the chances of change passing successfully require understanding the likely affect on the political economy of a change which has considerable explanatory power about what will work what will not. Change also requires support from stakeholders and consequently attitude of various stakeholders toward reform has been assessed. Assessment of the twin motors of change are necessity and opportunity. The greatest change will happen when the problem is most pressing – as with groundwater overdraft – and when the time is right – as with a politically favorable conjuncture occasioned by a decisive moment. Opportunism can push difficult changes through. There is a certain “adaptive capacity” in every community, more or less pronounced and powerful. Understanding this adaptive capacity is the key to predicting and promoting change.

The paper presents a detailed discussion of each of possible options/model that can be a mean of intervention to prevent groundwater overexploitation and their respective advantages and shortcomings.

Results and Discussion

Current situation: Until recently, government policies have been promoting the rapid development of water resources and use. For example, public investment in water resources development, subsidies to private investment and use of water etc. Now, scarcity of water and economic crisis are forcing changes. The thinking on change began within Government in the early 1990's, driven by the emerging shortage of water and growing fiscal crisis. Attitudes of other stakeholders have been changing too. Where farmers previously looked on groundwater as a limitless bounty, they see now that further development of groundwater is a negative sum game. A typical user would wish to limit further extraction – provided that his own existing rights were assured. A keen constituency for groundwater recharge has emerged, driving the contentious small dams program. MAI's dams program has proved controversial both technically and

managerially. In some cases dams have had a palpable effect on groundwater, in other areas; they have proven to be white elephants⁶. A full evaluation of this poorly managed program is needed.

Important changes have occurred in the way in which the state's role in development is understood. There is no unanimity or homogeneity in this understanding, but the evidence shows that Yemen is moving away from planned subsidized regimes towards a revised model of development with more emphasis on partnership, user involvement, local initiative and sustainability. In both urban and rural supply and in irrigation, this is contributing to a more business-like approach to the financing and running of water projects. At the same time, the state's role in steering development for the benefit of the poor is clearer and non-market interventions have an increasingly pro-poor cast.

The natural resource constraint, the crisis in the public sector and the change in the view of the role of the state together are combining to move Yemen's water policy from its “unregulated development and expansion phase” to its “management phase” and from a preoccupation with supply alone to increased awareness of the need for demand management. This readiness to consider change has been slow to come in water management. Generally, this is consistent with experience in many countries where two to three decades have elapsed from the first sign of a problem in natural resource management to a final stage of effective and decisive action to deal with it. The slow and reluctant development of awareness in Yemen fits this global experience. Change has, however, been helped along by certain “decisive moments”. The “shock” of the Taiz water shortages in 1995 is one such decisive moment that accelerated Yemen along the policy curve, in that case acting as a driver of the urban water reform program.

An appraisal of the water law (existing model/situation) reflects that it represents one of those situations where the government essentially controls and regulates the use and extraction of groundwater; while private owners own and manage the wells. The government monitors and regulates the level of groundwater extraction through National Water Resources Authority, which in turn has the power to restrict construction of groundwater boreholes in any area, if considered necessary. In other words, government neither owns groundwater nor wells but uses regulations to limit the right to use and extract groundwater. Registration of existing wells, issuing permits for digging new wells and declaring an over-exploited area to be a ‘prohibited area’ are some of the provisions of groundwater legislations. While, the Water Law concentrate the power at the government level (i.e. NWRA), with little/no local involvement. Since the commencement of the water law, there has been practically very little progress in implementation of groundwater legislations in different areas. The reason could be lack of either effective implementation mechanisms due to lack of local involvement or the sensitivity of the government

attempting to regulate what for landowners, is essentially an open access resource.

Options (models): Direct Regulation: Water laws technically assessed for its completeness according to international principles for good water governance and do they address the main issues in an adequate manner to provide an effective regulatory framework for water resources management.

Direct governmental control on private uses of groundwater is followed to conserve groundwater resources. This is commonly done by limiting the digging of new wells in a particular zone; through imposing minimum spacing requirement between wells, licensing well digging, and forbid extraction of groundwater for irrigation in critical areas, where water table falls below a pre specified level, etc. However, the problem with such control procedures is that of enforcement. The high 'monitoring cost' and 'inefficient bureaucracy' make it difficult to organize a system of centralized control on groundwater extraction rate.

Regulations for minimum spacing between boreholes create and strengthen the power of existing owners of water extraction mechanisms protecting them from competition from other suppliers and keeping water prices higher than would otherwise be the case.

In practice, the actual effect of that is the mode of their enforcement is often inequitable and regressive. Spacing between wells when landholdings are small and fragmented, can deprive latecomers farmers who commonly with lower credit potential, when their proposed well come within the radius of influence of the existing well in an aquifer. For example, a proposed new borehole is not allowed within the command area of a supply borehole or existing borehole within the radius of 500m⁷.

The applicant for digging well is required to have the consent of neighboring well owners before license is provided. Furthermore, since the spacing standards do not apply to a borehole being located close to a dug well, they seek to protect resource rich early exploiters from late exploiters; but do not offer any protection to existing owners of dug wells who are usually poor. Precisely, spacing regulations, which have come in more recently, often serve to exclude the poor who are late entrants into the game. To add to this, since the standards are enforced through licensing boards, the well-off farmers who can dig their own well without license remain completely unaffected by them. Unofficial drilling wells are common and often quite high.

Indirect regulation: Government has removed some of the elements of the incentive framework that previously drove groundwater overdraft. Low cost credit and targeted loans are no longer available for groundwater development. Concerns regarding the unregulated groundwater resource use have prompted certain state governments to intervene in groundwater

management through certain indirect mechanisms. Some of the important indirect interventions to regulate groundwater use may include:

Water rates: "Theoretically, introduction of 'water rates' irrespective of the way in which water is extracted is the best form of indirect governmental regulation because it" ^{8,9,10} would induce farmers to economize water use. Therefore, changing the water rate could control the overall extraction rate of groundwater. This system is feasible when water extraction mechanisms are publicly owned, as it prevailed in China prior to the economic liberalization of the 1980s¹¹. However, when most water extraction mechanisms are privately owned, as in Yemen, Middle East and North Africa countries, collection of water rates is practically impossible because of the obvious problems of monitoring and the associated corruption.

Cropping patterns/prices: Cropping patterns depend on a wide range of factors, some of which can be influenced to discourage the more water intensive crops. However, in Yemen it is rather difficult to raise the support prices of water-intensive crops to conserve water because of political pressures. For, example Qat and banana cultivation can cause enormous damage to groundwater resources in areas of scarcity. Since, a tax on qat and banana would not be feasible, a more realistic measure could be to ban export of qat and banana in water-scarce areas, which in turn would curb qat and banana cultivation. Nevertheless, how pragmatic this policy could be needs a careful examination. If qat and banana export are banned, farmers could divert qat and banana to coffee and mango production as groundwater use is influenced by input output price ratio and relative profitability. Based on this argument, qat and banana cultivation under groundwater could be claimed to be a criminal waste of water.

Diesel pricing: It is commonly assumed to be a powerful measure of regulating groundwater use. The marginal cost of extraction is little under subsidized price and hence it creates strong incentives against conservation of groundwater. Increase price/remove subsidy by contrast, imposes a cost on every unit of water extracted and therefore induces farmers to economize water. However, subsidies diesel pricing is associated with certain distributional effects by enabling resource poor farmers to access the resource at a reduced cost. Poor urban supply also are to be affected by diesel price rise, as they buy water from private wells who expected to increase water price due to diesel price increase. Government has been reluctant to increase the diesel price to import equality levels, despite recognizing that cheap energy has played a role in driving groundwater overdraft. The last increase (in 1996) provoked riots and Government has considered that the political risk and the negative impact on other sectors of the economy outweigh the possible water conservation benefits. There is some empirical evidence that higher pumping costs push cropping patterns towards higher value crops. It is to be expected that if and when government implements diesel price increases, the farmer will

grow more qat as it seems that only qat will be able to pay the higher returns the farmers need if diesel prices rise. But there has been no measured impact on groundwater overdraft. Evidently, the price rise has been insufficient to reduce demand (diesel is still only a minor percentage of average production costs) and the diesel price is too blunt an instrument by itself to contain groundwater overdraft. It needs to be combined with other measures to increase water use efficiency and to get farmers to reduce pumping.

Incentives: Tangible incentives have proven more effective at influencing policy and behavior. Stakeholders both opposed to and supportive of groundwater extraction regularly engage in influence-peddling with government officials and community groups alike. Along with technical know-how, in fact, funds are the international donor community's most influential assets⁷. It has been suggested that refinement of the incentive structure is the most powerful influence on use of water in agriculture¹². The willingness to fund National Water Resources Authority, Water User Associations and other programmes, projects and institutions can provide a counter-balance for economic disparity, but not at a scale that can compete with the revenues generated by the production of bananas or qat.

Environmental opportunities: There is a strong general feeling that a growing number of stakeholders are considered to be changing their position from opposition to support for controlling groundwater extraction, for instance, because of the worsen of the situation. That is, over limits of safe yield of the groundwater are reached, the water table drops even beyond the reach of most deep wells. The 1996 Taiz incident and other water shortages accelerated the policy curve, in that case acting as a driver of the urban water reform program¹³. Faced with the option to continue unsustainable pumping activities, even the powerful irrigators and authorities may become more receptive to the water conservation plans promoted by the National Water Resources Authority.

Political opportunities also exist, particularly with Arab Spring movements. Large part of the people starts to participate and show eager to participate in many public activities call for improvement of way of life and resources conservation of the country. Managing water resources which are a life threaten to people and the country would have a sound for people to be active in this aspect. These open and shut for stakeholder groups both opposed to and supportive of water demand management, preceding and following election campaigns or other types of regime change. The burden of change in promoting and implementation of control of groundwater extraction will rests largely on the shoulders of youth who started the Arab Spring and seen as an stake for big farmers and stakeholders etc.

Adaptive capacity: Several communities in Yemen are coping admirably with their diminishing springs⁷. 'In social science terms, they retain a strong adaptive capacity, defined as the sum of social resources available to counter an increasing natural

resource scarcity. Developing coping mechanisms at the community level is a step in the right direction'. However, coping mechanisms will not be enough to solve Yemen's water crisis. The structural problems among them, the draining of aquifers to irrigate fields of cash crops must be addressed. Yemen needs to demonstrate adaptive capacity at the national level. A national debate on water was undertaken during 2010, involving top decision makers. This conference had been crucial test of political will. Although it concludes with clear messages/decisions regarding control of water, enforcement/implementation is the common problem.

Administrative, Legal and organizational issues: After almost a decade of sporadic reform in the water sector, Government had passed a broad water law in 2003, and grouped all water institutions, with the exception of irrigation and watershed management functions, under a single ministry, The Ministry of Water and Environment (MWE). The National Water Resource Authority (NWRA) of MWE is tasked with issuing licenses for water wells and enforcing the water laws. However, NWRA's lowly status among Yemen's central institutions reflects the lack of top-level recognition that secure water supplies underpin the country's future stability³. The situation in Yemen is striking as the National Water Resources Authority is effectively alone in challenging established water use pattern which benefits the farmer sheikhs, large landowners and the Ministry of Agriculture and Irrigation.

Traditional tribal structures, relatively young ministries following the 1960s revolution and unification in 1990, and remaining internal political tensions suggest that governance of the water sector is a significant challenge throughout the country¹⁴. International experience shows that recovering control of groundwater is difficult and Yemen is very poorly placed. Control of groundwater is a multi-faceted environmental problem of considerable complexity. To facilitate the introduction of controlling measures it will be essential for NWRA to establish inters-sectorial cooperation and good relationships with groundwater users, since this will be essential during the negotiation process. It is also important that NWRA tries to reach a reasonable balance between economic development and conservation of groundwater resources. The preferred administrative arrangement for the promotion of groundwater control policy/law is for the resource over exploitation control function to be concentrated in a single regulatory agency, operating on a decentralized basis and supported by adequate legal powers. Other options are possible, and can be equally efficient, given the will and the commitment of adequate human resources.

Improving groundwater governance: When "elements of good groundwater governance" drawn from worldwide experience compared with situation in Yemen, it is clear that, at present, Yemen fulfils little to none of the basic conditions for groundwater governance table-1.

Table-1
Situation of groundwater governance

Elements of good groundwater governance	exist in Yemen	easy to introduce
1. strong government commitment	Yes	Moderate
2. intensive user involvement	NO	Moderate
3. knowledge of hydrogeology and monitoring	NO	Moderate
4 legal framework with equitable allocations and registered entitlements	NO	Hard
5. Regulations and institutions to manage abstractions at both governmental and user level	NO	Hard
6. Dispute resolution with peer-level enforcement	NO	Hard
7. conducive incentive framework	NO	Hard
8. education and public information programs	NO	Moderate
9. technological improvements	NO	Easy

Observations drawn regarding satisfying conditions of the above mentioned elements in Yemen are: It has been observed that government is increasingly committed but this being subject to political constraints. Water user Associations are starting through international donor support have had limited successes locally, however scaling up could be arduous, as observed with little or no effect at the national level.

Poor past experience regarding knowledge of hydrogeology and monitoring is observed, this necessitates NWRA to be energetic. NWRA's past experience toward education/awareness campaign was not convincing too⁵.

Needs of community institution and good local governance are required for four basic elements of groundwater governance include: implementation of the existing water law, regulations and institution to manage abstractions at both governmental and user level; dispute resolution with peer-level enforcement with historic tradition requires adaptation; and water markets that value water at opportunity cost of water which also requires clear water rights.

Past programs like LWCP have shown feasibility and some impact in regard to technological improvements, but have been

more focused on physical conveyance than on-farm water use efficiency. Finally, Yemen experiences show great difficulty in "getting the prices right" which hinder application of conducive incentive framework.

Based on easiness to introduce, five elements show moderately to start with and include: i. Strong government commitment, ii. intensive user involvement, iii. knowledge of hydrogeology and monitoring, iv. education and public information programs, v. technological improvements.

Catering for stakeholders interests: The attitude toward controlling groundwater extraction varies between different stakeholders. This means that understanding interests and influential power is crucial to the task of interpreting resistance to changes in groundwater extraction policy. Stakeholders in water include political leaders and parliamentarians, ministry of agriculture and irrigation, ministry of water and environment, local government, traditional leaders, NGOs, the private sector, the media, farmers and domestic water users. Table (2) gives a brief characterization of these stakeholders. Their relative influence toward and/or against implementation of groundwater extraction policy is discussed below. As Yemen remains dependent on external support, donors are also stakeholders. Donors are powerful agents for change because of their investment resources and the accompanying ability to influence what the Government does.

Table-2
Water Sector Stakeholders - Their Interests and Attitude to control groundwater extraction

The stakeholders	Vested interest	General stance
political leaders	Patronage risk aversion	Anti
MWE/NWRA	pro-poor development mandate	Pro
MAI	development mandate	Anti
Parliament	pro-poor development mandate patronage populism	Anti
Sheikhs and Ulama	Authority derived from status quo	Anti
local government	local development mandate	Pro
NGOs	public interest, Ethical motivations	Pro
private sector	profit motive	Pro
large farmers	water rights (to lose)	Anti
small farmers	water rights (to gain)	Pro

Discussing the dynamics between these stakeholders, it is noting for instance that the resistance to control groundwater extraction comes from the potential losers from the changes. The politically powerful, the tribal leaders and a large number of

farmers with access to capital gained from unregulated groundwater development and cash crop production. By contrast, poorer farmers and the rural landless did not benefit. In general, the small farmers have less influence over water use than do the wealthier and politically-connected farmer sheikhs, but there are substantial shades worth exploring.

The primary state authority resisting attempts at water control is the Ministry of Agriculture and Irrigation. At least until the updated 2010 Sector Strategy (NWSSIP), the Ministry of Agriculture and Irrigation looked upon the Ministry of Water and Environment 'as a menace to its power', and officials have openly discredited the NWSSIP. Resentment is also sensed through inequitable budgets. Agriculture uses about 86% of water has only 8% of the NWSSIP budget¹³. It is required from this ministry is to cooperate with MWE, more involvement in dialogue, commitment, appropriate decisions and actions.

The wealthy landowners and 'farmer sheikhs' benefitting directly from current water use practice are considered to be both the most opposed to control groundwater extraction and the most influential over actual water use. It is required from this group adoption of difficult adjustments and change of water use behavior. This may be achieved through public awareness, changes in incentives, support projects and programs and establishment of water users associations.

A primary policy instrument employed by the Ministry of Water and Environment to control water use has been the 2005-2009 National Water Sector Strategy and Investment Programme (NWSSIP), and its update in 2010. The strategy lists as one of its guiding social and economic principles that 'water supply concerns are to be balanced by demand management measures, including the use of economic incentives to reduce the demand'¹⁵. The National Water Resources Authority is judged to be very centralized and topped by a rather inert headquarter with lack of management vision or capability¹³. The ministry is considered to have generally low implementation capacity and bargaining power when faced with better-established ministries which enjoy more political clout¹⁶. Efforts to implement the water controlling strategy are led by the National Water Resources Authority, a Ministry of Water and Environment agency not any more financially dependent on donors (World Bank and the Dutch government), which further complicate carrying out their mandate. Capacity building, improve wages, etc. are needed. It is required from MWE is more commitment, decisions and actions. To achieve better results it is recommended to undertake sector analysis, workshops, projects, adjustment operation and Economic Development Investment (EDI) programs.

The 'parliamentarians' group has been considered by and large a positive force (through the Water and Environmental Committee) for reform of agricultural water¹³. This is in contrast to what has been reported as anti reform due to their vested interest which pro-poor development mandate and patronage

populism⁵. It is understood for this group to derive its power from legitimacy granted by people who are largely controlled by their tribe leaders/sheikhs who gave support to those parliamentarians during election. It is required of this group more commitment, leadership, laws. This could be facilitating through seminars, discussions, EDI programs.

Understanding of influence (power) in the water sector of Yemen: The difference in the influential toward groundwater extraction policy or implementation between those opposed to and those supportive is clear. The burden of overcoming inertia to change is thus carried by 'weaker' stakeholders with an interest in the principles of water demand management – namely the National Water Resources Authority, NGOs, local government, private sector, small farmers and the international donor community. Should it be taken on at all, part of the burden involves confronting a variety of forms of power used to maintain the status quo.

The use of firearms as restraint power in the water sector may be nowhere more obvious than in Yemen^{17, 18}. As an example, several people were killed in 1997 at Jabel Sabr in fighting between villages over the effects of a water development project¹⁹. Similar fighting in the same place occurred in 2014, too. Stakeholders in the agricultural sectors of Yemen use multiple manifestations of both hard and "soft" power, often in combination. The opposition of sheikhs and landowners to control extraction groundwater is obvious in discreet ways in non-compliance, or in cornering large shares of publicly subsidized programs²⁰. In addition, the wealthy farmers have the ability to drill wells and to bribe officials/police to bypass the law.

The general failure of the first NWSSIP is attributed to the fact that it avoided debate with the Ministry of Agriculture by ignoring it outright. The Ministry of Agriculture had little incentive to commit to the new policy as there is nothing to gain in return. The influence of newly formed governmental institutions such as the National Water Resources Authority (and, especially, Water Users Associations (WUAs) did not help. The influence power of NWRA and WUAs may remain limited until they 'prove' themselves to be technically and organizationally competent, and build legitimacy in the eyes of those they are attempting to regulate¹⁶. WUAs can be empowered through community interest way; at least, they can inform the NWRA of any illegal drilling. But the NWRA cannot enforce regulation, although it is supported by the Water Law. NWRA staffs are obliged to interpret or misrepresent the law in order to stop drilling¹³. It should be noted that in one group one can find some individual of support for and opposition to control groundwater extraction. This indicates a difference of opinion of individual within a group following certain believes or needs.

Public sector involvement (irrigation systems): A major instrument of public policy – irrigation system program which is

devised originally to improve irrigation efficiency and save groundwater extraction. This is in favor of irrigation systems considered as an institutional alternative, however, loses much of; its relevance in view of their incompatibility on technical grounds. Surface water needs to be considered a part from groundwater since promoting the former is one possible way to protect the latter²¹. Alderwish²² argues that wisdom lies in paying more attention to the development of surface irrigation works, so that a sizeable fraction of surface water ends up in the groundwater table. Water use efficiency technology is accepted by farmers (especially if subsidized) but in the absence of water rights and regulation has a modest impact on groundwater use, as some farmers simply expand their cropped area. Moreover, allocating large investment (capital) to secure providing sprinklers etc. to increase efficiency of irrigation should be assessed, given that 30- 40% of water applied in irrigation return to the aquifer²³. In other word, the amount of irrigation return to aquifers may obviate the need for physical or infrastructure investments.

This makes prospects of real impact on groundwater overdraft remain modest until detailed investigation is undertaken to assess the actual benefit of using irrigation techniques from different perspectives. Water conservation techniques have been tried and tested but the institutional framework that will encourage farmers to reduce water use has not been developed. In the meantime, groundwater mining has continued apace.

Factors and Risks Affecting Success: Serious effort is required for control of groundwater extraction since most water users believe they have a right to use (and waste) water freely, without appreciating the impacts of wasteful water use on society and the environment.

Education should change attitudes in the long term and communication campaigns are needed to change short-term behavior on water saving.

The chances of any program/option being effective are raised by the strategic and selective nature of the proposed action plan

Amongst risks the greatest is that political will may fade: Difficult changes will be required on the incentive framework (for groundwater management), on cost recovery (for water supply and irrigation) and on water rights and markets (for rural/urban transfer). Political robustness, and sheer stamina, will be essential. Failure of political will on these issues will entail continued groundwater overdraft, weakened service delivery, and worsening rural/urban tussles over water. What is needed is sustained dialogue and education at every level, phasing that respects the political economy constraints, and feedback from success, so that politicians have some benefits to show.

The other major risk is weak governance and implementation: Yemen's public sector shows "institutional

weakness" at every level. The risk from weak public sector institutions and the Government's feeble control over events on the ground has been discussed above. The mitigation measures are clear: decentralization, participation, partnerships, all designed to increase the role of civil society and markets as a substitute for the weakness of the public sector.

Habits will have to change: the groundwater problem can only be tackled if full responsibility is passed to local communities – regulation simply cannot work in Yemen, at least in the short to medium terms. Similarly, the proposals for restructuring rural water must minimize the public sector role. Otherwise, if an illusory reliance is placed on the public administration, sector performance will not improve. Government and donors will need to be clear in their analysis and firm in their decisions.

The challenge of public administration and the alternative options available to building institutional capacity in the Government of Yemen's (GOY's) agencies: The public sector managing water in Yemen is still widely dysfunctional. Implementation of the ongoing decentralization agenda will help, as Government progressively divests itself of its service delivery functions. Some other problems can be mitigated by working around government, but for essential public sector functions a concerted effort is needed to build capacity for core tasks.

Following the 2003 reorganization of the water sector, a new strategic focus means that clear water policy and strategy have an exceptional chance of influencing what happens on the ground, and the completion of the ongoing strategic exercises is therefore top priority. Similarly, public expenditure review and donor coordination in the current climate are likely to be productive. National debate and actions on groundwater overdraft should be continued . . . as should actions on sector policy and strategy formulation, and financial resource allocation. Finally the groundwater problem can only be tackled if full responsibility is passed to local communities.

Conclusion

Efforts to reduce water use are a direct challenging to the interests invested in the established political economy. Yet managing water demand remains the single most effective way of ensuring sustainable water use. Direct regulation can only be effective if the agency involved has enforcement capacity and the regulations are regarded by the regulated and the general public as necessary and appropriate. Over-stringent regulations which impose high costs on the regulated can lead to noncompliance or evasion, so undermining the whole regulatory endeavor.

Collection of water rates is practically impossible in Yemen, Middle East in Yemen and North Africa countries because of the obvious problems of monitoring and the associated corruption.

Under scarcity of water resources, qat and banana cultivation under groundwater could be claimed to be a criminal waste of water.

Controlling diesel price needs to be combined with other measures to increase water use efficiency and to get farmers to reduce pumping. The Yemeni political class will need to place a high priority on the development of viable alternatives to agriculture in order to prevent the country from slipping into catastrophe.

To improve the basic conditions for groundwater governance in Yemen and based on *easiness to introduce, five elements show moderately to start with and include: i. Strong government commitment, ii. intensive user involvement, iii. knowledge of hydrogeology and monitoring, iv. education and public information programs, v. technological improvements.*

Discussing the dynamics between stakeholders, the resistance to control groundwater extraction comes from the potential losers from the changes. The politically powerful, the tribal leaders and a large number of farmers with access to capital gained from unregulated groundwater development and cash crop production.

The amount of irrigation return to aquifers may obviate the need for physical or infrastructure investments. This makes prospects of real impact on groundwater overdraft remain modest until detailed investigation is undertaken to assess the actual benefit of using irrigation techniques from different perspectives. Water conservation techniques have been tried and tested but the institutional framework that will encourage farmers to reduce water use has not been developed. In the meantime, groundwater mining has continued apace.

Amongst risks the greatest is that political will may fade; weak governance and implementation. The challenge of public administration and the alternative options available to building institutional capacity in the Government of Yemen's (GOY's) agencies.

The review of experience suggests that many of the reforms started in the mid-1990s should be pursued but with varying emphasis and correction. Among the "high potential activities", promoting national debate is a slow maturing, unseen investment that is well worth pursuing. It represents the best hope for getting acceptance of real change in the incentive structure, a necessary condition for reining in groundwater overdraft. Water conservation programs for agriculture and the package of "decentralization, community partnership and self-regulation" have a vital role to play here too. Taken together, these actions, if vigorously applied, give some hope of delaying resource depletion. So these can be viewed as an exercise to allow Yemen time to develop patterns of economic activity less dependent on water mining.

References

1. Carapico S., 'Elections & Mass Politics in Yemen', *Middle East Report*, November–December 1993, Yemen became the first country in the Arabian Peninsula to introduce universal suffrage for multi-party parliamentary elections (1993)
2. OECD, Organization for Economic Cooperation and Development, *Whole-of-Government Approaches on Fragile States* (2006)
3. World Bank, Yemen Economic Update, Summer 2008, http://siteresources.worldbank.org/INTYEMEN/Resources/310077-1098870168865/YEU_Summer08.pdf. (2008)
4. Gabbrielli E., IWRM ToolBox Version 2, www.gwpforum.org, (2010)
5. World Bank, Country Water Resources Assistance Strategies (CWRAS), Report No.: 31779-YEM Water, Environment, Social and Rural Development Department Middle East and North Africa Region (2005)
6. Alderwish A.M., Integrated Water Management for Small Catchments in Arid Mountainous Region – Yemen, *International Journal of Energy, Environment, and Economics*, **19(6)**, 699-716, Nova Science Publishers, Inc. N.Y. USA. (2011)
7. Alderwish A.M., Review of Yemen's Water Law and Bylaws, Focus on Control of Random Water Well Drilling, Final Report, Research Triangle Institute, RTI international. USAID, Yemen (2012a)
8. Dhawan B.D., Groundwater markets: A critique, comments prepared for Indian Society for Agricultural Economics meetings, New Delhi, Mimeo, Institute for Economic Growth (1991)
9. Sengupta N., Irrigation: Traditional vs. Modern, *Economic and Political Weekly*, 20(45-47), Special number (November 1985) (1985)
10. Shah T., Efficiency and Equity Impacts of groundwater markets: A review of issues, evidence and policies, Research paper, Institute for Rural Management Anand, Gujarat, India (1989)
11. Kramer R.A., Groundwater management in China: Economic and Institutional issues, Institute for Rural Management, Anand, Gujarat (1989)
12. Ward C., Coping with water scarcity in Yemen: conflict and adaptation *Coping with Scarcity* World Bank, Washington DC (2005)
13. Ward C., Beddies S., Hariri K., Yaffiei S.O., Sahooley A. and Gerhager B., *Yemen's water sector reform program – a poverty and social impact analysis* Republic of Yemen, GTZ, World Bank, Washington DC (2007)

14. Negenman T., Evolution of water resources management in Yemen in **ILRI ed *Groundwater management: sharing responsibility for an open access resource – lessons from developing countries*** ILRI, Netherlands 65–80 (1996)
15. NWSSIP, *National water sector strategy and investment programme, 2005–2009* Republic of Yemen, Ministry of Water and Environment Final draft 17 December (2008)
16. Zeitoun M., Allan T., AlAulaqi N., Jabarin A. and Laamranis H., Water demand management in Yemen and Jordan: addressing power and interests, *The Geographical Journal*, **178(1)**, 54–66, doi: 10.1111/j.1475-4959.2011.00420.x (2012)
17. Handley C.D., Water stress: some symptoms and causes: a case study of Taiz, Yemen Ashgate, Aldershot (2001)
18. Lichtentahler G., Political ecology and the role of water: environment, society and economy in northern Yemen Ashgate, Aldershot (2002)
19. Ward C., Water conflict in Yemen: the case for strengthening local resolution mechanisms in Jagannathan V N, Mohamed A S and Kremer A eds *Water in the Arab world: management perspectives and innovations* The International Bank of Reconstruction and Development/The World Bank, Washington DC 233–67 (2009)
20. Ward C. and al-Aulaqi N., Yemen – issues in decentralized water management WaDImena Research Study, 5 August International Development Research Council –WaDImena project, Amman (2008)
21. Dhawan B.D., Management of groundwater resources; Direct versus indirect regulatory mechanisms, *Economic and Political Weekly*, 5-12 September (1987)
22. Alderwish A.M., Review the practical feasibility of prepared options for revising water management practices in the Sana’a Basin to increase the availability of water supply to Sana’a City Study, Final Report, Research Triangle Institute, RTI international, Research Triangle Park, NC 27709. USA (2012b)
23. Alderwish A.M., Estimation of groundwater recharge in aquifer of Sana’a Basin, unpublished PhD thesis, London University, UK (1996)